MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.
Director

BULLETIN 53

CLAY COUNTY

GEOLOGY
By
HARLAN RICHARD BERGQUIST, Ph.D.

TESTS
By
THOMAS EDWIN McCUTCHEON, B.S., Cer. Engr.

FOSSILS
By
VIRGINIA HARRIETT KLINE, Ph.D.

UNIVERSITY, MISSISSIPPI
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Prepared in cooperation with the Clay County citizens and the WPA as a report on O.P. 65-1-62-137.

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MISSISSIPPI GEOLOGICAL SURVEY

LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
March 11, 1943

To His Excellency,
Governor Paul Burney Johnson, Chairman, and
Members of the Geological Commission

Gentlemen:

Herewith is Bulletin 53, Clay County Geology, Tests, Fossils, which is published as a fulfillment in part of the sponsorshsip pledge necessary to obtain Federal WPA funds for the various county geologic mineral surveys of the State.

In addition to the usual Geology part by Dr. Harlan R. Bergquist and the usual Tests part by Mr. Thomas E. McCutcheon, the bulletin contains a Fossils part by Dr. Virginia H. Kline — a marked departure from the previous county reports except the one by Dr. Bergquist on Scott County which contains a "Fossils" part on the Foraminifera and Ostracoda of the Jackson formation which has been enthusiastically received by the many professional geologists of the various oil companies that are spending millions in developing the oil resources of the State.

For the benefit of those citizens not engaged in geologic work, it should be stated that Foraminifera are single-celled animals, most of which have limy shells about the size of the lead point of a pencil — so small in fact that thousands of them may be contained in one cup of sand from a drilling well. Whereas the larger fossil shells are practically all broken by the drill into bits too small for identification, the small foraminifera shells reach the surface unscathed. By studying these forms and especially by determining their vertical (stratigraphic) range, the few geologists so trained can determine the age of the formations in which the forams are embedded. By correlating these formations from place to place the "micro" paleontologist is able to locate structures favorable for oil and gas accumulations — just as Frederic F. Mellen was able to do by means of larger fossil shells in the surface beds in the Tinsley Dome. Thus no sooner is the result of pure scientific research published to the world than it is used in economic development.

The bulletin describes the Pheba Structure in the southwestern part of the county and a less definite structure in the northern part of the county — both small. Not only so, but the series of Coastal Plain beds involved in the deformation is thin, shallow, and fresh-water bearing. Despite these adverse conditions, the presence of bitumen-bearing Paleozoic rocks in northeastern Mississippi and adjoining Alabama, as described in Bulletin 23 by the present State Geologist, should not be overlooked, for these two small Clay County structures may reflect structures in deeper Paleozoic beds that may have served to trap some of the oil while so much of it was escaping toward the northeast.

The report by Mellen on Mississippi Agricultural Limestone and the present bulletin reveal a belt of the upper Demopolis member of the Selma chalk in central Clay County suitable for agricultural purposes, the area east of Cedarbluff having chalk that runs as high as 87 percent calcium carbonate ($CaCO_3$). Even lower grade chalk elsewhere could be used on the local farms with profit.

Natural cement can be made from the lower Selma chalk and the Demopolis member as well as from the Prairie Bluff. And mineral wool can be manufactured from the lower Selma, the Prairie Bluff, the Clayton, and the basal calcareous Porters Creek clay. Gravel for local use is already being produced from a terrace deposit at Waverly.

The Tests part of the report shows that the Porters Creek clay in the western part of the county would make both face brick and common brick. One sample (M35-2) of a terrace deposit some 5 miles northeast of West Point revealed exceptional properties — a clay suited for making high grade red face brick, hollow structural tile, roofing tile, fire proofing, flower pots, and drain tile.

Although material suitable for the manufacture of Portland cement is available according to Ceramist McCutcheon, he is of the opinion that the manufacture of natural cement would be the more profitable procedure. He recommends an appropriation to the State Geological Survey for the erection of a pilot plant for manufacturing trials, and the construction of strips of roadway for testing such natural cement beneath an asphalt or tar surface. The raw material has a great vertical (stratigraphic) range in the Selma chalk and the Prairie Bluff chalk, and a wide horizontal (geographic) range in the county.

Material suitable for the manufacture of mineral wool likewise has a great vertical range — from the lower Selma chalk through the Clayton to the Porters Creek — and likewise a wide geographic range in the county.

As in the geological surveys of the mineral resources of the other counties, the Mississippi State Geological Survey acknowledges the cooperation of both the WPA and the Clay County Board of Supervisors in supplying additional funds. Special credit must be given Mr. Howard Coleman, Deputy Chancery Clerk, and Mr. Sam Dexter, Secretary of the West Point Chamber of Commerce, as well as other members of the Chamber, not to mention the support of many other good citizens of Clay County.

Very sincerely yours,

William Clifford Morse,

State Geologist and Director

CONTENTS

CLAY COUNTY GEOLOGY

Page

Introduction 11

Climate and agriculture 12

Physiography 13

Stratigraphy 14

Mesozoic group — Upper Cretaceous system — Gulf series 14

Eutaw formation — Tombigbee sand member 14

Selma chalk 18

Lower chalk member 21

Arcola limestone member 22

Demopolis member 26

Ripley formation 31

Prairie Bluff chalk 36

Cenozoic group — Paleocene system — Midway series 43

Clayton formation 43

Porters Creek clay 45

Cenozoic group — Pliocene, Pleistocene, and Recent 50

Pleistocene and Pliocene ? Terraces 50

Alluvium 50

Structural geology 51

Pheba structure 51

Northern Clay County structure 53

Economic geology 54

Agricultural lime 54

Lime products 56

Page

Brick and tile clays 57

Gravel 57

Sections and test hole records 58

Acknowledgments 70

References 70

CLAY COUNTY TESTS

Introduction 72

Clays 73

Physical properties in the unburned state 73

Screen analyses 73

Chemical analyses 75

Pyro-physical properties 76

Possibilities for utilization 77

Chalk and limestone 79

Chemical analyses 79

Chemical analyses, calcined basis 80

Possibilities for utilization 81

Laboratory procedure 83

Preparation 83

Forming of test pieces 83

Plastic, dry, and working properties 83

Fired properties 84

Screen analyses 84

Chemical analyses 85

Page

Conversion table 87

Sections and test hole references.......................... 88

Index 89

CLAY COUNTY FOSSILS*

Introduction 5

Stratigraphy 5

Description of Foraminifera 13

Description of Ostracoda 64

Logs and locations of test holes 72

Plates and explanations 79

Index 97

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*Inasmuch as additional copies of the "Clay County Fossils" part of this report are being printed separately for inclusion, in the years to come, in a combined volume on fossils, the pages of this part are numbered separately. Any workers especially interested in fossils may obtain a copy of this part on request.

ILLUSTRATIONS

Page

Figure 1.—Location of Clay County............................ 11

Figure 2.—Indurated concretionary ledge in basal Tombigbee sand of the Eutaw formation, Bartons Bluff........................ 16

Figure 3.—Arcola limestone overlying upper strata of the lower Selma chalk 22

Figure 4.—Two thin beds of Arcola limestone separated by a layer of Selma chalk 23

Figure 5.—Weathered Arcola limestone ledge.................. 25

Figure 6.—Upper Demopolis chalk bald spots in northern Clay County 26

Figure 7.—Gullied upper Demopolis chalk...................... 27

Figure 8.—Gullies in lower Demopolis member of the Selma chalk.. 27

Figure 9.—Large valves of *Gryphaea mutabilis* Morton and *Exogyra costata* Say 31

Figure 10.—Basal Ripley silty clays.......................... 33

Figure 11.—Disconformable contact of the Prairie Bluff arenaceous chalk above and cross-bedded white micaceous sand of the Ripley formation below 34

Figure 12.—Disconformable contact of Clayton formation above and Prairie Bluff chalk below................................ 40

Figure 13.—Characteristic Pleistocene terrace gravels............ 57

Figure 14.—Pheba structure 52

Map 1.—Geologic map of Clay County........................Back

Plates I to VII.—Midway Foraminifera.......................... 81

Plate VIII.—Midway Ostracoda 95

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CLAY COUNTY GEOLOGY

HARLAN RICHARD BERGQUIST, PH.D.

INTRODUCTION

In 1871 an irregular-shaped area of 408 square miles was organized into a new county from parts of Lowndes, Webster, Chickasaw, Monroe, and Oktibbeha Counties. At first this was known as Colfax County, but the name was later changed to Clay. Two governmental surveys, begun from different base lines, converged on this county from the north and south, resulting in an abrupt change in the numbering of sections, townships, and ranges along the old Choctaw-Chickasaw boundary line in the west and along Line Creek and Tibbee Creek in the south.

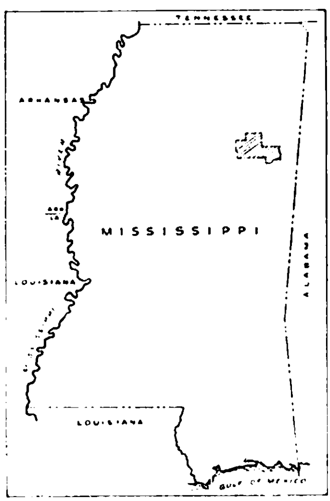

Figure 1.—Location of Clay County.

Clay County is located in the northeastern part of the state. Its eastern boundary along the Tombigbee River, is 15 miles west of the Alabama state line, its western boundary is about 130 miles east of the Mississippi River; its northernmost part lies 80 miles south of the Tennessee line.

Along the southern part, the county is 31 miles east and west, and through a point 3 miles west of West Point its greatest north and south length is 17 miles.

Three railroads, the Illinois Central, the Southern, and the Gulf, Mobile, and Ohio, provide transportation for the eastern and southern portions of the county and intersect in West Point, the county seat and largest populated center. One main trunk line of pavement, through West Point, crosses the county from north to south, and three gravelled state highways connect the various distant parts of the county to the eastern industrial area. A network of improved secondary roads reaches outlying points in the county.

Population has not changed greatly during this century. The census of 1900 listed 19,560 people; that of 1920 gave 17,490; and that of 1940, 19,005. There has been a slight decline in the percentage of negroes, however, for the 1940 census lists 60 percent negro, whereas in 1900 nearly 70 percent were colored. In the county are 54 public schools for negroes and two denominational colleges. Five large consolidated schools and two smaller ones provide for the white children.

Clay County was the first county in the state to benefit from rural communication by the extension of lines of the Southern Bell Telephone Company to every rural community. An additional 110 miles of forestry telephone lines are under construction. T.V.A. electrical power is available to every home in the county at a reasonable rate, and home electrification is common on many farms.

CLIMATE AND AGRICULTURE

A mean maximum temperature of 74.3 degrees and a mean annual temperature of 52.6 degrees are recorded for Clay County. Although daytime summer heat may be uncomfortable, the evening atmospheric radiation is rapid, and the night temperatures are usually cool. Annual rainfall averages about 50 inches. Winters are short and mild, and the growing season is over seven months duration. The first killing frost may be expected around November 1 or shortly after that date, and the last freezing dangers about March 25.

Although considerable cotton and other agricultural products are grown in the county, the production of cotton has been declining in recent years, largely due to the ravages of the boll weevil. An increase in cattle raising is rapidly changing the county to a dairy center. Beef cattle are also raised. A packing plant is located at West Point.

Since 1940 the county has been under protection of the Mississippi Forestry Service. The loss of timberland by fire was reduced about 75 percent the first year. Some lumbering is still conducted, but it is of lesser importance than agriculture and grazing.

PHYSIOGRAPHY

Except for the extreme eastern and western parts, most of the county lies within the Black Prairie belt developed from Upper Cretaceous chalks. The eastern area of 2 or 3 miles adjacent to the Tombigbee River is composed of ferruginous red sandy hills of the Eutaw formation; in the extreme western part of the county a gently undulating to slightly wooded plain known as Flatwoods has been developed on the calcareous and micaceous Porters Creek clay. This belt is 4 or 5 miles wide and extends laterally into Webster County.

An extension of the Pontotoc Hills forms a belt 3 to 5 miles in width between the Flatwoods and the prairie lands. Though composed mainly of Ripley sands and clays, some Prairie Bluff chalk and basal Midway materials form the western portion. The hills rise gently 50 or 60 feet above the valleys on the western side but are steeper on the east where the valleys are narrower. Altitudes are about 350 feet in the south and about a hundred feet higher in the northern part of the belt in the portion known as the Kilgore Hills. Erosion has formed deep gullies in the red sand formation, producing lands of poor agricultural value.

Extensive prairie areas have been developed from the Selma chalk. In the eastern part, a silty dark-brown to black calcareous residual soil has formed on the lower Selma chalk and the lower part of what is termed the Demopolis or upper division. In the west-central part of the county the regolith is thin, and vast bald white areas are conspicuous on the prairie lands of the Demopolis.

Broad alluvial-filled bottomlands of high fertility border the streams. Extensive remnants of Pleistocene terraces form low hills and ridges north of Tibbee and Line Creeks, and lesser terrace deposits lie along the Sakatonchee River.

The drainage is southeasterly into the Tombigbee River from Sakatonchee River and Tibbee, Line, and Houlka Creeks and their tributaries. To this system of drainage several canals have been added in the north-central and western portions of the county, where drainage projects have been instigated to enhance the agricultural value of lowland areas and lessen the damage of overflows. In the northwest part of the county a small northwest-southeast divide controls the drainage of the tributaries of Line Creek and Sakatonchee River.

STRATIGRAPHY

All the strata exposed in Clay County belong to the Upper Cretaceous and Paleocene. The succession of several hundred feet of sediments is entirely of marine materials, though lithologic differences yield different formations; and an interval of erosion gives a break in deposition between the Cretaceous and younger sediments. The formations strike northwest-southeast in the southern part, but in most of the county a general north-south strike prevails. An average general westerly regional dip of about 30 feet to the mile prevails over considerable areas, but locally flattening and folding have altered this average.

MESOZOIC GROUP—UPPER CRETACEOUS SYSTEM—GULF SERIES

EUTAW FORMATION — TOMBIGBEE SAND MEMBER

The oldest stratigraphic unit in the county is the Eutaw formation represented chiefly by the Tombigbee sand member exposed along bluffs of the Tombigbee River and in the rolling hills for 2 or 3 miles to the west. Most surface exposures show the material to be a micaceous somewhat fossiliferous ferruginous tan to reddish-brown sand and sandy clay, in places retaining a greenish cast due to the presence of some unaltered glauconite. The belt of outcrop is a poor agricultural area, and erosion has tended to make some of it unfit for cultivation. Pleistocene terrace sands and gravels cover part of the area adjacent to the river in the vicinity of Waverly, and extensive alluvium covers the bottomlands.

GENERALIZED SECTION OF EXPOSED FORMATIONS IN CLAY COUNTY

Group	System (Series)	Formation	Zone	Member or Phase	CHARACTER	Maximum Thickness
CENOZOIC	Recent			Alluvium	Sand, silt, and gravel along bottomlands and floodplains of streams crossing county.	10
	Pleistocene and Pliocene?			Terraces	Stream deposits of sand and clay in successive terraces above floodplains in eastern and central portion of county; gravel lenses along Tombigbee River.	20
	PALEOCENE (Midway)	Porters Creek clay			Smooth tough somewhat waxy tan to black jointed clays which fracture conchoidally; at intervals laminated or bedded with micaceous silt; scattered foraminifera and mollusk shells in lower part. Uppermost portion composed of very micaceous silty clays and silts with thin layers of fine-grained glauconitic sandstone.	125±
				Lower calcareous phase	Highly calcareous to chalky glauconitic clays; contains abundant foraminifera and some phosphatic pellets; thin layer of bentonite noted at Pheba. Zone appears to be 8 to 10 feet thick and gradational into overlying clays.	
		Clayton formation			Fossiliferous sandy somewhat micaceous glauconitic gray chalk; gypsiferous where weathered; **Ostrea pulaskensis** shells in abundance in upper part; scattered phosphatic internal molds of mollusk shells. Indurated layers common, especially in upper part; basal thin sandstone at one locality.	25±
		Disconformity				
MESOZOIC	CRETACEOUS (Upper or Gulf)	Prairie Bluff chalk	EXOGYRA COSTATA ZONE		Fossiliferous gray chalk; slightly micaceous in upper part; borings filled with glauconitic Midway sand beneath Clayton contact; crystalline limestone at one place Basal portion glauconitic and very sandy; contains abundant phosphatic pellets and internal molds of mollusk shells sand content decreases upwards in section	90
		Disconformity				
		Ripley formation	EXOGYRA COSTATA ZONE		Fossiliferous micaceous silty to sandy clays and sands in southern part of county; micaceous sands and silts in northern part. Sands, micaceous fine-grained to coarse-grained glauconitic greenish-gray weathering to tan and brown: ferruginous sandy nodules on surface Basal part chalky and somewhat gradational into Selma	150
		Selma chalk	EXOGYRA COSTATA ZONE / EXOGYRA PONDEROSA ZONE	Demopolis	Chalk of high combined $CaCO_3$ content, especially in upper part; guide fossil **Diploschiza cretacea** in lower part, beds more impure in lower portion	410±
			EXOGYRA PONDEROSA ZONE	Arcola limestone	Pure nodular yellowish-tan rock containing innumerable borings of ¼ to ½ inch diameter filled by glauconitic sandy chalk; weathered rock is pitted; cobbles numerous in areas of exposure; phosphatic nodules and internal molds of mollusks below bed.	1.0
			EXOGYRA PONDEROSA ZONE	LOWER: Smooth micaceous phase	Fossiliferous micaceous and somewhat glauconitic, argillaceous gray chalk; weathers tannish-gray; 100 feet to 125 feet thick.	150±
			EXOGYRA PONDEROSA ZONE	LOWER: Basal sandy phase	Glauconitic micaceous sandy chalk; basal few feet extremely sandy and contain shells reworked from Tombigbee sand; scattered foraminifera; maximum thickness about 25 feet	
		Eutaw formation		Tombigbee sand	Glauconitic greenish-gray micaceous fine-grained sand laminated by thin clay layers; scattered fossils throughout; phosphatic pebbles near base; weathers tan and brown	60±
				Typical Eutaw	Laminated irregularly stratified dark micaceous clay and glauconitic sand; scattered fossils. (Well data).	340±

The fresh unweathered material from numerous test holes is a fine-grained micaceous gray to greenish-gray glauconitic sand, which is in part laminated by thin layers of clay, and which bears scattered fossils, particularly *Exogyra ponderosa* shell fragments. Beneath the basal sandy chalk of the Selma, the Eutaw sands are very glauconitic and green.

Two sections of the best exposures of the Tombigbee sand along the Tombigbee River have been described by Stephenson and Monroe.[1]

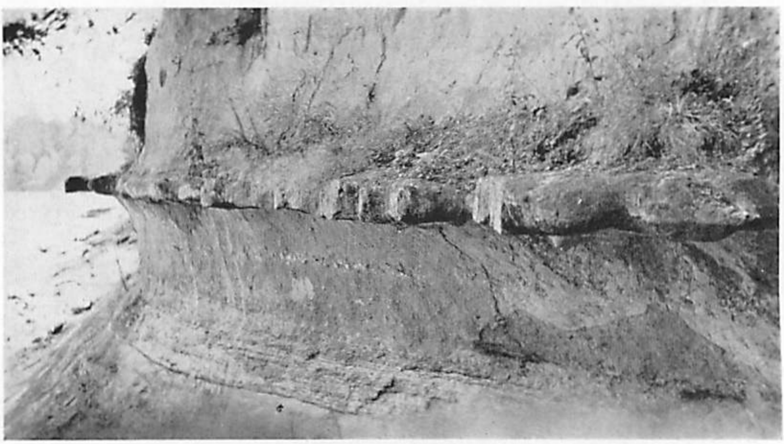

Figure 2.—Indurated concretionary ledge in basal Tombigbee sand of the Eutaw formation. Bartons Bluff, right bank of Tombigbee River (SW.1/4, Sec. 31, T.16 S., R.8 E.). August 1941.

SECTION AT BARTONS BLUFF, TOMBIGBEE RIVER, RIGHT BANK, 8½ MILES EAST BY NORTH OF WEST POINT

	Feet	Feet
Eutaw formation (Tombigbee sand member)....................		60.0
Compact greenish-gray glauconitic sand, somewhat argillaceous in some layers, especially toward the top; a few feet above the base is a prominent partly indurated concretionary ledge, and discontinuous ledges at other places; along the base is a layer containing large numbers of phosphatic pebbles, shark teeth, and fragments of bone...............	60.0	
Eutaw formation (typical)		15.0
Stratified, in places laminated, irregularly bedded dark-gray and yellow glauconitic sand..............................	15.0	

The concretionary ledge outcropping in the basal portion of the Tombigbee sand member forms a conspicuous feature of the bluff (Figure 2). *Exogyra ponderosa, Nerithea* sp., and shark's teeth were found in the softer sand below the indurated ledge.

SECTION AT VINTON BLUFF, TOMBIGBEE RIVER, RIGHT BANK, 8½ MILES NORTHEAST BY EAST OF WEST POINT

	Feet	Feet
Eutaw formation (Tombigbee sand member)		34.0
Greenish-gray glauconitic sand, mottled yellow and red	8.0	
Greenish-gray compact argillaceous, very micaceous, glauconitic sand	5.0	
Dark-gray compact finely arenaceous and micaceous shaly clay	3.0	
Greenish-gray compact argillaceous, very micaceous sand, grading downward into next layer	3.0	
Greenish-gray compact slightly argillaceous and micaceous glauconitic sand, with 3 indurated concretionary layers respectively, at the base, 4 feet above the base, and 3 feet below the top; these are discontinuous along the bluff; contains fossils; a layer 1 foot thick along the base contains large numbers of phosphatic pebbles and shark teeth and corresponds to a similar layer in the section at Bartons Bluff	15.0	
Eutaw formation (typical)		13.0
Laminated, irregularly stratified dark drab micaceous clay and yellowish to almost white glauconitic sand; in places the clay contains comminuted vegetable fragments, lignite, and fine gypsum crystals	13.0	

The Eutaw is the water-bearing formation that supplies most of the wells throughout the county. Wells are comparatively shallow in the eastern part, and in many of them the hydrostatic head is of sufficient pressure to produce a strong flow of water. Flowing wells are common in the area of the Tombigbee sand hills and the basal Selma chalk prairie, but the practice of allowing an unchecked flow will ultimately tend to lower the water for the entire area.

Well data indicate the Eutaw dips westward about 30 feet to the mile, the depth to the formation being increasingly greater across the county. At West Point the Selma-Eutaw contact is 195 feet below the surface; in the vicinity of Mhoons

Valley, 350 feet; Cedarbluff, 560 feet; Waddell, 635 feet; Pheba, 790 feet; Pinebluff, 898 feet.

The thickness of the formation is 362 feet in the Ohio Oil Company Cantrell No. 1 well (NE.1/4, NE.1/4, Sec. 16, T.15 S., R.5 E.).[2] In a water well on the Experiment Farm, 5 miles east of West Point, approximately 400 feet of Eutaw sands, between 75 feet and 475 feet beneath the surface, and nearly 200 feet of Tuscaloosa material were penetrated.

Bentonitic sands and thin layers of bentonite are reported to have been observed in the Clay County Eutaw sands. During this survey, a large number of holes were drilled in the northern sector in the sections west of the Tombigbee River. Not one of these holes revealed any recognizable bentonitic material. One must conclude from this investigation that the commercial bentonite beds of Monroe County do not extend into Clay County.

SELMA CHALK

The Selma Chalk is exposed in Clay County over a belt 12 to 16 miles wide, though a large part of the chalk, particularly the lower portion, is obscured in the eastern part of the county by terrace deposits and stream alluvium or by residual soil developed from the formation. Bald-spots crop out where the soil is thin in the north-central part of the county and expose large areas of the upper or Demopolis member of the Selma. Farther to the west are numerous good exposures of the upper Selma in gullies developed by erosion and in bluffs overlooking stream valleys.

The topography, exclusive of terraced areas, is relatively flat or gently rolling. In the flat areas prairie lands have developed, and two such regions are notable. One of the prairies is in the vicinity of Abbott and covers a large portion of a township in the central part of the county. The other covers a large acreage north and east of West Point where the lower Selma has weathered to produce a dark-brown to almost black fertile soil of a silty clay-loam or clay. The dark color of the soil is due to accumulated organic material developed from decayed prairie grasses prior to cultivation.

When wet the black clay loam of the prairie lands is very sticky and tenaceous, but because of the high lime content it becomes granular when dry. Soft yellowish-tan and white lime concretions are scattered in this soil which grades downward into a yellowish-brown subsoil of less organic content but greater lime content. Pieces of rotten chalk are common in the subsoil, and fossil shells, particularly the heavy valves of *Exogyra ponderosa* Roemer, are found in this zone. Usually these shells are greatly weathered and pitted, and many have been broken and have worked up to the surface of the ground. The high lime subsoil grades into weathered chalk, the bedrock material of the area. The entire transition from black soil to weathered chalk occupies a vertical range of 3 to 5 feet and can be seen in cuts adjacent to some fields.

The limy clay soil seems to be a favored habitat of crayfish, and the structures built by them are thickly scattered over many of the fields and pastures. The borings of these crustaceans prove a nuisance to the farmers, and the federal government has experimented with various poisons in an attempt to eradicate the pests, but all endeavors have been relatively ineffective to date. If a parasite could be found which is deleterous to the crayfish, the control problem would be solved.

Parts of two major fossil zones, *Exogyra ponderosa* Roemer and *Exogyra costata* Say, have been recognized in the Selma. The lower or *E. ponderosa* zone comprises about two-thirds of the formation and has six subdivisions:[3] 1. Basal Selma (sandy); 2. chalk interval; 3. Arcola limestone; 4. chalk interval; 5. *Diploschiza cretacea* zone; 6. upper *E. ponderosa* zone. The *Exogyra costata* zone of the upper Selma is divided into the *E. cancellata* zone and the upper sandy facies. This sandy facies has recently been assigned to the Ripley[4] and is conspicuous in the southern part of the Cretaceous belt in Mississippi but does not extend into Clay County.

Most of the fossils in the Selma chalk are long range forms and have little value as markers but are characteristic on outcrops. The heavy shelled *Exogyra ponderosa* Roemer is most commonly found and recognized, for it begins in the Eutaw and extends through two-thirds of the Selma strata. The plicated *Exogyra costata* Say ranges through a part of upper

Selma into the Ripley and Prairie Bluff formations. Other long range Upper Cretaceous fossils that are common in the Selma exposures are *Ostrea plumosa* Morton, of which the upper valve is most frequently preserved, and the characteristically serrated *O. falcata* Morton. The deeply convex lower valves of *Gryphaea convexa* (Say) and the heavy semi-circular shells of *G. mutabilis* Morton are common in the upper Selma. *Paranomia scabra* Morton is a thin-shelled form whose spiny oval-shaped valves stubbornly resist weathering, and the glistening thin but tough valves of *Anomia tellinoides* Morton and *A. argentaria* Morton are easily recognized and commonly found throughout the chalk. The arcuate and tapering small worm tubes *Hamulus onyx* Morton and the similar but wide-flanged *H. squamosus* Gabb range from the sands of the Eutaw into the Prairie Bluff chalk.

Exogyra cancellata Stephenson is confined to the upper part of the Selma; in the lower portion of the upper division are two small excellent index fossils: *Diploschiza cretacea* Conrad, a small scoop-shaped pelecypod, and *Terebratulina filosa* Conrad, a small fluted brachiopod, both being restricted to a vertical range of approximately 60 feet.

Some of the foraminifera and ostracoda are characteristic of the Selma but have not been systematically studied. The tests extend throughout the chalk. In contrast to these tiny forms are the shark teeth and lithified skeletal fragments of vertebrate forms, the latter represented chiefly by ribs and vertebrae of Mosaurian reptiles.

Round, cylindrical, tapering, and even irregular-shaped concretions of marcasite are common throughout the chalk and are found on nearly every outcrop. The surface of most of these is rough and oxidized a dark-brown, but broken specimens show the characteristic internal radiating structure of the unoxidized brassy mineral. Phosphatic nodules and internal molds of mollusk shells are present in at least one horizon of the chalk and are discussed under the subdivisions that follow.

The truncated Selma chalk increasingly thickens as the formation dips westward across the county. At Pheba and Pinebluff in the western part, wells pass through the entire thickness of the Selma, which drillers' logs indicate to be 530 to

560 feet. The regional dip for the formation is 30 feet to the mile, but well logs indicate that this is increased locally in the area east of the Kilgore hills in the northcentral part of the county, and a similar steepened dip is suggested 2 miles northeast of Cedarbluff.

LOWER CHALK MEMBER

The basal portion of the chalk is very sandy. Test holes indicate that the lowest few feet have a high sand content and contain fragments of shells of the heavier Ostreidae. Stephenson and Monroe determined this portion to be equivalent to a basal conglomerate,[5] the shells having been reworked from the underlying Tombigbee sands. The basal Selma material was penetrated in a test hole (M225) at the rear of a tenant house on the Clifton Rose property (SW.1/4, SW.1/4, NE.1/4, Sec. 14, T.17 S., R.7 E.) 1/2 mile south of the highway.

SECTION OF TEST HOLE M225, CLIFTON ROSE PROPERTY

	Depth
Selma chalk	
Residual black silty clay loam (Elev. 219 feet)	1.8
Clay, slightly calcareous, sandy, ferruginous tan	12.2
Chalk, very micaceous, somewhat glauconitic, sandy gray (S-3)	23.3
Chalk, glauconitic, micaceous, sandy gray; basal 2 feet very sandy and contain abundant shell particles; foraminifera abundant. Water at 34 feet (S-4)	36.5
Tombigbee member of the Eutaw formation	
Sand, fine-grained micaceous, very glauconitic greenish-gray; calcareous and argillaceous (S-5)	52.0

Above the basal sandy phase is an interval of 100 to 125 feet of slightly micaceous smooth chalk separated from the upper Selma by a thin bed of hard limestone known as Arcola. This lower portion of the chalk is covered by residual soil or terrace material and is exposed at only two or three places. On the eastward-facing slope 1/3 mile west of Town Creek and north of the Vinton road (SE.1/4, Sec. 20, T.16 S., R.7 E.), an exposure of 9.5 feet of compact tannish-gray and gray chalk containing shell fragments is capped by 0.5 foot of thin indurated brown chalk composed mostly of cemented shell fragments of *Ostrea falcata* Morton. Upper strata immediately below the Arcola limestone are exposed along Tibbee Creek from 3/4 mile to 1 1/2 miles north of Tibbee Station. The section is given under the discussion of the Arcola.

ARCOLA LIMESTONE MEMBER

The lower Selma is separated from the upper portion by the Arcola limestone,[6] a thin bed of yellowish-tan rock containing innumerable borings of 0.2 to 0.5 inch in diameter filled by glauconitic sandy chalk which weathers out leaving an irregular pitted surface. This limestone bed was traced across

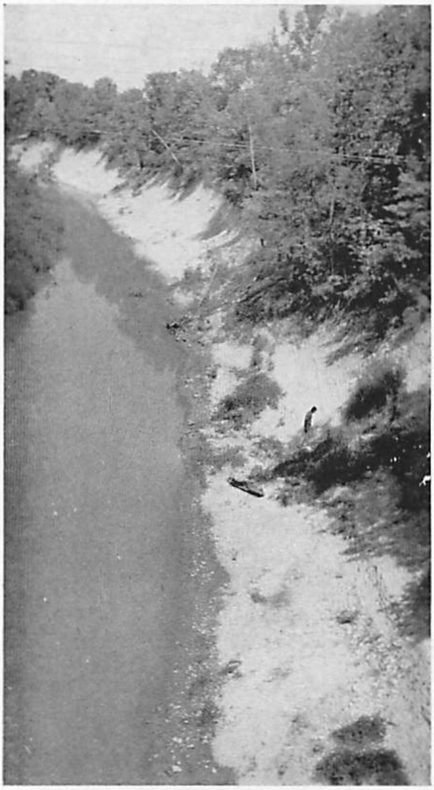

Figure 3.—Arcola limestone overlying upper strata of the lower Selma chalk, south bank of Tibbee Creek, east of Gulf, Mobile, and Ohio Railroad bridge, 3/4 mile north of Tibbee Station. August 1941.

the county. Usually cobble-like pieces could be found, but it was necessary to drill in the northern part of the county to locate the bed definitely. In the area immediately southeast of West Point, the information was taken from the map published in Bulletin 40 of the Mississippi Geological Survey.

An excellent continuous exposure of the Arcola can be traced downstream nearly 3/4 of a mile along the bluff side of Tibbee

Creek from the Gulf, Mobile, and Ohio Railroad bridge 3/4 of a mile north of Tibbee Station. The lower Selma chalk exposure along this bluff is the longest continuous outcrop in the county, for it can be followed for over a mile (Figure 3). The limestone is near the top of the exposed chalk and in places is divided into two thin beds separated by chalk (Figure 4). The following section is at a point 1/10 mile east of the railroad bridge.

Figure 4.—Two thin beds of Arcola limestone separated by a layer of Selma chalk, south bank of Tibbee Creek, 1/10 mile east of Gulf, Mobile, & Ohio Railroad bridge. August 1941.

TIBBEE CREEK SECTION OF SELMA CHALK ¾ MILE NORTH OF TIBBEE STATION

	Feet	Feet
Demopolis member		11.0
Residual clay to top of bank	8.0	
Chalk, light-tan to gray; grades into residual clay	3.0	
Arcola limestone member (Elev. 170 feet)		1.0
Limestone, nodular glauconitic light-tan; contains borings filled by glauconitic chalk; overlain by rounded cobbles and pebbles of reworked limestone. 0.5 to	1.0	
Lower chalk member		19.8
Chalk, glauconitic, argillaceous gray; thinly bedded	2.0	
Limestone, glauconitic tan; clear streaks	0.5	

Chalk, very glauconitic, somewhat micaceous and argillaceous gray; scattered *Exogyra ponderosa* Roemer shells, *Ostrea plumosa* Morton, *Hamulus onyx* Morton, and *H. squamosus* Gabb and abundant phosphatic black internal molds of mollusk shells, especially *Ideonarca* cf. *neglecta* Gabb and *Baculites ovatus* Say	2.5
Chalk, argillaceous, micaceous gray; jointed; weathers shaly; scattered fossils (one large mold of *Sphenodiscus* sp.)......	6.0
Chalk, slightly micaceous gray; abundantly fossiliferous, containing *Ostrea falcata* Morton and *Ostrea* sp.; top weathers to a friable coquina-like ledge. 0.5 feet to..................	0.8
Chalk, slightly micaceous compact gray; jointed; surface conchoidally pitted and water worn; iron oxide stains along some joints; a few pyrite concretions; contains *Exogyra ponderosa* Roemer, *Ostrea falcata* Morton, *O. plumosa* Morton, *Hamulus onyx* Morton, *H. squamosus* Gabb, and imprints of *Inoceramus proximus* Tuomey..................	8.0
Level of Tibbee Creek, August 15, 1941....................	

Black phosphatic internal molds of mollusk shells are abundant below the Arcola limestone along Tibbee Creek. Similar molds and nodules have been reported[7] to be in the chalk above the Arcola at several localities in Mississippi and Alabama, but none was found in that relationship along Tibbee Creek. The writer's observations in Lee County indicate that the molds and nodules are usually present in abundance above the Arcola in that county, but at one locality, 4 miles northeast of Nettleton where the limestone caps a ridge, the molds and nodules are abundant below the Arcola bed.

The molds along Tibbee Creek are mostly those of pelecypod shells, *Ideonarca* cf. *neglecta* Gabb being common. Other species include: *Inoceramus proximus* Tuomey, *Cymella bella* Conrad var. ?, *Baculites asper* Morton, *Pyropsis* sp., and *Gyrodes petrosus* (Morton), and two unidentified gastropods.

The Arcola limestone east of West Point appears to be about 150 feet above the base of the Selma as interpreted from regional dip and well data. The owners of a flowing well on the J. P. Horner property south of the highway 1 mile east of the corporate limits of West Point (NW. cor., Sec. 18, T.17 S., R.7 E.) report that sand (Tombigbee) was reached about 100 feet below the surface of the well (Elev. 213). Arcola limestone caps the hill to the south and is exposed east of the house at an altitude 37 feet above the well. If an estimated dip of 25 feet to the mile be applied to the chalk area to the east, the Arcola at this point would be about 150 feet above the base of the Selma chalk. This interval is in agreement with the data from the municipal well at West Point, 2 miles west of the flowing well. The municipal well, begun at 240 feet above sea level, penetrated 20 feet of Pleistocene material and 180 feet of Selma chalk. This estimate places the Arcola in Clay County stratigraphically lower than the recently reported[8] position of the Arcola in Noxubee and Lee Counties.

Figure 5.—Weathered Arcola limestone ledge on slope north of highway (SW.1/4, Sec. 12, T.17 S., R.6 E.) 1 mile east of corporate limits of West Point. August 1941.

Weathered Arcola limestone ledges (Elev. 225 feet) and float are exposed at several places along the hillsides north of the road in the area one mile east of the corporate limits of West Point (SW.1/4, Sec. 12, T.17 S., R.6 E.). Slight gullying has produced terrace-like outcrops (Figure 5).

Along the Monroe County line the limestone was located a few feet beneath the surface by drilling. The elevation is 270 feet at a point approximately 1/2 mile west of Strongs.

DEMOPOLIS MEMBER

In 1903 Smith[9] proposed three subdivisions for the Selma chalk of central and western Alabama on the basis of clayey impurities. The middle portion, in which he noted less than 25 percent clayey impurities, was termed "Demopolis division" after the Alabama town of that name. The term has recently been redefined in Alabama[10] to include all the chalk between the Arcola limestone and the Ripley formation. This is a convenient term for a well defined subdivision, and its usage is adopted in this report for that section of the Selma in Mississippi.

Figure 6.—Upper Demopolis chalk bald spots in northern Clay County (N. edge NE.1/4, NE.1/4, Sec. 2, T.16 S., R.4 E.). January 1942.

Upper beds of the Demopolis chalk member are well exposed in bald spots (Figures 6 and 7) in the central part of Clay County and along bluffs in the western part of the Selma belt, but the lower beds are almost completely obscured by the extensive terrace and alluvial deposits of Sakatonchee River and Tibbee Creek. However, one good exposure may be seen in the north-facing bluffs south of Tibbee Creek bottomlands, east and west of Highway 45W, 4 miles south of West Point corporate limits. The bluff is extensively gullied (Figure 8). The following typical section was measured on the Bory Moseley

Figure 7.—Gullied upper Demopolis chalk showing valves of Gryphaea mutabilis Morton and Exogyra costata Say scattered over surface (N. edge NE.1/4, NE.1/4, Sec. 2, T.16 S., R.4 E.). January 1942.

Figure 8.—Gullies in lower Demopolis member of the Selma chalk below Diploschiza cretacea zone, north-facing slope of Tibbee Creek (SE. 1/4, SE.1/4, Sec. 6, T. 19 N., R. 16 E.) 1/4 mile east of Highway 45W, 4 miles south of corporate limits of West Point. August 1941.

property (SE.1/4, SE.1/4, Sec. 6, T.19 N., R.16 E.) 1/4 mile east of the highway:

BORY MOSELEY SECTION M329

	Feet	Feet
Lower Demopolis chalk		45.2
Clay, chalky tan; contains numerous lime concretions	16.5	
Chalk, compact slightly micaceous light-gray; very fossiliferous (P-2)	23.0	
Chalk talus	5.7	

Irregular-shaped and tapered cylindrical concretions of radiating marcasite, usually somewhat oxidized on the surface, are very common at this locality. The top of this bluff is approximately at the base of the *Diploschiza cretacea* zone. Within the chalk, the following fossils are abundant:

Pelecypoda
- Ostrea plumosa Morton
- Ostrea falcata Morton
- Gryphaea sp.
- Exogyra ponderosa Roemer
- Anomia argentaria Morton
- Paranomia scabra (Morton)

Vermes
- Hamulus onyx Morton
- Hamulus squamosus Gabb

A fragmentary large Rudistid, scattered shark teeth, and a Mososaur clavula were also found.

The chalk exposed in the bluff on the Moseley property analysed 62.55 percent $CaCO_3$.[11] Analyses of residual clay and lower Demopolis chalk at the abandoned pit of the West Point Manufacturing Company in West Point show the following composition:[12]

	Residual clay	Selma
Moisture (H_2O)	4.25	2.75
Volatile matter (CO_2, etc.)	7.77	22.61
Silicon dioxide (SiO_2)	73.70	32.81
Iron oxide (Fe_2O_3)	11.14	4.65
Aluminum oxide (Al_2O_3)	3.81	11.15
Calcium oxide (CaO)	1.04	22.69
Magnesium oxide (MgO)	.00	1.53
Sulphur trioxide (SO_3)	.21	1.55

Within the lower Demopolis member is found the small bivalve *Diploschiza cretacea* Conrad which serves as an excellent index fossil. The thickness of the zone in which it exists is undetermined for Clay County, but shells of this fossil were found at an estimated 140 feet above the Arcola limestone in a road ditch beside State Highway 23 at a road fork 1/3 mile west of highway 45W (near cent., Sec. 7, T.19 N., R.16 E.) and 1 3/4 miles west of Tibbee Station. This position seems to mark the base of the zone in that locality.

Terrace deposits and alluvium cover most of the area where the *Diploschiza cretacea* zone probably crosses Clay County. A number of the shells were collected in an exposure at the road bend (near cent. W.1/2, Sec. 36, T.16 S., R.5 E.) 1 mile northeast of Siloam School. A few of the valves were obtained from a bald spot south of a section line road in a field (NW.1/4, NE.1/4, NW.1/4, Sec. 2, T.16 S., R.5 E.) 1 1/2 miles east and 3 miles north of Abbott. They are present in the roadcut to the north (approximately 1/2 mile east of the road corner) along the section line, and well preserved shells were traced 1 1/2 miles northwest along slopes overlooking the creek bottom. At one exposure (SW.1/4, SW.1/4, Sec. 35, T.15 S., R.5 E.) *Terebratulina filosa* Conrad was abundant. The zone could not be traced beyond a point 1/2 mile south of Houlka Creek (NE.1/4, NE.1/4, Sec. 33, T.15 S., R.5 E.), where the lowland area adjacent to the creek is covered by alluvium.

Diploschiza cretacea Conrad and abundant *Terebratulina filosa* Conrad are present in exposures north of a narrow road in western Monroe County (N.1/2, Sec. 19, T.15 S., R.6 E.) 3 1/2 to 4 miles northeast of the Clay County exposures cited above. The zone is also exposed in the northeastern corner of Clay County and in the west-facing slope of Sakatonchee River, 5 miles due east of Una.

At each locality where the zone is exposed the long ranging fossils *Ostrea plumosa* Morton, *O. falcata* Morton, *Paranomia scabra* (Morton), *Hamulus onyx* Morton, and *Hamulus squamosus* Gabb are common.

Thin-bedded white or creamy Demopolis chalk, above the *Diploschiza cretacea* zone, is exposed along roads and in the fields in the vicinity of Abbott and the prairie land to the north. In this area the regolith is thin and the chalk crops out in bald spots in fields and along roadsides, but the relief is so slight that only a few feet of material are exposed at each locality. In the buff-colored subsoil are abundant irregular ferruginous concretions (siderite ?) which are concentrated by weathering in small eroded ditches. The chalk in the area is light-gray to white and weathers in small thin pieces in a shale-like manner. Beds immediately above the *Diploschiza cretacea* zone are exposed along the road and adjacent fields northeast of Siloam School (Sec. 35, T.16 S., R.5 E.). Beds that are stratigraphically higher are exposed in an east-facing bluff of Long Creek 2 miles west of Siloam School. On the E. H. Walker property (SW.1/4, SW.1/4, Sec. 33, T.16 S., R.5 E.) north of the section line road, 15 feet of compact light-gray chalk, analyzing 70.05 percent $CaCO_3$,[13] underlie 9 feet of slightly sandy white chalk. The sandy chalk is in turn overlain by 11 feet of residual calcareous fine sandy brown clay containing shell fragments. *Exogyra costata* Say, *E. cancellata* Stephenson, *Anomia tellenoides* Morton, and scattered *Paranomia scabra* (Morton), and Mososaur ? vertebrae fragments are in the chalk. Cylindrical and round marcasite concretions are abundant in the lower gray chalk.

An exposure of 30 feet of chalk suitable for agricultural lime is on property owned by Mrs. John Walker and M. Weber, 3 miles north and 1/2 mile west of Abbot. This chalk contains 83.07 percent $CaCO_3$.[14]

Good chalk exposures of the upper Demopolis member are on Line Creek, 1 mile east of Cedarbluff; the west-facing bluff of Underwood Creek, 3/4 to 1 1/4 miles northwest of Griffith; roadside exposures 1/2 mile north of Deans Lake; gullies along section line road of the north edge of Sec. 1, T.16 S., R.4 E.; and in the vicinity of Caradine, 2 miles south of the Chickasaw County line. Other exposures are along the tributaries of Houlka Creek in the northwestern corner of the county. At each of these exposures *Ostrea falcata* Morton and *Gryphaea mutabilis* Morton are very abundant (Figure 9); less common are *Gryphaea convexa* (Say), *Exogyra costata* Say, *Paranomia scabra* (Morton), and a few valves of *Anomia argentaria* Morton and *A. tellenoides* Morton.

In the northern area the regolith is thin and badly eroded; bald spots have developed in the vicinity of Caradine and along the headwaters of Houlka Creek tributaries. Large valves of

Gryphaea mutabilis Morton are scattered in abundance over these areas.

Recent analyses[15] of the upper Demopolis chalk at two localities indicate the combined calcium carbonate content is relatively high. On the Pete Winfield property, south of Line Creek and along the road up the hill 1 mile east of Cedarbluff, massive chalk in a 50-foot bluff contains 83.07 percent $CaCO_3$ in a workable zone of 30 feet. The chalk is also exposed across

Figure 9.—Large valves of Gryphaea mutabilis Morton and Exogyra costata Say on a bald spot on the upper Demopolis chalk south of road (N. edge NE.1/4, NE.1/4, Sec. 2, T.16 S., R.4 E.). January 1942.

the road to the south, and all is fairly massive, light gray to creamy tan. Marcasite concretions are scattered throughout. *Ostrea falcata* Morton and *Gryphaea mutabilis* Morton valves are abundant near the top of the exposure. *Ostrea plumosa* Morton, *Paranomia scabra* (Morton), *Exogyra cancellata* Stephenson, and *Inoceramus* cf. *proximus* Tuomey were collected there.

RIPLEY FORMATION

The Ripley formation crops out in a belt 1 to 3 1/2 miles wide, striking north and south across the western part of Clay

County. The eastern margin forms broadly scalloped hills adjacent to the Selma chalk. This feature is not readily distinguishable in the southern part of the county, but the change from the Selma prairie lands is abrupt in the hilly area of the north. The western contact with the overlying Prairie Bluff formation is fairly irregular where ridges and hills of the Prairie Bluff chalk extend into the Ripley area.

The thickness of the Ripley increases from 100 feet to 115 feet in the southern part to possibly 150 feet of sands and clays in the Kilgore Hills of the northern townships. Most of the exposures are heavily weathered and range in color from greenish gray or tan to reddish brown. Fossiliferous sandy clays and sands are found in the southern part, but brown and tan micaceous sands from which the fossils have weathered are most prominent in the northern area.

Fossiliferous exposures contain some foraminifera and valves of the Ostreidae. *Exogyra costata* Say shells are well preserved, and *Paranomia scabra* (Morton) shells are frequently found on the outcrops. The sands grade from fine to coarse texture, are all micaceous, and, except where excessively weathered, some glauconite can usually be distinguished. Weathering has produced a mottled gray and brown effect on most exposures. The clays are silty to sandy micaceous greenish tan and greenish gray. Limy streaks are in some of the clays.

The unweathered material is very glauconitic, micaceous greenish gray. In the lower part of the formation it becomes increasingly more chalky and at places appears to be gradational into the Selma chalk.

Basal laminated clay beds are well exposed along the road ascending a hill from the Selma lowlands (SE.1/4, SW.1/4, SE.1/4, Sec. 35, T.15 S., R.4 E.) about 6 miles northwest of Abbott.

SECTION M333 NORTHWEST OF ABBOTT

	Feet	Feet
Ripley formation		71.1
Clay-silt, structureless to thin-bedded micaceous reddish-brown; mottled and streaked gray; grades into underlying bed	11.5	

Clay and silt, interbedded thinly laminated micaceous highly weathered reddish-brown; thin streaks of unweathered gray clay (Figure 10)	22.0
Clay, thin-bedded very silty micaceous, somewhat glauconitic grayish-tan to tan; silt interlensed and irregularly interbedded with clay; silt-filled borings in some clay layers; a few pyrite concretions; secondary gypsum along joints and fractures; basal 3 or 4 feet less weathered, more massive, containing abundant foraminifera and mollusk shell fragments	26.3
Clay-silt, micaceous heavily weathered and mottled tan, reddish-brown and gray; partly covered along roadside	11.3
Top of weathered Selma chalk	

Figure 10.—Basal Ripley silty clays in hillside roadcut (N. edge NW.1/4, NE.1/4, NE.1/4, Sec. 2, T.16 S., R.4 E.). June 1941.

In addition, approximately 18 feet of reddish-brown clay-silt are exposed around a curve near the hill top. At the base of the fossiliferous clay, a test hole to the Selma chalk revealed the following:

SECTION OF TEST HOLE M333A
Top of hole 350 feet

Ripley formation	Depth
Clay, silty calcareous, micaceous, somewhat glauconitic tan and gray; laminated by white silt; streaks of small gypsum crystals; foraminifera and chalky mollusk shell fragments throughout (S-1)	10.3

Chalk, silty slightly micaceous, glauconitic gray; contains foraminifera and fragments of chalky mollusk shells (S-2)..	11.0
Chalk, glauconitic, slightly micaceous grayish-tan; contains foraminifera and chalky shell fragments (S-3)............	12.0
Selma chalk	
Chalk, sparingly micaceous gray; foraminifera and scattered chalky mollusk shell fragments (S-4)....................	20.2

The Kilgore Hills are the southern extension of the Pontotoc ridge and form the most rugged area of the county. Steep V-shaped wooded valleys lie between high sinuous ridges. Where cultivation has been attempted and abandoned on some of the

Figure 11.—Disconformable contact of the Prairie Bluff arenaceous chalk above and cross-bedded white micaceous sand of the Ripley formation below, outlier on Sugar Hill, J. T. Davidson property (SE.1/4, SW.1/4, Sec. 8, T.15 S., R.4 E.) 2 1/2 miles west of Caradine.

steep slopes, tan or reddish-brown sands and sandy clays of the Ripley either are deeply gullied or form glaring barren knobs. Ferruginous concretions and sandy nodules lie in great numbers on the surface of some of the barren weathered areas. A heavily oxidized zone blankets the hills and may penetrate 40 or 50 feet beneath the crests of the ridges to the unweathered fine dark-gray glauconitic sands beneath.

In the northwestern part of the Ripley belt, a few ridges and hills are capped by Prairie Bluff chalk, and contacts are visible at several places. At Sugar Hill (Cent. NW.1/4, Sec. 8, T.15 S., R.4 E.), fine white micaceous cross-bedded sand underlies sandy indurated ledges of the Prairie Bluff which contain abundant phosphatic molds (Figure 11). Where unprotected by the younger sediments the sand is weathered tan. Another good contact can be seen in a gully on the Bell Moseley property south of a road intersection (SE.1/4, NE.1/4, SW.1/4, Sec. 29, T.15 S., R.4 E.), where an exposure of 2 feet of fine argillaceous and micaceous tan and gray sand is beneath 17 feet of fossiliferous basal Prairie Bluff chalk. A test hole revealed the Ripley sand to be 3.6 feet thick and underlain by at least 22 feet (T.D. of test hole) of micaceous silt. Fine sand or beds of silt were noted at other places beneath the Prairie Bluff. A few shell fragments were found.

An outlier of Prairie Bluff chalk caps a hill (SW.1/4, SW. 1/4, NE.1/4, Sec. 3, T.16 S., R.4 E.) 1 1/2 miles north of Big Springs, and a test hole (M130—Albert Langford property) on the crest penetrated the following sediments:

SECTION OF TEST HOLE M130, 1½ MILES NORTH OF BIG SPRINGS

	Depth
Prairie Bluff residual clay (388—altimeter elev.)	
Clay, very arenaceous, somewhat glauconitic heavily weathered brown; a few phosphatic internal molds of mollusk shells..	2.8
Prairie Bluff chalk	
Chalk, sandy glauconitic, slightly micaceous tannish-gray; scattered phosphatic internal molds of mollusk shells and valves of *Exogyra costata* Say (S-2)......................	10.6
Ripley formation	
Sand, fine-grained to silty argillaceous, calcareous, and micaceous tan; a few shell fragments (S-3)...................	19.2
Silt and fine-grained sand, micaceous, glauconitic gray (S-4a and S-4b). Water at 22.7 feet...........................	41.1

Another test hole (M131—A. N. Cothran property), to the east and approximately 30 feet below the crest of the hill, revealed the following:

SECTION OF TEST HOLE M131

	Depth
Ripley formation	
Clay, silty to sandy micaceous tan and gray.................	9.0
Silt, argillaceous and very micaceous, somewhat glauconitic tan (S-2). Water at 14.0 feet..............................	14.0

Clay-silt, very micaceous; tannish-gray in upper part to glauconitic dark-gray laminated by white silt; a few mollusk shell fragments (S-3)	26.5
Clay, very silty calcareous, micaceous, and glauconitic dark-gray; laminated by silt; contains foraminifera and chalky mollusk shell fragments; mica decreases and fossiliferous chalk increases in lower part (S-4a to S-4e)..............	66.6

Approximately 86 feet of Ripley sediments were penetrated in the two holes, which would seemingly bring the lowest bed within range of the upper part of the basal Ripley section 1 1/4 miles to the northeast.

PRAIRIE BLUFF CHALK

The chalk overlying the Ripley sands in Clay County is part of a formation that can be traced across northeastern Mississippi from the vicinity of New Albany in Union County to northeastern Kemper County and into Alabama. This chalk has recently been given the rank of a formation by Stephenson and Monroe,[16] who have retained the name Prairie Bluff, formerly applied to the uppermost Cretaceous chalk of Alabama by Winchell[17] in 1857.

This formation is 1 1/2 to 5 miles wide in Clay County and follows the prevailing strike of the other geological formations. It is not as extensively exposed as the Selma chalk, nor is the topography developed from it comparable. The eastern part of the Prairie Bluff chalk belt lies in the western margin of the Pontotoc Hills; a rolling topography is characteristic. Along the northeastern margin are scattered outliers which either cap hills of Ripley sand or form the crests of ridges in the western Ripley area. Alluvium obscures most of the area along Standing Reed and Prairie Creeks and part of the region adjacent to Line Creek where most of the exposures are small gullies in fields. The chalk weathers to a brown sandy soil which, together with vegetation, obscures the gray unweathered material except where barren patches have developed on denuded hillsides. Exposures of this sort are more common in the northeastern hilly area. A few bluffs and a number of roadcuts over the area reveal limited sections. The chalk is 70 to 80 feet thick in wells in the western part of the county.

The basal Prairie Bluff chalk is relatively sandy and contains abundant phosphatic pellets and internal molds of mollusk shells. In a test hole on the J. H. Dill property (NW.1/4, NW. 1/4, SE.1/4, Sec. 8, T.16 S., R.4 E.) the basal material was subangular medium to coarse sand with subordinate chalky material below less sandy chalk. Very sandy chalk is exposed south of the road in the bank of a branch on the Steve Sauls property (NW.1/4, NW.1/4, NW.1/4, Sec. 5, T.16 S., R.4 E.) and overlies micaceous, glauconitic medium-grained gray sand of the Ripley formation. At some of the places where a contact with the Ripley is exposed, the basal Prairie Bluff material forms indurated sandy chalk ledges over the friable Ripley sands. A gully southwest of the road intersection on the Bell Moseley property (SE.1/4, NE.1/4, SW.1/4, Sec. 29, T.15 S., R.4 E.) reveals the Prairie Bluff and Ripley.

SECTION ON THE BELL MOSELEY PROPERTY

	Feet	Feet
Prairie Bluff chalk		34.5
Residual clay, very sandy somewhat micaceous reddish-brown; ferruginous concretions and nodules on the surface	17.0	
Chalk, sandy tannish-gray; abundant phosphatic pebbles and internal molds of mollusk shells; valves of *Exogyra costata*, *Gryphaea convexa*, and *Paranomia scabra* common	17.5	
Ripley formation		2.0
Sand, fine-grained argillaceous, micaceous tan and gray; streaked and mottled tan	2.0	

A good contact with the Ripley is on a ridge capped by a Prairie Bluff outlier 2 1/2 miles west of Caradine. On the J. T. Davidson property (SE.1/4, SW.1/4, Sec. 8, T.15 S., R.4 E.) a cut along an abandoned road 1/4 mile from the main road exposes 9 to 13 feet of sandy massive tannish-gray chalk containing an abundant molluscan assemblage preserved chiefly as internal molds. The basal 2-foot interval of the formation is a very fossiliferous and calcareous tan and gray sandstone which projects as a ledge over friable fine-grained cross-bedded white micaceous sand of the Ripley (Figure 11). Basal Prairie Bluff chalk is exposed at intervals along the ridge to the southwest, but most of the material adjacent to the road is weathered to a brown sandy clay or argillaceous sand.

A few feet of coarse sandy gray chalk are exposed in the east bank of Sand Creek 1/4 mile north of the highway bridge (NW.1/4, NW.1/4, Sec. 21, T.16 S., R.4 E.). This material appears to be an outlier of basal Prairie Bluff and contains a few scattered shells of the oyster group.

Approximately 50 feet of basal Prairie Bluff chalk and residual clay are exposed on a hillside roadcut (NE.1/4, SW.1/4, Sec. 32, T.15 S., R.4 E.) about 2 1/2 miles northeast cross country from Montpelier. Nearly 30 feet of the exposure is very sandy somewhat glauconitic gray chalk. The basal part has a very high sand content and has in places weathered to an argillaceous brown sand consisting of medium to coarse grains. The sand content decreases gradually upwards through the section. Numerous *Exogyra costata* Say and *Gryphaea convexa* Morton shells are scattered through this chalk. A pustulose claw of a crab and a few echinoderms were found in the upper part of the chalk. Above the sandy phase is an interval of 5 to 10 feet of intensely weathered glauconitic chalk covered by sandy brown Prairie Bluff residual clay through an 8-foot interval to the hilltop. Poorly preserved phosphatic internal molds of mollusk shells lie in the soil. A large, 6-inch diameter, mold of *Eutrephoceras* sp. was found near the hilltop.

Lower Prairie Bluff chalk is exposed on a hillside roadcut and in gullies east of a tributary of Standing Reed Creek (SE. 1/4, SW.1/4, SW.1/4, Sec. 31, T.15 S., R.4 E.) about 1 1/2 miles northeast of Montpelier.

Section northeast of Montpelier

	Feet	Feet
Prairie Bluff chalk		49.3
Topsoil, fine silt; tan to gray, 2½ to	3.0	
Residual clay, slightly glauconitic sandy gray; heavily streaked and mottled by gray and tan sand; jointed, intensely weathered, and leached	11.0	
Clay, calcareous, glauconitic greenish-gray; streaked and mottled by glauconitic fine to medium gray sand; coating of brown iron carbonate and traces of white lime along joints; grades into sandy clay above	3.0	
Clay, very sandy glauconitic, calcareous highly weathered gray and tan; poorly preserved internal molds of mollusk shells and phosphatic and lime nodules	2.8	
Chalk, sandy Glauconitic thin-bedded argillaceous and fossiliferous gray to grayish-tan; lower part somewhat indurated; shells of *Gryphaea convexa* (Say), *Exogyra costata* Say, *Eutrephoceras* sp., and internal molds of gastropods and pelecypods	29.5	

At the base of the hill a test hole penetrated 7 feet of alluvium and 4 feet of sandy glauconitic chalky clay containing fossil fragments.

Upper Prairie Bluff chalk is exposed on an east-facing bluff west of the Prairie Creek bottoms. Approximately 24 feet of slightly micaceous chalk are present in a gullied area 1/4 mile northeast of the K. C. Curtis residence (SE.1/4, SW.1/4, SW.1/4, Sec. 14, T.16 S., R.3 E.). A secondary road crosses the bluff along the section line approximately 1/10 mile east of the Curtis residence. At this point, the following strata are exposed:

SECTION EAST OF THE CURTIS RESIDENCE

	Feet	Feet
Basal Midway (Clayton)		13.1
Clay-silt, micaceous tan to reddish-brown	1.8	
Chalk, finely sandy micaceous, glauconitic massive to thin-bedded grayish-tan; contains shells and molds of *Ostrea pulaskensis* Harris at the top and scattered internal phosphatic molds of other mollusks; base rests irregularly on the Prairie Bluff	11.3	
Prairie Bluff chalk		27.2
Chalk, gray slightly micaceous and glauconitic thin-bedded; weathers light tan to white; upper foot contains borings filled with basal Midway sandy chalk; shells of *Ostrea* sp., *Exogyra costata* Say, and internal molds of *Baculites* sp. scattered throughout	27.2	

A 4-foot covered interval of black chalky loam lies between the above section and a test hole (M64) near the edge of the field to the east of the bluff. The following material was revealed:

SECTION OF TEST HOLE M64

Prairie Bluff chalk	Depth
Chalk, weathered dark-gray to brown and light-tan; concretions and streaks of brown siderite (?); micaceous and silty to sandy in part; scattered glauconite, shell fragments and foraminifera (S-1)	15.7
Sand, fine-grained tannish-gray glauconitic; contains small sideritic and lime concretions and streaks........	17.4
Chalk, gray somewhat silty to finely sandy; concretionary streaks of dark-brown siderite (?) in the upper part; foraminifera scattered throughout (S-3)........	36.7

The upper Prairie Bluff chalk is exposed at several places for nearly a mile along the south edge of Johnson Creek Valley (S.1/2, Sec. 4, T.20 N., R.13 E.) 3 miles north of Pheba. Sections showing the unconformable relationship to the overlying Midway material are exposed on the north-facing slope of this valley in a road cut and at the edge of a wooded area nearly 1/2 mile to the northwest of the cut (Figure 12). A measured section (M61) of this exposure is described under the Clayton. Borings filled with glauconitic Midway sandy chalk are in the upper Prairie Bluff chalk at both localities. A bluff of chalk,

Figure 12.—Disconformable contact of Clayton formation above and Prairie Bluff chalk below, north-facing slope of Johnson Creek valley (NW.1/4, SW.1/4, Sec. 4, T.20 N., R.13 E.) 3 1/2 miles north of Pheba. August 1941.

1/2 mile southeast of the roadcut section described by Stephenson and Monroe,[18] does not show a contact with the Midway but exposes nearly 40 feet of the upper chalk.

SECTION M317 OF A BLUFF 3 MILES NORTHEAST OF PHEBA

	Feet	Feet
Basal Midway?		20.0
Clay-silt soil, tan	20.0	
Prairie Bluff chalk		47.4

Chalk and chalky clay, tan to brown; thin-bedded and greatly weathered and irregularly exposed to top of hill; grades into residual soil	11.7
Chalk, gray; merging into light tan where weathered in upper part; thin-bedded and very fossiliferous in lower 6 feet; abundant shells of oysters, phosphatic internal molds of mollusk shells, and shark teeth; some streaks of ferruginous material. Crystalline calcite developed along minor faults and stands in relief as resistant material	17.5
Sandstone, calcareous massive to thin-bedded fossiliferous tan; well indurated; mostly broken and lying in large blocks on hillside. 0.7 to	1.2
Chalk, gray; extensively weathered and covered	17.0

Internal molds of *Discoscaphites conradi* (Morton), *Baculites* sp., and *Liopistha protexta* (Conrad) are found in the upper phase at some places. Phosphatic material was not seen in the beds beneath the contact but was found in exposures 15 or 20 feet below the Midway. Foraminifera are present throughout the chalk.

Small exposures of upper Prairie Bluff chalk are in the eastward-facing low slope of Little Cane Creek Valley 1 mile west of Montpelier. This chalk and that penetrated in a 15-foot test hole are micaceous and somewhat sandy. Foraminifera are abundant. Above the chalk near the road is an 8-inch ledge of crystalline limestone containing scattered quartz grains, phosphatic nodules, and phosphatic internal molds of mollusk shells (*Baculites* sp. and gastropods), besides crinoid remains, ostracods, and foraminifera. Of the latter, *Tritaxia tricarinata* Reuss is extremely abundant, but a few *Nodosaria* sp. and *Robulus cultrata* (Montfort) were also noted. In all the foraminifera the chambers are filled with crystalline calcite. *Exogyra costata* Say and *Ostrea* sp. and a few shark teeth were also found in the limestone.

DISTRIBUTION OF PRAIRIE BLUFF FOSSILS

	M138	M300	M303	M311	M312	M313	M315	M317	M320	M321	M322	M323	M324
COELENTERATA													
Cliona sp.				x						x		x	
ECHINODERMATA													
Linthia variabilis Slocum										x			
VERMES													
Serpula rotula (Morton)								x		x			
Serpula pervermiformis Wade													x
Serpula sp.								x				x	
Hamulus huntensis Stephenson		x											
Hamulus onyx Morton								x					
MOLLUSCA													
Pelecypoda													
Nucula percrassa Conrad									x				
Nucula perequalis Conrad								x		x			
Nuculana longifrons (Conrad)	x												
Glycimeris rotundata (Gabb)					x								x
Idonearca capax (Conrad)	x	x		x		x		x		x	x	x	x
Idonearca sp.												x	
Inoceramus proximus Toumey													x
Inoceramus sp.								x					
Ostrea plumosa Morton	x							x		x			
Ostrea bryani Gabb					x								x
Ostrea tecticosta Gabb			x					x					x
Ostrea mesentarica Morton	x	x	x					x		x			
Gryphaea belli Stephenson									x				
Gryphaea mutabilis Morton	x							x					
Gryphaeostrea vomer (Morton)		x	x					x		x	x		x
Exogyra costata Say	x	x	x	x				x			x		x
Exogyra sp.								x				x	x
Trigonia thoracica Morton					x								x
Trigonia sp.				x		x						x	x
Pecten venustus Morton				x				x		x			x
Pecten sp.		x											
Plicatula urticosa Morton	x	x	x		x								
Lima reticulata Forbes	x												x
Anomia argentaria Morton	x			x				x					x
Paranomia scabra (Morton)												x	
Liopistha protexta (Conrad)					x								x
Cuspidaria jerseyensis (?) Weller	x												
Veniella conradi (Morton)	x					x							x
Crassatella vadosa Morton			x	x	x							x	x
Durania sp.								x					
Cardium spillmani Conrad													x
Cardium tenuistriatum (Whitfield)	x				x		x						x
Cyprimeria alta Conrad													x
Legumen ellipticum Conrad						x					x		x
Leptosolen biplicatus Conrad													x
Tenea parilis Conrad							x						
Gastropoda													
Epitonium sillimani (Morton)	x							x					x
Ellipsoscapha mortoni (Shumard)		x	x				x						
Ellipsoscapha aff. striatella (Shumard)								x					x
Aphrodina tippana Conrad													x
Capulus sp.								x		x			
Gyrodes abyssinus (Morton)			x							x	x	x	x
Gyrodes petrosus (Morton)	x	x	x		x		x	x		x	x		x
Xenophora leprosa (Morton)			x						x	x			x
Pleurotomaria crotaloides (Morton)								x					
Turritella encrinodes (Morton)													x
Turritella quadrilira Johnson	x												
Turritella vertebroides Morton				x						x	x		x
Turritella sp.			x										
Anchura abrupta Conrad											x		
Pyropsis aff. septemlirata Gabb											x		x
Pyropsis sp.		x	x										
Volutoderma (longoconcha) aff. dalli Stephenson											x		x
Volutoderma aff. tennesseensis Wade													x
Volutomorpha aff. ponderosa Whitfield													x
Pugnellus densatus Conrad													x
Cephalopoda													
Eutrephoceras perlatus (Morton)		x	x	x			x				x		x
Baculites claviformis Stephenson									x				
Baculites columna Morton									x				
Baculites asper (?) Morton								x	x				
Baculites sp.			x	x	x			x	x	x			x
Nostoceras cf. draconis Stephenson			x										x
Discoscaphites roanensis Stephenson								x	x				
Sphenodiscus sp.			x										
Belemnitella americana (Morton)		x											x
VERTEBRATA													
Shark teeth								x					
Fish vertebrae								x					

CENOZOIC GROUP — PALEOCENE SYSTEM — MIDWAY SERIES

CLAYTON FORMATION

The material unconformably overlying the Prairie Bluff formation belongs to the Clayton of the basal Midway. In Clay County the thickness averages 25 feet, whereas 35 or 40 miles to the north in Tippah County, the Clayton formation is 50 to 75 feet thick.[19] Outcrops are discontinuous in Clay County and limited to a few sidehill exposures. At a few places the disconformable relationship with the Prairie Bluff can be seen, but at other localities only the scattered shells of the little oyster, *Ostrea pulaskensis* Harris, identify the Clayton material.

The Clayton of Clay County is a glauconitic and micaceous finely sandy gray chalk that weathers to a reddish-brown sandy clay soil. At places this grades upward into gray or tan clays and silt forming the uppermost part of the formation and is transitional into the Porters Creek Clay. Dr. Kline's study of the fauna indicates that the contact at such places must be drawn on the basis of a faunal change for there is a mingling of Clayton fossils with Porters Creek fossils in the transitional zone. The basal portion has a relatively high sand content; it was this material that filtered into mollusk burrows in the uppermost Prairie Bluff chalk when the initial Midway sediments were laid down on the eroded Cretaceous surface.

The Clayton-Prairie Bluff contact is exposed in a roadcut (M61) on the north-facing slope of Johnson Creek Valley 3 miles north of Pheba, but at the edge of the valley about 1/2 mile to the northwest (NW.1/4, SW.1/4, Sec. 4, T.20 N., R.13 E.) a greater section is seen.

Section M61 of Johnson Creek Valley 3 miles north of Pheba

	Feet	Feet
Clayton ?		13.5
Clay, silty micaceous, somewhat glauconitic (in lenses usually associated with foraminifera) gray to light-tan; scattered lime nodules which weather out and collect on surface; hard waxy, conchoidally fractured in places; grades into silty topsoil (P-1)	13.5	
Clayton formation		15.2
Chalk, sandy glauconitic and somewhat gypsiferous greenish-gray; weathered brown on exposure; lower portion forms indurated ledge where exposed; *Ostrea pulaskensis* Harris		

shells in great abundance; scattered phosphatic internal molds of these and other mollusks	8.9	
Chalk, silty to sandy glauconitic, micaceous dark-gray; contains abundant internal molds of mollusks and scattered shell fragments	5.8	
Sandstone, fine-grained to medium-grained thin-bedded tan to brown calcareous; contains recrystallized calcite crystals; forms ledges on slopes above Prairie Bluff chalk	0.5	
Prairie Bluff chalk		5.8
Chalk, massive slightly micaceous soft gray; weathering light tan in upper part; contains internal molds of various mollusk shells, particularly *Baculites* sp.; borings filled with Midway sandy chalk in upper part (P-5)	5.8	

The following molds of diminutive mollusk shells from the Clayton chalk were identified:

Polinices sp.	Venericardia sp.
Anchura sp.	Leda aff. smirna Dall
Epitonium sp.	Anomia argentaria Morton (shells)
Cylichnina cf. recta Gabb	Cucullaea sp.
Caryophyllia sp.	Ostrea pulaskensis Harris (shells)

Small arenaceous tests of *Lituola erecta* Mellen and Gault are abundant on the Clayton outcrops at some places. These sturdy foraminifera are easily identified but may be overlooked because of the similarity of appearance to fragments of calcareous encrustations.

The most extensive exposure of the Clayton material is on the K. C. Curtis farm (SE. Cor., Sec. 14, T.16 S., R.3 E.) and adjacent properties, 8 miles north of Pheba. The basal Midway and Prairie Bluff chalk section exposed in the roadcut 1/10 mile east of the residence is given in the Prairie Bluff discussion. In addition to the chalk exposure, *Ostrea pulaskensis* Harris shells are scattered in the surface clay soil over most of the Curtis land north of the road and in the soil or on bald chalk patches on the properties to the southwest. Residual reddish-brown sandy clay of the Clayton forms part of the topsoil of a narrow strip approximately 1/2 mile long on the farms south of the Curtis property. Silicified fragmentary shells of *O. pulaskensis* Harris are found in this clay.

Such fragmentary shells are also in the same type of sandy clay soil at other localities (along road NE.1/4, SE.1/4, Sec. 31, T.21 N., R.13 E.; on pasture slopes SW.1/4, SW.1/4, Sec. 10, T.20 N., R.13 E.; in fields NE.1/4, NE.1/4, Sec. 21, T.20 N., R.13 E.) north and northeast of Pheba. Near Pheba the Clayton is obscured by a thin covering of alluvium.

A small exposure of Clayton is in the road ditch and embankment of the slope facing Prairie Creek 2 miles west of Montpelier. Pieces of indurated chalk or limestone containing abundant *Ostrea pulaskensis* Harris shells are scattered at the base of a slope in a pasture on the J. H. Cristopher property (N.1/2, N.1/2, NW.1/4, Sec. 9, T.20 N., R.13 E.) north of the road and 25 feet below an exposure of 15 feet of basal Porters Creek clay. About 3/4 mile farther east (NE. Cor., Sec. 9, T.20 N., R.13 E.) fossiliferous Clayton is exposed on a hillside north of the road.

The *Turritella mortoni* bed, characteristic of the Clayton in the northern part of the state, is not present in the material exposed in Clay County. The formation is represented by beds thinner than those to the north, but it appears to continue uniformly across the county into Oktibbeha County on the south.

PORTERS CREEK CLAY

The extreme western portion of the county lies in the eastern Flatwoods region composed of Porters Creek Clay and its residual soil. The belt of this formation in Clay County is approximately 5 miles wide in the southwestern township and narrows to an average width of 3 miles in the northern part. The clay seemingly attains a thickness of nearly 125 feet in the western edge of the county, but the maximum thickness in any exposure is not much over 50 feet. Alluvium covers the bottom lands of the southern part, but in the drainage canals a few feet of the Porters Creek clay are exposed. Numerous exposures of the clays of the lower part of the formation are along roadsides and hillside roadcuts from Johnson Creek at a point 3 miles north of Pheba northward to the county line. Canals and roadcuts in the western portion of the belt expose the clays higher in the formation.

The basal 8 or 10 feet of the clays are highly calcareous to chalky and glauconitic, and contain abundant foraminifera visible without the aid of a lens. Some of the larger foraminifera can be identified in the field, the long linear-chambered *Nodosaria latejugata* Gumbel and the coiled *Robulus midwayensis* (Plummer) being easily distinguishable in the clay. Good exposures of fossiliferous clays are in the lower part of gullies north of the road on the J. H. Cristopher property (SW.1/4, NE.1/4, NW.1/4, Sec. 9, T.20 N., R.13 E.) 3 miles north of Pheba and in gullies 1/2 mile northwest of the road where it enters Johnson Creek Valley.

On the Cristopher property 15 feet of clay are exposed in small gullies beginning at road level. The clay is smooth to silty, jointed and conchoidally fractured, and contains streaks or thin lenses of soft powdery lime along some of the fractures. Black iron carbonate stains some joints. The lower 2 feet of the exposure are very limy and glauconitic and contain a very abundant assemblage of foraminifera, many of the tests being clearly visible in the clay. Foraminifera continue in abundance in clays penetrated by a test hole below the exposure. About 8.5 feet of additional material were logged as Porters Creek clay.

The exposure to the northwest (NW.1/4, SW.1/4, Sec. 4) has been described under the discussion of the Clayton.

Basal clays are exposed on the Sim Dixon property in gullies north of the road west of a tributary of Little Cane Creek (NE. 1/4, Sec. 33, T.15 S., R.3 E.) 2 1/2 miles northwest of Montpelier. Approximately 20 feet of the clays are exposed, the base lying about 4 feet above the Clayton (penetrated by test hole). Foraminifera are abundant in buff-colored clays in the lower part of the exposure. Phosphatic nodules are scattered in the overlying clay.

A thin layer of ochreous tan bentonite was penetrated in test holes in the vicinity of Pheba 4.5 or 5 feet above the base of the Porters Creek clay. The extent of this bed is unknown, for in the holes drilled a few miles north of Pheba it was not noted but may have been so thin that it was overlooked.

Clays above the basal beds are exposed on Murrah Hill (SW. 1/4, NW.1/4, SW.1/4, Sec. 5, T.20 N., R.13 E.) in gullies on the Tom Logan property and along a roadcut on the slope facing Johnson Creek. The base of the lowest exposed clay is about 12 feet (test hole data) above the Clayton.

SECTION M48A OF MURRAH HILL

	Feet	Feet
Porters Creek clay		41.0
Clay, silty micaceous fossiliferous (foraminifera abundant in spots) tan; black stains along joints; thin-bedded, separating into thin layers when dry (P-2)	23.0	
Clay, tough compact uniform waxy; conchoidally fractured and greatly jointed; powdery lime concentrated along some of the joints; contains a few foraminifera and tiny flakes of mica (P-1)	18.0	

Abundant foraminifera were found in the lower 8 feet of the 12-foot interval of clay penetrated in the test hole drilled into the Clayton and Prairie Bluff chalk in the bottom of the gully.

Two miles farther west on the Mantee road, a cut on Dixie Hill 3/4 of a mile east of the Webster County line exposes the Porters Creek.

SECTION M88 OF DIXIE HILL

	Feet	Feet
Porters Creek clay		62.5
Clay-silt, heavily weathered reddish-tan	10.2	
Clay, very silty micaceous grayish-tan; breaks conchoidally, dries and splits into thin pieces; dark stains along joints; scattered foraminifera and a few shell fragments in lower part (P-2)	46.9	
Clay, compact tough slightly silty micaceous grayish-tan; streaks of gray; scattered foraminifera; breaks conchoidally (P-1)	5.4	

An excellent exposure of Porters Creek clay is along a road-cut on Pinebluff Hill (E.1/4, E.1/2, NW.1/4, Sec. 17, T.16 S., R.13 E.) overlooking Line Creek north of the Pinebluff community. The base of the following section is estimated to be about 40 feet above the Clayton as determined from a test hole at the base of the hill.

SECTION M332 OF ROAD CUT ON PINEBLUFF HILL

	Feet	Feet
Porters Creek clay		61.0
Silt and clay, sticky and tenaceous; mottled and streaked light tan and dark tan	9.0	
Clay, smooth tough somewhat waxy tan; greatly jointed, conchoidal fracture; laminated by micaceous silt, thin lenses of		

same material; iron oxide along joints; grades upward into silt (P-2) 10.0

Clay-silt, highly micaceous gray-brown; generally massive but jointed (lacks conchoidal fracture) with iron-oxide stains along joints; thin layers of silt at intervals; exposed weathered surface splits into thin sheets (P-3) 9.0

Clay, somewhat silty micaceous and somewhat waxy tough brown; silt scattered throughout; exposed weathered surface breaks into thin layers and small pieces; very massive and jointed in fresh exposure—some conchoidal fracturing; iron oxide along joints and fractures. Two internal molds of gastropods found. This bed is apparently the weathered equivalent of the bed below (P-4) 17.5

Clay, massive tough silty micaceous somewhat waxy black; jointed, conchoidal fractures; scattered (very rare) shell fragments; a few streaks of white silt and of iron oxide (along joints) with some concentration of the oxide in soft patches (P-5) 15.5

A well on the church and school grounds at Pinebluff (NW. 1/4, Sec. 17, T.16 S., R.3 E.) is reported by George Simmons, driller, to have penetrated the following formations:

	Thickness Feet	Depth Feet
Porters Creek clay	80	80
Clayton	18	98
Prairie Bluff chalk	90	188
Ripley formation	160	348
Selma chalk	550	898
Eutaw formation	75	973

The thickness of the Porters Creek clay in the above log is insufficient, for at least 95 feet of clays are accounted for in the exposure and the test hole on the hill slope below the cemetery to the north. It is probable that too great a thickness was assigned to the Ripley formation.

Extremely micaceous silty clays and silts and a few thin layers of gray and tan finely grained glauconitic sandstone are exposed in the bed and banks of a canal of Line Creek (NE.1/4, Sec. 19, and NW.1/4, Sec. 20, T.16 S., R.3 E.) for a mile west of the road bridge one mile south of Pinebluff. Scattered foraminifera are in the clays, and the imprint of a solitary coral (*Flabellum* ? sp.) was found. The clays show only a slight dip westward throughout the mile exposure in the canal, and at places a flattening is suggested. Spheroidal joint weathering has developed in some of the siltier clays in the bed of the canal. These beds of the Porters Creek clay are probably a little higher stratigraphically than the upper clays at Pinebluff.

COLUMBUS AND GREENVILLE RAILROAD WELL, WEST OF DEPOT, PHEBA
DRILLER: J. H. HARRIS ELEV. 275 FEET

	Thick.	Depth
Porters Creek clay*		
Weathered "soil"	16	16
Chalky clay, gray	14	30
Basal Midway (Clayton)*		
Chalky clay, gray	28	58
Prairie Bluff chalk		
Hard rock	9	67
Chalk-like flint	60	127
Ripley formation		
Sand	18	145
Sand, hard drilling	19	164
Rock with little sand	39	203
Tight sand	21	224
Tight sand, some water	14	238
Selma chalk		
Chalk, very tough white	3	241
Hard chalk	69	310
Hard flint	2	312
Hard white chalk	165	477
Gumbo, very hard	6	483
Dark chalk	158	641
Dark shale	26	667
Hard rock	1	668
Dark shale	36	704
Gumbo, very bad	20	724
Hard rock	4	728
Shale and gumbo	5	733
Hard rocks and gumbo	16	749
Gumbo and rocks	43	792
Eutaw formation		
Hard sand rock	6	798
Dark shale and gumbo	17	815
Tight sand	17	832
Hard sand rock	3	835
Good water sand	10	845
Tight sand	14	859
Very hard sand rock	1	860
Good water sand	51	911
Very hard sand rock	2	913

*Determined from test hole drilled east of depot.

CENOZOIC GROUP — PLIOCENE, PLEISTOCENE, AND RECENT

PLEISTOCENE AND PLIOCENE ? TERRACES

Over part of the region underlain by the lower Selma and lower Demopolis member of the chalk, terrace sand and clay were laid down by streams during the late Pliocene or Pleistocene. These deposits are extensive along Tibbee Creek in the eastern part of the county and cover the area of West Point to a depth of 10 to 20 feet. Similar deposits are adjacent to Sakatonchee Creek in the central portion of the county.

In the Tibbee Creek area two or three terraces appear to have been formed at successive levels. The materials are mostly fine-grained sands and clays, gravel being almost entirely absent. Along the Tombigbee River, terrace gravels cap the Tombigbee sand member of the Eutaw formation, and lenses of the gravels have been opened for road materials. The gravel pit at Waverly supplies most of the county needs.

Clays in the terrace deposits are silty to sandy, gray or tan and are usually streaked by iron oxide stains and laminated by thin layers of silt and fine-grained sand. Ceramic tests were made on samples of such clays in the southeastern part of the county.

During the present survey no attempt was made to study the terraces in any detail. Their distribution has been previously indicated on the surficial map of the Cretaceous area in the report by Stephenson and Monroe.[20]

ALLUVIUM

Alluvial sand, silt, and gravel, reworked from Cretaceous sediments and Pleistocene terrace deposits, cover the bottomlands and floodplains of streams crossing the county.[21] Built by the present drainage system in recent or late Pleistocene time, these areas are relatively fertile, but proper drainage is necessary to enable full utilization for agricultural purposes. Uncultivated portions quickly become covered with a thick vegetation of vines and briars. The alluvium is comparatively thin, and apparently its maximum thickness does not exceed 10 feet.

STRUCTURAL GEOLOGY

PHEBA STRUCTURE

In the southwestern portion of Clay County a minor structure was mapped on the basal Midway and was designated the Pheba structure, for it is restricted to the area in and around the town of Pheba (Secs. 20 and 21, T.20 N., R.13 E.).

Although the basal Midway key bed is exposed as indurated ledges of sandy limestone or weathered glauconitic sands containing innumerable shells and phosphatic internal molds of *Ostrea pulaskensis* Harris 3 miles north of Pheba, it is covered by basal Porters Creek clay and Clayton chalk in the Pheba environs. Consequently, the structure was determined by hand auger test holes.

The structure is a small flattened anticlinal nose extending westward across Pheba. In the eastern mappable limits the bed dips westward 30 or 40 feet in a half mile; in the town it flattens for 3/4 mile along the 230-foot and 240-foot contour line; in the southern part the bed dips south and southwest about 40 feet in a mile and forms an eastward-pointing synclinal nose, the south limb striking southwest; on the western part the bed dips sharply west and northwest approximately 70 or 80 feet a mile. A small irregularity from the northern eastward-pointing synclinal nose extends partway on to the structure.

A comparison of water well logs of Pheba and the areas to the east suggests possible minor faulting east of town. At Pheba the Selma-Eutaw contact is about minus 540 feet; near Waddell it is minus 380 feet; and at Cedarbluff it is minus 305 feet. Thus the 3 miles between Cedarbluff and Waddell average 25 feet a mile dip; whereas the four-mile interval from Waddell to Pheba averages 40 feet a mile; possibly the greatest rate of dip is in the mile and a half east of Pheba.

This structure is likely too small in itself to have permitted oil and gas accumulation. The Eutaw sands here are relatively shallow, lying about 800 feet below the surface and bearing fresh water. Furthermore the Clayton lies but a few feet above a disconformity between the basal Midway and the Prairie Bluff chalk, and a great unconformity separates the Cretaceous from the old Paleozoic rocks. This small Pheba structure, however, may be a part of a larger one toward the south and may especially reflect post-Cretaceous movement along an old buried Paleozoic structure.

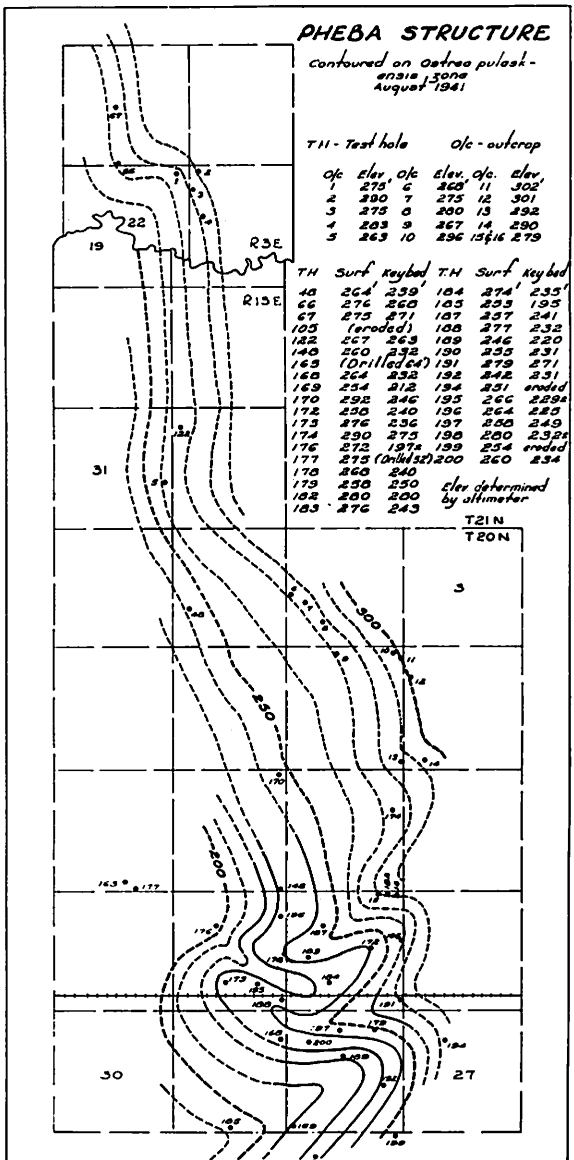

Figure 14.—Pheba structure.

NORTHERN CLAY COUNTY STRUCTURE

In the northern part of the county in the area east of the Kilgore Hills there is a suggestion of faulting though surface evidence is somewhat meager.

In 1930 and 1931 the Ohio Oil Company drilled a 4680-foot well, known as Cantrell No. 1, in a test for oil (NE.1/4, NE.1/4, Sec. 16, T.15 S., R.5 E.). The derrick floor elevation of the well is given as 270 feet. Monroe and Stephenson[22] suggest that the well commenced about midway between the *Diploschiza cretacea* zone and the top of the *Exogyra ponderosa* zone. The well penetrated 523 feet of Selma chalk.

Water wells drilled in and around the vicinity of Cedarbluff, Pheba, Beasley, Pinebluff, and Montpelier indicate that 520 to 560 feet of Selma chalk were penetrated and represent the thickness of the chalk in that region. Records for individual wells are as follows:

THICKNESS OF SELMA CHALK IN WATER WELLS*

Location	Well	Driller	Thickness
Cedarbluff	School well	George Tribble	560
Cedarbluff	Lyon's well	George Tribble	560
Pheba	C. & G. R. R. well	J. H. Harris	554
Pheba	J. R. Terry	J. H. Harris	548
Caro		George Simmons	530
Henryville	Walter Powell	George Simmons	520
Beasley		George Simmons	540
Montpelier	(2 miles north)	George Simmons	540
Pinebluff	School & Church	George Simmons	550

*Interpretations from drillers' logs.

Using these figures as a basis, they would indicate that the total original thickness of the Selma at the Cantrell No. 1 well site could not have greatly exceeded 570 feet, whereas its stratigraphic position given by Monroe and Stephenson would mean an original thickness of 100 to 125 feet more than was penetrated.

To the southeast of the Cantrell well in Sec. 35, T.15 S., R.5 E., the *Diploschiza cretacea* zone at 238 feet elevation swings northwest across Sec. 34 and in the middle of the section is at

213 feet elevation. Beyond the northeast corner of Sec. 33, the zone is lost in a swamp at a point 3 miles south of the test well site and cannot be located north of the swamp. On the east edge of the county, however, in the same township and range the zone is exposed in two areas, one bordering Sec. 24 and an adjacent area in Monroe County; the other locality in the east edge and northeast corner of Sec. 1 and along the road adjacent in Monroe County. At this latter point (SW.1/4, SW.1/4, Sec. 6, T.15 S., R.6 E.) the elevation was determined at 240 feet.

The conditions cited above can be explained if a fault is postulated. Assuming the thickness of the Selma chalk in the western part of the county as being indicative of the total thickness of the chalk throughout that area, the Cantrell No. 1 log suggests that nearly the entire thickness of the chalk may be present and that the well was located on the downthrow side of a fault trending northwest-southeast through the region (T.15 S., R.5 E.). This would place the top of the Selma at the well site at 70 to 80 feet lower than it is 5 miles down dip to the southwest and west, for altimeter readings on the Ripley-Selma contact at several localities across T.15 S., R.4 E. give elevations ranging from 335 to 350 feet.

The distribution of the *Diploschiza cretacea* zone also suggests faulting. In the northern part of Clay County the zone does not appear to be more than a few feet thick. On the east edge of the county the zone is exposed 3 miles east of what should be the normal projected area of its continuance from the south. The absence of the zone as noted and its presence to the east suggest structural conditions, for in both areas the elevation is about the same.

ECONOMIC GEOLOGY

AGRICULTURAL LIME

Mellen in 1941 made an investigation of the limestones of Mississippi for the Agricultural Adjustment Administration, and the results of this survey were published as Bulletin 46 of the Mississippi State Geological Survey. In Clay County the Selma chalk was sampled at five localities, and the material was analyzed at the Mississippi State Chemical Laboratory. The published analyses show a range of 62.55 percent[23] $CaCO_3$ for the lower Demopolis chalk to 87.48 percent[24] for the upper beds. Mellen's work and subsequent tests made in the Mississippi State Geological Survey laboratory indicate that the upper portion of the Demopolis member of the Selma chalk offers the best material for agricultural lime because of the high-calcium content. The soil mantle is thin over most of the upper Demopolis area and the numerous bald spots are indicative of the accessibility of the chalk. There are several exposures of considerable thickness along this belt, and some of these are so conveniently located to the highways that the deposits could be easily worked to supply a large amount of lime for local needs and for shipment.

The most accessible high-calcium chalk deposit is located on Highway 10, one mile east of Cedarbluff. There a total thickness of 50 feet of the Demopolis chalk is exposed near the road, south of Line Creek. A 30-foot composite sample of chalk from the Pete Winfield property (Sec. 22, T.20 N., R.14 E.) analyzed 83.07 percent $CaCO_3$; samples from adjoining property of Williams Brothers, 86.13, 87.48, and 85.06 percent.[25] Mellen points out that this deposit is accessible to portions of Chickasaw, Calhoun, Webster, Montgomery, and Oktibbeha Counties and possibly to other counties farther west. This chalk could easily be quarried and hauled by truck to Cedarbluff for rail shipment in the raw state, or a lime plant could be maintained at the town. The site offers excellent possibilities for development because of the accessibility and extent of the exposure.

Another exposure of the same high-calcium chalk lies 3 1/2 miles north of Abbott. This is on property owned by Mrs. John Walker and M. Weber. The exposure (SW.1/4, Sec. 33, T.15 S., R.5 E.) of 30 feet of chalk is located conveniently to the county road. Chalk exposures of the Andrew Dexter property (Sec. 14, T.15 S., R.5 E.) south of Caradine community analyzed 79.06 percent[24] $CaCO_3$. This property is adjacent to Highway 47.

The chalk on the Pete Winfield property east of Cedarbluff listed herein as sample M331-1 and on the E. H. Walker property as sample M330-3 (SW.1/4, SW.1/4, Sec. 33, T.16 S., R.5 E.)

was tested in the Mississippi Geological Survey laboratory and found to contain 48.30 percent lime (CaO) and 40.28 percent lime (CaO) respectively. An analysis from the laboratory of the State Chemist of the 15-foot exposure on the Walker property shows 70.05 percent[24] $CaCO_3$. This same chalk is exposed for nearly 3/4 mile in the east-facing bluff of Long Creek, 2 miles west of Siloam School which is on Highway 47.

The lower Demopolis chalk appears to be lower in combined $CaCO_3$ content than chalk from the upper portion of the member. Mellen's report[26] on a sample from the Bory Moseley property (see M329 for section of exposure) indicates it is considerably below the 70 percent minimum requirement for agricultural lime.

A sample, M325-3, of lower Selma chalk on the McDonald property (NE.1/4, SW.1/4, Sec. 20, T.16 S., R.7 E.) north of the Vinton road and west of Town Creek was tested in the Survey laboratory and found to have the qualities necessary for agricultural usage. However, the tests in general indicate the lower Selma and lower portion of the Demopolis chalk member would be better adapted for natural cement material.

LIME PRODUCTS

Chemical and physical tests of the chalk from the lower Selma and the Demopolis member as well as from the Prairie Bluff indicate an abundance of material suitable for natural cement in Clay County. Exposures are accessible to good roads at many places in the county, and the convenience of transportation to West Point offers an excellent opportunity for development.

Portland cement could be made from the Demopolis chalk, but, as McCutcheon suggests, the economic factors involved adapt the chalk deposits better for natural cement development.

Mineral wool could be manufactured from the impure chalk of the lower Selma, the Prairie Bluff, the Clayton, and from the basal calcareous Porters Creek clay. Convenience of location and accessibility of material would determine the geologic formation to be utilized.

BRICK AND TILE CLAYS

Some of the typical lower Porters Creek clay of Clay County can be used for face brick and common brick, but the area of exposure is limited to the extreme western portion of the county and development would be handicapped for rail facilities. The basal portion of the Porters Creek clay is so highly calcareous that it is of no value for most ceramic purposes but may supply some local lime needs.

Terrace and alluvial clays overlying the lower Selma chalk are of value for tile and face brick. Some of these were for-

Figure 13.—Characteristic Pleistocene terrace gravels of the Tombigbee River area, gravelpit near Waverly. August 1941.

merly used in the past when two clay pits were in operation in West Point. The relative thinness of the deposits is a drawback to any extensive development.

GRAVEL

Pleistocene terrace gravel deposits are found along the Tombigbee River, resting on the Tombigbee sand member of the Eutaw. A pit opened in a lens deposit (Figure 13) at Waverly furnishes considerable gravel which is transported by truck or rail to supply some of the local county needs for highway and construction purposes. The deposits are too limited to be of value for other than local use.

SECTIONS AND TEST HOLE RECORDS

BEN SMITH PROPERTY

TEST HOLE M19

Location: T.17 S., R.7 E., Sec. 35, NE.1/4, NE.1/4, NW.1/4; along a fence row 50 feet south of road and 1/2 mile east of Stevens Switch

Drilled: April 25, 1941

Water level: 14.5 feet

No.	Depth	Thick.	Description of strata
			Terrace deposits
1	10.5	10.5	Clay, sandy gray; streaked by dark brown and black iron oxide or siderite; small concretions of the same material; traces of limey material and of lignite; basal part smooth; P-1
2	12.6	2.1	Clay, sandy tan; greenish-gray streaks
3	15.8	3.2	Clay, stiff sandy gray; iron oxide streaks
4	17.2	1.4	Clay, sandy yellow mottled, gray; interbedded thin layers of sand
			Eutaw formation (?)
5	24.9	7.7	Sand, fine-grained to silty somewhat micaceous tan; gray sandy clay streaks; scattered tiny lime concretions; S-5
			Eutaw formation (Tombigbee member)
6	26.5	1.6	Sand, fine-grained to silty micaceous, glauconitic dark greenish-gray

Remarks: Part of the lower terrace deposits may be reworked Selma.

CHARLIE HUNTER PROPERTY

TEST HOLE M21

Location: T.17 S., R.7 E., Sec. 27, SW.1/4, NW.1/4, NW.1/4; at edge of field, 12 feet east of road and 5 feet east of ditch

Drilled: April 24, 1941

Water level: 16.0 feet

No.	Depth	Thick.	Description of strata
			Alluvial deposits
1	8.0	8.0	Clay, sandy gray; scattered concretions and iron oxide streaks; P-1
2	12.0	4.0	Clay, silty to arenaceous gray; mottled and streaked by tan iron oxide; iron carbonate; S-2
3	14.5	2.5	Clay, silty; heavily oxidized tan; laminated by thin layers of silt and fine-grained brown sand; S-3
4	15.4	0.9	Clay, sandy gray and tan; S-4
5	18.4	3.0	Clay, silty to arenaceous tan and gray; streaks of smooth sticky light-tan clay; S-5

HENRY GIBBS PROPERTY

TEST HOLE M31

Location: T.17 S., R.7 E., Sec. 29, SE. Corner; on wooded slope, 75 feet southwest of road corner
Drilled: April 29, 1941
Water level: 5.0 feet

No.	Depth	Thick.	Description of strata
			Terrace deposits
1	7.5	7.5	Clay, sandy gray; streaked brown; laminated by gray silt
			Lower Demopolis member of Selma chalk
2	14.4	6.9	Clay, silty, calcareous gray; very sticky when wet; P-3

ALEC MELTON PROPERTY

TEST HOLE M35

Location: T.17 S., R.7 E., Sec. 4, SE.1/4, SE.1/4, NE.1/4; at foot of hill near pecan tree 30 feet west of road
Drilled: April 29, 1941
Water level: 2.2 feet

No.	Depth	Thick.	Description of strata
			Alluvium
1	2.2	2.2	Sand, medium-grained grayish-tan
			Terrace deposits
2	19.5	17.3	Clay, sandy gray; streaked by brown iron oxide and white silt; concretions of siderite (?); iron content increases with depth; P-2
			Selma formation (?)
3	25.6	6.1	Clay, silty to somewhat sandy, slightly micaceous gray; tan streaks; laminated by white silt and fine-grained sand; P-3

Tom Logan property

Test hole M48

Location: T.20 N., R.13 E., Sec. 5, SW.1/4, NW.1/4, SW.1/4; at the base of a gully developed in the Porters Creek clay on Murrah Hill; about 50 yards west of county road Drilled: May 1-3 and 7, 1941

Elevation: 264 feet Water level: 14.5 feet

No.	Depth	Thick.	Description of strata
			Porters Creek clay
1	12.2	12.2	Clay, silty to smooth and tough; somewhat micaceous grayish-tan; abundant foraminifera; P-1
			Clayton chalk
2	23.7	11.5	Chalk, slightly silty micaceous, glauconitic gray; abundant foraminifera; P-2
3	32.0	8.3	Chalk, sandy glauconitic, pyritiferous gray; scattered foraminifera; shells of *Ostrea pulaskensis* Harris at 24.8 feet and for 5 or 6 feet below
			Prairie Bluff chalk
4	45.5	13.5	Chalk, fossiliferous slightly micaceous gray

Remarks: Hole, 50 feet to west, drilled on July 18 logged water at 24 feet.

Highway right-of-way and Tom Logan property

Section M48A

Location: T.20 N., R.13 E., Sec. 5, SW.1/4, NW.1/4, SW.1/4; gully west of road and roadcut along Murrah Hill Sampled: May 1, 1941

No.	Feet	Thick.	Description of strata
			Porters Creek clay (lower part)
1	23.0	23.0	Clay, silty, micaceous fossiliferous tan (forams abundant in spots); black manganiferous (?) stains along joints; thin-bedded, separating into thin layers when dry; P-2
2	41.0	18.0	Clay, tough compact uniform waxy; conchoidally fractured and greatly jointed; powdery lime concentrated along some of the joints; contains a few foraminifera and tiny flakes of mica; P-1

Remarks: Section exposed in gully and along roadcut to top of hill; base 2 feet above surface at test hole M48.

JABE CHRISTOPHER PROPERTY

SECTION AND TEST HOLE M49

Location: T.20 N., R.13 E., Sec. 9, SW.1/4, NE.1/4, NW.1/4; in gullied area 10 yards N. of road and about 1/10 mile E. of road forks

Drilled: May 2-7, 1941

Elevation: test hole 286

Water level: 16.2 feet

No.	Depth	Thick.	Description of strata
			Porters Creek clay (basal)
1		15.3	Clay, smooth to slightly silty compact but jointed and conchoidally fractured; streaks and lenses of soft powdery lime filling some fractures; black iron carbonate stains along some joints; lower 2 feet glauconitic and contains very abundant foraminifera, P-1
	(Surface of hole)		
2	8.7	8.7	Clay, tough gray calcareous, chalky, slightly glauconitic; foraminifera very abundant; a few fragments of oyster shell; S-2
			Clayton chalk
3	17.6	8.9	Clay, tough gray calcareous, somewhat glauconitic and micaceous; abundant foraminifera and fragments of shells; S-3
4	26.0	8.4	Clay, sandy micaceous, glauconitic gray to somewhat chalky; scattered foraminifera and shell fragments; S-4
5	26.5	0.5	Sandstone, calcareous, glauconitic hard greenish-gray

Remarks: Bed No. 1 exposed in gullies; measured by hand level.

GEORGE SANDERS PROPERTY

TEST HOLE M55

Location: T.16 S., R.3 E., Sec. 29, SW.1/4, NW.1/4, SE.1/4; near base of N. sloping hill; 25 feet east of road and 1/10 mile north of road intersection
Drilled: May 5, 1941
Water level: 23.6 feet

No.	Depth	Thick.	Description of strata
			Porters Creek clay
1	2.3	2.3	Clay, slightly micaceous silty tan-streaked, brown; laminated by ferruginous silt; upper part contains small black siderite concretions
2	9.0	6.7	Clay, tough somewhat waxy silty micaceous tan; streaks and concretions of dark brown siderite; P-2
3	25.8	16.8	Clay, silty micaceous, gypsiferous brown; streaked mottled slightly by reddish-brown siderite; P-3

W. B. SNELL PROPERTY

TEST HOLE M59

Location: T.16 S., R.3 E., Sec. 9, NE.1/4, NE.1/4, SW.1/4; in pine grove opposite farm house, 50 feet west of road location
Drilled: May 7, 1941
Water level: Dry

No.	Depth	Thick.	Description of strata
			Colluvial Porters Creek clay
1	2.4	2.4	Clay, very silty gray; reddish brown streak
			Porters Creek clay
2	14.0	11.6	Clay, tough waxy smooth grayish-tan; somewhat silty and micaceous in places; jointed and conchoidally fractured; lime (?) streaks along some joints; P-2

Remarks: 5 to 6 feet exposure of hard waxy conchoidal fractured clay in ditch on east side of road. Part of P-2 taken from this interval.

First National Bank property

Section and test hole M61

Location: T.20 N., R.13 E., Sec. 4, NW.1/4, SW.1/4; on S. wooded slope overlooking Johnson Creek valley, 1/2 mile west of road

Sampled and drilled: May 5, 1941

Water level: 19.0 feet

No.	Depth	Thick.	Description of strata
			Clayton ?
1	13.5	13.5	Clay, silty micaceous, somewhat glauconitic (in lenses usually associated with foraminifera); gray to light-tan; contains scattered lime nodules which weather out and collect on surface; in places hard and grades into silty topsoil; P-1
			Clayton chalk
2	22.4	8.9	Chalk, sandy glauconitic and somewhat gypsiferous greenish-gray; weathered brown on exposure; lower portion forms indurated ledge where exposed; *Ostrea pulaskensis* shells in great abundance; scattered phosphatic internal molds of these and other mollusks
3	28.2	5.8	Chalk, silty to sandy glauconitic, micaceous dark-gray; contains abundant internal molds of mollusks and scattered shell fragments
4	28.7	0.5	Sandstone, calcareous fine-grained to medium-grained thin-bedded tan to brown; contains recrystallized calcite crystals; forms ledges on slopes above Prairie Bluff chalk
			Prairie Bluff chalk
5	34.5	5.8	Chalk, massive slightly micaceous soft-gray; weathering light-tan in upper part; contains internal molds of various mollusks particularly *Baculites* sp.; P-5
6	37.0	2.5	Chalk, soft crumbly slightly micaceous grayish-tan; contains foraminifera; S-6
7	48.1	11.1	Chalk, soft slightly micaceous gray; S-7

Remarks: Composite log obtained from test hole on top of slope and data of measured section exposed in gullies; samples from exposures; beds 6 and 7 drilled at base of slope.

JIM MAYS PROPERTY

SECTION M88

Location: T.15 S., R.3 E., Sec. 31, NW.1/4, SE.1/4, NE.1/4; on Dixie Hill

Sampled: May 20, 1941

No.	Feet	Thick.	Description of strata
			Porters Creek clay
1	10.2	10.2	Clay-silt, heavily weathered reddish-tan
2	57.1	46.9	Clay, very silty micaceous grayish-tan; breaks conchoidally, dries and splits into thin pieces; dark stains (iron carbonate) along joints; scattered foraminifera and a few shell fragments in lower part; P-2
3	62.5	5.4	Clay, compact tough slightly silty micaceous grayish-tan; gray streaks; scattered foraminifera; breaks conchoidally; P-3

Remarks: Section measured along road on hill; hole drilled 16.2 feet at top of hill beside oak at west edge of wagon trail and 10 yards east of road.

FEDERAL LAND BANK PROPERTY

TEST HOLE M90

Location: T.15 S., R.3 E., Sec. 29, NE.1/4, SE.1/4, NW.1/4; 75 feet east of road and about 80 feet north of gullies on hillside Drilled: May 20, 1941

Water level: Dry

No.	Depth	Thick.	Description of strata
			Colluvium of Porters Creek clay
1	2.6	2.6	Clay, silty brown mottled, tan and reddish-brown
			Porters Creek clay (lower part)
2	4.7	2.1	Clay, compact light grayish-tan; breaks readily into small rectangular pieces
3	8.9	4.2	Clay crumbly silty gray; mottled tan and brown except in lower part of bed
4	16.5	7.6	Clay, compact tough micaceous grayish-tan; streaks of silt and dark-gray stains; breaks conchoidally and drys in thin sheets; scattered foraminifera and chalky shell fragments; P-4a

Remarks: Test hole 9.9 feet deep; bed 4 was measured and sampled from gullied hillside.

ROADSIDE PROPERTY

SECTION M148A

Location: T.20 N., R.13 E., Sec. 20, NE.1/4, NE.1/4, NE.1/4; roadcut through bluff facing north on Double Cabin Creek

Sampled: August 2, 1941

Elevation: 247 feet

No.	Feet	Thick.	Description of strata
			Porters Creek clay (lower phase)
1	8.0	8.0	Clay, smooth compact light-tan; jointed and conchoidally fractured, manganese stains along joint planes; scattered tiny flakes of mica and calcareous foraminifera; P-1

McDONALD PROPERTY

SECTION M325

Location: T.16 S., R.7 E., Sec. 20, NE.1/4, SW.1/4; on east-facing slope north of Vinton road; 1/3 mile west of Town Creek

Sampled: August 14, 1941

No.	Feet	Thick.	Description of strata
			Lower Selma chalk
1	20.0	20.0	Colluvial clay, calcareous light-brown; contains numerous shell fragments
2	20.6	0.6	Chalk, layers; brown thin indurated; composed mostly of cemented shell fragments from *Ostrea panda* and *O. falcata;* S-2
3	30.0	9.4	Chalk, compact tannish-gray and gray; contains shell fragments; grades down beneath flood plain of Town Creek; P-3

H. C. SUGG PROPERTY

SECTION M326

Location: T.16 S., R.7 E., Sec. 28, NE.1/4, NW.1/4, NE.1/4; on west-facing bank of Town Creek; 300 feet south of Vinton road

Sampled: August 14, 1941

No.	Feet	Thick.	Description of strata
			Lower Selma chalk colluvium
1	8.0	8.0	Clay-soil, residual dark-brown; contains a small amount of broken and badly weathered thin shell fragments (*Ostrea panda* ?)
			Lower Selma chalk
2	18.0	10.0	Chalk, compact slightly micaceous and pyritiferous gray; contains numerous shell fragments, especially complete *Ostrea panda* specimens; a few imprints of *Inocerami* sp. shells; P-2, S-2

K. C. CURTIS PROPERTY

SECTION M328

Location: T.16 S., R.3 E., Sec. 14, SE.1/4, SW.1/4, SW.1/4; exposure along bluff about 1/4 mile northeast of K. C. Curtis residence

Elevation: 301 feet Sampled: May 10, 1941

No.	Feet	Thick.	Description of strata
			Clayton colluvium
1	11.3	11.3	Clay, sticky dark-brown to black; scattered molds and silicified shells of *Ostrea pulaskensis* on hillside
			Clayton chalk
2	17.3	6.0	Chalk, sandy glauconitic, slightly micaceous grayish-tan; abundant fossils; shells and molds of *Ostrea pulaskensis* form an indurated ledge about 3 feet above base and are scattered on surface and slope above; P-2
			Prairie Bluff chalk
3	24.0	6.7	Clay, chalky tan; scattered shells of *Ostrea plumosa*; this is the weathered phase of the chalk and varies in thickness from 6 to 8 feet along the slope of the exposure
4	41.5	17.5	Chalk, slightly micaceous, glauconitic gray; abundant foraminifera, oyster shells, and internal molds of *Baculites* sp.; P-4a (upper 6 feet), P-4b

BORY MOSELEY PROPERTY

SECTION M329

Location: T.19 N., R.16 E., Sec. 6, SE.1/4, SE.1/4; on north-facing bluff of Tibbee bottoms; 1/4 mile east of Highway 45W

Sampled: August 26, 1941

No.	Feet	Thick.	Description of strata
			Lower Demopolis member of Selma chalk
1	16.5	16.5	Clay, chalky brownish-tan; contains numerous lime concretions
2	39.5	23.0	Chalk, compact slightly micaceous light-gray; very fossiliferous — chiefly *Ostrea plumosa*, *Hamulus squamosus* and scattered *Exogyra* valves; P-2
3	45.2	5.7	Chalk talus from above

Remarks: Area extensively gullied; top at the base of *Diploschiza cretacea* zone.

E. H. WALKER PROPERTY

SECTION M330

Location: T.16 S., R.5 E., Sec. 33, SW.1/4, SW.1/4; exposure in eastward facing bluff of Long Branch; north of county road

Sampled: August 27, 1941

No.	Feet	Thick.	Description of strata
			Selma chalk colluvium
1	11.0	11.0	Clay, calcareous finely sandy brown; contains shell fragments
			Demopolis member of Selma chalk
2	20.0	9.0	Chalk, white massive, slightly sandy
3	35.0	15.0	Chalk, massive compact light-gray; contains following fossils—*Exogyra costata*, *Exogyra cancellata* and *Anomia tellinoides* in abundance; *Paranomia scabra* scattered; a few vertebrate fragments; marcasite concretions abundant; P-3
4	40.6	5.6	Colluvial chalk to Long Branch flood plain

Remarks: Listed fossils range throughout exposure; collection made.

PETE WINFIELD PROPERTY

SECTION M331

Location: T.20 N., R.14 E., Sec. 22, NW.1/4, NE.1/4; roadside on bluff along west bank of Line Creek, one mile east of Cedarbluff

Sampled: June 10, 1941

No.	Feet	Thick.	Description of strata
			Demopolis member of Selma chalk
1	50.0	50.0	Chalk, massive light-gray to white; contains abundant marcasite concretions of irregular shape and size, also the following fossils: *Gryphaea mutabilis* Morton, *Ostrea falcata* Morton, *Exogyra cancellata* Stephenson, *Paranomia scabra* (Morton). *Pecten* sp., *Inoceramus* sp.

Remarks: Sample P-1 was taken from the upper 15 feet of the section.

TOM MOSELEY PROPERTY

PINEBLUFF SECTION M332

Location: T.16 S., R.3 E., Sec. 17, SW.1/4, NW.1/4, NE.1/4; cut along roadside on Pinebluff Hill Sampled: May 5, 1941

No.	Feet	Thick.	Description of strata
			Porters Creek clay colluvium
1	9.0	9.0	Silt and clay, sticky and tenaceous; mottled and streaked light and dark tan
			Porters Creek clay (lower part)
2	19.0	10.0	Clay, smooth tough somewhat waxy tan; greatly jointed; conchoidally fractured; laminated by micaceous silt, thin lenses of same material; iron oxide along joints; grades upward into silt; P-2
3	28.0	9.0	Clay-silt, highly micaceous gray-brown; generally massive but jointed (lacks conchoidal fracture) with iron oxide stains along joints; thin layers of silt at intervals; exposed weathered surface splits into thin sheets; P-3
4	45.5	17.5	Clay, tough somewhat silty micaceous and somewhat waxy brown; silt scattered throughout; exposed weathered surface breaks into thin layers and small pieces; very massive and jointed in fresh exposure—some conchoidal fracturing; iron oxide along joints and fractures. Two internal molds of gastropods found. This bed is apparently the weathered equivalent of bed below; P-4
5	61.0	15.5	Clay, tough massive silty micaceous and somewhat waxy black; jointed; conchoidally fractured; very rare shell fragments; a few streaks of white silt and of iron oxide (along joints) with some concentration of the oxide in soft patches; P-5

Remarks: A test hole (M58) was drilled at a point 14 feet lower than the base of the section.

ACKNOWLEDGMENTS

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During most of the survey the crew was operated in six units of two or three men to a unit with a foreman-sampler in charge of two units. Considerable drilling efficiency was attained in this manner. Ordinary post hole augers were used for clay sampling, but for the exploratory work 2-inch spiral hard pan augers with stellite tips were used. With these augers it was possible to drill relatively deep holes in the chalk. Breakage of wrenches, frequently a somewhat costly and certainly a nuisance item in this work, was eradicated by discarding the Stillson type of wrench and using unbreakable 14-inch Ridgid wrenches.

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CLAY COUNTY TESTS

THOMAS EDWIN McCUTCHEON, B.S., CER. ENGR.

INTRODUCTION

Two classes of minerals are found in Clay County: (1) the clays and (2) the chalk and limestone.

The Porters Creek clay, which was sampled extensively, seems to be of variable composition. Quartz silt and micaceous silt are the principal contaminating accessory minerals in the Porters Creek clay. Samples from Terrace deposits and Alluvial deposits are included in the clayey materials.

The calcareous or limy materials are from the Selma, Clayton, and Prairie Bluff formations. The compositions of the various materials show considerable variation; however, deposits are of sufficient size that a fairly uniform material could be won at a given location. The limy materials consist essentially of calcium carbonate and clay. Thermal decomposition curves of M326-2 indicate that the clay content is of the montmorillonite type. Under heat treatment, combined water in the sample is liberated at a fairly constant rate which varies with the degree of heat. Some of the lime appears to be combined with silica or alumina or both and is not present as the carbonate.

Two samples (M31-3, M35-3) contain so much clay that they are also classified under the clays.

CLAYS

PHYSICAL PROPERTIES IN THE UNBURNED STATE

Hole No.	Sample No.	Water of plasticity in percent	Drying shrinkage		Modulus of rupture in pounds per square inch	Color
			Volume in percent	Linear in percent		
M19	1	38.96	67.93	31.60	593	Brownish gray
M21	1	37.41	62.88	28.14	608	Brownish gray
M31	3	37.51	41.59	16.41	460	Gray
M35	2	25.10	34.17	13.02	433	Brownish gray
M35	3	27.32	32.35	12.24	448	Gray
M48	1	66.08	83.95	45.71	633	Gray
M48A	1	65.07	64.97	29.53	418	Gray
M48A	2	60.36	56.89	24.46	408	Gray
M49	1	70.96	82.27	43.85	420	Gray
M55	2	36.89	56.72	24.40	487	Brownish gray
M55	3	43.19	67.81	31.53	581	Brownish gray
M59	2	59.92	71.00	33.81	503	Gray
M88	2	50.83	41.75	16.51	281	Gray
M88	3	68.41	43.70	17.57	341	Gray
M90	4	60.61	63.30	28.40	432	Gray
M148A	1	64.42	60.07	26.38	522	Gray
M332	2	54.45	72.49	34.97	564	Gray
M332	3	47.29	41.63	16.46	345	Gray
M332	4	52.37	52.79	22.14	501	Gray
M332	5	57.80	56.97	24.52	465	Dark gray

SCREEN ANALYSES

Sample M31-3

Retained on screen	Percent	Character of residue
60	6.14	Abundance of calcareous clay nodules; considerable quantity of fossil fragments; small amount of pyrite.
100	13.13	Abundance of calcareous clay nodules; considerable quantities of fossils and fossil fragments; traces of quartz, limonite, and muscovite.
250	16.30	Abundance of calcareous clay nodules; considerable quantity of fossils.
Cloth	64.43	Clay substance including residue from above.

SAMPLE M35-2

Retained on screen	Percent	Character of residue
60	2.20	Abundance of quartz; considerable quantity of limonitic nodules; small amount of ferruginous material; trace of plant fragments.
100	6.50	Abundance of quartz; considerable quantity of limonitic clay nodules; trace of ferruginous material.
250	13.91	Abundance of quartz; considerable quantity of limonitic clay nodules; small amount of ferruginous material.
Cloth	77.39	Clay substance including residue from above.

SAMPLE M35-3

Retained on screen	Percent	Character of residue
60	9.31	Abundance of calcareous clay nodules, some stained with limonite; considerable quantity of quartz; small amount of fossils.
100	13.29	Abundance of calcareous clay nodules; considerable quantity of quartz; small amount of fossils; trace of limonite.
250	17.69	Abundance of quartz; considerable quantity of clay nodules; trace of ferruginous material.
Cloth	59.71	Clay substance including residue from above.

SAMPLE M48A-2

Retained on screen	Percent	Character of residue
60	26.26	Abundance of calcareous, micaceous clay nodules; trace of ferruginous material.
100	12.24	Abundance of calcareous clay nodules; small amount of muscovite; trace of ferruginous material.
250	16.52	Abundance of clay nodules; considerable quantity of muscovite; small amount of biotite.
Cloth	44.98	Clay substance including residue from above.

SAMPLE M55-3

Retained on screen	Percent	Character of residue
60	10.25	Abundance of gray clay nodules; considerable quantity of limonitic nodules; small amounts of ferruginous material and gypsum.
100	8.00	Abundance of gray clay nodules; considerable quantity of limonitic nodules; small amounts of ferruginous material and quartz; trace of muscovite.
250	9.72	Abundance of clay nodules, considerable quantity stained with limonite; considerable quantities of quartz and muscovite.
Cloth	72.03	Clay substance including residue from above.

SAMPLE M88-2

Retained on screen	Percent	Character of residue
60	36.37	Abundance of arenaceous, micaceous clay nodules; trace of limonite.
100	14.47	Abundance of arenaceous, micaceous clay nodules; trace of limonite.
250	15.52	Abundance of clay nodules; considerable quantity of muscovite; trace of limonite.
Cloth	33.64	Clay substance including residue from above.

Alta Ray Gault, laboratory geologist.

CHEMICAL ANALYSES*

SAMPLE M31-3

Ignition loss 25.58	Iron oxide, Fe_2O_3. 3.77	Magnesia, MgO ... 0.73
Silica, SiO_2 ......25.77	Titania, TiO_2 ..... 0.55	Manganese, MnO_2 None
Alumina, Al_2O_3 ...12.23	Lime, CaO 29.37	Alkalies, K_2O, Na_2O 0.67

SAMPLE M35-2

Ignition loss 5.06	Iron oxide, Fe_2O_3. 4.30	Magnesia, MgO .. 0.47
Silica, SiO_2 ......75.00	Titania, TiO_2 .... 0.92	Manganese, MnO_2 None
Alumina, Al_2O_3 ...12.89	Lime, CaO 1.28	Alkalies, K_2O, Na_2O 0.48

SAMPLE M35-3

Ignition loss 13.97	Iron oxide, Fe_2O_3. 3.55	Magnesia, MgO ... 0.81
Silica, SiO_2 ......53.71	Titania, TiO_2 .... 0.71	Manganese, MnO_2 None
Alumina, Al_2O_3 ...11.67	Lime, CaO 14.90	Alkalies, K_2O, Na_2O 0.43

SAMPLE M48A-2

Ignition loss 7.50	Iron oxide, Fe_2O_3. 4.60	Magnesia, MgO .. 0.55
Silica, SiO_2 ......66.03	Titania, TiO_2 .... 0.49	Manganese, MnO_2 None
Alumina, Al_2O_3 ..16.46	Lime, CaO 3.82	Alkalies, K_2O, Na_2O ....None

SAMPLE M55-3

Ignition loss 6.01	Iron oxide, Fe_2O_3. 5.84	Magnesia, MgO ... 0.87
Silica, SiO_2 ......67.39	Titania, TiO_2 .... 0.81	Manganese, MnO_2 None
Alumina, Al_2O_3 ...16.60	Lime, CaO 1.97	Alkalies, K_2O, Na_2O 0.53

SAMPLE M88-2

Ignition loss 6.51	Iron oxide, Fe_2O_3. 5.63	Magnesia, MgO ... 1.62
Silica, SiO_2 ......63.04	Titania, TiO_2 .... 0.90	Manganese, MnO_2 None
Alumina, Al_2O_3 ...17.28	Lime, CaO 3.35	Alkalies, K_2O, Na_2O 0.61

B. F. Mandlebaum, analyst.

*Samples ground to pass 100-mesh screen.

PYRO-PHYSICAL PROPERTIES

TEST HOLES M19, M21, M31, M35, M48, M48A, M49, M55

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
M19 1	03	10.59	4.96	2.11	2.36	11.76	4.10	651*	Brown Cr., St. H.
M21 1	03	15.32	6.84	2.05	2.52	10.20	3.52	677*	Brown Cr., St. H.
M31 3	03	37.03	24.77	1.50	2.37	12.45	4.35	1422	Yellowish gray
	01	38.50	26.72	1.57	2.33	9.10	3.13	1267	Yellowish gray
	2	38.92	27.04	1.46	2.38	9.32	3.24	1606	Yellowish gray
	4	39.57	26.87	1.47	2.43	10.88	3.77	1385	Yellowish gray St. H.
	6	34.37	20.50	1.68	2.56	22.18	8.03	1061	Yellowish gray
	8	30.56	16.11	1.93	2.78	31.91	12.06	1500	Yellowish gray
M35 2	03	24.18	12.35	1.96	2.58	1.21	.44	1816	Light red St. H.
	01	23.70	12.12	1.96	2.57	.91	.33	1391	Light red
	2	23.18	11.84	1.96	2.55	1.36	.47	1505	Red
	4	22.70	11.61	1.99	2.53	1.05	.37	1295	Red
	6	23.43	11.84	1.98	2.59	1.81	.64	1584	Red
	8	20.98	10.77	2.01	2.47	1.37	.47	1492	Dark red
	10	17.12	8.28	2.07	2.49	6.36	2.18	1488	Reddish brown
M35 3	03	32.18	18.23	1.77	2.61	6.67	2.29	1111	Yellowish gray St. H.
	01	35.15	20.56	1.71	2.64	3.57	1.21	1143	Yellowish gray
	2	31.16	16.99	1.84	2.67	10.18	3.52	1038	Yellowish gray
	4	30.67	16.76	1.83	2.64	9.39	3.24	1062	Yellowish gray
	6	2.50	1.24	2.02	2.07	18.03	6.44	N.D.	Greenish gray Bl.
M48 1	03	10.20	5.14	2.04	2.23	26.34	9.71	N.D.*	Reddish brown St. H.
M48A 1	03	30.37	18.61	1.63	2.34	19.17	6.86	1525	Salmon
M48A 2	03	33.42	21.11	1.59	2.37	14.10	4.94	1861	Salmon
	01	31.92	19.81	1.61	2.36	15.24	5.38	1394	Salmon
	2	29.60	17.55	1.69	2.43	20.24	7.28	1281	Salmon
	4	26.13	14.54	1.73	2.34	21.55	7.79	1735	Salmon gray
	6	12.08	5.83	2.08	2.31	24.47	8.94	2583	Brown St. H.
	8	7.76	3.82	2.03	2.20	33.14	12.58	1760	Brown
M49 1	03	13.68	7.55	1.81	2.10	23.09	8.38	N.D.*	Salmon Cr., St. H.
M55 2	03	16.00	7.74	2.07	2.46	9.78	3.38	2441	Red St. H.
M55 3	03	5.77	2.62	2.20	2.33	16.97	6.02	3318	Reddish brown St. H.
	01	7.07	3.21	2.19	2.36	21.98	7.95	2429	Reddish brown
	2	2.81	1.29	2.19	2.28	21.95	7.95	N.D.*	Reddish brown
	4	5.63	2.65	2.13	2.31	21.28	7.67	N.D.*	Reddish brown Bl.

*Data unreliable due to cracks on firing.

Abbreviations: Cr., cracked; Bl., bloated; St. H., steel hard.

TEST HOLES M59, M88, M90, M148A, M332

Hole No. Sample No.	At cone	Porosity in percent	Absorption in percent	Bulk specific gravity	Apparent specific gravity	Volume shrinkage in percent	Linear shrinkage in percent	Modulus of rupture in lbs./sq. in.	Color and remarks
M59 2	03	21.87	12.56	1.74	2.22	18.80	6.71	1530	Salmon St. H.
M88 2	03	26.65	14.82	1.82	2.47	21.93	7.95	1233	Salmon St. H.
	01	28.52	16.21	1.76	2.47	19.80	7.09	1056*	Red
	2	16.99	8.39	2.03	2.44	30.22	11.34	984*	Reddish brown
	4	16.25	8.08	2.01	2.40	29.71	11.13	1113*	Reddish brown
	6	2.15	.95	2.25	2.30	37.33	14.46	2098	Brown
	8	3.41	1.60	2.18	2.25	36.05	13.87	1910	Brown
M88 3	03	42.83	30.43	1.41	2.44	15.93	5.65	1629	Buff
	01	42.86	30.64	1.40	2.45	15.82	5.61	858*	Salmon
M90 4	03	27.24	15.85	1.72	2.36	20.25	7.28	1849	Salmon St. H.
M148A 1	03	30.51	22.15	1.53	2.31	14.93	5.27	1209	Salmon St. H.
M332 2	03	9.74	4.52	2.16	2.39	24.84	9.10	673*	Brownish green Cr., St.H.
M332 3	03	28.87	16.03	1.80	2.53	17.07	3.06	1279	Reddish gray
	01	21.74	11.20	1.97	2.51	23.60	3.58	1074	Reddish brown
M332 4	03	26.49	14.72	1.80	2.39	20.10	7.21	1898	Dull red St. H.
	01	16.04	8.38	2.05	2.37	27.50	10.16	1464	Greenish gray
M332 5	03	17.84	9.98	1.76	2.17	20.46	7.36	2038	Reddish brown St. H.
	01	.90	.54	1.67	1.69	16.90	5.98	1174	Brown Bl.

*Data unreliable due to cracks on firing.

Abbreviations: Cr., cracked; Bl., bloated; St. H., steel hard.

POSSIBILITIES FOR UTILIZATION

Typical Porters Creek clay is represented by samples M48-1, M48A-1, M48A-2, M49-1, M59-2, M88-2, M88-3, M90-4, and M148A-1. These samples have a shale-like texture when burned. The colors are salmon at low temperatures, darkening to shades of red and reddish brown at higher temperatures. The average value for water of plasticity is 64.5 percent. The linear drying shrinkage ranges between 16 and 46 percent. The water of plasticity and drying shrinkage are factors whose values depend on the degree of grinding and wedging of the individual samples. In view of the high drying shrinkage of these samples they are not suitable for manufacture into heavy clay products by the plastic process but could be used in making a dry press or semi-dry press product. Face brick and common brick are the products for which these clays are best suited.

Sample M55-3 is vitrified at cone 03 and does not overburn at cone 4. The drying shrinkage of this clay is too high to permit manufacture into heavy clay products by the plastic process; however, by using the dry press or semi-dry press process excellent vitrified face brick could be made. The burned color is uniformly reddish brown. The clay has possibilities as a slip clay and as a bond clay for use in sewer pipe.

Samples M55-2, M332-2, 3, 4, and 5 contain too much silt to be of particular value. The clays have a short maturing range, unattractive burned colors, high drying shrinkage, and are generally unsuited for ceramic products.

Samples M19-1 and M35-2 are from Terrace deposits. Sample M21-1 represents the Alluvial deposits. Samples M19-1 and M21-1 have practically identical properties in both the burned and unburned states. These samples crack on firing and are unsuited for ceramic ware. Sample M35-2 is exceptional. This clay has well balanced properties in the raw and fired states. The burned color gradually darkens from light red at cone 03 to reddish brown at cone 10. The shades of red are bright and uniform. The drying and burning shrinkage is normal. The clay is well suited for making a high grade red face brick, hollow structural tile, roofing tile, fire proofing, flower pots, and drain tile.

Samples M31-3 and M35-3 are from the lower Selma. They contain too much lime to be a good ceramic clay. Possibilities for utilization are discussed under Calcareous Materials.

CHALK AND LIMESTONE

CHEMICAL ANALYSES*

Sample	Formation	Ignition loss	Silica, SiO_2	Alumina, Al_2O_3	Iron oxide, Fe_2O_3	Titania, TiO_2	Lime, CaO	Magnesia, MgO	Manganese, MnO_2	Alkalies, K_2O, Na_2O	Total percent	Carbon dioxide, CO_2
M61-1	Clayton ?	27.24	25.23	7.68	2.57	0.26	34.45	0.63	None	0.33	98.39	21.36
M48-2	Clayton	23.29	31.24	10.65	3.65	0.37	27.52	1.25	None	0.44	98.41	17.29
M328-2	Clayton	21.00	39.10	7.21	2.33	0.34	27.21	0.84	None	0.41	98.94	16.78
M31-3	Selma, lower	25.58	25.77	12.23	3.77	0.55	29.37	0.73	None	0.67	98.67	21.34
M35-3	Selma, lower	13.97	53.71	11.67	3.55	0.71	14.90	0.81	None	0.43	99.75	10.11
M325-3	Selma, lower	30.93	13.93	7.72	2.62	0.46	41.88	0.96	None	0.50	99.00	26.68
M326-2	Selma, lower	26.64	25.08	11.88	3.59	0.53	30.49	1.09	None	0.35	99.65	19.26
M329-2	Selma, lower	29.31	20.80	10.60	3.17	0.36	34.30	0.84	None	0.51	99.89	21.36
M330-3	Selma, upper	33.16	13.93	8.26	2.32	0.30	40.28	0.55	None	0.43	99.23	25.49
M331-1	Selma, upper	35.86	9.33	4.92	1.55	0.13	48.30	0.23	None	0.50	99.82	30.69
M61-5	Prairie Bluff	34.42	11.46	5.21	2.39	0.15	44.95	0.39	None	0.49	99.46	33.46
M328-4a	Prairie Bluff	26.86	22.90	10.09	3.08	0.36	34.53	0.42	None	0.33	98.57	20.52
M328-4b	Prairie Bluff	30.88	18.23	7.02	3.11	0.28	38.77	0.38	None	0.35	99.02	24.44

B. F. Mandlebaum, analyst.

*Samples ground to pass 100-mesh screen.

CHEMICAL ANALYSES, CALCINED BASIS

Sample	Formation	Silica, SiO_2	Alumina, Al_2O_3	Iron oxide, Fe_2O_3	Titania, TiO_2	Lime, CaO	Magnesia, MgO	Manganese, MnO_2	Alkalies, K_2O, Na_2O	Total percent
M61-1	Clayton ?	34.78	10.55	3.53	0.36	47.45	0.87	None	0.45	97.99
M48-2	Clayton	40.80	13.90	4.76	0.48	35.85	1.63	None	0.57	97.99
M328-2	Clayton	49.50	9.15	3.58	0.43	34.45	1.06	None	0.52	98.69
M31-3	Selma, lower	34.60	16.50	5.07	0.74	39.45	0.98	None	0.90	98.24
M35-3	Selma, lower	62.50	13.52	4.13	0.83	17.33	0.94	None	0.50	99.75
M325-3	Selma, lower	20.20	11.20	3.80	0.67	60.52	1.39	None	0.73	98.51
M326-2	Selma, lower	34.25	16.17	4.90	0.72	41.60	1.49	None	0.48	99.61
M329-2	Selma, lower	29.40	15.00	4.48	0.51	48.50	1.19	None	0.72	99.80
M330-3	Selma, upper	20.90	12.40	3.48	0.45	60.40	0.83	None	0.65	99.11
M331-1	Selma, upper	12.78	7.55	2.38	0.20	74.00	0.35	None	0.77	98.03
M61-5	Prairie Bluff	17.43	7.95	3.64	0.23	68.25	0.59	None	0.75	98.84
M328-4a	Prairie Bluff	31.30	13.78	4.20	0.49	47.15	0.57	None	0.45	97.94
M328-4b	Prairie Bluff	26.40	10.15	4.50	0.41	56.00	0.55	None	0.51	98.52

B. F. Mandlebaum, analyst.

POSSIBILITIES FOR UTILIZATION

The calcareous or limy materials include limestone and chalk combined chemically or physically with clay, silica, and other impurities. These materials are from the Clayton, Prairie Bluff, Selma, and Porters Creek formations and represent the major mineral resources of Clay County. Their potential possibilities are limited only by the extent of commercial development.

Limy materials are used for making Portland cement, natural cement, mineral wool, agricultural lime, quick lime, and hydrous lime. All these products are in increasing demand in Mississippi; none except agricultural lime is being exploited, and it only in a limited manner. Building construction and road construction, curtailed during war times, are normally expected to accelerate after the war. Good lumber has long been at a premium and will be scarcer than ever for post-war construction. The mineral resources of Clay County could be developed to supply building and road materials.

Raw materials represented by samples M331-1 and M61-5 are suitable for the manufacture of Portland cement. The materials are higher in lime than necessary and could be blended with sand for the correct composition. Their possibility is limited to a certain extent by competition from the Alabama cement mills which have the advantage of being near deposits of coal essential to Portland cement manufacture. Development of Portland cement manufacture in Clay County would be governed by economic factors rather than the availability of the calcareous raw material. An adequate road construction program combined with normal building construction in Mississippi could utilize the output of a cement plant.

Natural cements are similar in some respects to Portland cement. Calcareous materials of various composition are suitable for natural cements. These cements are less expensive to produce and probably fit into the economic conditions governing cement production in Clay County better than Portland cement. The raw material for natural cement is calcined at a lower temperature and is easier to grind than Portland cement. Its ultimate strength is less than Portland cement but is adequate for major uses. This material could be extensively used to produce a stable road bed when mixed with locally available sandy soil. The base would provide adequate subsurface for asphalt and tar surface. The natural cement could be utilized in various concrete construction projects and as a mortar in brick and stone constructions. Samples M61-5, M325-3, M329-2, M328-4a, M328-4b, and M330-3 are particularly suited for use as natural cement raw material.

It is recommended that the state appropriate to the Mississippi State Geological Survey funds to build a pilot plant of sufficient size to produce natural cement for use as test strips in road construction. By this procedure the raw material yielding the highest grade of cement can be determined, and the serviceability of roads made from these cements can also be determined. Such work is a prerequisite for commercial development.

Mineral wool, though not essential to building construction, is fast becoming a necessity for comfortable houses in winter and summer. Over a period of a few years, the saving in winter fuel is said to off-set the original cost. Mineral wool is not an expensive product to manufacture, the larger part of the cost to a Mississippi home owner being that of transportation and distribution. Mineral wool is a bulky product that cannot be shipped long distances economically. Samples M48-2, M61-1, M326-2, and M328-2 are especially suitable for mineral wool production. These materials along with others in the state should be tested in a pilot plant to determine which raw materials are best suited. Pilot plant production would encourage commercial interests toward further development.

All samples listed under Calcareous Materials are suitable for use as agricultural lime. The materials could best be used without burning as burning would reduce the activity of the lime. On burning the calcareous materials of Clay County, calcium aluminates and silicates are formed which are slower to react with acid soil than calcium carbonate. Samples M61-5, M325-3, M330-3, and M331-1 contain the higher percentages of lime and are best suited for agricultural purposes.

Hydrated lime and quick lime cannot be made from the calcareous materials without beneficiation.

LABORATORY PROCEDURE

PREPARATION

Preliminary drying of the clays was unnecessary, for they had been collected in the field and stored in a steam-heated laboratory several months prior to testing. Primary samples of about 200 pounds were crushed in a No. 2 jaw crusher. The crushed material was screened through a No. 20-mesh Tyler standard screen; residue coarser than 20-mesh was ground in a burr mill until it passed the 20-mesh screen. The clay which had passed 20-mesh screen was thoroughly mixed and reduced to a 10-pound sample by coning and quartering. This operation was accomplished in a metal lined tray approximately 4 feet square and 8 inches deep. The 10-pound sample was reserved for screen analysis, chemical analysis, and for making pyrometric cones. Approximately 75 pounds of clay from the remainder were mixed with water and kneaded by hand to a plastic consistency. The plastic mass was divided into small portions and thoroughly wedged to remove entrapped air and to develop a homogenous plastic body. The small portions were recombined in the same manner and stored in a metal lined damp box until used for making test pieces.

FORMING OF TEST PIECES

Test pieces were of two sizes: short bars, 1 inch square by 2 inches long; and long bars, 1 inch square by 7 inches long. The test pieces were made by wire-cutting bars of approximate size from the plastic mass and pressing in molds to the final size. The long bars were pressed by hand in a hardwood mold of the plunger type. The short bars were formed in a Patterson screw press fitted with a steel die. Each test piece was identified as to test hole number, sample number, and individual piece number. The identification was made by stamping the necessary letters and numerals on the test pieces. A shrinkage mark of 10 centimeters was stamped on the long bars. Sixty long bars and thirty short bars were made from each primary clay sample. Certain samples were not large enough to make the full number of test pieces.

PLASTIC, DRY, AND WORKING PROPERTIES

Immediately on forming the short bars their plastic volume was determined in a mercury volumeter. The plastic weight was measured to .01 gram using a triple beam balance. All the test pieces were allowed to air-dry several days on slatted wooden pallets and then oven-dried by gradually increasing the temperature of the oven from room temperature to 100°C. in 4 hours and maintaining the oven temperature between 100°C. and 110°C. for an additional hour. After drying, the short bars were placed in desiccators, and on cooling to room temperature they were reweighed, and their volume was determined as above described. Five long bars were broken on a Fairbanks cross-breaking machine to determine modulus of rupture.

The workability of the clay was observed during grinding, wedging, and the forming of the test pieces. The water of plasticity, modulus of rupture, and volume shrinkage were calculated by methods outlined by the American Ceramic Society. The linear shrinkage was calculated from the volume shrinkage and is based on the dry volume.

FIRED PROPERTIES

The long and short bars were burned in a down-draft surface combustion kiln especially designed for the purpose. Butane gas was used for fuel. Oxidizing conditions were maintained in the kiln during the entire period of firing. The test pieces were stacked criss-cross in the kiln to permit complete circulation of gases. The kiln was fired at the rate of 200°F. per hour to within 200°F. of the maximum temperature. The last 200°F. rise was accomplished in two to three hours. The rate of firing was measured by means of a Chromel-Alumel thermocouple up to 2,100°F., at which point the couple was withdrawn from the kiln; and, by means of pyrometric cones above 2,100°F.

On completing the firing of the long and short test pieces the kiln was cooled gradually in twenty-four to thirty-six hours, after which the short bars were immediately placed in desiccators and weighed to an accuracy of .01 gram on a triple beam balance. After weighing, the bars were placed in water which was then heated to the boiling point and was kept boiling for four hours. They were allowed to cool in the water to room temperature and were reweighed as before mentioned. Immediately thereafter the volumes of the test pieces were determined in a mercury volumeter. Volume shrinkage, porosity, absorption, bulk specific gravity, and apparent specific gravity were calculated in accordance with methods outlined by the American Ceramic Society. The long bars were broken on a Fairbanks testing machine to determine modulus of rupture. Five long bars were burned and tested for each clay at each cone temperature indicated in the table of pyro-physical properties. Three short bars were fired as test pieces for each clay at each cone temperature.

SCREEN ANALYSES

A quantity of clay from each quartered sample was dried at 110°C. constant weight, after which exactly 100 grams were blunged in approximately two liters of water by pouring the slip back and forth until all the substance apparently disintegrated.

The disintegrated clay in slip form was poured through a nest of Tyler standard screens, the sizes being 60, 100, and 250. The material passing through the 250-mesh screen was caught on a cloth in a plaster vat. After a fair sample was caught on the cloth, the screens, still in nest, were then washed with a stream of water until no further material passed through the screens. The screens were dried at 110°C., after which the residue from each screen was weighed and collected in glass vials for further study.

It is evident that the above treatment would not completely disintegrate all of the clay nodules; and, though this could have been accomplished by blunging with rubber balls, it was not the purpose of this screen analysis to break the clay down to a finer state of division than would ordinarily occur in usual commercial blunging procedure; consequently, the screen analyses will show residue as "clay nodules" which indicates that a very thorough blunging will be necessary to disintegrate completely the clay in commercial use.

The residue from each screen was examined carefully under a binocular microscope. The finer material was examined under a petrographic microscope. Determinations were made from the physical appearances of mineral grain and crystal form corroborated by use of physical properties test, magnetized needle, reactions to wet reagents; and, where grain size permitted, blow pipe analyses were made.

Undoubtedly there were minerals present in the clays that could not be distinguished under the microscope, because of their fine state of division. However, those that have been recorded have been definitely identified.

Terms used in the tables of screen analyses for describing quantity of residue are: "abundance," meaning one-half or more of residue on screen; "considerable quantity," between one-fourth and one-half; "small amount," less than one-fourth; and "trace," few grains scattered throughout residue.

CHEMICAL ANALYSES

Grinding: Samples were ground to pass a 100-mesh screen.

Ignition Loss: One gram of each sample was heated in a platinum crucible at full heat of a blast burner for one hour.

Silica: Ignited samples were fused with 6 to 8 times their weight of anhydrous sodium carbonate, and the fusion dissolved in dilute hydrochloric acid. The samples were double dehydrated with hydrochloric acid. The silica was filtered off, washed, ignited, weighed, volatilized by hydrofluoric acid, and the crucible reweighed. SiO_2 was found by loss in weight. Any residue after evaporation was fused with sodium carbonate and dissolved in the original filtrate for alumina determination.

Alumina: Alumina, iron, and titania were precipitated together by ammonium hydroxide in the presence of ammonium chloride. Double precipitations were necessary to remove all the chlorides. The mixed hydroxides were filtered off, washed free of chlorides, ignited, and weighed. The weight represents the total of alumina, iron, and titania. The mixed oxides were fused with potassium bisulphate and dissolved in dilute sulphuric acid. In some cases small amounts of silica were recovered by filtration, ignition, and volatilization with hydrofluoric acid. This was added to silica and deducted from alumina.

Iron: An aliquot of the solution of bisulfate fusion was reduced with aluminum dust in sulphuric acid solution and titrated with standard potassium permanganate solution. The iron was calculated as Fe_2O_3.

Titania: Another aliquot of the bisulfate solution was placed in a Schreiner type colorimeter tube and a few drops of hydrogen peroxide added. This was compared in color with a standard titania solution. The total of iron and titania was subtracted from the mixed precipitate of alumina, iron, and titania, leaving alumina.

Manganese: Manganese was removed from the sample used for the ultimate analysis, but discarded, and the determination was made on a separate larger sample. The sample was treated with hydrofluoric acid and sulfuric acid, twice evaporated, and the insoluble residue removed by filtering. Manganese was determined colorimetrically using potassium periodate as the color reagent, and matching against a standard color sample.

Lime: Lime was determined from the filtrate of the manganese determination by precipitation as the oxalate in the presence of ammonium acetate in alkaline solution. It was weighed as CaO.

Magnesia: Magnesia was determined from the lime filtrate by precipitation as mixed ammonium phosphate in alkaline solution. It was ignited and weighed as $Mg_2P_2O_7$, and calculated to MgO.

Alkalies: Alkalies were determined by the J. Lawrence Smith method as outlined in Scott "Standard Methods of Chemical Analysis." Sodium and potassium were not separated but reported as combined oxides.

Carbon Dioxide: Carbon dioxide was determined by use of a Schroedter alkalimeter, using dilute hydrochloric acid to evolve the CO_2 and concentrated sulphuric acid to trap any moisture evolved.

Duplicates were made on all samples and the average was reported.

CONVERSION TABLE
CONES TO TEMPERATURES

Cone No.	When fired slowly, 20°C. per hour		When fired rapidly, 150°C. per hour	
	°C	°F	°C	°F
010	890	1,634	895	1,643
09	930	1,706	930	1,706
08	945	1,733	950	1,742
07	975	1,787	990	1,814
06	1,005	1,841	1,015	1,859
05	1,030	1,886	1,040	1,904
04	1,050	1,922	1,060	1,940
03	1,080	1,976	1,115	2,039
02	1,095	2,003	1,125	2,057
01	1,110	2,030	1,145	2,093
1	1,125	2,057	1,160	2,120
2	1,135	2,075	1,165	2,129
3	1,145	2,093	1,170	2,138
4	1,165	2,129	1,190	2,174
5	1,180	2,156	1,205	2,201
6	1,190	2,174	1,230	2,246
7	1,210	2,210	1,250	2,282
8	1,225	2,237	1,260	2,300
9	1,250	2,282	1,285	2,345
10	1,260	2,300	1,305	2,381
11	1,285	2,345	1,325	2,417
12	1,310	2,390	1,335	2,435
13	1,350	2,462	1,350	2,462
14	1,390	2,534	1,400	2,552
15	1,410	2,570	1,435	2,615
16	1,450	2,642	1,465	2,669
17	1,465	2,669	1,475	2,687
18	1,485	2,705	1,490	2,714
19	1,515	2,759	1,520	2,768
20	1,520	2,768	1,530	2,786

Cone No.	When heated at 100°C. per hour		Cone No.	When heated at 100°C. per hour	
	°C	°F		°C	°F
23	1,580	2,876	32	1,700	3,092
26	1,595	2,903	33	1,745	3,173
27	1,605	2,921	34	1,760	3,200
28	1,615	2,939	35	1,785	3,245
29	1,640	2,984	36	1,810	3,290
30	1,650	3,002	37	1,820	3,308
31	1,680	3,056	38	1,835	3,335

The properties and uses of pyrometric cones: The Standard Pyrometric Cone Company, Columbus, Ohio.

SECTIONS AND TEST HOLE REFERENCES

Sections and test holes	Sample tested	Property	Pages			Geologic units									
												Selma chalk			
			Stratigraphic log	Ceramic tests	Chemical analyses	Alluvium	Pleistocene terraces	Porters Creek	Clayton	Prairie Bluff	Ripley	Demopolis	Arcola limestone	Lower	Eutaw
M19	P1	Ben Smith	58	73, 76			x								o
M21	P1	Charlie Hunter	58	73, 76		x									
M31	P3	Henry Gibbs	59	73, 76	75, 79, 80		o					x			
M35	P2	Alec Melton	59	73, 74, 76	75	o	x								
	P3			73, 74, 76	75, 79, 80	o								x	
M48	P1	Tom Logan	60	73, 76				x		o					
	P2				79, 80				x	o					
M48A	P1	Tom Logan	47, 60	73, 76, 77				x							
	P2			73, 74, 76	75			x							
M49	P1	Jabe Christopher	61	73, 76				x	o						
M55	P2	George Sanders	62	73, 76				x							
	P3			73, 74, 76	75			x							
M59	P2	W. B. Snell	62	73, 77				x							
M61	P1	First National Bank	43, 63		79, 80				x	o					
M64		K. C. Curtis	39							o					
M88	P2	Jim Mays	47 64	73, 75, 77	75			x							
	P3			73, 77				x							
M90	P4	Federal Land Bank	64	73, 77				x							
M130		Albert Langford	35							o	o				
M131		A. N. Cothran	35, 36								o				
M148A	P1	Roadside	65	73, 77				x							
M225		Clifton Rose	21											o	o
M317			40, 41							o					
M325	P3	McDonald	65		79, 80									x	
M326	P2	H. C. Sugg	66		79, 80									x	
M328	P2				79, 80				x						
	P4a	K. C. Curtis	66		79, 80					x					
	P4b				79, 80					x					
M329	P2	Bory Moseley	28, 67		79, 80							x			
M330	P3	E. H. Walker	67		79, 80							x			
M331	P1	Pete Winfield	68		79, 80							x			
M332	P2				73, 77			x							
	P3	Tom Moseley	47, 69		73, 77			x							
	P4				73, 77			x							
	P5				73, 77			x							
M333		Roadside	32, 33								o				
M333A		Roadside	33, 34								o	o			

INDEX

Page

Acknowledgments 70
Agricultural lime 54-56, 82
Alluvium 14, 50
Arcola limestone member 22-25
  phosphatic molds below 24
Bartons Bluff, section at 16
Bentonite in Eutaw formation 18
Black Prairie Belt 13
Board of Supervisors, Clay County 4
Brick and tile clays 57, 78
Cantrell No. 1 well (See Ohio Oil Company Cantrell No. 1 well)
Caradine, chalk exposed near 30
Cedarbluff, chalk exposed near 30
Chalk
  Clayton
    chemical analyses 79, 80
    physical properties 73
    possibilities for utilization 81
    pyro-physical properties 77
    samples of
      M48 .... 60, 79, 80
      M61 .... 43, 63, 79, 80
      M328 .... 66, 79, 80
  Prairie Bluff
    chemical analyses 79, 80
    possibilities for utilization 81
    sample of
      M328 .... 66, 79, 80
  Selma
    Demopolis
      chemical tests 75, 79, 80
      physical properties 73
      possibilities for utilization 81
      pyro-physical properties 76
      samples of
        M31 .... 59, 73, 75, 76, 79, 80
        M329 .... 28, 67, 79, 80
        M330 .... 67, 79, 80
        M331 .... 68, 79, 80
    Lower
      chemical analyses 75, 79, 80
      physical properties 73
      possibilities for utilization 81
      pyro-physical properties 76
      samples of
        M35 .... 59, 73, 74, 75, 76, 79, 80
        M325 .... 65, 79, 80
        M326 .... 66, 79, 80
      screen analyses 74
Chickasaw County 11
Choctaw-Chickasaw boundary line 11
Christopher, J. H., property 45, 46
Clays, ceramic
  Alluvium
    chemical analyses 75, 79, 80
    physical properties 73
    possibilities for utilization 78

Page

    pyro-physical properties 76
    samples of
      M21 .... 58, 73, 76
      M35 .... 59, 73, 74, 76, 79, 80
    screen analyses 74
  chemical analyses 75, 79, 80
  laboratory procedure 83-87
  physical properties 73
  Pleistocene Terrace
    chemical analyses 75, 79, 80
    physical properties 73
    possibilities for utilization 78
    pyro-physical properties 76
    samples of
      M19 .... 58, 73, 76
      M31 .... 59, 73, 76
      M35 .... 59, 73, 76
    screen analyses 73, 74
  Porters Creek
    chemical analyses 75, 79, 80
    physical properties 73
    possibilities for utilization 77, 81
    pyro-physical properties 76
    samples of
      M48 .... 60, 73, 76, 79, 80
      M49 .... 61, 73, 76
      M55 .... 62, 73, 74, 75, 76
      M59 .... 62, 73, 77
      M88 .... 47, 64, 73, 75, 77
      M90 .... 64, 73, 77
      M148A 65, 73, 77
      M332 .... 47, 69, 73, 77
    screen analyses 74, 75
  possibilities for utilization 77, 81, 82
  pyro-physical properties 76, 77
  screen analyses 73-75
Clayton formation (See also Chalk) 4, 43-45
  fossils of 44
  section of 43
Climate 12
Coleman, Howard, Deputy Chancery Clerk 4, 70
Colfax County 11
Columbus and Greenville Railroad well at Pheba 49
Curtis, K. C., property 39, 44
Demopolis member of Selma chalk 4, 13, 26-31
Dexter, Andrew, property, chalk on 55
Dexter, Sam 4, 70
Dill, J. H., property 37
Diploschiza cretacea zone 19, 20, 27, 28, 29, 30, 53, 54
Dixie Hill section 47
Drainage 14
Economic geology 54-57
Eutaw formation 13, 14, 16, 17, 18
  bentonite in 18

Page

sections of 17, 18
thickness of 18
Exogyra cancellata zone 19, 20, 30, 31
Exogyra costata
zone 19, 27, 30, 31, 32, 38, 41
Exogyra ponderosa zone 19, 53
Flatwoods 13
Foraminifera 3, 20
Lituola erecta Mellen and Gault 44
Nodosaria latejugata Gumbel 45
Nodosaria sp. 41
Robulus cultrata (Montfort) 41
Robulus midwayensis (Plummer) .. 45
Tritaxia tricarinata Reuss 41
Fossils 3
Anomia argentaria Morton 20, 30
Anomia tellinoides Morton 20, 30
Baculites asper (?) Morton.......24, 41
Cymella bella Conrad var........... 24
Discoscaphites conradi (Morton).... 41
Eutrephoceras sp. 38
Exogyra ponderosa Roemer.....16, 17, 19
Flabellum ? sp. 48
Gryphaea convexa (Say).......20, 30, 38
Gryphaea mutabilis Morton..20, 27, 30, 31
Gyrodes petrosus (Morton)......... 24
Hamulus onyx Morton.............20, 29
Hamulus squamosis Gabb..........20, 29
Ideonarca cf. neglecta Gabb........ 24
Inoceramus proximus Tuomey.....24, 31
Liopistha protexta (Conrad)........ 41
Ostrea falcata Morton...20, 21, 29, 30, 31
Ostrea plumosa Morton........20, 29, 31
Ostrea pulaskensis Harris...43, 44, 45, 51
Ostrea sp. 41
Paranomia scabra (Morton)...20, 29, 30, 31, 32
Pyropsis sp. 24
Terebratulina filosa Conrad 20, 29
Geologic section 15
Gravel 57
Gulf, Mobile, and Ohio Railroad....... 12
Harris, J. H., driller...............49, 53
Houlka Creek 14, 30
Illinois Central Railroad 12
Jackson formation 3
Johnson Creek valley, Prairie Bluff
chalk in 40
Kilgore Hills 13, 34
Langford, Albert, property 35
Lime products 56
Line Creek 11, 14
Little Cane Creek valley, Prairie Bluff
chalk in 41
Logan, Tom, property 46
Lowndes County 11
McCutcheon, Thomas E. 3, 4
Marcasite concretions 31
Mellen, Frederic F. 3, 54, 55, 56

Page

Mesozoic group 14
Midway system 13
Mineral wool from chalk 56
Mississippi Forestry Service 13
Monroe County 11
Monroe, W. H. 36, 40, 50, 53
Moseley, Bell, property 35, 37
Moseley, Bory, property, chalk on 56
Mososaur vertebrate 30
Murrah Hill, section on 47
Ohio Oil Company Cantrell
No. 1 well 18, 53
Oktibbeha County 11
Ostracoda 3, 20
Paleocene 14
Pheba Structure 3, 51
map of 52
Physiography 13
Pinebluff Hill section 47
Pinebluff, well at 48
Pleistocene terraces 13, 14, 50
Population 12
Porters Creek clay 4, 45-49
bentonite in 46
sections of 47, 48
Portland cement 4, 56, 81
Prairie Bluff chalk 4, 13, 34, 35, 36-42
distribution of fossils 42
sections of 37, 38, 39, 40
References 70
Ripley formation 13, 31-36
contact with Prairie Bluff 32
section in 32
test holes in 33, 35
Sakatonchee River 14, 29
Schools 12
Selma chalk 4, 13, 18
Arcola limestone member 22-25
Demopolis member 26-31
Diploschiza cretacea zone ..19, 20, 27, 28, 29, 30, 53, 54
Exogyra cancellata zone 19, 20
Exogyra costata zone 19
Exogyra ponderosa zone 19
fossil zones in 19
general lithology 18-20
Lower chalk member 21
Selma-Eutaw contact 17, 18
Siloam School 30
Simmons, George, driller 48, 53
Southern Bell Telephone Company 12
Southern Railroad 12
Stephenson, L. W. 36, 40, 50, 53
Stratigraphy 14
Structural geology 51
northern Clay County 53
Pheba Structure 51
Sugar Hill, white sand on 34
Tennessee Valley Authority 12

Page

Test hole records 58-69
Tibbee Creek 11, 14
Tombigbee River 11, 13, 14, 16, 17
Tombigbee sand member 14, 16, 17
Tribble, George, driller 53
Turritella mortoni bed 45
Vinton Bluff, section at 17
Walker, E. H., property, chalk on 55
Walker, Mrs. John, property, chalk on 55
Water wells
  Beasley 53
  Caro 53
  Cedarbluff 51, 53
  Henryville 53
  Montpelier 53
  Pheba 51, 53
  Pinebluff 53
  Waddell 51
Water wells in Eutaw sand 17
Waverly 4, 14, 57
Weber, M., property 55
Webster County 11
West Point 4, 11, 12, 13
Williams Brothers property, chalk on .. 55
Winfield, Pete, property, chalk on ...31, 55

MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph. D.
DIRECTOR

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CLAY COUNTY

FOSSILS

MIDWAY FORAMINIFERA AND OSTRACODA

By

VIRGINIA HARRIETT KLINE, Ph. D.

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CONTENTS

	Page
Introduction	5
Stratigraphy	5
Description of Foraminifera	13
Family Textulariidae	13
Family Verneuilinidae	13
Family Valvulinidae	16
Family Lagenidae	17
Family Polymorphinidae	39
Family Nonionidae	44
Family Heterohelicidae	44
Family Buliminidae	47
Family Ellipsoidinidae	50
Family Rotaliidae	52
Family Cassidulinidae	55
Family Chilostomellidae	56
Family Globigerinidae	58
Family Globorotaliidae	59
Family Anomalinidae	59
Description of Ostracoda	64

Page

Family Cytherellidae 64

Family Cypridae 64

Family Bairdidae 65

Family Cytheridae 66

Logs and locations of test holes.. 72

Plates and explanations 79

Index 97

ILLUSTRATIONS

Plates I to VII.—Midway Foraminifera 81

Plate VIII.—Midway Ostracoda 95

CLAY COUNTY FOSSILS
MIDWAY FORAMINIFERA AND OSTRACODA

VIRGINIA HARRIETT KLINE, PH.D.

INTRODUCTION

During the Spring and Summer of 1942 about 300 hand auger tests were bored in Clay County by field crews under the supervision of Dr. Harlan R. Bergquist. Included in the samples collected for stratigraphic purposes and clay testing were about a hundred samples of Midway chalks and clays which have been examined for microfossils.

The Clay County Midway is rich in both species and specimens of foraminifera and ostracoda, including a number of new forms. In the following discussion a total of 110 species or varieties of foraminifera is described and illustrated. A complete list of foraminifera would include, probably, about 120 species. About 25 species of ostracoda are present, of which number 12 are illustrated and described. Most of the remainder are probably new.

Earlier bulletins of the Mississippi Geological Survey have listed some of the Midway macrofossils of the state, but no previous record of the microfossils has been published. This report is the second in a contemplated series on microfossils of the various formations in the state. The first, a study of the Jackson foraminifera and ostracoda of Scott County made by Dr. Bergquist, appeared as a part of Bulletin 49 of the Mississippi Geological Survey.

The material studied was collected, washed, and placed in temporary mounts under the supervision of Dr. Bergquist. All illustrations were drawn by Mary Louise Pegues.

Subsequent identifications and additions to the manuscript that are marked HRB are by Dr. Bergquist.

STRATIGRAPHY

The Midway series crops out as a north-south trending belt about 3 to 5 miles wide in the extreme western part of Clay County. It overlies the Prairie Bluff chalk unconformably.

Highest Midway strata are not present, cropping out in Webster County to the west.

In Mississippi the Midway series has been divided into two formations: the Clayton chalk overlain by the Porters Creek clay. Both formations are present in Clay County.

The Clayton chalk is poorly developed and exposed only in limited areas, for the most part along hillsides. Thicknesses are not great, averaging about 25 feet.

The basal Clayton chalk in most places consists of a layer only a few inches thick of very sandy clay or silt which is sometimes glauconitic. Overlying the sandy zone the typical Clayton is made up of glauconitic, micaceous, finely sandy gray chalk which may grade upward into gray or tan clays and silt in the extreme upper part of the formation.

About 10 to 15 feet above the base of the Clayton is a bed characterized by an abundance of shells of *Ostrea pulaskensis* Harris. Below the top of the *O. pulaskensis* bed the fauna is a typically lower Midway one containing many species in common with the Kincaid formation of Texas and the lower Midway of Alabama. The *O. pulaskensis* bed is overlain by about 10 to 20 feet of typical Clayton chalk or of micaceous, glauconitic silty clays which lithologically resemble the overlying Porters Creek clay. Where clays form the upper part of the formation, the Clayton-Porters Creek contact must be drawn on the basis of faunal changes. This 10 to 20-foot interval contains a transitional fauna in which there is a mingling of Clayton fossils with Porters Creek fossils which make their first appearance in this zone. Plummer reports from the Midway of Texas at some localities a similar transitional zone in which such a characteristic lower Midway species as *Vaginulina gracilis* Plummer is associated with the typical upper Midway species *Cibicides alleni* (Plummer), *Vaginulina robusta* Plummer and *Gyroidina subangulata* (Plummer). One species, *Polymorphina cushmani* Plummer, described as confined to the transitional zone in Texas, was also noted only in the same zone in Clay County. In the logs of test hole localities at the end of this report the Clayton-Porters Creek contact has been placed at the top of the highest bed showing typical lower Midway species rather than at the base of the bed containing the earliest Porters Creek species. In the notes under descriptions of species these transitional beds are referred to as uppermost Clayton.

Of the 110 species and varieties of foraminifera herein described, 14 are confined to the lower Clayton or to the Clayton and the transitional beds; 14 Porters Creek species range downward into the uppermost strata, but are absent from the *O. pulaskensis* and lower beds. Ostracoda are not common in the Clayton. A single species is confined to this formation. Three Porters Creek species are present in the transitional zone. The *Turritella mortoni* Conrad bed, commonly present in the Clayton chalk of the state, has not been observed in Clay County.

In the following list of species identified from the Clayton, those which are confined to that formation are marked with a double asterisk; species from the uppermost beds which are also present in the Porters Creek clay are indicated by a single asterisk.

CLAYTON

Spiroplectammina laevis (Roemer) var. cretosa Cushman
*Clavulinoides midwayensis Cushman
**Gaudryina sp.
Marssonella oxycona (Reuss)
Robulus midwayensis (Plummer)
Robulus pseudo-costatus (Plummer)
Robulus pseudo-costatus (Plummer) var. inornatus Kline, n. var.
Robulus rosetta (Gumbel)
Robulus turbinatus (Plummer)
Lenticulina degolyeri (Plummer)
**Marginulina earlandi (Plummer)
*Hemicristellaria subaculeata (Cushman) var. tuberculata (Plummer)
Dentalina aculeata (?) (d'Orbigny)
**Dentalina basiplanata Cushman
Dentalina crinita Plummer
**Dentalina delicatula Cushman
**Dentalina gardnerae (Plummer)
*Dentalina plummerae Cushman
Dentalina pseudo-obliquestriata (Plummer)
Nodosaria latejugata Gumbel
Nodosarina (Nodosaria) longiscata (d'Orbigny)
Chrysalogonium granti (Plummer)
Pseudoglandulina cf. caudigera (Schwager)
Pseudoglandulina comata (Batsch)
Pseudoglandulina manifesta (Reuss)

Saracenaria cf. sublatifrons (Plummer)
*Saracenaria trigonata (Plummer)
**Vaginulina gracilis Plummer
Vaginulina legumen var. elegans d'Orbigny
Vaginulina plumoides Plummer
*Vaginulina robusta Plummer
Palmula cf. budensis (Hantken)
Palmula cf. primitiva Cushman
**Palmula rugosa (d'Orbigny)
**Frondicularia archiaciana d'Orbigny
Frondicularia cf. frankei Cushman
**Lagena hispida Reuss
Lagena laevis (Montagu)
Lagena cf. primigera H. B. Brady
Lagena sulcata (Walker and Jacob) var. semiinterupta Berry
Guttulina problema d'Orbigny
Globulina gibba d'Orbigny
Pyrulina cylindroides (Roemer)
**Sigmomorphina sp.
**Polymorphina cushmani Plummer
Polymorphina frondea (Cushman)
**Polymorphina sp.
Ramulina globulifera (H. B. Brady)
Bullopora chapmani (Plummer)
Bullopora laevis (Sollas)
*Nonionella welleri (Plummer)
*Gumbelina morsei Kline, n. sp.
Planoglobulina acervulinoides Cushman
*Eouvigerina excavata Cushman
Pseudouvigerina naheolensis Cushman and Todd
Siphogenerinoides eleganta (Plummer)
Bulimina (Desinobulimina) quadrata Plummer
Entosolenia morsei Kline, n. sp.
*Virgulina wilcoxensis Cushman and Ponton
Bolivina midwayensis Cushman
Loxostoma applinae (Plummer)
Ellipsonodosaria alexanderi Cushman
Ellipsonodosaria plummerae Cushman
**Discorbis midwayensis Cushman
Valvulineria allomorphinoides (Reuss)
*Gyroidina subangulata (Plummer)
*Eponides cf. tenera (H. B. Brady)
*Parrella expansa Toulmin
Siphonina prima Plummer
Pulvinulina exigua H. B. Brady
Pullenia quinqueloba (Reuss)
*Globigerina compressa Plummer
Globigerina pseudo-bulloides Plummer
Globigerina triloculinoides Plummer

Anomalina cf. ammonoides (Reuss)
Anomalina acuta (Plummer)
Anomalina midwayensis (Plummer)
**Anomalina midwayensis (Plummer) var. trochoidea (Plummer)
*Cibicides alleni (Plummer)
*Cibicides browni Kline, n. sp.
Cibicides praecursorius (Schwager)
Cibicides vulgaris (Plummer)
Cytherella symmetrica Alexander
Argilloecia faba Alexander
Bairdia magna Alexander
Brachycythere formosa Alexander
*Brachycythere interrasilis Alexander
Brachycythere plena Alexander
Cythereis prestwichiana Jones and Sherborn
Cythereis spiniferrima Jones and Sherborn
*Cytheromorpha scrobiculata Alexander
Loxoconcha mississippiensis Kline, n. sp.
*Krithe perattica Alexander

Except for the very limited outcrops of Clayton chalk, Midway rocks exposed in Clay County are of Porters Creek age. The formation reaches a maximum thickness of about 125 feet in the county.

Basal Porters Creek clays are highly calcareous or chalky and glauconitic. Fossils are very abundant in the lowermost 8 to 10 feet. Upward the rocks grade into silty micaceous tan or gray clays which are frequently waxy in appearance; the number of fossils decreases rapidly upward in these clays. All of the fossils examined were from the basal 25 feet of the formation.

In addition to the 14 Porters Creek species of foraminifera which first appear in the transitional zone at the top of the Clayton, 19 species are confined to the Porters Creek formation. Ostracods are more abundant in this formation than in the Clayton chalk. Three species are present in the Porters Creek and uppermost Clayton; a fourth, known by a single specimen, is confined to the Porters Creek.

In the following list of species identified from the Porters Creek clay, a single asterisk indicates those species which first appear in the uppermost Clayton, a double asterisk those confined to the Porters Creek.

PORTERS CREEK

Spiroplectammina laevis (Roemer) var. cretosa Cushman
*Clavulinoides midwayensis Cushman
Gaudryina rugosa d'Orbigny
Heterostomella cuneata Sandidge
**Heterostomella sp.
Marssonella oxyconca (Reuss)
**Dorothia sp.
Robulus midwayensis (Plummer)
Robulus pseudo-costatus (Plummer)
Robulus pseudo-costatus (Plummer) var. inornatus Kline, n. sp.
**Robulus cf. pseudo-mammilligerus (Plummer)
Robulus rosetta (Gumbel)
Robulus turbinatus (Plummer)
Robulus wilcoxensis Cushman and Ponton
Lenticulina degolyeri (Plummer)
**Lenticulina rotulata (Lamarck)
*Hemicristellaria subaculeata (Cushman) var. tuberculata (Plummer)
Dentalina aculeata (?) (d'Orbigny)
Dentalina crinita Plummer
**Dentalina havanensis Cushman and Bermudez
*Dentalina plummerae Cushman
Dentalina plummerae Cushman var.
Dentalina pseudo-obliquestriata (Plummer)
Dentalina cf. solvata Cushman
Dentalina (?) sp.
Nodosaria latejugata Gumbel
**Nodosaria oligotoma Reuss
**Nodosarina (Nodosaria) aspera (Reuss)
**Nodosarina (Frondicularia) goldfussi (Reuss)
Nodosarina (Nodosaria) longiscata (d'Orbigny)
Chrysalogonium granti (Plummer)
Pseudoglandulina cf. caudigeria (Schwager)
Pseudoglandulina comata (Batsch)
Pseudoglandulina manifesta (Reuss)
**Saracenaria midwayensis Kline, n. sp.
Saracenaria cf. sublatifrons (Plummer)
*Saracenaria trigonata (Plummer)
**Vaginulina glabra (d'Orbigny)
Vaginulina legumen (Linnaeus)
Vaginulina legumen (Linnaeus) var. elegans d'Orbigny
Vaginulina plumoides Plummer
*Vaginulina robusta Plummer
Palmula cf. budensis (Hanther)
**Palmula delicatissima (Plummer)
Palmula cf. primitiva Cushman
Frondicularia cf. frankei Cushman
Lagena laevis (Montagu)
**Lagena orbignyana (Seguenza)

Lagena sulcata (Walker and Jacob) var. semiinterupta Berry
Guttulina problema d'Orbigny
Globulina gibba d'Orbigny
Pyrulina cylindroides (Roemer)
Polymorphina frondea (Cushman)
Ramulina globulifera (H. B. Brady)
Bullopora chapmani (Plummer)
**Bullopora chapmani (Plummer) var. hispida Kline, n. var.
Bullopora laevis (Sollas)
**Bullopora laevis (Sollas) var. hispida Kline, n. var.
*Nonionella welleri (Plummer)
*Gumbelina morsei Kline, n. sp.
*Eouvigerina excavata Cushman
Siphogenerinoides eleganta (Plummer)
Bulimina arkadelphiana Cushman and Parker var. midwayensis Cushman and Parker
**Bulimina cacumenata Cushman and Parker
Bulimina (Desinobulimina) quadrata Plummer
Entosolenia morsei Kline, n. sp.
*Virgulina wilcoxensis Cushman and Ponton
Bolivina midwayensis Cushman
Loxostoma applinae (Plummer)
**Pleurostomella cf. brevis var. alternas Schwager
Ellipsonodosaria alexanderi Cushman
Ellipsonodosaria plummerae Cushman
Valvulineria allomorphinoides (Reuss)
*Gyroidina subangulata (Plummer)
*Eponides cf. tenera (H. B. Brady)
*Parrella expansa Toulmin
Siphonia prima Plummer
Pulvinulinella exigua (H. B. Brady)
**Allomorphina trigona Reuss
**Chilostomella subtriangularis Kline n. sp.
**Chilostomelloides eocenica Cushman
Pullenia quinqueloba (Reuss)
*Globigerina compressa Plummer
Globigerina pseudo-bulloides Plummer
Globigerina triloculinoides Plummer
**Globotruncana sp.
Anomolina acuta (Plummer)
Anomalina cf. ammonoides (Reuss)
Anomolina midwayensis (Plummer)
*Cibicides alleni (Plummer)
*Cibicides browni Kline, n. sp.
Cibicides praecursorius (Schwager)
Cibicides vulgaris (Plummer)
Cytherella symmetrica Alexander
Argilloecia faba Alexander
**Paracypris perapiculata Alexander

Bairdia magna Alexander
Brachycythere formosa Alexander
*Brachycythere interrasilis Alexander
Brachycythere plena Alexander
Cythereis prestwichiana Jones and Sherborn
Cythereis spiniferrima Jones and Sherborn
*Cytheromorpha scrobiculata Alexander
Loxoconcha mississippiensis Kline, n. sp.
*Krithe perattica Alexander

DESCRIPTION OF FORAMINIFERA

FAMILY TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA LAEVIS (Roemer) var. CRETOSA Cushman

Plate I, 1

Spiroplectammina laevis (Roemer) var. *cretosa* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 8, pt. 4, p. 87, pl. 11, fig. 3, 1932; Vol. 16, pt. 3, p. 52, pl. 9, fig. 3, 1940.

"Test tapering, usually somewhat longer than broad, the greatest breadth toward the apertural end, periphery subacute, apertural end only slightly rounded, broad in end view, tapering rapidly to the subacute periphery chambers with the early portion coiled, later biserial, distinct, the margin of the apertural face distinctly raised, giving a series of raised ridges at the suture lines and forming a raised zigzag line along the center of the test; wall finely arenaceous, stout, not usually collapsed; aperture a low opening on the inner margin of the apertural face with the peripheral portion of the face extending forward so that the aperture itself is in a reentrant. Length up to 0.65 mm.; breadth 0.45 mm.; thickness 0.25 mm."

This variety, present in the Upper Cretaceous as well as the Midway, is especially characteristic of the Porters Creek clay, where tests are both widespread and abundant. In the Clayton chalk specimens are extremely rare.

FAMILY VERNEUILINIDAE

Genus CLAVULINOIDES Cushman, 1936

CLAVULINOIDES MIDWAYENSIS Cushman

Plate I, 2

Clavulina angularis Plummer (not d'Orbigny), Univ. Texas Bull. 2644, p. 70, 71, pl. 3, figs. 4, 5, 1927.

Clavulinoides midwayensis Cushman, Cushman Lab. Foram. Res., Spec. Publ. 6, p. 21, pl. 3, figs. 9, 15, 1936; Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 53, pl. 9, fig. 6, 1940.

"Test in microspheric form rapidly increasing in diameter toward apertual end, in megalospheric form with sides parallel in adult, in last-formed chambers with diameter decreasing, triangular throughout or in megalospheric form later portion rounded, sides concave, in megalospheric form in adult becoming convex; chambers distinct, not inflated except in last chambers of megalospheric form; sutures distinct, very slightly depressed in earlier portions and in microspheric form, but in megalospheric form becoming deeply depressed in adult; wall coarsely arenaceous, often roughly finished; aperture in megalospheric form rounded, in microspheric form with somewhat irregular lobes projecting toward the angles of the test. Length up to 1.25 mm.; diameter 0.30-0.60 mm."

Tests of this species, reported from the upper Midway of Alabama and throughout the Midway of Texas, appear to be confined to the Porters Creek clay and uppermost Clayton chalk. Tests are frequently abundant.

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA RUGOSA d'Orbigny

Plate VII, 11

Gaudryina rugosa d'Orbigny, Mem. soc. geol. France, Vol. 4, p. 44, pl. 4, figs. 20, 21, 1840.

Gaudryina rugosa Plummer, Univ. Texas Bull. 2644, p. 135, pl. 8, fig. 11, 1927.

Gaudryina rugosa Cushman, Rept. Tenn. Div. Geol. Surv. Bull. 41, p. 20, pl. 1, figs. 9, 10, 1931.

"Test elongate, tapering, greatest breadth toward the apertural end, periphery broadly rounded, early triserial portion usually much reduced, but the change to the biserial stage very abrupt; chambers numerous, usually distinct in the biserial portions, indistinct in the triserial portion, very slightly inflated in the later development; sutures becoming more distinct in the later portion, straight, very slightly oblique; wall rather coarsely arenaceous but usually fairly smoothly finished; aperture in the ordinary specimens, narrow, at the inner margin of the chamber with distinct lobular projections at the sides, in very long specimens the aperture tending to be somewhat higher. Length 0.50-1.00 mm."

Several specimens, found in a sample of basal Porters Creek clay from a test hole (M168) in a pasture at a point 37 feet west of the road and 0.4 mile south of the railroad at Pheba, appear to be the same as the Cretaceous species. These were compared with specimens from the Selma chalk of Clay County and found to be identical.—HRB.

GAUDRYINA sp.

Plate VII, 14

Both the young and adult forms of this large species of *Gaudryina* were found in a few Clayton chalk samples. The young tests show only the triserial stage with flattened sides and rounded to subacute angles. The sutures on these are slightly depressed. Adult forms have 3 or 4 biserially arranged chambers above the triserial stage. These chambers are somewhat compressed laterally with lobed angles giving a subquadrate transverse section. The sutures of the biserial part are deeply incised on some specimens. The walls of all tests are arenaceous and usually contain conspicuous pieces of glauconite cemented with the sand grains of various sizes. The arched aperture is at the base of the last formed chamber.—HRB.

Genus HETEROSTOMELLA Reuss, 1865

HETEROSTOMELLA CUNEATA Sandidge

Plate VII, 4

Heterostomella cuneata Sandidge, Jour. Pal. Vol. 6, No. 3, p. 269, pl. 41, figs. 11, 15, 16, 1932.

"Test elongate, tapering, cuneiform, sides flattened or slightly concave, initial end pointed, tripyramidal, apertural portion quadrilateral, apertural face broad and slightly arched, angles marked by a row of small fistulae; chambers variable in number, eight in the holotype, first few triserial, later ones becoming biserial, low, flat; sutures not clearly defined, sometimes slightly impressed; wall finely arenaceous, surface irregular; aperture terminal, located near the middle of the last-formed chamber, small, round, with a short tube-like neck. Length of holotype, 0.45 mm."

Three specimens like that figured were found in a sample of basal Porters Creek clay from a test hole (M168) in a pasture at a point 37 feet west of the road and 0.4 mile south of the railroad in Pheba. These were compared with specimens from the Ripley formation of Clay County and appeared to be identical.—HRB.

HETEROSTOMELLA sp.

Plate VII, 3

Test elongate, triangular in transverse section, expanding rapidly with some curvature from triserial portion; angles subacute, periphery somewhat lobate along adult biserial chambers; sides flattened to slightly concave; sutures strongly curved upward, depressed in biserial portion; wall smooth, finely arenaceous; aperture with short stout cylindrical neck, at base of last chamber.—HRB.

Specimens were found only in a sample of lower Porters Creek clay from a gully on the Sim Dixon property (NE.1/4, SW.1/4, NE.1/4, Sec. 33, T. 15 S., R. 3 E.) 2 1/2 miles northwest of Montpelier.

FAMILY VALVULINIDAE

Genus MARSSONELLA Cushman, 1933

MARSSONELLA OXYCONA (Reuss)

Plate VII, 10

Gaudryina oxycona Reuss, Sitz. Akad. Wiss. Wien, Vol. 40, p. 229, pl. 12, fig. 3, 1860.

Marssonella oxycona Cushman, Contr. Cushman Lab. Foram. Res., Spec. Publ. No. 8, 56, pl. 5, figs. 27-29, pl. 6, figs. 1-17, 1937. Toulmin, Jour. Pal. Vol. 15, No. 6, p. 573, pl. 78, figs. 12, 13, 1941.

"Test trochiform, conical, rapidly and evenly tapering, circular in transverse section, apertural end flattened, in early stages with four or five chambers to a whorl, later reduced to three and sometimes to two; chambers short, not inflated, simple (not labyrinthic); sutures indistinct, very slightly if at all depressed; wall arenaceous, studded with numerous clear grains, rather smoothly finished; aperture a small semicircular opening at base of the inner margin of the last-formed chamber, near the center of the apertural end of the test. Length up to 1 mm.; maximum diameter up to 0.64 mm."

The figured specimen is rather coarsely arenaceous with only two chambers showing on the flattened apertural end. Its general appearance is much like that of *Textulariella cretosa* Cushman but the chambers are not subdivided. The specimen came from a sample of uppermost Clayton chalk from a test hole (M65A) on the Dr. T. D. Houston property (NW.1/4, NE.1/4, NW. 1/4, Sec. 10, T. 16 S., R. 3 E.), above a roadcut 1/4 mile west of Prairie Creek.—HRB.

Genus **DOROTHIA** Plummer, 1931

DOROTHIA sp.

Plate VII, 6, 7a, b

Test nearly conical with slight curvature, slightly compressed laterally in adult portion; chambers arranged in a trochoid spire with 4 or 5 in the initial whorl, later triserial, and finally biserial; sutures faintly impressed where chambers overlap; wall smoothly finished, of finely arenaceous material; aperture a small arched opening in middle of the base of the last chamber with a slight thickening of the wall along either side.

This form bears some surficial resemblance to the genus *Gaudryina,* but when specimens are sectioned at intervals across the axis they are seen to have chambers added in a trochoid spire and at least 4 are visible near the initial end.

Sutures are less distinct and the test more conical than those of *D. alabamensis* Cushmen from the Midway of Alabama. Tests are found sparingly in the Porters Creek clay and in the uppermost Clayton chalk beds.

Specimen VII, 6 is from Porters Creek clay in gully above test hole M49, on J. Christopher property, 2 1/2 miles north of Pheba; VII, 7a, b is from the Clayton chalk, test hole M49, S3.

FAMILY LAGENIDAE

Genus **ROBULUS** Montfort, 1808

ROBULUS MIDWAYENSIS (Plummer)

Plate I, 3

Cristellaria midwayensis Plummer, Univ. Texas Bull. 2644, p. 95, 96, pl. 13, figs. 5a-c, 1927.

Robulus midwayensis Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 55, pl. 9, fig. 12, 1940; Vol. 18, pt. 2, p. 26, pl. 5, figs. 4a, b, 5, 1942. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 579, pl. 78, fig. 23, 1941.

"Test large, circular, very closely coiled, full bodied, though somewhat compressed; periphery distinctly angular but not flanged in its typical form; chambers 10-12 in adult form, smooth, narrow, gently curved, radiate from a conspicuous central boss and tapering somewhat toward the peripheral margin; aperture at apex of broad septal face. Diameter up to 1.5 mm., usually less."

Typical specimens of this species are common, though nowhere abundant, throughout the lower Midway.

ROBULUS PSEUDO-COSTATUS (Plummer)

Plate I, 5

Cristellaria pseudo-costata Plummer, Univ. Texas Bull. 2644, p. 98, 99, pl. 7, figs. 9a, b, 1927.

Robulus pseudo-costatus Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 55, pl. 9, fig. 18, 1940.

"Test much compressed, not completely involute, changing from the loosely coiled form to linear development in specimens developed beyond maturity; periphery bound by a distinct, thin, transparent flange; chambers 7-8 in last whorl, ornamented by two to four irregularly developed thin costae that follow roughly the direction of coiling; sutures marked by thin, high, uneven ridges; aperture protruding from a strongly inflated septal face. Diameter up to .7 mm."

Specimens of this species exhibit extremely great variation, the figured specimen being a median type. Many tests show very prominently developed costae extending the length of the test; others show as few as two faint costae appearing on only one chamber.

Plummer reports this species as confined to the basal Midway, one of the most distinctive forms of that unit. In the Clay County material it is wide spread and abundant in the Clayton chalk, but is also known by a few specimens from the basal Porters Creek clay at two localities, where it is associated with typical Porters Creek fossils.

ROBULUS PSEUDO-COSTATUS (Plummer) var. INORNATUS Kline, n. var.

Plate I, 6

Test much compressed, almost completely involute; periphery with a distinct, thin, transparent flange which is usually broken; chambers about 7 in final whorl, smooth; sutures marked by thin, high ridges which vary from smooth to crenulated; septal face less strongly inflated than in species; aperture less distinctly protruberant. Average diameter about .5 mm.

Plummer describes the species as being characterized by costae which may be almost absent in some specimens. Associated with typical tests of *R. pseudo-costatus* (Plummer) were other specimens which showed a complete lack of costae and a much less strongly inflated septal chamber.

The variety is nowhere as abundant as the species. It is characteristic of Clayton beds, but has been identified from the Porters Creek clay at two localities.

Holotype: *Ostrea pulaskensis* bed, Clayton chalk, test hole M93, 3.8 to 11.0 feet below surface, 1 1/2 miles northwest of Montpelier; Type slide I, 6, Mississippi Geological Survey.

ROBULUS cf. PSEUDO-MAMMILLIGERUS (Plummer)

Plate I, 12

Cristellaria pseudo-mammilligera Plummer, Univ. Texas Bull. 2644, p. 98, pl. 7, figs. 11a, b, 1927.

Robulus pseudo-mammilligerus Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 55, pl. 9, fig. 16, 1940.

"Test very slightly elongate, strongly compressed; periphery bounded by a rather thick keel that shows on some specimens a slight lobation; chambers 9-11 in final convolution, distinctly curved; sutures marked by conspicuous tapering elevations curving outward from an irregularly developed central boss or from a group of protuberances; aperture radiate, protruding. Diameter up to 1.6 mm."

In the highest Porters Creek clays examined were several large tests which may belong to this species. They differ from the typical form in possessing a rather wide thin flange which is usually broken.

ROBULUS ROSETTA (Gumbel)

Plate I, 9

Robulina rosetta Gumbel, K. bayer. Akad. Wiss. Munchen, Math.-Physik. Cl., Abh., Vol. 10, pt. 2, p. 642, pl. 1, figs. 73a, b, 1868 (1870).

Robulus rosetta Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 55, pl. 9, fig. 24, 1940.

Cushman reports this species from the lower Midway in Alabama. In Clay County *R. rosetta* (Gumbel) is one of the most abundant Midway species of *Robulus*. It has a range throughout the Midway but is more characteristic of the Clayton formation.

ROBULUS TURBINATUS (Plummer)

Plate I, 7

Cristellaria turbinata Plummer, Univ. Texas Bull. 2644, p. 93, 94, pl. 7, figs. 4a, b; pl. 13, fig. 2, 1927.

Robulus turbinatus Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 55, pl. 9, fig. 17, 1940.

"Test circular, considerably compressed; peripheral margin sharp and extended into a fragile, white flange that is typically ragged; chambers 8 in final convolution, narrow, smooth; sutures strongly elevated and of about equal width from the large umbonal area to the periphery, very strongly curved; aperture at apex of narrow septal face. Diameter up to .6 mm."

Typical specimens of this species are widely distributed, but rare. The species is most characteristic of the Porters Creek and uppermost Clayton but is extremely rare in lower Clayton beds and is reported by Plummer from the Cretaceous.

ROBULUS WILCOXENSIS Cushman and Ponton

Plate VII, 27

Robulus wilcoxensis Cushman and Ponton, Contr. Cushman Lab. Foram. Res., Vol. 8, pt. 3, p. 52, pl. 7, figs. 3a, b, 1932. Toulmin, Jour. Pal., Vol. 15, p. 579, pl. 78, figs. 24, 25, 1941. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 18, pt. 2, p. 27, pl. 5, fig. 7, 1942.

"Test compressed, close coiled except in the oldest (latest) portion where 1 or 2 chambers may become uncoiled, periphery in the earlier portion with a narrow blunt keel, in the adult chambers with the keel becoming obsolescent and the periphery rounded in the last chambers; chambers numerous, 9 or 10 in the last-formed coil of the adult, later ones slightly inflated and uncoiling, early ones of uniform shape, gradually increasing in size as added; sutures distinct, rather strongly curved, in the early portion limbate and raised, then becoming flush with the surface and in the adult slightly depressed; wall smooth except for the earlier raised sutures; aperture terminal, radiate in the adult, in the earlier chambers at the outer peripheral angle. Length 1.00-1.15 mm.; breadth 0.75-0.80 mm.; thickness 0.25-0.30 mm."

Cushman's holotype is described as having raised sutures on the early portion of the test, but these are not present on the Salt Mountain limestone forms described by Toulmin and are only slightly developed on specimens reported by Cushman from the Naheola (Midway) of Choctaw County, Alabama. The Clay County forms lack the raised sutures in the early part but show other characteristics of the species. A few specimens were noted, all being from Porters Creek clay samples.—HRB

Genus **LENTICULINA** Lamarck, 1804

LENTICULINA DEGOLYERI (Plummer)

Plate I, 8

Cristellaria degolyeri Plummer, Univ. Texas Bull. 2644, p. 97, 98, pl. 7, figs. 7a, b, 1927.

Lenticulina degolyeri Toulmin, Jour. Pal., Vol. 15, no. 6, p. 580, 581, pl. 78, figs. 29, 30, 1941.

"Test somewhat longer than broad, moderately compressed; peripheral margin very sharp and bounded by a ragged flange; chambers 7-9, gently curved, smooth; sutures marked by strong elevations of clear shell matter tapering outward from a conspicuous umbonal boss; aperture at apex of an elongate septal face. Length up to .8 mm.; usually less."

Specimens assigned to this species show as many as 10 chambers and usually approach the maximum size cited by Plummer.

The species ranges throughout the Midway and is reported from the Wilcox by Toulmin.

LENTICULINA ROTULATA (Lamarck)

Plate I, 4

Lenticulites rotulata Lamarck, Ann. Mus., Vol. 5, p. 188, no. 3, 1804; Vol. 8, pl. 62, fig. 11, 1806.

Cristellaria rotulata d'Orbigny, Mem. soc. geol. France, ser. 1, Vol. 4, p. 26, pl. 2, figs. 16-18, 1840. Plummer, Univ. Texas Bull. 2644, p. 91, 92, pl. 7, figs. 8a, b, 1927.

"Test round, biconvex; peripheral margin sharply angular but not flanged; chambers 8-9 in final convolution; sutures visible as distinct lines or very slight elevations that curve very little and radiate rather acutely from the central umbonal area; apertures of all chambers usually visible on periphery in clear fresh specimens. Diameter up to .5 mm."

Rare specimens of this species have been identified from the Porters Creek clay. Plummer reports it from the upper Midway, and Cushman reports a similar form from the Naheola.

Genus MARGINULINA d' Orbigny, 1826

MARGINULINA EARLANDI (Plummer)

Plate I, 10

Cristellaria earlandi Plummer, Univ. Texas Bull. 2644, p. 103, 104, pl. 7, fig. 10, 1927.

Marginulina earlandi Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 56, pl. 9, figs. 14, 15, 1940.

"Test very elongate, much compressed; peripheral margin narrowly rounded; chambers numerous, first six or seven closely coiled about a conspicuous and only slightly protruding boss, later ones in an erect series; sutures oblique in both the coiled and uncoiled portion of test, strongly elevated in rather even development in the coiled area but more greatly thickened on each side of the linear series; aperture marginal. Length probably up to about 3 mm."

Two poorly preserved specimens from the Clayton chalk have been assigned to this species. Plummer describes the species from the entire Midway of Texas, and Cushman reports it from the upper Midway of Alabama.

Genus HEMICRISTELLARIA Stache, 1865

HEMICRISTELLARIA SUBACULEATA (Cushman) var. TUBERCULATA (Plummer)

Plate I, 11

Cristellaria subaculeata Cushman var. *tuberculata* Plummer, Univ. Texas Bull. 2644, p. 101, pl. 7, fig. 2; pl. 14, figs. 1a-c, 1927.

"Test elongate, somewhat compressed; periphery rounded on early chambers and very bluntly angular on later chambers of mature forms; chambers numerous, smooth, first six or seven plano-spiral followed by a linear succession of short, compact chambers; sutures marked by rows of distinct beadlike tubercles best developed on the coiled portion of the test and giving place to more ridgelike elevations between later chambers or even to depressions in extreme maturity; aperture protruding, radiate, peripheral. Length up to 1.4 mm.; average 1 mm."

Specimens of this upper Midway species were identified in Porters Creek samples from three localities. The species is very rare.

Genus DENTALINA d'Orbigny, 1826

DENTALINA ACULEATA (?) (d'Orbigny)

Plate II, 1

Nodosaria (*Dentalina*) *aculeata* d'Orbigny, Mem. soc. geol. France, Vol. 4, no. 1, p. 13, pl. 1, figs. 2, 3, 1840.

Dentalina aculeata (?) Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 59, pl. 10, figs. 16, 17, 1940.

Specimens similar to those identified by Cushman from Alabama as *D. aculeata* (?) (d'Orbigny) are very abundant throughout the lower Midway. All of the specimens consist of single chambers, a fairly large number of which show apertures. There is considerable variation among tests assigned to this species. It is possible that more than one species may be represented, or that some of the tests may be terminal chambers of other species.

DENTALINA BASIPLANATA Cushman

Plate II, 2

Dentalina basiplanata Cushman, Contr. Cushman Lab. Foram. Res., Vol. 14, pt. 2, p. 38, 39, pl. 6, figs. 6-8, 1938; Vol. 16, pt. 4, p. 82, pl. 14, figs. 1-6, 1940.

"Test very elongate, slightly tapering, usually slightly curved, early portion showing oblique costae indicating coiling especially in the microspheric form and often slightly compressed; chambers distinct, earlier ones not inflated, later becoming increasingly inflated as added, earlier ones much more strongly overlapping; sutures distinct, somewhat limbate, earlier ones flush with the surface, oblique, later ones progressively more depressed and more nearly at right angles to the elongate axis; wall smooth, or the earliest portion sometimes slightly roughened; aperture terminal, radiate. Length up to 2.50 mm.; diameter 0.20-0.25 mm."

A few specimens from the Clayton chalk seem to be identical with this species described from the upper Cretaceous of Mexico. The species is very rare.

DENTALINA CRINITA Plummer

Plate II, 3

Dentalina crinita Plummer, Univ. Texas Bull. 3101, p. 154, 155, pl. 11, figs. 12, 13, 1931.

"Test very elongate, arcuate, only slightly tapering, without apical spine; chambers slowly enlarging in youth, but of about equal breadth through maturity, short, appressed throughout most of the test but slightly longer and more inflated in late maturity, typically ornamented by faint and discontinuous striae that bear irregularly distributed minute nodes giving the chambers a hirsute appearance; sutures flush to markedly constricted between the later chambers, transverse; aperture a radiate protruding orifice, somewhat eccentric. Length up to 2.5 mm."

Specimens which check closely with the species described from the Navarro of Texas are common in samples of Clayton chalk and Porters Creek clay at a small number of localities.

DENTALINA DELICATULA Cushman

Plate II, 4

Dentalina delicatula Cushman, Contr. Cushman Lab. Foram. Res., Vol. 14, pt. 2, p. 40, 41, pl. 6, figs. 19, 20, 1938; Vol. 16, pt. 3, p. 56, pl. 10, figs. 22-24, 1940.

"Test elongate, slender, gently curved, initial end with a distinct spine, very slightly tapering; chambers distinct, earlier ones not inflated, somewhat overlapping, increasing very slightly in height as added until, in the adult, becoming more remote and strongly inflated, somewhat pyriform; sutures distinct, limbate, later ones somewhat depressed; wall ornamented with numerous, 15-20, rather high, plate-like, longitudinal costae, somewhat less raised and more delicate on the final chambers, independent of the sutures; aperture terminal, radiate, with a tapering neck. Length up to 1.60 mm.; diameter 0.20 mm."

Rare specimens of this species have been identified from the Clayton chalk at a small number of localities. The species, described from the Navarro of Texas, is reported by Cushman from the lower Midway of Alabama.

DENTALINA GARDNERAE (Plummer)

Plate II, 5

Marginulina gardnerae Plummer, Univ. Texas Bull. 2644, p. 106, pl. 5, figs. 11a-c, 1927.

Dentalina (?) *gardnerae* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 57, pl. 10, figs. 10-12, 1940.

Dentalina gardnerae Toulmin, Jour. Pal., Vol. 15, no. 6, p. 585, pl. 79, fig. 15, 1941.

"Test elongate, straight to slightly arcuate, somewhat stout, tapering bluntly toward the initial extremity; early chambers very slightly compressed, later ones round in transverse section, compact, subcylindrical, narrow; sutures evident as dark bands or faint lines, constricted only between the last two or three chambers, early sutures oblique or displaying even a suggestion of coiling, later ones transverse; aperture accentric, protruding, radiate. Length up to 1.5 mm.; average 1 mm."

Tests of this short stout species are widely distributed, being present in about half of the Clayton samples examined, but extremely limited in number. As in Texas, the species is known only from the lower (Clayton) beds.

DENTALINA HAVANENSIS Cushman and Bermudez

Plate II, 11

Dentalina havanensis Cushman and Bermudez, Contr. Cushman Lab. Foram. Res., Vol. 13, pt. 1, p. 11, 12, pl. 1, figs. 39, 40, 1937.

"Test elongate fusiform, greatest breadth at about the middle, thence tapering nearly equally toward either end, one side convex, the other slightly concave, initial end bluntly pointed; chambers few, increasing rapidly in size as added, overlapping; sutures fairly distinct, slightly oblique, becoming less so in the later portion; wall smooth, finely perforate; aperture terminal, radiate. Length 0.75 mm.; diameter 0.18 mm."

This is an extremely rare species which has thus far been observed only in the Porters Creek clay.

DENTALINA PLUMMERAE Cushman

Plate II, 6

Dentalina plummerae Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 57, pl. 10, figs. 7-9, 19, 1940.

"Test slender, elongate, slightly curved, tapering, greatest breadth at the last-formed chamber, initial end rounded in the megalospheric form, pointed in microspheric; chambers distinct, rapidly increasing in size as added, the later ones much inflated, subspherical; sutures of the later portion very strongly depressed, limbate; wall smooth; aperture with a distinct, rather elongate, tapering neck, radiate. Length 1.30-2.00 mm.; diameter 0.20-0.32 mm."

Rare, and usually fragmentary, specimens of this species are present in the Porters Creek clay and uppermost Clayton chalk.

Cushman described the species from the upper Midway of Alabama.

DENTALINA PLUMMERAE Cushman var.

Plate VIII, 17

The figured specimen differs from the typical form in having numerous fine costae on each chamber. On some specimens the sutures are extremely depressed, and the later chambers are separated by a slender connecting neck.

Specimens were found only in the basal Porters Creek clay on the Christopher property, 2½ miles north of pheba.—HRB

DENTALINA PSEUDO-OBLIQUESTRIATA (Plummer)

Plate II, 14

Nodosaria pseudo-obliquestriata Plummer, Univ. Texas Bull. 2644, p. 87, 88, pl. 4, fig. 18, 1927.

Dentalina pseudo-obliquestriata Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 58, pl. 10, fig. 18, 1940.

"Test long, slender, arcuate, tapering toward the aboral extremity; chambers numerous, strongly inflated, ornamented by coarse costae that follow the length of the test somewhat obliquely; sutures strongly constricted; aperture protruding, round, somewhat eccentric. Length up to 2 mm."

This species has been reported from the basal Midway of Texas and the upper Midway of Alabama. Fragmentary tests are extremely rare in both Clayton and Porters Creek beds.

DENTALINA cf. SOLVATA Cushman

Plate VII, 23

Specimens in one sample of Porters Creek clay from the Christopher property 2½ miles north of Pheba are compared to the species described in the Selma chalk near Booneville, Mississippi. Broken specimens with larger chambers than on the illustrated form have costae confined largely to the deep sutures but extend a short distance onto each chamber.—HRB

DENTALINA (?) sp.

Plate VII, 22

The figured specimen is a delicate costate form found in the Porters Creek clay on the Christopher property 2½ miles north of Pheba. Adjacent costae coalesce at the ends of chambers and obliquely cross the connecting slender necks.—HRB

Genus NODOSARIA Lamarck, 1812

NODOSARIA LATEJUGATA Gumbel

Plate II, 10

Nodosaria latejugata Gumbel, K. bayer. Akad. Wiss. Munchen, Cl. 2, Abh., Vol. 10, p. 619, pl. 1, fig. 32, 1868 (1870). Toulmin, Jour. Pal., Vol. 15, no. 6, p. 588, pl. 79, figs. 26, 27, 1941.

Nodosaria affinis Plummer (not d'Orbigny), Univ. Texas Bull. 2644, p. 89-91, pl. 14, figs. 2a-d, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 59, pl. 10, figs. 30-33, 1940.

"Test straight, elongate, apiculate; chambers cylindrical or only slightly inflated in earliest portion of test to more strongly globular in later development, ornamented by 9-11 strong, longitudinal costae; sutures transverse, generally slightly constricted in early part of test to deeply constricted above; aperture protruding, round, mammillate. Length up to 7 mm."

This species, one of the largest of the Midway forms, was identified in most of the samples examined. As in the Texas and Alabama Midway, it ranges through the entire section but is more abundant and more widely distributed in the lower (Clayton) beds.

NODOSARIA OLIGOTOMA Reuss

Plate II, 16

Nodosaria oligotoma Reuss, Palaeontographica, Vol. 20, pt. 1, p. 135, pl. 33, fig. 16, 1872. Plummer, Univ. Texas Bull. 2644, p. 87, pl. 4, fig. 14. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 59, pl. 10, figs. 25, 26, 1940.

"Test elongate, somewhat tapering posteriorly; chambers very few, generally 4-5 at most, somewhat elongate, ornamented by about six major thin costae alternating with faint minor costae that may be very weakly developed; sutures transverse, somewhat constricted; aperture greatly protruding, small, round. Length up to .65 mm."

Reported from the upper Midway of Alabama and Texas, this species is rare in and confined to the Porters Creek clay.

Genus NODOSARINA Parker and Jones, 1859

NODOSARINA (NODOSARIA) ASPERA (Reuss)

Plate II, 15

Nodosaria aspera Reuss, Verstein. bohm. Kreide., pt. 1, p. 26, pl. 13, figs. 14, 15, 1845. Cushman and Jarvis, Proc. U. S. Nat. Mus., Vol. 80, art. 14, p. 35, pl. 11, fig. 5, 1932. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 4, p. 88, 89, pl. 16, fig. 2, 1940.

"Test elongate, somewhat tapering with the greatest breadth near apertural end; chambers fairly distinct, subglobular, increasing rather uniformly in size as added, somewhat overlapping; sutures distinct, but only slightly depressed; wall ornamented with small, closely set spines covering the entire surface; aperture with a slender, elongate, cylindrical neck projecting well beyond the outline of the final chamber. Length up to 1.60 mm.; diameter 0.50-0.55 mm."

This species appears to be confined to the Porters Creek beds in Clay County. Tests are extremely rare.

NODOSARINA (FRONDICULARIA) GOLDFUSSI (Reuss)

Plate II, 7

Frondicularia goldfussi Reuss, Sitz. Akad. Wiss. Wien, Vol. 40, p. 192, pl. 4, fig. 7, 1860. Plummer, Univ. Texas Bull. 2644, p. 115, pl. 5, fig. 3, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 62, pl. 10, fig. 29, 1940.

"Test elongate oval, very thin, anteriorly acute; initial segment long, narrow, highly elevated along its axis, extended into a long apical spine; later chambers sagittate and narrow; sutures fine, narrow, gracefully curved ridges; apertures extended, radiate. Length up to 1 mm.; average .5 mm."

In Texas and Alabama, this species is confined to the upper part of the Midway. It is fairly abundant in Porters Creek samples from three localities in Clay County.

NODOSARINA (NODOSARIA) LONGISCATA (d'Orbigny)

Plate II, 8

Nodosaria longiscata d'Orbigny, Foram. Foss. Vienne, p. 32, pl. 1, figs. 10-12, 1846. Plummer, Univ. Texas Bull. 2644, p. 82, pl. 4, figs. 17a, b, 1927.

"Test very long and slender; chambers probably numerous (entire specimens impossible to procure), very elongate, smooth, cylindrical to very elongate ellipsoid; sutures transverse, only slightly to very distinctly depressed; aperture probably round and radiate. Length unknown."

Fragmentary tests of this species, consisting of 1 or 2 chambers, are common in the Clayton. They show a limited geographical distribution in Porters Creek beds, but are abundant where present.

Genus CHRYSALOGONIUM Schubert, 1907

CHRYSALOGONIUM GRANTI (Plummer)

Plate II, 9

Nodosaria granti Plummer, Univ. Texas Bull. 2644, p. 83, 84, pl. 5, figs. 9a-d, 1927.

Ellipsonodosaria (?) *granti* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 12, pt. 3, p. 51, 52, pl. 9, figs. 3-5, 1936.

Chrysalogonium granti Toulmin, Jour. Pale., Vol. 15, no. 6, p. 589, pl. 79, figs. 34, 35, 1941.

"Tests very long, slender, arcuate, smooth, apiculate; chambers numerous, varying from rarely compact to the more average elongate chamber that is about twice as long as broad, cylindrical to gently inflated, elliptical to ovoid; sutures transverse, unconstricted to gently constricted; wall thick, opaque, aperture round, radiate. Length probably up to several millimeters."

Tests consisting usually of from 2 to 4 chambers are common in the Clayton, less common in the Porters Creek. Considerable variation is shown, specimens ranging from extremely short stout forms to forms about two and one half times as long as broad.

Genus PSEUDOGLANDULINA Cushman, 1929

PSEUDOGLANDULINA cf. CAUDIGERA (Schwager)

Plate II, 17

Glandulina caudigera Schwager, Palaeontographica, Vol. 30, Pal. Theil, p. 107, pl. 26(3), figs. 6a, b, 1883.

Pseudoglandulina cf. *caudigera* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 60, pl. 11, figs. 2, 3, 1940.

Specimens assigned to this species appear to be identical with those so identified by Cushman from the Midway of Alabama.

Cushman reports the species as rare and confined to the lower beds. Clay County specimens were present, though rare, throughout the lower Midway, with a relatively wider distribution and greater abundance in the Porters Creek clay.

PSEUDOGLANDULINA COMATA (Batsch)

Plate II, 13

Nautilus (*Orthoceras*) *comatus* Batsch, Conch. Seesandes, pl. 1, fig. 2, 1791.

Nodosaria (*Glandulina*) *comata* Plummer, Univ. Texas Bull. 2644, p. 76, pl. 4, fig. 7, 1927.

Pseudoglandulina pygmaea Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 60, pl. 11, fig. 4, 1940.

Pseudoglandulina comata Toulmin, Jour. Paleo., Vol. 15, no. 6, p. 589, 590, pl. 79, fig. 31, 1941.

"Test short, ovate, apiculate; chambers few, greatly overlapping, striate; sutures transverse, only faintly depressed if at all; aperture large, round. Length up to .7 mm."

Specimens identified as this species show considerable variation, ranging from nearly globular to highly elongated forms. The majority exhibit little sutural construction, but other tests are markedly constricted.

This is one of the most common of the Midway forms, being present and abundant in most of the samples examined.

PSEUDOGLANDULINA MANIFESTA (Reuss)

Plate II, 12

Glandulina manifesta Reuss, Haidinger's Naturwiss. Abhandl., Vol. 4, pt. 1, p. 22, pl. 1, fig. 4, 1857.

Nodosaria radicula Plummer (not Linnaeus), Univ. Texas Bull. 2644, p. 77, 78, pl. 4, figs. 9a, b, 1927.

Pseudoglandulina manifesta Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 60, pl. 11, fig. 1, 1940.

"Test elongate, stout; chambers few and somewhat overlapping, smooth, short, compact, enlarging very little; sutures transverse, slightly depressed in early part of test but increasingly more constricted toward the oral extremity; shell wall thick, glossy; aperture small, round, protruding, radiate. Length up to 1 mm."

This species is widely distributed and fairly common in the Porters Creek clay; it is extremely rare in the Clayton chalk. Although the species is rarely present in beds of Clayton age or older, its appearance as a common form may be considered indicative of probable Porters Creek age.

Genus SARACENARIA Defrance, 1824

SARACENARIA MIDWAYENSIS Kline, n. sp.

Plate III, 3a-c

Test nearly triangular, periphery acute, apertural face elliptical; closely coiled; chambers few, 4 to 5 usually visible, increasing rapidly in size; sutures distinct, depressed slightly or not at all, slightly curved; wall smooth, glossy; aperture peripheral, radiate. Average length 0.5 mm.

This species is rare but widely distributed in the Porters Creek clay. It appears to be confined to that formation.

Cotypes: Porters Creek clay, east of test hole M93, at surface, 1½ miles northwest of Montpelier; Type slide III, 3a-c, Mississippi Geological Survey.

SARACENARIA cf. SUBLATIFRONS (Plummer)

Plate III, 1

Cristellaria sublatifrons Plummer, Univ. Texas Bull. 2644, p. 100, 101, pl. 7, figs. 6a, b, 1927.

"Test elongate, smooth, tapering at both ends; peripheral margin bluntly angular; chambers few, passing from very slightly spiral to linear oblique in rapidly lengthening series, later chambers bluntly triangular but not keeled; sutures strongly oblique, smooth, distinct; aperture at apex of a long, narrow, slightly inflated septal face marked by a faint longitudinal furrow. Length up to .5 mm."

A single poorly preserved specimen from each of four localities may belong to the above species. These tests differ from the specific description in lacking the longitudinal furrow, which, however, may be due to the poor preservation.

Plummer reports the species as known only from the upper Midway. Three of the Clay County specimens are from the Porters Creek clay, the fourth from the Clayton chalk.

SARACENARIA TRIGONATA (Plummer)

Plate III, 2

Cristellaria trigonata Plummer, Univ. Texas Bull. 2644, p. 101, pl. 7, figs. 3a, b, 1927.

"Test elongate, triangular in cross section, tapering toward the oral end; peripheral margin carinate; early chambers closely coiled; later ones sharply carinate on each side of the septal face; sutures as dark lines; aperture at the apex of a long broad septal face on mature specimens. Length up to .7 mm."

Rare specimens of this species, reported from the upper Midway of Texas and Alabama, have been identified in samples from six localities, four in Porters Creek and two in the uppermost Clayton.

Genus VAGINULINA d'Orbigny, 1826

VAGINULINA GLABRA (d'Orbigny)

Plate III, 4

Marginulina glabra d'Orbigny, Ann. Sci. Nat., Vol. 7, p. 259, No. 6, Modele No. 55, 1826.

Marginulina glabra Plummer, Univ. Texas Bull. 2644, p. 104, 105, pl. 6, figs. 3a-d, 1927.

"Test short, stout, slightly curved, bluntly rounded at the base, circular in transverse section; chambers smooth and few, first three or four being inrolled; sutures not at all depressed in the coiled portion of the test but merging into slightly depressed sutures above; shell wall generally thick and opaque but rarely thin and transparent, very smooth; aperture radiate, protruding, marginal in youth but becoming more central with maturity. Length up to 1 mm."

Plummer reports this species from the upper and upper basal Midway of Texas. In Clay county the species is known only from the Porters Creek, where it is rare.

VAGINULINA GRACILIS Plummer

Plate III, 7

Vaginulina gracilis Plummer, Univ. Texas Bull. 2644, p. 111, pl. 6, figs. 5a, b, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 61, pl. 9, fig. 27, 1940.

"Test long, slender, slightly arcuate, gradually tapering toward the initial end, compressed; chambers numerous, short, smooth, compact, except the primordial chamber which is bulbous in megalospheric forms; sutures oblique on early portion of test to less oblique above, expressed outwardly by distinct and narrow ridges that extend around the apertural margin; wall moderately strong; aperture marginal, protruding, radiate. Length up to 2.5 mm."

Tests of this species are widely distributed throughout the Clayton chalk, being very abundant at some localities. As in Texas and Alabama, the species is confined to the Clayton.

VAGINULINA LEGUMEN (Linnaeus)

Plate VII, 13

Nautilus legumen Linnaeus, Syst. Nat., ed. 10, p. 711, no. 248, 1758; ed. 12, p. 1164, no. 288, 1767.

Vaginulina legumen, Plummer, Univ. of Texas Bull. 2644, p. 109, pl 6, fig. 2, 1927. (See this reference for other references).

"Test elongate, arcuate, slender, smooth, tapering gracefully toward the apical end; chambers compact, as many as 13 in very well-developed specimens with an average of 8-9, very oblique, slightly turgid in maturity, initial chamber provided with a prominent spine; sutures oblique, slightly constricted above; aperture eccentric, radiate, all visible through the sutures of pellucid specimens. Length up to 1.3 mm.; usually much less."

Specimens identical with those described from the Texas Midway were found in the Porters Creek clay from the Cristopher property 2½ miles north of Pheba.—HRB

VAGINULINA LEGUMEN (LINNAEUS) var. ELEGANS d'Orbigny

Plate III, 5

Vaginulina elegans d'Orbigny, Ann. Sci. Nat., Vol. 7, p. 257, No. 1, Modele No. 54, 1826.

Vaginulina legumen var. *elegans* Cushman, U. S. Nat. Mus. Bull. 100, Vol. 4, p. 258, pl. 41, fig. 4, 1919. Plummer, Univ. Texas Bull. 2644, p. 110, 111, pl. 6, fig. 1, 1927.

"Test elongate, stout, very bluntly tapering toward the initial end, compressed in its early portion to less compressed in its later development; chambers smooth, 8-10 in tests of average size to as many as 13 in especially well-developed ones; proloculum nearly round but not inflated above the general contour of the test; sutures very faintly elevated to smooth, conspicuous as dark bands on pellucid specimens, very oblique in early part of test to almost transverse above, unconstricted except between last two or three; aperture eccentric, protruding, radiate, all visible through the sutural bands of very fresh tests. Length up to 1.5 mm.; average 1 mm."

A rather stout bluntly tapering species of *Vaginulina* appears to be identical with the Texas form referred to the above species by Plummer. Although reported confined to the upper Midway of Texas, the species ranges throughout the Clay County lower Midway.

VAGINULINA PLUMOIDES Plummer

Plate III, 6

Vaginulina plumoides Plummer, Univ. Texas Bull. 2644, p. 113, pl. 6, fig. 6, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 61, pl. 9, fig. 26, 1940.

"Test very thin, wing shaped, acuminate posteriorly and anteriorly, spreading rapidly upward; chambers very oblique and somewhat curved, ornamentated by very fine delicate striae parallel to the direction of growth; aperture protruding. Length up to .8 mm."

Clay County specimens of this species are large, averaging about 1.5 mm. in length. Tests are abundant in a small number of samples from both Porters Creek and Clayton beds.

VAGINULINA ROBUSTA Plummer

Plate III, 8

Vaginulina robusta Plummer, Univ. Texas Bull. 2644, p. 112, pl. 6, figs. 4a, b; pl. 13, fig. 3, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 61, pl. 10, figs. 1-4, 1940.

"Test elongate, moderately broad, stout, somewhat compressed, tapering bluntly in megalospheric forms but very acutely in microspheric forms; chambers smooth, few, first two or three very slightly twisted followed by the usual straight linear series; sutures oblique, conspicuously marked by sharp, high ridges that on most specimens encircle the test, though a slight amount of discontinuity is frequently evident; aperture on extreme margin. Length up to 1.4 mm."

This is one of the most characteristic of the Porters Creek species. Tests are extremely rare in most samples, but are present in all Porters Creek clay material examined. At one locality specimens were found in the uppermost Clayton chalk associated with *Vaginulina gracilis* Plummer.

Genus PALMULA Lea, 1833

PALMULA cf. BUDENSIS (Hantken)

Plate III, 9

Flabellina budensis Hantken, Mittheil. Jahrb. k. geol. Anstalt, Vol. 4, p. 44, pl. 4, fig. 17, 1875.

Frondicularia budensis Plummer, Univ. Texas Bull. 2644, p. 116, 117, pl. 5, figs. 5a, b, 1927.

Palmula cf. *budensis* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 62, pl. 10, figs. 5, 6, 1940.

"Test transparent, thinly and evenly compressed, elongate elliptical to ovate, rarely apiculate, aboral extremity bluntly pointed; periphery very narrowly rounded; chambers numerous, narrow, smooth, partially coiled in early portion of test followed by typical sagittate chambers; sutures very faintly depressed between later chambers; shell wall very thin and smooth; aperture central, circular, prolonged, radiate. Length up to 1 mm."

This is a widely distributed and rather common species. Although reported from the upper Midway only in Texas and Alabama, Clay County specimens appear to be distributed rather uniformly throughout the Clayton and lower Porters Creek.

PALMULA DELICATISSIMA (Plummer)

Plate III, 12

Frondicularia delicatissima Plummer, Univ. Texas Bull. 2644, p. 120, pl. 5, fig. 4, 1927.

Palmula delicatissima Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 61, pl. 9, figs. 28, 29, 1940.

"Test very thin, broadly subovate, tapering rapidly toward the apertural extremity and bluntly rounded posteriorly; peripheral edges narrowly quadrate; early chambers flabelline and irregularly coiled, later series typically sagittate; sutures delicate, thin, raised ridges from which branch a few wavy elevations especially near the apertural extremities of the sutures; shell wall coarsely punctate; aperture protruding. Length up to .95 mm., average .5 mm."

A single specimen of this species was identified from the Porters Creek clay.

PALMULA cf. PRIMITIVA Cushman

Plate III, 10

Palmula simplex Cushman, Contr. Cushman Lab. Foram. Res. Vol. 14, pt. 2, p. 36, pl. 6, fig. 1, 1938.

Palmula primitiva Cushman, Contr. Cushman Lab. Foram. Res., Vol. 15, pt. 4, p. 91, pl. 16, figs. 4, 5, 1939.

"Test elongate, much compressed, greatest thickness at the umbo, formed by the proloculum, thence thinning toward the periphery, the later portion greatly compressed, rounded at the base, sides in the adult nearly parallel, periphery acute, at the base slightly carinate, early portion close-coiled, later uncoiling, and in the adult with a few chambers chevron-shaped; chambers distinct, not inflated; sutures distinct, slightly limbate, not depressed; wall with very delicate, longitudinal striae; aperture terminal, elongate, with a slender neck. Length up to 1.60 mm.; breadth 0.30-0.35 mm."

Midway specimens differ from the typical species, described from the upper Cretaceous of Texas, in being relatively broader, the ratio of length to breadth being as about 3 to 1. In this respect they more closely resemble the specimen figured by Cushman from the Midway of Alabama.

The species is rare in Clayton samples from several localities, and abundant in a Porters Creek sample from one locality.

PALMULA RUGOSA (d'Orbigny)

Plate III, 11

Flabellina rugosa d'Orbigny, Mem. soc. geol. France, Ser. 1, Vol. 4, p. 23, pl. 2, figs. 4, 5, 7, 1840.

Frondicularia rugosa Plummer, Univ. Texas Bull. 2644, p. 118-20, pl. 5, fig. 1, 1927.

Palmula rugosa Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 62, pl. 9, fig. 30, 1940.

"Test equally compressed, thin, subrhomboid; early chambers Flabelline followed by the typical sagittate chambers, smooth or with few punctations; sutures marked by conspicuous, thin elevations; aperture protruding, radiate, central. Length up to 1 mm.; usually less."

Tests of this species are rare, but widely distributed, being present in about half of the Clayton samples examined.

Genus FRONDICULARIA De france, 1826

FRONDICULARIA ARCHIACIANA d'Orbigny

Plate III, 13

Frondicularia archiaciana d'Orbigny, Mem. soc. geol. France, Ser. 1, Vol. 4, p. 20, pl. 1, figs. 34-36, 1840. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 12, pt. 1, p. 19, pl. 4, figs. 8-10, 1936. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 592, pl. 80, fig. 4, 1941.

"Test elongate, slender, widest at the base of the final chamber, much compressed, with a small inflated smooth proloculum, periphery truncate, flat; chambers numerous, chevron-shaped, increasing gradually in size as added; sutures distinct, strongly oblique to the periphery; wall smooth; aperture small, terminal, protruding, at the end of a slender neck. Length up to 1.4 mm.; width up to 0.42 mm.; thickness 0.09-0.17 mm."

Rare tests of this species were identified from Clayton beds at five localities. The figured specimen, the only complete one, is not entirely typical, in that the chambers of most specimens increase in width more gradually, giving rise to a relatively more slender test.

FRONDICULARIA cf. FRANKEI Cushman

Plate III, 14

Frondicularia archiaciana var. *strigillata* Plummer, Univ. Texas Bull. 2644 p. 114, 115, pl. 5, figs. 2a, b, 1927.

Frondicularia frankei Cushman, Contr. Cushman Lab. Foram. Res., Vol. 12, pt. 1, p. 18, pl. 4, figs. 6, 7, 1936. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 592, 593, pl. 80, fig. 5, 1941.

Frondicularia cf. *frankei* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 63, pl. 10, figs. 36, 37, 1940.

"Test elongate, lanceolate, widest at the base of the final chamber, compressed, with a rather large inflated proloculum and stout initial spine, periphery truncate, flat; chambers up to about 8 or 10 in number in large specimens, chevron-shaped, gradually increasing in size as added; sutures indistinct, obscured by the ornamentation of the test, limbate, especially near the median line of the test; wall marked by fine longitudinal, discontinuous raised costae, proloculum ornamented by one to three longitudinal raised costae; aperture terminal, protruding. Length up to 3.04 mm.; width up to 0.74 mm.; thickness up to 0.28 mm."

A large *Frondicularia* which rather closely resembles *F. frankei* Cushman is common throughout the lower Midway. It differs from the typical form in showing sutures rather distinctly and in posesssing costae many of which are continuous and most of which cross several chambers. It is possible that this form should be considered a separate species. However, although specimens were rather numerous, they were too poorly preserved to be so designated.

Genus LAGENA Walker and Jacob, 1798

LAGENA HISPIDA Reuss

Plate IV, 3

Lagena hispida Reuss, Zeitshr. deutsch. geol. Gesell., Vol. 10, p. 434, 1858. Carsey, Univ. Texas Bull. 2612, p. 30, pl. 4, fig. 8, 1926. Plummer, Univ. Texas Bull. 3101, p. 159, pl. 10, fig. 12, 1931.

"Test globular and covered by short delicate spines that are evenly distributed over the test; aperture at end of long tube. Length of globular body of test .18 mm.; breadth .17 mm.; length of test including apertural tube .27 mm."

A few specimens of this species were identified from Clayton beds at two localities.

LAGENA LAEVIS (Montagu)

Plate IV, 4

"Serpula (Lagena) laevis ovalis" Walker and Boys, Test. Min., p. 3, pl. 1, fig. 9, 1784.

Vermiculum laeve Montagu, Test. Brit., p. 524, 1803.

Lagena laevis Cushman, U. S. Nat. Mus. Bull. 71, pt. 3, p. 5, pl. 1, fig. 3, 1913. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 593, pl. 80, fig. 7, 1941.

"Test globular to ellipsoid, circular in transverse section, with long slender neck and phialine lip; wall without ornamentation; aperture a round opening at the end of the long neck. Length (including neck) up to 0.6 mm.; diameter up to 0.35 mm."

This species has the widest distribution of the Midway *Lagenas*. Rare specimens have been obtained from the Clayton at several localities and from the Porters Creek at one locality.

LAGENA ORBIGNYANA (Seguenza)

Plate IV, 5a, b

Fissurina (Fissurine) orbignyana Seguenza, Dei terreni Terziarii del distretto di Messina, p. 66, pl. 2, figs. 25, 26, T. Capra, Messina, Italy, 1862.

Lagena orbignyana Cushman, Rept. Tenn. Div. Geol. Bull. 41, p. 39, pl. 6, figs. 1a, b, 2a, b, 1931.

Specimens assigned to this species differ slightly from the originally figured specimen, but are well within the limits of the species as identified by Cushman from the Cretaceous of Texas. Tests are moderately convex, with a strong median keel merging into the apertural lip, and well developed secondary heels lying very close to the median keel.

A number of tests were collected from samples from the Porters Creek at one locality.

LAGENA cf. PRIMIGERA H. B. Brady

Plate VII, 21

Lagena primigera H. B. Brady, Quart. Jour., Micr. Sci., Vol. 21, p. 62. Cushman, Rept. Tenn. Div. Geol. Bull. 41, p. 37, pl. 5, fig. 8, 1931.

The figured specimen is not identical with the species described by Brady, nor is it identical with specimens referred to this species from the Ripley formation of Tennessee. Brady's species has 10 to 12 longitudinal costae whereas the Mississippi specimen has only 6. These costae are fairly uniform throughout the length of the test but slightly thickened towards the neck. The surface of the test between the costae is smooth, but a striking ornamentation is developed along the costae by the numerous tubules aligned normal to the axis of each.

The specimen was the only one of its kind that was found in the Clay County material. It came from the uppermost Clayton chalk in a test hole (M66) on the John E. Snell, Jr. property (SE. 1/4, SE.1/4, SW.1/4, Sec. 15, T. 16 S., R. 3 E.) 30 feet west of a road curve.—HRB

LAGENA SULCATA (Walker and Jacob) var. SEMIINTERUPTA Berry

Plate VII, 15, 16

Lagena sulcata (Walker and Jacob) var. *semiinterupta* W. Berry, in Berry and Kelly, Proc. U. S. Nat. Mus., Vol. 76, art. 19, p. 5, pl. 3, fig. 19, 1929. Cushman, Rept. Tenn. Div. Geol. Bull. 41, p. 37, pl. 5, figs. 9-11, 1931. Bergquist, Miss. Geol. Surv. Bull. 49, p. 52, pl. V, 21, 22, 1942.

Specimens that have coalescing costae were found sparingly in both lower Porters Creek clay and from the Clayton chalk in Clay County. These are similar to the specimens found in the Ripley formation.—HRB

FAMILY POLYMORPHINIDAE

Genus GUTTULINA d'Orbigny, 1839

GUTTULINA PROBLEMA d'Orbigny

Plate IV, 2

Guttulina problema d'Orbigny, Ann. Sci. Nat., Vol. 7, p. 266, no. 14, 1826. Cushman and Ozawa, Proc. U. S. Nat. Mus., Vol. 77, art. 6, pp. 19-22, pl. 2, figs. 1-6; pl. 3, figs. 1a-c, 1930. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 594, pl. 80, fig. 8, 1941.

"Test subovate, broadly rounded at the initial end, acute at the apertural end; chambers elongate, inflated, each succeeding chamber slightly removed from the base; sutures distinct, depressed; wall smooth; aperture radiate. Length up to 1 mm.; width up to 0.68 mm."

Specimens from the Midway show few chambers, closely resembling those figured from the Midway of Texas. Tests are small, averaging about .5 mm. in length.

The species is fairly common in the Clayton, extremely rare in the Porters Creek.

Genus GLOBULINA d'Orbigny, 1839

GLOBULINA GIBBA d'Orbigny

Plate IV, 1

Globulina gibba d'Orbigny, Ann. Sci. Nat., Vol. 7, p. 266, No. 10, Modele No. 63, 1826. Cushman and Ozawa, Proc. U. S. Nat. Mus., Vol. 77, art. 6, pp. 60-64, pl. 16, figs. 1-4, 1930. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 63, pl. 11, fig. 6, 1940. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 594, pl. 80, fig. 9, 1941.

Polymorphina gibba Plummer, Univ. Texas Bull. 2644, p. 122, 123, pl. 6, figs. 8a, b, 1927.

"Test globular to subglobular, circular in transverse section; chambers few, rounded; sutures marked by dark lines, often indistinct, not depressed; wall smooth, or with a fistulose growth near the apertural end of some specimens; aperture radiate. Diameter up to 0.83 mm."

Tests of this species are abundant in the Clayton but extremely rare in the Porters Creek beds.

Genus PYRULINA d'Orbigny, 1839

PYRULINA CYLINDROIDES (Roemer)

Plate VII, 5

Polymorphina cylindroides Roemer, Neues Jahrb. fur Min., p. 385, pl. 3, fig. 26, 1838. H. B. Brady, Parker and Jones, Trans. Linn. Soc., Vol. 27, p. 221, pl. 39, figs. 6 a-c, 1870.

Pyrulina cylindroides Cushman and Ozawa, Proc. U. S. Nat. Mus., Vol. 77, Art. 6, p. 56, pl. 14, figs. 1-5, 1930. Cushman, Rept. Tenn. Div. Geol. Bull. 41, p. 40, pl. 6, figs. 7, 8, 1931. Toulmin, Jour. Pal. Vol. 15, no. 6, p. 594, pl. 80, fig. 10, 1941.

"Test elongate, fusiform to cylindrical, acuminate toward both extremities, almost circular in cross section; chambers elongate, not much embracing, arranged in a nearly triserial series, tending to become biserial, each succeeding chamber farther removed from the base; sutures but little depressed; wall smooth; aperture radiate. Length 0.50-1.10 mm.; breadth 0.18-0.32 mm.; thickness 0.15-0.30 mm."

There are a few specimens that appear to belong to this widely distributed species. These show variation in tests from the fusiform type to the elongated and somewhat irregular form illustrated herein. These are sparingly found in the basal Porters Creek clay and the uppermost Clayton chalk.—HRB

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

SIGMOMORPHINA sp.

Plate IV, 6

The figured specimen was collected from the Clayton formation.

Genus POLYMORPHINA d'Orbigny, 1826

POLYMORPHINA CUSHMANI Plummer

Plate IV, 8

Polymorphina cushmani Plummer, Univ. Texas Bull. 2644, p. 125, pl. 6, fig. 9; pl. 15, figs. 1a-c, 1927. Cushman and Ozawa, Proc. U. S. Nat. Mus., Vol. 77, art. 6, p. 117, pl. 30, figs. 8a, b, 1930.

"Test broadly ovoid, strongly compressed; peripheral margin narrowly rounded and somewhat lobate; sutures marked by faint depressions toward the margins but marked by irregularly disposed and broken elevations down the central axis on each side of the test; aperture extended, radiate. Length up to 1 mm."

The figured specimen, the only one of this species noted in the Clay County material, is from a bed at the top of the Clayton.

POLYMORPHINA FRONDEA (Cushman)

Plate IV, 7

Bolivina frondea Cushman, U. S. Geol. Survey Prof. Paper 129-F, p. 126, pl. 29, fig. 3, 1922; Prof. Paper 133, p. 20, 1923.

Polymorphina frondea Cushman, Contr. Cushman Lab. Foram. Res., Vol. 5, p. 41, 1929. Cushman and Ozawa, Proc. U. S. Nat. Mus., Vol. 77, art. 6, p. 118, 119, pl. 30, figs. 11a, b, 1930.

"Test compressed, of uniform thickness, the broad sides nearly parallel, oblong, broadest above the middle, acuminate toward the initial end, margins with a raised rim; chambers compressed, elongated, alternating; sutures depressed, distinct; wall smooth, often with obscure fine costae; aperture radiate. Length 0.50-0.65 mm.; breadth 0.30-0.40 mm.; thickness 0.04-0.05 mm."

A small number of specimens appear to be identical with the above species, described from the lower Oligocene. Considerable variation is exhibited by the Midway specimens, the figured test being an intermediate form. The species is most common in the Porters Creek clay, but is also rarely present in the Clayton chalk.

POLYMORPHINA sp.

Plate IV, 9

The illustrated specimen was collected from the uppermost Clayton beds.

Genus RAMULINA Rupert Jones, 1875

RAMULINA GLOBULIFERA (H. B. Brady)

Plate IV, 10, 15

Ramulina globulifera H. B. Brady, Quart. Jour. Mic. Soc., Vol. 19, p. 272, pl. 8, figs. 32, 33, 1879. Plummer, Univ. Texas Bull. 3101, p. 174, pl. 11, figs. 15a, b, 1931. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 596, 597, pl. 80, fig. 21, 1941.

Ramulina cf. *aculeata* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 64, pl. 11, figs. 13, 14, 1940.

"Test free, branching, composed of segments of different sizes connected by stoloniferous tubes. Segments numerous (two to eight or more), globular or subglobular, each with several (two to six) tubulated apertures extended from different portions of the periphery, some of which terminate in fresh chambers. Stoloniferous tubes narrow, circular in section, about equal in length to the diameter of the larger chambers. Texture hyaline; surface hispid or aculeate. Length, when complete, 1/15 inch (1.7 millim.) or more."

Single chambers, globular or ovate, and fragments of stoloniferous tubes are common in many samples from both the Porters Creek and Clayton.

Genus BULLOPORA Quenstedt, 1856

BULLOPORA CHAPMANI (Plummer)

Plate IV, 11

Vitriwebbina chapmani Plummer, Univ. Texas Bull. 2644, p. 128, pl. 8, figs. 2a, b, 1927.

Bullopora chapmani Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 64, pl. 11, figs. 10, 11, 1940.

"Test adherent, composed of strongly inflated, perfectly smooth, elongate chambers joined by narrow slender tubes, and edged by a slight flange that is so thin and merges so well into the shell on which it is adherent, that it is hardly evident unless the test has been broken away from its support. Average length of single chamber .7 mm.; average width .3 mm."

Tests assigned to this species are slightly smaller, on the average, than those from the Midway of Texas. The species is rare throughout the Clay County Midway, being somewhat more common in the Porters Creek beds. Tests are usually broken free or attached to shells of *Nodosaria latejugata* Gumbel.

BULLOPORA CHAPMANI (Plummer) var. HISPIDA Kline, n. var.

Plate IV, 12

Variety differs from the species in having a finely hispid surface. The variety resembles the species very closely in size and shape, but may readily be identified by its hispid test. No intermediate forms between species and variety have been noted.

This is the most abundant of the Midway species of *Bullopora*. It is restricted to the Porters Creek beds, whereas the species is rarely present in the Clayton.

Holotype: Porters Creek clay, test hole M49, surface to 8.7 feet below, 2 1/2 miles north of Pheba; Type slide IV, 12, Mississippi Geological Survey.

BULLOPORA LAEVIS (Sollas)

Plate IV, 13

Webbina laevis Sollas, Geol. Mag., Vol. 4, p. 103, pl. 6, figs. 1-3, 1877.

Vitriwebbina laevis Chapman, Geol. Mag., Vol. 8, p. 53, pl. 2, fig. 4, 1892. Plummer, Univ. Texas Bull. 2644, p. 128, pl. 8, fig. 3, 1927.

Bullopora laevis Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 64, pl. 11, fig. 12, 1940.

"Test adherent, composed of a few smooth, hemisphaerical chambers; aperture protruding, small, round. Average length of chamber .3 mm."

Tests of this species from the Midway are larger than those reported by Plummer from the Midway of Texas, and average about the same size as specimens of *B. chapmani* (Plummer). Present throughout the lower Midway, the species is more common in the Porters Creek clay. Tests are usually broken free; a few are attached to tests of *Nodosaria latejugata* Gumbel.

BULLOPORA LAEVIS (Sollas) var. HISPIDA Kline, n. var.

Plate IV, 16

Variety differs from the species in having a finely hispid surface.

This is a well defined variety which is identical with the species in size and shape but may readily be distinguished by the hispid character of the surface. No intermediate forms were observed.

The variety is a little more abundant than the species in the Midway beds, but is more restricted in range, being confined to the Porters Creek.

Holotype: Porters Creek clay, test hole M49, surface to 8.7 feet below, 2 1/2 miles north of Pheba; Type slide IV, 16, Mississippi Geological Survey.

FAMILY NONIONIDAE

Genus NONIONELLA Cushman, 1926

NONIONELLA WELLERI (Plummer)

Plate IV, 21a, b

Truncatulina welleri Plummer, Univ. Texas Bull. 2644, p. 143, pl. 9, figs. 6a-c, 1927.

"Test small, equally biconvex, considerably compressed; chambers 10-11 in final whorl, strongly punctate, narrow, curved, increasing gradually in size; sutures distinct, narrow, tapering, slightly elevated, and curved in a broad gentle swing, those on the ventral side being joined in a low ridge about the small umbilical depression, aperture a low arch very close to the periphery and narrowing toward the umbilicus under a narrow lip. Diameter up to .35 mm.; usually about .25 mm."

Rare specimens of this species are present in the Porters Creek clay and uppermost beds of the Clayton chalk.

FAMILY HETEROHELICIDAE

Genus GUMBELINA Egger, 1899

GUMBELINA MORSEI Kline, n. sp.

Plate VII, 12

Test small, about twice as long as broad, regularly tapering, with greatest breadth at apertural end, periphery rounded and lobulate; chambers with breadth greater than height, inflated, increasing rapidly in size, especially in breadth; sutures distinct, depressed; wall finely but distinctly spinose; aperture high, arched, with distinct lateral flanges.

This minute species resembles *Gumbelina midwayensis* Cushman, from the Midway of Alabama, but may readily be distinguished from that species by the proportionately greater breadth of the chambers.

The species is common in the Porters Creek and transitional beds, but is not known from typical Clayton beds.

Holotype: Porters Creek clay, test hole M49, surface to 8.7 feet below, 2 1/2 miles north of Pheba; Type slide VII, 12, Mississippi Geological Survey.

Genus **PLANOGLOBULINA** Cushman, 1927

PLANOGLOBULINA ACERVULINOIDES Cushman

Plate VII, 1

Gumbelina acervulinoides Egger, Abhandl. kon. bay. Akad. Wiss. Munchen, Cl. II, Vol. 21, p. 36, pl. 14, figs. 17, 18, 20-22, 1899.

Pseudotextularia acervulinoides Cushman, Jour. Wash. Acad. Sci., Vol. 15, p. 134, 1926; Contr. Cushman Lab. Foram. Res., Vol. 2, pt. 1, p. 17, 1926.

Planoglobulina acervulinoides Cushman, 1. c., Vol. 3, pl. 13, fig. 5, 1927. Jour. Pal., Vol. 1, p. 158, pl. 27, fig. 3, 1927. Special Publ. No. 1, Cushman Lab. Foram. Res., pl. 33, figs. 8, 9; pl. 34, fig. 5, 1928. White, Jour. Pal., Vol. 3, p. 33, pl. 4, fig. 6, 1929. Cushman, Special Publ. No. 4, Cushman Lab. Foram. Res., pl. 21, fig. 8, 1933. Special Publ. No. 5, pl. 26, fig. 17, 1933. Contr. Cushman Lab. Foram. Res., Vol. 14, pt. 1, p. 23, pl. 4, figs. 5-8, 1938.

"Test much compressed, early stages similar to *Pseudotextularia,* later with the subglobular chambers spread out in one plane; sutures fairly distinct, depressed; wall longitudinally costate. Length up to 0.75 mm.; breadth 0.75 mm.; thickness 0.10-0.15 mm."

The figured specimen was the only one noted. It came from a sample of Clayton chalk from a test hole (M172) on the C. H. Hubbert property north of Highway 10, 0.1 mile west of the bridge over Double Cabin Creek. The striated chambers and general characteristics appear to be the same as on specimens described from the Ripley formation, at Old Canton Landing, Alabama River, Alabama.—HRB

Genus **EOUVIGERINA** Cushman, 1926

EOUVIGERINA EXCAVATA Cushman

Plate IV, 19

Eouvigerina excavata Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 66, pl. 11, fig. 18, 1940. Cushman and Todd, Contr. Cushman Lab. Foram. Res., Vol. 18, pt. 2, p. 35, pl. 6. figs. 20, 21, 1942.

"Test small, mostly biserial, in the adult quadrangular in end view, tapering, greatest breadth formed by the last two chambers, initial end rounded; chambers very distinct, the broader faces deeply excavated, the angles of the chamber raised into narrow plate-like projections; sutures distinct, strongly raised; wall smooth, finely perforate; aperture terminal, rounded, with a distinct neck and lip. Length 0.18-0.25mm.; diameter 0.08-0.10 mm."

This rare species has been observed only in Porters Creek beds from one locality and the uppermost Clayton from a second locality.

Genus **PSEUDOUVIGERINA** Cushman, 1927

PSEUDOUVIGERINA NAHEOLENSIS Cushman and Todd

Plate VII, 2

Pseudouvigerina naheolensis Cushman and Todd, Contrib. Cushman Lab. Foram. Res., Vol. 18, pt. 2, p. 36, pl. 6, figs. 18, 19, 1942.

"Test small, broadly fusiform in front view, in end view triangular with the sides flattened or somewhat concave, the periphery angled and slightly carinate, or slightly truncate; chambers distinct, very slightly inflated in the last whorl; sutures distinct, slightly depressed in the later portion; wall distinctly perforate, generally smooth; aperture circular, at the end of a short but distinct cylindrical neck with a slight phialine lip. Length 0.30 mm.; breadth 0.15 mm."

Minute tests from samples of both the basal Porters Creek clay and the Clayton chalk show characteristics of the species described from the Naheola formation of Alabama.—HRB

Genus **SIPHOGENERINOIDES** Cushman, 1927

SIPHOGENERINOIDES ELEGANTA (Plummer)

Plate IV, 18

Siphogenerina eleganta Plummer, Univ. Texas Bull. 2644, p. 126, pl. 8, figs. 1a-c, 1927.

Siphogenerinoides eleganta Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 66, pl. 11, fig. 17, 1940.

"Test elongate; early chambers biserial merging into a succession of alternately oblique chambers that very rarely reach a Nodosarian development; very earliest portion of test marked by indistinct and irregularly developed longitudinal striations and spinulose projections that disappear rapidly upward; mature chambers very smooth and coarsely punctate; sutures sharply depressed; aperture terminal, elliptical, bounded by a short, flaring rim and connected to earlier apertures by an inner tube. Length up to .9 mm.; average .5 mm."

Tests of this species are widely distributed but seldom common throughout the Clayton and lower Porters Creek.

FAMILY BULIMINIDAE

Genus BULIMINA d'Orbigny, 1826

BULIMINA ARKADELPHIANA Cushman and Parker, var. MIDWAYENSIS Cushman and Parker

Plate VII, 9

Bulimina aculeata Plummer, Univ. Texas Bull. 2644, p. 73, pl. 4, fig. 3, 1927.
Bulimina arkadelphiana Cushman and Parker var. *midwayensis* Cushman and Parker; Contrib. Cushman Lab. Foram. Res., Vol. 12, pt. 2, p. 42, pl. 7, figs. 9, 10, 1936.

"Test small, about 1 1/2 times as long as broad, tapering, usually with a well-defined basal spine; chambers distinct, undercut at base, giving a "collared" effect, about 5 whorls, last-formed chambers inflated; sutures distinct, depressed; wall of all but the last-formed whorl, covered with sharp, fine spines, usually extending from the lower edges of the chambers, last-formed whorl smooth, finely perforate; aperture loop-shaped with a well-defined lip. Length 0.26-0.38 mm.; diameter 0.16-0.25 mm."

A single specimen from a sample of the basal Porters Creek clay from a test hole (M195) in a pasture 0.1 mile south of the Columbus & Greenville Railway tracks and 0.2 mile east of Pheba, appears to have the characteristics of the species described from the Midway of Texas.—HRB

BULIMINA CACUMENATA Cushman and Parker

Plate VII, 8

Bulimina cacumenata Cushman and Parker, Contrib. Cushman Lab. Foram. Res., Vol. 12, pt. 2, p. 40, pl. 7, figs. 3 a-c, 1936; Vol. 16, pt. 3, p. 67, pl. 11, fig. 20, 1940.

"Test small, somewhat fusiform, greatest width slightly above the middle, gradually tapering to a long, subacute point; chambers numerous 6-7 whorls, those of the last whorl somewhat inflated, arranged in a slightly twisted series, those of adjacent series meeting in a zigzag line; sutures distinct in the upper part, obscure in the lower part of the test, very slightly depressed; wall, except for the last whorl and occasionally for the next to the last, covered with irregular, low, closely set costae, last whorl smooth, coarsely perforate; aperture loop-shaped, with a slight lip. Length 0.20-0.23 mm.; diameter 0.10-0.11 mm."

Figured specimen is from basal Porters Creek clay (test hole M49) on J. Christopher property, 2 1/2 miles north of Pheba. Specimens of this small species were also found in a few samples of the uppermost Clayton chalk.—HRB

BULIMINA (DESINOBULIMINA) QUADRATA Plummer

Plate IV, 20a, b

Bulimina (Ellipsobulimina) quadrata Plummer, Univ. Texas Bull. 2644, p. 72, pl. 4, figs. 4, 5, 1927.

Bulimina (Desinobulimina) quadrata Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 67, pl. 11, fig. 21, 1940.

"Test of megalospheric form almost cylindrical, stout, increasing in diameter only very slightly from the broad blunt initial end toward the broadly rounded oral extremity; microspheric form pointed aborally through a sucession of small chambers that followed the proloculum to the later mature chambers that comprise a test identical in shape with that of the much more frequent megalospheric form; chambers smooth, very little inflated, broad, and short; sutures as sharp lines in early part of test and faintly depressed above; wall thin; aperture a large vertical slit on the inner side of the last chamber and connected with all previous apertures by an inner tube that traverses the entire length of the shell. Length up to .65 mm. in megalospheric form, average .5 mm.; up to .8 mm. in microspheric form."

This is one of the most widely distributed of the Midway species. Although reported confined to the upper Midway of Texas and Alabama, it ranges throughout the Clay County lower Midway. In the Clayton it is widespread but rare; in the Porters Creek it is usually somewhat larger and is frequently extremely abundant.

Genus ENTOSOLENIA Ehrenberg, 1848

ENTOSOLENIA MORSEI Kline, n. sp.

Plate IV, 17

Test ovate to globular, greatest width usually a little below center, with short apical spine; surface smooth; aperture round, small, at end of short but distinct neck. Length of holotype 0.46 mm.; breadth 0.34 mm.

This is probably the same species as that described by Plummer as *Lagena apiculata* (Reuss) and by Cushman as *Entosolenia* sp. Many of the tests are well enough preserved to show the internal structure. The species is present throughout the Clayton chalk and Porters Creek clay.

Holotype: Porters Creek clay, test hole M49, surface to 8.7 feet below, 2 1/2 miles north of Pheba; Type slide IV, 17 Mississippi Geological Survey.

Genus VIRGULINA d'Orbigny, 1826

VIRGULINA WILCOXENSIS Cushman and Ponton

Plate VI, 24

Virgulina wilcoxensis Cushman and Ponton, Contr. Cushman Lab. Foram. Res., Vol. 8, pt. 3, p. 67, pl. 8, figs. 22a-c, 1932. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 67, pl. 11, fig. 19, 1940.

"Test elongate, fusiform, somewhat compressed, about 2 1/2 times as long as broad, early portion irregularly spiral, adult irregularly biserial, periphery rounded; chambers distinct, very slightly inflated; sutures distinct, very slightly depressed; wall smooth, distinctly perforate; aperture a broad, comma-shaped opening at the base of the apertural face in the median line. Length 0.50 mm.; breadth 0.15 mm.; thickness 0.10 mm."

This species, originally described from the Wilcox and later from the upper Midway of Alabama, is fairly common in most of the Porters Creek clay samples studied. A few specimens range downward into the higher Clayton chalk beds.

Genus BOLIVINA d'Orbigny, 1839

BOLIVINA MIDWAYENSIS Cushman

Plate IV, 14

Bolivina midwayensis Cushman, Cushman Lab. Foram. Res., Spec. Publ. 6, p. 50, pl. 7, figs. 11a, b, 1936; Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 67, pl. 11, fig. 22, 1940.

"Test elongate, very slightly tapering, much compressed, periphery rounded, biserial throughout; chambers distinct, slightly inflated, low and broad, very slightly overlapping, of rather uniform shape throughout; sutures distinct, slightly depressed, strongly oblique, forming an angle of at least 45° with the horizontal, slightly curved; wall smooth, very finely perforate; aperture an oval opening, tending very slightly to be somewhat removed from the inner margin. Length up to 0.85 mm.; breadth 0.15-0.18 mm., thickness 0.08-0.10 mm."

Tests of this species are abundant in most of the Clayton samples. A few specimens have been identified from the Porters Creek clay at two localities.

Genus LOXOSTOMA Ehrenberg, 1854

LOXOSTOMA APPLINAE (Plummer)

Plate V, 7

Bolivina applini Plummer, Univ. Texas Bull. 2644, p. 69, pl. 4, fig. 1, 1927.
Loxostoma applinae Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 68, pl. 11, fig. 23, 1940.

"Test long and slender, somewhat compressed, tapering to a blunt point; periphery broadly rounded; shell wall strongly punctate; chambers smooth except for distinct striae extending from the initial extremity upward over several early chambers; sutures in early part of test faint dark lines that become more distinct upward and are finally somewhat depressed and show crenulations; aperture an elongate loop-shaped orifice extending from near the apex downward on the inner side of the last chamber. Length up to 1 mm."

This is one of the most widely distributed of the Midway species, being present in most of the samples studied. It ranges throughout the section. Plummer reports it as most abundant in the upper Midway of Texas and Cushman as confined to that horizon in Alabama. In Clay County the species appears to be about equally characteristic of the lower Porters Creek and Clayton.

FAMILY ELLIPSOIDINIDAE

Genus PLEUROSTOMELLA Reuss, 1860

PLEUROSTOMELLA cf. BREVIS var. ALTERNANS Schwager

Plate VI, 23

Pleurostomella alternans Schwager, Novara-Exped., Geol. Thiel, Vol. 2, p. 238, pl. 6, figs. 79, 80, 1866. Plummer, Univ. Texas Bull. 2644, p. 69, 70, pl. 4, figs. 2a, b, 1927.

Pleurostomella cf. alternans Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 68, pl. 11, figs. 25, 26, 1940.

"Test elongate, tapering very bluntly toward the aboral extremity; chambers few, 7-8 in adult specimens, smooth, alternating but rarely Textularian even in the beginning of the test, inflated; sutures sharply but not deeply depressed; aperture highly arched and almost vertical with a sharply pointed tooth extending inward from each side. Length up to .4 mm."

Tests of this small species were fairly common in Porters Creek beds at three localities only.

Genus ELLIPSONODOSARIA A. Silvestri, 1900

ELLIPSONODOSARIA ALEXANDERI Cushman

Plate V, 1, 2

Nodosaria spinulosa Plummer (not Montagu), Univ. Texas Bull. 2644, p. 84, pl. 4, figs. 19a-c, 1927.

Ellipsonodosaria alexanderi Cushman, Contr. Cushman Lab. Foram. Res., Vol. 12, p. 52, pl. 9, figs. 6-9, 1936; Vol. 16, pt. 3, p. 69, pl. 11, figs. 27-29, 1940.

"Test elongate, straight or slightly curved, microspheric form increasing rather rapidly in diameter from the small proloculum, the megalospheric form with proloculum having nearly as great a diameter as the last-formed chambers; chambers distinct, inflated, increasing rather gradually in length, the adult ones about twice as long as broad; sutures distinct, strongly depressed; wall ornamented with short backwardly pointing spines, in the early stages of the microspheric form with a single ring of spines slightly below the middle of the chamber, in the adult with numerous spines rather irregularly scattered over the surface; aperture a semi-circular opening with a single tooth, with a distinct neck and slightly raised lip. Length up to 2.00 mm.; diameter 0.20 mm."

Specimens assigned to this species show considerable variation from forms ornamented with costae terminating in a ring of spines at the base of each chamber to others covered with numerous short outwardly pointing spines.

The species ranges throughout the lower Midway, but is more common in the Clayton.

ELLIPSONODOSARIA PLUMMERAE Cushman

Plate V, 8

Nodosaria sagrinensis Plummer (not Bagg), Univ. Texas Bull. 2644, p. 85, 86, pl. 4, fig. 16, 1927.

Ellipsonodosaria plummerae Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 69, pl. 12, figs. 4, 5, 1940.

"Test elongate, very slightly tapering, chambers in a straight linear series, circular in transverse section, initial end with one or more short spines; chambers distinct, later ones becoming pyriform with the greatest breadth toward the base, which is somewhat excavated, increasing in size very gradually as added; sutures deeply excavated in the later portion; wall ornamented by low, longitudinal costae, broken into irregular short spines, and limited largely to the upper part of the chamber, ending often in short spines at the ridge near the base of the chamber; aperture terminal, rounded, with a distinct tooth at one side, and with a definite neck and slight lip. Length 0.80-1.00 mm.; diameter 0.10-0.14 mm."

This small distinctive species of *Ellipsonodosaria* is very abundant and widely distributed. It is equally characteristic of the Porters Creek and Clayton beds.

FAMILY ROTALIIDAE

Genus DISCORBIS Lamarck, 1804

DISCORBIS MIDWAYENSIS Cushman

Plate V, 9, 10

Discorbis midwayensis Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 70, pl. 12, figs. 6a, b, 1940.

"Test trochoid, plano-convex, dorsal side somewhat convex, ventral side flattened or even slightly concave, periphery subacute but not keeled, ventral side umbilicate; chambers normally 7 in the last-formed whorl, fairly distinct, of uniform shape, increasing gradually in size as added, slightly inflated on the dorsal side; sutures distinctly curved on both dorsal and ventral sides, slightly depressed; wall distinctly papillate on both dorsal and ventral sides, the center of the dorsal side sometimes slightly umbonate and smooth; aperture on the ventral side, in the umbilical region, low and elongate, with a distinct, overhanging lip. Diameter 0.65-0.80 mm.; thickness 0.18-0.25 mm."

In typical form this species is confined to the Clayton chalk, where it is usually present but rarely abundant.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA ALLOMORPHINOIDES (Reuss)

Plate V, 11, 12

Valvulina allomorphinoides Reuss, Sitz. Akad. Wiss. Wien, Vol. 40, p. 223, pl. 11, figs. 6a-c, 1860.

Discorbis allomorphinoides Plummer, Univ. Texas Bull. 2644, p. 139, 140, pl. 9, figs. 2a, b, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 70, 71, pl. 12, figs. 9a, b, 1940.

"Test elongate oval, somewhat more strongly convex on the dorsal side; peripheral margin very broadly rounded giving the form a very rotund appearance; chambers few, four in last whorl, enlarging rapidly; sutures faintly depressed; gently curving; shell wall very smooth and glistening; aperture opening into the umbilicus under a large, triangular umbilical flap. Length up to 0.5 mm.; average 0.4 mm."

Considerable variation is shown by specimens assigned to this species, some having 5 chambers instead of the more typical 4. The species is present throughout the lower Midway, but much more abundant and widely distributed in the Porters Creek, in which formation specimens are also usually much larger.

Genus GYROIDINA d'Orbigny, 1826

GYROIDINA SUBANGULATA (Plummer)

Plate V, 13-15

Rotalia soldanii (d'Orbigny) subangulata Plummer, Univ. Texas Bull. 2644, p. 154, 155, pl. 12, figs. 1a-c, 1927.

Gyroidina subangulata Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 71, pl. 12, figs. 7a-b, 1940.

"Test almost plano-convex, the dorsal side being flat or faintly convex, the ventral side very strongly convex, composed of about two convolutions; peripheral margin bluntly angular; chambers 8-9 in final whorl; sutures slightly depressed between the last two or three chambers on both sides and around the small umbilical excavation, otherwise plain or faintly elevated, moderately oblique dorsally and radiate ventrally; shell wall very finely punctate, very smooth, glistening; aperture a long narrow slit at the base of a broad septal face extending from a point below the periphery almost into the umbilicus. Diameter up to 0.4 mm.; usually less."

This species, as typically developed, is confined to the lower Porters Creek clay and uppermost Clayton chalk. Tests are frequently very numerous.

Genus EPONIDES Montfort, 1808

EPONIDES cf. TENERA (H. B. Brady)

Plate V, 16, 18

Truncatulina tenera H. B. Brady, Challenger, Vol. 9 (Zool.), p. 665, pl. 95, fig. 11, 1884. Plummer, Univ. Texas Bull. 2644, p. 146, pl. 9, figs. 5a-c, 1927.

Eponides sp. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 71, pl. 12, figs. 8a, b, 1940.

"Test biconvex, the ventral face being very rotund and thick, the dorsal face not so high and somewhat more sharply elevated near the center; peripheral margin bluntly acute and in general somewhat lobate; chambers very smooth and finely punctate, usually 6 in the final convolution; sutures expressed by faint, slightly oblique, narrow bands on the superior face, distinctly depressed, almost straight lines below; aperture a gently curved slit under a narrow lip. Diameter up to .4 mm."

This is one of the most characteristic and most abundant of the Porters Creek species. It has been reported from the upper Midway only of Texas and Alabama. In Clay County it is also present rarely in the uppermost Clayton chalk.

Genus PARRELLA Finlay, 1939

PARRELLA EXPANSA Toulmin

Plate V, 19, 20

Truncatulina culter Plummer, Univ. Texas Bull. 2644, p. 147, pl. 10, figs. 1a-c; pl. 15, figs. 2a, b, 1927.

Pulvinulinella culter var. *mexicana* Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, p. 72, pl. 12, figs. 12a, b, 1940.

Parrella expansa Toulmin, Jour. Pal., Vol. 15, no. 6, p. 604, text figs. 3 a-c, 4 F, G, 1941.

"Test trochiform, close coiled, subcircular in outline, ventral side strongly convex, dorsal side nearly flat with earliest coils gently elevated, periphery sharply acute with a broad thin flange; all chambers visible on dorsal side, with flange of all coils forming a limbate whorl suture, only chambers in the final convolution visible ventrally, eight or nine chambers in the final whorl; dorsal sutures broad, oblique, slightly curved, flush or slightly elevated, ventral sutures limbate between early chambers of the final whorl, generally depressed between the last two or three chambers, radiating from a small umbilical filling and curving backward near the junction with the peripheral flange; wall smooth, perforate; aperture consisting of two portions, a narrow elliptical opening extending from the base of the final chamber near the periphery obliquely across the apertural face, at an angle of 45 degrees or more to the peripheral plane, and a very narrow slit at base of the septal face extending ventrally toward the umbilical area from the dorsal end of the oblique opening. Average diameter 0.5 mm."

This is one of the most characteristic Porters Creek species, tests being abundant in most of the samples examined. A single specimen was identified from each of three localities in the uppermost Clayton, but the presence of a large number of specimens may be considered indicative of the Porters Creek. It has been recorded from the upper Midway only of Texas and Alabama.

Genus SIPHONINA Reuss, 1850

SIPHONINA PRIMA Plummer

Plate V, 21, 22

Siphonina prima Plummer, Univ. Texas Bull. 2644, p. 148, pl. 12, figs. 4a-c, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 71, pl. 12, fig. 10, 1940.

"Test almost circular, about equally biconvex, considerably compressed laterally; peripheral angle sharply acute and delicately serrate, slightly lobate; chambers usually 5 in last-formed convolution, distinctly punctate, smooth, strongly curved; dorsal sutures marked by the serrate edges of the successive chambers and obliquely curved; ventral sutures excavated, radial from a small, shallow central depression; aperture a small, narrow, elliptical opening at the periphery on the ventral side. Diameter up to .25 mm."

Tests assigned to this species differ slightly from the typical in that most have only 4 chambers rather than 5 in the last whorl.

The species is present, though nowhere abundant, throughout the lower Porters Creek and Clayton.

FAMILY CASSIDULINIDAE

Genus PULVINULINELLA Cushman, 1926

PULVINULINELLA EXIGUA (H. B. Brady)

Plate V, 23, 24

Pulvinulina exigua H. B. Brady, Challenger, Vol. 9, (Zool.), p. 696, pl. 103, Figs. 13, 14, 1884. Plummer, Univ. Texas Bull. 2644, p. 150, 151, pl. 11, figs. 3a-c, 1927.

"Test small, almost equally biconvex; peripheral margin bluntly acute, very faintly lobate; chambers smooth, finely punctate, 6 in final convolution; sutures on the dorsal side very oblique, almost straight, and expressed as conspicuous, fine dark lines; ventral sutures radiate and slightly curving from a small umbilical filling that lies flush with the convexity of the inferior face; aperture a long, narrow slit extending from near the peripheral margin almost to the umbilicus. Diameter up to .5 mm.; usually less."

This species is one of the most widely distributed of the Midway forms, and is usually rather common. Although Plummer reports it as characteristic of the upper Midway of Texas, it ranges throughout the Clay County lower Midway.

FAMILY CHILOSTOMELLIDAE

Genus ALLOMORPHINA Reuss, 1850

ALLOMORPHINA TRIGONA Reuss

Plate VI, 1, 2

Allomorphina trigona Reuss, Denk. Akad. Wiss. Wien., Vol. 1, p. 380, pl. 48, fig. 14, 1850. Plummer, Univ. Texas Bull. 2644, p. 129, 130, pl. 8, figs. 5a, b, 1927.

"Test bluntly subtrigonal; periphery broadly rounded; chambers few, 3 in each whorl, considerably embracing, inflated; sutures slightly depressed; shell wall thin, very smooth, distinctly porous; aperture a narrow slit bearing a conspicuous flap at the base of the final chamber on the ventral face. Length up to .35 mm."

Specimens assigned to this species appear to be identical with those figured by Plummer from the Midway of Texas. The species was found at only one locality, east of M93, where tests proved abundant in beds of Porters Creek age.

Genus CHILOSTOMELLA Reuss, 1850

CHILOSTOMELLA SUBTRIANGULARIS Kline, n. sp.

Plate VI, 3

Test subtriangular, about one and one-half times as long as broad, greatest width a little above middle, ends bluntly rounded; wall smooth, finely punctate; aperture narrow, nearly straight. Average length 0.75 mm.

Rare specimens of this species are known from two localities where they are present only in the highest Porters Creek beds examined. They are associated with an extremely large number of tests of *Bulimina quadrata* Plummer and *Valvulineria allomorphinoides* (Reuss).

Holotype: Porters Creek clay, east of test hole M93, at surface, 1 1/2 miles northwest of Montpelier; Type slide VI, 3, Mississippi Geological Survey.

Genus CHILOSTOMELLOIDES Cushman, 1926

CHILOSTOMELLOIDES EOCENICA Cushman

Plate VI, 8

Chilostomelloides eocenica Cushman, Contr. Cushman Lab. Foram. Res., Vol. 1, pt. 4, p. 78, pl. 11, fig. 20, 1926. Plummer, Univ. Texas Bull. 2644, p. 129, pl. 8, figs. 8a, b, 1927.

"Test elongate ellipsoid, about twice as long as broad; shell wall very thin, smooth, and finely punctate; aperture semi-lunar and highly flaring, with a conspicuous lip. Length of only perfect specimen .38 mm."

A single large specimen from the Porters Creek near test hole M49 appears to belong to this species.

Genus PULLENIA Parker and Jones, 1862

PULLENIA QUINQUELOBA (Reuss)

Plate VI, 4, 7

Nonionina quinqueloba Reuss, Zeitschr. deutsch. geol. Gesell., Vol. 3, p. 47, pl. 5, fig. 31, 1851.

Pullenia quinqueloba H. B. Brady, Challenger, Vol. 9, (Zool), p. 617, pl. 84, figs. 14, 15, 1884. Plummer, Univ. Texas Bull. 2644, p. 136, pl. 8, figs. 12a, b, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 72, pl. 12, figs. 13, 14, 1940.

"Test plano-spiral, closely coiled, completely embracing, bilaterally symmetrical; peripheral margin broadly rounded; chambers 5 in last-formed whorl; shell wall very smooth and glistening; sutures faintly depressed between last two chambers; aperture a long narrow slit extending over the periphery at base of septal face. Diameter up to .3 mm."

This is one of the commonest Midway forms, being present and usually abundant in all of the samples examined. It has been reported throughout the entire Midway of Texas and Alabama.

FAMILY GLOBIGERINIDAE

Genus GLOBIGERINA d'Orbigny, 1826

GLOBIGERINA COMPRESSA Plummer

Plate VI, 5, 6

Globigerina compressa Plummer, Univ. Texas Bull. 2644, p. 135, 136, pl. 8, figs. 11a-c, 1927. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 607, pl. 82, figs. 1, 2, 1941.

"Test small, rotaliform, closely coiled, somewhat compressed, equally biconvex; peripheral margin bluntly angular, lobate: chambers increasing gradually, 5 in last-formed whorl, moderately inflated, overlapping on dorsal face; sutures distinctly depressed and strongly curved on the dorsal side; shell wall thin, smooth, finely punctate; aperture a single moderately arched slit protected by a definite flaring flap at base of septal face and extending into the small but distinct umbilical depression. Diameter up to .4 mm.; average .3 mm."

This species, reported by Plummer to be confined to the upper Midway of Texas, has been found only in Porters Creek and uppermost Clayton beds. Tests are rare.

GLOBIGERINA PSEUDO-BULLOIDES Plummer

Plate VI, 9-11

Globigerina pseudo-bulloides Plummer, Univ. Texas Bull. 2644, p. 133, 134, pl. 8, figs. 9a-c, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 72, pl. 12, figs. 16a, b, 1940.

"Test rotaliform, very obtusely trochoid to plane dorsally, composed of about two and one-half convolutions, of which the last consists most generally of 5 (rarely 6) highly ventricose chambers increasing rapidly in size; periphery broadly rounded and lobate; shell wall thin and distinctly punctate but finely reticulate; superior face bearing a spire of small chambers only very slightly elevated, if at all, above the circumambient chambers of the final whorl; inferior face less convex and with a very distinct, though not large, umbilical depression; aperture a single, moderately large, lunate opening on the last chamber extending from the margin to the umbilicus and edged with a narrow, delicate, flaring lip. Diameter up to .4 mm."

This is one of the most abundant Midway species, ranging throughout the entire lower section in Clay County. Tests are relatively a little more common in the Porters Creek clay.

GLOBIGERINA TRILOCULINOIDES Plummer

Plate VI, 12, 13

Globigerina triloculinoides Plummer, Univ. Texas Bull. 2644, p. 134, 135, pl. 8, figs. 10 a-c, 1927. Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 72, 73, pl. 12, figs. 15a-b, 1940. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 607, 608, pl. 82, fig. 3, 1941.

"Test spiral, trochoid, composed of about 2 convolutions, the last of which is composed of 3 1/2 very rapidly increasing and highly globose chambers; periphery very broadly rounded and distinctly lobate; shell surface strongly reticulate; superior face rounded with a very low spire of neatly coiled tiny chambers of the preceding whorl; inferior face rounded with a very shallow umbilical depression; aperture a small arched slit on the last chamber and edge with a more or less prominent, delicately notched flap that extends from a point near the periphery to the umbilical depression. Greatest diameter up to .35 mm.; usually less."

This species is commonly present in the Porters Creek. Tests are rare in beds of Clayton age.

FAMILY GLOBOROTALIIDAE

Genus GLOBOTRUNCANA Cushman, 1927

GLOBOTRUNCANA sp.

Plate VI, 14

This species was obtained from a sample from the base of the Porters Creek clay at a single locality.

FAMILY ANOMALINIDAE

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA ACUTA (Plummer)

Plate V, 3, 4

Anomalina ammonoides var. *acuta* Plummer, Univ. Texas Bull. 2644, p. 149, 150, pl. 10, figs. 2a-c, 1927.

Anomalina acuta Cushman and Renz, Contr. Cushman Lab. Foram. Res., Vol. 18, pt. 1, p. 12, pl. 3, figs. 6a-c, 1942.

"Test involute, much compressed, almost equally biconvex but slightly more flattened above; peripheral margin subacute; chambers numerous, about 13-15 to the final convolution, narrow, and slightly curving; sutures marked by more or less distinct limbatious, which on the ventral face terminate along the inner edge of the convolution in a series of fine beads that surround a thick spiral of irregular filling of translucent shell material in the umbilical recess, and on the dorsal face merge at the center into a more or less prominently developed boss; shell wall distinctly but not coarsely punctate; aperture on arched opening over the peripheral margin and extending toward the umbilicus. Diameter up to 0.4 mm.; average 0.25 mm."

Clay County specimens average slightly larger in size than the species as described from the Midway of Texas, and frequently have but 12 chambers in the last whorl. The species ranges throughout the lower Midway of Clay County.

ANOMALINA cf. AMMONOIDES (Reuss)

Plate VII, 24-26

The figured specimens have strongly raised limbate sutures over most of the test except that on the ventral side, the last two or three are depressed. The final chamber appears to be usually greatly inflated ventrally.

A few specimens from the Midway of Alabama have been referred to this Upper Cretaceous species by Cushman; the Clay County forms appear to be most like it also.

Specimens were found in both the basal Porters Creek clay and the Clayton chalk of Clay County.—HRB

ANOMALINA MIDWAYENSIS (Plummer)

Plate VI, 17, 18

Truncatulina midwayensis Plummer, Univ. Texas Bull. 2644, p. 141, 142, pl. 9, figs. 7a-c, 1927.

Anomalina midwayensis Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 73, pl. 12, figs. 18a, b, 1940.

"Test almost equally biconvex, moderately compressed; peripheral margin rounded; convolutions about 2, the final one being strongly embracing; chambers usually 9 in final whorl, conspiciously punctate, gradually increasing, moderately curving; sutures broadly elevated on both sides, tapering toward the margin, and curved; aperture a slit at base of septal face under a narrow lip that extends to the umbilicus. Diameter up to .5 mm.; usually less.

This species is very abundant and widely distributed throughout the lower Midway in Clay County.

ANOMALINA MIDWAYENSIS (Plummer) var. TROCHOIDEA (Plummer)

Plate VI, 15, 16

Truncatulina midwayensis (Plummer) var. *trochoidea* Plummer, Univ. Texas Bull. 2644, p. 142, pl. 9, figs. 8a-c, 1927.

"From the type this variety is distinguished by the more strongly trochoid dorsal coiling of the convolutions. Diameter up to 0.6 mm.; usually less."

It is extremely difficult to separate this variety from the species, since most tests appear to be intermediate in form. Tests which could definitely be assigned to the variety were identified from Clayton beds at a small number of localities.

Genus CIBICIDES Montfort, 1808

CIBICIDES ALLENI (Plummer)

Plate VI, 21, 22

Truncatulina alleni Plummer, Univ. Texas Bull. 2644, p. 144, pl. 10, figs. 4a-c, 1927.

Cibicides alleni Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 73, pl. 12, figs. 19a, b, 1940.

"Test almost equally biconvex, the ventral side of most specimens being the more rounded; periphery subacute and bordered by a band of clear shell material, faintly lobate in its latest development; chambers 10-11 in last convolution, very coarsely punctate, previous whorls concealed by strong elevations of shell matter that follow the base of the chambers on the dorsal face; sutures on dorsal side marked by conspicuous elevations of transparent shell matter that taper and curve gently toward the periphery; sutures of the ventral face very slightly elevated and curving outward from the large smooth umbilical boss; aperture a large arched opening over the periphery and extending farther downward on the ventral side. Diameter up to .7 mm.; average about .4 mm."

Clay County specimens are large, averaging close to the maximum size reported by Plummer, strongly convex, and show 8 to 9 chambers in the final whorl.

The species is abundant in the lower Porters Creek clay and ranges downward into the uppermost Clayton chalk.

CIBICIDES BROWNI Kline, n. sp.

Plate VII, 18-20

Test plano-convex, ventral side convex, dorsal side flat, frequently showing signs of attachment, periphery subacute but not keeled; chambers usually 5 in the last-formed whorl, distinct, increasing rapidly in size, inflated on ventral side; sutures distinctly curved on dorsal and ventral sides, depressed on ventral side; aperture near periphery, small.

This species is common throughout the Clay County lower Midway. Tests are often deformed as a result of attachment to irregularly shaped objects.

Cotypes: Clayton chalk, test hole M49, surface to 8.7 feet below, 2 1/2 miles north of Pheba; Type slide VIII, 18-20, Mississippi Geological Survey.

CIBICIDES PRAECURSORIUS (Schwager)

Plate V, 5, 6

Discorbina praecursoria Schwager, Palaeontographica, Vol. 30, Pal. Theil, p. 125, pl. 27 (4), figs. 12a-d, 13a-d; pl. 29 (6), figs. 16a-d, 1883.

Cibicides praecursorius Cushman and Ponton, Contr. Cushman Lab. Foram. Res., Vol. 8, p. 72, pl. 9, figs. 14a-c, 1932. Toulmin, Jour. Pal., Vol. 15, no. 6, p. 610, pl. 82, figs. 19-21, 1941. Cushman and Renz, Contr. Cushman Lab. Foram. Res., Vol. 18, pt. 1, p. 13, pl. 3, figs. 9a-c, 1942.

"Test trochiform, plano convex, dorsal side flat or nearly flat, ventral side moderately convex; periphery acute, slightly lobate; chambers distinct, seven to nine in the final whorl, slightly inflated on both sides in the later part of the whorl, increasing regularly in size as added, of uniform moderately curved shape; sutures distinct, slightly depressed on the dorsal side, more deeply depressed on the ventral side and radiating from a low small umbo, rather strongly curved on dorsal side, slightly curved on ventral side; wall smooth, rather finely perforate, polished; aperture a low slit at base of final chamber on the ventral side, arching across the periphery onto the dorsal side where it extends along the base of the last two chambers. Length 0.37 mm.; width 0.33 mm.; thickness 0.16 mm."

This species is widely distributed and common throughout the Clayton chalk, more restricted in distribution and numbers in the Porters Creek clay. Known also from the Wilcox, the species has no stratigraphic value.

CIBICIDES VULGARIS (Plummer)

Plate VI, 19, 20

Truncatulina vulgaris Plummer, Univ. Texas Bull. 2644, p. 145, 146, pl. 10, figs. 3a-c, 1927.

Cibicides vulgaris Cushman, Contr. Cushman Lab. Foram. Res., Vol. 16, pt. 3, p. 73, pl. 12, fig. 21, 1940.

"Test almost equally biconvex, the ventral face being slightly the more elevated; peripheral margin broadly rounded, frequently somewhat lobate; chambers 7-9 in last whorl, last two or three distinctly turgid; sutures marked by strong elevations of clear shell material curving gently toward the periphery from a very high ridge of irregularly disposed mass of shell matter that follows the inner edge of the whorl and produces a more or less well-developed spiral on both faces; shell wall more coarsely punctate than any other species in the fauna; aperture a long, arched slit extending from the periphery toward the umbilicus under a narrow lip. Diameter up to 0.6 mm."

Typical specimens of this species are abundant and widely distributed throughout both the Clayton and the lower Porters Creek. Although reported by Plummer from the upper and upper basal Midway of Texas and by Cushman from the upper Midway only of Alabama, the species ranges downward into the lowest Midway beds present in Clay County.

DESCRIPTION OF OSTRACODA

FAMILY CYTHERELLIDAE

Genus CYTHERELLA Jones, 1849

CYTHERELLA SYMMETRICA Alexander

Plate VIII, 9

Cytherella symmetrica Alexander, Jour. Pal., Vol. 8, no. 2, p. 212, pl. 32, fig. 9; pl. 35, fig. 13, 1934.

"Female carapace elongate-quadrate in outline. Dorsal and ventral margins nearly straight and parallel, slightly and evenly convex. Anterior end broadly and evenly rounded. Right valve overlaps left moderately around entire periphery; overlap slightly less around anterior end and in lower half of posterior margin than elsewhere. Anterior border of left valve bears a very fine, narrow, obscure marginal rim or flange. Surface of valves smooth or finely and densely punctate. Valves moderately convex. In dorsal view carapace widest at, or slightly behind, middle; anterior end subacute, posterior end blunt, rounded.

"Measurements of holotype: length 0.79 mm., height 0.46 mm., width 0.36 mm."

Shells belonging to this species are rare in beds of Clayton age, but moderately common in the Porters Creek clay.

FAMILY CYPRIDAE

Genus ARGILLOECIA Sars, 1865

ARGILLOECIA FABA Alexander

Plate VIII, 2

Argilloecia faba Alexander, Jour. Pal., Vol. 8, no. 2, p. 213, 214, pl. 32, fig. 16; pl. 35, figs. 12, 14, 1934.

"Carapace minute, in side view elongate, highest slightly behind middle. Height equal to nearly one-half of length. Dorsal margin rather strongly arched, curving downward somewhat more steeply posteriorly than anteriorly from highest point of arch. Ventral margin nearly straight, very slightly convex downward. Anterior end low, obliquely rounded. Posterior end tapering to rather blunt postero-ventral angle. Right valve overlaps left distinctly both dorsally and ventrally, with strongest overlap along anterior half of dorsal margin and at middle of ventral margin. Carapace in side view lanceolate, widest at middle; ends similar, acute. Surface of valves smooth.

"Length of holotype, 0.42 mm., height 0.2 mm., width 0.16 mm."

Shells of this minute species are limited in number but show a wide distribution, being present in about half of the samples examined. It ranges throughout the Clayton and lower Porters Creek.

Genus PARACYPRIS Sars, 1865

PARACYPRIS PERAPICULATA Alexander

Plate VIII, 1

Paracypris perapiculata Alexander, Jour. Pal., Vol. 8, no. 2, p. 214, pl. 32, fig. 18; pl. 35, figs. 9, 15, 1934.

"Carapace in side view elongate, highest at antero-cardinal angle, tapering strongly posteriorly. Dorsal margin gently arched, nearly straight along hinge-line, obscurely angled at ends of hinge-line. Ventral margin almost straight, slightly sinuate at middle. Anterior end broadly and somewhat obliquely rounded. Posterior end slender, tapering, acute. In dorsal view narrow, lanceolate, widest at about anterior one-third of length; anterior end somewhat less acute than posterior. Surface smooth.

"Length of holotype, 1.07 mm., height 0.37 mm., width 0.28 mm."

A single specimen of this species was obtained from the Porters Creek clay. The species is reported as rare in upper and lower beds of the Texas Midway.

FAMILY BAIRDIDAE

Genus BAIRDIA McCoy, 1844

BAIRDIA MAGNA Alexander

Plate VIII, 4

Bairdia magna Alexander, Jour. Pal., Vol. 1, p. 32, pl. 6, figs. 7, 8, 1927; Univ. Texas Bull. 2907, p. 63, pl. 3, fig. 8, 1929; Jour. Pal., Vol. 8, no. 2, p. 215, 1934.

"Carapace in side view subtriangular; height equal to slightly less than three-fourths the length. Greatest height at about middle. Dorsal margin strongly and evenly arched. Ventral margin convex downward. Anterior end broadly and somewhat obliquely rounded. Posterior end obtusely angled, not produced. Left valve larger than and overlapping right valve along dorsal and ventral margins. Valves strongly and evenly convex. Surface punctate.

"Length, 1.44 mm.; height, 0.99 mm.; width, 0.78 mm."

This species, originally described from the Navarro clay, occurs rarely in both Clayton and Porters Creek beds.

FAMILY CYTHERIDAE

Genus BRACHYCYTHERE Alexander, 1933

BRACHYCYTHERE FORMOSA Alexander

Plate VIII, 7

Brachycythere formosa Alexander, Jour. Pal., Vol. 8, no. 2, p. 217, pl. 33, fig. 3, 1934. Murray and Hussey, Jour. Pal., Vol. 16, no. 2, p. 175, pl. 27, figs. 1, 4; text fig. 2, figs. 17, 18, 21, 22, 1942.

"Carapace in side view, oblong ovate, highest at anterior end, tapering strongly posteriorly. Dorsal margin arched, flattened and nearly straight along hinge line. Ventral margin straight. Anterior end compressed, broadly rounded, bearing a broad, thin, marginal keel. This keel is so thin and fragile that it is partially or wholly destroyed in all individuals observed. Posterior end compressed, narrow, obtusely angled. The elongated, obliquely disposed anterior cardinal tubercle is connected at its upper end to a low, rounded ridge which continues backward along the dorsal margin, becoming lower and less distinct posteriorly. A second low, rounded ridge arises a short distance below and behind the anterior cardinal tubercle and extends obliquely backward and upward to join the dorsal marginal ridge at about the middle of the hinge margin. A broad, low, obscure subcentral node gives rise to a low ridge which extends backward for a short distance along the median longitudinal line. The ventro-lateral edge of the valve bears a high, strong, longitudinal ridge which bears a row of strong pits along its upper surface, and which terminates posteriorly in a short, sharp backward-projecting angle. Surface of valves with a few large, widely spaced, shallow pits.

"Length of holotype 0.6 mm., height 0.42 mm., width 0.33 mm."

This is the most abundant of the Midway species of ostrocods, numerous specimens being present in about three-fourths of the samples examined. Although reported restricted to the upper Midway in Texas, the species ranges throughout the lower Midway in Clay County.

BRACHYCYTHERE INTERRASILIS Alexander

Plate VIII, 5

Brachycythere interrasilis Alexander, Jour. Pal., Vol. 8, no. 2, p. 217, pl. 33, fig. 4, 1934.

"Carapace in side view ovate in outline, highest near anterior end. Dorsal margin arched, flattened along hinge line. Ventral margin gently and evenly convex downward. Anterior and posterior ends rounded, posterior narrower than anterior; anterior end minutely denticulate, posterior bearing three to four short, stout spines along inferior border. Valves strongly convex, widest ventrally, ventral surface broad and flat. Ventro-lateral edge of valves bears a strong, high, curved, longitudinal ridge. The surface of a narrow area at the anterior end of the shell is marked by a fine, strong, dense punctation. The remainder of the valve surface is strongly and coarsely reticulate, the meshes becoming finer near the dorsal, anterior, and posterior margins of the shell.

"Length of holotype, 0.9 mm., height 0.53 mm., width 0.49 mm."

A single specimen of this species was collected from the Porters Creek at one locality and a second specimen from the uppermost Clayton at a second locality. The species is reported from both upper and lower Midway beds in Texas.

BRACHYCYTHERE PLENA Alexander

Plate VIII, 3

Brachycythere plena Alexander, Jour. Pal., Vol. 8, no. 2, p. 216, 217, pl. 33, fig. 6, 1934. Murray and Hussey, Jour. Pal., Vol. 16, no. 2, p. 176, pl. 27, figs. 2, 5, 6; text fig. 2, figs. 3, 7, 1942.

"Carapace in side view, oblong ovate, highest near anterior end. Dorsal margin gently arched, almost straight along hinge line. Ventral margin gently convex downward. Anterior end broadly rounded, posterior end narrow, rounded. Ventro-lateral edge of valves bears fine, narrow ridge, which in some individuals is obscure and almost imperceptible. Immediately above the anterior end of this ridge, the right valve bears a curved, somewhat crescent-shaped depression. Surface of valves finely and discretely punctate.

"Length of holotype, 1.15 mm., height 0.68 mm., width 0.65 mm."

A small number of shells of this species are known from both

Clayton and Porters Creek beds. The species appears to be a little more common in the Clayton formation. It is also known from Wilcox beds in other localities.

Genus CYTHEREIS Jones, 1840

CYTHEREIS PRESTWICHIANA Jones and Sherborn

Plate VIII, 11

Cythereis prestwichiana Jones and Sherborn, Geol. Mag., p. 454, pl. 11, figs. 11a, b, 1887; Jones and Sherborn, Suppl. Monogr. Tertiary Entom. England, Paleont. Soc. London, p. 33, pl. 2, figs. 13, 14, 1889. Alexander, Jour. Pal., Vol. 8, no. 2, p. 220, 221, pl. 32, figs. 14, 15, 1934.

"Carapace oblong, highest in front. Dorsal and ventral margins straight, subparallel, converging slightly posteriorly. Anterior end rounded, rimmed, denticulate. Posterior end bluntly angled at about middle, bearing four or five short, stout teeth along lower margin. Continuations of the anterior marginal rim extend ridge-like, along the dorsal and ventral borders of the valves; ventral ridge more strongly elevated than dorsal. Both ridges terminate posteriorly in sharp rectangles, immediately in front of the compressed posterior end. An obscure subcentral node forms the anterior end of a short, narrow, median longitudinal ridge which, near the posterior end, turns obliquely upward to join the down-turned end of the dorsal marginal ridge. Surface of valves covered with a distinct, but delicate, lace-like reticulation.

"Length of plesiotype, 0.6 mm., height 0.33 mm., width 0.28 mm."

None of the shells was well enough preserved to show the short spurs projecting into the pits, described as characteristic of the species. In all other respects the Clay County specimens appear identical with those from Texas. The species is fairly common in both the Clayton and Porters Creek.

CYTHEREIS SPINIFERRIMA Jones and Sherborn

Plate VIII, 6

Cythereis spiniferrima Jones and Sherborn, Suppl. Monogr. Tertiary Entom. England, Paleont. Soc. London, p. 34, fig. 3, 1889. Alexander, Jour. Pal., Vol. 8, no. 2, p. 220, pl. 32, fig. 11, 1934.

"Carapace distinctly oblong, highest in front. Dorsal and ventral margins straight, converging posteriorly. Anterior end rounded, strongly rimmed, bearing a double row of short, sharp spines. Posterior end compressed, triangular in form, acutely angled at middle, finely denticulate along upper border and bearing three or four long, stout, outward--and downward-projecting spines along the outer border. Surface of valves coarsely reticulate, with scattered spinose projections arising from the junctions of the ridges of the meshes. The spines are somewhat longer near the dorsal and ventral borders, and the reticulation distinctly coarser near the anterior end of the shell.

"Length of plesiotype 0.69 mm., height 0.45 mm., width 0.28 mm."

Specimens assigned to this ornate species are rather large, averaging nearly a millimeter in length. Although reported from the upper and lower Midway of Texas, it is almost entirely confined to the Porters Creek, only 2 specimens having been obtained from Clayton samples.

Genus CYTHEROMORPHA Hirschman, 1901

CYTHEROMORPHA SCROBICULATA Alexander

Plate VIII, 8

Cytheromorpha scrobiculata Alexander, Jour. Pal., Vol. 8, no. 2, p. 223, pl. 32, fig. 19, 1934.

"Carapace in side view narrow, elongate, highest at anterior end. Dorsal margin nearly straight, very slightly arched. Ventral margin slightly sinuate near middle. Anterior end obliquely rounded. Posterior end much narrower than anterior, bluntly rounded. Surface of valves except for narrow zone near anterior end, coarsely and strongly pitted, and with two low, short, longitudinal plications; one of these plications is curved slightly upward and lies near the median longitudinal line of the valves, the other is straight, and is near the ventral margin. A narrow, crescent-shaped area at the anterior end of the shell is smooth except for a few low, narrow, radiating ridges.

"Length of holotype 0.43 mm., height 0.22 mm., width 0.09 mm. (single valve)."

A single specimen of this species was collected from the Porters Creek at one locality, and a second specimen from the uppermost Clayton at a second locality. The species is reported from both upper and lower Midway beds in Texas.

Genus LOXOCONCHA Sars, 1865

LOXOCONCHA MISSISSIPPIENSIS Kline, n. sp.

Plate VIII, 10

Carapace in side view subrectangular, nearly twice as long as high. Dorsal margin straight. Ventral margin straight, curving gently upward posteriorly to the short, blunt caudal process. Anterior end obliquely rounded, with narrow, compressed border. Surface of valves strongly and finely reticulate. Most of reticular ridges low and rounded; two short ridges elevated to set off small central depressed area; third fairly distinct ridge beginning near ventral margin a little anterior to center of shell, paralleling ventral margin, then curving upward parallel to dorsal margin, terminating below center of shell. Strongly convex, with greatest thickness at center.

Loxoconcha mississippiensis is very similar in appearance to *Loxoconcha perdecora* Alexander of the Texas Midway, from which it differs in the development of more or less distinct ridges.

This species is rare throughout the lower Midway, although it is relatively more abundant in the Clayton division.

Holotype: *Ostrea pulaskensis* bed, Clayton chalk, test hole M173, 36.3 to 41.5 feet below surface, 1/2 mile west of Pheba; Type slide VIII, 10, Mississippi Geological Survey.

Genus KRITHE Brady, Crosskey and Robertson, 1874

KRITHE PERATTICA Alexander

Plate VIII, 12

Krithe perattica Alexander, Jour. Pal., Vol. 8, no. 2, p. 229, pl. 34, figs. 1, 2; pl. 35, fig. 18, 1934.

"Carapace of female rhomboidal in side view, highest at middle. Dorsal margin rather strongly arched, curving downward posteriorly in a smooth, unbroken curve to the rounded, subacute postero-ventral angle. Ventral margin gently convex downward. Anterior end evenly rounded. Carapace strongly convex, widest at middle.

"Carapace of male similar in outline to that of female, but with dorsal margin less strongly arched, ventral margin nearly straight, and with valves less strongly convex.

"Length of holotype (females) 0.7 mm., height 0.37 mm., width 0.15 mm. (single valve)."

This is a rare species, a small number of specimens having been identified in samples from 5 localities. Stratigraphically, it appears to be confined to the Porters Creek and uppermost Clayton.

LOGS AND LOCATIONS OF TEST HOLES

M49 Jabe Christopher property (SW.1/4, NE.1/4, NW.1/4, Sec.9, T.20 N., R.13 E.) In gullied area 10 yards north of road and about 0.1 mile east of road forks

	Feet
Porters Creek clay	
Clay, smooth to slightly silty; lower 2 feet glauconitic and very fossiliferous, P1	15.3
(Surface of hole)	
Clay, tough gray calcareous, chalky, slightly glauconitic, S2	8.7
Clayton chalk	
Clay, tough gray calcareous, somewhat glauconitic and micaceous, S3	8.9
Clay, sandy micaceous, glauconitic gray to somewhat chalky, S4	8.4
	41.3

M65A Dr. T. D. Houston property (NW.1/4, NE.1/4, NW.1/4, Sec.10, T.16S., R.3E.) Above roadcut in basal Midway 1/4 mile west of Prairie Creek; 20 feet south of road

	Feet
Topsoil	
Clay, sandy black	1.3
Clayton chalk	
Clay, silty micaceous to smooth waxy glauconitic gray, S2	9.4
	10.7

M66 John Edd Snell, Jr., property (SE.1/4, SE.1/4, SW.1/4, Sec.15, T.16 S., R.3 E.) 30 feet west of road curve; at corner of garden

	Feet
Porters Creek clay	
Clay, silty slightly micaceous reddish-brown	8.3
Clayton chalk	
Chalk, fine sandy glauconitic grayish-tan; scattered lime nodules, S2	8.4
Chalk, fine sandy slightly micaceous glauconitic greenish-gray, S3	1.5
	18.2

M67 Walton Hill property (SW.1/4, SE.1/4, NW.1/4, Sec.15, T.16 S., R.3 E.) 20 yards north of road on east slope

	Feet
Clayton chalk	
Chalk, tan sandy glauconitic highly fossiliferous; scattered lime nodules, S1	6.1
Chalk, sandy glauconitic grayish-tan, S2	1.7
	7.8

M84 Archie Murrah property (NW.1/4, SE.1/4, SW.1/4, Sec.34, T.15 S., R.3 E.) Between 2 large trees 15 feet northeast of road

	Feet
Colluvium (Porters Creek clay?)	
Clay, tough silty grayish-tan	6.0
Clay-silt, gray, S2	3.0
Clayton chalk	
Clay, very silty ferruginous brown and gray; scattered glauconite, S3	3.3
Chalk, glauconitic slightly micaceous tan; highly fossiliferous, S4	2.4
	14.7

M93 Sim Dixon property (NE.1/4, SW.1/4, NE.1/4, Sec.33, T.15 S., R.3 E.) At base of slope and 150 yards northeast of road

	Feet
Porters Creek clay	
Clay, compact stiff grayish-tan	3.8
Clayton chalk	
Chalk, glauconitic grayish-tan; abundant lime nodules, *Ostrea pulaskensis* shells and foraminifera, S2	7.2
	11.0

M122 W. F. Walker property (SW.1/4, NW.1/4, NW.1/4, Sec.32, T.16 S., R.3 E.) Half way down eastward facing slope, 100 yards northeast of the Ozzie Brownlee house

	Feet
Porters Creek clay	
Clay, smooth khaki-tan, S1	3.8
Clayton chalk	
Chalk, increasingly sandy glauconitic fossiliferous grayish-tan; scattered lime concretions, S2	5.2
	9.0

M148 J. A. Murrah property (SE. corner, Sec.17, T.20 N., R.13 E.) On section line, 50 feet west of road and bridge over Double Cabin Creek

	Feet
Alluvium	
Silt, tan	1.0
Porters Creek colluvium	
Clay, very sandy brown	11.0
Porters Creek clay	
Clay, silty calcareous to chalky tannish-gray; slightly glauconitic; foraminifera abundant, S3	7.5
Clayton chalk	
Chalk, gray slightly micaceous; glauconitic near top; foraminifera abundant, S4	8.5
Chalk, glauconitic gray; *Ostrea pulaskensis*, S5	5.8
	33.8

M168 Bank of West Point property (NE.1/4, SE.1/4, NE.1/4, Sec.29, T.20 N., R.13 E.) In pasture, 37 feet west of road at point 0.4 mile south of railroad in Pheba

	Feet
Alluvium	
Clay, silty slightly micaceous gray and brown; ferruginous concretions	8.1

Clay, silty to sandy highly ferruginous concretionary brown and gray, S2	1.3
Porters Creek clay	
Clay, silty calcareous to smooth tannish-gray; foraminifera abundant, S3	10.0
Clayton chalk	
Chalk, silty glauconitic fossiliferous gray, S4	12.6
Chalk, very glauconitic gray; *Ostrea pulaskensis*, S5	2.0
	34.0

M169 Bank of West Point property (SW.1/4, SW.1/4, SW.1/4, Sec. 28, T.20 N., R.13 E.) On north bank of Sun Creek Canal, 30 feet west of county line, 30 feet east of road, and 1.2 miles south of Pheba

	Feet
Alluvium	
Clay, sandy and silty brownish-gray	8.7
Porters Creek clay	
Clay, silty somewhat micaceous gray and brown	10.3
Clayton chalk	
Clay, calcareous to chalky compact gray; foraminifera abundant in lower part; increasingly glauconitic toward base, S3	4.5
Chalk, glauconitic dark-gray; foraminifera abundant	16.3
Chalk, glauconitic dark-gray; *Ostrea pulaskensis*, S5	1.4
	41.2

M170 J. P. Champion property (SE. corner, Sec.8, T.20 N., R.13 E.) 50 feet west of county road; in small clump of trees in open pasture, near power line

	Feet
Porters Creek clay	
Clay, silty micaceous tan	25.0
Clayton chalk	
Clay, silty calcareous to chalky glauconitic dark-gray; foraminifera abundant, S2	5.0
Chalk, glauconitic light-gray; foraminifera abundant, S3a, S3b	16.5
Chalk, glauconitic gray; *Ostrea pulaskensis*, S4	2.0
	48.5

M171 (NE.1/4, SW.1/4, SW.1/4, Sec.20, T.20 N., R.13 E.) In canal bed 25 feet north of bridge 0.8 mile due west of Pheba

	Feet
Porters Creek clay	
Clay, compact silty micaceous ferruginous grayish-tan and tan	3.0
Clay, very silty micaceous somewhat calcareous grayish-tan; foraminifera, S 2	5.0
Clayton chalk	
Clay, very silty micaceous gray; increasingly chalky with abundant foraminifera toward base, S3a, S3b	26.0
	34.0

M172 C. H. Hubart property (SE.1/4, SW.1/4, NE.1/4, Sec.21, T.20 N., R.13 E.) On north side of Highway 10, 0.1 mile west of bridge over Double Cabin Creek

	Feet
Alluvial sand and silt	1.5
Clayton chalk	
Clay, silty calcareous to chalky glauconitic tannish-gray; foraminifera and phosphatic grains abundant, S2	8.7
Chalk, slightly micaceous glauconitic tan to gray; foraminifera abundant	8.1
Chalk, slightly micaceous glauconitic gray; *Ostrea pulaskensis*, S4	2.0
	20.3

M173 John Duke property (NE.1/4, SE.1/4, SW.1/4, Sec.20, T.20 N., R.13 E.) 0.5 mile west of Pheba at intersection of West Pheba Street and Harpole road

	Feet
Porters Creek clay	
Clay, silty micaceous tannish-gray	3.5
Clay, silty calcareous gray; micaceous in upper half; slightly chalky and glauconitic at base	21.8
Clayton chalk	
Chalk, glauconitic gray; foraminifera abundant, S3	11.0
Chalk, sandy glauconitic slightly micaceous; *Ostrea pulaskensis* in lower 2 feet, S4	5.2
	41.5

M174 Cliett Estate property (NE.1/4, SE.1/4, NE.1/4, Sec.16, T.20 N., R.13 E.) Beside wagon trail at edge of woods on west side of county road; 1.1 miles north of Highway 10

	Feet
Porters Creek clay	
Clay, slightly silty grayish-tan	3.0
Clay, slightly silty micaceous grayish-tan; small ferruginous concretions abundant	2.0
Clayton chalk	
Clay, silty micaceous grayish-tan	6.7
Chalk, silty glauconitic grayish-tan; *Ostrea pulaskensis* from 15.5 feet to bottom, S4	6.5
	18.2

M178 James Terry, Jr., property (NW.1/4, NW.1/4, SW.1/4, Sec.21, T.20 N., R.13 E.) Beneath large oak 15 feet east of road and 300 feet north of Pheba crossroads

	Feet
Porters Creek colluvium	2.5
Porters Creek clay	
Clay, silty to smooth tannish-gray	15.0
Bentonite, silty ocherous yellow	0.4
Clay, smooth compact blocky grayish-tan	3.1
Clay, silty slightly micaceous gray	1.3
Clayton chalk	
Clay, chalky glauconitic gray; foraminifera abundant	6.2
Chalk, glauconitic slightly micaceous gray; *Ostrea pulaskensis* and abundant foraminifera, S7	3.8
	32.3

M183 Henry Miller Estate property (NW.1/4, NE.1/4, SW.1/4, Sec.21, T.20 N., R.13 E.) 50 feet north of Highway 10 at a point near woods and fence corner, 0.3 mile east of Henry Miller residence

	Feet
Porters Creek colluvium	10.0
Porters Creek clay and upper Clayton chalk	
Clay, calcareous to chalky grayish-tan and gray; foraminifera in lower part	19.0
Clayton chalk	
Chalk, silty very glauconitic clay; foraminifera abundant, S3	2.0
Chalk, glauconitic slightly micaceous gray; *Ostrea pulaskensis*, S4	2.2
	33.2

M184 Negro church property (C., E.1/2, SW.1/4, Sec.21, T.20 N., R.13 E.) 200 feet west of Pheba negro church and schoolhouse

	Feet
Porters Creek colluvium	9.1
Porters Creek clay	
Clay, silty, slightly micaceous grayish-tan; lower part sandy, containing abundant foraminifera, S2	17.4
Clayton chalk	
Chalk and chalky clay, silty glauconitic slightly micaceous gray; foraminifera abundant, S3	12.5
Chalk, sandy slightly micaceous glauconitic gray; foraminifera abundant; *Ostrea pulaskensis*, S4	1.8
	40.8

M185 (SW.1/4, SW.1/4, SW.1/4, SE.1/4, Sec. 29, T.20 N., R.13 E.) On canal bank just north of county line at a point 0.5 mile west of Pheba-Starkville road

	Feet
Alluvial clay	8.0
Porters Creek colluvium	5.0
Porters Creek clay	
Clay, silty micaceous tannish-gray	8.0
Clay, dark-gray silty micaceous; foraminifera abundant in basal part	23.0
Clayton chalk	
Chalk, somewhat glauconitic gray; foraminifera	12.0
Chalk, glauconitic gray; *Ostrea pulaskensis*, S6	1.9
	57.9

M187 Emmett Griffith property (NW.1/4, SE.1/4, NW.1/4, Sec.21, T.20 N., R.13 E.) At a point 0.3 mile northwest of Pheba cemetery on north facing slope south of Double Cabin Creek

	Feet
Porters Creek colluvium	7.0
Porters Creek clay	
Clay, silty manganiferous or sideritic to bentonitic	1.8

Clayton chalk	
Chalk and chalky clay, glauconitic slightly micaceous grayish-tan; foraminifera and scattered phosphatic pebbles, S3	2.7
Chalk, glauconitic slightly micaceous gray; *Ostrea pulaskensis* in lowest foot, S4	5.7
	17.2

M188 C. & G. Railway property (SE.1/4, SE.1/4, Sec.20, T.20 N., R.13 E.) Near center of Pheba; 100 feet west of Starkville road crossing and 100 feet south of C. & G. Railway tracks

	Feet
Porters Creek colluvium	8.0
Porters Creek clay	
Clay, silty micaceous tannish-gray	16.4
Clay, smooth calcareous gray somewhat glauconitic, S4 (in part)	4.5
Clayton chalk	
Chalk, silty slightly micaceous glauconitic gray; foraminifera abundant, S4 (in part)	7.6
Chalk, glauconitic fossiliferous gray; foraminifera abundant; *Ostrea pulaskensis* at base, S5 (?)	8.0
	44.5

M189 Guy Terry property (SW.1/4, SW.1/4, NE.1/4, Sec.28, T.20 N., R.13 E.) In pasture at a point about 0.5 mile east of Pheba-Starkville road and 0.5 mile south of C. & G. Railway tracks

	Feet
Alluvium	2.0
Porters Creek colluvium	6.0
Clayton chalk	
Clay, silty calcareous to very chalky highly glauconitic; foraminifera abundant in lowest 2 feet, S3	10.5
Chalk, massive gray glauconitic and fossiliferous; foraminifera abundant; *Ostrea pulaskensis* in basal foot, S4	8.0
	26.5

M190 Federal Land Bank property (SW.1/4, NE.1/4, NW.1/4, Sec.33, T.20 N., R.13 E.) Margin of field and woods at a point 900 feet north of sawmill site and 1100 feet east of Pheba-Starkville road

	Feet
Alluvium	9.0
Porters Creek clay	
Clay, smooth dark-gray to black	8.0
Clayton chalk	
Chalk, glauconitic fossiliferous gray; foraminifera abundant; *Ostrea pulaskensis* in basal 2 feet, S3	8.4
	25.4

M192 James Milton property (N.1/2, SE.1/4, SE.1/4, Sec.28, T.20 N., R.13 E.) In bottom land of Sun Creek; by huge water oak about 0.2 mile east of section line and 0.1 mile north of creek

	Feet
Alluvium	8.0
Clayton chalk	
Sand and chalky clay, glauconitic; *Ostrea pulaskensis* at 12.0 feet, S2	9.9
	17.9

M195 Joe Washington property (SE.1/4, SW.1/4, SW.1/4, Sec.21, T.20 N., R.13 E.) In a pasture 0.1 mile south of C. & G. Railway tracks and 0.2 mile east of Pheba

	Feet
Porters Creek colluvium	8.0
Porters Creek clay	
Clay, silty tannish-gray	11.5
Clay, silty to smooth somewhat calcareous dark-gray	10.0
Chalk, silty to sandy massive glauconitic gray; foraminifera very abundant in lower part, S4	6.0
	35.5

M196 Amzi Bennett property (C., SE.1/4, Sec.20, T.20 N., R.13 E.) On north side of road, 30 feet north of C. & G. Railway tracks and 0.3 mile west of Pheba

	Feet
Porters Creek clay and colluvium	
Clay, silty to sandy tannish-gray; bentonite at 15 or 18 feet; foraminifera in lower part, S1a, S1b	26.5
Clayton chalk	
Clay, smooth to silty calcareous dark-gray; lower part glauconitic, with abundant foraminifera, S2a, S2b	11.0
	37.5

M197 James Milton property (NE.1/4, SE.1/4, NW.1/4, Sec.28, T.20 N., R.13 E.) Near tree at edge of pasture 0.5 mile east of Pheba-Starkville road

Not logged. Drilled to 11.5 feet in Clayton chalk, S1 (?)

M198 May Smith property (SE.1/4, NE.1/4, NE.1/4, Sec.20, T.20 N., R.13 E.) Beside large oak tree between 2 houses; 30 feet west of Pheba-Colony road and 0.4 mile north of crossing at Highway 10

	Feet
Porters Creek colluvium	9.0
Porters Creek clay	
Clay, silty micaceous tannish-gray; tan bentonitic clay	17.0
Clay, smooth compact dark-gray	15.5
Chalk, glauconitic somewhat sandy gray; foraminifera abundant in lower part, S4	4.0
	45.5

M200 James Milton property (NE.1/4, SW.1/4, NW.1/4, Sec.28, T.20 N., R.13 E.) Beside oak tree near negro cabin in open pasture; 0.2 mile east of Pheba-Starkville road

Not logged. Drilled to 27.5 feet in Clayton chalk, S1 (?)

PLATES AND EXPLANATIONS

DRAWINGS

BY

MARY LOUISE PEGUES

PLATE I

		Page
1.	Spiroplectammina laevis (Roemer) var. cretosa Cushman, x33. Test hole M168, S4	13
2.	Clavulinoides midwayensis Cushman, x33. Test hole M198, S4	13
3.	Robulus midwayensis (Plummer), x33. Test hole M65A, S2...	17
4.	Lenticulina rotulata (Lamarck), x33. Outcrop east of M93....	21
5.	Robulus pseudo-costatus (Plummer), x33. Test hole M192, S2..	18
6.	Robulus pseudo-costatus (Plummer) var. inornatus Kline, n. var., x33. Test hole M93, S2	18
7.	Robulus turbinatus (Plummer), x33. Test hole M192, S2......	20
8.	Lenticulina degolyeri (Plummer), x33. Outcrop above test hole M49	21
9.	Robulus rosetta (Gumbel), x33. Test hole M49, S3..........	19
10.	Marginulina earlandi (Plummer), x33. Test hole M93, S2.....	22
11.	Hemicristellaria subaculeata (Cushman) var. tuberculata (Plummer), x33. Test hole M49	22
12.	Robulus cf. pseudo-mammilligerus (Plummer), x33. Outcrop above test hole M49	19

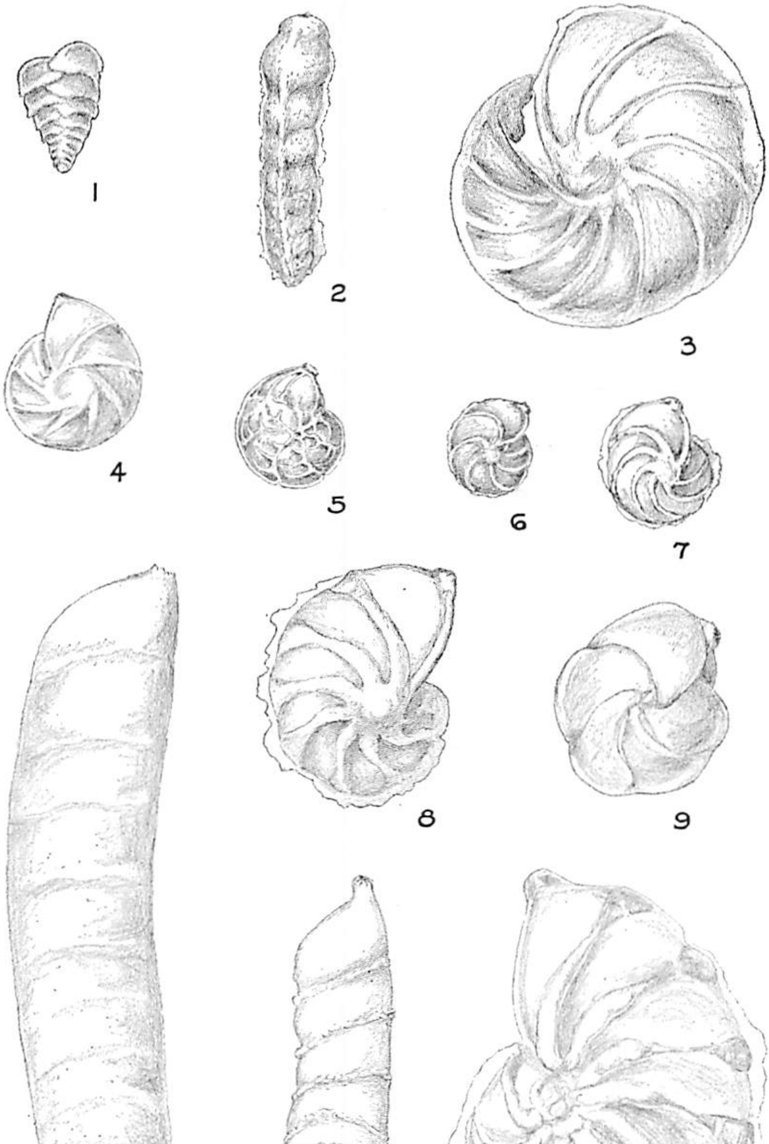


PLATE I

PLATE II

		Page
1.	**Dentalina aculeata (?) (d'Orbigny), x33. Test hole M93, S2....**	23
2.	**Dentalina basiplanata Cushman, x33. Test hole M49, S3......**	23
3.	**Dentalina crinita Plummer, x33. Test hole M170, S4........**	23
4.	**Dentalina delicatula Cushman, x33. Test hole M67, S1.......**	24
5.	**Dentalina gardnerae (Plummer), x33. Test hole M49, S2.....**	24
6.	**Dentalina plummerae Cushman, x33. Test hole M65A, S2.....**	25
7.	**Nodosarina (Frondicularia) goldfussi (Reuss), x33. Test hole M49 ....**	28
8.	**Nodosarina (Nodosaria) longiscata (d'Orbigny), x33. Test hole M49 ....**	28
9.	**Chrysalogonium granti (Plummer), x33. Test hole M170, S4..**	29
10.	**Nodosaria latejugata Gumbel, x33. Test hole M200, S1......**	27
11.	**Dentalina havanensis Cushman and Bermudez, x33. Outcrop above test hole M49 ....**	25
12.	**Pseudoglandulina manifesta (Reuss), x33. Outcrop east of test hole M93 ....**	30
13.	**Pseudoglandulina comata (Batsch), x33. Test hole M49......**	29
14.	**Dentalina pseudo-obliquestriata (Plummer), x33. Test hole M185, S5b ....**	26
15.	**Nodosarina (Nodosaria) aspera (Reuss), x33. Test hole M49...**	27
16.	**Nodosaria oligotoma Reuss, x33. Outcrop east of test hole M93..**	27
17.	**Pseudoglandulina cf. caudigera (Schwager), x33. Outcrop above test hole M49 ....**	29

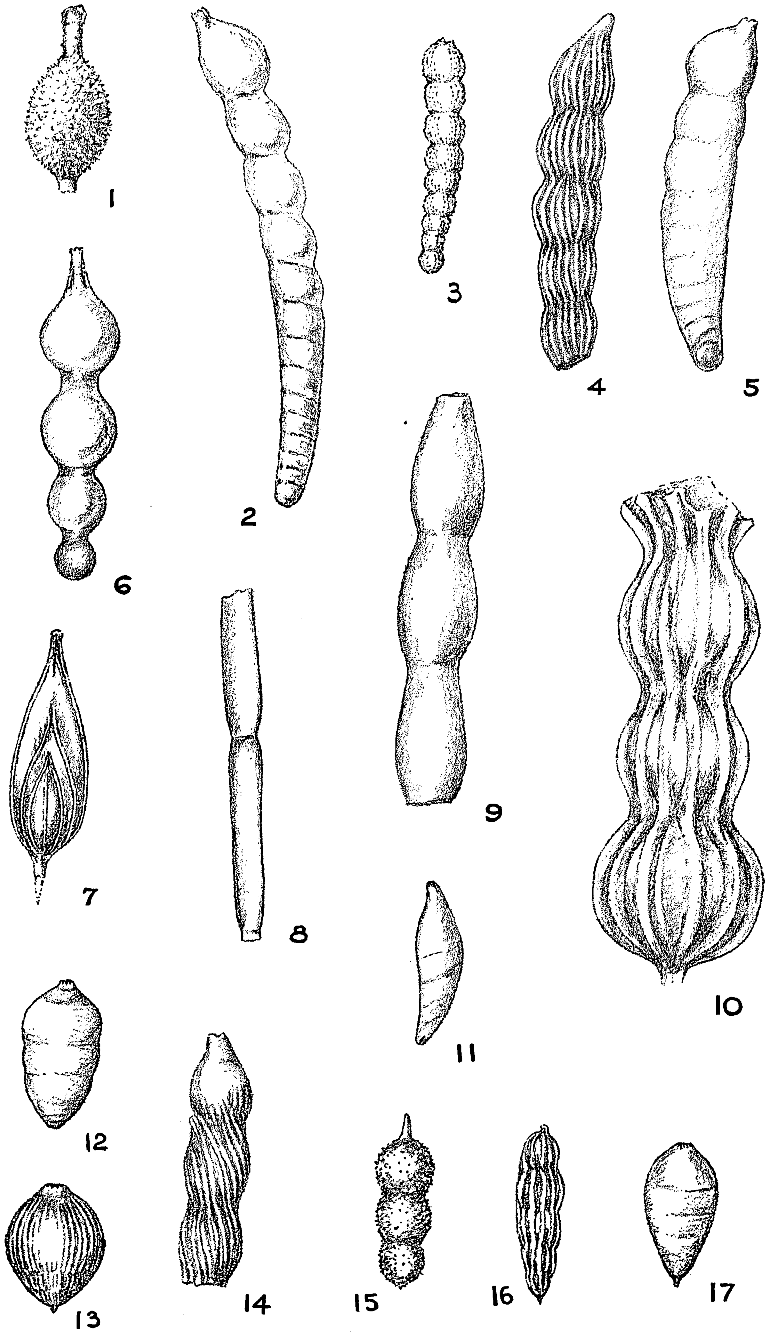


PLATE II

PLATE III

Page

1. Saracenaria cf. sublatifrons (Plummer), x33. Outcrop east of test hole M93 31

2. Saracenaria trigonata (Plummer), x33. Outcrop east of test hole M93 31

3. Saracenaria midwayensis Kline, n. sp., x33. a, b, Peripheral views. c, Side view. Cotypes. Outcrop east of test hole M93.......... 30

4. Vaginulina glabra (d'Orbigny), x33. Outcrop east of test hole M93 32

5. Vaginulina legumen var. elegans d'Orbigny, x33. Test hole M170, S4 33

6. Vaginulina plumoides Plummer, x33. Test hole M169, S5...... 33

7. Vaginulina gracilis Plummer, x33. Test hole M187, S4........ 32

8. Vaginulina robusta Plummer, x33. Test hole M49............ 34

9. Palmula cf. budensis (Hantken), x33. Outcrop east of test hole M93 34

10. Palmula cf. primitiva Cushman, x33. Outcrop east of test hole M93 35

11. Palmula rugosa (d'Orbigny), x33. Test hole M174, S4........ 36

12. Palmula delicatissima (Plummer), x33. Test hole M198, S4.. 35

13. Frondicularia archiaciana d' Orbigny, x33. Test hole M93, S2.... 36

14. Frondicularia cf. frankei Cushman, x33. Test hole M66, S2..... 37

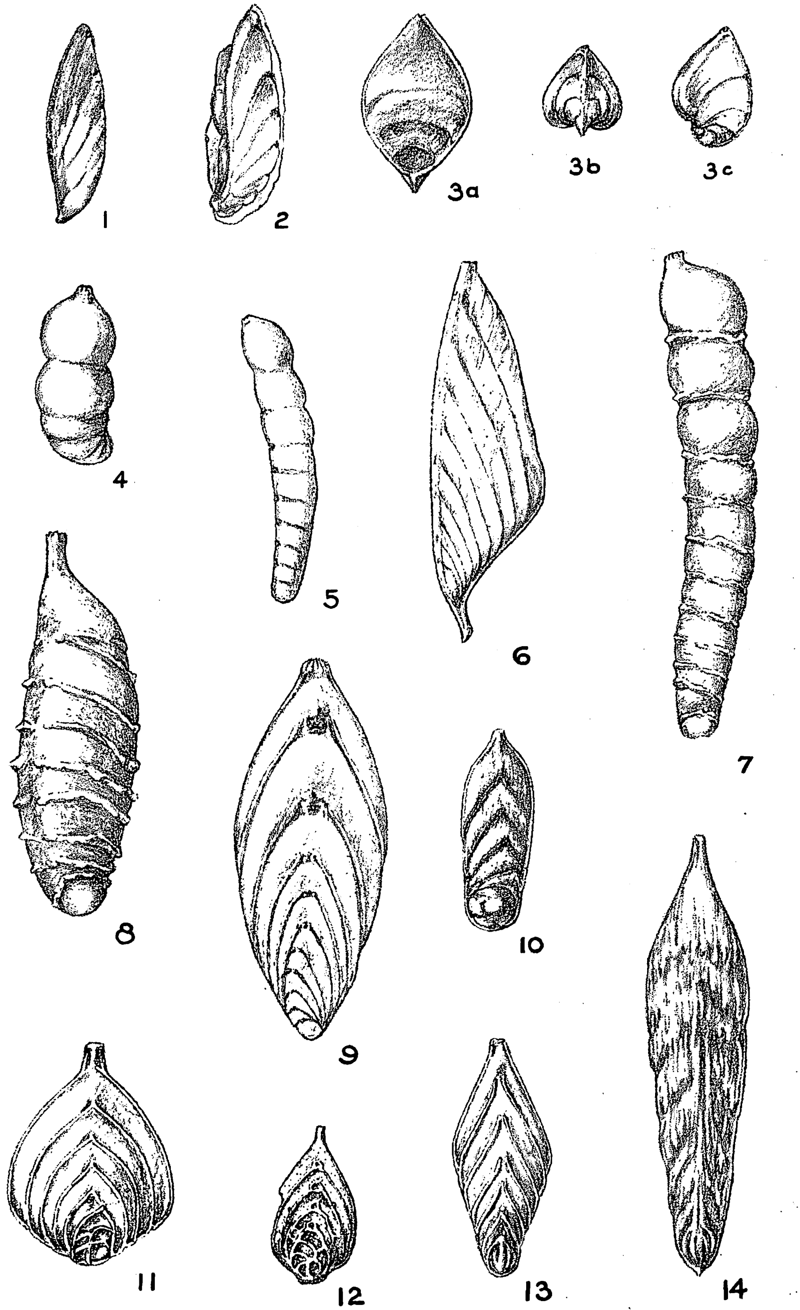


PLATE III

PLATE IV

Page

1. Globulina gibba d'Orbigny, x33. Test hole M93, S2 40

2. Guttulina problema d'Orbigny, x33. Test hole M93, S2 39

3. Lagena hispida Reuss, x33. Test hole M65A, S2 37

4. Lagena laevis (Montagu), x33. Test hole M65A, S2 38

5. Lagena orbignyana (Seguenza), x50. a, Side view. b, Peripheral view. Test hole M49 38

6. Sigmomorphina sp., x33. Test hole M170, S3b 41

7. Polymorphina frondea (Cushman), x33. Test hole M178, S7 41

8. Polymorphina cushmani Plummer, x33. Test hole M184, S3 41

9. Polymorphina sp., x33. Test hole M190, S3 41

10. Ramulina globulifera (H. B. Brady), x33. Outcrop east of test hole M93 42

11. Bullopora chapmani (Plummer), x33. Test hole M171, S3b 42

12. Bullopora chapmani (Plummer) var. hispida Kline, n. var., x33. Holotype. Test hole M49, S2 43

13. Bullopora laevis (Sollas), x33. Test hole M178, S7 43

14. Bolivina midwayensis Cushman, x33. Test hole M200, S1 49

15. Ramulina globulifera (H. B. Brady), x33. Outcrop east of test hole M93 42

16. Bullopora laevis (Sollas) var. hispida Kline, n. var., x33. Holotype. Test hole M49, S2 43

17. Entosolenia morsei Kline, n. sp., x33. Holotype. Test hole M49, S2 48

18. Siphogenerinoides eleganta (Plummer), x33. Test hole M187, S4 46

19. Eouvigerina excavata Cushman, x60. Outcrop above test hole M49 45

20. Bulimina (Desinobulimina) quadrata Plummer, x33, a, Megalospheric form. b, Microspheric form. Test hole M187, S4 and outcrop above M49 48

21. Nonionella welleri (Plummer) x33. a, Ventral view, b. Dorsal view. Test hole M188, S4 44

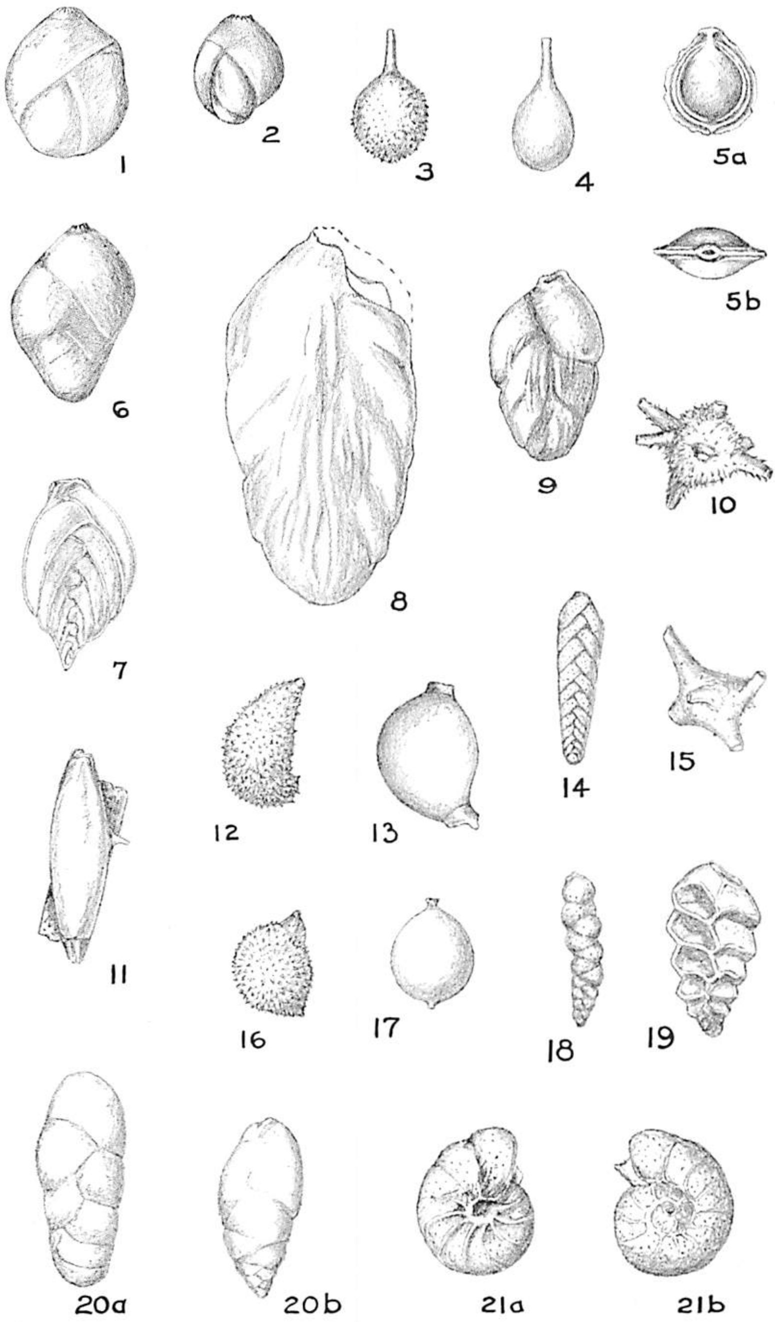


PLATE IV

PLATE V

Page

1. **Ellipsonodosaria alexanderi Cushman, x33. Test hole M49, S2. . 51**
2. **Ellipsonodosaria alexanderi Cushman, x65. Test hole M49, S2. . 51**
3. **Anomalina acuta (Plummer), x33. Ventral view. Test hole M148, S3 . . . . 59**
4. **Anomalina acuta (Plummer), x33. Dorsal view. Test hole M148, S3 . . . . 59**
5. **Cibicides praecursorius (Schwager), x33. Dorsal view. Test hole M170, S4 . . . . 62**
6. **Cibicides praecursorius (Schwager), x33. Ventral view. Test hole M65A, S2 . . . . 62**
7. **Loxostoma applinae (Plummer), x33. Test hole M200, S1 . . . . . . 50**
8. **Ellipsonodosaria plummerae Cushman, x33. Outcrop east of test hole M93 . . . . 51**
9. **Discorbis midwayensis Cushman, x33. Dorsal view. Test hole M84, S4 . . . . 52**
10. **Discorbis midwayensis Cushman, x33. Ventral view. Test hole M84, S4 . . . . 52**
11. **Valvulineria allomorphinoides (Reuss), x33. Ventral view. Test hole M198, S4 . . . . 52**
12. **Valvulineria allomorphinoides (Reuss), x33. Dorsal view. Test hole M198, S4 . . . . 52**
13. **Gyroidina subangulata (Plummer), x33. Dorsal view. Test hole M198, S4 . . . . 53**
14. **Gyroidina subangulata (Plummer), x33. Side view. Test hole M198, S4 . . . . 53**
15. **Gyroidina subangulata (Plummer), x33. Ventral view. Test hole M198, S4 . . . . 53**
16. **Eponides cf. tenera (H. B. Brady), x33. Dorsal view. Outcrop east of test hole M93 . . . . 53**
17. **Eponides cf. tenera (H. B. Brady), x33. Ventral view. Outcrop east of test hole M93 . . . . 53**
18. **Eponides cf. tenera (H. B. Brady), x33. Side view. Outcrop east of test hole M93 . . . . 53**
19. **Parrella expansa Toulmin, x33. Dorsal view. Test hole M49 . . . 54**
20. **Parrella expansa Toulmin, x33. Ventral view. Test hole M49 . . . . 54**
21. **Siphonina prima Plummer, x33. Ventral view. Test hole M49, S3 . . . . 55**
22. **Siphonina prima Plummer, x33. Dorsal view. Test hole M49, S3 . . . . 55**
23. **Pulvinulina exigua H. B. Brady, x33. Ventral view. Test hole M200, S1 . . . . 55**
24. **Pulvinulina exigua H. B. Brady, x33. Dorsal view. Test hole M200, S1 . . . . 55**

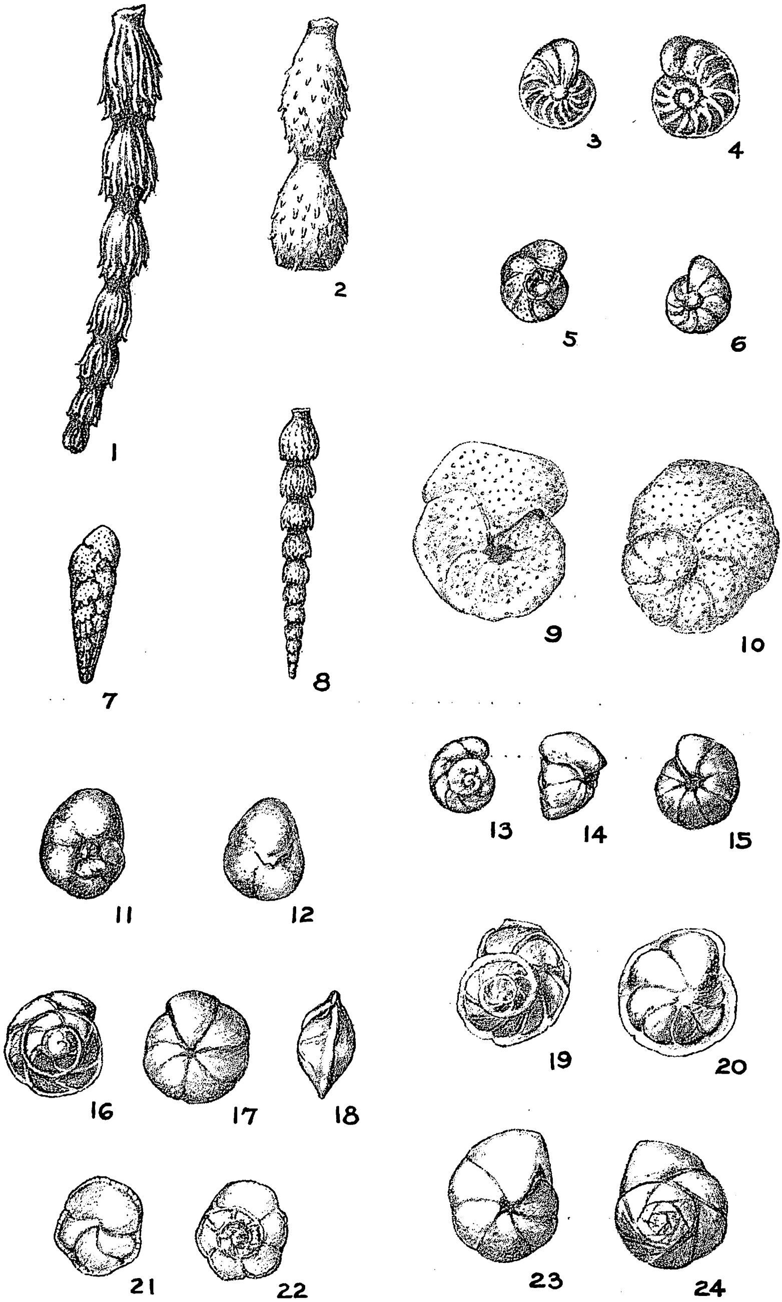


PLATE V

PLATE VI

Page

1. **Allomorphina trigona Reuss, x33. Dorsal view. Outcrop east of test hole M93 .... 56**
2. **Allomorphina trigona Reuss, x33. Ventral view. Outcrop east of test hole M93 .... 56**
3. **Chilostomella subtriangularis Kline, n. sp., x33. Holotype. Outcrop east of M93 .... 56**
4. **Pullenia quinqueloba (Reuss), x33. Test hole M187, S4 .... 57**
5. **Globigerina compressa Plummer, x33. Side view. Outcrop east of M93 .... 58**
6. **Globigerina compressa Plummer, x33. Ventral view. Test hole M171, S3b 58**
7. **Pullenia quinqueloba (Reuss), x33. Test hole M187, S4 .... 57**
8. **Chilostomelloides eocenica Cushman, x33. Test hole M49 .... 57**
9. **Globigerina pseudo-bulloides Plummer, x33. Ventral view. Test hole M49 .... 58**
10. **Globigerina pseudo-bulloides Plummer, x33. Dorsal view. Test hole M168, S3 .... 58**
11. **Globigerina pseudo-bulloides Plummer, x33. Side view. Outcrop east of M93 .... 58**
12. **Globigerina triloculinoides Plummer, x33. Ventral view. Test hole M178, S7 .... 59**
13. **Globigerina triloculinoides Plummer, x33. Dorsal view. Test hole M168, S3 .... 59**
14. **Globotruncana sp., x33. Test hole M168, S3 .... 59**
15. **Anomalina midwayensis (Plummer) var. trochoidea (Plummer), x33. Ventral view. Test hole M84, S4 .... 61**
16. **Anomalina midwayensis (Plummer) var. trochoidea (Plummer), x33. Dorsal view. Test hole M84, S4 .... 61**
17. **Anomalina midwayensis (Plummer), x33. Ventral view. Test hole M148, S3 .... 60**
18. **Anomalina midwayensis (Plummer), x33. Dorsal view. Test hole M49, S2 .... 60**
19. **Cibicides vulgaris (Plummer), x33. Ventral view. Test hole M174, S4 .... 63**
20. **Cibicides vulgaris (Plummer), x33. Dorsal view. Test hole M174, S4 .... 63**
21. **Cibicides alleni (Plummer), x33. Dorsal view. Test hole M168, S3 .... 63**
22. **Cibicides alleni (Plummer), x33. Ventral view. Test hole M148, S2 .... 63**
23. **Pleurostomella cf. brevis. var. alternans Schwager, x33. Test hole M49, S2 .... 50**
24. **Virgulina wilcoxensis Cushman and Ponton, x33. Test hole M49, S2 .... 49**

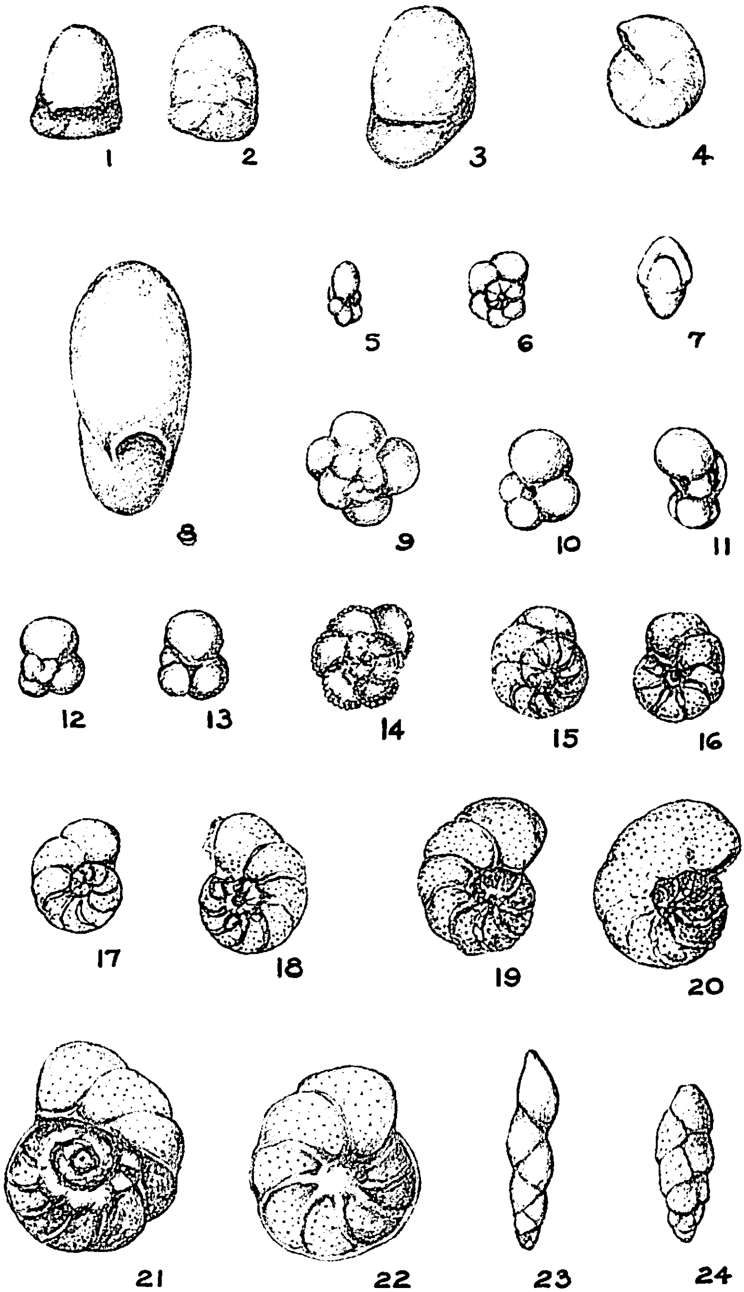


PLATE VI

PLATE VII

		Page
1.	Planoglobulina acervulinoides Cushman, x65. Test hole M172, S2	45
2.	Pseudouvigerina naheolensis Cushman and Todd, x65. Test hole M49, S2	46
3.	Heterostomella sp., x65. East of test hole M49	16
4.	Heterostomella cuneata Sandidge, x33. Test hole M168, S2	15
5.	Pyrulina cylindroides (Roemer), x33. Test hole M168, S2	40
6.	Dorothia sp. x33. Gully above test hole M49	17
7a, 7b.	Dorothia sp., x33. Sections transverse to axis. Test hole M49, S3	17
8.	Bulimina cacumenata Cushman and Parker, x65. Test hole M49, S2	47
9.	Bulimina arkadelphiana Cushman and Parker var. midwayensis Cushman and Parker, x33. Test hole M195, S4	47
10.	Marssonella oxyconca (Reuss), x33. Test hole M65A, S2	16
11.	Gaudryina rugosa d'Orbigny, x33. Test hole M168, S3	14
12.	Gumbelina morsei Kline, n. sp. x65. Holotype test hole M49, S2	44
13.	Vaginulina legumen (Linnaeus) x33. Gully above test hole M49	32
14.	Gaudryina sp., x33. Test hole M170, S4	15
15, 16.	Lagena sulcata (Walker and Jacob) var. semiinterupta Berry, x65. 15 from test hole M200, S1; 16 from test hole M171, S3b	39
17.	Dentalina plummerae Cushman var. Gully above test hole M49	25
18, 19, 20.	Cibicides browni Kline, n. sp., x33. 18, dorsal view; 19, ventral view; 20, peripheral view. Cotypes from test hole M49, S2	62
21.	Lagena cf. primigera H. B. Brady, x65. Test hole M66, S2	38
22.	Dentalina (?) sp., x33. Gully above test hole M49	26
23.	Dentalina cf. solvata Cushman, x33. Gully above test hole M49	26
24, 25, 26.	Anomalina cf. ammonoides (Reuss). 24, dorsal view; 25, peripheral view; 26, dorsal view. Specimens from test hole M93, S2	60
27.	Robulus cf. wilcoxensis Cushman and Ponton, x33. Gully above test hole M49	20

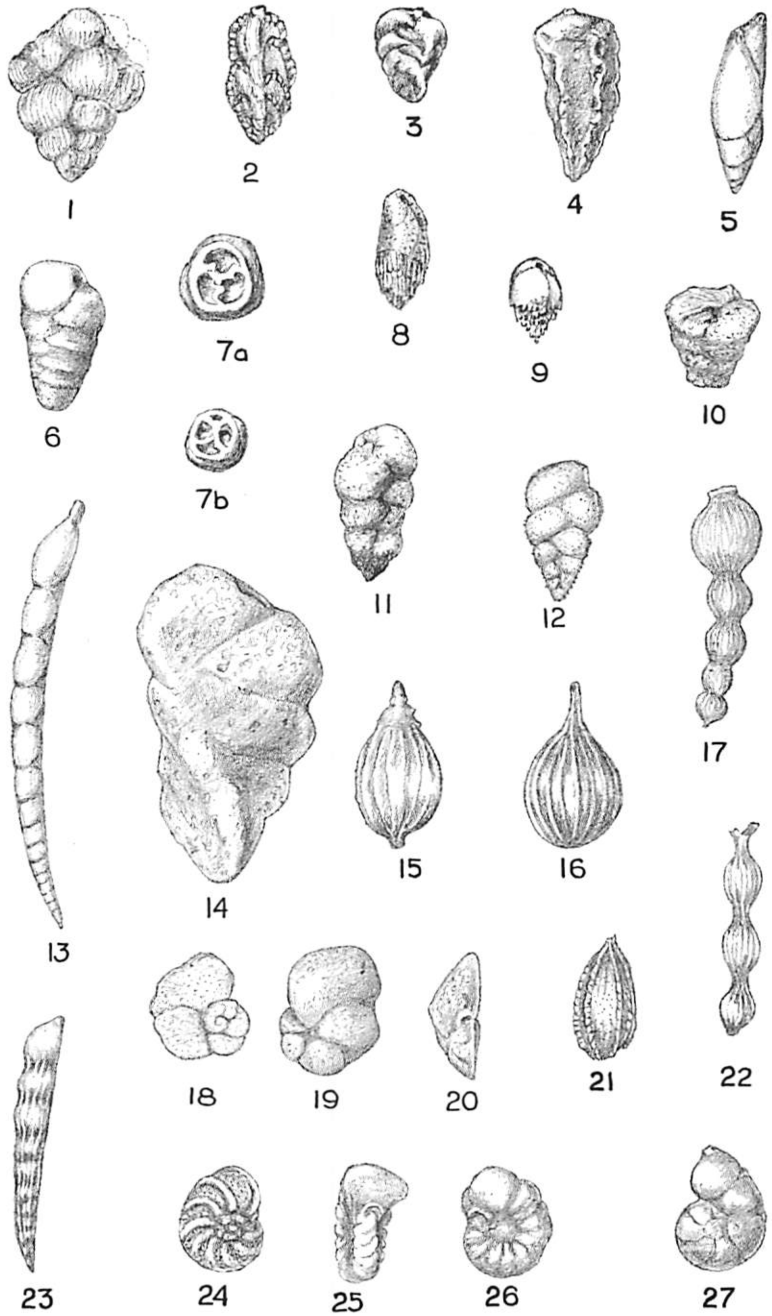


PLATE VII

PLATE VIII

Page

1. **Paracypris perapiculata Alexander, x33. Test hole M49........ 65**

2. **Argilloecia faba Alexander, x65. Test hole M178, S7.......... 64**

3. **Brachycythere plena Alexander, x33. Test hole M196, S2b.... 67**

4. **Bairdia magna Alexander, x33. Test hole M192, S2........... 65**

5. **Brachycythere interrasilis Alexander, x33. Test hole M49, S3.... 67**

6. **Cythereis spiniferrima Jones and Sherborn, x33. Test hole M49.. 68**

7. **Brachycythere formosa Alexander, x33. Test hole M49, S3...... 66**

8. **Cytheromorpha scrobiculata Alexander, x65. Test hole M171, S3a 69**

9. **Cytherella symmetrica Alexander, x33. Test hole M49, S3..... 64**

10. **Loxoconcha mississippiensis Kline, n. sp., x65. Holotype. Test hole M173, S4 .... 70**

11. **Cythereis prestwichiana Jones and Sherborn, x33. Test hole M65A, S2 .... 68**

12. **Krithe perattica Alexander, x33. Test hole M170, S3a 70**

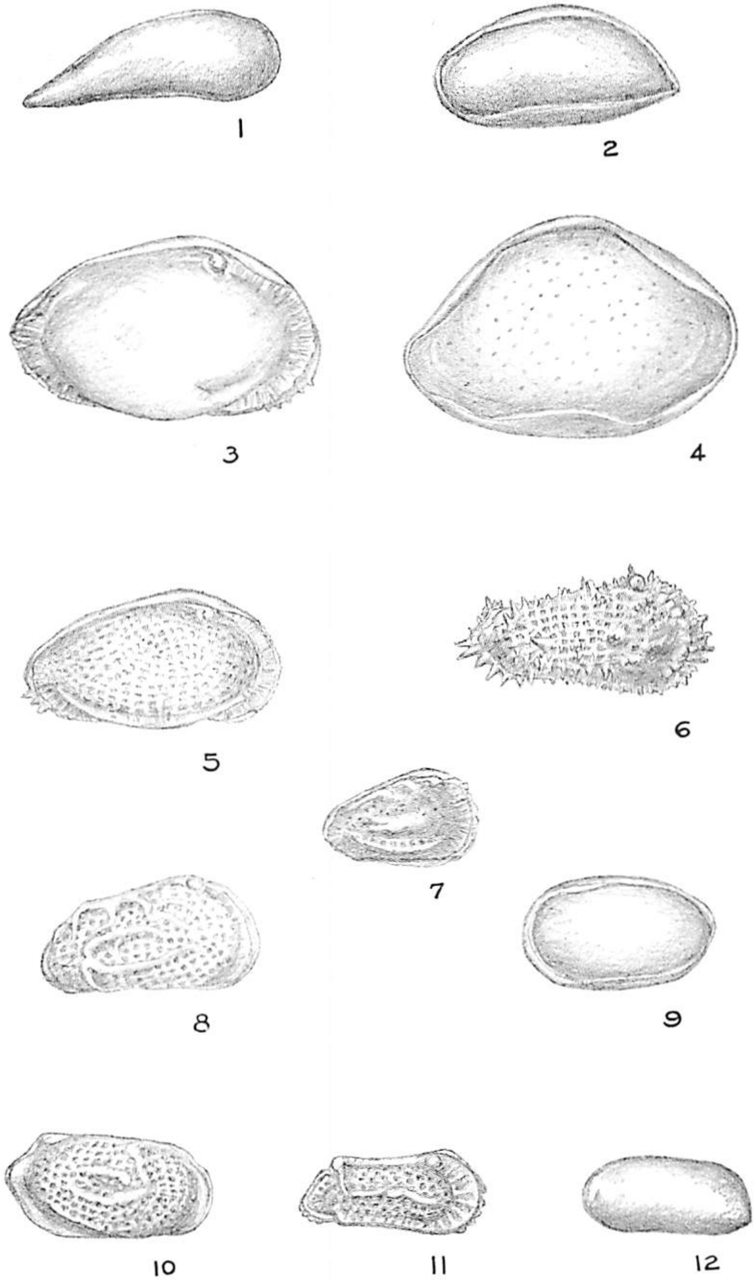


PLATE VIII

INDEX

Page

Alabama 6, 14, 17, 19, 22, 23, 24, 26-29, 31, 32, 35, 36, 45, 46, 48, 49, 50,54, 55, 57, 60, 63
Allomorphina trigona 11, 56, 90, 91
Anomalina acuta 9, 11, 59, 88, 89
cf. ammonoides 9, 11, 60, 92, 93
midwayensis 9, 11, 60, 90, 91
midwayensis trochoidea 9, 61, 90, 91
Argilloecia faba 9, 11, 64, 94, 95
Bairdea magna 9, 12, 65, 94, 95
Bank of West Point property........73, 74
Bennett, Amzi, property of 78
Bergquist, Harlan R. 5, 15, 16, 17, 21,26, 33, 39, 40, 45, 46, 47, 48, 60
Bolivina midwayensis 8, 11, 49, 86, 87
Booneville 26
Brachycythere formosa 9, 12, 66, 94, 95
interrasilis 9, 12, 67, 94, 95
plena 9, 12, 67, 94, 95
Bulimina arkadelphiana
midwayensis 11, 47, 92, 93
cacumenata 11, 47, 92, 93
(Desinobulimina) quadrata ..8, 11, 48, 57, 86, 87
Bullopora chapmani 8, 11, 42, 43, 86, 87
chapmani hispida 11, 43, 86, 87
laevis 8, 11, 43, 86, 87
laevis hispida 11, 43, 86, 87
C. & G. Railway property 77
Champion, J. P., property of.......... 74
Chilostomella subtriangularis 56, 90, 91
Chilostomelloides eocenica 11, 56, 90, 91
Choctaw County 21
Christoper, J., property of ...17, 26, 33, 72
Chrysalogonium granti 7, 10, 29, 82, 83
Cibicides alleni 6, 9, 11, 61, 90, 91
browni 9, 11, 62, 92, 93
praecursorius 9, 11, 62, 88, 89
vulgaris 9, 11, 63, 90, 91
Clavulinoides midwayensis ..7, 10, 13, 80, 81
Cliett Estate property 75
Cretaceous 13, 14, 20, 23, 36, 69
Cushman, Joseph A. ..19, 20, 21, 22, 24, 26, 29, 36, 38, 49, 50, 60, 63
Cythereis prestwichiana 9, 12, 68, 94, 95
spiniferrima 9, 12, 68, 94, 95
Cytherella symmetrica 9, 11, 64, 94, 95
Cytheromorpha scrobiculata 9, 12, 69, 94, 95
Dentalina aculeata (?) 7, 10, 23, 82, 83
basiplanata 7, 23, 82, 83
crinita 7, 10, 23, 82, 83
delicatula 7, 24, 82, 83
gardnerae 7, 24, 82, 83
havanensis 10, 25, 82, 83
plummerae 7, 10, 25, 82, 83
plummerae var. 10, 26, 92, 93
pseudo-obliques triata 7, 10, 82, 83
cf. solvata 10, 26, 92, 93
(?) sp. 10, 26, 92, 93
Discorbis midwayensis 8, 52, 88, 89

Page

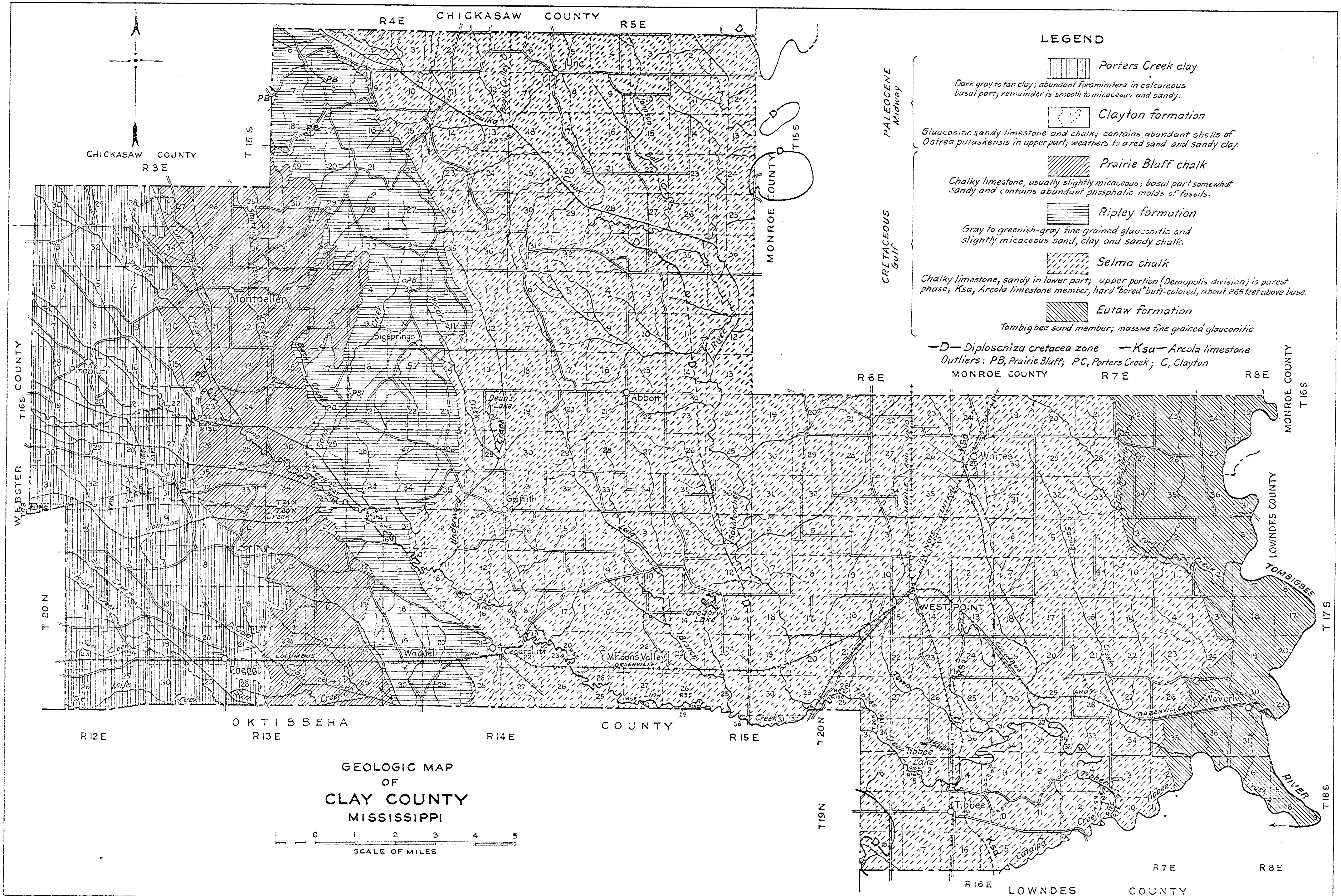
Dixon, Sim, property of 16, 73
Dorothia alabamensis 17
sp. 10, 17, 92, 93
Double Cabin Creek 45, 73, 76
Duke, John, property of 75
Ellipsonodosaria alexanderi 8, 11, 51, 88, 89
plummerae 8, 11, 51, 88, 89
Entsolenia morsei 8, 11, 48, 86, 87
Eouvigerina excavata 8, 11, 45, 86, 87
Eponides cf. tenera 8, 11, 53, 88, 89
Federal Land Bank property 77
Frondicularia archiaciana 8, 36, 84, 85
cf. frankei 8, 10, 37, 84, 85
Gaudryina rugosa 10, 14, 92, 93
sp. 7, 15, 92, 93
Globigerina compressa 8, 11, 58, 90, 91
pseudo-bulloides 8, 11, 58, 90, 91
triloculinoides 8, 11, 59, 90, 91
Globotruncana sp. 11, 59, 90, 91
Globulina gibba 8, 11, 40, 86, 87
Griffith, Emmett, property of 76
Gumbelina midwayensis 44
morsei 8, 44, 92, 93
Guttulina problema 8, 11, 39, 86, 87
Gyroidina subangulata ... 6, 8, 11, 53, 88, 89
Hemicristellaria subaculeata
tuberculata 7, 10, 22, 80, 81
Heterostomella cuneata 10, 15, 92, 93
sp. 10, 16, 92, 93
Hill, Walton, property of 72
Houston, Dr. T. D., property of......16, 72
Hubbert, C. H., property of 45, 74
Jackson formation 5
Kincaid formation 6
Krithe perattica 9, 12, 70, 94, 95
Lagena apiculata 49
hispida 8, 37, 86, 87
laevis 8, 10, 38, 86, 87
orbignyana 10, 38, 86, 87
cf. primigera 8, 38, 92, 93
sulcata semiinterupta 8, 11, 39, 92, 93
Lenticulina degolyeri 7, 10, 21, 80, 81
rotulata 10, 21, 80, 81
Loxoconcha perdecora 70
mississippiensis 9, 12, 70, 94, 95
Loxostoma applinae 8, 11, 50, 88, 89
Marginulina earlandi 7, 22, 80, 81
Marssonella oxycona 7, 10, 16, 92, 93
Mexico 23
Miller, Henry, property of 76
Milton, James, property of 77, 78
Montpelier 16, 19, 31, 57
Murrah, Archie, property of 72
Murrah, J. A., property of 73
Naheola 21, 22, 46
Navarro 24, 66
Nodosaria latejugata 7, 10, 27, 42, 43, 82, 83
oligotoma 10, 27, 82, 83

Page

Nodosarina (Frondicularia)
goldfussi ---10, 28, 82, 83
(Nodosaria) aspera ---10, 27, 82, 83
(Nodosaria) longiscata ---7, 10, 28, 82, 83
Nonionella welleri ---8, 11, 43, 86, 87
Old Canton Landing, Ala. --- 45
Oligocene --- 41
Ostrea pulaskensis ---6, 7, 19, 70, 73, 74, 75, 76, 77, 78
Palmula cf. budensis ---8, 10, 34, 84, 85
delicatissima ---10, 35, 84, 85
cf. primitiva ---8, 10, 35, 84, 85
rugosa ---8, 36, 84, 85
Paracypris perapiculata ---11, 65, 94, 95
Parrella expansa ---8, 11, 54, 88, 89
Pegues, Mary Louise --- 5
Pheba ---14, 17, 26, 43, 44, 45, 47, 48, 49, 62, 73, 74, 76, 77, 78
Planoglobulina acervulinoides --- 8, 45, 92, 93
Pleurostomella cf. brevis
alternans ---11, 50, 90, 91
Plummer, Helen J. ---6, 18, 19, 20, 21, 22, 31, 32, 33, 43, 49, 50, 56, 58, 61, 63
Polymorphina cushmani ---6, 8, 41, 86, 87
frondea ---8, 11, 41, 86, 87
sp. ---8, 41, 86, 87
Prairie Bluff chalk --- 5
Prairie Creek ---17, 22
Pseudoglandulina cf. caudigera ---7, 10, 29, 82, 83
comata ---7, 10, 29, 82, 83
manifesta ---7, 10, 30, 82, 83
Pseudouvigerina naheolensis --- 8, 46, 92, 93
Pullenia quinqueloba ---8, 11, 57, 90, 91
Pulvinulina exigua --- 8, 11, 55, 88, 89
Pyrulina cylindroides ---8, 11, 40, 92, 93
Ramulina globulifera ---8, 11, 42, 86, 87
Ripley formation ---15, 38, 39, 45
Robulus midwayensis ---7, 10, 17, 80, 81
pseudo-costatus --- 7, 10, 18, 19, 80, 81
pseudo-costatus inornatus 7, 10, 18, 80, 81
cf. pseudo-mammilligerus --- 10, 19, 80, 81
rosetta ---7, 10, 19, 80, 81
turbinatus ---7, 10, 20, 80, 81
wilcoxensis ---10, 20, 92, 93
Salt Mountain --- 21
Saracenaria midwayensis ---10, 30, 84, 85
cf. sublatifrons ---8, 10, 31, 84, 85
trigonata ---8, 10, 31, 84, 85
Scott County --- 5
Selma chalk ---15, 26
Sigmomorphina sp. ---8, 41, 86, 87
Siphogenerinoides eleganta 8, 11, 46, 86, 87
Siphonina prima ---8, 11, 55, 88, 89
Smith, May, property of --- 78
Snell, John E., Jr., property of --- 39, 72

Page

Spiroplectammina laevis cretosa --- 7, 10, 13, 80, 81
Sun Creek ---74, 77
Tennessee --- 38
Terry, Guy, property of --- 77
Terry, James, Jr., property of --- 75
Test hole M49 ---17, 43, 44, 45, 48, 49, 57, 62, 72, 80, 82, 86, 88, 90, 92, 94
M65A ---72, 80, 82, 86, 88, 92, 94
M66 ---39, 72, 84, 92
M67 ---72, 82
M84 ---72, 88, 90
M93 ---19, 31, 56, 57, 73, 80, 82, 84, 86, 88, 90, 92
M122 --- 73
M148 ---73, 88, 90
M168 ---14, 15, 73, 80, 90, 92
M169 ---74, 84
M170 ---74, 82, 84, 86, 88, 90, 94
M171 ---74, 86, 90, 92, 94
M172 ---45, 74, 92
M173 ---75, 94
M174 ---75, 84, 90
M178 ---75, 86, 90, 94
M183 --- 76
M184 ---76, 86
M185 ---76, 82
M187 ---76, 84, 86, 88, 90
M188 ---77, 86
M189 --- 77
M190 ---77, 86
M192 ---77, 94
M195 ---78, 92
M196 ---78, 94
M197 --- 78
M198 ---78, 80, 84, 88
M200 ---78, 82, 86, 88
Texas ---6, 14, 24, 25, 26, 27, 28, 31, 32, 33, 35, 36, 38, 39, 42, 43, 47, 48, 50, 54, 55, 56, 57, 58, 60, 63, 65, 66, 67, 68, 69, 70
Textularia cretosa --- 16
Toulmin, L. D. --- 21
Turritella mortoni --- 7
Vaginulina glabra ---10, 32, 84, 85
gracilis ---6, 8, 32, 34, 84, 85
legumen ---10, 32, 92, 93
legumen elegans ---8, 10, 33, 84, 85
plumoides ---8, 10, 33, 84, 85
robusta ---6, 8, 10, 34, 84, 85
Valvulineria allomorphinoides ---8, 11, 52, 57, 88, 89
Virgulina wilcoxensis ---8, 11, 49, 90, 91
Walker, W. F., property of --- 72
Washington, Joe, property of --- 73
Webster County --- 6
Wilcox formation ---21, 49, 62, 68



NOTE: IN THE LEGEND THE C. CLAYTON OUTLIER SHOULD READ INLIER.