

ANNUAL REPORT
OF THE
GEOLOGICAL SURVEY
OF
ARKANSAS

FOR 1892

VOLUME II
THE TERTIARY GEOLOGY OF SOUTHERN ARKANSAS
By Gilbert D. Harris.

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November, 28, 1893.

*To His Excellency,
Hon. W. M. Fishback,
Governor of Arkansas.*

Sir :

At the expiration of my term of office as State Geologist of Arkansas (March 16, 1893), several volumes of my reports remained unfinished. The Legislature of 1893 therefore made an appropriation for completing the reports of the Survey, and it was expected that their publication would be paid for out of the appropriation "for printing, publishing, and binding done for the state." This arrangement has enabled me to complete and publish Volume II, of the Annual Report of the Geological Survey of Arkansas for the year 1892—the year in which the work was done.

That volume I have the honor to submit herewith.

*Your obedient servant,
John C. Branner.*

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EXPLANATION OF MAP.

The geological map accompanying this report has been constructed with two distinct ends in view, viz., (1) To show the exact location of points and places referred to in the text; (2) To show as nearly as possible the distribution of the different Eocene stages over the area discussed. Portions of eastern Texas, northern Louisiana, and northern Mississippi, have been included in order to give a more comprehensive view of the questions of geographic distribution involved. The geology of Mississippi is after Hilgard, that of Arkansas is original, as likewise is that of Louisiana except the hypothetical Jackson-Claiborne boundary line, extending in a general way northeast from Montgomery to Monroe, which is after L. C. Johnson of the U. S. Geological Survey.

It must be constantly borne in mind that, in southern Arkansas, on account of the paucity of molluscan remains and the total want of any persistent structural features, the borders of the areas representing the different Eocene stages may, and probably will be somewhat changed by future research. Hard and fast lines cannot at present be drawn.

The geographical distribution of the different stages west of the Mississippi is fraught with suggestions regarding the probable trend of the same in the so-called Northern Lignitic of Mississippi.

EXPLANATION OF PLATES.

- Plate I. Organic remains, mainly from the Midway stage.
II. Organic remains of the Midway stage.
III. Organic remains of the Midway stage.
IV. Map showing the distribution of the Red-land of Cleveland county, Arkansas.
V. View of the fossiliferous outcrop three fourths of a mile above Vince Bluff, Saline River, Arkansas.
VI. Organic remains of the Claiborne and Jackson stages.
VII. Organic remains of the Claiborne and Jackson stages.

EXPLANATION OF FIGURES.

- Fig. 1. Section along Hot Springs road, Little Rock, Ark.
2. Section at Arkadelphia, Clark county, Ark., extending from near the Baptist school south to the St. Louis, Iron Mountain and Southern Railway.
3. Portion of Fig. 1, Pl. 18, Bull. No. 43, U. S. Geol. Surv., Smith and Johnson.
4. Section on Fourche Creek, near the mouth of Crooked Creek, Pulaski county, Ark.
5. Section at the old mine of the Camden Coal Company, Ouachita county, Ark.
6. Cut on the Camden and Alexandria Railway, about a half mile south of Camden station, Ouachita county, Ark.
7. Section on the north side of the St. Louis Southwestern Railway a few yards southwest of the Camden and Alexandria Junction.
8. Section on the St. Louis Southwestern Railway about four miles west of the junction with the Camden and Alexandria Railway.
9. Section on the St. Louis Southwestern Railway, 3 3-4 miles southwest of Buena Vista, Ouachita county, Ark.
10. Section on the St. Louis Southwestern Railway, 7 2-3 miles west of Buena Vista, Ouachita county, Ark.
11. Section on the St. Louis Southwestern Railway, 2-3 of a mile west of Stephens, Ouachita county, Ark.
12. Section on the St. Louis Southwestern Railway, 6 miles west of Stephens, Columbia county, Ark.
13. Section on the St. Louis Southwestern Railway, near Magnesia Springs, Columbia county, Ark.
14. Section in the immediate vicinity of that mentioned under Fig. 13.
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16. Section of White Bluff, Jefferson county, Ark.
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31. Section at a cut on the Camden and Alexandria Railway, 1 1-2 miles north of El Dorado, Union county, Ark.
32. Diagram of the beds exposed in the east side of a cut on the Camden and Alexandria Railway, 3.3 miles north of El Dorado, Union county, Ark.
33. Section of Walnut Bluff, Ouachita River, 4 miles below Frenchport, Ark. (Right bank.)
34. Section of Miller's Bluff, Ouachita county, Ark.; right bank of Ouachita River.

PREFACE.

The present report on the Tertiary embraces the results of the work undertaken by the Geological Survey for the purpose of distinguishing the subdivisions of the Tertiary formation of Arkansas and for determining their areal distribution in the southern part of the state. The work was entrusted to Professor Gilbert D. Harris, formerly of the U. S. Geological Survey and now of Cornell University, than whom no more trustworthy authority could have been found.

The task undertaken by Professor Harris was not an easy one: the country with which he had to deal is one of low topographic relief and heavily timbered, the rock exposures that might otherwise have been expected are generally concealed by the disintegration and breaking down of the original beds, while the marked paucity of marine fossils throughout the entire region has added to the difficulty of the work. These obstacles, however, have been so well overcome that the present report, besides dealing with the general features and distribution of the Tertiary geology of the State south of the Arkansas River, brings out several new points of especial interest. Among other things Professor Harris has shown:

1. That the Midway beds of the Alabama section are the oldest of our Arkansas Tertiary rocks.
2. That the beds at Olsen's Switch, Pulaski county, from which *Enclimatoceras ulrichi* came are not Cretaceous but Tertiary.
3. That the Cretaceous beds, although not known at the surface, are penetrated by the wells at Beebe and Cabot.
4. That the Arkadelphia shales, referred by Hill to the Tertiary, are of Cretaceous age.
5. That the Cretaceous-Tertiary border from Arkadel-

phia southwest lies south of the St. Louis, Iron Mountain and Southern Railway, and not north of it, as hitherto believed.

The purely economic features of the Tertiary area of the state will be treated at length in the Survey's report on clays which is now in preparation.

The Survey is under especial obligation to J. N. Marks of Cleveland county for assistance in doing the field work. Besides contributing of his time, means, and information, he has helped us by his intelligent interest in the Survey's work.

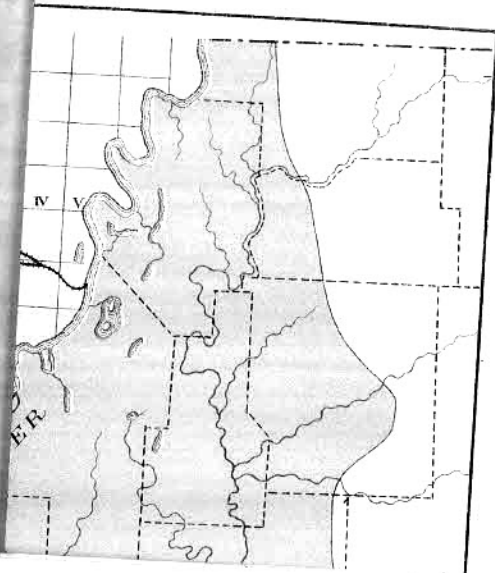
JOHN C. BRANNER,
State Geologist.

ERRATA AND ADDENDA.

PAGE.

18. Thirty-first line, for "Big Decipher" read *Big Deciper*.
33. Twenty-seventh line, for "*Turritella mortoni*," read *Turritella mortoni?*
39. Twenty-fourth line, for "*Rosellaria*," read *Rosellaria*.
48. Twentieth line, omit the ? after *multilira*.
63. Last line, after "1888" read *Vol. II*.
92. Seventeenth line, omit the † under *Harris*.
To list of fossils add: *Mesalia vetusta* Con.,
"*Delphinula*" *depressa?* Lea, *Turbonilla* sp.,
Scala (cavoscala) sp.
140. Seventh line, for "number," read *member*.
142. Sixteenth line, for "Lewport," read *Newport*.
147. Tenth line, omit (*Y. protexta* Con.);
165. Eleventh line, for "found," read *founded*.
190. Second line, after "localities," read 145.
Third line, after "*Aximæa*," read 39.
Eighth line, after "section near," read 94.
192. Twenty-first line, after "Conglomerate along Red River," read 2.

GIST



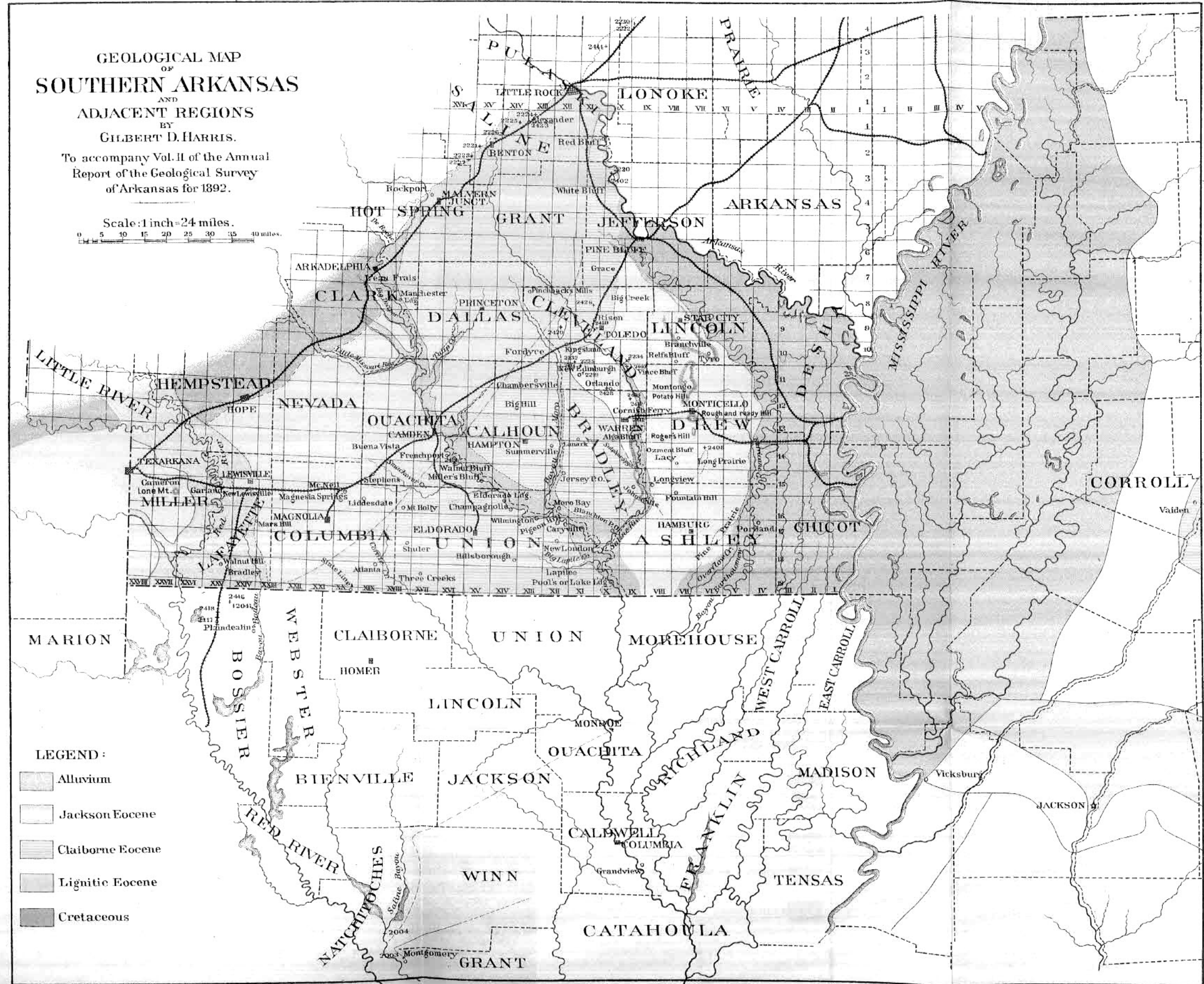
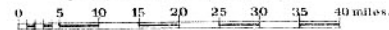
GEOLOGICAL SURVEY OF ARKANSAS. JOHN C. BRANNER, STATE GEOLOGIST

GEOLOGICAL MAP
OF
SOUTHERN ARKANSAS

AND
ADJACENT REGIONS
BY
GILBERT D. HARRIS.

To accompany Vol. II of the Annual
Report of the Geological Survey
of Arkansas for 1892.

Scale: 1 inch = 24 miles.



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THE TERTIARY GEOLOGY OF SOUTHERN ARKANSAS.

BY GILBERT D. HARRIS, Assistant Geologist.

CHAPTER I.

PRELIMINARY CONSIDERATIONS.

SCOPE OF THIS REPORT.

In the following report an effort is made to describe from a geological standpoint that portion of the state of Arkansas, consisting of Tertiary deposits, lying south of the Arkansas River. Frequent references are made to certain portions of eastern Texas, northwestern Louisiana, northeastern Arkansas, Mississippi, and Alabama whenever by doing so a side light can be thrown on the difficult problems of the special regions under consideration.

BRIEF REVIEW OF THE LITERATURE RELATING TO THE TERTIARY OF SOUTHERN ARKANSAS.*

Maclure.—On the geological map accompanying "Observations on the geology of the United States, explanatory of a Geological Map. By William Maclure,"† "alluvial rocks" (including alluvium Tertiary and Cretaceous rocks) are represented as occupying a strip of land in southern Arkansas adjacent to the Mississippi River with a breadth of from 30 to 50 miles.

In 1817 Maclure published more extended observations on the geology of the United States together with a map, whereon all of Arkansas Territory is represented as "Sec-

*Some of the matter herein given is of no serious importance, and is of interest only from a historical standpoint.

†Transactions of the American Philosophical Society. Vol. VI, pt. 2, 1809, pp. 411-428, and map.

ondary" except a very narrow strip along the Mississippi River from the mouth of White River southward which is classed as alluvial.*

Nuttall.—In December, 1820, Mr. Thomas Nuttall read before the Philadelphia Academy of Sciences a paper entitled "Observations on the Geological Structure of the Valley of the Mississippi."† He called attention to the "Ancient maratime alluvium" at "Pine Bluffs" and commented on the same as follows:

"Amongst the least equivocal marks of marine origin visible in this deposition, is the discovery of shells, which accidentally came to my notice a few miles below the Pine-bluffs, picked up by the children of some of the French hunters resident in this country, and consisting of a species of ostrea, like that on the Santee, penetrated by seams of calcareous crystals, exhibiting marks of a former attachment to a softish ferruginous sandstone, and containing fragments of lignite" (pp. 45-46).

The lignites on the banks of the Ouachita River he also referred to as well as the conglomerates along Red River (pp. 42-46).

The term "ancient maratime alluvium" as used by him includes the Tertiary and Cretaceous of Arkansas as now understood.

Featherstonhaugh.—Next in chronologic order may be mentioned the observations of G. W. Featherstonhaugh, made during the year 1834.‡ He recognized as of Tertiary

*Observations on the Geology of the United States of America with Some Remarks on the Effect Produced on the Nature and Fertility of Soils, by the Decomposition of the Different Classes of Rocks; and an Application to the Fertility of Every State in the Union, in Reference to the Accompanying Geological Map. With Two Plates. By William Maclure. Read as a Memoir before the American Philosophical Society, and inserted in the 1st Vol. of their Transactions, New Series. Philadelphia: Printed for the Author, by Abraham Small, No. 112, Chestnut Street, and sold by him and J. Melish. 1817. 8 vo., 127 pp., and map.

†Journ. Acad. Nat. Sci., Phila., Vol. II, 1821, pp. 14-52.

‡Geological Report of an Examination made in 1834, of the Elevated Country between the Missouri and Red Rivers, by G. W. Featherstonhaugh, U. S. Geologist. Published by order of both Houses of Congress. Washington: Printed by Gales & Seaton, 1835. 8vo., 97 pp., and a colored section.

age the calcareous layers in the vicinity of Little Rock, upper Saline, lower Caddo, and at Red Bluff on the Arkansas River, and specifically referred them to the "Eocene period of Lyell" (pp. 39-86).

Marcou.—On Marcou's geological map of the United States, published in 1853,* the Tertiary area of southern Arkansas is spoken of as "Tertiary and Quaternary."

On a "Carte Géologique des États-Unis et des Provinces Anglaises de L'Amérique du Nord" which accompanies a somewhat more extensive work by this author on the same general subject, published in 1858,† the "Tertiary" area is represented with considerable accuracy in southern Arkansas, though its northern boundary is encroached upon by broad belts of fictitious Cretaceous.

Warder.—In Professor John A. Warder's "Geological Reconnaissance of the Arkansas River," published in 1854, an account is given of Pine Bluff, in which it is doubtfully assigned to the "Eocene period."‡

Owen.—The second report of Owen's geological reconnaissance of Arkansas was published in 1860.|| It contains brief notes on the topography, soil, and character of forest growth of nearly every county in southern Arkansas. They were mainly edited by Mr. Cox after Owen's death. The Eocene age of the Tertiary system of this

*A Geological Map of the United States, and the British Provinces of North America; with an Explanatory Text, Geological Sections, and Plates of the Fossils which Characterize the Formations. By Jules Marcou, United States Geologist, Member of the Geological Society of France, etc., etc. Boston: Gould & Lincoln, 59 Washington Street. 1853. 8vo., 92 pp., 8 pl., map.

†Geology of North America; with Two Reports on the Prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California. Originally made for the United States Government. By Jules Marcou. Zurich: Printed for the Author by Zuercher & Furrer. 1858. 4to., 144 pp., 7 pl., 3 maps.

‡A Geological Reconnaissance of the Arkansas River. By Prof. J. A. Warder of Cincinnati, O. Cleveland: Printed by Harris, Fairbanks, Cobb & Co., Herald Office. 1854. 8vo., 27 pp.

||Second Report of a Geological Reconnaissance of the Middle and Southern Counties of Arkansas. Made during the years 1859 and 1860. By David Dale Owen, Principal Geologist, Assisted by Robert Peter, Chemical Assistant; M. Leo Lesquereux, Botanist; Edward Cox, Assistant Geologist. Philadelphia: C. Sherman & Son, Printers. 1860. 8vo., 433 pp., and chart.

state is here for the first time satisfactorily established by the specific identification of molluscan remains. (pp. 35, 417 and plate IX.)

White.—From a small collection of fossils made by Mr. E. O. Ulrich "near Little Rock," Dr. C. A. White, in 1880, described two forms under the names of *Spirorbis? dickhauti* and *Callianassa ulrichi*.* These he regarded as Cretaceous.

During the following year this author published a list of the genera and species recognized in the Ulrich collection, and among them was "*Nautilus texanus?*" *Callianassa ulrichi* and *Tubulostium aickhauti* he figured.†

In Bulletin No. 4 of the U. S. Geological Survey‡ the *Nautilus texanus* is described and figured under the name of *Enclimatoceras (Nautilus) ulrichi*, but is still regarded as Cretaceous.

Heilprin.—On a map accompanying Heilprin's U. S. Tertiary Geology an attempt is made to subdivide the Eocene area of Arkansas into Jacksonian and pre-Jacksonian.|| The border line of these divisions is represented as passing from Helena in a southwestern direction until it meets the Arkansas-Louisiana line at Bayou Bodcaw. The molluscan remains from White Bluff, mentioned by Owen, are regarded as Claiborne fossils.

Hill.—The greater part of Vol. II, of the annual report of the Geological Survey of Arkansas for 1888, is occupied by an article by Mr. Robert T. Hill, on "The Neozoic Geology of Southwestern Arkansas." Chapter VI is exclusively devoted to the Tertiary portion of this area. On pages 188–189 a synoptical Table of the Neozoic Formations of Southwestern Arkansas is given wherein the

*Proc. U. S. Nat. Mus., Vol. III, p. 161.

†Proc. U. S. Nat. Mus., Vol. IV, p. 137.

‡Pages 16, 17, pls. 7, 8, 9. Published in 1884.

§Contributions to the Tertiary Geology and Paleontology of the United States, by Angelo Heilprin, Professor of Invertebrate Paleontology at, and Curator-in-Charge of the Academy of Natural Sciences of Philadelphia; Member of the American Philo-sophical Society, etc. Philadelphia: Published by the Author. Academy of Natural Sciences of Philadelphia, 19th and Race Sts. 1884. 4to., 117 pp., and map.

Eocene is styled the Camden series, and is subdivided into: (a) Cleveland county red land; (b) Camden beds; (c) Little Missouri lignites; (d) Manchester shales; (e) Arkadelphia shales. Another division used by Hill, "The Bingen Sand," is said to be a "westward continuation of the upper and lower beds of the typical Camden series." (p. 56.)

This constitutes the first attempt by any one with a knowledge based on personal observation, to subdivide the Eocene series of this state. The geological map accompanying his report however, including townships 6 to 15 south and ranges 17 to 33 west, does not show the geographical distribution of these subdivisions.

Call.—In a report on the geology of Crowley's Ridge, Prof. R. Ellsworth Call describes sections at Pine, White and Red Bluffs respectively. He finds nearly all the fossils figured by Owen at White Bluff, and regards them of Claiborne age.*

Williams.—In describing the Igneous rocks in Saline county,† Dr. J. Francis Williams gave a few notes on the Tertiary of that region as will appear later on in the body of this report.

Branner.—Dr. J. C. Branner, State Geologist, briefly described the bauxite deposits of Pulaski and Saline counties in the American Geologist for March, 1891. (pp. 181–183.)

Griswold.—On the "Hot Springs sheet" accompanying the Annual Report of the Geological Survey of Arkansas for 1890, Vol. III, (pub. 1892), by Mr. L. S. Griswold, the Tertiary-Paleozoic boundary line is carefully delineated from Little Rock southwestward to a point about eight miles beyond Rockport.

Penrose.—Volume I of the Annual Report of the Geological Survey of Arkansas for 1892, by R. A. F. Penrose, Jr., is devoted to the iron ores of the state. One area

*Annual Report of the Geological Survey of Arkansas for 1889, Vol. II, pp. 3–14. Publ. 1891.

†Annual Report of the Geological Survey of Arkansas for 1890, Vol. II, pp. 126–128. Publ. 1891.

described and mapped falls within the so-called Lignitic Tertiary of this report. (See pp. 105-138 of that volume.)

COLLECTIONS OF FOSSILS, FIELD NOTES, ETC., ON WHICH THE PRESENT REPORT IS BASED.

Owen's types.—Most of the types figured on Plate IX of Owen's report for 1860 are in the collection of the U. S. National Museum, and have been at the writer's service.

Ulrich collection.—A small collection was made by E. O. Ulrich from near the confluence of Fourche and Crooked Creeks, and was sent to the Museum in 1880. This has been thoroughly overhauled.

Branner's collections.—During the present geological survey of Arkansas, Dr. Branner, the State Geologist, has from time to time received Tertiary material from citizens and field assistants which he has forwarded to the U. S. Geological Survey. It has been studied, and now forms a part of the U. S. National Museum collection.

The author's collections.—The winter of 1891-92 was spent by the writer in southern Arkansas under the combined auspices of the United States and Arkansas Geological Surveys. The first part of September, 1892, was spent in reviewing work done along the Cretaceous-Tertiary boundary. The notes and collections made during these two visits constitute the main source of material used in the preparation of the present report.

STRATIGRAPHIC NOMENCLATURE.

In reading over the literature on the Tertiary of southern Arkansas one will observe that along with the attainment of more accurate knowledge regarding the distribution of the Neozoic deposits went the more careful discrimination between the Mesozoic and Tertiary. Then the Tertiary beds were styled Eocene, and soon the similarity between the fossil remains at White Bluff and elsewhere to those at Claiborne, Alabama, was recognized. Heilprin classified the

Tertiary of the state as Jacksonian and pre-Jacksonian. Afterward Hill gave the name "Camden series" to all Tertiary beds studied by him in the southwestern part of the state, and named the following subdivisions:

- a. Cleveland county red-lands.
- b. Camden beds.
- c. Little Missouri lignites. Bingen sands.
- d. Manchester shales.
- e. Arkadelphia shales.

The Lafayette formation.—Of late the term Lafayette formation has been applied to certain deposits of non-fossiliferous (?) clays, sands, and gravels found unconformably overlying much of the Neozoic area of the Atlantic slope together with portions of what once formed a part of the Mississippi embayment. Special attention is called to this "formation" inasmuch as its ablest expounder, W J McGee of the U. S. Geological Survey has recently referred to its various deposits found within the limits of the area covered by the present report. He mentions among other localities, Little Rock, the railway cuts north of Malvern Junction, Arkadelphia and Nashville.*

These localities the present writer has visited and carefully examined and can say that except in the matter of volume, the sands and gravels referred to by McGee have every appearance of those frequently spoken of or described in this report from nearly every county in the southern part of the state.

The term "Lafayette formation" has not been adopted in this report, since the writer is not fully convinced of the integral nature or synchrony of the deposits which have been referred to it. In Little Rock, sands, pebbles, and boulders even, are found underlying the Midway Eocene Limestone. In the same place, material of the same nature overlies the Lignitic Eocene. The "Plateau gravel" of Hill in eastern

*U. S. Geological Survey, 12th Ann. Rept., pp. 470-471.

Clark county contains in some localities ferruginous matter enough to cement it into a hard conglomerate. It then contains numerous impressions of Cretaceous fossils. (See page 62.) Again splendid deposits of this formation may be seen, for example, in eastern Bradley county, overlying Jackson Eocene beds. (See page 125.) The great similarity in appearance of all these deposits seem to lead to one conclusion, viz., that they were laid down under similar conditions though by no means in the same geological epoch.

It has therefore seemed expedient in discussing the Tertiary of this portion of the State to speak of these "Lafayette" deposits as "reworked," "rehandled," or "rearranged" material in contradistinction to the stratified and laminated material on which it rests, without attempting to say just when the rearrangement took place except where paleontological or stratigraphic evidence determines the matter beyond a doubt.

Eocene series.—The term "Midway series" was used by Smith and Johnson in 1887* to designate a calcareous formation lying at the base of the Eocene of Alabama, and was classified by them as a subdivision of the "Lignitic" (Eolignitic of Heilprin). Owing, however, to its persistent nature, occurring, interruptedly to be sure, from Georgia to western Texas, and to its generally marked lithological and paleontological differences from the remainder† of "Lignitic" deposits, it seems advisable to make the terms of coordinate rank.

The term "Lignitic stage" will be used in the present report to designate the lignite and leaf bearing clays and sands occurring between the calcareous Midway below and the fossiliferous Claiborne above.

Both "Claiborne stage" and "Jackson stage" will be used in the manner ordinarily accepted by students of Mississippi and Alabama geology.

*U. S. Geological Survey, Bull. No. 43, p. 62.

†It is quite probable that the Black Bluff and Matthews' Landing beds of Alabama should be classed in the Midway stage.

The above statements may be thus summarized :

Tertiary Deposits of Arkansas.

Eocene series.	{	Jackson stage.	} All capped by shore deposits, some of which evidently date back to the age of the underlying beds, while other have been subsequently rearranged.* The "Orange sand" of Hilgard. In part, at least, the "Lafayette formation" as understood by McGee.
	{	Claiborne "	
	{	Lignitic "	
	{	Midway "	

*Much of this rearrangement presumably took place before the close of the epoch represented by the underlying stratified beds.

The terms, *series*, *stage*, *age*, and *epoch* are intended to be used in strict accordance with the meanings assigned to them in Secretary Dewalque's report of the Commission for the Uniformity of Nomenclature. See the Work of the International Congress of Geologists, published by the American Committee, 1886, pp. 50-51.

CHAPTER II.

NATURE OF THE ROCKS ON WHICH THE TERTIARY WAS
DEPOSITED.

Owen's views.—Referring to the Tertiary marls, limestones, etc., of St. Francis, Jefferson, and Pulaski counties, David Dale Owen remarks that they “undoubtedly rest on Cretaceous deposits beneath the drainage of the country.” The reasons for this belief are not explicitly stated; indeed, on the preceding page he says: “I have not been able to detect any symptoms of Cretaceous strata, even in deep wells, any further north in Arkansas than Clark county, about two and a quarter miles northwest of Arkadelphia; i. e., near the line between Townships 7 and 8 south, in about latitude 34° 6'.*”

White county.—At Beebe, White county, Professor R. Ellsworth Call evidently thought that he found no† indications of Cretaceous beneath the Tertiary deposits, for in a well section at that place (more exactly the southwest quarter of the southwest quarter of section 5, in 5 N., 8 W., on the farm of Mr. Cyrus Heller) a “blue, clayey marl, similar in all respects to that * * * at White Bluff, on the Arkansas River,” is said to contain an abundance of “broken marine shells,” among them “*Venericardia planicosta* and *Turritella carinata*,” and to lie “uncomfortably on Carboniferous rocks.” This blue clayey marl stratum is represented as extending from a depth of 29 to 64 feet.

A fragment of this marl from Beebe was obtained by the present writer from the State Survey collection, and when

examined its Cretaceous characters were definitely ascertained. The matter was accordingly submitted to the Mesozoic division of the U. S. Geol. Survey, and Mr. T. W. Stanton reports finding in it the following species of Cretaceous (Ripley) fossils:

Nucula percrassa Conrad,*

Gari (?) *elliptica* Gabb,

Veleda lintea Con.?

Scaphites conradi (Morton),

Baculites anceps Lamarck,

Placenticeras sp.

In addition to these several undetermined species are represented by fragments.

If Mr. Call is correct in his identification of the two Tertiary forms cited above, it necessarily follows that this blue clayey marl stratum or bed “6” of his section consists of two members, one of which is Cretaceous and the other Tertiary.

Lonoke county.—Among some material sent to the U. S. Geological Survey in 1890 by Dr. Branner are three or four fragments of *Exogyra costata* labelled “Well at Cabot Station, Iron Mt. R. R., Lonoke Co., Arkansas, Sect. 18, 4N. 9W., E. C. Buchanan, Collector, April, 1873.” Another package marked, “Well at Cabot, Hendricks,” contains numerous specimens of an *Anomia* and *Cardium eufalense*? and other more indistinct forms all imbedded in a bluish gray calcareous sandstone resembling closely the concretionary rocks of the upper Ripley group.

In reply to the writer's inquiry regarding the authenticity of the labels accompanying these specimens Dr. Branner sent the following letter that had been received by him from Mr. Hendricks, the collector:

*Another small collection made at this place and labelled “Tertiary” by Call, contains the same general fauna.

*Geological Reconnaissance of Arkansas, 2d Rept., 1860, p. 35.

†Ark. Geol. Surv. Anul. Rep. 1889, Vol. II, pp. 14 and 15.

WARD, ARKANSAS, April 24, 1890.

DR. J. C. BRANNER, State Geologist,
Little Rock, Ark.

DEAR SIR: * * * * *

At Cabot, at a depth of from 15 to 20 feet, many fossils are found in the form of teeth and a few other remains * * * As you go down, a few scattering remains are found until a depth of about 40 feet is reached. There you encounter sandrock of 1 or 2 feet and just under it for 10 feet is the bed of marl from which the specimens came. It is said to be solid marl and breaks up in chunks like rotten stone. It came from a well in Neeley's gin lot at Cabot. Two or three other wells near the same spot show the same conditions. That is the only place in the town that I now think of where wells have been dug. The inhabitants are supplied with water from cisterns from 15 to 20 feet deep; in the bottom of them is where the teeth are found.

Plenty of it can be obtained at Cabot. It lies scattered in chunks in one place and another, around there. This specimen was picked up in front of Patton's store, and at that time several other chunks were lying there.

Yours truly, T. E. HENDRICKS.

Pulaski county.—It is at present impossible to say to what extent the Eocene deposits of Pulaski county are underlain by Cretaceous. In the vicinity of Little Rock, however, there is good, though not absolutely positive evidence, that beneath the limestone layer of the Midway Eocene there are Cretaceous deposits from 10 to 30 feet in thickness. A package was sent to the U. S. Geological Survey by Dr. Branner, marked "J. S. Taylor's well West 7th St., near Bishop St., Little Rock, E. C. Buchanan, collector, July, 1875," containing the following Cretaceous forms:

Anomia (as at Cabot),
Cardium eufalense?,

Leptosolen biplicata (Stanton's identification),
Turritella triliria.

The striking similarity between the matrix and fossils from this locality to those found at Cabot has led to the suspicion, though perhaps ungrounded, that all may have come from the latter place and at some time had been improperly labeled. Yet even though this be true there are other evidences which go far to show that there are Cretaceous deposits within the limits of the city of Little Rock.

Nineteenth street, or the "Hot Springs road," where it crosses the Iron Mountain Railway track furnishes the profile given in the illustration below:

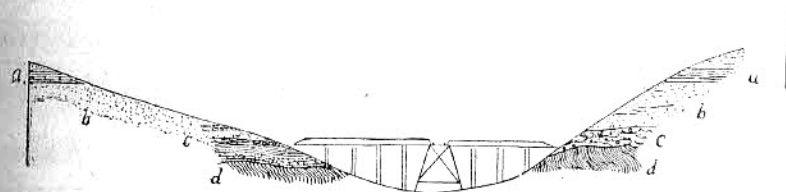


Fig. 1. Section along the Hot Springs road at the crossing of the St. Louis, Iron Mountain and Southern Railway, Little Rock, Ark.

The highest bed of importance in this figure is that represented at *a*, which is the lowest known Eocene bed, the Midway limestone. The bed is not more than 2 feet in thickness where it outcrops as represented on the left of this figure, while on the right its presence would not be suspected were it not for the well section described on page 27 and represented in its proper stratigraphic position by the small column at the right. Below *a* there is a bed of massive white and yellowish sands *b*, 20 feet in thickness. On the right, bed *c* consists of a deposit of impure bog iron ore about 10 feet thick; on the left it is represented by a two-foot layer of ferruginous sand and gravel, underlain by white clay, sand, and gravel. The lowest rocks exposed are the upturned Paleozoic slates *d*.

It is to bed *c* that special attention is called. On either flank of the depression in western Little Rock through which

the St. Louis, Iron Mountain and Southern Railway passes, are patches or bands plainly marked by the red color which they impart to the sands and clays in their immediate vicinity. At the corner of 6th and Wolfe streets, there are numerous ferruginous concretions containing obscure casts, at an elevation of 340 feet above tide. In circling around the hills to the west and south, this bed gradually descends, and at the Hot Springs road is not more than 290 feet above tide. West of the railway, it appears on 12th and 13th streets at an elevation of 360 feet, and where last seen toward the south, viz., about 100 yards south of the Hot Springs road, on the Iron Mountain Railway, it has an elevation of about 290 feet. The last mentioned locality is the most fossiliferous point observed in this bed, though here as elsewhere, the fossils are few, poor, and indistinct. They are an *Ostrea* with low undulations, and a form that is curved while young, but plain and straight when adult, agreeing well with *Ostrea franklini** Coquand, as figured by Hill; a small, smooth, tapering impression of *Baculites*?; impressions of what seem to be the imbricate margins of *Exogyra costata*; also a *Mytilus* and some crustacean remains. This evidence cannot be regarded as entirely conclusive in establishing the Cretaceous age of the deposit under consideration, but when taken in connection with the Taylor's well fossils enumerated above, and especially when it is borne in mind that well known fossils of this age have been found in a highly ferruginous conglomerate in the vicinity of Caddo Creek as described on page 61, the probabilities are greatly in favor of this view.

As stated above this bed consists mainly of impure bog iron ore, but in some localities it contains semi-transparent quartz in pockets and seams. Often too the whole mass has been so saturated by quartz-bearing solutions that it is now as hard as the Paleozoic quartzites. Small pebbles are

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, Pl. V, figs. 1-9 and Pl. VII, figs 29-30.

common throughout its mass while in some instances it contains boulders from 2 to 6 inches in diameter.

Beneath the limestone represented in Fig. 4, page 28, there is a bed of massive sand of a generally light yellow hue containing nodules of bluish green glauconitic sand. This cannot have a maximum thickness of over 11 feet. It rests upon very dark Paleozoic slate, and is perhaps of Cretaceous age.

Saline County.—Where igneous rocks occur in Pulaski and Saline counties, they are overlain by Tertiary and Pleistocene deposits, showing that the latter were laid down subsequent to the extrusion of the former.*

Hot Spring county.—At Rockport, Mr. Hill found "marine Tertiary fossils" in the debris of a well being dug at the time of his visit; and he states that the crystalline limestone in which they occur "rests directly against the disturbed outcrops of the paleozoic novaculite."† This well the present writer was informed, never completely penetrated the limestone, but was abandoned and refilled with the material that came out of it. A few fragments of limestone found on the spot in 1892 sufficed to show that lithologically and paleontologically it cannot be distinguished from the Midway beds met with in wells and outcroppings in Little Rock and elsewhere.

Clark county.—At Arkadelphia, Clark county, Mr. Hill‡ found the Tertiary represented by the "Arkadelphia shales" which are typically exposed "in the ravine and creek a hundred yards southwest of the Baptist school." The word "southwest" in this quotation should, according to Mr. Hill, be changed to northwest. This locality was visited by the present writer, and the "Arkadelphia shales" were identified. The molluscan remains found consist generally of rather obscure bivalves, though the genus *Inoceramus* was defi-

*Annual Report of the Geological Survey of Arkansas for 1890, Vol. II, p. 5.

†Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 53.

‡Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, pp. 53-56.



Fig. 2.—Section at Arkadelphia, Clark County, Ark., extending from near the Baptist school south to the Iron Mountain Railway.

nately determined. Not knowing this to be the locality referred to by Hill, owing to the typographic error just referred to, less time was spent here than might otherwise have been. No pains, however, was spared in obtaining reliable data regarding the outcroppings referred to as “immediately north of the Cotton factory,” and those that “are best seen in the ravines beside the main streets that lead north from the railway into the business part of the city.” The accompanying diagram, it is hoped, will aid to a proper understanding of the stratigraphic relations of the various sections under discussion:

a. a. Greenish sand, more or less indurated, with cylindric casts and “borings.”

b. b. Greenish gray sands, becoming somewhat laminated and lighter in color on long exposure, and containing an ample molluscan fauna in form of casts.

c. c. “Arkadelphia shales, consisting of alternate bands of blue clay and white or orange colored sands.” The blue clays contain numerous particles of lignite. The complete segregation in these beds of the clay and sand layers is at least partially due to long weathering.

d. An unusually thick band of “blue” (really a jet black) clay, represented as seen in the ditch at the left of Moore street as one goes up from the railway to the business part of the town; contains well preserved Cretaceous fossils.

d'. Upper limit of the “Arkadelphia shales.”

e. e. Gravel, lying very unconformably on *c. c.* and *d'.* This bed is generally overlaid by sands of a yellowish color and of various degrees of coarseness.

As shown in Fig. 2, bed *d*, on the left side of Moore street, is developed to a thickness of 9 feet. On the right side of the road-bed, it is much thinner, is lighter in color, and contains no well preserved organic remains so far as observed. Where typically exposed, this bed contains a concretionary formation near its base where beautifully preserved fossils abound. Smaller specimens are found in the form of casts to the uppermost limit of the bed. To insure accurate identifications of the remains here collected the writer turned them over to Mr. T. W. Stanton of the Mesozoic Division of the U. S. Geological Survey, who in turn submitted the following note:

“List of Cretaceous fossils from Arkadelphia, Ark., collected by Mr. G. D. Harris.

Cyprimeria alta Con.,
Exogyra costata Say,
Venilia conradi Morton,
Crassatella vadosa Morton,
Leda pinnaformis Gabb,
Chemnitzia? interrupta Con.?

The last named species is probably a *Strepsidura* though it seems to be Conrad's species, which was certainly not a *Chemnitzia*. Gabb has called it a *Tritonium*. T. W. S.”

On the right of Callaway street (the street leading directly from the station up into the town) this same dark stratum is exposed. During a very short stay at this exposure a few traces of fossils were found. One, however, worthy of mention was a *Lingula*. Mr. Hill notes from this horizon *Nucula*, *Crassatella*, *Lingula*, and *Ostrea*, all of which, save perhaps the *Ostrea* which really has little significance, the writer has found in undoubted Cretaceous beds at this place.

From what has already been said it becomes evident that Mr. Hill has erred in assigning a Tertiary age to the Arkadelphia shales. This view Mr. Hill strengthened by the discovery of "nonconformity" between the Arkadelphia shales and the underlying High Bluff Cretaceous sands.*

Whatever opinion one may have regarding this nonconformity, there is positive evidence that well preserved Cretaceous forms are found in an undisturbed bed many feet above it. In the ravine north of the cotton factory (see central portion of Fig. 2), the line of the supposed nonconformity occurs at an elevation of 20 feet above the surface of the Ouachita River as determined by a series of levels made January 22, 1892. On Moore street (as seen on the extreme left of Fig. 2), the last Cretaceous fossils were found at an elevation of 40 feet above the river. There is moreover a southerly dip in this region as determined by Mr. Hill, which brings the top of the High Bluff section down near the water-level at Arkadelphia. The outcrops in the two ravines at the middle and to the right in Fig. 2, respectively go to prove the correctness of this statement. The dotted line indicates the amount of this south dip. This being taken into account, it results that the stratigraphic difference between the highest point where Cretaceous fossils were found on Moore street (the upper portion of bed *d*), and the line of the supposed nonconformity in the section just north or back of the cotton factory (the upper surface of bed *b*), can be no less than 26 feet. Such being the case it is obvious that all the undisturbed strata, or those lying beneath the gravels of the two ravines represented in Fig. 2 must be of Cretaceous age.

At the Big Decipher Bluff, what Mr. Hill regarded as a nonconformity seems to be a change in sedimentation without any perceptible discordance in stratification. Mr. Hill is doubtless right in correlating the beds in the upper portion of the bluff with his Arkadelphia shales.

It must now be noted that as these shales have been regarded as the base of the Tertiary system in southwestern Arkansas and as the Tertiary-Cretaceous line has been drawn accordingly, this line must be moved coastward to a greater or less extent in order to correctly represent the distribution of the Cretaceous and Tertiary rocks of this portion of the state.

The basal Tertiary limestone to the northeast, as will be seen further on, is sometimes associated with black clays, while similar material characterizes the upper Cretaceous or Arkadelphia shales. It is, therefore, impossible to state at present whether the dark colored clays found at the mouth of L'Eau Fraiche and at Manchester landing should be re-regarded as Cretaceous or Tertiary. At Hart's Chapel, about 11 miles due south of Arkadelphia, wells penetrate bluish or black clay which yields impotable water. An artesian well 296 feet deep after passing through a very hard blue rock, 18 inches in thickness, immediately filled with very saline water that rises several feet above the surface of the ground. Though a large portion of these dark clays may be referred to the Cretaceous, the writer is of the opinion that the sandy hills apparently destitute of fossil remains situated between the Decipher and the Terre Noir should be classified as Tertiary.

Hempstead county.—Mr. Hill found many outcrops of the Arkadelphia shales in southern Hempstead county. He mentions specifically those on the county poor-farm. This is located about half way between Fulton and Washington. At a comparatively high locality, namely at Hope, which, according to the State Geologist is 352 feet above tide level (about 195 feet above the Ouachita at Arkadelphia and 125 feet above the Red River at Fulton), artesian borings from a depth of only 25 feet furnished well preserved specimens of *Exogyra costata* Say.

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. 11, p. 55.

All the above facts indicate that while we have no means of determining the exact location of the Tertiary-Cretaceous boundary line in this part of the state, it cannot be regarded as extending north of the St. Louis Iron Mountain and Southern railway. The writer's own impressions on this subject are represented in a general way on the map accompanying this report.

Howard county.—According to Mr. Hill the Arkadelphia shales are well exposed at Nashville, "along the north and south banks of Mine Creek, in the 'old town' where fossil impressions similar to those at Arkadelphia are found."* This interesting locality was visited by the writer, and the beds referred to by Mr. Hill were identified. The most fossiliferous locality was observed on the left bank of the creek, about 300 yards northwest of the old town. The fossils consist of casts of small bivalve molluscs, the most abundant form being a *Leda* which Mr. Stanton regards as *Leda protexta* Gabb. Other forms like small *Crassatella* and *Nucula* were noted, but none seemed to present an Eocene appearance. The dark blue clays at this locality are overlaid unconformably by gravel. There is another small outcrop of blue clay a few yards below the foot-bridge in the northern outskirts of the old town. It is overlaid by about 2 or 3 feet of yellowish sand, which in turn is capped by a bed of gravel from 1 to 2 feet in thickness. By far the best exposure observed in this locality occurs about 200 yards northeast of a little cluster of churches, just east of the old town. The beds represented are as follows:

1. "Plateau gravel;" bed of gravel, sand, and boulders, often forming a ferruginous conglomerate at base and showing a total thickness of not less than 10 feet.
2. "Bingen sand;" quartzitic sand, slightly yellowish, irregularly laminated; lines of lamination often

marked by white clay nodules in upper part of the bed. Below, the white nodules become more numerous and finally form thin white seams between the layers of sand. Still lower the clay seams become thickened into bands, and they assume a dark bluish color. Finally these dark clay bands predominate (see below). Thickness 15 feet.

3. "Arkadelphia shales;" dark blue fossiliferous clay, 4 feet.

The only fossil observed in the blue clay bed at this place was the *Leda* referred to above. The "Bingen sands" seem to indicate a shoaling of the Cretaceous sea in which they were doubtless deposited; and in some instances both near Nashville and Bingen their upper layers appear to be more or less rehandled.

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 56.

CHAPTER III.

THE MIDWAY OR CLAYTON* STAGE.

EXTRA-LIMITAL AREA EAST OF ARKANSAS.

Alabama.—In eastern Alabama, according to Mr. Langdon,† this stage has a thickness of no less than 218 feet, and along the Chattahoochee River it is “the most important group of the Eocene.”

Mr. T. W. Stanton of the U. S. Geological Survey recently made a small collection on the banks of this river at a point 3 miles below the mouth of Pataula Creek, and obtained the following molluscan remains:

Ostrea præ-compressirostra,^{4 †}

Cytherea,¹⁴

Crassatella,¹¹

Venericardia,

Turritella humerosa,

Turritella mortoni?

The typical development of this stage is thus given by Smith and Johnson: ||

“Section from base of Graveyard Hill to Pine Barren Creek.

Black clays weathering yellow, basis of prairies. No. 5 of the preceding section.

6. Hard, grayish white limestone, characterized by great numbers of a large *Nautilus* (*Enclimatoceras ulrichi*), and hence known as the Nautilus Rock About 10 feet.

7. Calcareous sands forming the basis of the black, sandy prairies of this vicinity.. 6 feet.

*Name applied by D. W. Langdon, Bull. Geol. Soc. Am. Vol. II, 1891.

†Ibid pp. 594-595.

‡These numbers refer to the notes under “Organic remains of the Midway series” in Chap. IV of the present volume.

|| Bulletin 43, U. S. Geological Survey, p. 64.

8. Hard, yellowish white crystalline rock, sandy in places and filled with red specks, highly fossiliferous, containing *Turritella* in great numbers; also *Caraitas*, a *Rostellaria*, *Ostrea*, and two or three species of coral. This is one of the most persistent of the lower Tertiary rocks toward the east 8 feet.
9. Yellowish, micaceous sand, with Cretaceous fossils,” etc. Beds 6, 7, and 8 constitute the Midway stage in the section from which they are taken.

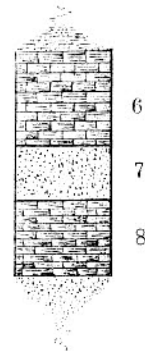


Fig 3. Typical Section of the Midway Stage.

(Portion of Fig. 1, pl. XVIII. Bull. 43, U. S. Geol. Survey; Smith and Johnson.)

The upper limestone or Nautilus Rock is said* to occur “at Midway, on the Alabama River and westward across Marengo county.”

Mississippi.—In Mississippi, this horizon may perhaps be represented by the small area in Tippah county colored on Hilgard's map† as Siliceous Claiborne. From one locality this author enumerates the following fossils:

Cardita planicosta,

Cardium nicolleti?,

Trochus,

Ostrea, etc.

*Op. Cit. p. 70.

†Report on the Geology and Agriculture of the State of Mississippi 1890.

In the collection of the Philadelphia Academy of Sciences there is a fragment of light gray limestone containing a specimen of *Turritella mortoni* labelled "Dr. Spillman, Ripley, Miss."

ARKANSAS.

Independence county.—In Arkansas the Midway stage forms a low, terrace-like elevation on the northeast flank of the Paleozoic upland just to the south and southwest of Bayou Departé, Independence county.

Jackson county.—The elevation referred to in the preceding paragraph comes close to the Iron Mountain railway at Russell Station; limestone ledges crop out in a cemetery at that place. Similar exposures are found in the immediate vicinity of Grand Glaise while more extensive ones occur along the railway cuts about half a mile further south.

The limestone layers are usually hard and crystalline, of a light gray color and with few or no traces of organic remains. They vary in thickness from six inches to two feet, and alternate with light yellow sand beds of equal thickness. Judging from the general horizontality of the beds and the fact that at Grand Glaise a cistern sunk in the uppermost part of the terrace encountered limestone at a depth of twelve feet, it is certain that the total thickness of this formation cannot be less than twenty feet.

Going southward towards Bradford the limestone ledges become more and more fossiliferous. Dr. J. C. Branner in 1887 collected specimens from two points in this vicinity, giving as localities "Between two and three miles north of Bradford on the Iron Mountain Ry." and "Two miles north of Bradford on the Iron Mountain Ry." The former (Station 2223, U. S. National Museum Register) consist of light gray limestone fragments holding on their ferruginated exterior numerous specimens of *Turritella mortoni*²⁶ (composed of calcite), and coral.³²

At the latter locality (Station 2229), the following forms were recognized:

Ostrea (young),
Cytherea (a cast),
Turritella mortoni.²⁵

The writer found at this point (Station 2438):

Turritella mortoni,
Cytherea (cast),
Cytherea.¹⁴

White county.—At an old limestone quarry by the side of the railway 1 3-4 miles north of Bradford (Station 2437), specimens of *Turritella mortoni* composed of crystalline calcite are of frequent occurrence; an indistinct cast of a *Cardium* was also noted at the last named locality.

One eighth of a mile nearer Bradford (Station 2436), perhaps 200 yards west of the railway track many boulders of highly crystalline limestone are strewn about in a field. Besides innumerable fragments of molluscan forms, this limestone encloses rounded pebbles of greenish sandy shale with major diameters in some instances of no less than 2 inches. The recognizable fossils are:

Ostrea præ-compressirostra,⁴
*Venericardia planicosta*¹⁰ (small),
Psammobia? (large and ill defined).

Lonoke county.—Further to the southwest, in Lonoke county, the Midway stage appears in the vicinity of Cabot. A specimen of more less friable limestone collected by the Survey is filled with fragments of oyster shells.

On the line between section 18, 4 N., 9 W., and section 13, 4 N., 10 W., midway of the line (Station 2230) Mr. A. G. Taff obtained specimens of:

*Ostrea*⁴ (young shells),
*Turritella mortoni*²⁵ (cast),
Shark's teeth and vertebræ, and
Fragment of light gray, firm limestone.

Mr. E. C. Buchanan collected at 3 N., 11 W., section 12, northwest quarter of the southwest quarter about 600 feet northwest of Henry's store (Station 2444) a specimen of limestone closely resembling those obtained at Station 2436, though no fossils besides *Ostrea* are determinable in it.

Pulaski county.—At Little Rock there are numerous outcroppings of this limestone formation, and it is frequently met with in sinking deep wells. The most satisfactory collection was made by Dr. Branner in 1887 within the city limits from Dr. Johnson's well on top of Capitol Hill, corner of Battery and 9th Sts. (Station 2218.) These fossils were collected from the earth that had been taken from the well and the depths from which they came could not be determined, but the nature of the matrix in which they are found when compared with that of specimens from known depths at Station 2443 shows clearly that they came from different horizons.

Those that were doubtless first met with are imbedded in a compact, light gray, crystalline limestone, often stained or blotched reddish brown in the immediate vicinity of the fossils.

The forms here recognized are as follows:

Ostrea præ-compressirostra,⁴

Cucullæa macrodonta,⁷

Cytherea,¹⁴

Venericardia planicosta,¹⁰

Protocardia,¹³

Volutilithes.

Those that represent a lower horizon are imbedded in a light yellowish and ash colored friable sandstone. They are:

Ostrea præ-compressirostra,⁴

Turritella mortoni (typical, very abundant),

Actæon,¹⁷

Potamides alabamiensis,²³

Echinoderm spines,³¹

Crab remains.³

The following section was obtained by Mr. E. C. Buchanan* at the northwest corner of Block 3, 19th and Griffith streets,—Howard Adams Addition (Station 2443):

- | | |
|--|---------|
| 1. Red marl..... | 8 feet. |
| 2. Firm, light, yellowish and gray limestone.
Fossils <i>Ostrea</i> and <i>Turritella</i> , red stained
and crystalized..... | 9 feet. |
| 3. More sandy and yellowish than above, with
the same forms of <i>Turritella</i> | 7 feet. |
| 4. Light yellowish white quartzose sand..... | 2 feet. |
| 5. White or light gray quartz sand, cemented
by calcite from the great number of
oysters it contains. Water at 26 feet. | |

The occurrence of a limestone stratum on the Hot Springs road as represented in Fig. 1 has already been referred to. It appears thin and presents no noteworthy features.

Station 2435. Near the site of an old lime kiln just west of the Iron Mountain railway about one-third of a mile north of the county hospital numerous fine casts of *Turritella mortoni* were found in a light yellowish and brownish sandy limestone. The same species together with many small varieties were seen in a compact bed of limestone east of the railway, opposite the hospital in the bed of a small stream.

At the hospital, Mr. Buchanan found the same limestone in a well, 10 feet below the surface.

David Dale Owen describes† these various limestone outcroppings as follows:

"Tertiary limestone and marl show themselves in several places in Pulaski County, viz., on the western outskirts of Little Rock, near the Penitentiary. Limestone has also been struck in some of the wells in the same vicinity; also two and a half miles from Little Rock, near the line between sections 8 and 9. Township 1 north. Range 12 west of

*See section at the right in fig. 1, p. 13.

†Second Report Geological Reconnaissance of Arkansas, p. 73.

the 5th P. M.; also on the northeast quarter of section 18, Township 1 south. Range 13 west, on the banks of Crooked creek; also on the line between the northeast end southeast quarters of Section 8. Township 1 south. Range 13 west, on the Fourche creek near the mouth of Crooked Creek, where it forms a low cliff of compact Tertiary limestone, about eighteen feet exposed. From the quality of the limestone at this locality it would make better lime than any other exposure I have seen in Pulaski county.

In the slope above there is probably a bed of marl; but at present it is covered with vegetation."

Station 2433. The cliff referred to by Owen is, according to Mr. John Olsen, a resident of that vicinity, in 1 S., 13 W., section 8, the northwest quarter of the southeast quarter, near Olsen's switch.

The following sketch will illustrate its principal features:

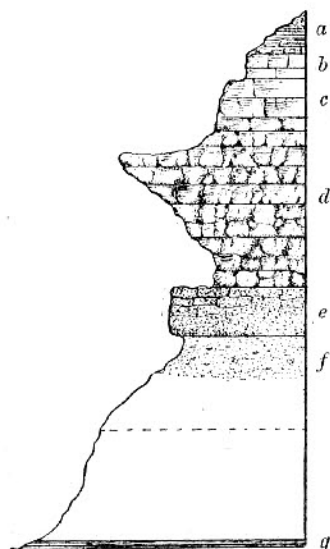


Fig. 4. Section on Fourche Creek, near mouth of Crooked Creek, Pulaski county, Arkansas.

a. Soil.

b. *Enclimatoceras* limestone; yellowish and gray, more or less friable; exterior of fossils often stained brownish by iron

oxide. Replete with *Enclimatoceras ulrichi*, varying in size from 1 to 12 inches in diameter. Thickness, 18 inches.

c. *Ostrea* limestone; compact, light gray limestone; containing innumerable specimens of *Ostrea pulaskensis* n. sp. Thickness, 3 feet.

d. *Turritella* limestone; light yellowish and gray, somewhat sandy; often honeycombed and cavernous, weathering very irregularly; at base especially, replete with *Turritella mortoni*. Thickness 8 1-4 feet.

e. Sandstone ledge, light yellowish, formed apparently by infiltration of waters charged with calacite, into sand like that below. Thickness 2 3-4 feet.

f. White compact sand, tinged yellowish on the exterior; contains scattering blue nodules. Exposed thickness 2 feet.

g. "Black slate, lying nearly horizontal; seen only at times of very low water."—Olsen.

The fossils obtained from this locality are:

- Enclimatoceras ulrichi*,³
- Ostrea pulaskensis* and *præ-compressirostra*,⁴
- Cucullæa macrodonta*,⁷
- Cytherea (Dosiniopsis?)*,¹⁴
- Crassatella*,¹¹
- Crassatella*,¹²
- Protocardia*,¹³
- Venericardia planicosta*,¹⁰
- Calyptrophorus velatus*,²²
- Turritella mortoni*,²⁵
- Turritella multilira*,²⁷
- Potamides alabamiensis*.²³

As nearly as can be ascertained from correspondence with Mr. Ulrich, this is very near the locality where he first obtained the large Nautiloid fossil described by Dr. White as *Enclimatoceras ulrichi*.³ The other forms he collected were

- Ostrea præ-compressirostra*,⁴
- Ostrea pulaskensis*,⁵

Cucullæa macrodonta,⁷
Leda,⁹
Crassatella,¹²
Venericardia planicosta,¹⁰
Protocardia,¹³
Cytherea (Dosiniopsis ?),¹⁴
Corbula,¹⁶
Actæon,¹⁷
Calyptrophorus velatus,²²
Volutilithes,¹⁹
Pyrula,²¹
Potamides alabamiensis,²³
Tubulostium dickhanti,²⁴
Turritella mortoni,²⁵
Turritella alabamiensis,²⁸
Scala,²⁰
Natica alabamiensis,³⁰
Callianassa ulrichi,²
 Shark's tooth,¹
 Echinoderm spines.³¹

Another small collection made at probably the same bluff was that of Mr. N. F. Drake, one of the assistants of the state survey, February 1st, 1888. The locality is given by him as 1 S., 13 W., section 8, southeast quarter of the northwest quarter. The fossils obtained were

Ostrea pulaskensis,⁵
Cucullæa macrodonta,⁷
Actæon.¹⁷

Station 2434. About half a mile to the southwest of Station 2433, a compact gray limestone appears in the bed of a stream just north of the railway track. From it the following fossils were obtained:

Cucullæa macrodonta,⁷
*Cytherea*¹⁴ (*Dosiniopsis ?*),
Crassatella,¹¹

Venericardia planicosta (large),
Calyptrophorus velatus.²²

Saline county.—In 1 S., 14 W., section 9, southwest quarter of the southeast quarter (Station 2233) Mr. A. G. Taff collected a few specimens of highly ferruginous sandstone which contain fragmentary casts of forms belonging to the horizon under consideration. They are

Venericardia planicosta,¹⁰
Turritella mortoni.²⁵

In 1 S., 14 W., section 15, southeast quarter of the northwest quarter (Station 2225) from a bluish slate colored argillaceous limestone matrix, Mr. Taff obtained

Ostrea præ-compressirostra,⁴
Ostrea pulaskensis.⁵

The same collector found in 2 S., 15 W., section 10, the northwest quarter of the southeast quarter (Station 2226), a dark gray limestone filled with fragments of *Ostrea* and smooth polished pebbles.

Mr. Taff also obtained in 2 S., 15 W., section 18, the northeast quarter of the southeast quarter, (Station 2221):

Ostrea præ-compressirostra.⁴
Leda eborea?,⁹
Cytherea,¹⁴
Venericardia planicosta,¹⁰
Calyptrophorus velatus,²²
Turritella multilira?,²⁷
Turritella sp.²⁰
Volutilithes petrosa?.¹⁸

These fossils are for the most part imbedded in a blue clay limestone. One rock fragment is composed of crystalline limestone filled with comminuted shells and a few well rounded pebbles.

In 2 S., 16 W., section 36, the northwest quarter of the northeast quarter (Station 2228) numerous casts were collected from a very light yellowish sandy limestone. They include the following species:

Ostrea pulaskensis,⁵
Cytherea,¹⁴
Venericardia planicosta,¹⁰
Protocardia,¹³
Crassatella.¹¹

The most southwesterly locality from which Mr. Taff obtained fossil remains belonging to this series was in 3 S., 16 W., section 2, the northeast corner of the northwest quarter of the northeast quarter. (Station 2227.) The fossils are imbedded in a light bluish, sandy and clayey limestone and include the following forms:

Ostrea pulaskensis,⁵
Cucullæa macrodonta,⁷
Leda,⁹
Nucula,⁸
Venericardia,
Crassatella,¹¹
Protocardia,¹³
Corbula,¹⁶
Turritella (large *humerosa*-like form),
Volutilithes limopsis ?.¹⁹

Hot Spring county.—Mr. Hill notes the occurrence of a "crystalline limestone, containing marine tertiary fossils" two miles west of Malvern, at the site of old Rockport.* A specimen of similar material was collected by Mr. L. S. Griswold in 4 S., 17 W., section 17, the southwest quarter. It contains among other less recognizable forms:

Cucullæa macrodonta,⁷
Turritella mortoni,
Venericardia.

This locality is the most western known limit of the Midway stage in Arkansas.

From this point westward, then, we cannot at present speak with certainty regarding the lower limit of the Tertiary until

a point in Kaufman county Texas is reached, where Mr. T. W. Stanton collected basal Tertiary fossils as will appear below. The line along which known Cretaceous marine deposits disappear may be and has been traced both in southwestern Arkansas and in northeastern Texas. The proximity to this line of the known Tertiary deposit in Kaufman county, Texas, just referred to, seems to justify us in regarding the real Tertiary-Cretaceous line as not far from the line marking the disappearance of the marine Cretaceous fauna. Yet in the sections of these two states here considered, there may have been an embayment of brackish water, or water unsuitable to the existence of the Cretaceous fauna while the same may have luxuriated elsewhere. In this case a considerable strip of the unfossiliferous sands and clays regarded by Hill and others as Eocene may belong to an older period.

EXTRA-LIMITAL AREAS WEST OF ARKANSAS.

Texas, Station 2440.—The occurrence of the Midway stage in Texas is confirmed by a few molluscan remains recently brought from Kaufman and Travis counties by Mr. T. W. Stanton. Four miles northeast of Kemp, in the former county, this horizon is represented by light gray and yellowish calcareous sandstone containing

*Cucullæa macrodonta*⁷ (in great abundance),
Cytherea,¹⁴
Venericardia planicosta,
Turritella mortoni,
Natica alabamiensis.³⁰

Near Webberville, Travis county, on the Colorado River below Austin (Station 2439) Mr Stanton found a clayey limestone more or less streaked with brown and yellowish shades but usually of a light yellowish gray hue. Chocolate colored siliceous pebbles, generally cuboidal in form, are often found in the more clayey beds. The enclosed shells, nearly always crystalline, are

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 53.

Cucullæa macrodonta,⁷
Leda,⁹
Venericardia,
Venericardia planicosta (as at Station 2436),
*Crassatella*¹¹ (large),
Lithodomus,
Volutilithes?,
 Coral,
 Shark's teeth.

Station 583 (18 miles southeast of Eagle Pass, Texas, first night's camp, October 25, 1887.—C. A. White). The fossils collected here by Dr. White are

Cucullæa macrodonta,⁷
Pectunculus,
Venericardia (See Pl. I, fig. 7),
Cardium (See Pl. I, fig. 8).

The shelly matter of these species is completely crystallized.

The matrix was evidently a calcareous light sand or sandstone.

This place is far to the north of Laredo, where Claiborne fossils are found. Much doubt is felt regarding the Tertiary affinities of some of the fossils, although they were turned over to the writer from the Mesozoic division of the U. S. Geological Survey as non-Cretaceous forms.

TUBULOSTIUM BED.

Where the deposit immediately overlying the limestone formation just described is exposed in Arkansas, it consists of a light colored marly clay. It usually contains scaly flakes of molluscan remains as well as fragments of Echinoderms and Foramenifera, but it is characterized more particularly by the small univalve, called by Dr. C. A. White *Tubulostium dickhauti*.

From Marshall's well, 39 feet below the surface, on Capitol Hill in the city of Little Rock (810 W. 9th St.), Dr. Bran-

ner obtained a considerable amount of this clayey material. It is of a bluish color, and contains less of the comminuted shelly matter than is usual, though the recognizable forms are rather more numerous. They are

Pecten (Pleuronectia) alabamensis,⁶
Cardium,
Corbula,¹⁶
Crassatella,
Leda,⁹
Tubulostium dickhauti,²⁴

Many sea urchin spines, imprints and fragments.

This bed crops out on the Hot Springs road (Fig. 1), immediately above the limestone layer, and also in a ditch at the county hospital.

In the ditch on the south side of the Iron Mountain railway track, about a quarter of a mile due south of Station 2433, this bed appears to a considerable thickness. The larger and more important fossil fragments are in the bottom of the ditch, while above the material is finer and few organic remains can be detected. The upper weathered part of this bed is used as a fuller's earth for refining oil.

This is doubtless the "marl" referred to by Owen in the passage quoted on page 27.

CHAPTER IV.

THE ORGANIC REMAINS OF THE MIDWAY STAGE IN ARKANSAS.

VERTEBRATA.

- (1) Shark's tooth. Pl. I, fig. 1.

Localities:

Station 2230, Cabot, Lonoke county.
Ulrich collection.

INVERTEBRATA.

CRUSTACEA.

- (2)
- Callianassa ulrichi*
- . Pl. I, figs. 2 a and b.

SYN.—*Callianassa ulrichi* White. Proc. U. S. Nat.
Mus., Vol. III, 1880, 161.

Callianassa ulrichi White, Proc. U. S. Nat.
Mus., Vol. IV, 1881, 137, Pl. figs. 10
and 11.

Localities:

Station 2218, Johnson's well, Little Rock.
Ulrich collection.

MOLLUSCA.

CEPHALOPODA.

- (3)
- Enclimatoceras ulrichi*
- . Pl. II.

SYN.—*Nautilus texanus* White, Proc. U. S. Nat.
Mus., Vol. IV, 1881, 137.

Enclimatoceras (Nautilus) ulrichi White,
Bull. U. S. Geol. Surv., No. 4, 1884,
17, Pls. VII, VIII, IX.

Enclimatoceras hyatti? Aldrich. Bull. Geol.
Surv. Ala. No. 1, 1886, p. 60.

This fossil being obviously one of the most characteristic of this horizon both in Arkansas and Alabama, it is deemed

advisable to here insert Dr. White's account of it together with his original description as found in Bulletin No. 4 of the U. S. Geological Survey, pages 16 and 17.

ON THE NAUTILOID GENUS ENCLIMATOCERAS HYATT, AND A DESCRIPTION OF THE TYPE SPECIES.

In the year 1880 Mr. E. O. Ulrich sent to the Smithsonian Institution a small collection of fossils which he had obtained from the Cretaceous strata near Little Rock, Ark. A part of these fossils were described by me in Vols. III and IV of Proceedings of the United States National Museum; but the Nautiloid shell now described was then only casually noticed. Its peculiarities were recognized at that time, and the specimens were laid aside with the hope that better material might be procured for study. Other specimens belonging to this or a closely related species were afterwards collected by Mr. Lawrence C. Johnson from strata supposed to be of Cretaceous age, in Wilcox County, Alabama, but they are no more perfectly preserved than the Arkansas specimens.

Prof. Alpheus Hyatt having had an exhaustive work on *Nautilus* and its allies, the Arkansas specimens were placed with him for examination. In a preliminary work of his, just published he divides the genus *Nautilus* as it has been generally recognized, into numerous genera besides those previously proposed by other authors. To one of these groups he has given the generic name *Enclimatoceras*, and made the species here described the type of the genus. The following is his generic diagnosis, which he has also published in the Proceedings of the Boston Society of Natural History, Vol. XXII, 1884, p. 270.

Genus ENCLIMATOCERAS Hyatt.

"*Enclimatoceras* includes species of the Trias to the Tertiary, inclusive, which are connected by the outlines of their sutures. The whorls are involute from an early stage, and compressed. The abdomens are rounded, but become acute in many species. The sutures have prominent ventral saddles, flatted in species with rounded abdomens, and acute in those with acute abdomens; never divided by ventral lobes. The lateral lobes are deep, and the lateral saddles well marked. The ventral saddles in the young are broad and closely resemble the ventrals of the *Hercoglossæ*, as do also the broad lateral saddles of the later larval stages in some species. There are no annular lobes at any stage in the Triassic, according to Mojsisovics. They do not seem to be present in

some of the Jurassic and Cretaceous species, at least during the early stages, and are very small in some adults. The Triassic species are nearly related to *Grupoceras*, according to Mojsisovics' figures and descriptions in 'Das Gebirge um Hallstatt.' The siphon in this type is a little below the center in the young, though ventral in the adult; and this also agrees with the characteristics of *Enclimatoceras styriacus*, sp. Mojsisovics, of the Trias, and *Grupoceras*. Nevertheless there is no ventral lobe at any stage; the annular lobe is absent in the Triassic forms, and young of later forms; and the siphon in two species is short-funneled, with connective walls, or elliphochoanoidal. Type, *Enclim. (Naut.) ulrichi* White."

Enclimatoceras (Nautilus) ulrichi White.

(Plates VII, VIII, and IX.)

Shell moderately large; somewhat narrowly but regularly rounded upon the periphery in the adult state, and broadly rounded at the sides; whorls almost completely involute, the umbilici being very small; septa somewhat deeply concave; ventral saddles large, prominent, and regularly rounded; lateral lobes broad and moderately deep; lateral saddles prominent and narrow, and rounded at the outer end, and also becoming laterally prominent in the later formed septa of adult shells. The character of the surface is unknown, but it was apparently plain; and the test was moderately thin. In the young state the shell was more globose in form, and the septa were much less deeply lobed.

All the specimens which have yet come under my observation are in the condition of natural casts, and all are imperfect. The best one of these specimens is figured on plates VII, VIII and IX, [Pl. VII only has been reproduced in this work, see Pl. II] together with a fragment showing the inner volutions. The outlines which are added to the figures represent the supposed outline of the aperture of the adult shell.

The diameter of the coil of the type specimen, when perfect, was apparently about 180 millimeters. The greatest transverse diameter about 125 millimeters. Some of the specimens already referred to, which were collected in Alabama by Mr. Johnson, indicate a considerably larger size.

In Vol. I of the Transactions of the St. Louis Academy of Science Dr. Shumard described a form under the name of *Nauti-*

lus texanus, but which he did not figure. Judging from his description, it seems to agree with the form here described, except for the material difference that it is marked by numerous flexuous transverse ribs, while the surface of our form is evidently plain. The difference between *E. ulrichi* and most of the other Cretaceous Nautiloid shells of the United States has now been made generic by Professor Hyatt, and specific comparisons are therefore unnecessary. The collection sent by Mr. Ulrich to the Smithsonian containing the type specimens of this species, also contains representatives of numerous other species, but all of them, like these types, are imperfect. Among them are *Callianassa ulrichi* White, *Tubulostium dickhanti* White, *Gryphæa pitcheri* Morton?, *Turritella*, *Anchura*, *Aximæa*, *Cucullæa*, etc.

The type specimens bear the Museum catalogue number 8349; and permission to use them in the preparation of this article has been given by the Director of the Museum.

The surface of this shell is indeed nearly smooth but the substance of the same is quite thick, say at least one-fourth of an inch in many instances. It will be noticed, moreover that Dr. White regards this as a Cretaceous species. This error was first pointed out by L. C. Johnson in his studies of the Pine Barren region of Alabama in 1883. He showed that the *Enclimatoceras* rock overlies a crystalline limestone holding *Turritellas*, *Carditas*, a *Rosellaria* and other species. (See Bull. 43, U. S. Geol. Surv., 1887, 65-66.)

The section given on page 28 it is hoped will likewise satisfactorily establish its Eocene age in the state of Arkansas.

Localities:

Station 2433, 1 S., 13 W., section 8, northwest quarter of the southeast quarter. Ulrich collection.

PELECYPODA.

(4) *Ostrea præ-compressirostra*, n. sp.

Shell elongate, ovate-triangular; larger valve moderately deep; beak curving to the left as seen from within, sometimes direct but strongly incurving, especially in old speci-

mens; muscular impression large, pyriform, the smaller or exterior terminus turned obliquely towards the beak; margin more or less dentate about the inferior border; within the line of dentations and continuing to the beak is a line of small pits; exterior generally ornamented by radiating somewhat divaricate and imbricated costæ (resembling those of *Ostrea compressirostra* Say.); smaller valve more oviform in outline, shallow; muscular impression corresponding to that in the larger valve; margin crenulate throughout; exterior irregularly undulating, showing lamellar lines of growth. This valve resembles Lea's figure of *O. alabamensis*. The costæ are not so numerous as in *O. divaricata*, nor is the body of the shell so arcuate; differs from *O. compressirostra* principally in its narrower form and strongly crenulate margins. Length, from 2" to 3"; breadth, from 1" to 2".

Localities:

Station 2436, 1 5-8 miles N. of Bradford, St. L., I. M. & S. Ry.
2218, Johnson's well, Capitol Hill, city of Little Rock.
2225, 1S., 14W., section 15.
2433, 1S., 13W., section 8, northwest of southeast quarter.
Ulrich collection.
2221, 2S., 15W., section 18.
2230, Cabot, Lonoke Co.
Prairie Creek, Alabama.
3 miles below the mouth of Pataula Creek, Chattahoochee River, Ga.

- (5) *Ostrea pulaskensis*, n. sp. Pl. I, figs 3a, b, c, d.
SYN.—"*Gryphæa pitcheri* Morton?" White, Proc. U. S. Nat. Mus., Vol. IV, 1881, 137.

Outline of the larger valve rightangle-triangular; a carination from the umbo to the posterior basal margin forming

the hypothenuse, the basal margin the base, and the shorter margin from umbo to base the perpendicular with proportional lengths of 8, 7 and 5 respectively; beak generally very incurving; carination often very pronounced; between it and the margin of the valve are one or two more or less distinct sulci; surface comparatively smooth, though possessing a few slight concentric undulations which, curving upwards in the middle of the valve, form a very shallow sulcus extending from beak to base; muscular impression not distinctly marked; lesser valve thin, flat, circular; marked exteriorly by lines of growth; smooth within with an oval muscular impression which is submarginally located.

This description and the figures referred to, show the most *Gryphæa*-like phase of this species. Other forms are less distinctly sulcate and carinate.

Localities:

Station 2433, 1S., 13W., section 8, northwest of the southeast quarter.

Ulrich collection.

2225, 1S., 14W., section 15.

2227, 3S., 16 W., section 2.

2228, 2S., 16 W., section 36.

- (6) *Pecten alabamensis*.

SYN.—*Pecten (Pleuronectia) alabamensis* Aldrich, Geol. Surv. Ala. Bull. No. 1, 1886, 40.

Locality:

Marshall's well, Little Rock. *Tubulostium* bed.

- (7) *Cucullæa macrodonta*.

SYN.—*C. macrodonta* Whitf., Am. Jr. Conch. Vol. I, 1865, 267, Pl. 27, fig. 17.

This form is quite abundant in the Midway series of Arkansas. The original description of *C. macrodonta* is more applicable to this form than to those from the typical locality, insomuch as the latter possess strong irregular ribbing on the left valve while in the right the sculpturing corresponds

to Whitfield's description and to that of both the valves of the specimens from Arkansas.

Localities:

- Station 2434, half a mile southwest of 2433.
 2218, Johnson's well, Capitol Hill,
 Little Rock.
 2433, 1S., 13 W., section 8, northwest
 of the southeast quarter.
 Ulrich collection.
 2227, 3S., 16 W., section 2.

In Texas it occurs at stations 2440, 2432 and 583; or four miles north of Kemp, Kaufman county, near Webberville, Travis county, and 18 miles southeast of Eagle Pass.

(8) *Nucula* sp.

Cast of a medium sized *Nucula*.

Locality:

Station 2227, 3S., 16W., section 2.

(9) *Leda* (*Yoldia*) *eborea*?

SYN.—*L. eborea* Conrad, Jour. Phila. Ac. Nat. Sci.
 (2), Vol. IV, 1860.

A rather long and inflated form. Possibly two species.

Localities:

- Marshall's well, Capitol Hill, Little Rock.
 Station 2227, 3S., 16W., section 2.
 2221, 2S., 15W., section 18.
 Ulrich collection.
Tubulostium bed at Olsen's clay pits.

(10) *Venericardia planicosta*.

SYN.—*V. planicosta* Lam., Ann. du Mus. Vol. 7,
 1806, 55; Vol. IX, 1807, Pl. 31, figs. 10a, b.

This species assumes in the Midway group a form somewhat at variance with the typical, since the costæ are extremely high and narrow in the umbonal region. They broaden out somewhat toward the inferior margin but still are high and well defined. The surface of these ribs are somewhat corrugated by coarse transverse lines. The

variety here referred to is generally small. The basal margin is generally straight or slightly concave for some distance anterior to the posterior-basal extremity.

Localities:

- Station 2436, 1 5-8 miles north of Bradford,
 on the St. L. I. M. & S. Ry.
 2218, Johnson's well, Little Rock.
 2233, 1S., 14W., section 9.
 2433, 1S., 13W., section 8, northwest of
 the southeast quarter.
 Ulrich collection.
 2221, 2S., 15W., section 18.
 2228, 2S., 16W., section 36.

(11) *Crassatella* sp.

This shell bears more resemblance to *C. aliformis* than to any other American Eocene form. It is however comparatively shorter and deeper, and its entire exterior, save perhaps the post-umbonal slope, is ornamented with even, sharply defined, concentric plicæ like those in *C. flexura* of the Jackson group. There is moreover a shallow, though noticeable depression just anterior to the umbonal ridge as in *C. tumidula* Whitfield.

Localities:

- Station 2434, half a mile southwest of station 2433.
 2433, 1S., 13 W., section 8, northwest
 of the southeast quarter.
 2228, 1S., 16W., section 36.
 In Texas at station 2439 near Webberville.
 In Alabama at station 2441, three miles
 below the mouth of Pataula Creek,
 Chattahoochee River.

(12) *Crassatella* sp.

There is an undescribed form in the Eocene at Prairie Creek, Ala., which is small and short like the present species,

but it has not such well defined thick set concentric plicæ; they consist of broad undulations instead.

Localities:

Station 2433, 1S., 13W., section 8, northwest of the southeast quarter.

Ulrich collection.

2227? and 2228?

(13) *Protocardia* sp. Pl. I, fig. 4.

Usually in form of casts. The impression of an exterior shows that the anterior portion is radiately striate, without such prominent serrations on the striæ as *P. nicoletti* has.

Localities:

Station 2218, Johnson's well, Little Rock, Ark. 2433, 1S., 13W., section 8, northwest of the southeast quarter.

Ulrich collection.

2227, 3S., 16W., section 2.

2228, 2S., 16W., section 36.

(14) *Cytherca* (*Dosiniopsis*?) sp. Pl. I, fig. 5.

In general surface markings and outline this form bears much resemblance to *Dosiniopsis*; but so far as can be ascertained with the material in hand the large anterior tooth is not rugose nor is the cartilage plate granulated. It also lacks the cavity under the beak as described by Conrad for that genus. It also differs from *Dosiniopsis* and more especially from *Cytherca* in having the anterior tooth beneath the lunule so prolonged backward as to actually coalesce with the anterior cardinal tooth. (*Cytherca texana* Dall, has this peculiarity to some extent.)

Localities:

Station 2438, two miles north of Bradford.

2434, half a mile southwest of 2433.

2433, 1S., 13W., section 8, northwest of the southeast quarter.

Ulrich collection.

(15) *Psammobia* sp.

An imperfect cast perhaps belonging to this genus.

Locality:

Station 2436, 1 5-8 miles north of Bradford, St. L., I. M. & S. Ry.

(16) *Corbula* sp. Pl. I, fig. 6.

Internal casts of a small species.

Localities:

Marshall's well, Capitol Hill, Little Rock, *Tubulostium* bed.

Ulrich collection.

Station 2227, 3S., 16W., section 2.

GASTROPODA.

(17) *Actæon* sp. Pl. III, fig. 1.

Casts of a small species.

Localities:

Station 2218, Johnson's well, at Little Rock.

Ulrich collection.

(18) *Volutilithes petrosa*.

SYN.—*V. petrosa* Con., Fossil Shells of the Tertiary Formations, 1833, 29, Pl. 16, fig. 2. Sec. ed. 1835. Cast and impression of a stout variety of this species.

Locality:

Station 2221, 2S., 15W., section 18.

(19) *Volutilithes limopsis*?

SYN.—*V. limopsis* Con., Jour. Ac. Nat. Sci. Phila. (2), Vol. IV. 292, Pl. 47, fig. 24.

Casts of a slender *Volutilithes* probably belonging to this species.

Localities:

Ulrich collection.

Station 2227, 3S., 16W., section 2.

(20) *Scala* sp. Pl. III, fig. 2.

One fragmentary specimen only.

Locality:

Ulrich collection.

(21) *Pyrula*. Pl. III, fig. 3.

Fragmentary specimens, generally in form of casts, including the body whorl and sometimes a spiral one or two. There are no signs of costæ or nodules. A specimen from Prairie Creek, Alabama, is very closely allied to this.

Ulrich collection.

(22) *Calyptrophorus velatus*.

SYN.—*Rostellaria velata* Con., Foss. Sh. Tert. Form. 1833 p. 31; Pl. 15, fig. 4. 2d. ed. 1835.

Specimens referable to this species are generally in the form of casts, and small as at Stations 2433, 2434 and in the Ulrich collection. Dwarfed forms often occur in the same horizon at Prairie Creek, Alabama. At station 2221 they are of normal size and show the shelly structure.

Localities:

Station 2221, 2S., 15W., section 18.

2433, 1S., 13W., section 8, northwest of southeast quarter.

2434, half mile southwest of 2433.

2227? 3S., 16W., section 2.

Ulrich collection.

(23) *Potamides alabamiensis*.

SYN.—*P. alabamiensis* Whitf., Am. Jr. Conch. 1865, Vol. I, 266, Pl. 27, fig. 13.

Generally decorticated and imperfect, though seemingly identical with the Alabama species.

Localities:

Station 2218, Johnson's well, Little Rock.

2433, 1S., 13W., section 8, northwest of the southeast quarter.

Ulrich collection.

(24) *Tubulostium dickhauti*. Pl. III, fig. 4.

SYN.—*Spirorbis? dickhauti* White, Proc. U. S. Nat. Mus. 1880, Vol. III, 16.

Tubulostium dickhauti White, Proc. U. S. Nat. Mus. 1881, Vol. IV, 138, Pl. figs. 12 and 13.

In volume IV of the Proceedings last referred to Dr. White remarks: "Since the description of this species was published (*loc. cit.*), certain fragments have been brought to light which indicate that this shell really belongs to a group for which Dr. Stoliczka in Pal. Indica. Vol. II, p. 237, proposed the generic name *Tubulostium*. Our species is indeed very closely related to his *T. discoideus* (*op. cit.*, Pl. XVIII, figs. 20-25). The tubular prolongation of the mouth is one of the distinguishing features of this group of shells. Our specimens do not show this feature clearly, but it is probable that that portion of the shell has been broken off, as is suggested by the added outline in figure 12."

An impression made in blue clay at Marshall's well (*Tubulostium* bed) is shown on Plate III, figure 4, which proves that the tubular prolongation referred to does exist in the Arkansas species.

Localities:

Marshall's well, and in a ditch by the county hospital, and in fact, almost everywhere that the *Tubulostium* bed exists.

Ulrich collection, probably from the marly layer above the limestone in which most of Ulrich's fossils were found.

(25) *Turritella mortoni*.

SYN.—*Turritella mortoni* Con., Jour. Ac. Nat. Sci. Phila. (1) Vol. VI, 221, Pl. 10, fig. 2.

Localities:

Station 2437, one and a quarter miles north of Bradford.

2435, third of a mile north of the county hospital, Little Rock.

2218, Johnson's well, Little Rock.

2433, 1S., 13W., section 8, northwest of southeast quarter.

Ulrich collection.

2229, two miles north of Bradford.

2230, Cabot.

2233, 1S., 14W., section 9.

(26) *Turritella mortoni* (variety). Pl. III, fig. 5.

Differs from the typical in having the carina at the very base of each whorl, less pronounced and often almost obsolete, giving the shell a cone-like appearance.

Localities:

Station 2438, two miles north of Bradford.

2437, one and three-quarter miles north of Bradford.

2223, two-thirds of a mile north of Bradford.

(27) *Turritella multilira*?

SYN.—*T. multilira* Whitf., Am. Jour. Conch., Vol. I, 1865, 266.

Casts of fragments belonging to this species are not uncommon at the following

Localities:

Station 2433, 1 S., 13 W., section 8, northwest of the southeast quarter.

2221, 2 S., 15 W., section 18.

(28) *Turritella alabamiensis*?

SYN.—*T. Alabamiensis*, Whitf., Am. Journ. Conch. Vol I, 1865, 267.

In the Ulrich collection there are a few specimens that seem to belong to this species. They are possibly a variety of *T. mortoni*.

(29) *Turritella* sp.

Numerous small forms, generally extremely attenuated, and smooth on the exterior are found among larger and better defined specimens at Little Rock, in the stream directly east of the county hospital; also at Station 2221, Saline county.

(30) *Natica alabamiensis*.

SYN.—*N. alabamiensis* Whitf., Am. Jr. Conch. Vol. I, 1865, 265, Pl. 27, figs. 9, 10.

Casts of a *Natica* with prominent shoulder beneath the suture and resembling in size and other features *N. alabamiensis*.

Localities:

Ulrich collection.

Also at Station 2440 below Austin, Travis county, Texas.

ECHINODERMATA.

(31) Sea-urchin spines, also one testa.

Localities:

Ulrich collection.

Station 2227, 3 S., 16 W., section 2.

2218, Johnson's well, Little Rock.

At Little Rock, Marshall's well, and elsewhere wherever the *Tubulostium* bed crops out.

ACTINOZOA.

(32) Coral. Pl. III, fig 6.

Localities:

Station 2223, 2 to 3 miles north of Bradford, on the St. Louis Iron Mountain and Southern railway.

PLATE I.

(All figures natural size.)

- Fig. 1. Shark's tooth from the Ulrich collection, near Alexander, p. 36.
2. *Callianassa urichi* White. Proc. U. S. Nat. Mus., Vol. IV, 1881, plate between pp. 138 and 139. Ulrich collection. See p. 36.
- a. Left manus, exterior view.
b. The same interior view.
3. *Ostrea pulaskensis* n. sp. Ulrich collection; near Alexander. See p. 40.
- a. Larger valve, exterior view.
b. The same, viewed from one side.
c. Lesser valve, exterior view.
d. The same, viewed from within.
4. *Protocardia* sp., from near Alexander.
5. *Cytherea (Dosiniopsis?)* sp., from near Alexander. Station 2433. See p. 44.
6. *Corbula* sp. See p. 45. Station 2227, 3 S., 16 W., section 2.
7. *Venericardia* sp. nov. See p. 34. Station 583, 18 miles southeast of Eagle Pass, Texas.
8. *Cardium* sp. Locality as for Fig. 7.

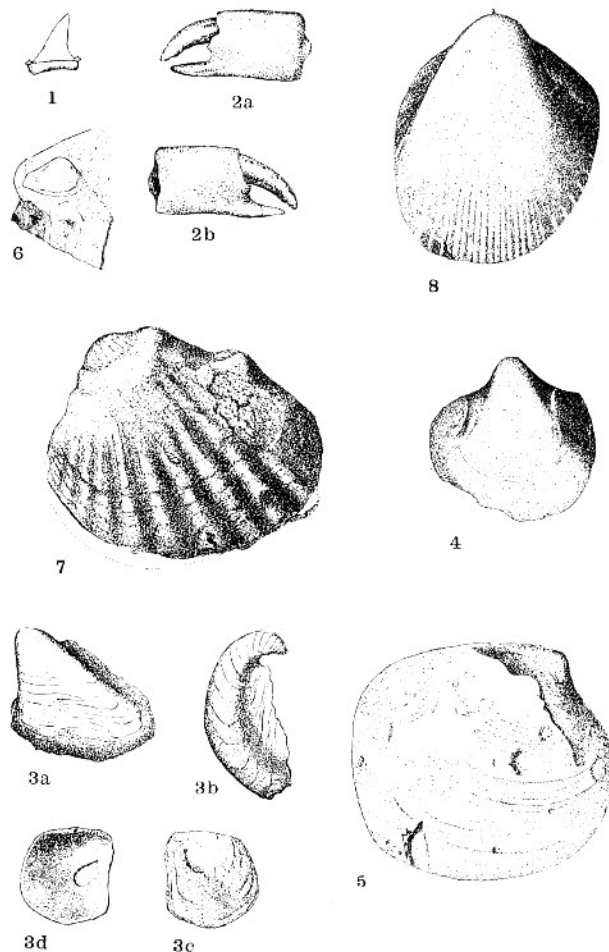
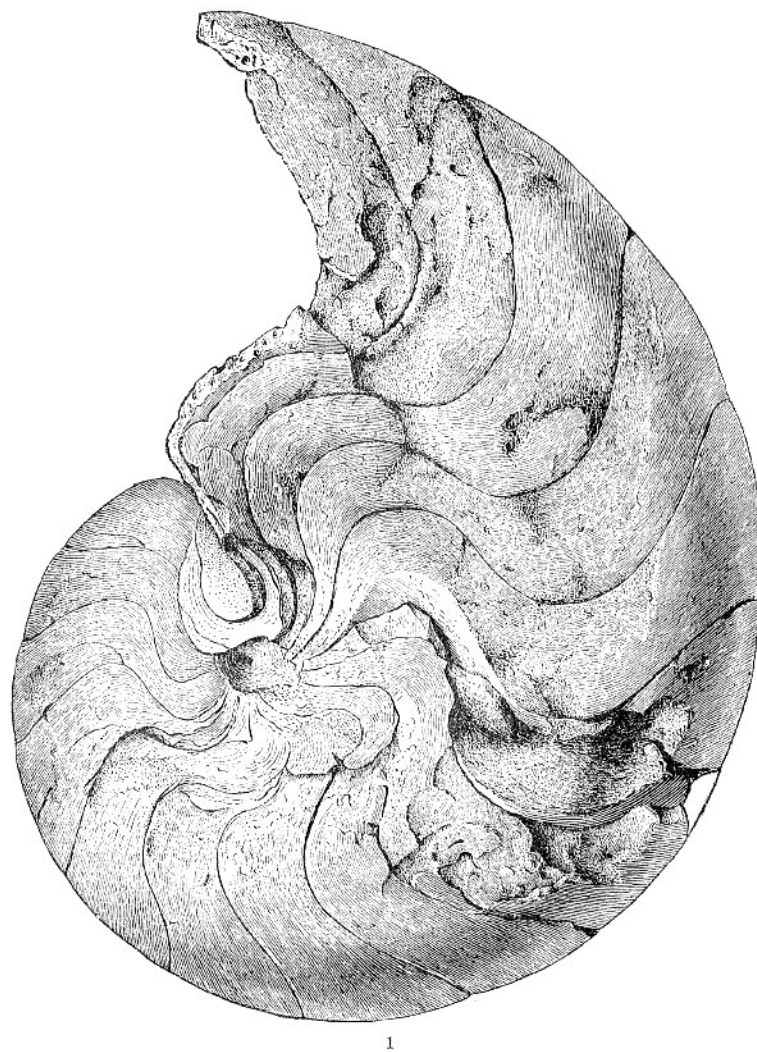
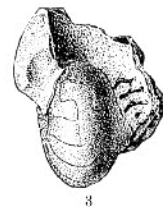
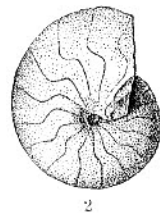


PLATE II.

(Pl. VII of Bull. No. 4, U. S. Geological Survey.)

ENCLIMATOCERAS ULRICHI.

- FIG. 1. Lateral view of the type specimen, four-fifths natural size.
- FIGS. 2, 3. Two views of a fragment, showing the inner volutions.

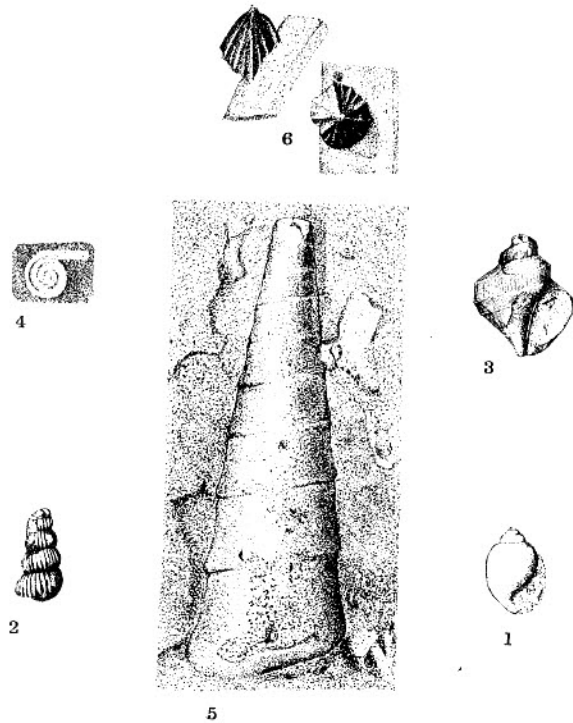


ENCLIMATOCERAS ULRICHI.

PLATE III.

(All figures natural size.)

- Fig. 1. *Actæon* sp. Ulrich collection, near Alexander.
See p. 45.
2. *Scala* sp. Ulrich collection. See p. 45.
3. *Pyrula*. Ulrich collection. See p. 46.
4. *Tubulostium dickhanti* White. Marshall's well,
Tubulostium bed, Little Rock, Ark.
5. *Turritella mortoni* var., one and three-quarter
miles north of Bradford, Station 2437. See
p. 48.
6. Cor.l. Station 2223, two-thirds of a mile
north of Bradford.



CHAPTER V.

THE LIGNITIC STAGE.

The horizons of the Midway and Claiborne stages are separated in southwestern Arkansas by extensive deposits of sand and clay, characterized to some extent by the amount of lignitic material they contain, but more especially by the paucity or total absence of organic remains. In the vicinity of Little Rock there is no good reason for supposing, as will appear later, that these deposits are developed to any great extent, or that they have an extensive areal distribution. On the Ouachita, however, Mr. Hill gives their approximate thickness as 1000 feet, while he finds their "typical development" to be in northeastern Texas. They must of necessity represent, in a general way, the Lignitic stage of Alabama and Mississippi, and this term will therefore be retained and employed in the present report.

The lower limits of the Lignitic stage are indefinite where the Midway is absent or is represented by nonfossiliferous sands and clays, for in such instances there are no criteria whereby to distinguish one from the other or either of them from the uppermost beds of the Cretaceous system. The uppermost limit is more or less indefinite from the fact that deposits regarded as belonging to the Claiborne stage are often, in southwestern Arkansas, quite wanting in organic remains, and moreover, there are no marked lithologic differences between the two stages. Nevertheless it is believed that the lines of demarcation given on the map accompanying this report represent general truths subject only to minor modifications.

SALINE COUNTY.

Alexander Mountain.—It is probable that all of the southwestern third of Saline county is composed of deposits referable to the Lignitic stage, though this cannot be positively affirmed for the writer's observations were limited to a small area just to the south of Alexander. The surface is here rough and broken with ridges rising generally from 100 to 200 feet above the intervening lowlands. Alexander "Mountain" is made up of successive layers of sand and lignitic clay, and is generally capped with a brown or yellowish sandstone containing in some localities many white quartz pebbles. Lignite is said to crop out in various places on the flanks of this ridge but none was observed by the writer.

Fossil leaves.—In the vicinity of Benton, the Geological Survey has collected a number of well preserved fossil leaves from Henderson's clay pit (Township 2 S., 15 W., section 11, the northwest quarter of the northeast quarter). Some of these were recently shipped to Washington, and are now in the Paleobotanic division of the U. S. Geological Survey. Mr. Knowlton of that department in hastily looking over the specimens recognized

Magnolia laurifolia Lx.,

Quercus retracta Lx.,

Quercus moorei Lx.

These species were originally described from the Lignitic of Mississippi. From Hick's pit numerous specimens were collected which are also now in Washington, but unfortunately they have not been identified. These so-called leaves are impressions only, in a light creamy pink colored clay, the texture of which is fine enough to receive and preserve the imprints of the delicate veinlets. The abundance and good state of preservation of these fossil remains lead one to hope that they will at some time be collected in large

quantities, and their chronologic relations with other fossil floras be determined.

GRANT COUNTY.

Little can here be said regarding the geology of Grant county. Mr. Call who had occasion to spend some time within its limits found no traces of animal remains in any of the Tertiary outcrops. These consist usually of ligniferous clays.

CLEVELAND COUNTY.

Well records.—A small portion of the northwestern quarter of this county is doubtless underlaid by Lignitic deposits. Records of well borings at Pinchback's Mills, according to Mr. J. C. Simmes of New Edinburgh, show no traces of molluscan remains. The prevalent materials passed through are sands and dark lignitic clay. In the vicinity of Cross Roads church, about four and a half miles northwest of Kingsland, fossils belonging to the Jackson horizon were found in the form of casts and impressions in concretionary ferruginous sandstone. These will be discussed in connection with the Jackson stage farther on. Wells in the immediate vicinity of Kingsland and to the west are said to pass through 25 or 30 feet of sandy clay of a light yellowish color, and then to encounter bluish clay and sometimes lignite. The clay sometimes continues for 30 feet or more when it becomes soft and sandy and furnishes water in abundance.

HOT SPRING COUNTY.

The Tertiary geology of Hot Spring county has received but little attention. As stated under the head of Midway stage the last recognizable outcrops of that age are in the vicinity of Rockport from which locality westward the boundary lines between the Cretaceous system, the Midway, and the Lignitic stages become obscure and perhaps absolutely indeterminable.

Dr. Branner and Prof. R. E. Call made small collections of fossil leaves from the base of Atchison's clay pit, 4S., 17W., section 24, the southwest quarter, in the vicinity of Malvern Junction. These are in a clay matrix similar to that at Benton. They have been turned over to the Paleobotanic division of the U. S. Geological Survey but up to date have received no attention.

DALLAS COUNTY.

The greater part of Dallas county may for the present be classified as belonging to the Lignitic stage. Doubtless, however, there are beds in the extreme southeastern corner, which are of the same horizon as the fossiliferous deposit at Cross Roads church already referred to, but a demonstration of the fact other than that based on the general trend of the various formations in this region is quite out of the question owing to the lack of paleontologic evidence.

Vicinity of Fordyce.—Proceeding along the railway in either direct or from Fordyce, one may observe in all the more important cuts beds of light slaty blue clay containing fine particles of lignite and impressions of dicotyledonous leaves. Notwithstanding this fact, these beds, for reasons which will appear later, will be classified as Claibornian and treated under that head.

Proceeding northward from Fordyce towards Princeton, few outcrops of undisturbed Tertiary deposits are seen. The rehandled Orange sand division is well displayed in nearly every steep ascent in the roadway and in the ditches on either side, as well as in the banks of creeks and rivulets. It contains many ferruginous tubular concretionary structures like those represented in fig. 9, page 76. In the upper portion of this Orange sand are beds sometimes several feet in thickness which are mainly composed of white, water-worn, chert pebbles. Many sandstone chunks or boulders of considerable size are found in 9S., 15W., section 35, and in 10S., 15W., section 2, that are thoroughly indurated and

serve fairly well for building purposes. They are very ferruginous and appear in every way to be genetically equivalent to those described in this report as capping Alexander and Lone Mountains. Farther west, the hills and dales show a general covering of Orange sand with pebbles until the broad low lands of Tulip Creek and its forks are reached. These lowlands or bottoms average about a mile in width, but are surrounded on all sides by sandy uplands.

Griswold's mill.—On the right bank of Tulip Creek not far below the junction of its east and west forks, there is a low bluff of indurated and concretionary sandstone. This is in 10S., 16W., section 4, about two or three rods above Griswold's mill.* The upper portion of the bluff, which is about 15 feet in height, consists of loose yellow sand layers separated by bands of thin, firm, ferruginous, sandy clay. Below, the material is more indurated and is formed into concretionary masses of from half a foot to ten feet in diameter. More especially in the lower part of this bluff there are greenish particles mixed with the sand, and also traces of lignite. Mr. Daniels, one of the proprietors of the mill, found a "perfect Dogwood leaf" in one of these concretions, and it was reported that sea shells had been found while blasting the rocks at a point perhaps ten feet above the surface of the water. They were described as resembling small clam shells, and if the report be true, they were probably species of *Cytherea*. Several hours of digging and rock breaking at this place, however, failed to reveal a single trace of animal remains.

It is believed that if determinable molluscan species are to be found in the Lignitic of Arkansas at all, they will most probably occur in the southwestern part of this county. Several small areas of red-land were described as occurring in this region but time was too limited to admit of visiting

*For description of this locality see the Annual Report of the Geological Survey of Arkansas for 1892, Vol. I, p. 117.

them. Again, the owner of the farm just south of Mr. Daniels' stated that he had found a hog's tusk in his well at a depth no less than 25 feet below the surface. This, if a tooth at all, was probably that of a shark and would indicate that at least some forms of marine life were able to exist in the brackish waters that characterized the Lignitic age.

Lignite.—Lesquereux described a deposit of lignite visited by him on Little Cypress Creek, Dallas county, on the property of Mr. Watson.* This material is said to occur in various places within the limits of Dallas county, but its significance is so slight either from an economic or scientific point of view that no time was spent in visiting its rumored outcrops.

CLARK COUNTY.

The region about Arkadelphia was studied by the writer, and no traces of Tertiary deposits were found. Owen says little regarding the Tertiary geology of Clark county. On page 121 of his Second Report of a Geological Reconnaissance of Arkansas, he remarks: "A considerable proportion of the northern part of this county, that is in range 6, is based on Tertiary limestone." This is certainly a mistake since that district is known to be occupied by older formations.

Cretaceous outcrop at the mouth of De Roche—Mr Hill refers to a "small patch of alternating sands and lignites, which probably belong to the base of the Camden [Eocene] series."† He says "They consist of 100 feet of alternating sands and lignites resting directly upon the upturned edges of the paleozoic rocks. This is an isolated patch which has been cut off from the main body of the formation by the erosion of the Ouachita. No cretaceous strata intervene between the paleozoic and cenozoic, at or north of this point."

*Second Report of a Geological Reconnaissance of Arkansas, page 318.

†Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 58.

In Dr. O. P. Hay's report in the same volume (page 265) he refers these sands and lignites to the "mesozoic" and says that their westward extension cannot be determined on account of the thick layer of post-Tertiary gravels and clays that overlie them.

This section, referred to by Hill and Hay, was recently visited by the writer. It is more or less obscured by underbrush and debris, but presents, as nearly as can be determined the following beds:

1. Steep sloping hillside, composed mainly of sand..... 25-30 feet.
2. Ferruginous conglomerate, pebbles of nearly all sizes, shapes and colors, firmly cemented below, loose above; with Cretaceous fossils..... 2 feet.
3. Lignite..... 2 feet.
4. Light yellowish sand..... 12 feet.
5. Lignite..... 4 feet.
6. Sand (not well exposed).. 15 feet.

This Cretaceous deposit evidently extends uninterrupted to the Caddo, for the ferruginous conglomerate was met with in digging a well along the main road about half way from the De Roche to that stream. Near the mouth of the Caddo it forms bluffs from 30 to 50 feet high, and in its more calcareous layers contains well preserved Cretaceous fossils.

Cretaceous conglomerate at the mouth of De Gray Creek.—Farther to the west, on the banks of the De Gray, near its mouth, fragments of Cretaceous conglomerate are strewn over the Paleozoic rocks in great abundance. They contain pebbles precisely similar to those strewn loose over the same region; in fact, it is the writer's belief that they all belong to one and the same period. Some are composed almost entirely of these pebbles and barely cohere, while others consist of highly ferruginated sands with only a few

pebbles. When there is cementing material enough to retain molluscan impressions, they can generally be found. They include besides numerous small bivalves:

Cyprimeria, sp.,
Cardium eufalense,
Crassatella sp.,
Turritella trilira,
Liopeplum? sp.

These fossils exist in the form of casts only. They, together with the ferruginous conglomerate containing them, indicate the nature of the old Cretaceous sea beach of which they formed a part.

Owing to the fossiliferous character of these shore deposits, it can now be said that they are not post-Tertiary* nor are they Lafayette unless that formation be so extended as to include the greater part of the Neozoic.

Relative to the Geology of this county farther down the Ouachita, Mr. Hill makes the following observations:

1. Mouth of L'Eau Frais.—A clay shale formation, "the structure of which in every detail, except that of consolidation, is the counterpart of that seen in the more ancient shales of the earlier geologic formations; * * * when dry this clay shale weathers into fine scales of a slate blue color."

2. Section at Manchester Landing, Ouachita River.—

1. Blue and drab, finely laminated, micaceous sands. 3 feet.
2. Very dark blue, or, when wet, dense black clay shales. When dry these shales are light blue, and covered with a white efflorescence, like those at Nashville. They are the same as those at the mouth of L'Eau Frais ... 5 feet."

3. At the mouth of Big Deciper.—A bluff of 100 feet.

Its "beds consist of fine micaceous sands, laminated in the upper two-thirds, and alternations of arenaceous and black clay layers at its base, which are more fully described in the L'Eau Frais section."

For further information on the geology of Clark County, see pp. 15-19 of this report.

OUACHITA COUNTY.

Owen's remarks.—The observations of Owen regarding the physical features of Ouachita county* relate chiefly to kinds and fertility of soil, forest growth, and general topographic features of the localities he visited. Special attention is given to the lignite of the Camden Coal Mining Company in 5S., 18W., section 12, for there a bed six feet thick occurs, easy of access and supposed to be of value on account of the crude oil it contains. No definite statement is made regarding the series or system to which the rocks of this county belong, though it is said† that "There are no black, Cretaceous lands, in Ouachita," and that "Tertiary? sandstones and shales, associated with the Lignitic bed" are noted in the vicinity of 12S., 18W., section 30.

Mr. Hill's observations in this county were apparently limited to the outcrops along the course of Ouachita River from Camden northward.‡

The writer examined, (1) the lignite deposits referred to by Owen as stated above; (2) the various outcrops along the Ouachita River south of Camden; (3) the exposures along the Camden and Alexandria railway; and (4) those along the St. Louis Southwestern railway.

From the above three sources therefore the following statements regarding the geology of Ouachita county are obtained:

*Second Report of a Geological Reconnoissance of Arkansas, pp. 128-133.

†Op. Cit. 133 and 280.

‡Annual Report of the Geological Survey of Arkansas for 1888, pp. 50-51.

Mouth of Little Missouri.—About 200 yards below the junction of the Little Missouri and Ouachita Rivers the following section was observed by Hill:*

1. River deposit of yellow alluvium..... 20 feet.
2. Quarternary ironstone and iron conglomerate, evidently the result of the ferrugination of the underlying gravel and sand..... 6 feet.
3. Alternating lignitic and sandy laminae, of the same structure as No. 3 of the Camden section.
4. Chocolate colored micaceous sands of very fine texture..... 1 foot.
5. Alternating lignitic and arenaceous laminae, as in No. 3, to water..... 8 feet.

“The dip is here distinctly southeastward, which would carry the beds of this section, which are of later age (except the uppermost two members), far beneath the Camden exposures.”†

Ten miles below the mouth of the Little Missouri, Mr. Hill found bituminous sands and lignites, dipping in apparently the same direction as the Cretaceous beds at Arkadelphia, “showing that there is no considerable nonconformity of direction between the dip of the Cretaceous and that of the Tertiary.”‡

The coal mine.—At the coal mine 12S., 18W., Section 12, Owen obtained the following section:

Sand and ferruginous sandstone.....	20 to 30 feet.
Ash colored clay	6 to 7 feet.
Lignite	6 feet.
Pipe clay with segregations of limonite ore. Light gray sandy clay, somewhat ferruginous.....	}

The lignitic stratum he found to be 50 feet below high water of the Ouachita.||

*Op. Cit. p. 51.

†Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 51.

‡Ibid.

||Second Report of a Geological Reconnaissance of Arkansas, 1860, p. 120.

This was probably the same locality visited by the writer; and Mr. Richmond Hibbard who resides at that place says it is in the northeast quarter of the above mentioned section. The following outcrop is at present visible:

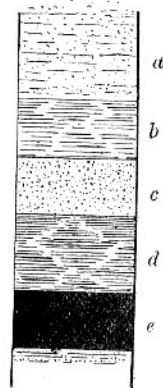


Fig. 5. Section at the old mine of the Camden coal company, Ouachita county, Arkansas.

- | | |
|---|---------|
| a. Arenaceous material, not well exposed..... | |
| b. Light pinkish clay | 6 feet. |
| c. White sand | 6 feet. |
| d. Bluish clay | 8 feet. |
| e. Lignite | 6 feet. |

The bed of lignite here represented is unbroken by sand or clay partings but vertical joints passing in a north-northwest and south-southeast direction stained with iron oxide are numerous. Its color is more nearly that of true coal than that of any other lignitic deposit seen by the writer in the state. It is generally dull black though streaks from one quarter to three quarters of an inch thick of hard shiny matter are not uncommon.

There is a new opening into this bed, in 12S., 18W., section 14, the northwest quarter of the southeast quarter, which is, according to Mr. Hibbard, very nearly or quite on a level with the old opening. Other outcrops of this bed are said to occur in sections 2, 11 and 13.

The only fossils found in this vicinity by the writer were leaves, or their impressions, in a sandy, indurated, and highly ferruginated matrix. Numerous chunks taken from the new opening were seen to be literally packed with scaly, leaf-bearing layers.

The surface of this district is rendered exceedingly rough by the obdurate character of numerous sandstone beds which are underlaid by more yielding clays and sands. The absence of Orange sand is noteworthy.

The same general group of deposits doubtless obtains in 12S., 18W., section 30, where as stated above, Owen found "Tertiary" sandstone and shales, associated with the lignitic bed.*

Geology about Camden.—The vicinity of Camden is extremely interesting from a geological point of view, in that it furnishes the most extensive outcroppings of the Lignitic stage known in Arkansas. On account of these extensive and typical exposures, Hill has given the name "Camden series" to all the deposits recognized by him in southwestern Arkansas as belonging to the Tertiary system.†

The most striking feature regarding these outcrops is the preponderance of arenaceous material. To be sure there is more or less agillaceous matter scattered through nearly all the beds, and to this constituent doubtless the permanence and perpendicularity of many of the bluffs are due; but the few purely clay beds are comparatively insignificant and grade out laterally into almost pure sand. Lignitic matter is often present to such an extent as to give the surface of an outcrop a dark gray color, but this material will generally be found upon close examination to be finely comminuted and mixed with a much greater amount of white fine quartz sand. This peculiar feature is remarkably pronounced all along the ravine in the south central part of the town crossed by both the St. Louis Southwestern and

*Sec. Rep. of a Geological Reconnaissance of Arkansas, 1860, p. 230.

†Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, pp. 50, 188.

the Camden Division of the St. Louis, Iron Mountain and Southern Railways. Both above and below the lower terminus of this ravine there are high bluffs along the right bank of the Ouachita which are difficult of ascent, and often perpendicular. This is especially true of those just below, where they rise about 70 feet above the river at a mean stage.

On account of the importance attached to these exposures by Mr. Hill who regards them as typical for the Tertiary system of southwestern Arkansas his section is here reproduced, being longer and more varied in its component materials than any the writer was able to obtain. Its exact location he unfortunately omitted.

Section No. 1. Bluff on the Ouachita River near Camden:*

1. Surface soil (residuum of substructure) ferruginous, sandy 5 feet.
2. Laminated sand with green sand specks, originally white, but ferruginating and cementing into red iron sandstone, with a tendency to shaly disintegration on exposure 32 feet.
3. Little Missouri Lignites, or lignitic shales, with white sand between layers, of the same character as those seen at the mouth of Little Missouri 20 feet.
4. Buff-colored micaceous sand and clay shales changing on exposure to pink and light yellow. (The same as those seen in the deep gulches at Camden.) 10 feet.
5. Bituminous shales, with bituminous masses, and asphalt-like concretions, resembling the so-called "nigger-heads" of the Mississippi Tertiary. This stratum is full of concretions of iron pyrites which oxidize on exposure, coloring the neighboring strata red 15 feet.

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, p. 50.

6. Light drab, fine, micaceous sands or sandy clays, finely laminated. (The exposures were moist when seen.) 25 feet.
7. Concealed 25 feet.
8. Repetition of No. 6 to the water line 10 feet.

Interspersed in the sandy deposits about Camden are thin hard shelly laminae caused by the great amount of iron oxide they contain. They are particularly abundant in the upper portion of the exposures as in the cuts on the St. Louis Southwestern Railway just north of the trussle over the ravine referred to on page 62 as well as all along in the cuts on the Camden Division of the St. Louis, Iron Mountain and Southern Railway from Camden north for two or three miles. The Orange sand in these cuts is mainly composed of broken fragments of this ferruginous matter. Sometimes, however, the material has been so little disturbed that no line can be satisfactorily drawn between the first deposition and the rehandled Orange sand.

Frenchport.—In passing down the Ouachita River* at a rather low stage of water November 24, 1891, no deposits were seen that could be regarded as Tertiary until Frenchport, about 16 miles below Camden (by river) was reached.

The right bank of the river at this place is about 30 feet in height and consists mainly of Pleistocene deposits, though just at the water's edge was observed a bed of gravel, whose thickness could not be determined, composed of cherty pebbles and resembling in every way the gravelly deposits found along the Saline River immediately overlying the undisturbed Tertiary marls. The next outcrop seen was at Walnut Bluff, about six miles by river farther down stream; but as its fossils indicate for it a Claiborne age it will be described in a subsequent chapter.

*By row boat; accompanied by Prof. T. C. Hopkins of the State Geological Survey for whose kind and efficient assistance the writer is under much obligation.

Cuts on the Camden and Alexandria Ry.—Between the station of the Camden and Alexandria Railway and its junction with the St. Louis Southwestern Railway there is a cut which may be thus represented.



Fig. 6. Cut on the Camden and Alexandria Railway about a half mile south of the station at Camden.

The lower 2 feet of this section are composed mainly of white sand but with enough fine carbonaceous material to produce a dark gray or black appearance. There are, however, a few thin yellowish and gray laminae observable. The lines of bedding are more or less curved.

Above this highly carbonaceous bed the material is much lighter in color and the gray and light yellowish streaks each one inch thick, alternating, form the upper part of the cut excepting the top soil which is red. Near the south end of this cut there are a few light pink clay layers intercalated between the yellow and gray sandy laminae.

Farther to the south along this railway and within the bounds of Ouachita county there are numerous shallow cuts showing Tertiary formations. The latter are characterized by their extreme arenaceous character, and are of a light yellowish or red color. The same difficulty will be experienced here as in many of the cuts north of Camden if one attempts to discriminate between undisturbed and rehandled (Orange sand) material.

Cuts on the St. Louis Southwestern Railway.—Proceeding along the St. Louis Southwestern Railway a few

yards from the junction of the Camden and Alexandria Railway, one will observe a bank presenting the following appearance.

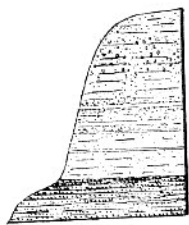


Fig 7. Section on the north side of the St Louis Southwestern Railway a few yards southwest of the Camden and Alexandria Railway junction near Camden, Ark.

The Yellowish color of these sands is doubtless due to weathering for there are numerous limited areas where this process has not proceeded to such an extent and the original bluish gray color remains. Thin streaks of laminae of pinkish clayey sand are not unfrequent. The pebbles here mark no line of unconformability; they are simply scattered about in the upper portion of the section.

Still further to the southwest along this line of railway numerous exposures were observed and recorded, many of which seem scarcely worthy of mention in this place, yet for convenience in reference they are here briefly enumerated and described.

A quarter of a mile from the railway junction referred to above, the following section was observed:

1. Yellow sand 18 inches.
2. Reddish and yellowish sand, few white pebbles 24 inches.
3. Yellowish, grayish and pinkish sands 38 inches.
4. White sand streaked with fine lines of pinkish sandy clay, quite micaceous 38 inches.

A quarter of a mile still further to the southwest the two lower layers of this section appear, but are more or less

concealed by Orange sand composed of gravel which consists of broken or ferruginous arenaceous Tertiary laminae.

One and three fourths miles from the junction a cut presents the following section:

1. Yellowish and blackish sands 4 feet.
2. Grayish sand with yellowish blotches, eroding irregularly 3 feet.

Three and a half miles from the railway junction a cut of 10 feet shows a fairly homogeneous mass of what was formerly a light bluish gray sand, but is now much streaked and blotched with red and brown. A few white pebbles are scattered about in the upper part of the section, but whether the whole or a part should be regarded as Orange sand is not known. The last described deposit appears along the roadside at various places, up to a point three and three quarter miles from the railway junction. In a few instances it is capped with ferruginous fragmentary Orange sand, but is particularly interesting from the numerous hollow vertical concretions it contains. These consist of ferruginous matter, and are perhaps of a comparatively recent origin. They may have been formed around the roots of trees, which, having decayed, left no other trace of their existence.

Four miles from the railway junction in the ditches at the sides of the track, beds of light yellowish or bluish, fine sandy compact clay outcrop. They are composed of layers from a quarter of an inch to one inch in thickness, often separated by thin ferruginous laminae. The clay breaks up in irregular fragments, and sometimes presents lignitic matter enough to give the whole mass a slightly brownish tinge. Higher up in the cut, this clay is stained reddish by iron oxide, and still above, rehandled Tertiary material appears consisting mainly of Tertiary ferruginous gravelly fragments among which are a few white chert pebbles; 150 yards farther west, only the reddish or yellowish sandy clay

appears and is there characterized by the hollow vertical ferruginous concretions. In one instance there is a layer of sandstone extending along the cut as shown in Fig. 8, through which the concretionary structures do not pass. The various beds here lie very nearly or quite horizontal. Still farther southwest the lower part of the bed

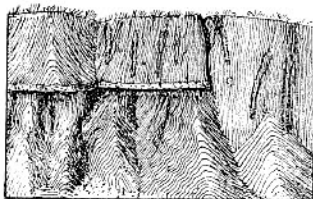


Fig. 8. Section on the St. Louis Southwestern Railway about four miles west of the junction with the Camden and Alexandria Railway.

represented in the above figure as yellowish or grayish clayey sand becomes very arenaceous and carbonaceous like the basal bed represented in Figs. 6 and 7.

Four and three quarter miles from the railway junction a cut shows the following beds:

1. Reddish and pebbly sandy soil 18 inches.
2. Ferruginous band 1 inch.
3. Grayish and yellowish sand 30 inches.
4. Ferruginous band 2 inches.
5. Grayish clayey sand with yellow streaks ... 36 inches.
6. Blackish sandy clay with lighter streaks.... 30 inches.

The lowest member (6) contains yellowish sulphurous spots or blotches probably due to the decomposition of iron pyrites. This locality is about 150 yards west of the 343 mile post.

Six and a half miles from the railway junction, about (250 yards west of the 344th mile post, and at section house No. 48), there is a shallow cut showing gray sandy beds dipping at the rate of 1 in 15 to the west. They are overlaid by red sand and Tertiary gravel. Two hundred

yards farther west the same beds appear without any appreciable dip.

Seven and two third miles from the railway junction (a fifth of a mile east of the 346th mile post) is a long cut about 10 feet deep consisting of grayish sand, blotched deep red in places and containing hollow vertical concretions.

Eight and a third miles from the railway junction is a cut showing at its eastern termination, at base, a solid bed two feet thick of grayish sand, sometimes reddened from exposure. Stratigraphically above and nearer the middle of the section, rest evenly and alternately bedded, light bluish clays and yellow ferruginous crusts. Still above and nearer the west end of the cut these clays seem to grade into brownish sandy clays with very numerous white sand partings. These beds extend to the top of the bluff. Near the eastern end of the cut the dip is to the east, but at the western end it is to the west, forming accordingly a slight anticlinal fold.

Eight and three quarter miles from the railway junction there is a cut in which white pebbles pass beneath at least twelve feet of heavy gray sand.

Nine miles from the railway junction, (347th mile post) are grayish and slightly brownish and sandy clay like that four miles from the junction described on page 71. It contains numerous leaf impressions and lignitic fragments. The dip is slightly eastward sufficient to carry this clay beneath a gray sand outcrop some yards to the east. This sand is separated by ferruginous partings as was the case with the sands overlying the clay bed at the four mile station referred to.

Nine and a quarter miles from the railway junction there is a cut about 200 yards long; a typical section of which is as follows:

1. Reddish sand, with fragments of ferruginous re-handled Tertiary material, becoming grayish

- with red blotches, the latter disappearing below..... 8 feet.
2. Generally a bluish gray sand, yellowish in spots, with a very few irregular laminæ of ferruginous material 5 feet.
 3. Brown and gray sands with ferruginous partings, the latter becoming thinner below, where finally the whole bed consists of compact, laminated clayey sand with yellowish white sandy partings. At base a slightly brownish black..... 7 feet.

There is a general southeast dip in this cut of not less than one to one hundred and perhaps double that amount, and there are also slight undulations.

Another cut a half mile farther to the southwest presents the following strata:

1. Yellowish soil and sand with a few white pebbles 3 feet.
2. Yellowish and grayish clay sands becoming bluish and grayish below 4 feet.
3. Bank of solid unlaminated bluish gray (red blotched) sand containing rare white pebbles..... 6 feet.

Nine and seven eighths miles from the railway junction in a cut the easterly dip continues and amounts to one in twenty-five. A heavy sand bed appears at the eastern end, but light gray clays with conchoidal fracture soon appear beneath it and in the middle of the cut compose the whole outcrop. There are irregular jointings in these clays which are coated with red iron oxide.

A few yards further to the west a cut appears with blackish lignitic sands at base and the section becomes a duplicate of that at the preceding station.

Ten miles from the railway junction there is a cut 12 feet deep showing a distinct eastern dip. It is divisible in two well defined beds:

1. Red unstratified clayey sand with some ferruginous Tertiary gravel 6 feet.
2. Sand with gray and red parting 6 feet.

A quarter of a mile west of Buena Vista (*Senter* of the old maps), a cut occurs 200 yards in length, a typical section of which is as follows:

1. Clay like that below, but reddened by exposure 1 to 3 feet.
2. Light gray clay with red blotches..... 4 feet.
3. Slightly brownish gray clay with more or less conchoidal fracture and with vertical fractures stained with yellow 3 feet.

The lowest bed is very variable in color, appearing nearly black in some places and containing more or less finely comminuted lignitic material. This cut exhibits a slight anticline, but in the main the strata dip to the west about one to one hundred.

A mile and a half west of Buena Vista a cut gives the following section:

1. Reddish sandy clay 3 feet.
2. Evenly bedded, yellowish, ferruginous material, with gray and red partings 2 feet.
3. Brownish yellow sands, irregular lines of bedding marked by white sand partings 2 feet.
4. Cross bedded yellow sand 2 feet.

A mile and a half west of Buena Vista an exposure occurred as follows:

1. Red, slightly stratified sand and clay with some Tertiary gravel 3 feet.
2. Light gray, sandy clay with numerous specks and blotches of red 3 feet.

Two and a half miles from Buena Vista there is a cut 10 feet deep composed of solid red sandy material with lines of bedding dipping one in three east.

Three miles from Buena Vista a cut of about 12 feet occurs. The soil is reddish; lighter and more distinctly laminated for five feet where it consists almost entirely of a white sand with yellow partings; farther below it is brownish and sulphurous and at the base it consists of black micaceous sands.

Three and three quarter miles from Buena Vista the main features of the cut are those shown in Fig. 9. The line of white pebbles is usually found on the eroded surface of the undisturbed sedimentary Tertiary. Here it appears in the midst of a heavy bed of orange colored sand. The depth of this section is about 10 feet. The upper surface is covered by 1 foot of red soil. At the left and base there are nearly horizontal layers of coarse yellowish sand.



Fig. 9. Section at a cut on the St. Louis Southwestern Railway three and three quarter miles southwest of Buena Vista, Ouachita county, Ark.

Five and three quarter miles from Buena Vista there is an exposure of light, thin bedded clayey sands, with traces of dictyledonous leaves. At the western end of the exposure some beds become black, and support a dense growth of grass as the lignitic beds often do.

Six and a quarter miles from Buena Vista is a cut showing the following beds:

1. Red massive sand bed 6 to 10 feet.
2. Bluish massive sand bed 3 to 6 feet.

The lower bed is often clayey and red blotched. At the western end of the cut a bed stratigraphically beneath this appears. It is a reddish sand, underlaid by a layer of white pebbles.

Seven and two thirds miles from Buena Vista is an exposure indicating the presence of a slight fault. (Fig. 10.) *a*, Loamy filling in what seems to have been a creek channel; *b*, Light colored clay sand; *c*, heavy bed of yellow sand; *d*, Compact clay sand. The whole exposure is about 10 feet in vertical section.

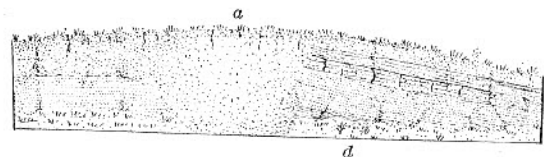


Fig. 10. Section at a cut on the St. Louis Southwestern Railway seven and two thirds miles west of Buena Vista, Ouachita county, Ark.

Between this point and Stephens, other cuts were seen, but they presented no features worthy of special mention.

The village of Stephens occupies the northeast quarter of 15S., 19W., section 28. In a well boring made at this place a bed of black lignitic material 6 feet thick was said to have been met with at a depth of 30 feet. A cut along the railroad 15 feet deep shows only a solid bed of reddish sand in its eastern portion, while in its western extremity light clays appear and a few white pebbles occur on the surface.

Two thirds of a mile west of Stephens is a long cut giving at its eastern termination the following section:

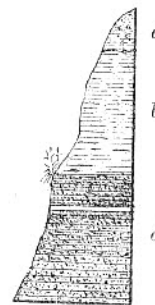


Fig. 11. Section at a cut on the St. Louis Southwestern Railway, two thirds of a mile west of Stephens, Ouachita county, Ark.

The line of demarcation between the undisturbed strata

and the Orange sand is here very well defined. The reddish sand *a*, contains numerous white pebbles and rests upon the irregularly eroded surface of the evenly laminated Tertiary *b*. Near the western end of the cut, however, the dark color of the lower carbonaceous layer *c*, fades out and the layers appear as light gray clayey sands with yellow and red ferruginous partings, while still further west the whole assumes a massive reddish appearance and contains white pebbles and vertical, ferruginous, cylindrical concretions.

COLUMBIA COUNTY.

Cuts along the St. Louis Southwestern Railway.—Continuing our observations along the line of the St. Louis Southwestern Railway, and passing from Ouachita county into Columbia county, the first outcrop worthy of mention is about 150 yards from the 363d mile post, or about 6 miles from Stephens. This outcrop consists of a cut about 14 feet deep; in the lower part of which is a heavy bed of blue clayey sand channeled out as represented in Fig. 12. In the bottom of this channel are quartz pebbles above which lies a bed of Orange sand.



Fig. 12. Section on the St. Louis Southwestern Railway, six miles west of Stephens, Columbia county, Ark.

Nowhere in this county are better exposures than those in the vicinity of a station called Magnesia Springs about two miles east of McNeil. The banks of a small rivulet at this place are often perpendicular and show 15 feet of blackish, lignitic, clayey sand finely laminated, with white sand partings. The numerous cuts along the railway in this vicinity

show very unevenly bedded sands and clays, some of which are represented in the following sketches:

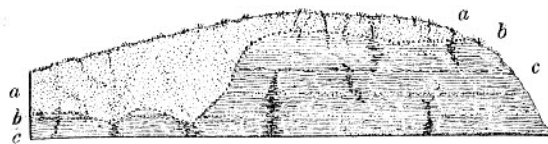


Fig. 13. Section of a cut on the St. Louis Southwestern railway near Magnesia Springs, Columbia county, Ark. (a) Deposit of massive Orange sand; (b) pebbles; (c) sand of a yellowish red color.



Fig. 14. Section on the railway in the immediate vicinity of Fig. 13. (a) Soil and clay; (b) lignitic clay; (c) ferruginous sand.

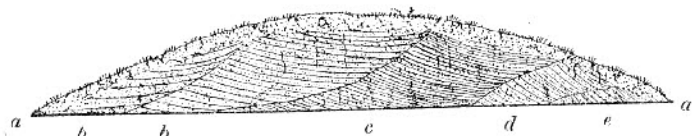


Fig. 15. Section just west of those numbered 13 and 14. (a) Reddish sand and soil; (b) reddish sand with white partings; (c) sandy clay; (d) orange colored sand; (e) clay.

Along the railway westward from McNeil are many cuts, but none of them present features worthy of special mention. There is in general a lack of any features whereby one may determine whether they should be regarded as of primary or secondary Tertiary deposition. The same remarks are equally applicable to the outcrops along the Magnolia branch road. Quartz pebbles are more abundant in the upper portions of the exposures where the material is most completely oxidized.

From Magnolia to Mars Hill.—In going westward from Magnolia to Mars Hill, one passes over a low wet country

for a distance of about five and a half miles when the surface becomes undulating, and white quartz pebbles appear in numerous exposures. On the Lamartine road there are many outcrops of Orange sand with white quartz pebbles. For two or three miles east of Dorcheat Creek the surface is quite level. From this point to Mars Hill no outcrops were seen that could be regarded as Tertiary beyond a doubt. Wells furnish no other material than a red, somewhat clayey fine sand similar to the Pleistocene exposures along Red River.

From Magnolia to Mt. Holly.—Northeast from Magnolia, towards Liddesdale few exposures occur. A highly ferruginous sandstone however was noticed by the roadside about one mile from Magnolia. It is granular in texture and noticeably micaceous. White pebbles are frequently met with along this road. A cut about 5 feet deep two and a half miles from Liddesdale shows a bed of massive, yellowish red and some gray sand with vertical hollow reddish concretions like those shown in Figs. 8 and 9. Two and a half miles northeast of Liddesdale, on the road to Mt. Holly an exposure of lignitic clay occurs. It is of a light gray color, contains fine particles of brownish colored lignite, is interstratified with light sandy layers, and is immediately overlaid by a pebble bed.

Peace ford.—In the southeastern part of the county where the Shuler-Atlanta road crosses the Big Cornie Creek (Peace ford) there is an Eocene exposure of five feet which shows beds extremely similar in their lithological appearance to the outcrop at Walnut Bluff, Ouachita River (See fig. 33). The various beds appear as follows:

1. Reddish soil..... 14 inches.
2. Light gray, slightly yellowish sand..... 9 inches.
3. Brownish lignitic or micaceous clays, breaking up into fibrous fragments without distinct lines of bedding though inter-

persed with a few yellowish ferruginous laminae 42 inches.

4. No. 3 passes down into a black wet sandy clay to the water's edge. In this there are light colored concretions, apparently calcareous, strongly resembling those of the upper bed at Vince's Bluff, though not more than from three to twelve inches in diameter.

No. 4 reappears about 150 yards farther down stream, where it is no less than 14 inches above water level at medium stage. It can be seen for at least twelve inches below. Its concretions average from 6 to 12 inches in diameter. Another exposure of this bed occurs about 400 yards farther down stream. At the two latter localities there is a dip of one to twenty-five to the southeast. Fossils were diligently sought for in these apparently more or less calcareous concretions, but to no avail.

Atlanta is built on thick massive deposits of Orange sand that show a more or less jointed structure.

From Atlanta to Magnolia.—Along the roadside from Atlanta to Magnolia there are several exposures of alternately laminated sands and clays, with some hard ferruginous layers. The first is in the road-bed on a hillside about two and a half miles from Atlanta. In another such exposure there are several concretions like those described above. White pebbles are here again met with, and reappear at intervals to Magnolia. One and a half miles from the last mentioned locality the exposures along a hillside furnish the following sequence of strata:

1. Soil and red sand..... 2 feet.
2. Massive yellow sand bed, with white pebbles..... 8 feet.
3. Massive yellow sand with streaks of white, tough, sandy clay and ferruginous bands 12 feet.

4. Ferruginous band of sandstone 2 inches.
5. Gray and brown Lignitic clayey sands with
yellowish hardened ferruginous laminae 9 feet.

From Magnolia to State Line.—Along the road leading from Magnolia to State Line post-office the land is usually level and but few Tertiary exposures are to be seen. On the west slope of the little rise upon which Bristol is situated there are outcrops of a red clayey sand which seem to represent the rehandled Lignitic Tertiary formation. This material contains white quartz pebbles. Two miles north of Eden is another exposure exhibiting at the base a light gray and yellow, laminated, sandy clay upon which rests a bed of yellowish, clayey sand two feet thick.

LAFAYETTE COUNTY.

Vicinity of New Lewisville.—Along the St. Louis Southwestern Railway a few low cuts occur between the Columbia-Lafayette county line and Bodcaw Creek, but they expose no undisturbed Tertiary beds. A few of these cuts show deposits referable to the Orange sand and contain a few white pebbles. Half a mile east of New Lewisville there is a cut, showing at its base five feet of bluish white sandy clay, red blotched, with vertical hollow concretions in which are white pebbles. Above this rests a ten-foot bed of typical Orange sand containing white pebbles in its mass and penetrated with vertical concretions.

The towns of Old and New Lewisville are situated on an Orange sand island, so to speak, in the midst of fluviatile deposits of Red River and Bodcaw Creek. The most noticeable feature of this Orange sand is the abundance of white quartz pebbles which in some instances as in the northwest quarter of the latter town form beds from 6 to 10 feet in thickness. The St. Louis Southwestern Railway has made extensive excavations in this material using it for ballast along the track for many miles to the east of Lewisville. At old Lewisville, occur fragments or chunks

of conglomerate masses composed of these pebbles cemented by iron oxide; indeed all depositions in this vicinity are highly colored by iron.

South of the railway no deposits have been seen that can be regarded as Tertiary, except, of course, in the immediate vicinity of New Lewisville.

Mars Hill.—Between Dorcheat and Bodcaw Creeks along the Magnolia-Mars Hill road the land is usually level. Within a mile of either creek however there is a ridge extending in a general way parallel to the creeks. Mars Hill is located on the westerly one of these ridges. Half a mile west of this place the surface suddenly descends 30 feet and exposes a bed of red sand without lines of bedding. At the edge of the Bodcaw the banks are 25 feet high and upon them are strewn a few white pebbles which have doubtless been washed out of the Orange sand to the north and deposited on these banks in times of freshets. From this place to New Lewisville the surface of the land seems once to have been at a level with the tops of the small hills or knolls as they now appear along the road, for the sands are horizontally bedded and when at some distance from streams always rise up to a certain height but never above it. The materials exposed are the same as those found along the bluffs of the Red River, namely, semi-indurated, massive, red, clayey sand beds.

Bradley Station.—Near Bradley Station, a well on the land of H. Smith, in 19S, 25W., section 13, the northwest quarter of the southeast quarter, gives the following section:

1. Soil and sand 18 feet.
2. Red clay 9 feet.
3. Light sand with water 10 feet.

Walnut Hills.—At Walnut Hills are massive beds of red sand sometimes 10 feet in thickness. The sand is very fine and contains a few white particles, probably white grains of

quartz. In some localities there are streaks or thin beds of very bright red clay.

The level tract of land in central and southern Lafayette county is peculiar in many respects. It seems in many places to be quite impervious and the water that falls during showers stands on the surface until it evaporates. In slight depressions it remains for weeks, and the hogs that herd in the wooded parts of this area in quest of acorns, root and wallow in these shallow ponds and mud holes, and hence, as Owen has remarked, these districts are known as "hog-wallow lands."

MILLER COUNTY.

Cuts along the St. Louis Southwestern Railway.—Along the St. Louis Southwestern Railway from Red River to McKinney's Bayou there is nothing but alluvial or bottom land, upon inquiry it was ascertained that in all probability no Tertiary exposures exist between these two streams either to the north or south of the railway. Immediately west of the Bayou at Steam Shovel, considerable excavations have been made in a hillside exposing a vertical section of at least 50 feet. The entire length of the exposure is about 100 yards. In this distance the component strata vary greatly in thickness, so that in order to present an accurate view of the beds a sketch of the whole cliff would have to be given on a rather large scale. In a general way, however, the sequence of strata, beginning above is as follows:

1. Yellowish sand and loam 5-8 feet.
2. Light pinkish clay..... 4 feet.
3. Brownish yellow sand with pellets and laminae of pinkish clay..... 2-5 feet.
4. Jet black clay shale 6-9 feet.
5. Brownish black micaceous sand with oblong concretions 10-15 feet.

Beneath No. 5 at the western end of the exposure occur:

6. Green sand..... 2 feet.
7. White sand..... 3 feet.
8. Black tough clay 2 feet.

This is probably the most extensive outcrop of Tertiary west of the Ouachita River. Though some time was spent here not a trace of a fossil was found in any of the beds. The sands and clays are alike being removed and used along the railway for ballast; and in this county and Lafayette, large blocks or chunks of bed No. 4 can be seen strewn along the track. These blocks in weathering break up in precisely the same way that fissile Paleozoic shales do and one would almost suppose without examining closely that they had been obtained from the roof of some coal mine. The great resemblance of these shales to those described by Hill at the mouth of L'Eau Fraiche on the Ouachita may prove to be of more than passing interest.

Lone Hill.—In going westward from Steam Shovel towards Texarkana, the railway runs generally through slightly depressed valleys, but on either side there are rather abrupt hills rising to an elevation of 150 or 175 feet above Red River. Among the more prominent of these is Lone Hill, in 16S., 27W., section 12. This is a solitary point rising to a height of at least 175 feet above the river. The summit of Lone Hill is roughly circular and is covered in places by fragments of a sandstone stratum about one foot thick. This is of a deep red hue, and shows innumerable shining specks, probably of crystalline quartz and not of mica. No conglomerate was observed.

North of the railway and bounding a narrow bottom land west of McKinney's Bayou, are abrupt ascents from 100 to 150 feet in height, on whose flanks there are often masses of conglomerate. Similar masses are found *in situ* on the summits of the heights, where in composition and mode of occurrence they resemble the Millstone Grit of the northern

part of the state. Sometimes this conglomerate is heavy bedded, being three feet in thickness without a partition line. The mass is composed of white quartz pebbles, just such as are found strewn over all the Tertiary of southern Arkansas, together with sand and iron oxide.

Nearly all of Miller county south of the railway and west McKinney's Bayou is said to be hilly and undulating except the bottom land from one to two miles wide along Sulphur River.

CHAPTER VI.

THE CLAIBORNE AND JACKSON STAGES.

There are but few outcrops known in the State of Arkansas which yield a distinctive Claiborne fauna. In the special area under consideration there are three, viz., White Bluff, Jefferson county; the vicinity of Rison and Toledo, Cleveland county; and Walnut Bluff on the Ouachita River.

Fossiliferous outcrops of the Jackson stage are much more numerous, and their consideration will occupy the major part of the present chapter. The areal distribution of these stages as given on the accompanying map is based largely on their respective distribution in the state of Louisiana.

JEFFERSON COUNTY.

Red Bluff.—There are two remarkably good exposures of marine Eocene deposits in the northern part of Jefferson county. The more northern, at Red Bluff, is described by Prof. R. E. Call on pages 10–14 of this Survey's report on Crowley's Ridge, and since it possesses but few features that are not as well exhibited at the more southerly exposure at White Bluff, a mere mention of it will suffice in this place.

White Bluff.—White Bluff was referred to briefly by Owen* in 1860, who found that "beds of Quaternary date occupy the higher part of the bluff; while the lower fifty or sixty feet, extending down to low water mark of the Arkansas, is most decidedly Tertiary shell marl of Eocene date, affording the following species: *Cardita densata*, *Fusus magnocostatus*, *F. Fittonii*, *Corbula alabamensis*, *Monocerus vetustus*, and others undetermined."

*Second Report of a Geological Reconnaissance of Arkansas, p. 35.

In Owen's special notes on Jefferson county, edited by E. T. Cox, the following statements occur :*

Section at White Bluff:

Soil	}	10 feet,
Sand and clay.....		
Gravel		

Thin banded light gray clay, alternating with sand

Green marly clay, with fossils, underlaid by light and dark colored marls, highly fossiliferous

60 feet.

The fossils found in the above section (some of which are figured on Plate IX, accompanying this report) belong to the Eocene Tertiary.

The Plate IX referred to contains figures of nine species, most of which are very common at this locality; the names applied to them are often wrong or merely generic and will be referred to later on in this report.

In Vol. II of the Annual Report of the Geological Survey of Arkansas for 1889, Professor Call defines this locality as on the south side of the Arkansas River, 3S., 10W., section 19, the west half of the southwest quarter and the northwest quarter of the northwest quarter of section 30. He gives a section consisting of 10 distinct beds aggregating 125 feet in thickness, which "was observed four hundred feet west of a deep gulch which cuts through the entire section at right angles to the face of the bluff, directly opposite the house of Mr. J. Wallace at White Bluff landing." The lower 40 feet of this section he found to be fossiliferous. He recognized: *Venericardia planicosta*,^{17†} *Cytherea nuttalli*,²⁵ *Corbula alabamensis*,³⁷ *C. oniscus*,³⁸ *Dentalium turritum*,³⁹ *Pseudoliva vetusta*,⁵³ *Ancillaria subglobosa*,⁵⁴ *Turritella mortoni*,⁷⁴ and *T. carinata*.⁷⁸ The recognition of other forms, viz., *Nucula ovula*,⁸ *Cylichna jacksonensis*?,^{42a} *Turritella*

*Ibid, p. 152.

†These numerals refer to corresponding paragraphs in the next chapter.

arenicola,⁷³ *T. perdita*?,⁷⁴ and *Fasciolaria oweni*,⁶³ is credited to W. H. Dall of the United States Geological Survey, and it is stated that there is substantial agreement that the beds in question are lower Eocene. These marls are believed to have practically no economic value owing to the small quantity of carbonate of lime they contain. Tertiary gravels are said to be absent from this bluff though its altitude is about the same as Redfield where they are well exposed.

This classic locality was visited by the writer on the 19th and 20th of November, 1891, when the waters of the Arkansas River had been unusually low. Figure 16, on the following page, represents the bluff at the gulch referred to by Professor Call.

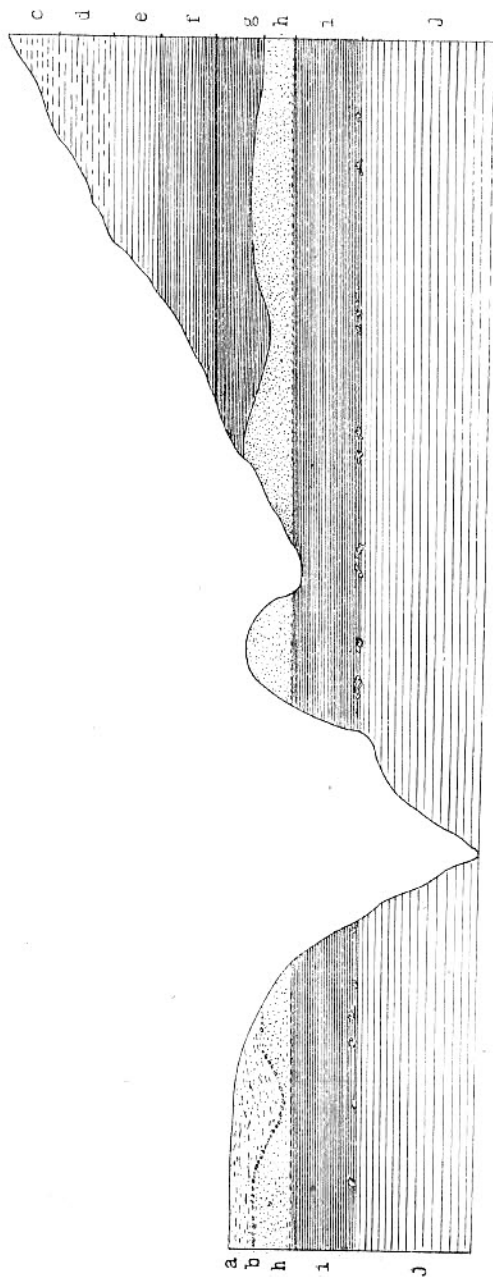


Fig. 19. Section of White Bluff, Jefferson county, Arkansas.

The beds shown in the section on the preceding page are : a, light colored sand, 5 to 10 feet ; b, line of chert pebbles ; c, soil and sand, 8 feet ; d, light grayish sandy clay, 9 feet ; e, very light pink colored clay containing numerous well preserved dicotyledonous leaves, 8 feet ; f, similar to "i", 9 feet ; g, dark lignitic clays, resting unconformably on c and containing two bands of lignite, separated from the overlying bed by a seam of pure lignite from 3 to 6 inches thick, 5 to 9 feet ; h, white sand, sometimes stained yellowish, 4 to 8 feet ; i, evenly laminated dark lignitic and more or less sulphurous shaly clay, 11 feet ; between this bed and the former are occasional ferruginous concretions ; j, bed of dark bluish sandy marl, containing in its lower portion an abundant molluscan fauna, 22 feet.

In tracing these various beds down the river from White Bluff they were observed to be fairly persistent and to decline sufficiently in this direction to carry the lower bed *j*, beneath the water within a distance of a mile and a half. Near the lower end of the bluff one feature is especially prominent namely, the line of chert pebbles. Prof. Call, as remarked above, laid special stress on the singular absence of such pebbles *in situ* along this bluff; he probably did not visit this portion of the escarpment. A few hundred yards below the place represented in Fig. 16, huge angular blocks of bed *e*, or the leaf bearing pinkish clay, have broken off and fallen to the base of the bluff. Vast quantities of leaf impressions were observed in them.

It is however to the fossils of bed *j*, that special attention is called in this report. The following table represents the species or forms recorded from this place, together with the authority of identification.

LIST OF FOSSILS FOUND AT WHITE BLUFF.

SPECIES	Owen	Call	Dall	Harris
<i>Ostrea</i> ³				
<i>Nucula magnifica</i> ⁸ (small)				†
(<i>Nucula ovula</i>)				†
<i>Leda albirupina</i> sp. nov. ¹³			†	
<i>Venericardia planicosta</i> ¹⁷				†
(<i>Cardita densata</i>)	†	†		†
<i>Cytherea discoidalis</i> ²⁵				†
(<i>Cytherea nuttalli</i>).				†
<i>Tellina</i> sp. ³¹		†		
<i>Corbula oniscus</i> ³⁶				†
<i>Corbula nasuta</i> var. ³⁷		†		
(<i>C. alabamensis</i>)				†
<i>Maetra albirupina</i> sp. nov. ³³	†	†		
<i>Dentalium minutistratum</i> ³⁹				†
(<i>D. turritum</i>)				†
<i>Acteon pomilius</i> ⁴¹		†		†
<i>Bullinella jacksonensis</i> var. <i>exta</i> ^{42a}				†
(<i>Cylichna jacksonensis</i>)				†
<i>Terebra</i> ⁴³			†	
<i>Pleurotoma</i> near <i>lonsdalii</i> ⁵⁰				†
<i>Pleurotoma</i> near <i>childreni</i> ⁴⁹				†
<i>Cancellaria impressa</i> ⁵¹				†
<i>Volutilithes petrosus</i> ⁵⁶				†
(<i>Volula</i> sp.)				†
<i>Mitra millingtoni</i> ⁶⁰	†	†		
<i>Pseudoliva vetusta</i> ⁵³				†
(<i>Monoceros vetustus</i>)		†		†
<i>Ancillaria subglobosa</i> ⁵⁴	†			
<i>Mazzalina inaurata</i> ⁶³		†		
(<i>Fasciolaria oweni</i>)				†
(<i>Fusus</i> sp.)			†	
(<i>Fusus fittonii</i>)	†			
<i>Levifusus branneri</i> sp. nov. ⁶¹	†			
<i>Macron</i> ⁶⁴				†
<i>Fusus</i> ⁶²			†	
(<i>F. magnocostatus</i>)				†
<i>Phos albirupina</i> n. sp. ⁶⁵	†			
<i>Turritella arenicola</i> var. <i>branneri</i> ⁷³				†
(<i>T. plebeia</i>)				†
(<i>T. carinata</i>)	†			
(<i>T. mortoni</i>)		†		
(<i>T. arenicola</i>)		†		
<i>Turritella clevelandia</i> ⁷⁴ n. sp.			†	
(<i>T. perdita</i> ?)				†
<i>Solarium bellastriatum</i> ⁷⁷			†	
<i>Natica eminula</i> ⁸⁰				†
(<i>Natica</i>)				†
	†			

The general aspect of this fauna is indeed Claibornian as was suggested by Heilprin* and maintained more confidently by Call.†

Yet the presence of such forms as *Solarium bellastriatum*, *Mitra millingtoni*, and *Bullinella jacksonensis* var., show that the fauna is uppermost Claibornian or perhaps transitional between that and the Jackson. The most common fossils obtained at this locality are: *Venericardia planicosta*, *Turritella arenicola* var. *branneri*, *Mazzalina inaurata*, *Pseudoliva vetusta*, *Cytherea discoidalis* and *Volutilithes petrosus*, all of which are found in Arkansas associated with typical Jackson fossils as will be shown further on.

Pine Bluff.‡ Owen and Call have given in their respective reports sections of the beds exposed at Pine Bluff. The notes of the former are very brief, having been edited after his death by Mr. E. T. Cox.

Prof. Call's notes are much more copious and specific. The lowest member of his section at the foot of North Beech street, as well as some of the strata exposed at Brump's Bayou one mile to the west, he regards as Orange sand Tertiary.

The writer visited this locality November 30, 1892, and traced several beds of light sand and clay for more than a mile up and down the river but could not find any phase in any bed that necessarily suggested a pre-Quaternary origin. The town of Pine Bluff is really built on the old flood plain of the Arkansas River which is bounded on the west by tributaries of Bayou Bartholomew.

Mr. Carter, of Pine Bluff, who has bored scores of wells in this vicinity, some to the depths of 200 and 300 feet, states that never have any signs of molluscan remains been found in them.

The first undisturbed Tertiary exposures observed in going

*Con. to Tert. Geol. and Pal. of the U. S. 1884, p. 37.

†Annual Report of the Geological Survey of Arkansas for 1889, Vol. II, p. 1.

‡See notes under Nuttall p. 2 and Warder p. 3.

southwestward along the St. Louis Southwestern Railway are in low cuts near the crossing of Bayou Bartholomew. One of these presents the following beds:

1. Somewhat irregularly bedded, Orange sand... 10 feet.
2. Line of chert pebbles 1 to 3 inches.
3. Light brown clay, with light yellow sulphurous spots..... 4 feet.

Another cut along the steep grade one third of a mile south-southwest of Bayou Bartholomew shows the following beds:

1. Soil and yellowish and greenish Orange sand.. 5 feet.
2. Line of chert pebbles..... 3 to 6 inches.
3. Brownish lignitic clay with yellow sulphurous spots, separated into beds from 2 to 4 feet thick by darker bands 9 feet.

There is in this cut a local dip to the southwest of one in a hundred.

Locust Cottage.—In the southwestern part of Jefferson county, namely, in the vicinity of Locust Cottage, no traces of fossils have been seen, nor have any been reported from wells or other excavations. At this place it was said a well passed through light clay for about 25 feet, and at a depth of 30 feet water was found in a coarse sand. A mile or two to the east a bed of black dirt was struck in a well at a depth of 60 feet. To the west, in the banks of a small stream a light sandy clay was seen interlaminated by thin ferruginous scaly layers and resembling in general appearance the sands exposed at Camden.

CLEVELAND COUNTY.

To the paleontologist Cleveland county is the most interesting county in the Tertiary area of the state. Organic remains so much prized and sought after in the counties already described are by no means abundant in a well pre-

served condition at surface exposures in this county, but from innumerable casts preserved in ferruginous sandstone, and from fossils obtained in a perfect condition by boring artesian wells, the fossil fauna can be very satisfactorily made out.

The northwestern portion of Cleveland county has already been referred to in a preceding chapter.

Rison.—The village of Rison is located in a very fossiliferous district. In the ferruginous and sandy layers exposed in the cuts along the railway track just southwest of the station, imprints of many of the more common White Bluff species can be recognized. The shells themselves can be obtained in great quantities by boring or digging wells in the southern part of the village. The town well opposite the depot, dug but a few years ago was said to have yielded numberless shells, some of which were collected by Mr. J. N. Marks and sent to the State Geologist, who in turn forwarded them to the Cenozoic division of the U. S. Geological Survey. This collection includes (Station 2231):

Venericardia planicosta,¹⁷

*Corbula nasuta*⁵⁷ var.,

Volutilithes petrosus,⁵⁶

Turritella, var. *branneri*,⁷³

Turritella clevelandia,⁷⁴

Natica eminula.⁸⁰

Station 2413. Between the depths of 30 and 50 feet in a well sunk in 9S., 11W., section 1, southeast quarter of the southwest quarter, the writer obtained the following:

Cytherea discoidalis,²⁵

Venericardia planicosta,¹⁷

Pseudoliva vetusta,⁵³

Volutilithes petrosus,⁵⁶

Phos albirupina,⁶⁵

*Mazzalina inaurata*⁶³ (all var's.),

Turritella, var. *branneri*⁷³

Station 2423. About 100 yards northwest of the depot a well recently excavated at a depth of 30 feet casts of the following species:

Ostrea,²

Modiola texana,⁶

Venericardia planicosta,¹⁷

*Mazzalina inaurata*⁶³ (with varieties),

Turritella, var. *branneri*,⁷³

Natica sp.

Casts of the Oyster above referred to, together with those of *Mazzalina*, *Turritella*, etc., can be found in abundance along the railway cut about 75 yards southwest of the station. To the west of this exposure about an equal distance on Mr. J. B. Williams' land in 9S., 11W., section 1, the southwest quarter of the southwest quarter, a well, according to this gentleman, afforded the following section:

1. Soil and light sands	20 feet.
2. Joint clay	20 feet.
3. Clay and selenite	10 feet.
4. Shells	10 feet.
5. Leaves	5 feet.
6. Dark blue earth	12 feet.
7. Coarse white sand. No water	4 feet.

Limited fossiliferous exposures were seen at various localities about Rison as follows: At a cemetery one and a half miles north of the village; along the roadside one and a half miles still farther north, or towards Locost Cottage; east of Big Creek, along the roadside about a quarter of a mile south of the Widow White's. In a deep well bored by Mr. Carter of Pine Bluff near Kedron Station, numerous "penniwinkles" are reported to have been found, and Mr. J. N. Marks is under the impression that shells have been found at Gum Springs.

About 100 yards south of Mr. Noble Atwood's house along the roadside typical grayish selenitic clays and ferru-

ginous layers of sandstone hold rather imperfect molluscan casts.

Toledo.—Near Toledo, on the old Orton place, Mr. J. W. Hollis bored a well which passed through extremely fossiliferous deposits at a depth of from 60 to 90 feet. So numerous was the most common species, *Turritella clevelandia*,⁷⁴ (of which he had luckily preserved one specimen for over 15 years) that water and dirt had to be dropped into the auger hole in order to form a mass of sufficient coherence to admit of raising the borings from the well. South of this village between one and two miles, various exposures of selenitic clay with some fossil remains were noted. These are about 90 feet above Saline River, while Toledo is about 100 feet above the same level.

Bridge's Bluff.—On Saline River three and a half miles south-southwest of Toledo, there is a bluff commonly known as Bridge's Bluff, that rises about 43 feet above the mean level of the river. This bluff is quite steep but at the time of the writer's visit, when the water was above average height, it was completely grassed over and exposed no Tertiary beds. An upturned tree, however, showed selenitic clays and small clay ironstone nodules, in which was a small cast of a *Nucula* and a minute univalve. These were about five feet above water at the time of the visit.

Mt. Elba.—In a ravine on Mt. Elba, a short distance south of Bridge's Bluff the following sequence of strata was observed:

1. Pebbly dark soil	2 feet.
2. Clayey sand, yellowish	7 feet.
3. Bed of white chert pebbles	7 feet.
4. Light lignitic clay, with casts of <i>Leda</i>	3 feet.
5. Unexposed to the water's edge	15 feet.

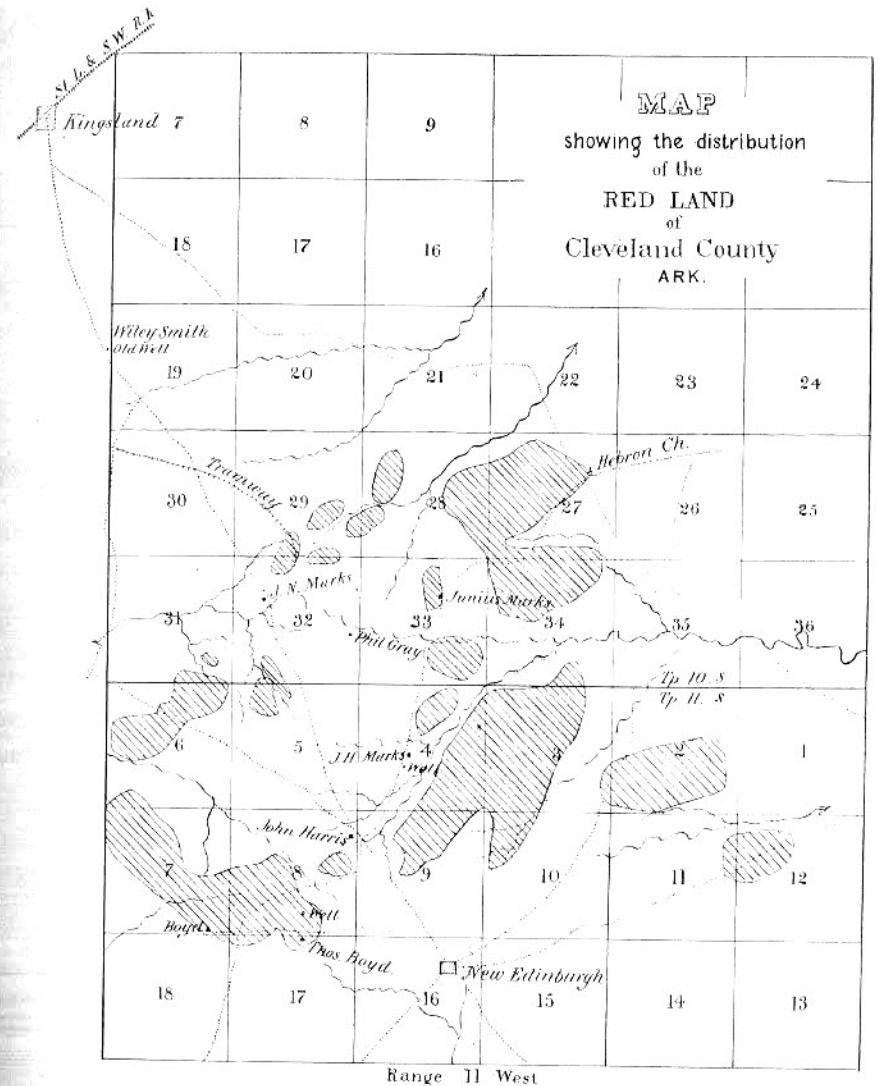
As far as can be determined by evidence of fossil remains, the majority, if not all the exposures and fossils seen in the

vicinity of Rison and Toledo are the exact equivalents of those at White Bluff, Jefferson county.

Cross Roads Church, Station 2420.—Four and a half or five miles northwest of Kingsland in 9S., 12W., section 22, the southwest quarter, a half mile north of Cross Roads Church numerous ferruginous arenaceous concretions are scattered over the surface of the ground, a very few of which when broken show imperfect casts of molluscan remains. The more common forms are as follows: *Leda multilineata*,¹² *Leda mater?*,¹¹ *Venericardia rotunda*,¹⁶ *Volutilithes petrosus*,⁵⁶ *Mazzalina inaurata*,⁶³ *Turritella* var. *branneri*,⁷³ besides *Ostrea*,² *Avicula*,⁵ *Nucula*,⁹ *Sphaerella*,²⁴ *Maetra*,³² *Tellina*,³¹ *Cytherea* (var. of *discoidalis*²⁵), *Dentalium*,³⁹ *Bullinella*,⁴² and a spire resembling that of *Ancillaria subglobosa*. From these identifications it is quite certain that the fauna represented is of the Jackson stage similar to that of the other "red-land" areas of Cleveland county.

Red-lands.—In the midst of the red-lands resides Mr. James N. Marks, who for many years has been the county surveyor, and whose love for knowledge, coupled with the power of close observation, has gained him an uncommon store of knowledge relating to the physical features of this portion of the state; and it is but just to acknowledge that the map of the red-lands herewith given is based exclusively on his observations. Much of the area represented was visited by the writer in company with Mr. Marks, the latter carefully locating each place of collecting, or otherwise interesting point, by quarter, half, and section lines, all of which he had run with compass and chain and about which there could be no uncertainties.

In passing along the road from Kingsland towards New Edinburgh, the first place where undoubted marine fossiliferous beds occur is about two and a quarter miles from the former town at the point marked on the map as "Old well"



near Wiley Smith's. Here some selenitic clay together with small ferruginous fragments had been long ago thrown out. Among these a few impressions of molluscs were noted. One mile further south near the crossing of the highway and the tram-road another well is known to have yielded fossil remains. Along the line between sections 29 and 32 there is, as indicated on the map, an outcrop of red-land. This consists of a reddish soil over and in which are scattered ferruginous sandstone fragments generally containing a great number of fossil impressions. This is a rather superficial deposit as will be seen from the following well section made at the terminus of the tram-road.

1. Soil and selenitic clay 4 feet.
2. Clay with selenite crystals 4 feet.
3. Clay with layers of red fossiliferous rock 4 feet.
4. Black lignitic clay 6 inches.
5. Black lignitic sandy clay becoming softer and
more sandy below 7 inches.

Across the road from Mr. J. N. Marks' dwelling a well that had been recently bored furnished, according to Mr. Marks, the following section :

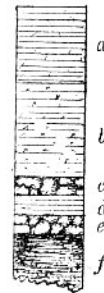


Fig. 17. Section of a well at Mr. J. N. Marks' five miles southeast of Kingsland, Cleveland county, Arkansas.

- a.* Soft light gray plastic clay, red blotched 4 feet.
- b.* White tenacious clay, with selenite crystals, 5 feet.
Some green sand.

- c. Ferruginous fossiliferous layer, 1 foot.
- d. Gray clay with red streaks, 1 foot.
- e. Ferruginous fossiliferous layer. 1 foot.
- f. Black sand and clay.

Selenitic clays and ironstone concretions were seen in the material thrown out of Mr. Phillip Gray's well, about three quarters of a mile southeast of Mr. Marks.'

On the old battle field of Marks' Mills, in section 5, a mile south-southeast of Mr. Marks' there are many fragments of ferruginous rocks, lying over the surface of the ground, that contain vast numbers of casts and impressions of *Venericardia planicosta*¹⁷ together with a few other obscure forms, among which maybe mentioned *Modiola*,⁶ *Turritella*,⁷¹ *Mazzalina*.⁶³ Fossiliferous rocks are again exposed in the stream that crosses the road at John Harris'; but the best exposure by far in this vicinity is on the left bank of a small stream in 11S., 11W., section 4, the southwest quarter of the southwest quarter, as indicated on the map. When not weathered this material consists of a bluish, slightly greenish and grayish marly sandstone, rendered firm and hard by the lime carbonate derived from the vast number of shells it contains. Upon weathering it loses all traces of its calcareous constituent and the iron upon oxidization turns the whole mass a deep red color; such is the origin of the fragments of red ferruginous sandstone scattered about over the soil in the "red-land" areas of this county. The fossils from this locality are as follows:

- Avicula*⁵ sp.
- Pecten claibornensis*,⁴
- Leda mater*,¹¹
- Nucula*⁹, sp.,
- Bysoarca cuculoides*,⁷
- Venericardia rotunda*¹⁶ var.,
- Venericardia parva*¹⁵ var.,
- Venericardia planicosta*,¹⁷

- Crassatella protexta*,²⁰
- Astarte parilis*,¹⁸
- Tellina linifera*,³⁰
- Tellina*,³¹
- Cytherea annexa*,²⁹
- Mactra*,³²
- Sphaerella*,²⁴
- Corbula bicarinata*,³⁵
- Corbula nasuta*,³⁷
- Calyptrophorus velatus*,⁷⁰
- Pleurotoma*¹⁸ (Jackson sp.),
- Bullinella jacksonensis*,⁴²
- Volutilithes petrosus*,⁵⁶
- Lapparia pacticilis*,⁵⁸
- Capulus americanus*,⁷⁹
- Natica semilunata*.⁸¹

Some of the above were collected by Mr. Marks two or three years ago and sent to the office of the State Geological Survey, whence they were shipped to the U. S. Geological Survey in April, 1890. Others were collected by Mr. Marks and the writer at the time of the latter's visit to this locality in December, 1891.

Practically the same material was passed through in digging a well on the Thomas J. St. Johns' place, (Station 2219,) township 11S., 11W. Judge W. T. Hollis of Orlando, Cleveland county, forwarded to the State Survey some of this material which was afterwards sent to the U. S. Geological Survey. Among this the following forms were recognized:

- Avicula*,⁵
- Nucula*,⁹
- Venericardia parva*⁵ var.,
- Venericardia rotunda*¹⁶ var.,
- Venericardia planicosta*¹⁷
- Sphaerella*,²⁴

Crassatella protexta,²⁰

Mactra,³²

Cytherea a n x a ³

Corbula nasuta,³⁷

Bullinella jacksonensis,⁴²

Turritella,⁷¹

Capulus americanus,⁷⁰

Scutella,

Corals.⁸⁶

According to Mr. J. C. Simmes the record of this well was as follows :

1. Soil and sand..... 4 feet.
2. Hard, cemented "shell-rock" 10 feet.
3. Black sandy clay..... 30 feet.
4. Soft blue sand, nearly white when dried.

On the old J. H. Marks place, perhaps half a mile southwest of where Owen obtained his soil for analysis (See map Pl. IV), several fragments of ferruginous fossiliferous sandstone were collected by Mr. Marks and the writer ; they contain the following species :

Leda multilneata,¹²

Leda mater,¹¹

*Venericardia rotunda*¹⁶ var.

Tellina linifera,³⁰

Mactra,³²

Cytherea securiformis?,²⁸

Corbula bicarinata,³⁵

Dentalium,³³

Cadulus,⁴⁰

Volutilithes petrosus,⁵⁶

Calyptrophorus velatus,⁷⁰

Cassidaria petersoni.⁶³

Station 2430. On a low ridge of ground in 10S., 11W., section 33, the southwest quarter of the southeast

quarter, chunks of ferruginous sandstone lying scattered over the ground furnished the following species :

*Ostrea*² sp.,

*Avicula*⁵ sp.,

Pecten claibornensis,⁴

Leda multilneata,¹²

Leda mater?,¹¹

*Sphaerella*²⁴ sp.,

*Venericardia*¹⁴ sp.,

*Mactra*³² (Jackson sp.),

*Trochita*⁷⁸ sp.

Station 2429. Along the roadside in 11S., 11W., section 8, the southwest quarter of the southwest quarter, practically the same fauna occurs. Among the more common forms are : *Tellina linifera*³⁰ and *Mactra*³² sp. together with imperfect fragments of *Nucula*,⁹ *Leda*,¹¹ *Venericardia*,¹⁴ *Cytherea* and *Alveinus*?.¹⁹ Similar fossils were also seen at Hebron Church, in 10S., 11W., section 27.

Before closing these remarks on the red-lands of Cleveland county, a few words must be added regarding the stratigraphic relations of the beds represented in the several small areas whose distribution has been given by Mr. J. N. Marks on the accompanying map. We must also refer these beds to their proper place in the Eocene scale as represented by the Alabama and Mississippi sections.

It will be observed that in Owen's section of the rocks in this vicinity* beneath the marly and calcareous beds come beds of "black dirt," lignite, blue clay, sand," etc. The same appear in well sections given in the present report from the vicinity of Kingsland southward to this district. The same fact is admirably shown by a section in 10S., 11W., section 34, the southeast quarter, as exhibited in the right bank of a stream. The sequence is as follows :

*See p. 141 of the Sec. Rep. of a Geol. Recon. of Ark.

1. Base of red-land soil as shown several yards south of the brink of the bluff.
 2. Unexposed..... 2 feet.
 3. Reddish soil and sandy clay at top of bluff ... 5 feet.
 4. Weathered light colored sand .. 5 feet.
 5. Somewhat micaceous and sulphurous laminated sands and clays becoming dark grayish from lignite particles towards the base 9 feet.
 6. Black clay, with conchoidal fracture 6 feet.
- Dip to the southwest two in twenty-five which is, of course, local.

From the above facts it is safe to assume that underneath the fossiliferous marls, selenitic clays, and calcareous sandstones are beds of lignitic clay and sand.

Regarding the thickness of the calcareous beds it may be stated that according to aneroid measurements the top of the fossiliferous sandstone ridge in the central part of the southeast quarter of section 33 (of 10 S., 11W.), is 35 feet above the marl that crops out in a little brook which crosses the road about about three quarters of a mile southwest of the former locality, or about a quarter of a mile north of the J. H. Marks house. Other observations go to show that these beds aggregate at least 35 feet in thickness.

The geographical distribution of the red-land areas as given on the accompanying map is, until properly explained, somewhat misleading. For example no red-land is shown in 11S., 11W., section 4, the southwest quarter of the southwest quarter, but there, as has been said, is the very best exposure of fossiliferous rocks in this whole district. They have been denuded at a comparatively recent period and have not lost their calcareous constituent, nor has the iron been oxidized into the hemetitic ore. The areas represented on the map therefore refer to such fossiliferous beds as have been acted upon by the elements for a long time.

A most striking feature of these fossiliferous deposits is their liability to local lithologic variations. For example, between Mr. J. N. Marks' house and that of Phillip Gray there is a low ridge separating the waters of the Moro and the Saline. Owing to the near approach of the lignitic beds in the well at Mr. Marks' it would seem that this ridge must be almost entirely made up of the 35-foot fossiliferous formation; but not a sign of red land or of fossils has been seen along this upland. This may in part be due to lack of good exposures and to a thick covering of superficial material. This reason however cannot be used in case of the sands and clays about New Edinburgh, for at that place wells have been frequently sunk but no traces of fossiliferous deposits have been observed.

Finally in regard to the stratigraphic position of the fossil bearing horizon of this region it will suffice to say that associated with numerous species common to both a Jackson and Claiborne horizon there are others characteristic of the Jackson alone as *Leda multilineata*, *Astarte parilis*, *Tellina linnifera*, *Pleurotoma americana*, *Cassidaria petersoni*, which characterize it as Jackson and not Claiborne as has previously been maintained.*

In the region just described, the Orange sand is very inconspicuous, being generally limited to a few loose cherty pebbles. Where the fossiliferous feature disappears, there the Orange sand becomes more noticeable. For example, in going along the road from New Edinburgh towards Warren the characteristic white gravel beds and reworked sandy material are frequently met with. About 2 miles southeast of New Edinburgh in the road ditch at a steep eastern declivity the following sequence of deposits was observed:

1. Reworked material of No. 2 (i. e. Orange sand) with white pebbles intermixed; line of contact with No. 2 sometimes indicated by a yellow ferruginous thin crust..... 5 feet.

*Annual Report of the Geological Survey of Arkansas for 1888, Vol. II, pp. 59-61.

2. Evenly laminated sandy layers of a light gray color or somewhat yellowish on planes of bedding 3 feet.
3. Streak of clay, light brownish gray with leaf impressions, among them a *Sabal* 1 inch.
4. Like No. 2 but with coarser lines of lamination 2 1-2 ft.

Between this point and Judge Hollis', 5 miles from New Edinburgh, the usual sequence of strata wherever observed is: (1) soil and rehandled reddish sandy clay; (2) pebble bed; (3) undisturbed lignitic clay.

In the road-bed in front of Mr. Hollis' house there are numerous fragments of ferruginous concretions which upon close examination are found to contain impressions of small bivalve shells. Half a mile farther on towards Warren, where a stream crosses the highway, it was observed that in the slope just across the bridge there occur concretionary ferruginous masses in the undisturbed Eocene. These hold a few generally minute casts of *Leda*, *Corbula* and *Solarium alveatum* apparently of the red-land fauna already described. Following this stream 200 or 300 yards to the north of the road, a bank of 15 feet is found on the right or eastern side. Here are exposed alternating layers of clay of a light brownish slate hue from a quarter of an inch to an inch in thickness, and light sandy layers of equal thicknesses. These, from observations made in the field, are known to lie below the exposures along the road just mentioned, so that here as in the typical red-land area the fossiliferous ferruginous layers are immediately underlain by lignitic clays and sands. This feature is admirably shown in the vicinity of the cotton gin at Orlando. Moreover a well at this place penetrated the leaf-bearing clays for over 20 feet without coming to deposits of a different character. Between this point and Warren, Orange sand prevails.

Vince Bluff.—Along the Saline River two bluffs have

already been mentioned in Cleveland county, viz: Bridge's and Mt. Elba, both of which are very sparsely fossiliferous. Passing down the river to within three quarters of a mile of Vince Bluff ford, one finds at low water an exposure of fossiliferous clays, marls and ferruginous claystone concretions. Attention was first called to this locality by Judge W. T. Hollis, who sent some specimens of the fossiliferous marl to the State Geologist by whom they were forwarded to the U. S. Geological Survey. The molluscan forms determinable in this material were the following (Stanton 2234):

Avicula,⁵

Pecten,⁴

Leda mater,¹¹

*Venericardia rotunda*¹⁶ var.,

Tellina linifera,³⁰

Cytherea securiformis,²⁸

Corbula bicarinata,³⁵

Gastrochæna,³⁸

*Mazzalina dalli*⁶⁴ sp. nov.,

*Comus sauridens*⁴⁵ (*tortilis*).

*Pseudoliva vetusta*⁵³ var. *perspectiva*,

Caricella,⁶⁷

Volutilithes petrosus,⁵⁶

Mitra millingtoni,⁶⁰

Clavilithes humerosus,^{62a}

Calyptrophorus velatus,⁷⁰

Solarium bellastriatum,⁷⁷

*Solarium alveatum*⁷⁸ var.

On November 5th, 1891, the writer visited this place and found the various deposits exposed as follows: (See fig. 18 on the following page.)

a, Bank unexposed, probably alluvium; *b*, line of white quartz pebbles, varying in size from 1-6 to 2 inches in diameter; *c*, light gray tenacious clay 3 feet thick; *d*, yellowish sandy clay in whose upper surface as well as in the

lower of *c*, occur huge yellowish sandy clay concretions at intervals of 3 to 5 yards, 1 foot; *e*, sandy marly clay with fossils and concretions, 3 feet; *f*, bed of clay ironstone

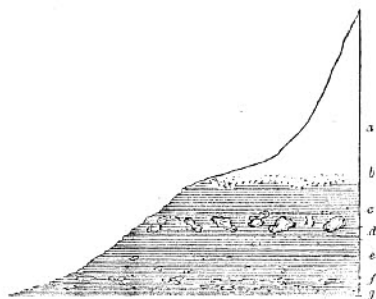


Fig. 18. Section on the left bank of Saline River, three quarters of a mile above Vince Bluff, Cleveland county, Ark.

concretions, 6 inches. These are generally of an oblong and branching form as seen in the accompanying cut. Externally these concretions are black; just within, yellowish; in the interior of a light gray with white and black specks. *g*, bluish clayey sand with fossils, 1 foot, to water's edge.

Little or no dip was observed in this outcrop. The general trend of the bluff is south 19° west.

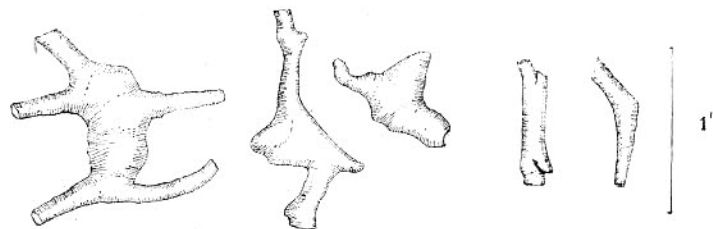


Fig. 19. Forms of concretions near the water's edge in the Tertiary outcrop three quarters of a mile above Vince Bluff, Saline River, Ark.

The fossils collected here by the writer are (Station 2403):

Pecten claibornensis,⁴

Byssosarca cuculloides,⁷

Leda mater,¹¹

View of the fossiliferous outcrop three-fourths of a mile above Vince Bluff, Saline River, Ark.



Nucula,⁹
Leda multilincata,¹²
Lucina,²³
Sphærella,²⁴
Crassatella protexta,²⁰
Astarte parilis,¹⁸
Mactra,³²
Panopæa sp.
Tellina linifera,³⁰
Venericardia planicosta,¹⁷
*Venericardia rotunda*¹⁶ var.,
Cytherea securiformis,²⁸
Cytherea discoidalis,²⁵
Terebra,⁴³
Conus sauridens,⁴⁵
Pleurotoma americana,⁴⁸
Pseudoliva vetusta,⁵³
*Mazzalina dalli*⁶⁴ sp. nov.,
Mazzalina inaurata,⁶³
Mitra millingtoni,⁶⁰
Caricella,⁵⁷
Volutilithes petrosus,⁵⁶
Lapparia pactilis,⁵⁸
Marginella,⁵⁵
Turritella var. *branneri*,⁷³
*Turritella*⁷¹ sp.,
Cypræa,⁶⁹
Natica eminula,⁸⁰
Solarium bellastriatum,⁷⁷
Capulus americanus,⁷⁹
Flabellum wilesi,⁸⁵
 Coral,⁸⁶ undetermined.

Cow ford.—At Cow ford four miles below Vince Bluff, and on the right bank of the river there is another fossiliferous Eocene outcrop. In some places this exposure rises

to a height of three feet above the water at a medium stage, and consists originally of a light bluish sandy clay often discolored by iron, with concretions resembling those figured on page 108 though more generally fossil bearing. The species are small and in form of casts and include *Leda mater*,¹¹ *Leda multilineata*,¹² *Corbula*, etc. The uppermost layer is very ferruginous and is besprinkled with white pebbles. Above it is 15 feet of clayey Pleistocene loam.

Pansy post-office.—In this connection may perhaps most conveniently be mentioned a locality that at one time yielded many fossil remains, but from which the supply is now cut off entirely. Reference is made to a well bored many years ago on the Frank Marks place, one mile north-east of Bradley (Pansy post-office). This spot was visited by the writer; it was with difficulty identified, and not a trace of a shell was found in the vicinity.

The following notes on the beds passed through in boring this well were communicated by Mr. F. M. Parkman who helped do the work:

1. Soil and sandy material.....	16 feet.
2. Blue marl without shells	30 feet.
3. Blue marl with many shells, becoming sandy at the bottom.....	38 feet.
Total.....	84 feet.

Many of the shells were taken home by Mr. Parkman who lives near Orlando and although they had been strewed around the yard and lost for years, he was able to recover one beautiful specimen of *Murex marksi* n. sp.⁶⁷ (Sta. 2409.)

In the southwestern part of Cleveland county on the Moro Bay-Pine Bluff road, but one good exposure of undisturbed Tertiary beds was seen. This was five miles southwest of New Edinburgh, and its component beds as seen by the roadside give the following section:

1. Soil, sand, etc., very few white pebbles.....	2 feet.
--	---------

2. Light, evenly laminated bluish gray clay.....	4 feet.
3. Sand, light gray micaceous.....	6 inches.
4. Leaf-bearing clay, bluish gray, with conchoidal fracture	8 feet.

One mile nearer New Edinburgh some ferruginated clay-stones were observed which resemble those often found in the fossiliferous marls of Cleveland county.

LINCOLN COUNTY.

At least three fifths of Lincoln county is covered by alluvial deposits of the Arkansas River while the remaining two fifths, which lies to the southwest of Bayou Bartholomew, consists of evenly bedded Tertiary clays and sands, the upper part of which has been reworked into Orange sand. This material is particularly noticeable in the ridge or plateau-like elevation that extends from Tyro to the northwest, broadening all the while and including Branchville near the southwest border, and Star City near its northeast edge. At Star City on the uplands, and at Relf's Bluff on the lowlands (not alluvium) wells penetrate blue clays and black gypsiferous clay sands that yield water unfit for drinking purposes. No fossils were seen by the writer in Lincoln county but the probability is that they might be found by boring, since the clays are about the same as those passed through farther west and south before the fossil bearing beds are reached. Indeed, Judge Hollis of Cleveland county, feels confident that when his drilling tools were at work in this county a few miles southeast of Star City they encountered marine shells.

DREW COUNTY.

Topography.—At the time of the writer's visit to Drew county the ground was covered with snow as it was when visited by Owen. Notwithstanding this fact the general topographic and structural features can be stated with a considerable degree of certainty. The highlands which occur

in Jefferson county near Grace, and continue with more or less interruption into Lincoln county as has here been pointed out under that heading, are separated from similar elevated tracts in Drew county by the broad valley of Indian Creek. Four miles southeast of Relf's Bluff, however, a ridge arises which extends and rapidly broadens southward, so that at Montongo it is nearly four miles wide, this hamlet being nearly in the middle. Towards Monticello it gradually narrows and practically terminates in Gaster Hill, a mile and a quarter north-northwest of the town. Potatoe Hill, three miles due north of Monticello is about 200 feet in diameter and about 40 feet high and is a solitary remnant evidencing the once great extension of the highland area. Gaster Hill, as nearly as the writer could determine, is about 385 feet above tide. Monticello, 271 feet above tide, is surrounded on the immediate north, as well as on the east and west by comparatively level lands. One mile south of this town is Rough-and-Ready Hill, extremely irregular in outline, being washed and carved by the head-waters of Cypress Creek. Its summit is about 410 feet above tide. For some distance to the southeast of Monticello the surface is hilly and somewhat broken, but the last elevated area in this direction is Roger's Hill, four miles south of Monticello. This rises about 80 feet above the plains that stretch far to the east, south, and west.

Geological formations.—The eastern part of Drew county, or from Hurricane Creek eastward, is mainly, if not entirely, occupied by alluvial deposits of the Mississippi River. Orange sands are developed to a slight extent on the plains, as mentioned above, but are particularly noticable in the elevated regions, as on the northern portion of Roger's Hill, Rough and-Ready Hill, and in the vicinity of Montongo where they are extremely ferruginous, and vary from 8 to 10 feet in total thickness. Some huge fragments of the Orange sand conglomerate were seen in this vicinity resem-

bling in every way those which are found on the summits of high elevations in Saline county, northern Miller county, and elsewhere. The underlying, undisturbed Eocene beds of the highlands seem to consist, whenever observed in steep ravines, of light colored sands with some clay and lignite. A well on the border of the upland area, 3 miles southwest of Montongo, is said to pass through dark selenitic clays and a considerable deposit of lignitized wood and leaves. In the plains, from Monticello westward along the railway, several shallow cuts expose light gray joint clay that contains a few lignitic particles and obscure impressions of small marine shells, as *Corbula*, *Yoldia*, and *Turritella*. The best exposure noticed, about three miles west of Monticello, is as follows:

1. Soil, sandy 1 foot.
2. Yellowish sandy clay 2 feet.
3. Red sandy clay 2 feet.
4. Gray sand and clay with *Corbula*, *Turritella*.....10 feet.

No. 4 consists of sands and clays alternating in thin bands.

The clay layers are subdivided by laminæ of fine white and yellowish sand with mica specks. These sandy lines are often stained reddish by iron oxide. The fossils are in the thicker and more compact clay seam.

Section at Monticello.—An artesian well sunk in the public square at Monticello, 150 to 160 feet deep, passed through

- | | |
|--|-----------|
| Yellow soil and subsoil | |
| Yellow clay | 20 feet. |
| Red clay and a little sand | |
| Black dirt, a dark sticky clay with segregations.. | 140 feet. |

At 145 feet deep fossil shells were found. Around Monticello, water is generally obtained at a depth of 20 feet in the black dirt.*

*Owen's Second Report of a Geological Reconnoissance of Arkansas, 1860, p. 143.

Section on Long Prairie.—Near the northern end of Long Prairie, 14S., 6W., section 5, the southwest quarter, at the residence of Hon. N. Y. Wadsworth, a well was sunk to a depth of 150 feet, which passed through:

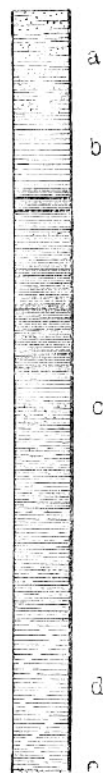


Fig. 20. Section of Wadsworth's well, Drew County, Arkansas.

a, Gravel and reddish clay, 20 feet; b, reddish clay with lignitized logs at base, 20 feet; c, bluish black sand with streaks of sand 1-4 to 3-4 of an inch in thickness every 5 feet, 80 feet; this bed contains numerous fossils as will be described below; d, tough clay "hard pan," 27 feet; e, light gray tough clay with many small shells. This layer was so tough that after passing through it for 3 feet the auger broke and could not be extracted.

This well was bored in July 1891, and several fossils ob-

tained from it were preserved by the members of Mr. Wadsworth's family. These were purchased by the writer, and are:

- Pecten claibornensis*,⁴
- Nucula magnifica*,⁸
- Leda* sp.,
- Venericardia planicosta*,¹⁷
- Corbula bicarinata*,³⁵
- Cadulus*,⁴⁰
- Dentalium*,³⁹
- Actæon*,⁴¹
- Volutilithes petrosus*,⁵⁶
- Levifusus branneri*⁶¹ sp. nov.,
- Turritella branneri*,⁷³
- Natica eminula*,⁸⁰
- Solarium*,⁷⁵
- Flabellum wailesi*,⁸⁵

Besides these the writer saw in the possession of some children at Lacy, *Turritella* var. *branneri*,⁷⁸ *Pseudoliva vetusta*,⁵⁸ and a *Phos*, which were obtained from this well. Upon the whole, the fauna is remarkably similar to that of White Bluff on the Arkansas River.

Cornish Ferry.—At Cornish Ferry (Caveness Landing) on Saline River, a section as represented in Fig. 21 was obtained.

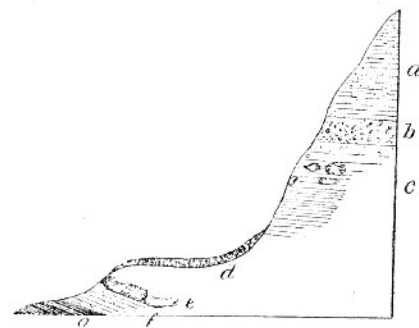


Fig. 21. Section at Cornish Ferry, Saline River, Arkansas.

This consists of: a, bed of light sand, 14 feet; b, white

pebbles, 5 feet; *c*, bluish or slightly greenish blue sandy clay generally much stained by iron oxide. Numerous small white particles of shelly matter occur in this bed. Small nodules of calcareous concretionary matter are likewise common. Near the upper part of the bed are larger concretions. *d*, Tertiary deposits concealed by overlying clays, sands, and gravels of recent origin; *e*, bed of huge, yellowish, sandy concretions, dipping strongly towards the bank. Some of these concretions have diametric measurements of 2, 3, and 10 feet respectively; *f*, bluish clay with concretionary layers like *c*, fossiliferous; *g*, black lignitic clay also fossiliferous.

The lower beds crop out along the river for several yards and have evidently been much disturbed. The black lignitic bed forms the bed of the river at this point.

The fossils collected at this locality are apparently of the same horizon as those from Vince Bluff. They are less abundant however, and not so well preserved. The following were obtained:

Avicula,⁵
Venericardia rotunda ¹⁶ var.,
Venericardia parva,¹⁵
Gouldia pygmaea,²²
Mactra,³²
Corbula bicarinata,³⁵
Cytherea discoidalis,²⁵
Cadulus,⁴⁰
Volutilithes petrosus,⁵⁶
Calyptrophorus velatus,⁷⁰
 An echinoderm.⁸⁴

Ozment Bluff.—Another bluff within the confines of Drew county, and on the Saline River is Ozment Bluff, in Crook township.

This is represented in Fig. 22, and consists of the following beds:

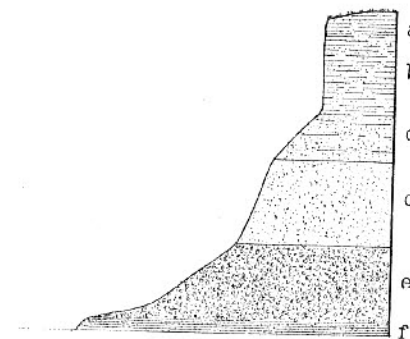


Fig. 22. Section at Ozment Bluff, Saline River, Ark.

a. Soil	1 foot.
b. Light clayey sand	7 1-2 feet.
c. White sand sometimes yellowish, generally wet.....	4 feet.
d. Pure white sea sand.....	6 1-2 feet.
e. White pebble bed.....	6 feet.
f. Blue clay (Tertiary)	1 foot.

BRADLEY COUNTY.

Topography.—The northern, central, and western parts of Bradley county present no striking topographic features, being generally rolling, with slight declivities of sometimes 30 feet in the immediate vicinity of streams. Towards the south, the surface gradually descends to the alluvial lands on the Ouachita River. The eastern part of the county however presents an abrupt front towards the Saline River from Warren to Johnsville. At the latter place this abrupt topography becomes less marked, and gradually leaving the Saline, it swings to the southwest and dies out entirely before leaving L'Agles Creek.

Geological formations.—Alluvial or bottom lands extend along the western bank of the Saline, varying generally from half a mile to 2 miles in width, though at some places they are

cut off entirely by abrupt bluffs. Such lands also extend north from the Ouachita River from 2 to 4 miles and the distinction between alluvium becomes here somewhat arbitrary owing to the slight elevation of the true Tertiary lands. The alluvial deposits along the Moro are similar to those on the Saline, though generally not so extensive.

The Orange sand phase is usually well developed in Bradley county, being here, as elsewhere, most conspicuous near the upper part of the steeper declivities as exposed along the road. In the immediate vicinity of Warren, as in the red-land district, deposits of this kind are not extensively developed; but to the south and west, from the alluvials and of the Saline to those of the Moro, white pebble beds are frequently exposed, some overlaid by masses of orange colored sand several feet in thickness. At the left of the roadside, as one passes along the Warren-Johnsville road, from 4 to 5 miles from the latter place, at the heads of little ravines that make eastward into the Saline valley, there is, underneath 2 or 3 feet of fine sandy material, a great development of the gravel bed, in some instances 20 feet in thickness. This bed rests upon light gray lignitic clay. In the upper layer of the latter and in immediate contact with the gravel, a semi-lignitized log was seen. Fragments of silicified wood were found near the line of contact in considerable abundance. Mr. J. C. Simmes of New Edinburgh reports that in boring wells southwest of Johnsville in Bradley county he found white pebbles, sometimes as far as 30 or 36 feet beneath the surface. Gravel banks are of common occurrence along L'Agles Creek and especially along the border line between the Tertiary and alluvium of the Moro. Mr. Watson, at Jersey post-office, states that in digging his well, white pebbles were found to a depth of 15 feet. From Lanark northward several fragments of an Orange sand conglomerate were observed, similar to those mentioned as occurring in Drew, Saline and Miller counties.

The undisturbed Tertiary deposits of Bradley county consist of light colored lignitic clays usually intermixed with more or less light colored siliceous sand. Bluish or black clay is occasionally met with in digging or boring wells, and there is some pure lignite.

Lee Hammaker's well section.—Mr. Lee Hammaker, who resides near the center of section 8, 12S., 6W., had a well sunk a few yards north of his house, which according to his statement, passed through:



Fig. 23. Well section at Lee Hammaker's, Bradley county, Arkansas.

- | | |
|---|----------|
| a. Light, even bedded clay | 28 feet. |
| b. Clay ironstone | 2 feet. |
| c. Reddish, white and yellow clay | 5 feet. |
| d. Blue fossiliferous clay | 6 feet. |

- e. Clay ironstone 1 foot.
 f. Black sand, becoming lighter, with water
 below 5 feet.

The fossils of bed "d" are as follows:

- Avicula*,⁵
Pecten claibornensis,⁴
Leda mater,¹¹
Leda multilineata,¹²
*Venericardia planicosta*¹⁷
Venericardia rotunda var. *jacksonensis*,¹⁶
Astarte parilis,¹⁸
Crassatella protexta,²⁰
Lucina,²³
Mactra,³²
Corbula bicarinata,³⁵
Dentalium multistriatum?,
Cadulus,⁴⁰
 ? *Bullinella jacksonensis*,⁴²
Conus sauridens,⁴⁵
Pleurotoma,⁴⁹
Olivella,⁵²
Cancellaria, fragment,
Volutilithes petrosus,⁵⁶
Caricella subangulata,⁵⁷
Mitra hammakeri,⁵⁹
Calyptrophorus velatus,⁷⁰
Cassidaria petersoni,⁶⁸
Phos hilli,⁶⁶
Turritella alveata,⁷²
Turritella var. *branneri*,⁷³
Turritella,⁷⁴
Natica parva?

Vicinity of Warren.—In the town of Warren, a few yards west of the railway station, a shallow cut of about 3 feet exposes ferruginated sands and clays with some concretionary

formations in which are poorly preserved casts of marine fossils, all of unusually small size for the species represented. The most abundant species is *Venericardia planicosta*. From the station eastward along the railroad there are several low cuts showing not only reworked Orange sand material, but also more or less ferruginated sands and clays of the undisturbed Tertiary. By far the best exposure of fossiliferous beds in this county can be seen in the last cut on this railroad as it enters the lowlands or bottom of the Saline River, about three miles east of Warren. Fig. 24 represents in a



Fig. 24. Section of a railway cut about three miles east of Warren, Bradley County, Arkansas.

general way the appearance of this cut. (1) A six-foot bed of white sea sand. Near its base there is some clayey and ferruginous matter interspersed. At the eastern end of the cut the upper part of this bed is interspersed with seams of whitish clay and reddish and yellow ferruginous concretions containing casts of mulluscan remains. This bed appears to dip to the west, but this is due to the ascent of the road-bed in this direction. The true dip is almost *nil* or slightly to the east. (2) The bed just described is overlaid by masses of ferruginous brownish and yellowish concretions which contain numerous casts of *Mactra* and very small bivalves like *Corbula*. This bed grades upward into No. 3. (3) This is of a light sandy nature towards the eastern end of the cut. This and the last described bed have each a thickness of 4 feet. Bed 3 may be traced westward past the middle of the cut where it makes a slight syncline and descends

to the level of the road-bed, but rises to the westward and becomes somewhat more argillaceous. It contains numerous marine shells and shell fragments. *Venericardia planicosta*¹⁷ is the most abundant form. A *Volutilithes petrosus*⁵⁶ was seen but it crumbled at the slightest touch. Other forms like small *Mactra*, *Corbula*, and *Leda* were also found; (4) red concretionary ferruginous band, 6 inches thick; (5) No. 4 seems in some instances to inter-grade with this bed which is of a yellowish sandy material, for the most part undisturbed, though in part perhaps reworked. In the middle of the syncline alluded to before this bed is 10 feet thick. It contains very rare, light yellowish concretions in one of which was obtained what appears to be an internal cast of *Mazzalina inaurata*.

Alga Bluff.—In going southward from Warren, along the eastern brink of the highlands that face Saline River as described above, one finds that in many little ravines that carve out and diversify this abrupt slope, light colored, slightly yellowish, blue and gray lignitic clays predominate. The first interesting and noteworthy exposure was observed at Alga Bluff, immediately on the Saline River in 13S., 9W., section 21, the northeast quarter of the southwest quarter; this bluff presents beds of varying character as represented in Fig. 25 on the opposite page. *a*, Loamy sand about 20 feet; *b*, is separated from the above by a dark lignitic thin sandy layer, and consists of light gray sand resembling "a" but less weathered; *c*, light brownish clay 1-2 feet; *d*, clay bed, 16-2-3 feet, upper portion somewhat sandy and of a brownish color, below light and more compact clay; *e*, lignite 18 inches thick; *f*, clay with leaf impressions, 3 feet; *g*, lignite, 13 inches thick, impure; *h*, firm, thick layers of light sandy clay, 5 feet; *i*, similar to "h" but coarser in texture and slightly brownish.

It has been said that the lignite from bed "e" will burn on a grate; it is certain however that when tried in an open

fire even with much kindling, it ignites with difficulty and seems to produce but little heat.

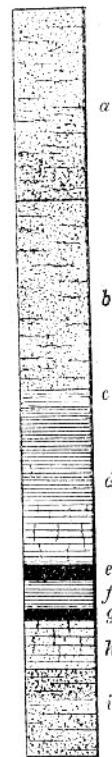


Fig. 25. Section of Alga Bluff on Saline River, four miles southeast of Warren, Bradley county, Arkansas.*

The section here given represents all the exposed beds at this bluff, aggregating 78 feet in thickness. The bank, however, slopes back several yards from the brink, and the total height of the river banks is 96 feet above the surface of the river at comparatively low water. The face of the exposure extends south 15° east. The strata are horizontal. No Orange sand was observed in this escarpment, but 100 yards farther down stream, a white gravel bed appears

*The writer is under obligations to Mr. Brooks of Warren, who furnished conveyance to this locality and materially assisted in its examination.

at the surface of the water which in some instances is so cemented that it forms a hard rock and is somewhat dangerous to navigation. This conglomerate, however, is overlaid by alluvium and not by orange colored sand as is generally the case.

Fossil shells.—Seven miles south of Warren on the Johnsville road Mr. Brooks was informed that on James Manus' place well preserved marine shells of good size were obtained, from a well, 40 feet beneath the surface. This locality being in a comparatively elevated region, it is quite certain that the shells were of a higher horizon than the lignitic layers represented in the section at Alga Bluff.

Sulphur Springs.—Below Alga Bluff, the next important exposure on the right bank of the Saline River is at and just below Sulphur Springs. This locality is about 12 miles below Warren and about 6 miles from Johnsville. The largest sulphur spring is about 30 yards from the river and discharges at least one barrel per minute of sulphurous tasting water. This is doubtless the spring referred to by Owen as in 14S, 9W., section 34, on J. H. Crawford's land. Regarding it, Owen says that a qualitative chemical examination shows it to be a strong sulphuret water, alkaline to test paper. The principal constituents are :

Carbonate of alkalis, probably both soda and potash.

Sulphate of alkalis.

Sulphate of magnesia (Epsom salts).

Chloride of Sodium (common salt).*

The coal referred to by Owen from this locality was not seen by the writer.

Crawford's Bluff.—One mile farther down the river, the banks approach the edge of the river and show limited outcrops at Crawford's Bluff. Half way between the two localities where the banks are about 60 feet high, 60 yards from the river, a layer of hard sandstone can be seen extending

for 15 yards in the face of the exposure at an altitude of about 35 feet above the water of the Saline River. Beneath this in some places, there is a bed of white friable sand 1 foot thick. Otherwise the bluff consists of beds of lignitic clay interstratified with thin seams of sand. At Crawford's Bluff, highly carbonaceous clays crop out at the water's edge. They are often jet black, with peculiar cavities resembling *Teredo* borings in them. These clays extend at least 2 feet beneath and 2 above the surface of the water as it stood at the time of the writer's visit. They are capped with a ledge of sandstone 6 inches thick. Above this sandstone occur the ordinary light colored lignitic clays, though, owing to the undergrowth at this place, they do not form extensive exposures. The black clay is sometimes solidified into a rocky mass of considerable hardness. This bluff can not be less than 150 feet above the level of the river, which is about a quarter of a mile away. Going westward from Crawford's Bluff towards the Warren-Johnsville road, one finds all along his course the gravel bed of the Orange sand developed to a thickness of 15 feet or more at the heads of little ravines. The same important development of the Orange sand about 4 or 5 miles north of Johnsville on the Johnsville-Warren road has already been referred to. The clay, lying immediately beneath it, is light grayish blue with more or less lignitic matter disseminated through it. The lignitized log referred to appeared to be mostly in the clay, but the silicified fragments of wood, very abundant in this vicinity, were in the gravel bed of the Orange sand.

Long View.—Going eastward from Johnsville towards Long View, one passes over high Tertiary plains till within about a mile and a half of the Saline, when the land becomes broken for about half a mile and then falls off to the alluvial plain of the river. In these broken areas, the Orange

*Report of a Geological Reconnoissance of Arkansas, 1850, p. 140.

sand crops out in many places, and the underlying lignitic clays also come to the surface in very steep slopes. They seem to have much light sand in their composition. The next important Tertiary exposure seen on the Saline was two miles below Blanchton post-office, but it was on the left bank of the river and hence will be discussed under Ashley county.

Lignite.—On Moro Creek, two and a half miles below Jersey post-office, on the land owned by a Mr. Gilbert, in 15S., 12W., section 21, there is said to be a deposit of lignite in the bed of the river, of which considerable quantities have been removed and burned. Its thickness is unknown. It is said to be found along down the river for about a mile and to gradually descend to the south at a rate of about 4 feet per mile. At the time of the writer's visit it was entirely beneath the water, and not a trace of it could be seen.

Jersey post-office.—As exposed in little cuts and wash-outs along the roadside the beds immediately underlying the pebble bed about Jersey post-office consist of the usual light colored, somewhat sandy clay, containing small lignitic particles. Mr. Watson, at Jersey, said that in digging his well he passed through sands and pebbly material for 15 feet, then entered a dark clay which at a depth of 32 feet was black.

Between Jersey and Lanark, no deposits of any consequence were seen beneath the Orange sand. The same remark applies to the undulating country between Lanark and Warren.

CALHOUN COUNTY.

Topography.—As far as observed, Calhoun county contains no peculiar topographic features. It is somewhat hilly in the northeastern portion, especially about Chambersville and Big Hill; but this feature gradually disappears south-

ward, and almost uninterrupted plains stretch southward to the Ouachita.

The alluvial lands along the Moro are on an average about a mile wide. They are generally sharply defined by a sudden descent of the Tertiary plains or uplands of from 10 to 20 feet. Along the Ouachita River no outcrops, that appeared to be undisturbed Tertiary, were seen on the Calhoun county side. Where inquiry was made the bottom lands were said to extend about 2 miles north from the river bank. In some places, however, they are certainly more extensive.

Geological formations.—The Orange sand deposit is chiefly represented by the bed of white gravel. This can be observed in the upper part of cuts along the St. Louis Southwestern Railway as will be described later, and in general in the hilly or undulating country about Chambersville and Big Hill. In the plains its presence is determined chiefly by well excavations. Along Moro Creek, or just to the west where the plains break down to the alluvial soil, the pebble bed with its accompanying sands is always present. Along the Ouachita River the pebble bed was observed near the surface of the water on the north side at one or two places between Miller's Bluff and El Dorado Landing.

The undisturbed Tertiary deposits seem to be identical with those of southern and western Bradley county, that is, more or less lignitic and without any traces of animal remains.

Vicinity of Fordyce.—Along the St. Louis Southwestern Railway there are several low cuts in the vicinity of Fordyce that are interesting and instructive. Three miles and a quarter southwest of this place there is a cut 12 feet deep which shows very peculiar lines of bedding together with many roundish ferruginous concretions filled

with brownish and greenish black clay. Figure 26 represents a small part of the exposure on the north side of the railway at this place. One mile farther west the section

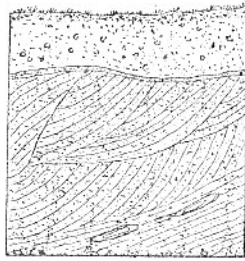


Fig. 26. Section on the St. Louis Southwestern Railway, three and a quarter miles west of Fordyce, Arkansas.

represented in Fig. 27 was obtained. The different beds may be thus characterized :

1. Soil with pebbles 2 feet.
2. Light gray laminated sand 3 1-2 feet.
3. Light gray massive sand 3 1-2 feet.
4. Very dark brownish sandy clay separated from the above by a line of unconformability 4 feet.

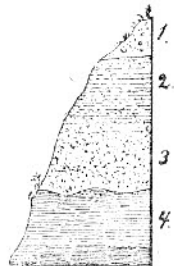


Fig. 27. Section on the St. Louis Southwestern Railway, four and a quarter miles west of Fordyce, Arkansas.

In going along the main road from Fordyce to Hampton, very few outcrops of undisturbed Tertiary beds were observed. However, on a northern slope about two and a half

miles from Fordyce some clay-stone concretions of considerable size, 3 feet or more in maximum diameter, were found. These rest in, and are overlaid by a tough bluish gray clay. Eighth miles further south similar exposures are found.

Well sections.—In digging wells in this county black clay and sand, or both, together with lignite are usually met with within less than 40 feet from the surface. Mr. Simmes, who bores many wells, especially in Cleveland county, states that 3 miles west of Kingsland the material passed through is as follows :

1. Soil, sand and clay 25 feet.
2. Black marl 15 feet.
3. "Coal" 7 feet.

The following section is taken from a well at A. W. Thomas' in the northern part of this county :

- "Soil, gray sand,
Subsoil, sandy clay or red ferruginous clay,
sometimes with gravel about 10 feet.
White sand 8 to 10 feet.
Pipe clay or sand with segregations of clay,
Black dirt, with fragments of leaves,
Lignite."*

The following well section is given by Owen as on Mr. William Thompson's place, one mile south of Hampton :

- Clay,
Gravel, with streaks of red clay,
Pipe clay 1 foot.
Black dirt and lignite. Total depth of well 23 feet.

At Mr. Harrews' half a mile east of Summerville, the writer was informed that in digging a well the following strata were met with :

1. Soil, sand and clay 8 feet.

*Owen's Second Report of a Geological Reconnoissance of Arkansas, 1860, pp. 137-138.

2. White sand with thin ferruginous lines of lamination 24 feet.
3. Black tough clay.

ASHLEY COUNTY.

Topography.—Ashley county is generally level, in fact it is almost one great plain, with only undulations and slight depressions in close proximity to streams. That portion, however, lying east of Overflow Creek and Bayou Bartholomew is about 30 feet lower than the plain to the west. The break between these two levels occurs generally about a mile west of the former creek. This county, like some portions of southern Drew is characterized by numerous small prairies. These are covered with coarse sedges, and the mounds which are scattered about at very irregular intervals support a growth of small trees and shrubs. Of these, sumac and sassafras are the most abundant, and they are often accompanied by black-berry briars. The sassafras trees sometimes attain a height of 20 feet and have a diameter of five inches. The mounds are from 100 to 800 feet apart and seldom rise over 3 feet high.

Geological formations.—That portion of Ashley county lying east of Overflow Creek is alluvium. Beds of this character were also seen along the left bank of the Saline River, but their extent cannot at present be given. It is moreover quite probable that all the southern half of the county has been inundated and has received deposits of considerable depth since the Eocene age. This statement is based upon the following facts: A resident of Pine Prairie, which is from 6 to 8 miles east of Hamburg, says that in digging and drilling wells in this region one finds below the soil, thick beds of joint clay and sand and at a depth of 80 feet a pebble bed is reached, some of the pebbles of which are as large as a hen's egg. This gravel bed contains an abundant supply of water. A partial section of the well

sunk to a depth of 60 feet at the Hamburg court-house is, according to Mr. Weissman of that place:

1. Sandy soil 3 to 4 feet.
2. ? 23 feet.
3. White pipe clay 10 feet.
4. Red clay 3 to 6 feet.
5. White quartz sand 20 feet.
6. Claystone concretions or geodes, yellow without, red, even black, within, small and numerous, forming a pebble bed from which an abundance of good water is obtained.

Specimens of No. 4, the red clay, were dug up from the mound where the material had been placed after digging, and it was found to resemble precisely the red sandy clay deposits, or the so-called chocolate clays, along the Arkansas River. The pebbles in No. 6 are evidently the same as may be seen in various places in the fossiliferous districts in northern Bradley county between Lee Hammaker's and Judge Hollis'. They probably mark the upper surface of the undisturbed Tertiary at this place.

The identification and the determination of the distribution of deposits referable to Orange sand was very difficult at the time of the writer's visit to Ashley county, owing to the almost complete mantle of snow that had recently fallen. Some material closely resembling the Orange sand was seen in the road-bed a mile west of Overflow Creek as one goes from Portland to Hamburg by the lower route. It consists of orange colored sand with here and there a quartz pebble. The latter however may have been erratic and the whole mass may be a Quaternary deposit. At Hamburg no white pebbles were seen, and it was said that they are limited to the northern or perhaps more particularly to the north-western half or third of the county.

In the Conway lignite bed about 2 miles below Blanchton, on the left bank of the Saline, there is a stratum of

white quartz pebbles immediately above the lignite, as stated on page 133.

The first white pebbles noticed by the writer north of Hamburg, were 7 miles distant from that place. Farther north wherever a glimpse could be had of the ground, the pebbles appeared to be quite abundant. A well recently dug about 1 mile north of Fountain Hill passed through at least 8 feet of Orange sand, largely composed of white quartz pebbles.

According to Owen "wells sunk at Fountain Hill reach water at a depth of 18 feet, passing through soil, subsoil, stiff red clay with some gravel, and white sand and gravel in which the water is found."* The writer was informed that in deeper wells a blue or light gray clay occurs to a depth of 40 feet. This clay contains some leaf impressions. Below the material is at first dark, bluish, and then almost black sandy marl that contains molluscan remains. Still below, leaves and twigs are very abundant.

Water obtained from the dark colored beds is here, as in Lincoln and Drew counties, more or less sulphurous and unfit for drinking purposes.

Blanchton lignite.—The bed of lignite on the left bank of the Saline already referred to was briefly described by Owen in 1860, but owing to the high stage of the river he did not see the coal itself and hence relying upon the statements of others was led into some slight errors.

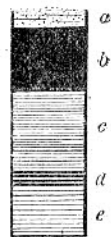


Fig. 28. Section on Saline River two miles below Blanchton, Ark.

Figure 28 shows the lignite where best exposed.

*Sec. Geol. Rep. of Recon. of Ark. 1860, p. 144.

- | | | |
|----|---------------------------------|-------------|
| a. | Light yellow sand | ? |
| b. | Lignite | 2 feet. |
| c. | Leaf bearing clay | 2 1-2 feet. |
| d. | Black. semi-lignitic clay | 6 inches. |
| e. | Clay | 1 1-2 feet. |

From the place where this section was obtained the strata dip at such an angle up stream that the top of *b* disappears, in the distance of 20 yards, beneath the level of the stream. The true amount and direction of the dip is six and one-half feet in 20 yards in a direction north 70° east. At the point of disappearance of bed *b* beneath the level of the water the following section was obtained:

- | | | |
|----|-----------------------------|-------------|
| 1. | Yellowish clayey loam | 3 1-2 feet. |
| 2. | White sand | 7 feet. |
| 3. | White quartz pebbles | 5 feet. |
| | Surface of water. | |

UNION COUNTY.

Topography.—Union county is traversed from Hillsboro westward by a well marked ridge or water-shed separating the tributaries of Smackover Creek on the north from those of the Big and the Little Cornie and Bayou de Luter on the south. This ridge averages from 250 to 300 feet above tide or roughly speaking from 130 to 180 feet above the Ouachita River. On both flanks of this broad ridge the surface of the country is undulating, broken only in the immediate vicinity of the water courses. Along the banks of the Ouachita there are occasional bluffs, as at Champagnolle, Wilmington, and Pigeon Hill, but these are exceptional, the banks being mainly composed of friable alluvial sands.

From Hillsboro eastward the land becomes less and less elevated and undulating and gradually descends to the bottom lands of the Ouachita.

Geological formations.—The greatest areal development of alluvium in this county is along the Ouachita River from Caryville southward, especially in that region lying north of

the Big Lapille Creek. The bottom land here averages from 4 to 6 miles wide. South of the Big Lapille the land is very low for an equal distance from the river but there are occasional ridges and mounds that appear to be formed of Tertiary material and that do not overflow.

Orange sand deposits, though nearly universally distributed over Union county do not seem to attain very great thickness. In the northern part of the county, especially along the confluents of the Smackover, beds of white quartz pebbles are very noticeable. Along the railway north of El Dorado these pebbles are often cemented into a ferruginous conglomerate, as they are also on the ridge between Mt. Holly and Shuler. Typical massive orange colored sand was observed in many places along the Lapille-Hillsboro road.

No white pebbles were seen along this road more than one mile east of Hillsboro. In that village they are strewn around over the various Tertiary outcroppings rather sparsely. In the vicinity of El Dorado it is very difficult if not impossible to distinguish beds of reworked material from those of primary deposition, owing to the extreme irregularity of the bedding exhibited in each and the similarity of the materials. (See sections below.)

Champagnolle.—In going down the Ouachita River, the first Tertiary outcrops exposed in Union county are those along the bluffs of Champagnolle. The following section will serve to illustrate the kinds of deposits occurring here:

1. Not well exposed, but apparently mostly
sand with a few bands of pinkish clay 72 feet.
2. Olive colored clay 7 feet.
3. Brownish, evenly laminated clay 5 feet.
4. Nearly black, brittle, clay shale 3 1-2 feet.
5. Hard, ferruginous, sandy layer 1-2 feet.
6. Bluish, micaceous clay, interlaminated with
thin, yellow layers 12 feet.

No. 5, or the hard, sandy layer, shows a dip down stream of 10 feet to 80 yards at one locality, though just below the

same layer rises again at the rate of 2 feet in 40 yards. It then continues along on a level for 40 yards beyond which it is concealed.

Vicinity of Wilmington.—One third of a mile above Wilmington Landing there is a steep bank rising up from the water level, composed of blue clay interlaminated with white sand; there are also some brownish clays and one thin layer of sandstone. The upper part of the bluff is very sandy. The hills back from the river seem to be from 60 to 80 feet above its surface.

Pigeon Hill.—At Pigeon Hill a ridge coming from the southwest forms a high bank on the south side of the river. The best exposures are found within a few feet of the water's edge and are limited to a distance of a quarter of a mile. The strata exposed show a considerable amount of disturbance. They exhibit an anticlinal fold whose flank descends at the rate of 20°, and which, as a whole, inclines to the north. Blue clays here predominate, though they are liberally interspersed with ferruginous concretions. In a few instances there are exposures in the bank 20 or 30 feet above the water. The material is very arenaceous, but there are some pinkish light clays in which impressions of dicotyledonous leaves are abundant; grass-like leaves are not uncommon, and one beautiful specimen of a large fern was noticed.

New London Landing.—At New London Landing a bed of lignite extends along near the water's edge for about 80 yards. At its westernmost point of exposure it rises about 2 feet above the surface of the water when the river is fairly low in summer. Forty or fifty yards farther east, it is but 1 foot above the same datum point; then it again rises to the east, but at a very moderate angle. It finally disappears under talus just above the water's surface. A thickness of at least 3 feet of this bed was seen, and it was said that in very dry seasons a thickness of no less than 6 feet has been observed.

This was the last locality seen by the writer where unquestionable Tertiary deposits are exposed along the banks of the Ouachita in the state of Arkansas. It is reported that lignite crops out about 3 miles below Jack's Island, but it was not observed.

From numerous outcrops of lignite in this region, Owen concluded that the whole country around the forks of the Ouachita and Saline Rivers is underlaid with beds of this material.*

Lake Landing.—Pool's or Lake Landing is about half a mile west of the "Lake," an overflow channel of the Ouachita River, on a ridge that rises just above high water and extends in a general northwest direction. The breadth of this ridge is from a quarter to a half mile at the landing, but it gradually widens to the northwest. Barren patches reveal a deep reddish soil with numerous ferruginous "buck shot" pebbles. Both corn and cotton are said to grow well in this soil, though the latter is subject to rust. On the western flank of this low rise the soil is black. Well borings at the Pool place consist wholly of a light, somewhat coherent sand. Going westward, the little rises along the road show a reddish soil which resembles disintegrated Eocene material. At Mr. White's, 2 miles west of Lapille, light colored sands are said to have been found in a well to a depth of 25 feet. About 10 miles from Hillsboro, in a ditch at the north side of the road, are beds of light clayey sand occasionally interlaminated with thin ferruginous crust-like seams. These are without doubt, undisturbed Tertiary deposits.

Hillsboro.—About Hillsboro there are many channels of erosion all of which exhibit good exposures of undisturbed Tertiary deposits. Perhaps the best of these are just to the north and south of Smith and William's store. Here the material consists of more or less laminated and coherent sand of a light brown color with occasional thin bands of

tough, brownish blue clay. In the clays which average from 1 to 3 inches in thickness, there are numerous thin seams of white sand with flakes of mica. Dicotyledonous leaves, together with particles of comminuted woody matter are found in these layers. Just northeast of the village there is a comparatively deep ravine in the banks of which good exposures, both of undisturbed and rehandled Tertiary material can be seen. The clay layers have here a tendency to form in concretions somewhat resembling those of the larger type at Vince Bluff on the Saline and those at Caveness Ferry. A peculiar slaty cleavage was noticed that seems to be the exact analogue of that in the Norristown sandstone of the Paleozoic.

The general dip of the beds observed in this vicinity appeared to be upon the whole slightly to the southeast though much variation is exhibited.

Vicinity of El Dorado.—About three and three quarter miles southwest of El Dorado on the Three Creeks road in Mr. Reeves' lot the following section was obtained:

1. Soil and reddish sand, grading into No. 2 5 feet.
2. Massive pure white sand..... 20 feet.
3. Somewhat as above, but becoming slightly clayey and more compact, and of a very light yellowish and greenish tinge, and containing some mica flakes 5 feet.
4. Becoming still deeper in hue and more clayey, greenish on exposed surfaces but deep blue within. This clay has a few seams of fine white sand, and breaks up into large rectangular blocks. Dicotyledonous leaves abound, but they are badly crumpled..... 20 feet.

It has already been remarked that in the immediate vicinity of El Dorado it is scarcely practicable to attempt a division of the beds exposed into undisturbed Tertiary and Orange sand. The figures here given (Figs. 29 and 30) show the general character of the material and the charac-

*Sec. Rep. of a Geol. Recon. of Ark., 1860, p. 137.

teristics of its bedding as seen in a railway cut 800 yards north of the station.

Figure 29 represents the following beds:

- | | | |
|----|---------------------------------------|---------|
| a. | Reddish soil, with a few pebbles..... | 2 feet. |
| b. | Gray sand with red bands..... | 3 feet. |
| c. | Grayish white sand..... | 4 feet. |
| d. | Concealed by talus..... | 2 feet. |

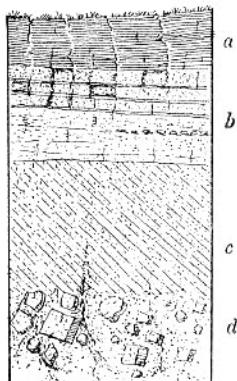


Fig. 29. Section on the Camden and Alexandria Railway, west side, 800 yards north of the station at El Dorado, Union county, Ark.

The beds represented in Fig. 30 are as follows:

- | | | |
|----|---------------------------------|---------|
| a. | Reddish sand..... | 3 feet. |
| b. | Clay, light bluish..... | 1 foot. |
| c. | Red banded light gray sand..... | 1 foot. |
| d. | White sand..... | 1 foot. |
| e. | Light gray sand and talus..... | 2 feet. |

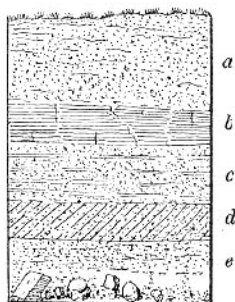


Fig. 30. Section on the Camden and Alexandria Railway, east side, 800 yards north of the station at El Dorado.

Along the railway, about a mile and a half north of El Dorado occur several fairly good exposures. One exhibiting very irregular bedding is shown in Figure 31.

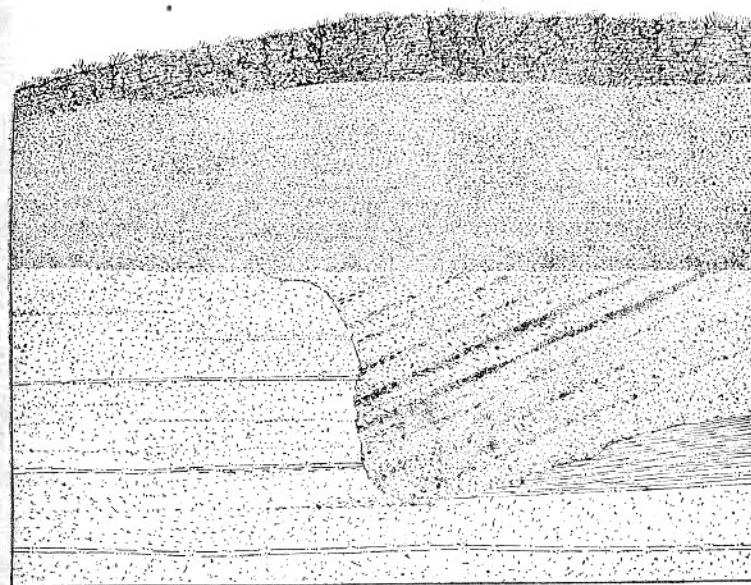


Fig. 31. Section at a cut on the Camden and Alexandria Railway a mile and a half north of El Dorado, Union county, Arkansas.

The uppermost part consists of a reddish sandy soil 1 foot in thickness. Below is 3 feet of yellow sand, which is in turn underlaid by grayish sand with brown clayey bands to the left and by pebbly sands to the right. A thick brown clay seam underlies the pebbly sand bed and contains dicotyledonous leaf impressions.

Fossil fresh-water shells.—The most interesting exposure seen along this road is 3.3 miles from El Dorado in 17 S., 15W., section 9, the southeast quarter of the southeast quarter. This is represented in Fig. 32.

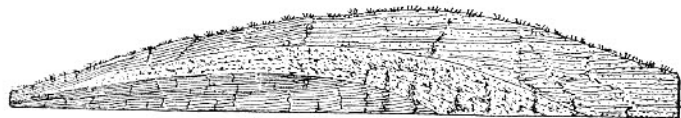


Fig. 32. Diagram of the beds exposed in the east side of a cut on the Camden and Alexandria Railway 3.3 miles north of El Dorado, Arkansas.

The lowest number represented consists of a dark brownish lignitic clay which breaks up into large conchoidal fragments. In it are thin seams of white sand, and the whole mass has the appearance of dipping to the north. The most remarkable feature of this bed is that it contains numerous impressions of fresh-water shells, especially a *Unio*⁸² and a *Vivipara*.⁸³ These occur most abundantly about 1 foot above the base of the section or above the bottom of the road ditch. In the dark clays above are numerous well preserved impressions of dicotyledonous leaves.

Resting upon this clay bed is a stratum of light gray sand that appears to lap upon and over the eroded surface of the clay below. This and the next higher or yellowish earth layer thicken rapidly southward and form there the total height of the exposure.

If the elevation of the Camden station of the railway on which this cut is located, is correctly given at 158 feet, the altitude of the lignitic clay is 190 feet above tide.*

Between this point and Camden, there are numerous good exposures of undisturbed Tertiary beds. The pebble bed is usually very thin and often absent. Ferruginous indurated beds, representing doubtless both undisturbed and re-handled Tertiary material, are frequently met with.

*The "Cotton Belt" station at Camden has an elevation of 143 feet.

OUACHITA COUNTY.

Walnut Bluff.—In descending the Ouachita River below Camden, the first indication of Tertiary deposits along the banks was noted at Frenchport. At this place there is a pebble bed at the water's edge which has the appearance of those so often referred to as lying immediately upon undisturbed Tertiary. About 4 miles down stream from this point, at Walnut Bluff occurs the most interesting section seen on the river; a profile of it is given in Fig. 33.

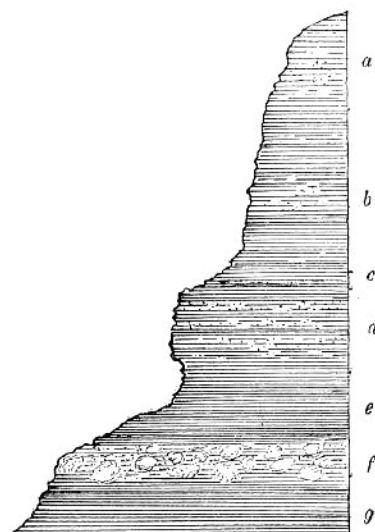


Fig. 33. Section of Walnut Bluff, Ouachita River (right bank) 4 miles below Frenchport, Arkansas.

The uppermost bed *a*, outcropping at this place consists of a light, sandy lignitic clay which becomes darker and more clayey below; thickness 5 feet. The projecting arenaceous bands *d*, in the middle of the profile are both underlaid and overlaid by black, or very dark clay (*c* & *e*). The concretionary bodies *f*, represented near the bottom of the section in sandy clay, consist of highly ferruginous sandstone and contain casts of Eocene fossils. These are rare and are only obtained in fragmentary form. The most

abundant are species of *Cytherea*, closely resembling *C. poulsoni*,²⁶ *C. discoidalis*,²⁵ and *C. subcrassa*,²⁷

Among the others are *Cardium* sp., *Tellina*,³¹ *Crassatella* (*C. texana*?)²¹, *Terebra houstonia*⁴⁴ Harris, *Levifusus tra-beatooides* Harris, and a few less distinct forms. Upon the whole the fauna seems to belong to the Claiborne rather than the Lignitic stage. Below this fossiliferous bed are more dark clays.

The particular interest in this locality centers upon the fact that here are found poorly preserved, yet more or less recognizable, marine molluscan remains. With this exception, all deposits seen by the writer either south or west of Bradley county appear to be wholly destitute of such vestiges.

Newport Landing.—A few miles further down the river, at Newport Landing, a bluff extends along the right bank of the river for about a third of a mile. The various beds exposed have an eastern dip of about 1 foot in 200. The following section was obtained a quarter of a mile above the landing:

1. Soil, reddish, sandy 1 foot.
2. Light, gray sand and shale, with a few ferruginous laminae and streaks of pinkish clay...24 feet.
3. Pinkish brown clay with leaf fragments..... 8 feet.
4. Dark, carbonaceous clay12 feet.
5. Like No. 4 but becoming lighter and more sandy 5 feet.
6. Dark sandy clay, somewhat reddish or brownish above and greenish below with ferruginous concretions10 feet.
7. Dark sandy clay with northeast and southwest joints; lower portion brownish and full of fragments of leaves and wood15 feet.

Lignite is reported from several localities in this vicinity. The only outcrop seen by the writer was in a little creek

channel perhaps half a mile southwest of the bluff just described. This lignite resembles closely that on the Conway estate on Saline River.

Miller's Bluff.—At Miller's Bluff the following section occurs (See Fig. 34): A thin soil *a*, is underlaid by a variable thickness of whitish sandy clay *b*, which is doubtless rehandled Tertiary material. Below this is a bed of chert pebbles *c*, 6 inches thick, resting very unconformably on the bed below. The latter *d*, consists of brownish sandy clay with thin bituminous layers showing a strong northwest dip. The total thickness of this bed is 15 feet.

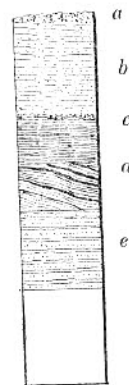


Fig. 34. Section at Miller's Bluff, Ouachita county, Ark.

Below this clay bed is a bed 12-15 feet thick of alternating, thin-banded sand and brown clay *e*. This presents a smooth unbroken front. From the base of this bed to the river's surface at the time of the writer's visit, a vertical distance of 15 feet, no outcrops were visible.

CHAPTER VII.

ORGANIC REMAINS OF THE CLAIBORNE AND JACKSON STAGES,
IN SOUTHERN ARKANSAS.

VERTEBRATA.

(1) Sharks' teeth.

Localities:

White Bluff. Owen's Sec. Rep. of a Geol.
Recon. of Ark., Pl. 9., fig. 7.

Station 2404, Hammaker's well, 12S., 9W.,
section 8.

2231, Rison, town well.

INVERTEBRATA.

MOLLUSCA (MARINE).

PELECYPODA.

(2) *Ostrea* sp.

A species known only by fragments and casts. In some
localities very abundant and forming *Ostrea* beds.*

Localities:

Red Bluff, Arkansas River.

Station 2423, well 100 yards northwest of Ris-
on depot.

2420, Cross Roads Church 5 miles north-
west of Kingsland.

2430, 10S., 11W., section 33, the south-
east quarter.

(3) *Ostrea* sp.

A small triangular deep valve somewhat resembling the

adult form of *O. thirsa*, but resembling still nearer the young
of *O. alabamensis*.

Locality:

White Bluff, Arkansas River.

(4) *Pecten claibornensis* Conrad.

Philadelphia Academy collection.

This rather small, thin *Pecten*, appearing smooth to the
naked eye, when examined under a microscope is found to
contain minute excurving radiate lines especially near the
anterior and posterior margins. It is fairly abundant at
Moody's Branch near Jackson, Miss.

Localities:

Station 2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2430, 10S., 11W., section 33, southeast
quarter.

2234 and 2403, three quarters of a mile
above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., sec-
tion 8.

2408, Wadsworth's well, 14S., 6W., sec-
tion 5.

(5) *Avicula* sp.

Fragments of a species evidently closely related to *A. lim-
ula* Conrad.

Localities:

Station 2420, Cross Roads Church, 5 miles
northwest of Kingsland.

2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2430, 10S., 11W., section 33, southeast
quarter.

2219, St. John's well, near New Edin-
burgh.

*Call's Report on Crowley's Ridge, An. Rep. Geol. Surv. of Arkansas, Vol. 11, 1889
pp. 12, 154, 163, etc.

Station 2234, three quarters of a mile above
Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

2412, Cornish Ferry.

(6) *Modiola texana* Gabb.

Proceedings Phila. Acad. Nat. Sci., 1861, p. 371

Localities:

Station 2423, well 100 yards northwest of Rison Station.

? 2424, Marks Mills battle field.

(7) *Byssoarca cuculoides* Conrad.

Fossil Shells of the Tertiary Formation, 1833,
part 3., p. 37. *B. lima* Conrad.

Localities:

Station 2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2404, Hammaker's well, 12S., 9 W.,
section 8.

2403, three quarters of a mile above
Vince Bluff, Saline River.

(8) *Nucula magnifica* Conrad.

Fossil Shells of the Tertiary Formation, 1833,
part 3, p. 37.

N. ovula Dall, Ark. Geol. Sur. An. Rep. for
1889, Vol. II, p. 8.

This is a small thin form, but in general characters it appears to correspond with this species.

Localities:

White Bluff.

Wadsworth's well, 14S., 6W., section 5.

(9) *Nucula* sp.

Possibly a variety of *N. ovula* Lea. Generally in form of casts.

Localities:

Station 2420, Cross Roads Church, 5 miles northwest of Kingsland.

2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2403, three quarters of a mile above
Vince Bluff, Saline River.

2219, St. John's Well.

2429, Boyd's place, 11S., 11W., section 8.

(10) *Nuculana protexta* Conrad (*N. protexta* Con.).

Amer. Jour. of Conchology, Vol. I, 1865, p.
147, Pl. 11, fig. 6.

Rather obscure casts apparently of this species.

Localities:

Station 2431, one and a half miles south of
Toledo.

? 2234, three quarters of a mile above
Vince Bluff, Saline River.

(11) *Leda mater* Meyer.

American Journal of Science, (3), Vol. XIX,
1885, p. 460, and Bull. No. 1. Ala. Geol.
Surv., 1886, p. 79, Pl. 3, fig. 20.

Generally in the form of casts.

Localities:

Station 2234, 2403, three quarters of a mile
above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

2420, Cross Roads Church, 5 miles
northwest of Kingsland.

2422, J. H. Marks place, 11S., 11W.,
section 4.

2414, 11S., 11W., section 4, southwest
of the southwest quarter.

Station 2429, Boyd's place, 11S., 11W., section 8, southwest quarter.
 ? 2430, 10S., 11W., section 33, southeast quarter.
 Cow ford.

(12) *Leda multilineata* Conrad.

Wailes' Agriculture and Geology of Miss. 1854, Pl. 14, fig. 4. Proceedings Phila. Acad. Nat. Sci. 1855, p. 258.

Localities:

Station 2420, Cross Roads Church, 5 miles northwest of Kingsland.
 2422, J. H. Marks place, 11S., 11W., section 4.
 2430, 10S., 11W., section 33, southeast quarter.
 2403, three quarters of a mile above Vince Bluff, Saline River.
 Cow ford, Saline River.
 • 2428, near Orlando, two thirds of a mile south of Judge Hollis'.
 2404, Hammaker's well, 12S., 9W., section 8.

(13) *Leda albirupina* n. sp. Pl. VI. fig. 1.

The general outline and appearance of this species can be seen by consulting Pl. VI. fig. 1. This is an adult specimen. When young, the form is slightly more arcuate and gibbous.

Specific characters: Presence of fine concentric striae on the posterior portion of the shell which bifurcate anteriorly and vanish entirely upon reaching a well marked sulcus which radiates from the umbo to the anterior basal margin; anterior portion, as well as posterior dorsal slope smooth and polished; the latter is traversed by a faint radiating fold.

This species has much the same general outline as *L. plicata* Lea, the surface of its anterior portion recalls that of *L. media* Lea.

Localities:

White Bluff, Arkansas River, Arkansas.
 Wadsworth's well, Long Prairie, Drew county.

(14) *Venericardia* sp.

Indistinct casts.

Localities:

Station, 2429, Boyd's place, 11S., 11W., sec. 8.
 2430, 10S., 11W., section 33, southeast quarter.

(15) *Venericardia parva* Lea.

Cont. to Geol. 1833, p. 49, Pl. 2, fig. 49.

Localities:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.
 2219, St. John's place near New Edinburgh.
 2412, Cornish Ferry, Saline River.

(16) *Venericardia rotunda* Lea, var.

Cont. to Geol. 1833, p. 70, Pl. 11, fig. 48.

The form in question differs somewhat from *V. rotunda* of Lea. It is a much smaller shell, has more costæ, and the imbrications on the same are much more regular. *V. tetrica* or *jacksonensis* of Conrad has a thicker, higher beak than this form does.

Localities:

Station 2420, Cross Roads Church, 5 miles northwest of Kingsland.
 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.
 2219, St. John's well near New Edinburgh.
 2422, J. H. Marks place, 11S., 11W., section 4.

Station 2234, 2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

2412, Cornish Ferry, Saline River.

(17) *Venericardia planicosta* Lamarck.

An. des. Mus. Vol. IX, Pl. 31, fig. 10.

V. planicosta, Owen's Sec. Rep. of a Geol. Recon. of Ark. 1860, Pl. 9, figs. 2, 2a, 2b.

Cardita densata, ibid, p. 35.

Cardita planicosta Heilprin, Cont. to Geol. and Pal. 1884, p. 37.

V. planicosta Call, Vol. II. Ann. Rep. Geol. Surv. of Ark. for 1889, p. 8.

Localities:

Station 2220, White Bluff, Arkansas River.

2402, White Bluff, Arkansas River.

2231, town well at Rison.

2423, 100 yds. northwest of Rison Station.

2413, well south of railway at Rison.

2424, Marks Mills battle field.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. Johns well, near New Edinburgh.

2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9 W., section 8.

Railway cut near the station at Warren.

2411, railway cut 3 miles east of Warren.

2408 Wadsworth's well, 14S., 6W., section 5.

(18) *Astarte parilis* Conrad.

Wailes' Agriculture and Geology of Miss., 1854, Pl. 14, fig. 2.

The Arkansas forms are much smaller than those from Mississippi.

Localities:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9 W., section 8.

(19) *Alveinus* sp.

Cast of a shell apparently belonging to this genus though double the size of *A. minuta* Con.

Locality:

Station 2429, Boyd's place, 11S., 11W., section 8, southwest quarter.

(20) *Crassatella protexta* Conrad.

Fossil Shells of the Tertiary Formation, 1832, part 2, p. 22, Pl. 8, fig. 2.

Localities:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. John's well, near New Edinburgh.

2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9 W., section 8.

(21) ? *Crassatella texana* Heilprin.

Proceedings Phila. Acad. Nat. Sci. 1890, p. 406, Pl. 9, fig. 6.

A fragmentary cast evidently belonging to this type of *Crassatella*.

Locality:

Walnut Bluff, Ouachita River.

(22) *Gouldia pygmaea* Conrad.

* Am. Jour. of Conchology, Vol. I, 1865, p. 139,
Pl. 21, fig. 5.

Much larger and proportionally longer than the type.

Locality:

Station 2412, Cornish Ferry, Saline River.

(23) *Lucina* sp.

A small shell resembling in a general way *L. crenulata*, but without the crenulations. Doubtless specifically identical with a rather common form at Moody's Branch, Jackson, Mississippi, though not so inflated.

Localities:

Station 2403, three quarters of a mile above
Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9 W., section 8.

(24) *Sphaerella* sp.

Casts and fragments belonging to this genus are very common in the Jackson beds of Arkansas.

Localities:

Station 2420, Cross Roads Church, 5 miles
northwest of Kingsland.

2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2430, 10S., 11W., section 33, the south-
east quarter.

2219, St. John's well near New Edin-
burgh.

2403, three quarters of a mile above
Vince Bluff, Saline River.

(25) *Cytherea discoidalis* Conrad.

Fossil shells of the Tertiary Formation, part. 3,
1833, p. 37.

C. trigonata Lea, Cont. to Geol. 1833, p. 67, Pl.
2, fig. 44.

C. sp. unid. Owen's Sec. Rep. of a Geol. Recon.
of Ark., 1860, Pl. 9, figs. 4a, 4b.

C. nuttalli? Heilprin, Cont. to Geol. and Pal.
1884, p. 37.

C. nuttalli Call, An. Rep. Geol. Surv. of Arkan-
sas, Vol. II, 1889, p. 8.

Localities:

White Bluff, Arkansas River.

Station 2413, well at Rison.

2419, Walnut Bluff, Ouachita River.

2420, Cross Roads Church, 5 miles north-
west of Kingsland.

2403, three quarters of a mile above
Vince Bluff, Saline River.

2412, Cornish Ferry, Saline River.

(26) *Cytherea poulsoni* Conrad.

Fossil Shells of the Tertiary Formation, part 3,
1833, p. 36.

Impression of exterior of a *Cytherea* apparently belonging
to this species.

Locality:

Walnut Bluff, Ouachita River.

(27) *Cytherea subcrassa* Lea.

Cont. to Geol. 1833, p. 67, Pl. 2, fig. 43.

Numerous casts of this or a closely allied species.

Locality:

Walnut Bluff, Ouachita River.

(28) *Cytherea securiformis* Conrad.

Amer. Jour. Conchology, Vol. I, 1865, p. 137,
Pl. 10, fig. 1.

Localities:

Station 2234, 2403, three quarters of a mile
above Vince Bluff, Saline River.

Station 2422, J. H. Marks place, 11S., 11W., section 4.

(29) *Cytherea annexa* Conrad.

Amer. Jour. Conchology, Vol. I, 1865, p. 137,
Pl 10, fig. 5.

Localities:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. John's well near New Edinburgh.

(30) *Tellina linifera* Conrad.

Amer. Jour. Conch. Vol. I, 1865, p. 138, Pl. 10,
figs. 16, 18,

Localities:

Station 2234, 2404, three quarters of a mile above Vince Bluff, Saline River.

2429, Boyd's place, 11S., 11W., section 8.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2422, J. H. Marks place, 11S., 11W., section 4.

(31) *Tellina*.

There are at least three species represented by fragments and casts as follows:

1st. At White Bluff, cast 7-8 by 1 1-4 inches.

2nd. At Station 2414 and 2420, a small nearly equilateral, inflated form.

3rd. At Walnut Bluff, a form resembling the last, but larger and more inflated.

32) *Maetra* sp.

A small, very common species about the size of *M. parilis* though very different otherwise. It is identical with an undescribed form from Bailey's marl bed, Jackson Miss.

Localities:

Station 2420, Cross Roads Church, 5 miles from Kingsland.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. John's well near New Edinburgh.

2422, J. H. Marks place, 11S., 11W., section 4.

2429, Boyd's place, 11S., 11W., section 8.

2430, 10S., 11W., section 33, the southeast quarter.

2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., sec. 8.

2412, Cornish Ferry, Saline River.

(33) *Maetra albirupina* sp. nov. Pl. VI, fig. 2.

For the size and general features of this species see Pl. VI, fig. 2. This is a thin and rather fragile shell, resembling in a superficial way *Maetra parilis* Conrad, though in reality it is very different. The exterior markings in both species are similar, but in that species the anterior end is produced, in this, the posterior.

Locality:

White Bluff, Ark.

(34) *Corbula* sp.

Obscure fragments.

Localities:

Station 2428, a half mile northwest of Orlando at the roadside.

Cow ford, Saline River.

(35) *Corbula bicarinata* Conrad.

Wailes' Agriculture and Geology, Miss., 1854,
Pl. 14, fig. 3. Proceed. Phila. Acad. Nat. Sci., 1855, p. 258.

Localities:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2422, J. H. Marks place, near 2414.

2234, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

2412, Cornish Ferry, Saline River.

2408, Wadsworth's well, 14S., 6W., section 5.

(36) *Corbula oniscus* Conrad.

Am. Jour. Sci., (1), 1833, Vol. 23, p. 341.

C. oniscus Call, Ann. Rep. of Geol. Surv. of Ark., Vol. II, 1889, p. 8.

Call cites this species from White Bluff, but the writer was unable to find it there.

(37) *Corbula nasuta* Conrad.

Fossil Shells of the Tertiary formation, part 3, 1833, p. 38.

C. alabamensis Lea, Cont. to Geol., 1833, p. 45, Pl. 1, fig 12.

C. alabamensis Call, Ann. Rep. Geol. Surv. of Ark., Vol. II, 1889, p. 8.

C. alabamensis Owen, Sec. Rep. of a Geol. Recon. of Ark., 1860, p. 35, Pl. 9, figs. 8, 8a.

This form is by no means a typical *nasuta* and may prove to be a distinct species.

Localities:

White Bluff, Arkansas River.

Station 2231, Public well, Rison, Ark.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. John's well near New Edinburgh.

(38) *Gastrochæna* sp.*Locality:*

Station 2234, three quarters of a mile above Vince Bluff, Saline River.

SCAPHOPODA.

(39) *Dentalium minutistratum* Gabb?

Jour. Phila. Acad. Nat. Sci., (2) 1860, p. 386, Pl. 67, fig. 46.

D. turritum Call, Ann. Rep. Geol. Surv. of Ark. Vol. II, 1889, p. 8.

The type specimens of this species are larger and show more marked external striations than do the Arkansas representatives.

Localities:

Station 2402, White Bluff, Arkansas River.

? 2420, Cross Roads Church, 5 miles northwest of Kingsland.

? 2422, J. H. Marks place, 11S., 11W., section 4.

2408, Wadsworth's well, Long Prairie.

(40) *Cadulus*.

Specimens too imperfect to admit of specific determination. They may be separated as follows:

1st. A slender form like *C. jacksonensis* Meyer.

Locality:

Station 2422, J. H. Marks place, 11S., 11W., section 4.

2nd. Specimens resembling *C. juvenis* Meyer, but rather larger.

Localities:

Station 2404, Hammaker's well, 12S., 9W., section 8.

2412, Cornish Ferry, Saline River.

2408, Wadsworth's well, Long Prairie.

3rd. Forms resembling *C. turgidus*.

Localities:

Station 2404, Hammaker's well, 12S., 9W., section 8.

2408, Wadsworth's well, 14S., 6W., section 5.

GASTROPODA.

(41) *Actæon pomilius* Conrad.

Fossil Shells of the Tertiary Formation, 1833, p. 45.

? *A. idoneus* Con. Fossil Shells of the Tertiary Formation, 1833, p. 45.

A small but perfect specimen.

Locality:

White Bluff, Arkansas River.

A fragment of a much larger specimen of probably the same species was obtained from Station 2408, Wadsworth's well, Long Prairie, Drew county.

(42) *Bullinella jacksonensis* Meyer.

Bull. Ala. Geol. Surv. No. 1., 1886, p. 77, Pl. 2, fig. 25.

The specimens from the following localities though imperfect, seem to belong to this species.

Localities:

Station 2420, Cross Roads Church, 5 miles northwest of Kingsland.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2219, St. John's well.

2204, Hammaker's well, 12S., 9W., section 8.

(42a) *Bullinella jacksonensis* var. *exta*, nov. var. Pl. VI., fig. 3.

By comparing *C. galba* Con. with *C. jacksonensis* Meyer, it will be found that the former is much more cylindrical

than the latter. The White Bluff form represents a yet greater removal from the *galba* type. Moreover, the upper extremity of the outer lip is generally slightly produced, giving the shell a *Volvaria*-like aspect. This feature is not well shown in the specimen figured.

Locality:

White Bluff, Arkansas River.

(43) *Terebra*.

Small imperfect specimens of two species from:

1st. White Bluff, Arkansas River.

2d. Station 2403, three quarters of a mile above Vince Bluff, Saline River.

(44) *Terebra houstonia* var.

Geol. Surv. Tex., 5th Ann. Report.

Impressions in ferruginous sandstone concretion.

Walnut Bluff, Ouachita River.

(45) *Conus sauridens* Conrad.

Fossil Shells of the Tertiary Formation, part 2, 1833, p. 33.

Fossil Shells of the Tertiary Formation, 1835, p. 38, Pl. 15, fig. 7.

Localities:

Station 2234, three quarters of a mile above Vince Bluff, Saline River.

2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

(46) *Pleurotoma* sp.

An undescribed Jackson species.

Locality:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

(47) *Levifusus trabeatoides* Harris.

5th Ann. Rept. Geol. Surv. Tex.

Locality:

Station 2419, Walnut Bluff, Ouachita River.

(48) *Pleurotoma americana* Aldrich.

Bull. No. 1, Ala. Geol. Surv., 1886, Pl. 1, fig. 16.

Locality:

Station 2403, three quarters of a mile above
Vince Bluff, Saline River.

(49) *Pleurotoma*.

Species very close to *childreni*, probably a varietal form
of this species.

Localities:

Station 2402, White Bluff.

2404, Hammaker's well, 12S., 9W., sec-
tion 8.

(50) *Pleurotoma*.

Species near *lonsdalii*.

Locality:

Station 2404, White Bluff.

(51) *Cancellaria impressa* Conrad.

Amer. Jour. Conchology, Vol. I, 1865, p. 145,
Pl. 11, fig. 16.

Locality:

White Bluff, Arkansas River.

A few imperfect fragments perhaps of this species were
obtained from Hammaker's well, 12S., 9 W., section 8.

(52) *Olivella*.

Small but perfect specimen, indistinguishable from the
young of *O. alabamensis*.

Locality:

Station 2404, Hammaker's well, 12S., 9W., sec-
tion 8.

(53) *Pseudoliva vetusta* Conrad.

Fossil Shells of the Tertiary Formation, No. 4,
1833, p. 44.

Fossil Shells of the Tertiary Formation, 1835, p.
37, Pl. 15, fig. 3.

P. vetusta Call, Ann. Rep. Geol. Surv. of Ark.,
for 1889, Vol. II, p. 8.

Localities:

White Bluff, Arkansas River.

Station, 2413, Rison.

2403, three quarters of a mile above
Vince Bluff, Saline River.

2234, three quarters of a mile above
Vince Bluff, Saline River.

2408, Wadsworth's well, Long Prairie.

(54) *Ancillaria subglobosa* Conrad.

Fossil Shells of the Tertiary Formation, No. 2,
1832, p. 25, Pl. 10, fig. 3.

A. subglobosa Call, Ann. Rep. Geol. Surv. Ark.,
1889, Vol. II, p. 8.

Call reports this species from White Bluff. The writer
was unable to find it there. An immature form of *P. vetusta*
found there has somewhat the appearance of the "*Ancillaria*
subglobosa" figured in Owen's Sec. Rep. of a Geol. Recon-
noissance, 1860.

(55) *Marginella*.

A portion of a small specimen closely resembling the
young of *M. larvata* Conrad.

Locality:

Three quarters of a mile above Vince Bluff, Sa-
line River.

(56) *Volutilithes petrosus* Conrad.

Fossil Shells of the Tertiary Formation No. 3,
1833, p. 29.

Fossil Shells, of the Tertiary Formation, 1835, p.
41, Pl. 16, fig. 2.

Voluta Owen, Sec. Rep. of a Geol. Recon. of
Ark., 1860, Pl. 9, fig. 5.

Voluta sayana? Heilprin, Cont. to Geol. and Paleont., 1884, p. 37.

Voluta Call, Ann. Rep. Geol. Surv. Ark., Vol. II, 1889, p. 8.

Localities:

White Bluff, Arkansas River.

Stations 2231 and 2413, wells at Rison.

2420, Cross Roads Church, 5 miles northwest of Kingsland.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

2422, J. H. Marks place near New Edinburgh.

2403, three quarters of a mile above Vince Bluff.

2234, three quarters of a mile above Vince Bluff.

2404, Hammaker's well, 12S., 9W., section 8.

2412, Cornish Ferry, Saline River.

2411, railway cut, three miles east of Warren.

2408, Wadsworth's well, Long Prairie.

(57) *Caricella*,

Mere fragments.

Localities:

Station 2434, 2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

From the last mentioned locality the species is doubtless *C. subangulata* of Conrad.

(58) *Lapparia pactilis* Conrad, var.

Fossil Shells of the Tertiary Formation, No. 4, 1833, p. 46.

Fossil Shells of the Tertiary Formation, 1835, p. 43, Pl. 16, fig. 21.

A variety precisely like that at Moody's Branch near Jackson, Mississippi.

Localities:

Station 2403, three quarters of a mile above Vince Bluff, Saline river.

2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

(59) *Mitra hammakeri* sp. nov. Pl. VI, fig. 4.

Specific characters: General form as figured; whorls 6; apical 1 1-2, smooth; below, faintly sculptured by, (a) longitudinal folds or costæ, and by, (b) a slightly impressed sub-sutural line; body whorl spirally striate at base; columellar plaits, 4, the second, counting from above, slightly stronger than the others; labrum with about 12 crenules within.

This shell is proportionately much longer than *M. fusoides* Lea; the sculpturing too is less marked.

Locality:

Station 2404, 12S., 9W., section 8, Lee Hammaker's well, Bradley county, Ark.

(60) *Mitra millingtoni* Conrad.

Wailles' Agriculture and Geology of Miss. 1854, Pl. 16, fig. 5.

Proceed Phila. Acad. Nat. Sci. 1855, p. 261.

Localities:

Station 2234, 2403, three quarters of a mile above Vince Bluff, Saline River; large typical form.

At White Bluff a *Mitra* is found indistinguishable from this species except for its size. It is slightly more than an inch in length.

(61) *Levifusus branneri* sp. nov. Pl. VI, fig. 8.

The general features of this species are well represented in the figure, except that it was drawn from a young

specimen, hence the spire is slightly too long in proportion to the remainder of the shell. This is rendered more noticeable from the fact that the canal has been broken off.

Specific characters: Body whorl ornamented, (1) on the shoulder by a row of short, flattened, sharp-pointed tubercles (about 12 in number), (2) in the middle, by a row of flattened obtuse modulations (about 12 in number), (3) still lower by an obtuse spiral ridge over which the lines of growth are often prominent and distinctly arcuate.

The specimen figured is from Wadsworth's well, Drew county.

The body whorl of one specimen from White Bluff has a diameter of two inches.

Localities:

White Bluff, Arkansas River, Ark.

Station 2408, Wadsworth's well Long Prairie,
Drew county, Ark.

(62) *Fusus* sp.

A fragment of a *Fusus* was found at White Bluff which is probably of the same species as the "*Fusus magnocostatus*" of Owen's Second Report of a Geological Reconnaissance, 1860. The specimen in hand, however, can scarcely be referred to *F. magnocostatus* of Lea.

(62a) *Clavilithes humerosus* Conrad.

Wailes' Agriculture and Geology, Miss., 1854,
Pl. 15, fig. 2.

Proc. Phila. Acad. Nat. Sci., 1856, p. 259.

Locality:

Station 2234, three quarters of a mile above
Vince Bluff ford, Saline River.

(63) *Mazzalina inaurata* Conrad. Pl. VII, fig. 6.

Fusus inauratus Conrad, Fossil shells of the Tertiary Formations, No. 3, 1833, p. 29.

Fusus inauratus Conrad, Fossil shells of the Tertiary Formations, 1835, p. 53, Pl. 18, fig. 2.

?*Mazzalina pyrula* Conrad, Jour. Phila. Acad. Nat. Sci., (2), Vol. IV, p. 295, Pl. 9, fig. 1.

Fusus fittonii Lea, Cont. to Geol., 1833, p. 150, Pl. 5, fig. 156.

Fusus sp. Owen's Sec. Rep. of a Geol. Recon., 1860, Pl. 9, fig. 1.

Fasciolaria (Mazzalina) oweni Dall, Trans. Wagn. Free. Inst. Sc., Vol. III, 1890, p. 105, also *F. oweni*, Ann. Rep. Geol. Surv. of Ark., Vol. II, 1889, p. 8, foot-note.

The genus *Mazzalina* was found by Conrad on a specimen now in the Philadelphia Academy collection, figured on Pl. VII, fig. 2, of this report. This appears on first sight to be specifically and generically distinct from the common "*Fusus*" *inauratus* of the Claiborne sands, inasmuch as the latter is not generally known to have plications on the columella nor strong sharp lines within the labrum. By looking over many specimens from this locality, exceptions can be found. Both columellar plaits and labrum striations are sometimes present. A specimen in the Museum of Natural History of New York, labelled "*Bulbifusus inauratus*, Eocene, near Orangeburg, S. C." shows very strong columellar plicæ. At White Bluff, Arkansas, this species presents an astonishing amount of variation. Some are long while others are short; some have columellar plications and a striated labrum, others have neither; some have plications or striations, either poorly or well developed. Some of the more remarkable varieties from this locality are shown on Pl. VII, figs. 1, 3, 4, 5. At Rison, Cleveland county, the same variations are exhibited.

In studying these specimens it becomes evident that the plaits or folds on the columella are not such in the true sense of the word. They are simply accretions left at times of stoppage in the growth of the shells.

Localities:

White Bluff, Arkansas River.

Station 2413 and 2423, Rison.

2420, Cross Roads Church, 5 miles from Kingsland.

? 2424, Marks Mills battle field.

2423, three quarters of a mile above Vince Bluff, Saline River.

2411, cut on the railway, three miles east of Warren.

(64) *Mazzalina dalli* sp. nov. Pl. VII, fig. 7.

Shell, short, fusiform; whorls about five, convex, with a well marked constriction just below the suture; aperture a little over one half the length of the shell, somewhat constricted above; canal short, nearly straight; columella smooth; interior of labrum smooth or containing acute, more or less interrupted striae; shoulder or constriction, and lower part of body whorl marked by revolving lines; upper whorls of spire coarsely nodose; fine sinuous lines of growth appear over the whole surface, but are more noticeable at resting stages in the growth of the shell.

This may possibly prove to be but a small diseased form of *Mazzalina inaurata*.

Localities:

Station 2234, 2403, three quarters of a mile above Vince Bluff, Saline River.

? White Bluff, Arkansas River. *Merion* of Dall?

(65) *Phos albirupina* sp. nov. Pl. VI, fig. 5.

Specific characteristics: General form and markings as shown in the figure; longitudinal ribs sharp, about 22 on the body whorl; whorls 7, in adult specimens upper two or three quite destitute of ornamentation; spiral lines alternating in size, not so prominent as the ribs; lower collumellar margin defined by a sharp fold; labrum denticulations about 10 in number.

The specimen figured is from White Bluff, and is the most perfect one obtained, though it is not quite full grown.

Localities:

White Bluff, Arkansas River.

Station 2413, Rison.

(66) *Phos hilli* sp. nov. Pl. VI, fig. 6.

Specific characteristics: General proportions as shown in the figure; surface ornamented with sharply defined, *Scala*-like longitudinal ribs, about ten on the body whorl, and less prominent alternating spiral lines; columellar fold, denticulation, and number of whorls as in the above species.

The specimen figured is slightly below the normal size of the species, it was obtained near Vince Bluff, Saline River.

Localities:

Station 2404, Hammaker's well, 9S., 12W., section 8.

2403, three quarters of a mile north of Vince Bluff.

(67) *Murex marksi* sp. nov. Pl. VI, fig. 10.

Specific characteristics: Size and form as indicated by the figure; whorls 6; ornamented by, (a) six rather narrow and high costae on each whorl (not continuous from one whorl to another), and by, (b) strong revolving lines, about ten on the penultimate whorl and thirty on the body whorl; umbilicus small; canal nearly closed in front; labrum thickened within and bearing about ten teeth.

On the humeral region there is a slight tendency to carination. Between this faint carina and the suture the revolving lines are comparatively obscure.

This species is very closely allied to Conrad's *Murex en-gonatus* from the Claiborne sands, from which it differs however in having a much smaller umbilicus, a trace of a carina, and ribs or varices non-continuous from whorl to whorl.

Locality:

From a well one mile northeast of Pansy post-

office, Cleveland county, Ark. Mr.
Parkman, collector.

- (68) *Cassidaria petersoni* Conrad.
Wailes' Agriculture and Geology of Miss., 1854

Pl. 17, fig. 9.

Proceedings Phila. Acad. Nat. Sci., 1855, p. 262.

Localities:

Station 2422, J. H. Marks place, 11S., 11W.,
section 4.

2404, Hammaker's well, 12S., 9W., sec-
tion 8.

- (69) *Cypræa* sp.

Small fragments of a species about the size of a small
C. pinguis.

Locality:

Station 2403, three quarters of a mile above
Vince Bluff.

- (70) *Calyptrophorus velatus* Conrad.

Fossil Shells of the Tertiary Formation, No. 3,
1833, p. 31.

Localities:

Station 2414, 11S., 11W., section 4, southwest
quarter of the southwest quarter.

2422, J. H. Marks place, 11S., 11W.,
section 4.

2234, three quarters of a mile above
Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., sec-
tion 8.

2412, Cornish Ferry, Saline River.

- (71) *Turritella* sp.

Indeterminable fragments and casts.

Localities:

Station 2424, Marks Mills battle field.

Station 2219, St. John's place, near New Edin-
burgh.

2403, three quarters of a mile above
Vince Bluff, Saline River.

- (72) *Turritella alveata* Conrad.

Wailes' Agriculture and Geology of Miss., 1854,
Pl. 17, fig. 7.

Proceedings Phila. Acad. Nat. Sci., 1855, p. 263.

Locality:

Lee Hammaker's well, 12S., 9W., section 8.

- (73) *Turritella arenicola* var. *branneri*, var. nov. Pl. VI,
fig. 7.

SYN. *T. plebeia* Owen, Sec. Ann. Rep. Geol. Recon.
Ark., 1860, Pl. 9, fig. 6.

T. carinata? Heilprin, Cont. to Geol. and
Paleont. 1884, p. 37.

T. carinata Call, Ann. Rep. Geol. Surv. Ark.
1889, Vol. II, p. 8.

T. arenicola Dall, foot-note in Call's report
page 8.

This variety differs from true *arenicola* in having fewer re-
volving lines, less rounded whorls, and in being of consid-
erably smaller size.

Localities:

White Bluff, Arkansas River.

Station 2231, 2413 and 2423, Rison.

2420, Cross Roads Church, 5 miles
northwest of Kingsland.

2403, three quarters of a mile above
Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., sec-
tion 8.

2408, Wadsworth's well, Long Prairie,
Drew county.

- (74) *Turritella clevelandia* sp. nov. Pl. VI, fig. 9.
T. perdita ? Dall, Ann. Rep. Geol. Surv. Ark.,
 1889, Vol. II, p. 8.
 ?*T. mortoni* Call, Ann. Rep. Geol. Surv. Ark.,
 1889, Vol. II, p. 8.

Specific characteristics : Size and general form as indicated by the figure ; whorls 13 or 14 ; generally ornamented by about three prominent revolving lines and a few subordinate ones ; from the uppermost and lowest of the revolving lines the whorls slope abruptly to the suture, while between these lines the sides of the whorls are straight.

Localities:

White Bluff, Arkansas River.
 Rison.
 Toledo, Ozon place.
 Above Vince Bluff, Saline River.

- (75) *Solarium*.
 Unidentified fragments
Locality:
 Station 2408, Wadsworth's well, Long Prairie,
 Drew county.
- (76) *Solarium alveatum* Conrad.
 Fossil shells of the Tertiary Formation, No. 3,
 1833, p. 31.
 Fossil Shells of the Tertiary Formation, 1835,
 p. 47, Pl. 17, fig. 3.
Locality:
 Station 2234, three quarters of a mile above
 Vince Bluff, Saline River.
- (77) *Solarium bellastriatum* Conrad.
 Wailes' Agriculture and Geology, Miss., 1854,
 Pl. 17, fig. 2.
 Proc. Phila. Acad. Nat. Sci., 1855, p. 261.

Localities:

Station 2402, White Bluff, Arkansas River.
 2234, 2403, three quarters of a mile
 above Vince Bluff, Saline River.
 2428, near Orlando.

- (78) *Trochita*.

A medium sized, decorticated specimen.

Locality:

Station 2430, 10S., 11W., section 33, southeast
 quarter.

- (79) *Capulus americanus* Conrad.

Wailes' Agriculture and Geology, Miss., 1854,
 Pl. 15, fig. 1.
 Proc. Phila. Acad. Nat. Sci., 1855, p. 259.

Localities:

Station 2219, St. John's well near New Edin-
 burgh.
 2414, 11S., 11W., section 4, southwest
 quarter of the southwest quarter.
 2403, three quarters of a mile above
 Vince Bluff, Saline River.

- (80) *Natica eminula* Conrad.

Fossil Shells of the Tertiary Formation, No. 4,
 1833, p. 46,

Localities:

White Bluff, Arkansas River.
 Station 2231, Rison.
 2403, three quarters of a mile above
 Vince Bluff, Saline River.
 2408, Wadsworth's well, Long Prairie,
 Drew county.

- (81) *Natica semilunata* Lea.

Cont. to Geol. 1833, p. 108, Pl. 4, fig. 93.

Locality:

Station 2414, 11S., 11W., section 4, southwest quarter of the southwest quarter.

MOLLUSCA (FRESH-WATER.)

(82) *Unio*.

Casts of a species closely allied to *U. complanatus* Sol., found in lignitic clays as described on page 140.

Locality:

Camden and Alexandria Railway, three and three tenths miles north of El Dorado, Union county.

(83) *Vivipara*.

Casts found with No. 82.

RADIATA.

ECHINODERMATA.

(84) A Sea-urchin, Pl. VI, fig. 11.

Locality:

Station 2412, Cornish Ferry, Saline River.

ACTINOZOA.

(85) *Flabellum wailesi* Conrad.*Localities:*

Station, 2403, three quarters of a mile above Vince Bluff, Saline River.

2404, Hammaker's well, 12S., 9W., section 8.

2408, Wadsworth's well, Long Prairie.

(86) Corals, undetermined.

Localities:

Station 2403, three quarters of a mile above Vince Bluff, Saline River.

2219, St. John's well, near New Edinburgh.

PLANTÆ.

(87) *Magnolia ovalis* Lx.

Found with Nos. 82, and 83, three and three tenths miles north of El Dorado.

(88) *Quercus saffordi* Lx.

Found with Nos. 82, 83, and 87.

(89) A *Sabal* palm leaf.

Roadside, two miles southeast of New Edinburgh.

PLATE VI.

Fig.			Page.
1.	<i>Leda albirupina</i> sp. nov.	x 2	148
2.	<i>Mactra albirupina</i> sp. nov.	x $\frac{3}{2}$	155
3.	<i>Bullinella jacksonensis</i> var. <i>exta</i>	x $\frac{7}{2}$	158
4.	<i>Mitra hammakeri</i> sp. nov.	x 3	163
5.	<i>Phos albirupina</i> sp. nov.	x 3	166
6.	<i>Phos hilli</i> sp. nov.	x 3	167
7.	<i>Turritella arenicola</i> var. <i>branneri</i>	x $\frac{3}{2}$	169
8.	<i>Levifusus branneri</i> sp. nov.	x 2	163
9.	<i>Turritella clevelandia</i> sp. nov.	x 2	170
10.	<i>Murex marksi</i> sp. nov.	x $\frac{3}{2}$	167
11.	Cast of an undetermined echinoderm, somewhat compressed laterally		172

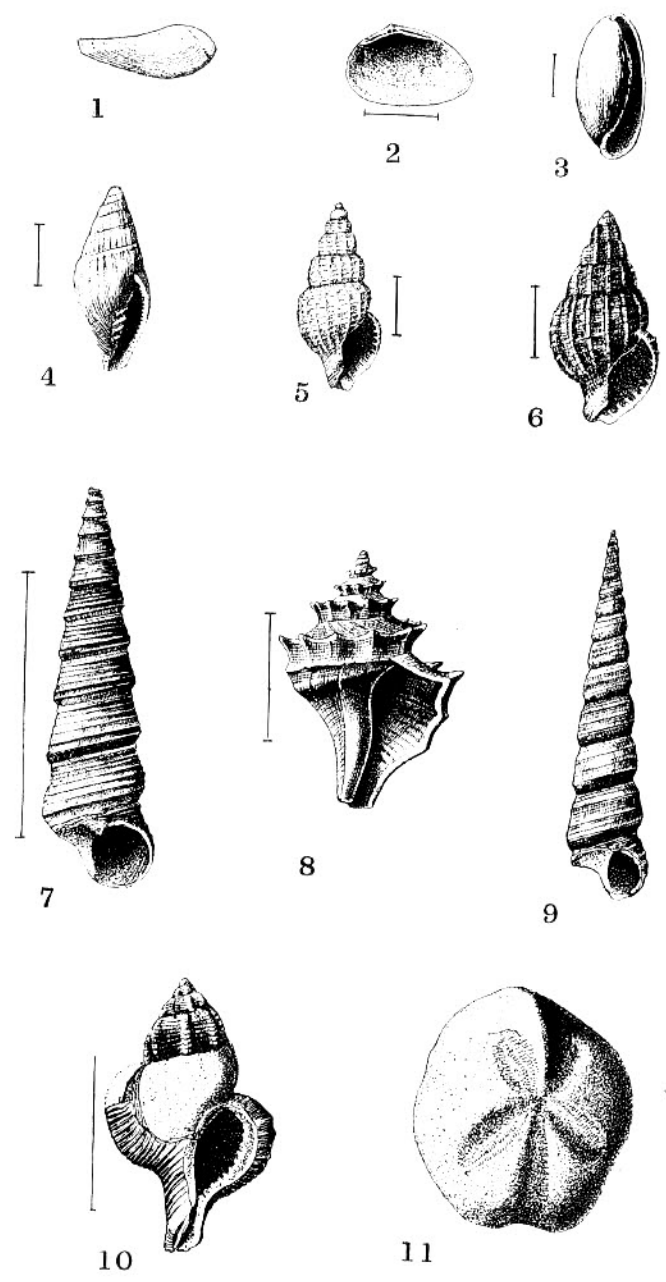
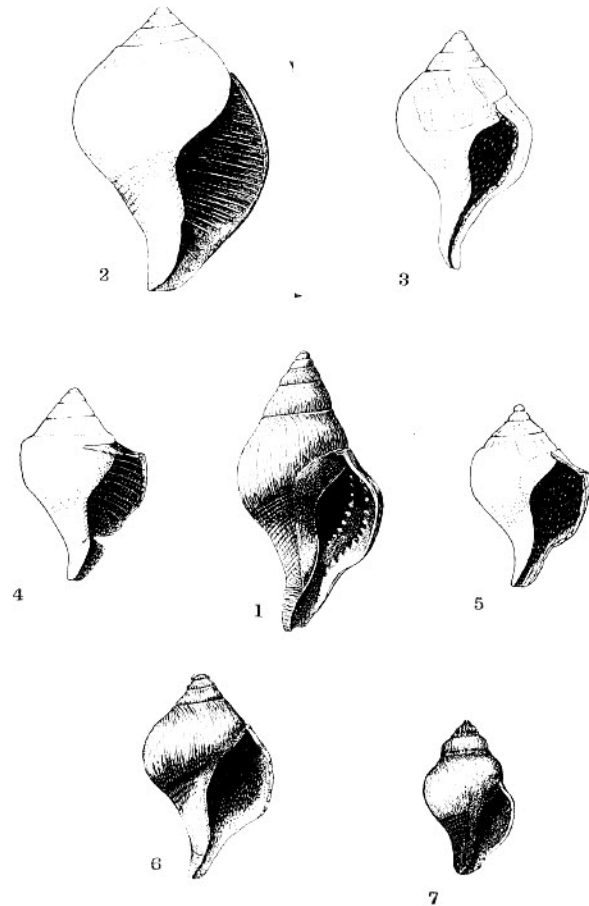


PLATE VII.

Fig.			Page.
1.	<i>Mazzalina inaurata</i> var. <i>oweni</i>	$x \frac{3}{2}$	165
2.	<i>Mazzalina</i> (<i>inaurata</i> ? var.) <i>pyrula</i> ..	$x \frac{3}{2}$	165
3.	<i>Mazzalina inaurata</i> var.	$x \frac{3}{2}$	165
4.	<i>Mazzalina inaurata</i> var. <i>humerosa</i> n. var.....	$x \frac{3}{2}$	165
5.	<i>Mazzalina inaurata</i> var.....	$x \frac{3}{2}$	165
6.	<i>Mazzalina inaurata</i> typical (from Claiborne).....	$x \frac{3}{2}$	164
7.	<i>Mazzalina dalli</i> sp. nov.....	$x \frac{3}{2}$	166



CHAPTRE VIII.

LOUISIANA.

THE CLAIBORNE STAGE.

The Claiborne Stage occupies a considerable area in north-western Louisiana,* extending in a general way from the Ouachita River westward to Texas and from Grant Parish northward to the Arkansas line. The writer's observations were very limited in this State, being confined to northern Bossier and Claiborne Parishes; but the collections in the National Museum, made by L. C. Johnson of the U. S. Geological Survey, prove the above general statement regarding the distribution of this stage beyond all doubt. Before entering upon paleontologic and stratigraphic details, it may be well to briefly consider the different views that have been held regarding the geological horizon or horizons here represented.

Hilgard in 1869 concluded from his field observations that nearly, if not all, this area is occupied by lignitic clays and sands representing a geological horizon above the Jackson strata and below the marls and limestone of the Vicksburg. To this lignitic phase he gave the name of Mansfield group.†

During the same year, a geological report on Louisiana was prepared by Dr. F. V. Hopkins and published in the Louisiana University Report for 1869, Part F. According to this author, the "Mansfield group" rests immediately upon the Cretaceous, and in passing south, dips beneath the Jackson stage.

* It must be borne in mind that the name "Claiborne stage" used in discussing the geology of Louisiana does not imply that the deposits referred to are the exact equivalents of the *Claiborne sand* of Alabama. More specifically, the stage might be denominated LOWER CLAIBORNE.

†Geol. Recon. La. 1869, pp. 8 and 9. Publ. in DeBow's Review, September 1869

In his report for the following year, Dr. Hopkins says that the new localities of fossils which he has discovered show that the "Mansfield group" is parallel in age with the marine Jackson strata.* Accordingly the whole Claiborne area of the state is represented on the geological map accompanying his report as "Jackson." He failed to discriminate between the true Jackson fossils occurring at Montgomery, Grant Parish, and those from Claiborne and Bienville Parishes of a Claiborne horizon.

These errors have to some extent been rectified by the researches of Lawrence C. Johnson, as may be seen by consulting his "Report on the Iron Regions of Northern Louisiana and Eastern Texas." Many obligations, he says, are due to Mr. Truman H. Aldrich of Cincinnati, "for the examination of fossils of Louisiana and of Texas."†

BOSSIER PARISH.

Section at Roberta.—In passing along the Shreveport Branch of the St. Louis Southwestern Railway through southern Lafayette county, Arkansas, one sees on all sides a monotonous level country, very peculiar for the retention of moisture at its surface and locally known as "hog-wallow" land. Soon after crossing into Louisiana, the surface becomes rolling and quite hilly. The first railway cut of considerable depth is found at Roberta. It presents the following beds:

No. 1. Soil	1 inch.
2. Solid red sand with a few light spots, and a few ferruginous pebbles	4 feet.
3. Sandstone, with laminae from 1-8 to 1 inch thick	1 foot.
4. Cross-bedded gray sands, turning red on exposure	2 feet.
5. Similar to No. 3	4 in's.
6. Similar to No. 4	1 foot.

*Sec. Ann. Rep., of the Geol. Surv. of La. In La. State University Rep. for 1870.
 †P. 54, Johnson's Rep., Ex. Doc. No. 136, 50th Congress, 1st Sess. 1888.

7. Similar to No. 3	3 inches.
8. Similar to No. 4	6 inches.
9. Similar to No. 3	4 inches.
10. Gray sand with yellow and red ferruginated flakes	30 inches.

The local dip is to the northeast.

Pope Joy cut—Farther south, a mile and a quarter from Plaindealing, fossils begin to appear in the cuts along the railway. Pope Joy cut, at about this locality, furnishes the best exposure in this parish. A section of the same is as follows:

No. 1. Sandy soil at top, reddish, becoming blacker for a few inches and then purplish and lighter at base, with ferruginous pebbles	4 feet.
2. Shelly ferruginous sandstone	6 inches.
3. Reddish sandstone, slightly argillaceous ..	6 inches.
4. Similar to No. 2	4 inches.
5. Reddish sandstone with layers of white plastic clay; soft and very ferruginous, showing patches here and there of yellowish, bluish and even greenish hues; fossil bearing	2 feet.
6. Light colored plastic clay; few arenaceous and ferruginous laminae in its upper portion. This bed is usually completely grassed over	2 1-2 feet.
7. Black, brittle clay	1 1-2 feet.
8. White tenaceous clay	10 inches.
9. Reddish, yellowish and white sandy clay ..	2 feet.
10. Yellowish and white sandy clay	2 1-2 feet.
11. Bluish black clay layers intermixed with fine seams of lighter sand; becoming brownish on weathering; resembling the Eocene of the Atlantic coast	3 feet.

Fossils are rare at this locality, but in the sandstone bed, No. 5 of the above section, *Venericardia planicosta*, *Turritella mortoni* (small), *Cytherea nuttalli?*, *Modiola texana*, together with a small gibbous *Tellina*, as at Walnut Bluff, were found.

Still nearer Plaindealing, only half a mile north of the station, small casts of *Cytherea*, *Maetra*, *Surcula*, *Dentalium*, *Nucula* and *Corbula* were found in fragments of concretionary sandstone.

Some distance to the northeast of these localities, in 23N., 12W., section 19, southeast quarter, (Station 2416 of Museum register), several very poorly preserved fragments of casts were found in ferruginous concretions. Among these were recognized, *Ostrea*, *Modiola texana*, *Tellina* (gibbous), *Maetra*, *Venericardia planicosta*, *Cytherea nuttalli?*, *Surcula* and *Flabellum*.

In this vicinity the hill tops are often strewn with fragments of ferruginous concretions, but it is only occasionally that they are found to be fossiliferous. Wells sunk about the lower portions of these elevations are said to pass through white clay for about 18 feet and then to enter a black, firm lignitic clay.

About 5 miles due south of this locality, (Station 2024, 23N., 12W., section 18) L. C. Johnson obtained in a ferruginous matrix, many casts of *Venericardia planicosta*, together with one specimen of "*Astarte conradi* Dana.

CLAIBORNE PARISH.

Vicinity of Homer.—Passing southward from Homer along the railway that connects that place with Gibbsland, one finds at intervals of from a quarter of a mile to a mile low cuts that furnish good exposures. Many sections have been made along this line, but they are as a rule uninteresting and uninformative, being simply made up of barren ferruginous clayey sands, showing irregularities in bedding precisely

like those described along the St. Louis Southwestern Railway, or along the Ouachita River in Arkansas.

Lignite.—North of Homer, the same uninteresting features obtain. Lignitic beds like those of Union county, Arkansas, have been penetrated in digging wells three miles southeast of State Line post-office.

Chert pebbles occur occasionally here and there, but they rarely form beds by themselves; moreover they are smaller than in Arkansas. Three miles north of Homer, on the Haynesville road, a silicified log, a foot and a half in diameter and at least 10 feet long was observed resting on lignitic clay and overlaid by reworked Tertiary material.

Claiborne fossils.—In the southern part of Claiborne Parish, Mr. L. C. Johnson collected many well preserved fossils that represent a typical lower Claiborne horizon, and contain in general the same species that are found in the Texan beds of the same epoch.

The most southern locality where such fossils have been found, and are now in the U. S. National Museum, is at "Station 2005, Mouth of Saline Bayou, La." The fauna has a decided resemblance to that two miles east of Newton, Miss., and includes, among other forms, *Limopsis aviculoides* Con., *Pecten deshaysii* Lea, *Pholadomya claibornensis* Aldr., *Ancillaria staminea* Con., *Pseudoliva linosa?* Con., *Distortio septemdentata* Gabb, and *Terebra houstonia* Harris.

THE JACKSON STAGE.

Creole Bluff.—A few miles southeast of Sta. 2005, at Creole Bluff, Montgomery, Grant Parish, Station 2003, the fauna assumes a typical Jackson aspect, and includes such species as *Conorbis alatoideus* Aldr., *Fusus (Papillina) dumosus* Con., *Clavilithes humerosus* Con., *Cassidaria petersoni* Con., *Turritella alveata* Con., "*Phorus*" *reclusus* Con., *Natica permunda* Con., *Capulus americanus* Con., *Umbrella planulata* Con., *Venericardia planicosta* Lam., *Venericardia*

jacksonensis (?*rotunda* Lea) Con., *Corbula densata* Con., and *Corbula bicarinata* Con.

West of Montgomery it is stated on good authority that "a bed of shells bearing most decidedly the Jackson character" was found at Sabine Town, Texas.*

Grand View.—The exact point at which the Jackson stage reaches the Ouachita River is still unknown. In 1832, Dr. Harlan described the genus *Basilisaurus* (*Zeuglodon*) before the American Philosophical Society, giving as its locality a point on the Ouachita River, fifty miles by land below Monroe. This means doubtless a locality not far from Grand View.†

In 1842 Conrad described *Cardium nicolletti*, giving as its locality "50 feet in height, on the right bank of the Washita River, Monroe county, Louisiana."‡

Dr. E. W. Hilgard has interpreted Harlan's locality for the *Zeuglodon* remains as "about half way between Columbia and Monroe." It is very difficult to see how this construction can be put on Dr. Harlan's statement.§

In 1870 Hopkins says "The *Zeuglodon* has so far only been found in Louisiana at Montgomery, in Grant parish, and at Grand View on the Ouachita." This shows that either Hopkins was entirely ignorant of Harlan's statements, which seems impossible, or that he identifies the locality given by the latter as at Grand View.||

L. C. Johnson in speaking of the northern limit of this stage says, "the boundary of this formation was traced by prairies and wells along the left bank of Bayou Saline and from the S. W. 1-4 of Sec. 20, T. 10 N., R. 5, W., north-eastward to Gansville, near the borders of Jackson and

Winn parishes, and probably runs diagonally through Jackson parish in the direction of Monroe, Ouachita parish."*

With the foregoing evidence in mind, together with what has already been said regarding the distribution of the Jackson stage in Arkansas, an attempt has been made on the map accompanying this report, to draw an approximate line of demarcation between this stage and the Claiborne lying in the north and west. (See map.)

*Rep. on Iron Ore Reg. of Northern La. and Eastern Texas, 1883, House Doc. No. 195, 50th Cong. 1st Sess., p. 16.

*Suppl. and Final Rept. Geol. Recon. La., E. W. Hilgard, 1873, p. 20.

†Trans. Am. Phil. Soc., 2d ser., Vol. IV, 1834, p. 398.

‡Jour. Phila. Acad. Nat. Sci., Vol. VIII, pt. 2, 1842, p. 190.

§Hilgard's Geol. Recon., La. 1869, p. 8.

||F. V. Hopkins, Sec. Ann. Rep. Geol. Surv. La. 1871, in La. State University Rep. for 1870, p. 13.

CHAPTER IX.

RESUME.

In brief, what conclusions are to be drawn from the foregoing study, or, how has our knowledge of the Geology of southern Arkansas been added to or modified by this work?

In anticipation of these and similar inquiries, the writer submits the following summary:

I. THE CRETACEOUS SYSTEM IN ARKANSAS.

1. Deposites belonging to the Cretaceous system are now known to exist much farther to the northeast than earlier writers had supposed.

2. In the southwest, the Cretaceous-Paleozoic boundary line is hypsometrically above the Tertiary-Cretaceous; in the central and northeast central part of the state, the former line is generally hidden beneath Tertiary deposits, i. e., is hypsometrically below the Tertiary-Paleozoic border lines. The critical point is but a few miles southwest of Rockport. Accordingly, this system is broadly expanded along the Indian Territory line, but narrows to a width of less than a mile at the mouth of De Roche Creek, and at Rockport is unknown. Slight outcrops again occur at Little Rock; and it is met with in wells at Cabot and Beebe stations farther northeast; at these places, however, it occurs below surrounding Eocene deposits.

3. The Arkadelphia shales of Hill belong to the Cretaceous system.

II. THE MIDWAY STAGE IN ARKANSAS.

1. The oldest known Tertiary deposits of this state con-

sist of impure limestones containing a fossil fauna similar to that of the Midway limestone of Alabama.

2. The Midway stage, it is believed, should not be treated as a subdivision of the Lignitic, but should be regarded as of coördinate rank. It seems to be far more persistent than any other so-called division of the Lignitic, and besides, many of its lithological and faunal features are quite characteristic.

3. *Enclimaceras ulrichi*, coming as it does from these limestone deposits is necessarily of Eocene age, and not Cretaceous, as was once supposed.

4. This stage is unknown within the limits of Arkansas southwest of a point two miles west of Rockport.

III. THE LIGNITIC STAGE IN SOUTHERN ARKANSAS.

1. Both lower and upper limits of this stage must be drawn somewhat arbitrarily, except where the basal Midway limestone occurs.

2. All its dips are extremely variable both as to amount and direction; hence, in the absence of authentic well records, its total thickness is unknown.

3. Fossil leaves are abundant; but so far as known, molluscan remains are wanting.

IV. THE CLAIBORNE STAGE IN SOUTHERN ARKANSAS.

1. This stage can be only vaguely defined within the limits of southern Arkansas owing to the paucity of molluscan remains. Considering its geographic distribution in Louisiana together with the few known fossiliferous outcrops in Arkansas, its distribution must be, in general, as represented on the map accompanying this report.

2. The deposits at White Bluff, Arkansas River, and at Rison, Cleveland county, referred to the Claiborne stage upon paleontologic grounds, must be regarded as forming the uppermost part of this stage, in that certain species usually considered as characteristic of Jackson deposits are

found at both these localities. The fossiliferous outcrop at Walnut Bluff, Ouachita River, represents a lower Claiborne horizon.

3. Some of these deposits are evidently of fresh-water origin, since they contain the remains of fresh-water mollusks.

4. The dips observed along the Ouachita River are slight and variable. At White Bluff on the Arkansas, the amount is no less than 40 feet to the mile in a southeast direction.

V. THE JACKSON STAGE IN SOUTHERN ARKANSAS.

1. The Jackson stage is separate from the Claiborne wholly on paleontologic grounds.

2. Along the Saline River, where its deposits are best exposed, there appears to be no north and south component to dips except those of extremely local character.

3. Fossils are locally abundant; the most fossiliferous layers often grade out laterally into barren sands and clays within a distance of only a few yards.

4. Perfect fossils in these, as well as in the Claiborne deposits, must generally be obtained from well borings. So true is this, that if one were desirous of making a good collection at the least possible expense, he could do no better than to hire a well or shaft put down for this special purpose.

VI. THE LAFAYETTE FORMATION.

The careful description of the Orange sand deposits of Mississippi given by Professor E. W. Hilgard in his *Agriculture and Geology of that state*, might in many places be applied verbatim to analogous deposits in southern Arkansas. In fact all are doubtless homogenetic. In Mississippi they have been recently classified as belonging to the Tuscaloosa or Lafayette formations according to their stratigraphic relations to the well known fossiliferous deposits.

In the same way in Arkansas, the Plateau gravels, Orange sands, reworked or rehandled material, or by whatsoever name one may see fit to designate them, cannot be regarded as forming one structural unit, but must be subdivided and classified according to the stratigraphic relation they bear to deposits whose ages can be determined by the evidence of fossil remains.

THE END.

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