Bulletin No. 211 Series C, Systematic Geology and Paleontology, 62

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

STRATIGRAPHY AND PALEONTOLOGY

OF THE

UPPER CARBONIFEROUS ROCKS

OF THE

KANSAS SECTION

BY

GEORGE I. ADAMS, GEORGE H. GIRTY, AND DAVID WHITE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 5, 1902.

SIR: I have the honor to transmit herewith for publication a manuscript on stratigraphy and paleontology of the Upper Carboniferous rocks of the Kansas section, by George I. Adams, George H. Girty, and David White. The stratigraphic portion of the paper is by Mr. Adams, the invertebrate paleontology by Dr. Girty, and the paleobotany by Mr. White. It is an attempt to summarize the available information concerning the section of the Carboniferous in Kansas, and its chief value lies in the fact that it clears up the synonymy of the stratigraphy and presents extensive faunal lists and such data as are available concerning the flora.

Very respectfully,

C. W. HAYES,
Geologist in Charge of Geology.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

STRATIGRAPHY AND PALEONTOLOGY OF THE UPPER CARBONIFEROUS ROCKS OF THE KANSAS SECTION.

By GEORGE I. ADAMS, GEORGE H. GIRTY, and DAVID WHITE.

INTRODUCTION.

By GEORGE I. ADAMS.

Present condition of reconnaissance work.—The Upper Carboniferous rocks of eastern Kansas have been sufficiently well studied by careful reconnaissances to permit the establishment of a section which may furnish a standard of reference for a large portion of the western interior Coal Measures area. The region here considered includes that part of the Carboniferous area of the State which lies south of the Kansas River. The formations have a general northeast-southwest strike. They are extensively represented in Missouri, Nebraska, and Iowa, but the portions of them that lie in these States are not considered in this paper, the discussion being confined chiefly to the portions in Kansas that have been studied connectedly. To the southwest, in Indian Territory, the formations continue for a considerable distance—approximately to the Arkansas River—with characters similar to those observed in Kansas. Some of the formations in this portion of the field have been named and described, as the localities are not far distant from Kansas and the reconnaissances have been extended to them.

The base of the Upper Carboniferous is marked by erosional unconformity, and apparently by an overlap of the higher formations, so that a very considerable thickness of the lower portion of the Upper Carboniferous is not represented in Kansas. The upper limit is not marked by a distinct stratigraphic or faunal break, sedimentation in this region having been continuous from the Carboniferous into the Permian. The formations are sandstones and shales with interstratified limestones. The conspicuousness of the limestones and the facility with which their outcrop can be followed in the field has made it possible to extend accurate reconnaissances over a large

area. The shales and sandstones have been considered as intermediate formations, their upper and lower limits being defined by the limestones.

Purpose of this report.—Reconnaissance and tentative correlation across areas that were not sufficiently studied have resulted in misconceptions which it is desirable to correct so far as present data permit. The discussion here presented is the result of a careful review of previous stratigraphic work, and the study of intermediate portions of the field. Wherever there has been reason to doubt the accuracy of previous correlations or the identity of the formations the field has been revisited and restudied. There are, perhaps, inaccuracies in the conclusions here presented, but an attempt has been made to set forth as clearly as possible what has been learned by the reconnaissances made, with the hope that the results will show the necessity in future studies of more accurate observations and more detailed mapping.

Authority and acknowledgments.—While the material embodied in this bulletin is derived from many sources, it is also based largely upon observations and studies that have not been previously reported. The stratigraphic portion of the paper is by Mr. Adams, and has as original sources his own field work and that done under his supervision by Mr. John Bennett and Mr. J. W. Beede. The faunal lists and the remarks on them are by Dr. Girty, and are based upon his study of material gathered by Messrs. Adams, Bennett, and Beede during the progress of the stratigraphic work, and of special collections made by them for the purpose of completing more fully the faunal lists. The portion of the paper dealing with the fossil flora is by Mr. White, and the source of his material is mentioned in his introductory remarks.

STRATIGRAPHY OF THE REGION.

By GEORGE I. ADAMS.

METHODS AND MATERIALS USED IN PREPARING THIS REPORT.

Method of mapping employed.—The maps used in the field in making the reconnaissances here reported were the county maps of the State, and, so far as they were available, the topographic maps of the United States Geological Survey. The formations mapped were the limestones, and their lines of outcrop were referred to the section lines of the land survey. When it was impossible to traverse them in detail the mapping indicates more particularly the eastern border of the areas in which the limestones are found. The dip carries the limestones underground to the west. The accompanying maps (Pls. III, IV) show the lines of outcrop of the limestone formations as closely as the scale and the available data permit, but, as a result of erosion and of the occurrence of outcrops along stream valleys, these formations, if examined in detail, will be found to occur at places not indicated on the maps. By mapping the limestones the intervening sandstones and shales have been limited and their approximate areas shown.

Area mapped by Adams.—The mapping of formations from the southern border of the State northward to an irregular line passing through Bourbon, Allen, Woodson, Coffey, and Greenwood counties was done under the University Geological Survey of Kansas, principally in the summer of 1896,[a] although it was largely facilitated by field work of the summer of 1893.[b] This information has already been used by the Kansas survey. The mapping of this area was partially reviewed in 1899 during a journey undertaken for the purpose of making paleontologic collections for the United States Geological Survey.

In the summer of 1901 a reconnaissance was made into the Indian Territory along the outcrop of the Fort Scott limestone,[c] the Drum

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, preface.

[b] Idem, Vol. I, 1896, Chapter I.

[c] Oil and gas fields of Kansas, Indian Territory, Texas, etc., by G. I. Adams: Bull. U. S. Geol. Survey No. 184, 1902, p. 15.

limestone, and the Elk Falls limestone,[a] and correlations were made with sections in the Indian Territory, given by N. F. Drake.[b]

Area mapped by Bennett.—In the summer of 1901 Mr. Bennett traversed the outcrop of the Stanton limestone from Miami County to Garnett, in Anderson County, for the purpose of correlation. He also extended the mapping of the formations from the limit of the work previously done by Adams in Greenwood and Woodson counties northward through Lyon, Coffey, and Osage counties to Shawnee County, correlating with the mapping done there by Beede. He also reviewed a portion of the mapping in Labette County done by Adams. In Indian Territory he traversed the outcrop of the Oologah limestones and verified some of the previous work of Adams. Mr. Bennett's knowledge of the field, which he had gained through his connection with the University Geological Survey of Kansas, was of material assistance in this work.

Area mapped by Beede.—The mapping of the formations in Shawnee County was done by Mr. Beede independently, and supplements his description of the geology of Shawnee County.[c] In the summer of 1901 he traversed the outcrop of the Barclay limestone from Shawnee County to Lyon County. This work connected with that done by Bennett, who mapped the same formation from Lyon County to Eureka, in Greenwood County. Mr. Beede was also employed in the detailed survey of the Cottonwood Falls quadrangle,[d] the principal portion of which lies in Chase County, and reviewed in part the map of Lyon County, made as an independent piece of work by A. J. Smith.[e] The mapping of the formations in Lyon County was taken from the work of Mr. Smith, and was partially reviewed by Bennett and Beede, as above noted.

The map by Haworth, reproduced in this report (Pl. II), supplements the mapping above mentioned by showing, approximately, the extension of the formations to the northeast.

The Cottonwood Falls folio should be referred to for the mapping of the formations above the Americus limestone in Chase and portions of adjacent counties.

Method of correlation.—The correlations accepted in this report are based upon the information embodied in the mapping presented herewith. Each formation has been traced, so far as practicable, from the locality at which it was originally described to such other parts of the field as had to be studied to determine equivalents. This report may contain errors in correlation, due to mistakes made in following the formations across country, but it is hoped and believed that such errors, if found, will prove to be unimportant.

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[a] Carboniferous and Permian age of the Red Beds of eastern Oklahoma from stratigraphic evidence, by G. I. Adams: Am. Jour. Sci., 4th series, Vol. XII, 1901, p. 384.

[b] A geological reconnaissance of the coal fields of the Indian Territory, by N. F. Drake: Proc. Am. Philos. Soc., Vol. XXXVI, 1897, pp. 326-419.

[c] Trans. Kans. Acad. Sci., Vol. XV, 1898, p. 27.

[d] Geologic Atlas U. S., Cottonwood Falls folio, in preparation.

[e] Trans. Kans. Acad. Sci., Vol. XVII, 1901, p. 190.

Rules of nomenclature followed.—In determining what names should be applied to the formations described in this field the usage of the United States Geological Survey has been followed. For guidance in specific cases which have arisen the following rules have been formulated:

1. The name adopted for a formation is the first geographic one proposed having an adequate definition; that is, a definition describing, or showing by means of a section, the character and succession of the beds composing the formation and indicating its upper and lower limits.

2. The type locality of a formation is the place where the outcrop appears on which the original description was based.

3. In case the mapping has shown that a named bed or series of beds is equivalent to one described and named earlier, the later name is regarded as a synonym, and is accordingly dropped.

4. In deciding questions of priority the date of the publication containing names proposed has been referred to, and, in case two names have been proposed in the same publication, the first one used which was not already preoccupied has been adopted.

5. In case the original definition was incomplete, but was adequately completed in subsequent descriptions of the same formation, by the same name, the original name is retained, provided no new name had been given prior to such adequate definition.

6. In case it has been necessary to recognize new units within the limits assigned to a formation in previous descriptions, the first name given is, if necessary, retained for use in its original sense, and new names are given to the new units.

7. The same geographic term is in no case adopted for more than one formation, even where additional designations had been given, as upper, or lower, or limestone, sandstone, shale, etc.

RÉSUMÉ OF PREVIOUS PUBLICATIONS.

GENERAL MAPPING OF THE DIVISIONS OF THE CARBONIFEROUS OF KANSAS.

The earliest information we have in regard to the Carboniferous formations of Kansas is derived from reports of exploring parties, who obtained scanty collections of fossils in traversing the eastern portion of the State. The more definite recognition of their extent followed the attempt to define their limits upon reconnaissance maps.

1858, Hayden.—The first map that shows in part the extent of the Carboniferous rocks in northeastern Kansas was published by Hayden in 1858,[a] and was accompanied by an article explanatory of the map and by a section from the mouth of the Platte River to Fort Benton. This map is reproduced here as fig. 1. A footnote states that the por-

[a] Proc. Acad. Nat. Sci. Phila., Vol. IX, 1857, p. 109.

tion of the map which relates to Kansas was based upon information furnished by Maj. F. Hawn, who was conneced with the lineal survey of the State. Major Hawn contributed his knowledge of the geology to various workers, and assisted Swallow in preparing his preliminary report of the geological survey of Kansas.[a]

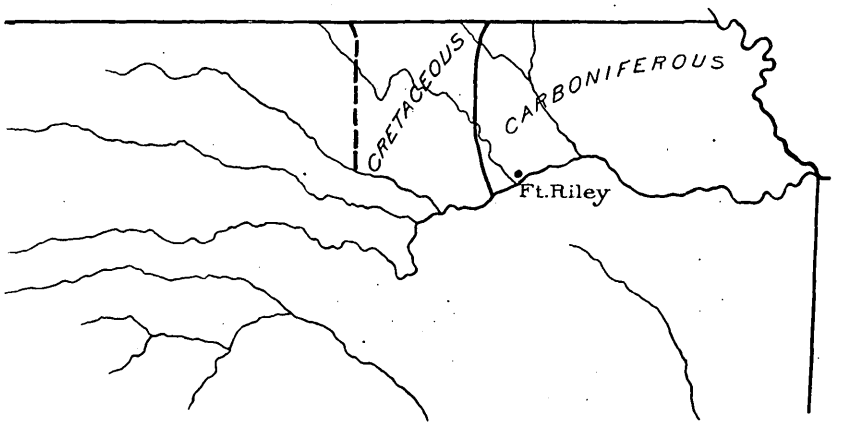


FIG. 1.—Sketch from a map by Hayden, 1858.

1862, Hayden.—A subsequent map published by Hayden (reproduced here as fig. 2)[b] is an outline reduction of a map of Kansas, Nebraska, and Dakota. The portion of Kansas which is embraced is larger than in the map above mentioned (fig. 1). The formations

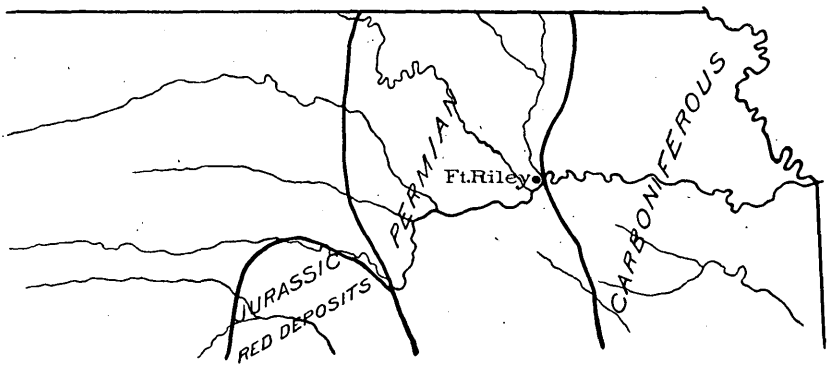


FIG. 2.—Sketch from a map by Hayden, 1862.

shown which are of interest here are the Carboniferous, the Permian, and the Red Beds, the latter being referred to the Jurassic.

1872, Hayden.—In Hayden's final report[c] of the survey of Nebraska and portions of adjacent Territories there is a map which shows a portion of northern Kansas. On this map the Carboniferous and

[a] Prel. Rept. Geol. Surv. Kansas, 1866,

[b] Trans. Am. Philos. Soc., new series, Vol. XII, 1863, p. 218.

[c] Final report of the U. S. Geological Survey of Nebraska and portions of adjacent Territories, made under the direction of the Commissioner of the General Land Office, Washington, 1872.

Permian areas are shown. The position of the Permian as mapped is too far to the west to agree with the descriptions in the report of its occurrence along the Kansas River. In the sketch presented herewith (fig. 3) a correction is suggested.

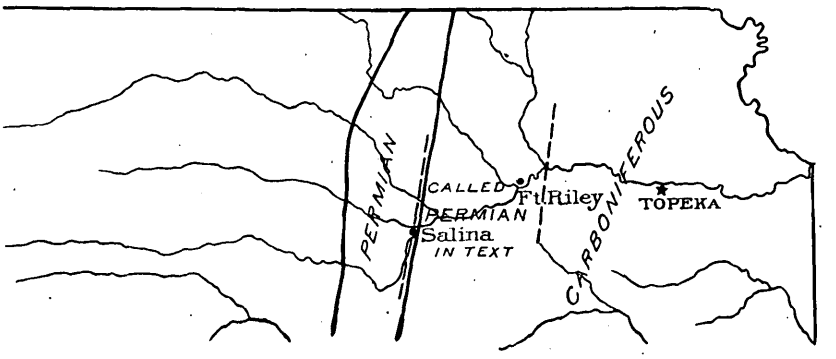


FIG. 3.—Sketch from a map by Hayden, 1872.

1877, Kedzie.—In the text-book on the Elements of Agricultural Geology, published by William Kedzie for the schools of Kansas, a geological map is inserted (fig. 4.) It is evidently a modification of a map by Mudge, since in the introduction the author acknowledges his indebtedness to the secretary of the agricultural board for the use

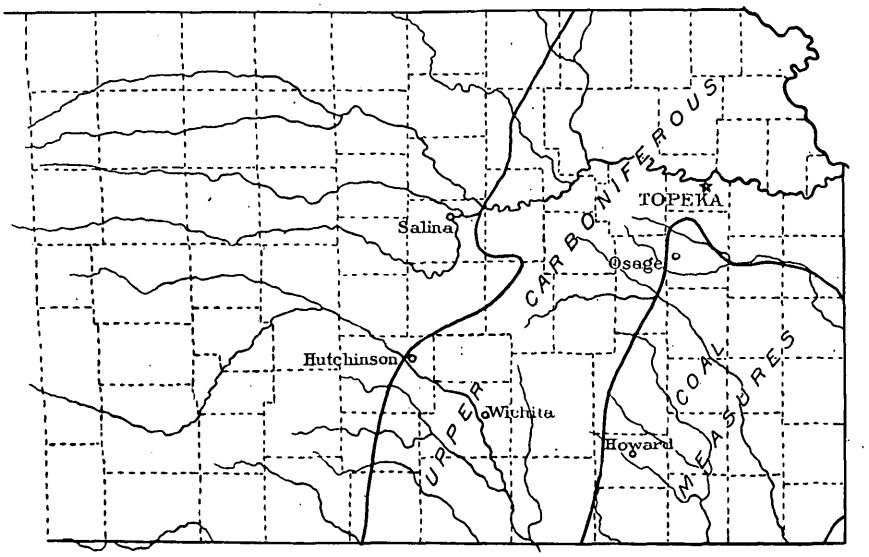


FIG. 4.—Sketch from a map by Kedzie, 1877.

of the geologic map of the State, and Mudge was at that time State geologist.

1878, Mudge.—The first biennial report of the State board of agriculture of Kansas for 1877–78 contains a map by B. F. Mudge, showing the surficial strata of Kansas (fig. 5). The areas of the rocks

shown which are of interest here are the Coal Measures and the Upper Carboniferous. It is obvious on examination of the map that the limit of the Coal Measures was drawn relative to the localities pro-

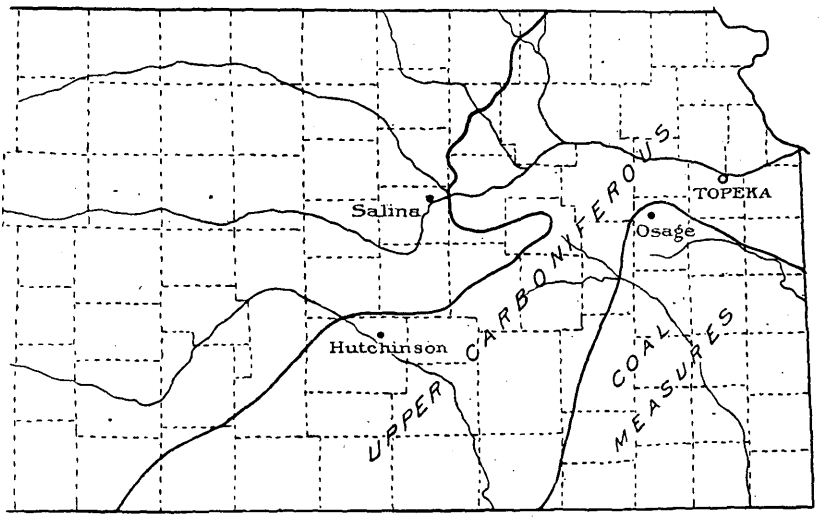


FIG. 5.—Sketch from a map by Mudge, 1878.

ductive of coal, since it does not follow the strike of the rocks. The western limit of the Upper Carboniferous as shown is not much different from that of the Permian and Red Beds as recorded on the latest maps.

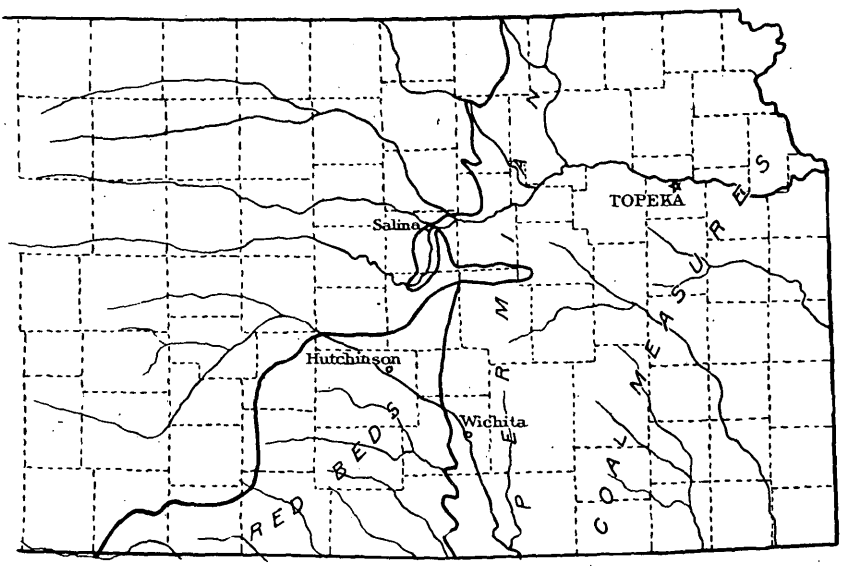


FIG. 6.—Sketch from a map by Hay, 1893.

1893, Hay.—Accompanying an article on the Geology and Mineral Resources of Kansas by Robert Hay in the Eighth Biennial Report of

the State Board of Agriculture for 1891–92 there is a map on which is shown approximately the boundary of some of the geologic divisions of Kansas. The accompanying sketch (fig. 6) shows the data which

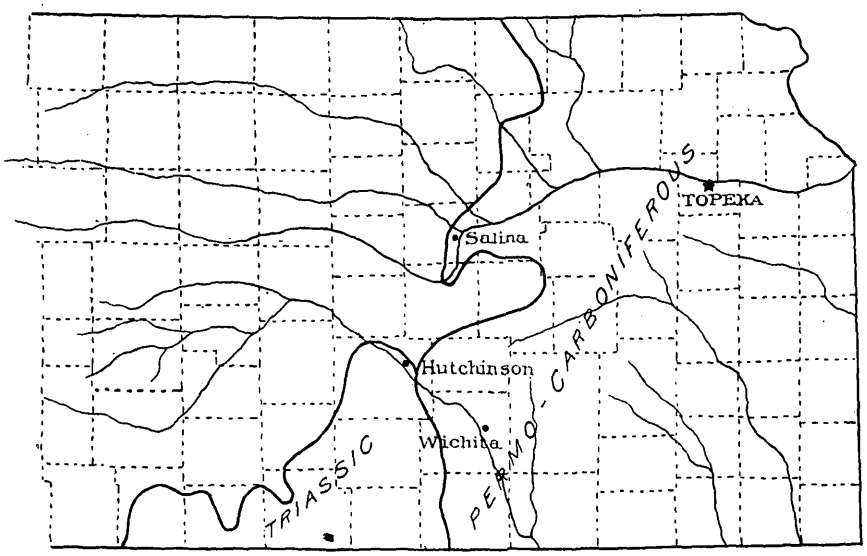


FIG. 7.—Sketch from a map by Williston, 1895.

are of interest in connection with the Carboniferous. No line is drawn between the Coal Measures and Permian. The area of the Red Beds is shown, and they are referred to the Permian.

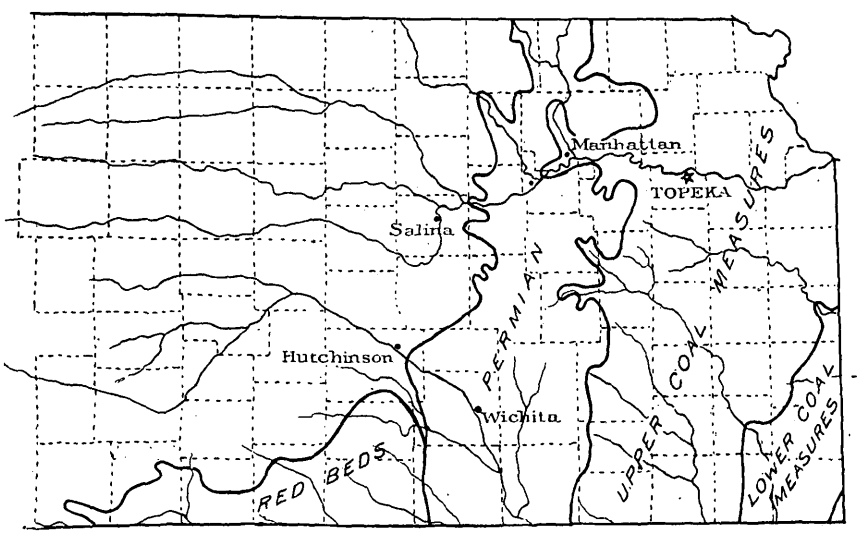


FIG. 8.—Sketch from a map by Haworth, 1899.

1895, Williston.—A geologic map of Kansas by S. W. Williston,[a] compiled for the particular purpose of showing the geologic divisions in the western portion of the State, classes the rocks of eastern Kansas

[a] Kansas Univ. Quart., Vol. III, 1895, p. 216.

with which we are here dealing as Permo-Carboniferous and Triassic, including in the latter the area of the Red Beds. This map is here reproduced as fig. 7.

1899, Haworth.—The next general geologic map of the State of Kansas is a semiperspective one by Erasmus Haworth[a] reproduced here as fig. 8. On it the areas of the Lower Coal Measures, Upper Coal Measures, Permian, and Red Beds are shown. The division line between the Lower and Upper Coal Measures is approximately the one recognized by Broadhead between the lower and middle divisions in Missouri. The division line between the Upper Coal Measures and Permian is drawn at the horizon which was considered by Prosser as the base of the Permian. The limit of the Red Beds is evidently drawn so as to include the area in which the Red Beds color prevails.

GENERAL MAP OF THE CARBONIFEROUS OF NORTHERN INDIAN TERRITORY.

1879, Drake.—Accompanying the report of Drake's reconnaissance of the coal field of the Indian Territory[b] there is a map showing divisions of the Carboniferous, which were mapped by correlating the sections that he made. The divisions shown in the accompanying sketch (fig. 9) of the portion of northern Indian Territory here considered are the Lower Coal Measures, the Cavaniol and Poteau groups, which are classed as Upper Coal Measures, and the Permian. The terms "Cavaniol" and "Poteau" were applied to groups whose typical sections are in the Choctaw Nation. It now appears that the rocks in the northern part of the Indian Territory referred to them occupy a higher position in the general section. The mapping of the divisions has been shown to be untenable in this part of the field, because the limits of the divisions cut diagonally across the lines of stratification.[c]

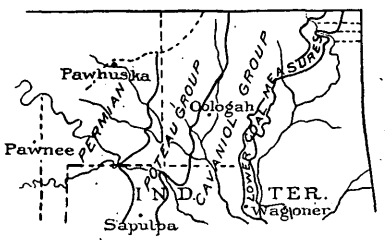


FIG 9.—Sketch from a map by Drake, 1879.

The line at the base of the Permian was drawn by Drake at the horizon at which he noted the first appearance of fossils which he called Permian species. The Permian is made to include the Pawhuska limestone, which Smith had referred to the Upper Coal Measures. Although the line between the Permian and Coal Measures is not extended on Drake's map to the border of Kansas, it appears from a comparison of its position with the position of the base of the Permian in Kansas as determined by Prosser that it is much lower in the section.

[a] Univ. Geol. Surv. Kansas, Vol. IV, 1898, Pl. XXXI.

[b] A geological reconnaissance of the coal fields of the Indian Territory, by N. F. Drake: Proc. Am. Philos. Soc., Vol. XXXVI, 1897, pp. 326-419.

[c] Adams, Bull. U. S. Geol. Survey No. 184, 1902, p. 158; also Am. Jour. Sci., 4th series, Vol. XII, 1901, p. 384.

PREVIOUS DETAILED STRATIGRAPHIC SURVEYS AND MAPPING.

1866, Swallow: Preliminary report of the geological survey of Kansas.[a]—The first section of the Carboniferous rocks of Kansas which attempted to show their succession in detail was that by G. C. Swallow.[b] In his report the beds are numbered from top to bottom and brief notes on their characters and occurrences are given. No. 1 of his

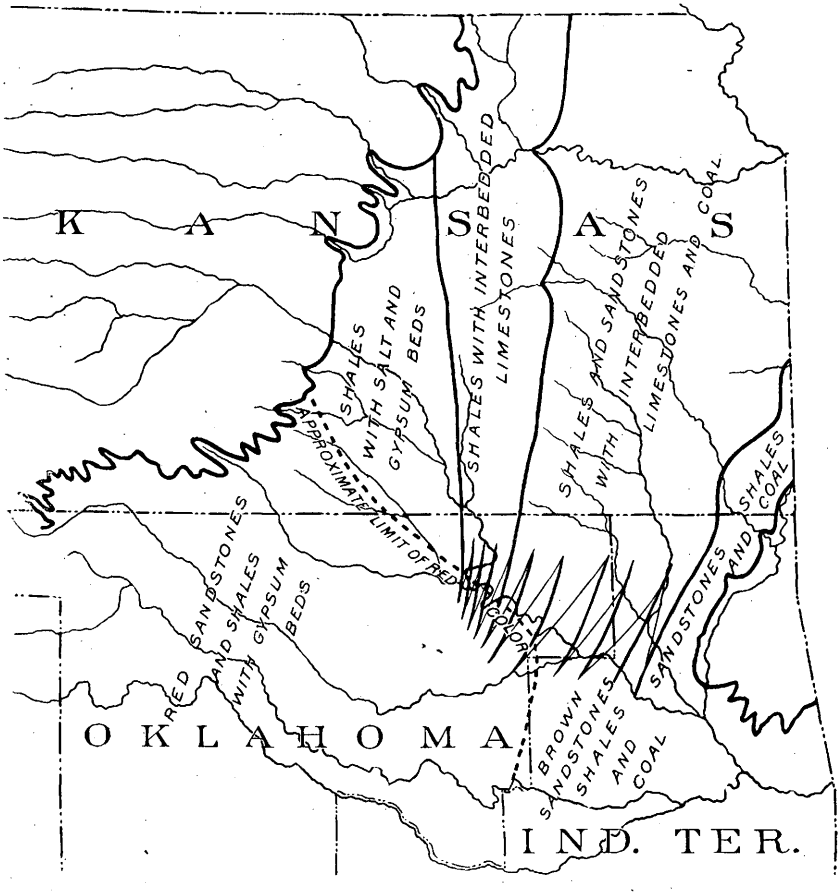


FIG. 10.—Sketch showing lithologic phases of the Carboniferous of Kansas, Indian Territory, and Oklahoma, by George I. Adams.

section includes the portion of the Cretaceous which he observed. Below this he recognizes 255 individual beds, which he classes as Triassic, Permian, Lower Permian, and Carboniferous. He describes simply most of the individual formations of the various series and states their thicknesses. The names assigned to the formations are

[a] The literature here cited is only that in which geographic names were used for some of the formations.

[b] Prel. Rept. Geol. Surv. Kansas, 1866, pp. 16-28.

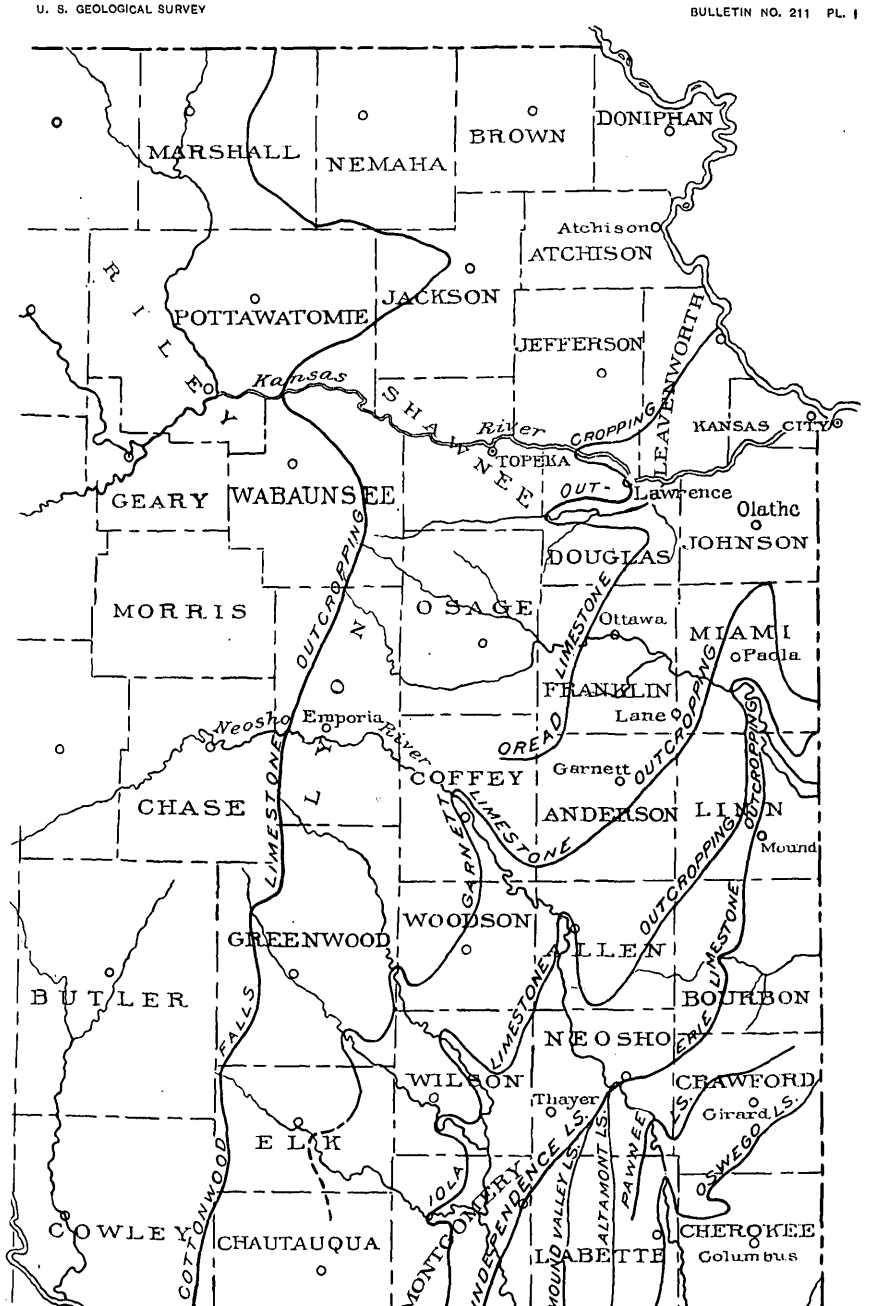
descriptive of their color, or their lithologic characters, or their fossil contents, or, in some cases, were of geographic significance. Those of the latter class are still admissible according to general usage. They are Fort Riley limestone, Stanton limestone, Pawnee limestone, Fort Scott limestone, and Fort Scott marble. The name "Fort Scott marble" is applied to a local bed which has a thickness of only 1 foot 6 inches and which is of no stratigraphic importance. The Fort Scott limestone has been identified and the term is now in use, although in a somewhat more extended sense than would be implied by the original definition. The name "Pawnee limestone" is applied to the formation for which it was originally proposed. The Stanton limestone, as is recorded in this report, has now been identified from the locality of Stanton post-office, in Miami County. As a result of tracing the outcrop of this limestone a number of formation names which were subsequently proposed have been found to be synonyms. The Fort Riley limestone has been identified by Hay and Prosser, and has been assigned its proper place in the section.

Although the section of the Carboniferous prepared by Swallow served the purpose of presenting the general features of the stratigraphy, it is largely impaired by erroneous correlation. It appears that the errors were due to the fact that he considered the rocks along the Kansas River, in the vicinity of Topeka, the same as those in Miami County, which he called the Stanton series. This would account for the omission of a portion of the rocks which belong in the section, and in part for the inconsistencies in the localities assigned to certain formations.

1893, Hay: Fort Riley section.[a]—In a description of the geology and mineral resources of Kansas by Robert Hay there is given a section of the rocks exposed in the vicinity of Fort Riley. The individual beds are described and their thicknesses are stated. For two of them names are used. These are the Wreford limestone and the Fort Riley ledge. The latter is applied to the same limestone which was named the Fort Riley by Swallow.

1894 (January), Haworth, Kirk, and Piatt: Report on field work in geology.[b]—This report, which embraces the results of the first season of work by the University Geological Survey of Kansas, contains general descriptions and sections of the formations of the Carboniferous of eastern Kansas. Sections drawn to scale were made along the routes traversed, and the formations were described and correlated in a tentative manner. No map accompanies this report. The sections may be denominated as follows: The Neosho River section, by Haworth and Kirk; the Verdigris River section, by Haworth and Piatt; sections from Cherryvale to Lawrence and from Ottawa to Holliday, by Haworth.

[a] Eighth Bienn. Rept. Kansas State Board Agric., 1893, p. 104.
[b] Kansas Univ. Quart., Vol. II, 1894, pp. 99-142.



MAP OF LIMESTONE OUTCROPPINGS, BY HAWORTH.

NOTE.—The geologic formation names are Haworth's. The United States Geological Survey equivalents are as follows: Independence=Drum; Mound Valley=Dennis; Altamont=Parsons; Oswego=Fort Scott; Cottonwood Falls=Cottonwood.

1894 (November), Prosser: Kansas River section of the Permo-Carboniferous and Permian rocks of Kansas.[a]—In this paper, which deals with the stratigraphy and paleontology, the section along the Kansas River given by Swallow in 1866 is reviewed, corrected, and amplified. Reference is made to the work of Hayden and other geologists. This publication is, in a sense, preliminary to the "Classification of the Upper Paleozoic rocks of central Kansas," published in the Journal of Geology by the same author.

1895 (April), Haworth: Stratigraphy of the Kansas Coal Measures.[b]—This article, which is published as a summary of the stratigraphy of the Coal Measures prior to the publication of Volume I of the University Geological Survey of Kansas, discusses the characteristics of the Coal Measures formations and the division of them into Upper and Lower. It also describes the position of the coal beds. The article is accompanied by a general columnar section of the Coal Measures and a semiperspective map of eastern Kansas, showing the surface outcrops of the principal limestone formations which had been studied and correlated.

1895 (October and November), Prosser: Classification of the Upper Paleozoic rocks of central Kansas.[c]—In this paper, which reports the results of studies of the higher portion of the Carboniferous, detailed sections are described, and in some cases names are given to individual beds. Formations previously named by Swallow and Hay are identified, and correlations are attempted for a considerable area. The beds which are named are grouped into formations or stages, and the base of the Permian, as identified by Prosser, is determined from paleontologic evidence.

1895 (December), Haworth: Stratigraphy of the Kansas Coal Measures.[d]—In this article the stratigraphy of the Coal Measures is outlined, and the division into Upper and Lower Coal Measures is discussed prior to publication of the same matter in a more extended form in Volume I of the University Geological Survey. A general columnar section and map of eastern Kansas showing the lines of outcrop of some of the limestone formations accompanies the article. This map (reproduced here as Pl. I) is essentially the same as the one above noted,[e] excepting that the name Garnett is used instead of Burlington for one of the limestones.

1896, Hay: Geology of Fort Riley Military Reservation.[f]—In this paper the section of the rocks in the vicinity of Fort Riley is described, the columnar section being the same as that contained in the Eighth Biennial Report of the State Board of Agriculture for 1893.

1896, Haworth and assistants: University Geological Survey of Kansas, Vol. I.—This volume, which is the first official report by the University Geological Survey of Kansas, was transmitted by Haworth,

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[a] Bull. Geol. Soc. Am., Vol. VI, 1894, pp. 29-54.
[b] Kansas Univ. Quart., Vol. III, 1895, p. 271.
[c] Jour. Geol., Vol. III, 1895, pp. 682-705 and 764-800.
[d] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 452.
[e] Kansas Univ. Quart., Vol. III, 1895, p. 271.
[f] Bull. U. S. Geol. Survey No. 137, 1896.

and, besides chapters that were written wholly by him, contains others edited by him which embodied the work of his assistants. The conclusions and correlations are by Haworth. The stratigraphic data embodied in this volume were obtained principally by means of studying a number of sections, which are as follows:

Section from Galena to Wellington, by George I. Adams, with an addendum, a section from Cedarvale to Winfield, by C. N. Gould.

Section from Baxter Springs to the State line, by Erasmus Haworth and John Bennett.

Section along the Neosho and Cottonwood rivers, by M. Z. Kirk.

Section from the State line in Bourbon County to Yates Center, Woodson County, by John Bennett.

Section principally along the Osage River, by John G. Hall.

Section along the Kansas River from Kansas City to McFarland, by John Bennett, with an addendum, a section from Manhattan to Abilene, by Adams.

Section from Coffeyville to Lawrence, by Erasmus Haworth.

Section from Atchison to Barnes, by E. B. Knerr.

The report also contains a preliminary catalogue of the fossils of the Carboniferous, by John Bennett.

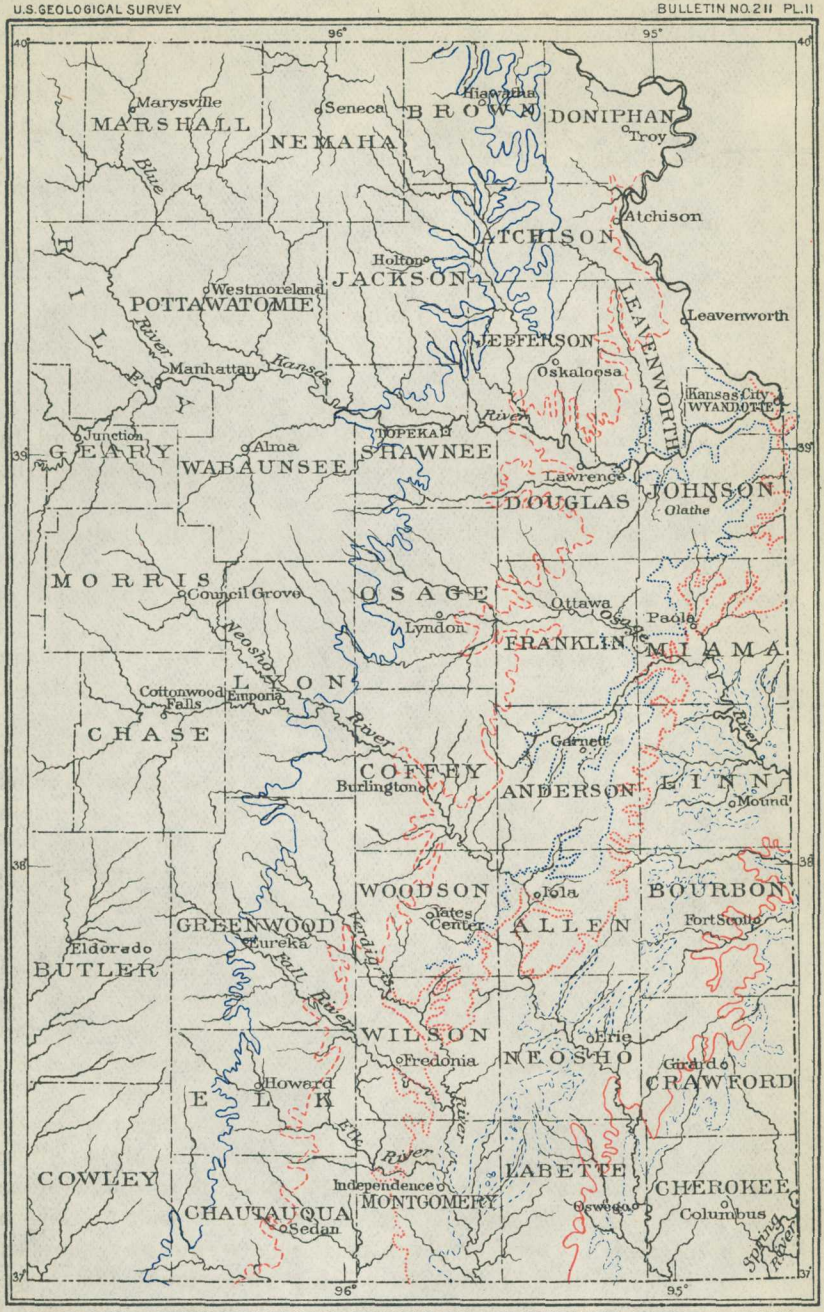
1897, Prosser: Permian and Upper Carboniferous of southern Kansas.[a]—This is a report of studies of the sections of rocks exposed in the Flint Hills. In it an attempt is made to identify, by means of the fossils and general lithologic characters, formations named and described by Prosser in the Kansas and Cottonwood River sections. Detailed sections are described, but no map accompanies the article.

1898, Beede: Stratigraphy of Shawnee County.—An independent piece of stratigraphic work, consisting of a detailed description of the rocks of Shawnee County, was read before the Kansas Academy of Sciences in January, 1896.[b] In this paper an attempt is made to identify certain formations named by Swallow. No map is presented.

1898, Haworth and Crane: University Geological Survey of Kansas, Vol. III.—This volume consists of essentially two parts. The first deals with the stratigraphy of the Kansas Coal Measures and is a summary of all previous work done by the university survey. The second part, by Crane, pertains to the detailed stratigraphy of the coals, their properties, and the methods employed in mining them. Part I is accompanied by a map showing the outcrops of the principal limestone formations of the Coal Measures (Pl. II), and a series of shaded maps, which, when the blank portions are cut away, show the order and superposition of the coal-bearing formations. The larger part of the field work subsequent to the publication of Volume I, which furnished the basis for the revisions of the stratigraphy con-

[a] Kansas Univ. Quart., Vol. VI, 1896, p. 149.

[b] The stratigraphy of Shawnee County, by J. W. Beede: Trans. Kansas Acad. Sci., Vol. XV, 1898, pp. 27-34.



MAP OF EASTERN KANSAS, SHOWING LIMESTONE OUTCROPPINGS

By Erasmus Haworth

LEGEND

BURLINGAME LIMESTONE | OREAD LIMESTONE | GARNETT LIMESTONE | IOLA LIMESTONE | ERIE LIMESTONE | PAWNEE LIMESTONE | OSWEGO LIMESTONE

Note: The geological formation names are Haworth's; the United States Geological Survey equivalents are as follows: Oswego=Fort Scott; Garnett=Stanton; Burlingame=Barclay; Erie=Drum, Dennis, and Hertha.

tained in this report, was done by George I. Adams, who was assisted by W. E. Ringle, and by John Bennett.

1899, Beede: On the Correlation of the Coal Measures of Kansas and Nebraska.[a]—In addition to paleontologic information, this paper contains references to the formations in Shawnee County and describes their continuation into Nebraska.

1900, Beede: Reconnaissances in the Blue Valley Permian.[b]—This paper furnishes information concerning the extension northward to the Nebraska line of the formations described by Prosser and others at localities along the Cottonwood and Kansas rivers. The paper is accompanied by a map showing Pottawatomie, Marshall, and portions of adjacent counties.

1901, Smith: Geological map of Lyon County.—In a paper on the Americus limestone, read before the Kansas Academy of Science, Mr. Alva J. Smith discusses the occurrence of this formation in Lyon County.[c] He identified in the field the formation described by Kirk in his Neosho River section[d] and traced its outcrop in detail. With this paper he published a map showing the outcrops of the other limestone formations over the larger portion of Lyon County. This map has been partially reviewed in the field and is incorporated in this report.

OUTLINE OF DETAILED STRATIGRAPHY OF THE KANSAS SECTION, WITH PRELIMINARY FAUNAL LISTS.[e]

CHEROKEE SHALES.

Definition and synonymy.—The name Cherokee shales is applied to the heavy bed of shales, with some interstratified sandstones and thin and unimportant limestones, which lie at the base of the section of the Carboniferous in Kansas.[f] The lower limit of the formation in Kansas is the Mississippian series, upon which it rests unconformably. The upper limit of the Cherokee shales is the Fort Scott limestone. In defining the upper limit of the Cherokee shales the statement is made that they include all the shales below the Oswego limestone, unless the Swallow limestone[g] should prove to be extensive, in which case the term should apply to the shales below the Swallow limestone. This limestone is unimportant, and the name, which was given in honor of the first State geologist of Kansas, is found only in its first description. Since the name Oswego is a synonym of Fort Scott, the latter is substituted in the original definition. Within the formation certain sandstones have been named

[a] Trans. Kansas Acad. Sci., Vol. XVI, 1899, pp. 70-84.
[b] Kansas Univ. Quart., Vol. IX, 1900, p. 191.
[c] Trans. Kansas Acad. Sci., Vol. XVII, 1901, p. 189.
[d] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 80.
[e] Faunal lists by Dr. G. H. Girty.
[f] Haworth and Kirk, Kansas Univ. Quart., Vol. II, 1894, p. 105.
[g] Ibid., p. 105.

the Columbus sandstones,[a] but since they have proved to be of so little stratigraphic importance, they have been practically disregarded. Mention of them has been made in one subsequent description by Haworth.[b]

Since the Cherokee shales are here discussed as a formation and definite limits are assigned to them, attention should be called to the fact that the tracing of the line of outcrop of the Fort Scott limestone into the Indian Territory shows that a much greater thickness of rocks there intervenes between it and the Lower Carboniferous, amounting in the central portion of the Indian Territory to approximately 9,000 feet. To the Cherokee shales in Kansas is assigned a thickness of approximately 450 feet. Since the contact of the shales with the Lower Carboniferous is one of unconformity and overlap, the details of which have not yet been studied, the base of the formation can not now be defined beyond the area recognized in Kansas.

Character and extent of the formation.—The thickness of the Cherokee shales, as obtained from the records of wells that have been drilled through them and by measuring the dip, is found to vary from place to place, but is usually between 400 and 500 feet. The average thickness is about 450 feet. Though the term shale has been applied to the formation, it contains beds of sandstone, which in some localities are of considerable thickness and extent. In the area around Columbus sandstone beds have had a considerable influence in determining the topographic features, and for those occurring at that locality the name Columbus sandstone was proposed, but since they have not proved to be of sufficient stratigraphic importance they have not been differentiated from the Cherokee shales. There are likewise thin limestones of local importance, which appear in the upper portion of the shales, but their outcrops are inconspicuous, and they can not be referred to as persistent horizons. One of these beds was named the Swallow limestone, but it has not been mapped or traversed far from its type locality. The area of the Cherokee shales is a belt approximately 20 miles wide, crossing the southeastern corner of the State. It includes Cherokee County (except the southeastern corner, where the rocks are Mississippian limestones), the eastern portion of Labette, the southeastern portion of Crawford, and the eastern border of Bourbon County.

Coal beds in the Cherokee shales.—The thickest and most valuable coal beds of Kansas occur in the Cherokee shales. A number of them are of only local importance, and since they occur at various horizons and have not been studied in detail they have received no definite names. The two beds which produce the most coal are known as the Weir-Pittsburg lower and upper beds. The lower has an average thickness of 40 inches and the upper an average thickness of 30 inches. A higher bed has been called the Fort Scott coal, from its

[a] Kansas Univ. Quart., Vol. II, 1894, p. 106. [b] Univ. Geol. Surv. Kansas, Vol. I, 1896, pp. 37, 38.

LEGEND

Neva

Americus

Emporia

Barclay

Howard

Hartford

DeerCreek

Lecompton

Oread

Stanton

Iola

Earlton

Drum

Dennis

Hertha

Parsons

Pawnee

Fort Scott

LITH. BY A. HOEN & CO., BALTIMORE, MD.

MAP OF SOUTHEASTERN KANSAS

SHOWING LINES OF OUTCROP OF LIMESTONE FORMATIONS

BY

George I. Adams

Scale

5 0 5 10 15 miles

occurrence near that town. This bed usually varies from 15 to 20 inches in thickness, and has been mined by stripping at many localities. It occurs a few feet below the lower member of the Fort Scott limestone, and in mining the coal not infrequently the limestone is quarried. The limestone and the coal form conspicuous beds, which are easily traced. The same coal bed is probably not coextensive with the limestone, but all the way from Fort Scott to near Claremore, in Indian Territory, coal is obtained at about the same horizon. The Cherokee shales, where they have been penetrated by drill holes in the area to the northwest of their outcrop, where they are overlain by a considerable thickness of the higher formations, have been found to carry valuable beds of coal. The coal mined at Leavenworth at a depth of over 700 feet is in the Cherokee shales.

Preliminary faunal list.[a]—This list is based on collections from four localities.

Lophophyllum proliferum.
Lingula carbonaria.
Chonetes mesolobus.
Productus nebraskensis.
Marginifera muricata.
Spirifer cameratus.
Seminula subtilita.

FORT SCOTT LIMESTONE.

Definition and synonymy.—The name Fort Scott limestone was first employed by Swallow in 1866,[b] but was by him applied only to the upper member of the formation, as here defined. Bennett[c] in 1896 described the upper member as the Fort Scott limestone and the lower as the Fort Scott cement rock, and calls the two the Oswego or Fort Scott limestone. The lower member is bed No. 217 of Swallow's section, described by him as an impure, brown and drab, hydraulic, concretionary limestone, in one bed 6 feet thick. The interval between the two members is occupied by shales, and, locally, by a thin coal bed. The name Oswego limestone was introduced by Haworth and Kirk,[d] and included the two limestones. The lower is spoken of by Haworth[e] as the Fort Scott cement rock. In a report by Adams[f] the lower is called the Fort Scott cement rock, and it is stated that these two might well be called the Fort Scott limestone, but, since the name Oswego had already been introduced, it would be used for the present. In the same report[g] the Oswego or Fort Scott limestones are regarded as the upper limit of the Cherokee shales. Haworth[h] says, concerning the terms by which these limestones should be designated, that, although the name Oswego has been used, the name Fort Scott would

[a] The faunal lists given in this bulletin have been prepared by Dr. Girty.
[b] Prel. Rept. Geol. Surv. Kansas, 1866.
[c] Univ. Geol. Surv. Kansas, Vol. I, 1896, pp. 89-91
[d] Kansas Univ. Quart., Vol. II, 1894, p. 105.
[e] Idem, Vol. III, 1895, p. 273.
[f] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 21.
[g] Ibid., p. 22.
[h] Ibid., Vol. I, p. 41.

be equally convenient. Haworth's[a] final usage is to apply the name Fort Scott to the individual members and the name Oswego limestone to the whole formation. In a geologic section through Fort Scott to Nevada, Mo., by Hay,[b] the limestones at Fort Scott are shown and denominated the Fort Scott limestone and the Fort Scott "cement" limestone. It has been shown[c] that Oswego had already been used by Prosser[d] as the name of the formation in the Silurian of New York, and is therefore preoccupied, and that, inasmuch as the name Fort Scott has been extended to the lower of the two members, and was proposed by Swallow for the upper and more important one, it should be accepted as a formation name for these closely associated limestones.

Character and extent of the formation.—The Fort Scott limestone as exposed at Fort Scott is described by Bennett as consisting of a lower limestone member 4½ feet thick, which is the rock used for making hydraulic cement, and an upper limestone member from 10 to 14 feet in thickness, which was the original Fort Scott limestone described by Swallow and by him stated to have a thickness of from 8 to 18 feet. In the interval between the lower and upper limestone members there is a shale member, which is usually about 7 feet thick. The line of outcrop of the Fort Scott limestone has been traced continuously from the Missouri line, near Fort Scott, southwestward to the Indian Territory line, and thence into the Indian Territory to the Arkansas River south of Catoosa.

Preliminary faunal lists.—This list is based on collections from the lower limestone member, obtained at three localities.

Fusulina cylindrica.
Sponge.
Aulopora ? sp.
Syringopora ? sp.
Lophophyllum proliferum.
Campophyllum torquium.
Prismopora sp.
Rhipidomella pecosi.
Meekella striaticostata.
Chonetes mesolobus.
Productus semireticulatus.
Productus punctatus.
Productus cora.
Productus nebraskensis.
Spirifer cameratus.
Seminula subtilita.
Allerisma terminale.
Edmondia sp.
Trepospira sphaerulata.
Naticopsis altonensis.
Loxonema ? sp.

The following list is based on collections from the middle shale member, obtained at two localities:

Axophyllum rude.
Orbiculoidea missouriensis.
Rhipidomella pecosi.
Chonetes mesolobus.
Chonetes flemingi.
Marginifera muricata.
Ambocœlia planiconvexa.
Spirifer cameratus.
Spiriferina kentuckyensis.
Cleiothyris orbicularis.

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 30.
[b] Fifth Bien. Rept. Kansas State Board Agr., 1887, p. 204.
[c] Adams, Bull. U. S. Geol. Survey No. 184, 1902, footnote, p. 15.
[d] Bull. Geol. Soc. Am., Vol. IV, 1892, pp. 100, 108, 116.

The following list is based on collections from the upper limestone member, obtained at six localities:

Fusulina cylindrica.
Chætetes milleporaceus.
Syringopora ? sp.
Axophyllum rude.
Polypora sp.
Fenestella sp.
Rhombopora lepidodendroides.
Meekella striaticostata.
Chonetes mesolobus.
Chonetes flemingi.
Productus semireticulatus.
Productus n. sp.
Productus punctatus.
Marginifera muricata.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Amboccelia planiconvexa.
Seminula subtilita.
Cleiothyris orbicularis.
Hustedia mormoni.
Aviculopecten occidentalis.
Euchondria neglecta.
Edmondia sp.
Ostracoda.

LABETTE SHALES.

Definition and synonymy.—The name Labette shales is applied to the formation lying between the Fort Scott limestone and the Pawnee limestone. The term was introduced by Haworth [a] and applied to this interval, although in the definition the name Oswego limestone was used instead of Fort Scott. In describing the formation succeeding the Fort Scott limestone, the name Laneville shales was used provisionally,[b] and was made to include the interval up to the base of the Erie limestone, the Pawnee limestone and other intervening formations not being observed in the section. Similarly Adams [c] used the term Pleasanton shales, correlating the formation with the beds described as such by Haworth [d] in the formation succeeding the Fort Scott, and supposing the Altamont was the equivalent of the lower Erie, and failing to recognize the Pawnee limestone in the section, gave as the upper limit of the shales the base of the Erie. The accepted use of the term Pleasanton shales is stated later in this paper. The name Laneville shales is now nowhere used, since it was applied to rocks occurring in an interval which embraces several formations.

Character and extent of the formation.—The Labette shales vary from 30 to 60 feet in thickness. Their outcrop forms an irregular belt, limited by the Fort Scott and Pawnee limestones. They carry relatively little sandstone and no coals of recognized importance, although a bed from 6 to 8 inches thick has been stripped in the vicinity of Prescott.

Preliminary faunal list.—The following list is based on collections obtained from two localities:

Lophophyllum proliferum.
Rhombopora lepidodendroides.
Derbya crassa.
Chonetes mesolobus.
Nucula ventricosa.

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 36.
[b] Haworth and Kirk, Kansas Univ. Quart., Vol. II, 1894, p. 108.
[c] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 22.
[d] Kansas Univ. Quart., Vol. III, 1895, p. 274.

PAWNEE LIMESTONE.

Definition and synonymy.—The name Pawnee limestone is applied to a heavy limestone formation which outcrops on Pawnee Creek, southeast of Fort Scott. It was first used by Swallow,[a] and is bed No. 203 of his section. The formation was identified by the Kansas University survey, and has been generally recognized. In the section along the Neosho River by Haworth and Kirk[b] this formation was omitted, as it was also by Adams.[c]

Character and extent of the formation.—The thickness of the Pawnee limestone, as given by Swallow, is 20 to 25 feet. Bennett, who has studied it more in detail, reports it to be 35 feet thick at certain exposures, and in a well near Redfield it was found to be 52 feet thick. Its thickness varies considerably from place to place. Its outcrop has been easily traced from Bourbon County southwestward into Labette County. There, however, it is inconspicuous, and its presence is indicated by the occurrence on the surface of masses of flint, which result from its disintegration. Its extent beyond the border of the State southwestward is questionable.

Preliminary faunal list.—The following list is based on collections obtained from three localities:

Fusulina cylindrica.
Lophophyllum proliferum.
Lophophyllum westi.
Zaphrentis ? sp.
Syringopora ? sp.
Chaetetes milleporaceus.
Rhipidomella pecosi.
Chonetes flemingi.
Productus semireticulatus.
Marginifera wabashensis.
Squamularia perplexa.
Ambocœlia planiconvexa.
Seminula subtilita.
Cleiothyris orbicularis.
Hustedia mormoni.
Naticopsis altonensis ?

BANDERA SHALES.

Definition and synonymy.—The term Bandera shales is here applied to the rocks occupying the interval between the Pawnee limestone and the Altamont limestone. These shales are the equivalent of the Lower Pleasanton shales of Haworth. The term Pleasanton shales, applied to the beds between the Pawnee limestone and the Erie limestone, was introduced by Haworth.[d] At that time it was supposed that the Altamont limestone was the lower member of the Erie formation. In a description of the shales by Kirk and by Bennett, and in the correlation by Haworth,[e] an 8-foot limestone is included in the shales. The Altamont limestone was found to be continuous with this limestone, and accordingly the Pleasanton shales were divided into the Upper Pleasanton shales and the Lower Pleasanton shales.[f] In the

[a] Prel. Rept. Geol. Surv. Kansas, 1866, p. 24.
[b] Kansas Univ. Quart., Vol. II, 1894, p. 108.
[c] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 22.
[d] Kans. Univ. Quart., Vol. III, 1895, p. 274; also Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 44.
[e] Loc. cit., pp. 74, 93, and 153, respectively.
[f] Haworth, Univ. Geol. Surv. Kansas, Vol. III, 1895, p. 39.

northward extension of these formations it is thought that the Altamont limestone thins and is finally absent in the vicinity of Pleasanton, where the term Pleasanton shales is applicable to the rocks occupying the whole interval.

Character and extent of the formation.—On the Marmaton River, near Bandera, this formation is variable in character and carries considerable thin-bedded sandstone, which is quarried for flagging. Its thickness may be stated tentatively as 100 feet. The formation varies in character throughout its lateral extent, but west of Farlington, near Brazilton, and near the Neosho River east of Parsons, flagging similar to that obtained near Bandera has been quarried. This shale carries some coal, which has been mined near Pleasanton, but contains no bed which has been extensively developed or is known to be persistent for any considerable distance.

PARSONS LIMESTONE.

Definition and synonymy.—This formation was first described by Adams[a] as the Altamont limestone, from its occurrence at Altamont, but was correlated with the lower member of the Erie.[b] It has since been shown that it is a distinct formation, which in its northward extension is continuous with the 8-foot limestone described by Bennett,[c] and, thinning, is probably finally absent from the section. The lower limestone at Altamont, continuing southwestward into the Indian Territory, becomes more important and is the equivalent of one of the beds exposed near Oologah, to which the name Oologah limestone was applied by Drake.[d] The name Parsons, here adopted, is from Parsons, Labette County, Kans., near which the formation is well exposed.

Character and extent of the formation.—The Altamont limestone is not well exposed in the vicinity of Altamont, and, although there are surface outcrops near by, its thickness can not be accurately stated. Along the Marmaton River it appears to be represented by a bed 8 feet thick. Farther south this bed thickens somewhat, and a second one is associated with it. These may be seen outcropping near Parsons, where a quarry has been opened in the lower one. South of Altamont the limestones are of much importance, and from there southward to the State line and in their outcrop westward to Coffeyville are seen to be separated into two distinct members by 15 feet or more of shale.

Preliminary faunal lists.—The following list is based upon collections from the Parsons limestone obtained from two localities:

Lophophyllum proliferum.	Chonetes flemingi.
Orbiculoidea missouriensis.	Productus nebraskensis.
Chonetes glaber.	Marginifera wabashensis.

[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 22.
[b] Ibid., p. 25.
[c] Ibid., p. 93.
[d] Proc. Am. Philos. Soc., Vol. XXXVI, 1897, p. 377.

Amboccelia planiconvexa.
Squamularia perplexa.
Seminula subtilita.
Pugnax utah.
Hustedia mormoni.
Nucula ventricosa.
Pleurotomaria sp.
Trepospira sphaerulata.

The following list was obtained from the lower limestone member of the Altamont, based on collections from five localities:

Sponge ?.
Chaetetes milleporaceus.
Crinoidal frag.
Stenopora sp.
Orbiculoidea missouriensis.
Derbya crassa.
Meekella striaticostata.
Chonetes mesolobus.
Productus semireticulatus.
Marginifera wabashensis.
Squamularia perplexa.
Seminula subtilita.
Dielasma bovidens.
Soleniscus sp.
Bellerophon crassus ?.
Bellerophon indt.

The following list is based on collections from the upper member of the Parsons limestone obtained from six localities:

Lophophyllum proliferum.
Campophyllum sp.
Chaetetes milleporaceus.
Cladopora sp.
Crinoidal frag.
Archaeocidaris sp.
Prismopora serrata.
Fistulipora sp.
Fenestella sp.
Orbiculoidea missouriensis.
Derbya crassa.
Meekella striaticostata.
Chonetes mesolobus.
Chonetes flemingi.
Marginifera splendens.
Marginifera wabashensis.
Productus semireticulatus.
Productus semireticulatus var.
Productus punctatus.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Amboccelia planiconvexa.
Seminula subtilita.
Cleiothyris orbicularis.
Hustedia mormoni.
Dielasma bovidens.
Pugnax utah.
Pugnax rockymontana.
Pleurophorus sp.
Astartella vera.
Leda bellistriata.
Nucula ventricosa.
Orthoceras rushense ?.
Dentalium? sp.
Naticopsis sp.
Euomphalus subrugosus.
Phanerotrema grayvillense.
Worthenia tabulata.
Trepospira sphaerulata.
Euphemus carbonarius.

DUDLEY SHALES.

Definition and synonymy.—The name Dudley shales is here applied to the beds occupying the interval between the Parsons limestone and the Hertha limestone, which, as explained above in the discussion of the synonymy, are the equivalent of Haworth's Lower Pleasanton shales.

Character and extent of the formation.—The thickness of the Dudley shales along the Marmaton River, as estimated by Bennett, is about 150 feet. The formation carries some sandstone and some thin beds of limestone, which, however, have not been found important stratigraphically. These shales thicken to the northwest. Along the Neosho River they are extensively developed, but near Altamont,

where the Parsons limestones thicken up, the shales are thinner. There are no coals of importance in this formation, although a number of thin beds are known to occur.

HERTHA LIMESTONE.

Definition and synonymy.—The name Hertha limestone is here introduced for the limestones succeeding the Upper Pleasanton shales as exposed in the vicinity of Hertha. This series of beds is the equivalent of the lower member of the Erie formation, for which no specific name has been used in Kansas. Haworth [a] in his correlation says that it is probably a continuation of the Bethany Falls limestone. This term was first used by Broadhead [b] for the formation occurring at Bethany, Harrison County, Mo. This locality is so far distant and there is so little certainty in our present knowledge of the continuation of the limestone to that place that it is thought best not to use the term in describing this formation, but should the correlation be established Bethany would displace Hertha, except in local usage.

The name Erie limestone was proposed by Haworth and Kirk in 1894.[c] Later the formation was called the Erie or Triple limestone by Haworth [d] and was recognized as consisting of three members separated by thin shales. It was also considered as a triple formation by Kirk [e] and by Bennett.[f] In their southward extension the intervening shales thicken, and individual members are described as independent formations. In this bulletin the three beds of which the Erie is composed are regarded as separate formations where they are independently developed, and are described as the Hertha, Dennis, and Drum limestones.

Character and extent of the formation.—The Hertha limestone, where its outcrop is farthest separated from the Dennis and Drum limestones, has a thickness of about 10 feet. Where it has been described as constituting the lower member of the Erie, it has a thickness of about 20 feet. The detailed section of this formation varies from place to place, as the character of the bedding of the rock varies from a massive limestone to a thin-bedded limestone with intercalated shale members. This formation thins out and disappears in the hills northwest of Altamont. Its extent from there to the northwest is continuous, and it reaches its greatest importance where it is most closely associated with the Dennis and Drum formations, from the Neosho River to the Missouri line.

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[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, pp. 45, 46.
[b] Missouri Geol. Surv., 1872.
[c] Kansas Univ. Quart., Vol. II, 1894, p. 108.
[d] Idem, Vol III, 1895, pp. 275, 276.
[e] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 76.
[f] Ibid., p. 95.

Preliminary faunal list.—The following list is based on collections from two localities:

Lophophyllum westi.
Stenopora sp.
Fistulipora sp. a.
Fistulipora sp. b.
Chonetes flemingi.
Productus cora.
Productus nebraskensis.
Marginifera splendens.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Dielasma bovidens.
Pinna? peracuta.
Myalina perattenuata.
Edmondia reflexa?
Schizodus sp.
Naticopsis sp. a.
Naticopsis sp. b.
Bellerophon crassus.
Euphemus nodocarinatus.
Phillipsia sp.

GALESBURG SHALES.

Definition and synonymy.—This name is here applied to the rocks occupying the interval between the Hertha limestone and the Dennis limestone. This formation is the equivalent of the Mound Valley shales of Haworth.[a] Before these were called the Mound Valley shales they had been described but not named.

Character and extent of the formation.—Near Mound Valley, where this formation was first differentiated and named the Mound Valley shales, its thickness is about 100 feet, and the interval is practically all occupied by sandy shales. At that point the lower limit can not be definitely pointed out, because the Hertha limestone, which marks the lower limit of the Galesburg formation, is probably absent from the section. In the vicinity of Galesburg the thickness of the shales is about 75 feet, but northward, along the Neosho River, it decreases rapidly, and beyond that stream is reduced to only a few feet, becoming, in fact, simply a shale member of the Erie formation as defined by Haworth and Kirk.

DENNIS LIMESTONE.

Definition and synonymy.—The name Mound Valley limestone was proposed in 1896 for the limestone exposed on the hills northwest of Mound Valley,[b] and the bed was correlated with the middle member of the Erie.[c] The formation, as exposed at Cherryvale, had been previously described but not named, and had been incorrectly correlated with the Oswego of Haworth.[d] The name Dennis, from the town of that name in Labette County, Kans., near which it is conspicuously exposed, is now proposed for this limestone.

Character and extent of the formation.—This formation has a thickness of from 10 to 15 feet, and varies from a heavy-bedded limestone to a thin-bedded limestone with shale partings. It has been traced

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 47.
[b] Adams, idem, Vol. I, 1896, p. 23.
[c] Ibid., p. 25.
[d] Kansas Univ. Quart., Vol. II, 1894, p. 118; also p. 124.

from Mound Valley southwestward to the Verdigris River, near Liberty, where it thins out. From Mound Valley its outcrop extends in an irregular line to the Neosho River, where the formation is closely associated with the underlying Hertha limestone and the overlying Drum limestone as a result of the thinning of the adjacent shales. In this portion of its extent it has a thickness of about 20 feet.

Preliminary faunal list.—The following list is based on collections from two localities:

Polypora sp. a.
Polypora sp. b.
Productus punctatus.
Productus cora.
Productus semireticulatus.
Productus nebraskensis.
Productus sp.
Spirifer cameratus.
Squamularia perplexa.
Seminula subtilita.
Pinna? peracuta.
Bellerophon sp.

CHERRYVALE SHALES.

Definition and synonymy.—This name was first used by Haworth,[a] and is applied to the bed of shales lying between the Dennis limestone and the Drum limestone as exposed at Cherryvale. In the previous descriptions of the bed no name had been applied to it.

Character and extent of the formation.—The thickness of the Cherryvale shales at Cherryvale is given as 120 feet by Haworth. In this locality they contain but little sandstone. They thin rapidly northward, and at the Neosho River become simply a shale member of the Erie formation, which is there composed of the Hertha, Dennis, and Drum limestones and intervening shales.

DRUM LIMESTONE.

Definition and synonymy.—The name Independence limestone was first used provisionally by Haworth and Piatt[b] for the limestone exposed at Independence, Kans., which was at that time erroneously correlated with the Oswego limestone. Exposures of the formation at Cherryvale were also described and correlated with the whole of the Erie.[c] Subsequently the name Independence was used by Adams[d] for the limestone which is exposed at the original locality, and the formation was correlated with the upper member of the Erie.[e] The name has since been used in this sense, but is preoccupied by the Independence shales in the Devonian of Iowa,[f] and the name Drum limestone, from Drum Creek, Kansas, where it is conspicuously exposed, is adopted.

Character and extent of the formation.—The thickness of this formation at Independence is fully 40 feet at the river bank, where it

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 47.
[b] Kansas Univ. Quart., Vol. II, 1894, p. 115.
[c] Ibid., pp. 118, 119.
[d] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 23.
[e] Ibid., p. 25.
[f] Calvin: Am. Jour. Sci., 3d series, Vol. XV., 1878, pp. 460–462.

occurs as a massive ledge. From there southward toward the State line it changes in character, becoming thin bedded and more argillaceous. To the northwest it maintains its importance, although somewhat thinner, and at the Neosho River is the upper member of the Erie formation, and has a thickness of about 25 feet.

Preliminary faunal list.—The following list is based on collections from two localities:

Lophophyllum sp.
Fenestella (several sp.).
Fistulipora sp.
Productus norwoodi.
Productus cora.
Productus nebraskensis.
Productus n. sp.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Dielasma bovidens.
Pugnax utah.
Aviculopecten sp.
Aviculopecten carboniferus.
Myalina perattenuata?.
Myalina sp.
Pinna? peracuta.
Edmondia aspinwallensis.
Pleurophorus sp.
Euconispira sp.
Phillipsia major.

CHANUTE SHALES.

Definition and synonymy.—This bed of shales was described and named by Haworth and Kirk.[a] The term Chanute was also used in a section given by Haworth.[b] Subsequently the name Thayer shales was introduced for the same bed,[c] and this term was used by Adams.[d] Haworth in a footnote in a paper on the stratigraphy of the Kansas Coal Measures, published in 1895,[e] states that the shales were called the Chanute shales by Haworth and Kirk, but that the name was subsequently changed to Thayer shales. It seems that there was no reason given for the change, and that the term Thayer shales, although known to be a synonym, was nevertheless used in subsequent publications by the Kansas survey.

Character and extent of the formation.—This formation reaches a thickness of fully 200 feet and is one of the important shales of the section. Along the Neosho River, in the vicinity of Chanute, it carries but little sandstone. Southward, in the vicinity of Thayer, and from there to the Indian Territory, the amount of the sandstone is so considerable as to form conspicuous outcrops within the area of the formation. Northwestward the shales are thinner, and toward the Missouri line become much less important than in their type locality. Near Thayer a coal bed occurs, which has been mined considerably for local use. Southward, toward the Indian Territory, coal is known to occur at several places within this formation, but is nowhere thick enough to be of commercial importance.

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[a] Kansas Univ. Quart., Vol. II, 1894, p. 109.
[b] Ibid., p. 124.
[c] Haworth, idem, Vol. III, 1895, p. 276.
[d] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 24.
[e] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 459.

EARLTON LIMESTONE.

Definition and synonymy.—The first description of this limestone was given by Haworth and Piatt[a] at the locality of Altoona, though certain outcrops of the Iola were confused with this in the description, and the whole was referred to the Erie formation. The Earlton limestone was not recognized as distinct from the Iola until it was described by Adams in 1898.[b] The formation was subsequently referred to under this name by Haworth.[c]

Character and extent of the formation.—To the Earlton limestone may be assigned a thickness of 15 feet, although it is variable in character and does not occur in a single bed. It has been studied in only a limited area from the Neosho River southwestward to the Verdigris. Apparently this limestone becomes closely associated with the Iola northward, and southward separates into beds which gradually thin out and disappear.

Preliminary faunal list.—The following list is based upon collections from three localities:

Amblysiphonella sp.
Lophophyllum westi.
Fenestella sp.
Polypora sp.
Pinnatopora sp.
Rhombopora lepidodendroides.
Thamniscus sp.
Fistulipora carbonaria.
Derbya crassa ?.
Chonetes flemingi.
Productus punctatus.
Productus semireticulatus ?.
Spirifer cameratus.
Seminula subtilita.
Spiriferina kentuckyensis.
Pugnax utah.
Dielasma bovidens.
Squamularia perplexa.
Hustedia mormoni.
Avicula sp.
Aviculopecten carboniferus.
Aviculopecten whitei.
Aviculopecten occidentalis.
Streblopteria sp.
Lima retifera.
Monopteria ? sp.
Conocardium sp.
Pleurophorus sp.
Edmondia sp.
Platyceras nebraskense.
Trepospira sphærulata.
Worthenia tabulata.
Pleurotomaria sp.
Soleniscus sp.
Loxonema sp.
Orthoceras sp.
Nautilus sp.

VILAS SHALES.

Definition and synonymy.—These shales occupy the interval between the Earlton limestone and the Iola limestone, and were so defined by Haworth.[c]

Character and extent of the formation.—The thickness of the Vilas shales is probably not greater than 75 feet. Where the Earlton limestone is closely associated with the Iola, the bed probably thins out. Southward, when the Earlton limestone disappears, the Vilas shales blend with the lower shales adjacent to them.

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[a] Kansas Univ. Quart., Vol. II, 1894, pp. 115, 116. [b] Idem, Vol. VII, 1898, p. 96.
[c] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 51.

IOLA LIMESTONE.

Definition and synonymy.—This name was introduced by Haworth and Kirk for the limestone exposed at Iola.[a] The formation has been generally correctly correlated.

Character and extent of the formation.—The thickness of this formation at Iola is about 30 feet, where it occurs as a massive bed. Along the line of its outcrop, which is traced with little difficulty, it maintains its importance nearly to the Indian Territory line, where it separates into thin beds and is relatively inconspicuous.

Preliminary faunal list.—The following list is based on collections from nine localities.

Fusulina cylindrica.
Lophophyllum westi.
Lophophyllum proliferum.
Chaetetes milleporaceus.
Eupachycrinus sp.
Fistulipora sp.
Fenestella sp.
Septopora sp.
Crania sp.
Rhipidomella pecosi.
Enteletes hemiplicatus.
Derbya crassa.
Meekella pyramidalis ?.
Chonetes flemingi.
Productus nebraskensis.
Productus cora.
Productus semireticulatus.
Productus norwoodanus.
Productus punctatus.
Productus subhorridus ?.
Productus sp.
Marginifera wabashensis.
Proboscidella sp.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Dielasma bovidens.
Aviculopecten interlineatus.
Pseudomonotis æquistriata.
Myalina subquadrata.
Myalina swallowi.
Yoldia sp.
Schizodus sp.
Euconispira sp.
Phanerotrema grayvillense.
Soleniscus ponderosus ?.
Naticopsis ? sp.
Leperditia sp.

LANE SHALES.

Definition and synonymy.—This name is given to the bed of shales lying between the Iola limestone and the Stanton limestone. The name was first introduced by Haworth,[b] and was applied to the shales lying between the Carlyle limestone and the Garnett or Burlington limestone at Lane. It has since been learned, as best the writer is able to understand, that the limestone there considered to be the Carlyle is the Iola, and that the limestone spoken of as the Garnett or Burlington is the same formation that was described as the Carlyle limestone and is now called the Stanton. Haworth says:[c] "Passing upward from the Iola limestone and leaving unnoticed a shale bed 40 to 50 feet thick and a limestone one-fourth as great, we come to the Lane shales." This shale bed, 40 to 50 feet thick, is probably the equivalent of the bed at Iola, which is now correlated with the Lane shales,

[a] Kansas Univ. Quart., Vol. II, 1894, p. 109. [b] Idem, Vol. III, 1895, p. 277.
[c] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 460.

and the limestone is probably the Stanton limestone. Haworth[a] describes the Garnett limestone as immediately above the Lane shales. Later[b] Haworth describes the Lane shales as lying between the Iola and the Garnett. In this section the Carlyle limestone is evidently not considered or not recognized as being present. Elsewhere the Lane shales are described as lying between the Carlyle and the Garnett limestones. Haworth in his final correlation[c] describes the formation as lying between the Iola and Garnett limestones. This is the position given to the Lane shales in the definition here accepted, with the correction necessitated by the facts now demonstrated, that the name Garnett is a synonym of Carlyle, and that both terms are synonymous with Stanton.

Character and extent of the formation.—This formation is stated by Haworth to vary from 75 to 100 feet in thickness at its occurrence near Lane. From Iola southward it apparently thins, so that the overlying Stanton limestone is brought into closer association with the Iola, and in the southern part of Woodson County the relations of the shale, as well as the Stanton limestone, become indefinite.

STANTON LIMESTONE.

Definition and synonymy.—The name Stanton limestone was given by Swallow[d] to bed No. 151 of his section, the name being derived from the post-office of Stanton, in Miami County. In his section of rocks in Miami County[e] this formation is No. 7, and is described in considerable detail, the place of its occurrence being given with unmistakable clearness. Mr. Bennett has visited this locality and traversed the outcrop of the formation southward, and as a result of this work the following correlations are made possible. The Stanton formation as exposed at Carlyle is described by Haworth and Kirk,[f] and is called the Carlyle limestone. Haworth described the exposures at Garnett and provisionally called the rocks the Garnett limestone, and also provisionally pronounced them identical with the Burlington limestone.[g] The limestone was also described at Ottawa as a distinct formation and named the Ottawa limestone by Haworth.[h] The section given in this connection is, reading upward: Carlyle limestone, shales, Garnett limestone, shales, Ottawa limestone. In the same article[i] certain limestones at Edgerton and Olathe were correlated with the Ottawa limestone. The name Ottawa was dropped without subsequent reference. In the descriptions given by Haworth[j] the Carlyle limestone is disregarded, although the name is used in the general section accompanying the article. The Garnett limestone is since referred to in the sense of the descriptions by Haworth and

[a] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 460.
[b] Univ. Geol. Surv. Kansas, Vol. I, 1896, pp. 48–49.
[c] Idem, Vol. III, 1898, p. 54.
[d] Prelim. Rept. Geol. Surv. Kansas, 1866, p. 20.
[e] Ibid., p. 74.
[f] Kansas Univ. Quart., Vol. II, 1894, p. 110.
[g] Ibid., p. 120.
[h] Ibid.
[i] Ibid., p. 125.
[j] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 460.

Kirk,[a] in which place it is correlated with the Burlington and called the "Burlington or Garnett, leaving the ultimate choice of name to some future time."

On an accompanying map the Carlyle is not shown, but the Garnett is indicated as present at Burlington and Garnett. This mapping and correlation is now known to be incorrect.[b] Later[c] Haworth describes the section as Carlyle limestone, Lane shales, and Garnett (or Burlington) limestone. The Carlyle limestone[d] is disregarded by Haworth, and the Garnett is stated to be the same as the Burlington or Garnett. Kirk[e] uses the Carlyle in the sense of its original description, and the Garnett is described as occurring at Burlington, and it is stated that it may bear the name Burlington or Garnett. Bennett[f] describes the Carlyle as originally defined, and the Burlington as occurring west of Yates Center. Hall[g] describes two limestones as the equivalent of the Garnett. Haworth[h] describes the following section: Carlyle limestone, Lane shales, and Garnett limestone. In his résumé[i] he gives the same section. In an article by Adams on the Physiography of Southeastern Kansas,[j] published with the consent of the Kansas Survey, the following footnote is given, which was written by Haworth:

> This limestone was named the Carlyle by Kirk (Kansas Univ. Quart., Vol. II, p. 110) and the first succeeding one above it the Garnett, or Burlington. It has since been learned, as will soon be published by Haworth, that the so-called Carlyle limestone is the lower member of the Garnett.

In the University Geological Survey of Kansas[k] Haworth makes the following statement:

> In previous descriptions it has been thought that the limestone exposed at Carlyle was distinct from the Garnett limestone, and therefore the term Carlyle was introduced, but during the summer of 1897 Bennett discovered that the so-called Carlyle limestone was the same as the Garnett. As the latter name had been used much more extensively than the former, and the two first used at the same time by the writer, it is preferable to retain the name Garnett and entirely do away with the name Carlyle.

In the final correlation by Haworth[l] the matter is discussed more fully.

Fortunately the confusion which has arisen in this part of the section can be entirely cleared away by recognizing the Stanton lime-

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[a] Kansas Univ. Quart., Vol. II, 1894, p. 110.
[b] The same mapping was also employed in Pl. III, Vol. I, Univ. Geol. Surv. Kansas.
[c] Kansas Univ. Quart., Vol. III., 1895, p. 277.
[d] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 49.
[e] Ibid., p. 78.
[f] Ibid., p. 98.
[g] Ibid., p. 101.
[h] Ibid., Ch. VI.
[i] Ibid., Ch. IX.
[j] Kansas Univ. Quart., 1898, Vol. III, 1895, p. 97.
[k] Vol. III, p. 56.
[l] Ibid., pp. 103, 104.

stone described by Swallow, which term, having been until now disregarded, is untrammelled by any usage excepting the original.

Character and extent of the formation.—The thickness assigned by Swallow to the Stanton limestone was from 6 to 28 feet. In the description of the same formation by Bennett it is shown to consist of two members separated by a thin shale member, each from 12 to 15 feet thick at Garnett. At Iola the thickness of the limestone is about 12 feet. West of these places it has a maximum thickness of 30 feet. The detailed section accordingly varies from place to place. The limestone has been traced southward as far as the northern part of Wilson County, where it apparently thins and becomes unimportant.

Preliminary faunal list.—The following list is based on collections from two localities:

Lophophyllum westi.
Archaeocidaris sp.
Eupachycrinus sp.
Polypora sp.
Fenestella sp.
Fistulipora sp.
Rhipidomella pecosi.
Enteletes hemiplicatus.
Derbya crassa.
Chonetes flemingi.
Marginifera wabashensis.
Productus nebraskensis.
Productus punctatus.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Pugnax utah.
Hustedia mormoni.
Dielasma bovidens.
Platyceras nebraskense.
Bellerophon sp.
Phillipsia major.

LE ROY SHALES.

Definition and synonymy.—The name Le Roy shales applies to the interval between the Stanton limestone and the Oread limestone. It was first proposed by Haworth and Kirk[a] for beds exposed near Le Roy and Moody. The limits given to the formation in the original description were the Carlyle below and the Burlington above. In the same place it is stated that they are the shales lying between the Carlyle and Garnett limestones farther east, the Garnett being supposedly the same as the Burlington. In the same paper, but in a different chapter, the Lawrence shales were named from exposures near Lawrence[b] and defined as lying between the Ottawa limestone and the Oread. These limits are in reality the same as those given for the Le Roy shales. Later[c] the Lawrence shales were described by Haworth as above the Garnett, then supposed to be the limestone at Burlington, and called the Burlington, and the Oread limestone at Burlington. The shales at the locality from which the shales were named were redescribed by Kirk[d] under the name Lane shales, and the Lawrence shales were described[e] as occurring above the Garnett limestone at Burlington, i. e., above the limestone called Burlington, now known as the Oread. The Lawrence shales are described by

[a] Kansas Univ. Quart., Vol. II, 1894, p. 110.
[b] Haworth, ibid., p. 122.
[c] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 460.
[d] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 79.
[e] Ibid.

Hall in accordance with a section at Lawrence,[a] as they also are by Bennett[b] and Haworth.[c] It is evident, as is shown by the erroneous mapping, that the Le Roy shales were at this time supposed to be below the Burlington-Garnett limestone, and the Lawrence shales above the limestone. This idea was corrected in 1898,[d] when the name Lawrence shales was used in preference to the name Le Roy, for the reason, it is stated,[e] that the name had been most frequently used. The name Le Roy shales, however, has precedence. The definition of Le Roy shales as originally given is here accepted, cognizance being taken, however, of the proper correlation of the Stanton and the Oread.

The term Chautauqua sandstone was used by Adams[f] for the sandstones which near the southern border of the State are the equivalent of the Le Roy shales. The term was employed in this sense by Haworth.[g] Since there is no special need of it as a formation name, it is here not used.

Character and extent of the formation.—The thickness of this formation, as given by Haworth and Kirk in the original description, is 150 feet in the vicinity of Le Roy. From there northward the formation is certainly heavier and at Lawrence has a thickness of 300 feet according to Haworth. Southward the formation outcrops in a broad belt. Although denominated a shale, it contains heavy sandstones, which, however, have not been defined as distinct formations. Toward the Indian Territory line the sandstones predominate in importance over the shales. This formation carries some coal beds which have been mined locally, but none of them can be said to be of commercial importance.

OREAD LIMESTONE.

Definition and synonymy.—The Oread limestone was described from the locality of Lawrence and named by Haworth from Mount Oread, the hill on which the State University stands.[h] The name Burlington, applied to the same formation at Burlington by Haworth and Kirk,[i] is a synonym, and, moreover, is preoccupied by the term Burlington in the section of the Mississippian rocks. The name Burlington was dropped by the Kansas survey in favor of Garnett, evidently because of its being preoccupied. The confusion which there has been in the recognition of the formation has been sufficiently reviewed above.

Character and extent of the formation.—At Lawrence the Oread

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[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 102.
[b] Ibid., p. 113.
[c] Ibid., p. 136.
[d] Idem, Vol. III, 1898, p. 57.
[e] Ibid., p. 104.
[f] Physiography of southeastern Kansas: Kans. Univ. Quart., Vol. VII, 1898, p. 98.
[g] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 59.
[h] Kansas Univ. Quart., Vol. II, 1894, p. 123.
[i] Ibid., p. 110.

limestone is described as consisting of two limestone members, each of which varies from 8 to 20 feet in thickness, with an intervening shale. From Burlington southward the limestone occurs usually as a single bed with a thickness of from 7 to 20 feet. Its outcrop is persistent and forms one of the well-marked horizons in the stratigraphy of the Coal Measures.

Preliminary faunal list.—The following list is based on collections from seven localities:

Fusulina cylindrica.
Lophophyllum proliferum.
Syringopora ? sp.
Fenestella sp.
Rhombopora lepidodendroides.
Fistulipora sp.
Rhipidomella pecosi.
Enteletes hemiplicatus.
Derbya crassa.
Derbya sp.
Meekella pyramidalis ?.
Chonetes flemingi.
Productus semireticulatus.
Productus cora.
Productus nebraskensis.
Productus punctatus.
Productus sp.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Amboccelia planiconvexa.
Seminula subtilita.
Hustedia mormoni.
Dielasma sp.
Pugnax utah.
Pseudomonotis equistriata.
Myalina kansasensis.
Allerisma sp.
Sedgwickia sp.
Soleniscus ponderosus.
Soleniscus ? sp.
Pleurotomaria ? sp.
Bellerophon indt.
Euomphalus subrugosus.

KANWAKA SHALES.

Definition and synonymy.—This name is here proposed for the formation lying between the Oread limestone and the Lecompton limestone. This formation was called the Lecompton shales by Haworth,[a] but the name Lecompton had previously been applied to a limestone formation. The name Elgin sandstone, which was applied by Haworth to the sandstones in the southern part of the State that occupy this interval, is applicable in the region in which the sandstones occur, but since the intervening distance is so great, and since the term was proposed as the equivalent of shale beds, it is not extended to the locality near the Kansas River.

Character and extent of the formation.—This formation at Lecompton is reported by Bennett to be 100 feet in thickness. It is persistent, and varies but little in character, except that in the southern portion of the State, south of the Verdigris River, sandstones are conspicuous within its limits.

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 64.

LECOMPTON LIMESTONE.

Definition and synonymy.—The Lecompton limestone was named and defined by Bennett in his section along the Kansas River.[a] It had already been mentioned by Haworth,[b] the name evidently being adopted from Bennett's manuscript. It was overlooked by Haworth and Kirk in the Neosho River section, where it is inconspicuous. It is the equivalent of the lower division of the Elk Falls limestone.[c]

Character and extent of the formation.—According to the description of the outcrops near Lecompton the thickness of this formation is about 20 feet. It is separated into three limestone members with intervening thin shales. Its outcrop is not conspicuous for considerable of the distance between the Kansas River and the Verdigris, since, as a result of its relation to higher limestones, it usually occurs at the base of long slopes. Where it is seen it consists of two or more members, and retains its relative importance. In the southern part of the State, south of Elk River, it is more massive and develops into a conspicuous ledge.

Preliminary faunal list.—The following list is based on collections from 14 localities:

Fusulina cylindrica.
Amblysiphonella sp.
Zaphrentis ? sp.
Lophophyllum proliferum.
Campophyllum sp.
Syringopora ? sp.
Archæocidaris sp.
Fistulipora 2 sp.
Fenestella sp.
Stenopora carbonaria.
Stenopora sp.
Rhombopora lepidodendroides.
Rhipidomella pecosi ?.
Enteletes hemiplicatus.
Derbya crassa.
Derbya robusta.
Meekella striaticostata.
Chonetes flemingi.
Chonetes granulifer.
Productus semireticulatus.
Productus pertenuis.
Productus nebraskensis.
Productus cora.
Productus punctatus.
Productus sp.
Marginifera wabashensis.
Marginifera lasallensis ?.
Strophalosia sp.
Spirifer cameratus.
Spiriferina kentuckyensis.
Ambocœlia planiconvexa.
Seminula subtilita.
Dielasma bovidens.
Dielasma sp.
Pugnax ? sp.
Hustedia mormoni.
Aviculopecten sp.
Myalina subquadrata.
Myalina wyomingensis.
Myalina kansasensis.
Aviculopinna sp.
Astartella vera.
Euconispira sp.
Bellerophon percarinatus ?.
Trachydomia wheeleri ?.
Naticopsis sp.
Glyphioceras ? sp.
Phillipsia major.

[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 116.
[b] Kans. Univ. Quart., Vol. III, 1895, p. 278.
[c] Haworth, Univ. Geol. Surv. Kansas, Vol. III, 1898, pp. 65, 66.

TECUMSEH SHALES.

Definition and synonymy.—The name Tecumseh applies to the formation, consisting largely of shales, which appears between the Lecompton limestone and the Deer Creek limestone. It was proposed by Beede[a] and was adopted by Haworth. The sandstones which occupy this interval south of the Elk River were called the Cave Spring sandstones by Haworth[b]. This name, however, has not come into use, since this portion of the section has not been discussed, and there has been no necessity for mentioning the sandstones.

Character and extent of the formation.—In the northern part of the State this formation is a shale bed which, according to Beede, is 75 feet thick in Shawnee County. In the southern part of the State it is much thinner, and the interval is occupied to a considerable extent by sandstone.

DEER CREEK LIMESTONE.

Definition and synonymy.—The name Deer Creek limestone was proposed by Bennett[c] for certain beds outcropping along Deer Creek near the Kansas River. It has been shown by Bennett's mapping of the formation that it is the equivalent of the Strawn of Kirk's Neosho River section. The name Strawn being preoccupied by the Strawn division of the Coal Measures of Texas, Deer Creek is accordingly applicable. This formation is equivalent to the basal portion of what was denominated the Upper Elk Falls.[d]

Character and extent of the formation.—The Deer Creek limestone, like the Lecompton, consists of two or more limestone members, with intervening shales carrying thin argillaceous limestone. The thickness of the formation is variable, but may be stated to average 25 feet. The outcrops are not always well defined, and because of the similarity of this formation to the subjacent Lecompton and superjacent Hartford it is not easily traced.

Preliminary faunal list.—The following list is based on collections from 14 localities:

Fusulina cylindrica.
Lophophyllum proliferum.
Syringopora ? sp.
Archæocidaris sp.
Fenestella (2 sp.).
Polypora sp.
Septopora sp.
Fistulipora (2 sp.).
Rhombopora lepidodendroides.
Derbya crassa.
Derbya robusta.
Derbya cymbula.
Meekella striaticostata.
Chonetes granulifer.
Productus semireticulatus.
Productus cora.
Productus nebraskensis.
Productus punctatus.
Productus pertenuis.
Productus sp.
Marginifera wabashensis.
Marginifera muricata.

[a] Trans. Kans. Acad. Sci., Vol. XV, 1898, p. 28.
[b] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 66.
[c] Idem, Vol. I, 1896, p. 117.
[d] Haworth, idem, Vol. III, 1898, pp. 65, 66.

Spirifer cameratus.
Squamularia perplexa.
Amboccelia planiconvexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Hustedia mormoni.
Dielasma bovidens.
Aviculopecten occidentalis.
Myalina subquadrata.
Allerisma terminale.
Nucula ventricosa ?.
Bellerophon crassus.
Euomphalus subrugosus.

CALHOUN SHALES.

Definition and synonymy.—The shales lying between the Deer Creek limestone and the Hartford limestone are known as the Calhoun. The name was introduced by Beede[a], and was applied to beds outcropping in Shawnee county.

Character and extent of the formation.—In the vicinity of the Kansas River these shales are about 60 feet thick. They maintain this importance southward to the vicinity of Elk River, where they are thinner, and the adjacent limestones are in consequence more closely associated.

HARTFORD LIMESTONE.

Definition and synonymy.—This name was proposed by Kirk[b] for limestones occurring at Hartford, on the Neosho River. The Topeka limestone, which was described by Bennett in the Kansas River section,[c] is equivalent to this formation. This was determined by the mapping done by Bennett. It is the equivalent of the upper part of the Upper Elk Falls as described by Haworth.[d]

Character and extent of the formation.—The thickness of the Hartford limestone is about 25 feet. The individual members are separated by thin shale beds. It is persistent as far as it has been studied, although it has many variations in the details of its section.

Preliminary faunal list.—The following list is based on collections from twelve localities.

Fusulina cylindrica.
Amblysiphonella sp.
Syringopora multattenuata.
Lophophyllum proliferum.
Eupachycrinus sp.
Archæocidaris sp.
Fistulipora carbonaria.
Rhombopora lepidodendroides.
Polypora sp.
Fenestella sp.
Derbya crassa.
Derbya robusta.
Chonetes granulifer.
Chonetes flemingi.
Chonetes mesolobus.
Productus punctatus.
Productus semireticulatus.
Productus nebraskensis.
Productus cora.
Productus pertenuis?.
Productus sp.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Dielasma bovidens.
Hustedia mormoni.

[a] Trans. Kansas Acad. Sci., Vol. XV, 1898, p. 29.
[b] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 80.
[c] Ibid., p. 117.
[d] Idem, Vol. III, 1898, pp. 65, 66.

Aviculopecten occidentalis.
Aviculopecten m'coyi.
Myalina subquadrata.
Astartella vera.
Leda arata.
Phanerotrema grayvillense.
Bellerophon sp.
Euphemus carbonarius.

SEVERY SHALES.

Definition and synonymy.—The shales lying between the Hartford limestone and the Howard limestone were called the Osage City shales by Hall.[a] This term was subsequently applied to this formation, together with the next higher shale formation, by Haworth[b] in his final correlation. In this usage the Howard limestone, which had been called the Osage City limestone by Hall, was considered not to be of sufficient importance to merit the rank of a formation. The term "Severy shales" was subsequently used for this formation by Haworth,[c] and in view of the use of the word "Osage" to denote other rocks elsewhere is here adopted.

Character and extent of the formation.—The Severy shales are between 60 and 75 feet thick, and maintain a surprising uniformity in their lithologic character. They are argillaceous, and within a few feet of their upper limit a coal bed is found, which has been mined extensively in the vicinity of Osage, Carbondale, and Burlingame. This coal, although not usually over 18 inches thick, is of importance because of its geographic location. It is the highest bed in the Coal Measures which is mined systematically.

Preliminary faunal list.—The following list is based on collections from four localities:

Lophophyllum proliferum.
Eocidaris sp.
Archæocidaris sp.
Eupachycrinus sp.
Rhombopora lepidodendroides.
Fistulipora sp.
Orbiculoidea sp.
Orbiculoidea missouriensis.
Lingula carbonaria.
Derbya crassa.
Chonetes flemingi.
Productus semireticulatus.
Productus sp.
Marginifera wabashensis ?.
Spirifer cameratus.
Spiriferina kentuckyensis.
Ambocœlia planiconvexa.
Seminula subtilita.
Hustedia mormoni.
Pugnax utah.
Aviculopecten whitei.
Aviculopecten sp.
Streblopteria sp.
Limi retifera ?.
Myalina sp.
Schizodus harei.
Astartella varica.
Astartella gurleyi ?
Clinopistha radiata var. lævis ?.
Chænomya ? sp.
Sedgwickia ? sp.
Trepospira sphærulata.
Worthenia tabulata.
Phanerotrema grayvillense.
Pleurotomaria ? (3 sp.)
Bulimorpha chrysalis.
Bulimorpha sp.
Soleniscus sp.
Loxonema sp.
Naticopsis altonensis.

[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 104.
[b] Idem, Vol. III, 1898, p. 73.
[c] Ibid., p. 66.

Euomphalus subrugosus.
Euphemus carbonarius.
Patellostium montfortianum.
Bellerophon stevensianus.
Bellerophon sp.
Orthoceras rushense.
Orthoceras sp.
Goniatites sp.
Nautiloid.
Phillipsia scitula.

HOWARD LIMESTONE.

Definition and synonymy.—The name Howard limestone was applied by Haworth[a] to the formation outcropping at Howard, in Elk County. This limestone is the same for which the name Osage City limestone was used by Hall.[b]

Character and extent of the formation.—In the vicinity of Howard the limestone is usually about 7 feet thick, and throughout its extent it is seldom of much importance. At many localities it is only a foot or two in thickness, but its occurrence above a bed of easily eroded shales makes it conspicuous. This limestone is of interest, since it indicates the general line of outcrop of the Osage coal. It was first studied in the southern part of the State and has been mapped there more extensively than northward. It has been noted in many descriptions and can be identified readily at localities not indicated upon the map.

Preliminary faunal list.—The following list is based on collections from ten localities:

Fusulina cylindrica.
Lophophyllum proliferum.
Stenopora sp.
Fistulipora sp.
Rhombopora lepidodendroides.
Fenestella sp.
Enteletes hemiplicatus.
Derbya robusta.
Derbya crassa.
Chonetes flemingi.
Chonetes sp.
Productus semireticulatus.
Productus cora.
Productus punctatus.
Productus nebraskensis.
Productus sp.
Marginifera wabashensis.
Spirifer cameratus.
Ambocœlia planiconvexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Hustedia mormoni.
Aviculopecten occidentalis.
Aviculopecten whitei.
Myalina subquadrata.
Myalina kansasensis.
Aviculopinna sp.
Sedgwickia topekensis.
Edmondia sp.
Nucula ventricosa.
Naticopsis altonensis.
Naticopsis sp.
Soleniscus sp.
Bulimorpha chrysalis ?.
Euomphalus subrugosus.
Pleurotomaria sp.
Trepospira sphærulata.
Phanerotrema grayvillense.
Bellerophon crassus.
Patellostium montfortianum.
Bucanopsis meekana ?.
Bucanopsis sp.
Euphemus carbonarius.
Dentalium sp.

[a] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 67.
[b] Idem, Vol. I, 1896, p. 104.

BURLINGAME SHALES.

Definition and synonymy.—This name was first used by Haworth.[a] It is applied to the shales which appear between the Howard limestone and the Barclay limestone. The term Osage shales was extended by Haworth to include this formation, but is here restricted to usage in its original sense. The formation referred to as the Osage shales by Haworth[b] is now shown to be the equivalent of the Burlingame.

Character and extent of the formation.—The Burlingame shales are about 120 feet thick in Shawnee County, and are approximately of the same importance throughout their extent. Since they are easily eroded, they give rise to an escarpment which is a conspicuous feature in this portion of the Coal-Measures area. In the vicinity of Silver Lake, west of Topeka, as well as at some localities in the southern part of the State, thin coal beds occur, which have been worked to a limited extent. The small mines in Greenwood, Elk, and Chautauqua counties are probably at this horizon.

Preliminary faunal list.—The following list is based on collections from four localities:

Lingula carbonaria.
Enteletes hemiplicatus
Derbya robusta.
Chonetes flemingi.
Productus semireticulatus.
Productus nebraskensis.
Marginifera wabashensis.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Dielasma bovidens.
Hustedia mormoni.
Myalina perattenuata.
Sedgwickia sp.
Yoldia subscitula.
Chænomya sp.
Pleurophorus sp.
Schizodus sp.
Bucanopsis meekana.
Ostracoda.

BARCLAY LIMESTONE.

Definition and synonymy.—This name is here introduced for the limestone which succeeds the Burlingame shales. The name Wyckoff limestone was used for this formation[c] and applied to outcrops in the Neosho River section. The name Wyckoff, however, is preoccupied by a limestone of the Cincinnatian of Minnesota.[d] The name Burlingame limestone, proposed by Hall,[e] is likewise preoccupied by the shale formation of that name, although the term has been extensively used by Haworth. The name Eureka limestone, introduced by Haworth,[f] is likewise preoccupied by the Eureka quartzite of Colorado.

Character and extent of the formation.—This formation is reported by Beede as consisting in Shawnee County of two members, separated

[a] Kansas Univ. Quart., Vol. III, 1895, p. 278.
[b] Univ. Geol. Surv. Kansas, Vol. III, 1898, p. 67.
[c] Kansas Univ. Quart., Vol. II, 1894, p. 111.
[d] Hall and Sardeson, Bull. Geol. Soc. Am., Vol. III, 1892, pp. 332–336.
[e] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 105.
[f] Idem, Vol. III, 1898, p. 67.

by a thin shale. The limestone has a thickness of from 4 to 7 feet. The lower member is the more conspicuous in the field. Hall reported it as 8 feet thick at Burlingame. It occurs in an escarpment above the Burlingame shales and can be readily traced. The upper member usually lies back some distance from the brow of the escarpment, and its occurrence is often masked.

Preliminary faunal list.—The following list is based on collections from four localities:

Fusulina cylindrica.
Archæocidaris sp.
Fenestella (several sp.).
Rhombopora lepidodendroides.
Enteletes hemiplicatus.
Derbya sp.
Chonetes flemingi.
Productus cora.
Productus nebraskensis.
Spirifer cameratus.
Seminula subtilita.
Pleurotomaria sp.
Euomphalus subrugosus.

OLPE SHALES.

Definition and synonymy.—This term is here proposed for the shales lying between the Barclay limestone and the Emporia limestone. These shales have been described, but thus far have received no name.

Character and extent of the formation.—The formation has not been studied extensively outside of Lyon County, where it has been limited by the mapping of the adjacent limestones. The thickness is reported to be from 50 to 60 feet.

Preliminary faunal list.—The following list is based on collections from four localities:

Archæocidaris sp.
Rhombopora lepidodendroides.
Fistulipora sp.
Enteletes hemiplicatus.
Derbya crassa.
Chonetes flemingi?.
Chonetes glaber.
Aulacorhynchus millepunctatum.
Productus cora.
Productus nebraskensis.
Spirifer cameratus.
Spiriferina kentuckyensis.
Aviculopecten sp.
Entolium aviculatum.
Bakewellia sp.
Myalina swallowi.
Modiola subelliptica.
Allerisma terminale.
Sedgwickia sp.
Edmondia sp.
Pleurophorus sp.
Pleurophorus occidentalis?.
Pleurophorus ? sp.
Astartella ? sp.
Macrodon carbonarius.
Schizodus sp.
Schizodus (small sp.).
Loxonema sp.
Soleniscus sp.
Bulimorpha sp.
Pleurotomaria ? (2 sp.).
Bellerophon stevensianus.
Bellerophon n. sp. (?)
Dentalium sp.

EMPORIA LIMESTONE.

Definition and synonymy.—This name was applied by Kirk[a] to a limestone formation in the Kansas River section, which had been previously described by Haworth and Kirk[b] as bed No. 10, but not otherwise named.

[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 80. [b] Kansas Univ. Quart., Vol. II, 1894, p. 111.

Character and extent of the formation.—This limestone has been mapped in Lyon County by A. J. Smith, where it is found to be persistent. Its thickness is not very definitely reported, but may be stated as about 10 feet.

Preliminary faunal list.—The following list is based on a collection from one locality:

Fusulina cylindrica.
Bellerophon indet.

ADMIRE SHALES.

Definition and synonymy.—This name is here introduced for the shales lying between the Emporia limestone and the Americus limestone. This formation has not heretofore been named.

Character and extent of the formation.—The Admire shales have been defined by the mapping in Lyon County. The thickness assigned to them is 40 feet, although they have been studied in only a very general way.

Preliminary faunal list.—The following list is based on collections from one locality:

Fusulina cylindrica.
Rhipidomella pecosi.
Meekella striaticostata.
Derbya crassa.
Productus cora.
Productus nebraskensis.
Productus semireticulatus.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Hustedia mormoni.

AMERICUS LIMESTONE.

Definition and synonymy.—The name Americus limestone was applied by Kirk[a] to a formation in the Neosho River section which had been previously described by Haworth and Kirk as limestone No. 11. This formation has been identified by A. J. Smith, and mapped by him in Lyon County.[b]

Character and extent of the formation.—This formation was reported by Kirk to be in two members, separated by a thin shale interval. The lower limestone is stated to have a thickness of 16 inches. This is the ledge which is quarried, and which Smith has stated to vary from 16 to 22 inches in thickness. The formation has not been mapped outside of Lyon County, excepting that Bennett has indicated in a general way its continuation into Greenwood County.

Preliminary faunal list.—The following list is based on collections from two localities:

Fusulina cylindrica.
Lophophyllum proliferum.
Archæocidaris sp.
Fenestella sp.
Fistulipora sp.
Rhombopora lepidodendroides.
Orbiculoidea sp.
Enteletes hemiplicatus.
Derbya crassa.
Meekella striaticostata.
Chonetes granulifer.
Chonetes verneuilianus.

[a] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 80. [b] Kansas Acad. Sci., Vol. XVII, 1901, p. 189.

Productus semireticulatus.
Productus nebraskensis ?.
Marginifera wabashensis.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Pugnax utah.
Pleurophorus sp.
Aviculopinna sp.
Sedgwickia geinitzi.
Phillipsia sp.

ELMDALE FORMATION.

Definition and synonymy.—This formation succeeds the Americus limestone. Its upper limit is the Neva limestone. It is a portion of what was called the Wabaunsee formation by Prosser,[a] but it has not heretofore received a distinct name.

Character and extent of the formation.—The rocks included within the Elmdale formation aggregate about 130 feet in thickness and consist largely of shales, with some thin interbedded limestones, which are not generally conspicuous. The individual beds of limestone are seldom more than 3 or 4 feet thick, and do not produce definite topographic features. Thus far the formation has been mapped only within the Cottonwood Falls quadrangle.

Preliminary faunal list.—The following list is based on collections from eight localities.

Fusulina cylindrica.
Archæocidaris sp.
Fenestella sp.
Stenopora sp.
Rhombopora lepidodendroides.
Derbya crassa.
Meekella striaticostata.
Chonetes flemingi?.
Chonetes granulifer.
Productus cora.
Productus nebraskensis.
Productus semireticulatus.
Productus sp.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Aviculopecten occidentalis.
Pseudomonotis sp.
Myalina aviculoides ?.
Aviculopinna sp.
Edmondia sp.
Pleurophorus sp.
Leda sp.
Schizodus sp.
Pleurotomaria ? sp.
Patellostium montfortianum.
Ostracoda.

NEVA LIMESTONE.

Definition and synonymy.—The Neva limestone has a conspicuous outcrop, although it is relatively a thin formation. It was named the Drybone limestone by Swallow,[b] but inasmuch as this is not a geographic term the name Neva has been adopted. The limestone denominated the Dunlap system by Kirk,[c] in his Neosho River section, embraces what is here called the Neva limestone, together with a thinner bed which is found in the upper part of the Elmdale formation. The Neva formation is a portion of what Prosser called the Wabaunsee.

Character and extent of the formation.—This formation has been

[a] Jour. Geol., Vol. III, 1895, p. 688.
[b] Prel. Rept. Geol. Surv. Kansas, 1866, p. 16.
[c] Univ. Geol. Surv. Kansas, Vol. I, 1896, p. 81.

identified at a number of places, but has been mapped only in the Cottonwood Falls quadrangle. The outcrop is conspicuous, and the peculiar texture of the rock is such as to have suggested the name Drybone. It weathers with a rough surface, and is not so suitable for building stone as the Cottonwood limestone, which lies a short distance above it. Its thickness is approximately 10 feet, and it occurs in two beds, separated by a thin, shaly member.

ESKRIDGE SHALES.

Definition and synonymy.—These shales have not been previously named. They are the highest beds which were included by Prosser in the Wabaunsee formation. Their lower limit is the Neva limestone and their upper limit the Cottonwood limestone.

Character and extent.—The thickness of the Eskridge shales varies from 30 to 40 feet and includes thin beds of limestone. The formation has been mapped within the Cottonwood Falls quadrangle.

Preliminary faunal list.—The following list is based on collections from four localities:

Amboccelia planiconvexa.
Aviculopecten occidentalis.
Myalina perattenuata ?.
Myalina sp.
Pseudomonotis hawni.

COTTONWOOD LIMESTONE.

Definition and synonymy.—This formation consists of a conspicuous limestone, which has been quarried extensively for building stone. It was denominated the Cottonwood Falls limestone by Haworth and Kirk.[a] It is the lower portion of Prosser's Cottonwood formation, which included, besides the limestone, which he called the Cottonwood,[b] the Cottonwood shales,[c] which succeed it.[d]

Character and extent of the formation.—The Cottonwood limestone is approximately 6 feet thick. It occurs with remarkable uniformity, and has been mapped in detail in the Cottonwood Falls quadrangle. Its general line of outcrop has been studied northward to the Kansas River by Prosser,[b] and Beede has mapped it approximately in a reconnaissance which he made in the valley of Blue River.[e] It is a conspicuous formation, and has been noted by many observers because of its adaptability for building stone.

Preliminary faunal list.—The following list is based on collections from six localities:

Fusulina cylindrica.
Septopora sp.
Fenestella sp.
Stenopora sp.
Rhombopora lepidodendroides.
Meekella striaticostata.
Chonetes granulifer.
Productus semireticulatus.
Seminula subtilita.
Aviculopecten occidentalis.

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[a] Kansas Univ. Quart., Vol. II, 1894, p. 112.
[b] Bull. Geol. Soc. Am., Vol. VI, 1894, p. 40.
[c] Ibid.
[d] Jour. Geol., Vol. III, 1895, p. 697.
[e] Kansas Univ. Quart., Vol. IX, 1900, p. 191.

GARRISON FORMATION.

Definition and synonymy.—The Garrison formation may be defined as occurring between the Cottonwood limestone and the Wreford limestone. It includes at its base the Cottonwood shales as defined by Prosser,[a] and the portion above these shales was referred by him to the Neosho formation.[b]

Character and extent of the formation.—The Garrison formation has been mapped only in the Cottonwood Falls quadrangle. It has not been studied as a distinct formation at other localities, but the limiting limestones have been observed at localities on the Kansas River and northward toward Nebraska. It is about 120 feet thick and consists largely of shales. The interstratified limestones are from 1 to 4 feet in thickness and are not of stratigraphic importance.

Preliminary faunal list.—The following list is based on collections from fifty-one localities:

Fusulina cylindrica.
Axophyllum rude.
Archæocidaris sp.
Serpula sp.
Thamniscus sp.
Fenestella sp.
Septopora sp.
Pinnatopora sp.
Cystodictya divisa.
Streblotrypa prisca.
Meekopora sp.
Stenopora carbonaria.
Rhombopora lepidodendroides.
Derbya robusta.
Meekella striaticostata.
Chonetes granulifer.
Productus semireticulatus.
Productus nebraskensis.
Productus cora.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Dielasma bovidens ?.
Pugnax utah.
Hustedia mormoni.
Aviculopecten occidentalis.
Aviculopecten m'coyi.
Aviculopecten cf. whitei.
Aviculopecten sp.
Pseudomonotis hawni.
Pseudomonotis equistriata.
Pseudomonotis kansasensis.
Myalina kansasensis.
Myalina perattenuata ?.
Pinna? peracuta.
Aviculopinna illinoisensis.
Sedgwickia granosa ?.
Schizodus sp.
Pleurophorus sp.
Edmondia sp.
Yoldia subscitula ?.
Soleniscus sp.
Naticopsis sp.
Euomphalus subrugosus.
Numerous indt. small gast.
Patellostium sp.
Orthoceras sp.
Phillipsia scitula.
Ostracoda.

WREFORD LIMESTONE.

Definition and synonymy.—This name was introduced by Hay[c] to denote the limestone which is the equivalent of what was subsequently denominated the Strong flint by Prosser[d] and which forms the base of what he called the Chase formation.[e]

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[a] Jour. Geol., Vol. III, 1895.
[b] Ibid., p. 706.
[c] Eighth Bien. Rept. State Bd. Agr., p. 104.
[d] Jour. Geol., Vol. III, 1895, p. 772.
[e] Ibid., p. 771.

Character and extent of the formation.—The Wreford limestone is about 40 feet thick. It contains a large amount of flint and is the first limestone in the series which has this character. It has thus far been mapped only within the Cottonwood Falls quadrangle. Its nature is such that its outcrop forms a conspicuous escarpment. Quarries have been opened in it at several localities, but it is valuable only for ballast and rough stone.

Preliminary faunal list.—The following list is based on collections from fourteen localities:

Archæocidaris sp.
Septopora sp.
Fenestella sp.
Rhombopora lepidodendroides.
Derbya robusta.
Meekella striaticostata.
Chonetes granulifer.
Productus nebraskensis.
Productus semireticulatus.
Seminula subtilita.
Aviculopecten occidentalis.
Aviculopecten sp.
Entolium aviculatum.
Pseudomonotis hawni.
Posidonomya ? sp.
Myalina aviculoides ?.
Myalina perattenuata ?.
Myalina kansasensis.
Modiola subelliptica ?.
Pinna ? peracuta.
Yoldia subscitula ?.
Edmondia sp.
Schizodus sp.
Macrodon carbonarius.
Pleurophorus calhouni.
Pleurophorus sp.
Bellerophon sp.
Naticopsis sp.
Euomphalus subrugosus.
Phillipsia scitula.
Ostracoda.

MATFIELD SHALES.

Definition and synonymy.—This formation has not previously been defined. It was included by Prosser in the Chase formation.[a] Its lower limit is the Wreford limestone and its upper limit the Florence flint.

Character and extent of the formation.—The Matfield shales have thus far been mapped only within the Cottonwood Falls quandragle, although the formations which limit them above and below have been studied more widely. Inasmuch as this formation consists largely of shales and lies between two beds which form escarpments, it usually occurs in a slope or bench. Some thin limestone beds are found within it. The thickness may be stated as 70 feet.

Preliminary faunal list.—The following list is based on collections from sixteen localities:

Axophyllum rude.
Archæocidaris sp.
Spirorbis sp.
Septopora sp.
Rhombopora lepidodendroides.
Derbya robusta.
Meekella straticostata.
Chonetes sp.
Productus nebraskensis.
Productus semireticulatus.
Amboccelia planiconvexa.
Seminula subtilita.
Aviculopecten occidentalis.
Myalina perattenuata.
Myalina subquadrata.
Bakewellia parva.

[a] Jour. Geol., Vol. III, 1895, p. 771.

Allerisma terminale.
Sedgwickia altirostrata.
Sedgwickia sp.
Chænomya minnehaha ?.
Edmondia sp.
Schizodus sp.
Pleurophorus ? sp.
Euomphalus sp.
Bellerophon indt.
Gasteropod indt.

FLORENCE FLINT.

Definition and synonymy.—This formation was named by Prosser from the locality of Florence, where it is quarried extensively. It is the second limestone formation of the series which contains an abundance of flint. It is a portion of what was denominated the Chase formation by Prosser.[a]

Character and extent of the formation.—The Florence flint has thus far been mapped only within the Cottonwood Falls quadrangle, but because of its strong lithologic characters it has been possible to identify it at widely separated localities. The thickness assigned is 20 feet.

Preliminary faunal list.—The following list is based on collections from fifteen localities:

Fenestella sp.
Septopora sp.
Derbya robusta.
Meekella striaticostata.
Productus semireticulatus.
Ambocœlia planiconvexa.
Seminula subtilita.
Aviculopecten occidentalis.
Myalina perattenuata.
Myalina aviculoides ?.
Pseudomonotis hawni.
Bakewellia parva.
Chænomya leavenworthensis.
Pleurophorus sp.
Euomphalus subrugosus.
Naticopsis sp.
Phillipsia scitula.

FORT RILEY LIMESTONE.

Definition and synonymy.—This name was introduced by Swallow.[b] It is No. 52 of his section, described as occurring at Fort Riley and on Cottonwood River and Fancy Creek. The central part of it is supposedly the equivalent of the Fort Riley main ledge, so denominated by Hay.[c] The limestone denominated the Florence flint and limestone by Prosser[d] is the equivalent of the upper portion of the Fort Riley limestone as here defined. This formation is a part of the Chase formation, as described by Prosser.

Character and extent of the formation.—The formation as above defined has been mapped within the Cottonwood Falls quadrangle, where it has a thickness of about 40 feet.

Preliminary faunal list.—The following list is based on collections from twenty-nine localities:

Fusulina cylindrica.
Archæocidaris sp.
Meekopora sp.
Rhombopora lepidodendroides.
Septopora sp.
Fenestella sp.
Derbya robusta.
Meekella striaticostata.

[a] Jour. Geol., Vol. III, 1895, p. 771.
[b] Prel. Rept. Geol. Surv. Kansas, 1866, p. 14.
[c] Eighth Bien. Rept. State Board Agr., p. 104.
[d] Jour. Geol., Vol. III, 1895, p. 772.

Chonetes granulifer.
Productus semireticulatus.
Marginifera wabashensis.
Amboccelia planiconvexa.
Seminula subtilita.
Aviculopecten occidentalis.
Aviculopecten germanus?.
Aviculopecten sp.
Streblopteria n. sp.
Pinna ? peracuta.
Bakewellia parva.
Allerisma terminale.
Allerisma granosum?.
Chænomya leavenworthensis.
Sedgwickia altirostrata.
Edmondia sp.
Pleurophorus sp.
Schizodus sp.
Euomphalus subrugosus.
Euomphalus pernodosus?.
Gasteropod indt.
Bellerophon indt.
Phillipsia major.

DOYLE SHALES.

Definition and synonymy.—These shales have not been previously named. They were included within the Chase formation by Prosser. As here defined they occur between the Fort Riley limestone and the Winfield formation.

Character and extent of the formation.—The Doyle shales have a thickness of about 60 feet. They include some thin, inconspicuous limestones. The formation occurs in benches and slopes, and has thus far been mapped only within the Cottonwood Falls quadrangle.

Preliminary faunal list.—The following list is based on collections from five localities:

Archæocidaris sp.
Fenestella sp.
Derbya robusta.
Meekella striaticostata.
Productus semireticulatus.
Seminula subtilita.
Aviculopecten occidentalis.
Bakewellia parva.
Myalina sp.
Pleurophorus sp.
Schizodus sp.
Edmondia ? sp.
Gasteropod indt.
Dentalium sp.

WINFIELD FORMATION.

Definition and synonymy.—This formation is the top of the Chase formation, as described by Prosser, and includes what he called the Marion flint and Marion concretionary limestone.[a]

Character and extent of the formation.—As here defined, the Winfield formation has a thickness of from 20 to 25 feet. At the base there is a bed of cherty limestone about 4 feet thick; above this there is a bed of shales about 13 feet in thickness, and at the top is a concretionary limestone about 10 feet in thickness. The name was introduced by Prosser from the locality of Winfield, but the formation is so characteristic in appearance that there is little doubt that it is identical with the Winfield formation in the Cottonwood Falls quadrangle, where it has been mapped and studied in detail.

[a] Jour. Geol., Vol. III, 1895, p. 772.

Preliminary faunal list.—The following list is based on collections from fifteen localities:

Archæocidaris sp.
Septopora sp.
Derbya robusta.
Productus semireticulatus.
Ambocœlia planiconvexa?.
Seminula subtilita.
Aviculopecten occidentalis.
Pseudomonotis sp.
Myalina perattenuata.
Aviculopinna illinoisensis.
Bakewellia parva.
Pleurophorus sp.
Nucula? sp.
Schizodus sp.
Bellerophon indt.

MARION FORMATION.

Definition and synonymy:—This name was introduced by Prosser[a] from the locality of Marion, where it is represented. The Marion concretionary limestone and Marion flint, named by him, should not be confused with it, since, as has already been stated, they belong in the Winfield formation. Although there may be some question because of apparent synonymy as to the propriety of retaining the name Marion, it is thought best to do so, since it was used as a formation name, the terms Marion flint and Marion concretionary limestone being names given to individual beds. It is probable that the Abilene conglomerate, named by Prosser,[b] will be included in the Marion formation.

Character and extent of the formation.—This formation consists largely of shales, although it contains some thin concretionary limestones and some thin-bedded limestones. Its upper limit has not been definitely fixed. About 100 feet of it is represented in the Cottonwood Falls quadrangle, where a portion of it has been mapped. Its entire thickness has been estimated at between 300 and 400 feet.

Preliminary faunal list.—The following list is based on collections from twenty-eight localities:

Spirorbis sp.
Septopora sp.
Derbya robusta.
Productus semireticulatus.
Seminula subtilita.
Aviculopecten occidentalis.
Pseudomonotis hawni.
Myalina aviculoides?
Bakewellia parva.
Pinna? peracuta.
Yoldia subscitula.
Leda sp.
Nucula sp.
Edmondia subtruncata?
Edmondia? sp.
Pleurophorus sp.
Aclis? sp.
Soleniscus sp.
Gasteropod indt.
Bellerophon stevensianus?
Phillipsia sp.

WELLINGTON SHALES.

The name "Wellington shales" was proposed by Cragin[c] for the shales above the Marion formation. This name has been accepted by Prosser.[d] On the Smoky Hill River, and to the west of the area in which the formations above described are typically represented, the

[a] Jour. Geol., Vol. III, 1895, p. 786
[b] Ibid., p. 788.
[c] Colorado College Studies, Vol. VI, pp. 3 and 16.
[d] Univ. Geol. Surv. Kansas, Vol. II, p. 67.

thickness of the Wellington shales is 200 feet or more. They are overlain on their western border by the Cretaceous rocks. A brief reference to their variation in their lateral extent has been made in this paper under the head of "Divisions of the Carboniferous on lithologic grounds."

FORMATIONS DESCRIBED IN NORTHERN INDIAN TERRITORY AND PRELIMINARY LISTS OF FOSSILS FROM THEM.

FORT SCOTT LIMESTONE.

This formation was traversed with considerable care from west of Chetopa, on the Kansas border, into Indian Territory as far as the Arkansas River.[a] It occurs in a prominent escarpment, and the stripping of coal and the quarrying of the limestone in this operation render the outcrop conspicuous. It trends past Kinnison and Eagle to Chelsea. From Chelsea the outcrop is nearly parallel with the railroad to Claremore and Catoosa. Throughout this interval the limestone is less important. A sandstone, which is interbedded between the two members, gradually develops, and the lower member is seldom seen. In the town of Catoosa, and on the creek to the southwest, the upper limestone is exposed. The strike of the formation from Catoosa is southwestward across the Arkansas River. It could not be followed with certainty because of the disappearance of the limestones, but the horizon, as indicated by associated sandstones, was traversed to a point between Holdenville and Wewoka. This made possible the correlation of the Kansas section of the Coal Measures with that of the area of the Choctaw coal field thus far surveyed, and shows that in the Choctaw Nation there are above the lowest productive coal 9,000 feet of shales and sandstone which are lower than the Fort Scott limestone. It will be remembered that the Cherokee shales, which occur below the Fort Scott limestone in Kansas, are but 450 feet thick. It is probable that the increased thickness of the section in the eastern part of the Indian Territory is due to a thickening of the shales and sandstones southward and an unconformity and overlap along the contact with the Lower Carboniferous.

Preliminary faunal list.—The following fossils were obtained at one locality:

Fusulina cylindrica.
Lophophyllum proliferum.
Archaeocidaris sp.
Rhombopora lepidodendroides.
Orbiculoidea missouriensis.
Derbya crassa.
Chonetes mesolobus.
Chonetes flemingi.
Productus semireticulatus.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Dielasma bovidens.
Hustedia mormoni.
Bellerophon crassus.
Orthoceras sp.

[a] Adams, Bull. U. S. Geol. Survey No. 184, 1902, p. 15.

OOLOGAH LIMESTONE.

Type locality.—This formation was named by Drake[a] from exposures at Oologah. The thickness assigned in the sections accompanying the description is 50 feet. The line of outcrop of this formation was not mapped.

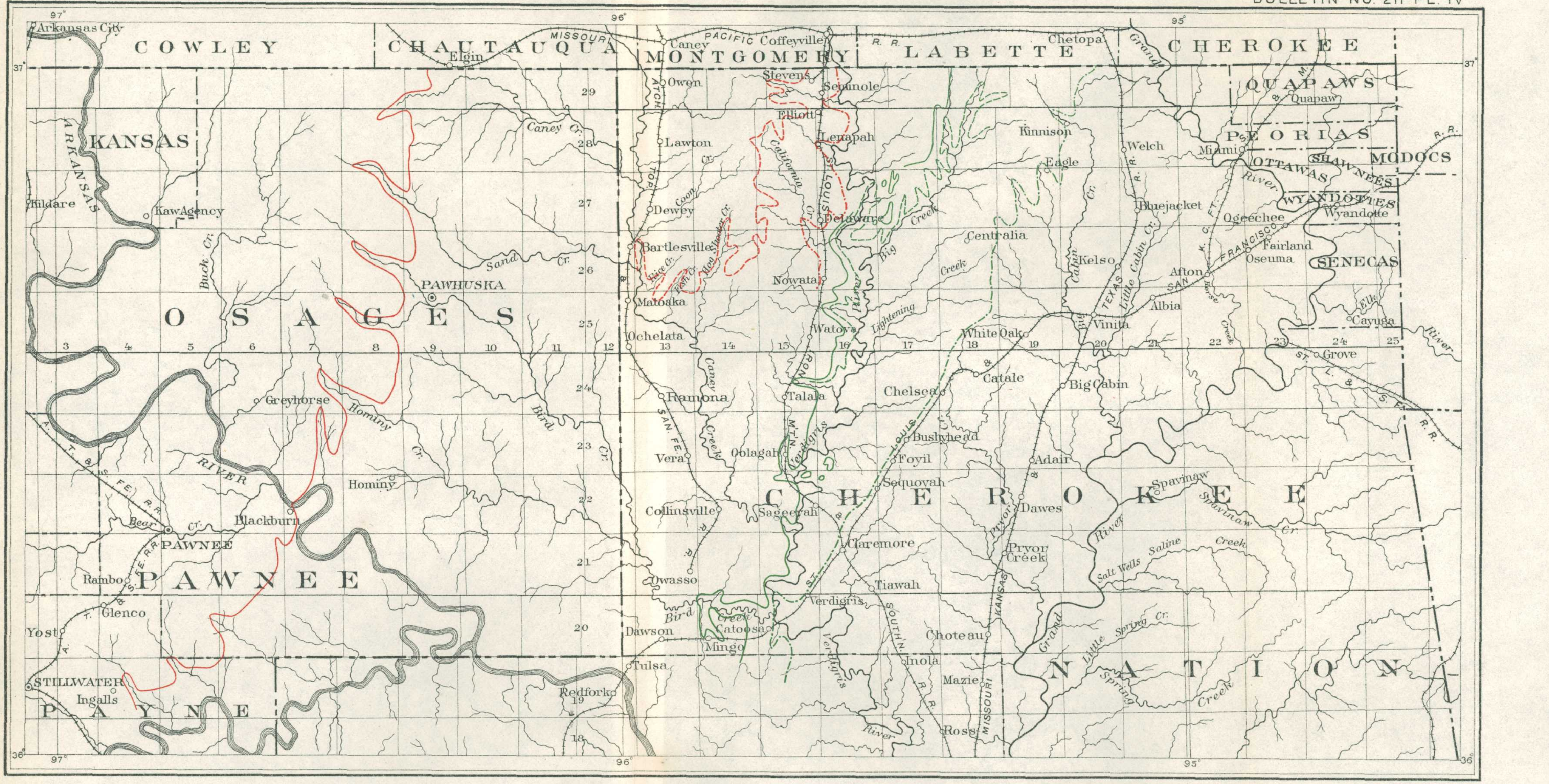
Correlation.—The limestone outcropping at Oologah is reported by Bennett to consist of two members, separated by a shale bed. From Oologah southwestward this formation occurs conspicuously in bluffs, which are particularly prominent on the Verdigris River and Bird Creek. West of Catoosa the limestone outcrops at many places on the divide between the Verdigris and Arkansas rivers. It is quarried extensively for ballast at Mingo, at which place it has a thickness of nearly 100 feet, according to the record of a drilled well. This estimate, however, may include some shale beds. The coal which is mined at Dawson and at places farther north toward Connellsville occurs above this limestone. The outcrop of the limestone trends to the southwest, but has not been followed beyond the Arkansas River.

From the vicinity of Oologah the formation was traced northeastward to the Kansas line. It is conspicuous along the Verdigris east of Nowata and in the escarpment west of Big Creek all the way to the Kansas boundary. In this interval there are two members, separated by an interval of shale which thickens northward until it is approximately 100 feet on the head of Big Creek. The upper member of the limestone was determined by Mr. Bennett to be the equivalent of the lower member of the Parsons formation as mapped and defined by Adams. The equivalency of the lower member of the Oologah has not been definitely determined. It is not impossible that it may prove to be a continuation of the Pawnee. The Parsons limestone in the southern part of Labette County has been reviewed by Bennett and found to consist of two members, the upper member of which has been mapped only tentatively in the Indian Territory. This limestone was observed by Adams along the Verdigris River at several localities south of Coffeyville. The thin ledge seen on the hill in the western part of Nowata is a representative of it. The shale bed which separates the upper and lower members of the Parsons apparently thickens in the Indian Territory.

Preliminary faunal lists.—The following fossils were obtained from the lower Oologah limestone and are from four localities:

Campophyllum sp.
Syringopora ? sp.
Fenestella sp.
Septopora sp.
Fistulipora sp.
Derbya crassa.
Productus nebraskensis.
Productus cora.
Productus semireticulatus.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Seminula subtilita.

[a] Proc. Am. Philos. Soc., Vol. XXXVI, 1897, p. 377.



MAP SHOWING LINES OF OUTCROPS OF CERTAIN LIMESTONES IN INDIAN TERRITORY AND OKLAHOMA

By George I. Adams

Scale

10 0 10 20 30 40 miles

Pawhuska limestone
Drum limestone
Upper Parsons limestone
Oologah limestone
Lower Oologah limestone
Fort Scott limestone

The following fossils are from the Oologah limestone at four localities where the upper and lower members are closely associated:

Amplexus sp.
Campophyllum torquium?
Axophyllum rude.
Syringopora ? sp.
Fenestella sp.
Fistulipora sp.
Prismopora serrata.
Rhombopora lepidodendroides.
Productus semireticulatus.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Cleiothyris orbicularis.
Hustedia mormoni.

The following fossils were obtained from the upper limestone member of the Parsons at one locality:

Lophophyllum proliferum.
Cladopora ? sp.
Fenestella sp.
Stenopora sp.
Fistulipora sp.
Prismopora serrata.
Orbiculoidea missouriensis.
Chonetes flemingi.
Marginifera wabashensis.
Spirifer cameratus.
Squamularia perplexa.
Spiriferina kentuckyensis.
Seminula subtilita.
Cleiothyris orbicularis.
Hustedia mormoni.

COAL ABOVE THE OOLOGAH LIMESTONE.

Localities.—At Dawson there is a bed of coal which is from 26 to 30 inches thick. It has been mined by stripping and has been opened at several localities adjacent to Dawson. The bed at Collinsville is perhaps in the same horizon. The position of the coal with respect to the Oologah limestone, as determined by a well record, is something over 200 feet higher.

Preliminary faunal list.—From the shales associated with the coal bed the following fossils were obtained from four localities:

Aulopora sp.
Fenestella sp.
Chonetes glaber.
Martinia ? sp.
Aviculopecten sp.
Aviculopecten carboniferus.
Allerisma terminale.
Edmondia sp.
Schizodus sp.
Nucula ventricosa.
Leda bellistriata.
Phanerotrema grayvillense.
Phanerotrema n. sp.
Euomphalus subrugosus.
Euphemus carbonarius.
Orthoceras rushense.
Temnocheilus sp.

DRUM LIMESTONE.

Locality and thickness.—In studying the oil and gas fields of the Indian Territory[a] the Drum limestone was traversed by Adams from the outcrop west of Coffeyville to Bartlesville. It occurs on the divide between the Verdigris and Caney, extending southward to Hogshooter Creek, and thence northwestward to Bartlesville. The section of the formation has not been studied in detail. Its thickness within the

[a] Bull. U. S. Geol. Survey No. 184, 1902.

Territory, however, varies considerably from that which it has near the Kansas line. The mapping of it presented herewith is only tentative.

Preliminary faunal list.—The following fossils were obtained at three localities:

Campophyllum torquium.
Axophyllum rude.
Fenestella sp.
Euconispira sp.
Seminula subtilita.

PAWHUSKA LIMESTONE.

Locality and thickness.—This formation was named by J. P. Smith,[a] who determined some fossils from it and referred it to the Upper Coal Measures. On the authority of Mr. H. C. Hoover, who collected the fossils, the formation is reported to be 100 feet thick and to consist of massive limestone, which is found outcropping 3 miles northwest of Pawhuska. In Drake's section the greatest thickness given for a bed identified as Pawhuska limestone is 10 feet. The line of outcrop of this formation was not mapped by Drake.

Correlation.—The Lecompton, Deer Creek, and Hartford limestone formations are shown in the mapping by Bennett to be the equivalent of the limestones which were reported by Haworth from Adams's field notes as the Upper and Lower Elk Falls. A more careful study has shown that what was called the Upper Elk Falls is the equivalent of the Deer Creek and Hartford.

In the reconnaissance made in the Osage Nation by Adams[b] the limestones which had been denominated the Elk Falls were traversed and found to be the equivalent of the Pawhuska, which had been named previously by Smith. In the report of this reconnaissance it is stated that the Pawhuska consists of three distinct members. It is possible that they are the equivalents of the Lecompton, Deer Creek, and Hartford formations, although there is little certainty in such correlation, the intervening distance being so great.

LIMESTONE AT PAWNEE, OKLA.

Locality.—This formation was named by Drake.[c] It is the limestone which outcrops on the east side of the court-house grounds at Pawnee, Okla. Its line of outcrop was not mapped. The name Pawnee is preoccupied by the Pawnee limestone of Swallow in the Kansas section. This limestone can not now be correlated with the Kansas section from stratigraphic information.

Preliminary faunal list.—The following fossils were obtained at the court-house square in Pawnee:

Fusulina cylindrica.
Sponge.
Eocidaris ? sp.
Meekopora sp.
Derbya robusta ?.
Meekella striaticostata.

[a] Jour. Geol., Vol. II, 1894, p. 199; see also Proc. Am. Philos. Soc., Vol. XXXV, 1896, p. 290.
[b] Carboniferous and Permian age of the Red Beds of eastern Oklahoma: Am. Jour. Sci., 4th ser., Vol. XII, 1901, p. 384.
[c] Proc. Am. Philos. Soc., Vol. XXXVI, 1897, p. 386, footnote.

Chonetes flemingi ?.
Productus semireticulatus.
Productus nebraskensis.
Productus cora.
Productus sp.
Marginifera wabashensis.
Spirifer cameratus.
Ambocœlia planiconvexa.
Seminula subtilita.
Hustedia mormoni.
Dielasma bovidens.
Pugnax utah.
Aviculopecten m'coyi.
Aviculopecten occidentalis.
Euomphalus subrugosus.

COLUMNAR SECTION.

The individual formations which have been described are here presented in a columnar section. No attempt is now made to group the formations, or to establish divisions of the Coal Measures, such as Upper, Middle, and Lower. The sedimentation was continuous, and there is no definite faunal break.

The thickness assigned to the individual formations is not in all cases the thickness observed where the type section was made, for in their lateral extent many variations are known to occur, and it has been thought best to state an average which may be used in estimating the total thickness of the formations. From a number of computations and from comparison with the records of deep wells it has been found that the sum of the thickness of individual formations agrees fairly well with the section which would be passed through in boring.

Columnar section of the Carboniferous rocks of Kansas.

No.	Name of formation.	Thickness in feet.
47	Wellington shales	+200
46	Marion formation	+100
45	Winfield formation	25
44	Doyle shales	60
43	Fort Riley limestone	40
42	Florence flint	20
41	Matfield shales	70
40	Wreford limestone	40
39	Garrison formation	120
38	Cottonwood limestone	6
37	Eskridge shales	40
36	Neva limestone	10
35	Elmdale formation	130
34	Americus limestone	5
33	Admire shales	40
32	Emporia limestone	10
31	Olpe shales	60
30	Barclay limestone	7

Columnar section of the Carboniferous rocks of Kansas—Continued.

No.	Name of formation.	Thickness in feet.
29	Burlingame shales	120
28	Howard limestone	7
27	Severy shales	75
26	Hartford limestone	25
25	Calhoun shales	60
24	Deer Creek limestone	25
23	Tecumseh shales	75
22	Lecompton limestone	20
21	Kanwaka shales	100
20	Oread limestone	40
19	Le Roy shales	150
18	Stanton limestone	30
17	Lane shales	100
16	Iola limestone	30
15	Vilas shales	75
14	Earlton limestone	15
13	Chanute shales	200
12	Drum limestone	30
11	Cherryvale shales	120
10	Dennis limestone	15
9	Galesburg shales	100
8	Hertha limestone	20
7	Dudley shales	150
6	Parsons limestone	25
5	Bandera shales	100
4	Pawnee limestone	25
3	Labette shales	60
2	Fort Scott limestone	25
1	Cherokee shales	450
	Total thickness	3,250

DIVISIONS OF THE CARBONIFEROUS AND GROUPINGS OF FORMATIONS.

DIVISIONS PREVIOUSLY PROPOSED.

The section of the Carboniferous rocks given by Swallow[a] was divided into a number of series, which apparently were made simply for convenience, for no reasons are given for the grouping, and practically no attention has been paid to his terms, since subsequent work has shown many errors of correlation in the section described by him. The names of the series are, from the base upward, Lower Coal series, Fort Scott marble series, Fort Scott Coal series, Pawnee limestone series, Marais des Cygnes series, Well Rock series, Spring Rock series, Cave Rock series, Stanton series, Chocolate limestone series, Upper Coal series, and above these the formations which he denominated Lower Permian, Permian, and Triassic.

Following a usage which seems to have originated in other coal fields, various writers have used the terms Lower and Upper Coal Measures, and sometimes Lower, Middle, and Upper Coal Measures. The division Middle Coal Measures has not been clearly outlined by anyone. The tendency has been to use only the two terms Lower and Upper Coal Measures, since they have been adequate in referring to the coal fields of the State. It may be appropriately remarked that, for purposes of convenience only, the limits might be placed equally well at any one of several horizons. In the publications by Haworth the line between the Lower and Upper Coal Measures has been drawn to correspond approximately with the divisions made by Broadhead between the Lower and Middle Coal Measures of Missouri. The formation which was used by Broadhead for reference in the field was a sandstone lying below the Bethany Falls limestone. Inasmuch as the sandstone is difficult to identify, Haworth has taken the base of the lower member of the Erie limestone, which he believes to correspond to Broadhead's Bethany Falls limestone, as the plane of separation in Kansas. The lower member of the Erie is here described as the Hertha limestone. This horizon has been identified in a tentative way through Kansas, Missouri, and Iowa. Instead of the terms Upper and Lower Coal Measures Keyes[b] has recently suggested the names Des Moinian and Missourian. These names are not adopted in this report, since they do not seem to serve any definite purpose in the discussion.

Certain other divisions or groupings of formations are made by Haworth in his final correlation,[c] as shown in the following table. The lithologic units to which Haworth has given names, as limestones and shales, have been variously denominated by him and his assist-

[a] Prel. Rept. Geol. Surv. Kansas, 1866, pp. 16–28.
[b] Missouri Geol. Surv., Vol. IV, 1894, p. 82.
[c] Univ. Geol. Surv. Kansas, Vol. III, 1898, pp. 91–94.

ants as "systems," "beds," and "formations." For the groups of these he has used the term "formation" in the table. While the terminology used does not materially affect the value of the field work done, it is nevertheless confusing, and general readers are likely to obtain mistaken ideas as to the value of stratigraphic units or groups of units.

Divisions of the Kansas Coal Measures, after Haworth.

B. Upper Coal Measures	7. Cottonwood formation	Cottonwood shales. Cottonwood limestone.
	6. Wabaunsee formation	A series of alternating limestones and shales to which individual names have not yet been given. Burlingame limestones.
	5. Shawnee formation	Osage shales. Topeka limestones. Calhoun shales. Deer Creek limestones. Tecumseh shales. Lecompton limestones. Lecompton shales.
	4. Douglas formation	Oread limestones. Lawrence shales.
	3. Pottawatomie formation.	Garnett limestones. Lane shales. Iola limestone. Thayer shales. Erie limestones.
A. Lower Coal Measures	2. Marmaton formation	Upper Pleasanton shales. Altamont limestone. Lower Pleasanton shales. Pawnee limestone. Labette shales. Oswego limestones.
	1. Cherokee shales	Cherokee shales.

In connection with these divisions a review is given of the use of the terms Lower, Middle, and Upper, and Lower and Upper Coal Measures, and the grouping of the formations which is made is stated to be "natural" and well marked stratigraphically.

In the study of the upper portion of the Kansas Carboniferous Prosser has likewise designated groups of "beds" as "formations or stages." With respect to his usage it is not inappropriate here to point out that certain strata which he has named "beds" are appropriately of the rank of formations. His formations or stages appear to have suggested the divisions which Haworth made for the lower part of the section. Indeed, Prosser's Wabaunsee and Cottonwood formations were adopted by Haworth. The following table exhibits the classifications and groupings which were made by Prosser.[a] They are presented here in abbreviated yet essentially complete form.

[a] Upper Paleozoic rocks of Kansas: Jour. Geol., Vol. III, 1895, p. 797.

Section of the Carboniferous rocks of Kansas, after Prosser.

Period.	Series.	Formation or stage.	Stratigraphic characters of the different beds.
Carboniferous	Permian	Marion	Shales and marls alternating with beds of gypsum. Limestones and marls. Abilene conglomerate. Shaly limestone, concretionary limestones, and thin limestones.
		Chase	Marion concretionary limestone. Yellowish shales. Marion flint. Various colored shales with limestone. Fort Riley or Florence limestone. Buff shaly limestone. Florence flint. Shales and limestone. Strong flint.
		Neosho	Shales, massive limestone, and interbedded shale and limestone.
	Upper Coal Measures.	Cottonwood	Cottonwood shales. Cottonwood limestone.
		Wabaunsee	Shales. Dry bone limestone. Shales and limestones.
		Missouri.	

Paleontologic collections were made and studied by Prosser for the purpose of determining the boundary between the Coal Measures and the Permian. The stages which he has recognized appear to have been established by the occurrence of fossils. In the case of the grouping by Haworth stratigraphy has been considered rather than paleontology. The only paleontologic evidence adduced in support of his divisions is the change in the fauna which Bennett reported as occurring at the division line between the Lower and Upper Coal Measures, and this, although it may prove to be important, is at present based upon the range of only a few species, and particularly on the occurrence of *Chonetes mesolobus*.

DIVISIONS OF THE CARBONIFEROUS ON LITHOLOGIC GROUNDS.

Considering the characters of the rocks as they appear to the casual observer, and more particularly to the student of stratigraphy, there are certain well-marked changes that may be seen by one crossing their area at right angles to the strike (see fig. 10, p. 23).

In the southeastern portion of the State, at the base of the section, there is a belt of country in which shales and sandstones are the only rocks found. This belt widens in the Indian Territory by the thickening of the formation and the addition to the lower portion of the section of beds which are not represented in Kansas because of unconformity by overlap.

At the western border of this bed of shales the first limestone of the section appears. In traveling westward, and consequently in crossing the higher formations, which are exposed as a result of the westward dip, other limestone beds are found interstratified with the shales and sandstones at varying intervals. The texture of the limestones and their general appearance is far from being uniform, but they are all alike in becoming, on exposure to atmospheric agencies, more or less yellowish by reason of the oxidation of the iron contained in them. The limestones which are valuable for building purposes are largely marred in beauty by the yellowish tinge which they gradually assume, and occasionally beds which have been long exposed are even brown.

Higher in the section, in the country to the west along a line passing approximately through Grenola, Eureka, Emporia, and Manhattan, the limestones, which are interstratified with shales, are seen to be much whiter. The line of transition from the yellowish to the whiter rocks is approximately at the Americus limestone. The occurrence of limestones in hillsides and terraces is conspicuous because of their glaring color, which is in strong contrast with the vegetation at all times of the year. Along with this change in color there is a certain change in texture, which is not easy to define but which is so marked a feature that anyone familiar with the building stones of eastern Kansas would have little hesitancy in stating whether a building was constructed of limestone from this belt or the one to the east. The higher rocks are less crystalline and have a rougher fracture. Their jointing is also less pronounced, and the individual blocks are usually right-angled, while those of the lower limestones are more acute. The difference in texture has given rise to the term "magnesian," although they are not properly so called.

Higher in the section of the Carboniferous in central Kansas the limestones gradually become unimportant and disappear. In this area the beds are practically all bluish or maroon-colored shales—the Wellington shales. The relation of the rocks of the Red Beds area to these shales has not been thoroughly studied, but it appears that there is a transition southward to beds of a more sandy nature and of a red color.

In order to avoid complications in the nomenclature of the Carboniferous it is thought advisable not to give names to these divisions. For the purpose of description they may be referred to, following the order in which they have been described above, as (1) lower shales

and sandstones; (2) interstratified limestones, shales, and sandstones; (3) limestones, interstratified principally with shales; (4) bluish and purplish shales. Corresponding in a measure with these divisions, there are certain other changes which may be mentioned here. The lower shales and sandstones carry the thicker beds of coal. The second belt of rocks carries the thinner beds of coal, some of which, however, are workable. Above the upper limit of the second division coal is not found, unless certain reported occurrences of beds an inch or two in thickness are to be considered. The shales in all the horizons where coal is found are not infrequently carbonaceous, and are laminated and fissile. The shales interstratified with the higher limestones and those occurring in the belt to the west of them are more clayey and seldom sandy. They carry beds of gypsum of considerable thickness at a number of horizons, particularly in the upper part of the limestone division and in the southern extension of the blue shales.

The distinctions which have thus far been outlined in Kansas do not hold when the rocks are followed southwestward along their strike into the Indian Territory. Approximately along the Arkansas River, or a little south of that stream, the interstratified limestones disappear from the section, and the formations are accordingly shales and sandstones. Moreover, the rocks in the Indian Territory gradually assume a red color in the higher portions of the section, the line of transition to this color being diagonal to the strike. The Red Beds of Kansas belong to this phase.

It appears that, for the purpose of studying the stratigraphy as well as the paleontology, Kansas is a better field than the Indian Territory, for the reasons that at varying intervals during the period of deposition conditions prevailed there which were favorable to an abundance of invertebrate life, and, moreover, the record of oscillation, which resulted in the change of sediments, is there sharply marked in the alternations of limestone and shale beds.

The changes in the character of the sediments and the differences in color and texture of the limestones are facts which should not be forgotten in establishing the divisions of the Carboniferous rocks. The question whether these changes were accompanied by faunal changes is one of particular interest. Thus far the broad divisional lines in the Carboniferous, which have been suggested by various workers, are the limits between the Lower and Upper Coal Measures and between the Upper Coal Measures and what has been called the Permian or Permo-Carboniferous. Both of these rest at present upon paleontologic grounds. It is interesting to note that the lower line has been drawn a relatively short distance above the first limestone in the section, and that the upper line has been drawn a similar distance above the first of the white limestones. It may be that the faunal changes are appropriately marked by these divisions, and in such case

they have followed certain changes of conditions of sedimentation. Regarding the paleontologic work which was used as a basis for the division between the Lower and Upper Coal Measures, it may be stated that it was far from being sufficiently exhaustive to settle the matter. That which was done in studying the higher portion of the section relative to the determination of the lower limit of the Permian was more extended, but it was not entirely in accord with the results of previous workers, and no subsequent corroborative faunal studies have been made. At both division lines the faunal changes are acknowledged to be not well marked, as naturally would be expected where sediments form an unbroken series.

RELATION OF PERMIAN VERTEBRATES TO THE KANSAS SECTION.

Near the southern border of Kansas, in Cowley County, at a place about 5 miles northeast of Maple City, some vertebrate remains were found in the shale thrown out in digging a well. These were collected by Mr. C. N. Gould and sent to Dr. Williston, who identified the bones generically[a] and considered them as indicating the Permian. The horizon in which these bones were found has been identified as the Garrison formation, although the correlation necessarily rests upon rather meager evidence, since the distance from the type locality is considerable and the invertebrate fossils have not been studied critically enough to admit of accurate identification of horizons.

In northeastern Oklahoma, in the area of the so-called Red Beds, there is a locality which has yielded Permian vertebrate remains. The material has come from two places, one known as McCann's quarry,[b] 5 miles southeast of Nardin, in Kay County, the other 2 miles northeast of Orlando. The material has been studied by Dr. Williston, who has found that it represents characteristic Permian forms, such as have been reported from Texas. The stratigraphic position of the vertebrates from near Nardin and Orlando has not been definitely determined. They occur to the southwest of the southern extension of the so-called Permian limestones of the Kansas section, but no horizon has been traced connecting the locality with the Kansas section.

The identification of the Permian in the western interior of the United States for a long time rested upon the occurrence of reptilian remains, such as were first described by Cope from the Red Beds of Texas. The occurrence in Kansas and Oklahoma of the same genera which are found in Texas makes it possible to correlate the formations tentatively. The material in the Kansas section is meager. No doubt more will be found, and possibly Permian forms occur, at lower horizons than the Garrison formation.

[a] Notice of the vertebrate remains from the Kansas Permian. Kansas Univ. Quart., Vol. VI, 1896, p. 53.

[b] Kansas Univ. Quart., Vol. IX, 1900, pp. 175–177; also Jour. Geol., Vol IX, 1901, p 337.

TABULATED LIST OF INVERTEBRATE FOSSILS FROM THE CARBONIFEROUS SECTION OF KANSAS.

By GEORGE H. GIRTY.

Value of the table.—The value attaching to tables such as the one given below depends upon the consideration of several factors. The most important among these appear to be the following:

(1) The precision with which the collections are located in the generalized section.

(2) The consistent accuracy of the determination of species.

(3) The variety and abundance of the formational faunas, and the uniformity maintained in these particulars throughout the section.

(4) The completeness with which the faunas are represented in these particulars by the collections.

With all these elements favorable, the sequence of faunas and the range of species shown by this table should be applicable to a considerable area. Its applicability should, indeed, be limited only by facts of identity of horizon and of basinal boundary.

As I have not visited the Kansas field, the assignment of the collections upon which the tabulated lists are based to their proper positions in the section is entirely the work of others—Messrs. Adams, Beede, Bennett, and Prosser—who made the collections while studying the stratigraphy.

The specific determinations were made by me, and I may add that I would not have chosen to present results of a preliminary character, such as these, if the careful discussion of the stratigraphy and nomenclature of Kansas Carboniferous rocks which Dr. Adams has prepared had not seemed to invite a brief and subordinate account of the fossils which they contain. Because it is my purpose at some future time to offer a fuller discussion, based upon a more accurate discrimination of species, I will pass over many points of interest in the sequence of Carboniferous faunas of Kansas, and touch lightly upon others.

The constituents of the Kansas section consist of alternations of limestone and shale, the latter sometimes containing more or less sandstone. During limestone-making periods invertebrate life was varied and abundant; but few of the mud beds, however, appear to have supported animal life. With some exceptions, therefore, only alternate formations are represented by fossil faunas. The youngest fauna obtained is that of the Marion formation, the Wellington having so far proved devoid of marine fossils. The oldest fauna occurs

in the Cherokee shales. It is rather meager, so far as known, but it is probable that numerous additions to our list of species can be obtained at favorable localities. Many of the faunas in the section are large and varied, and while all are not equally extensive, I believe that their uniform excellence is far above the average in sections of equal length.

The faithfulness with which faunas, as the term must necessarily be understood when fossils are in question, are represented by collections depends in some measure upon the collector, but chiefly upon the number and extent of the collections. These factors necessarily enter into all collections, but ours are open to unusually little criticism. In number they comprise not far from 500 local lots of greater or less extent, and while some horizons are more amply represented than others, it is thought that no serious misrepresentation of fact is occasioned by this circumstance. The preservation of almost all of the Kansas material, it should be remarked, is unusually fine, and, with the exception of the specific determinations, which, as already said, are of a preliminary character, the conditions are most favorable for making the Kansas section, as its association and range of species and succession of faunas are shown by our collections, representative for a large territory in central United States. There can be no doubt, however, that most of the formational faunas will be increased by additions of species not contained in my lists, and by the prolongation of the range of others.

In the table are included only species obtained from Kansas, and only those represented in our collection. Many faunal lists, some of them prepared with care, have been published by Bennett, Beede, Prosser, Rogers, and others, but it has been thought best not to incorporate these with my own. A few collections from equivalent horizons were obtained from Indian Territory, chiefly from the lower portion of the section. Lists of the species identified will be found in the stratigraphic discussion. They agree reasonably well with those of the horizons with which the geologic evidence indicates that they are equivalent. A single collection was made at Pawnee, Okla., the stratigraphic position of which is somewhere above the Pawhuska limestone. It was obtained from the bed which Drake named the Pawnee limestone, and which was included by him in the Permian. The position of the Pawnee fauna in the Kansas section is not low in the series nor yet at the very top. I judge that it represents about the horizon of the Elmdale or of the Garrison formation, at the base, or just below the base, of Prosser's Permo-Carboniferous.

An inspection of the table shows the evolution of the latest from the earliest faunas in the section to have been a progression from a brachiopod to a pelecypod facies. The gradual character of this replacement has been remarked by most paleontologists who have studied the faunal succession. It is without marked interruption at

any point, so that subdivisions appropriate for recognition are not clearly apparent, and there is room for differences of opinion as to where delimitation should be made. Several different classifications have in fact been proposed, but no one seems to be especially favored by the evidence of invertebrate paleontology.

Range of genera and species.—Previous writers have in several instances called attention to the range of individual genera and species in the Kansas section. Mr. Prosser has stated:[a] "We have not seen *Spirifer cameratus* above the Wabaunsee formation, or the last two species [*Athyris subtilita* and *Productus semireticulatus*] above the Chase formation." Our collections, however, extend the range of *Spirifer cameratus* into the Garrison formation, and of *Productus semireticulatus* and *Athyris subtilita* into the Marion. The same author has recorded that of the brachiopoda only a few specimens of *Derbya* have been found in the Marion formation, but by the occurrence above referred to a *Productus* of the type of *semireticulatus* and a *Seminula* resembling *subtilita* are added. Mr. Prosser also attaches significance to the abundance of *Fusulina* in the Cottonwood formation. Our collections show that this genus ranges from the Fort Scott limestone into the Fort Riley limestone, and that it is very abundant at several horizons. The Lecompton limestone may be mentioned in addition to the Cottonwood formation. Mr. John Bennett first directed my attention to the fact that *Chonetes mesolobus* does not range above the Parsons limestone. This observation our collections seem to substantiate; nor need the doubtful identification recorded for the Hartford limestone be taken in contradiction, for that form is probably new and as closely related to *Chonetes glaber* as to *Chonetes mesolobus*. Except for its reappearance in the Admire shale, *Rhipidomella pecosi* seems to be characteristic of the lower part of the section, while *Enteletes* first appears in the Iola limestone, where it is abundant, and ranges through nineteen formations. *Derbya crassa* is more or less completely replaced in the upper part of the section by the larger form, which I have identified as *Derbya robusta*, and similarly *Chonetes flemingi* is supplanted by the related *Chonetes granulifer*. The *Producti* are of course most abundant and persistent, the *semireticulatus* type continuing from the beginning to the end of the section. The other types have a less extensive range, which, so far as ascertained, can be seen in the table. The range of *Spirifer cameratus* has already been commented on. It seems to me a noteworthy fact that not a single *Spirifer* of the Keokuk type (*Spirifer opimus* Hall, probably = *Spirifer rockymontanus* Marcou) is to be found in our collection. *Squamularia perplexa*, a characteristic and frequently abundant species, appears to end with the Hartford limestone, while *Ambocœlia planiconvexa* extends with some interruptions almost to the top of the section. *Spiriferina ken-*

[a] Jour. Geol., Vol. III, 1895, p. 790.

tuckyensis occurs in the Olpe shale, but not later, and here again the absence of *Spiriferina* of the *spinosa* type is a marked peculiarity. *Seminula subtilita*, as already remarked, has a range coextensive with the section, and *Cleiothyris orbicularis*, usually a rare form, occurs only in the lower portion. Of the pelecypods I will speak at less length. Their appearance in the lower part of the section is at best scattering, and their preservation is such as usually to obliterate generic and frequently to obscure specific characters. *Pseudomonotis* and *Bakewellia* are interesting as being especially Permian types. Mr. Prosser mentions *Pleurophorus* in this connection, but that genus ranges well down into our Mississippian beds. *Pseudomonotis* begins as early as the Iola limestone, but it is rare, and only becomes abundant later in the section. This is still more true of *Bakewellia*, whose range, after an isolated occurrence in the Olpe shale, is restricted to the six formations at the top of the section. *Myalina subquadrata*, that large and striking Carboniferous species, ranges through the middle third of the section with a possible reappearance in the Matfield shale. However, while the range of individual species is interesting and often significant, the fact should not be lost sight of that all reliable results in stratigraphic paleontology must be based on the consideration of faunas.

List of invertebrate fossils from the Carboniferous section of Kansas.

[NOTE.—Sh.=shale; ls.=limestone.]

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh.	Drum ls.	Chanute sh.	Earlton ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhounsh.	Hartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Fusulina cylindrica		×		×												×				×		×		×					×	×										×				
Amblysiphonella sp														×												×																		
Axophyllum rude		×																																				×						
Lophophyllum proliferum	×	×	×	×		×										×				×		×		×		×	×	×					×					×						
Lophophyllum westi				×				×						×		×		×																										
Campophyllum torquium		×				×																×																						
Zaphrentis ? sp				×																		×																						
Cladopora ? sp						×																																						
Chaetetes milleporaceus		×		×		×										×																												
Syringopora multattenuata																										×																		
Syringopora ? sp		×		×																×		×		×																				
Aulopora ? sp		×																																										
Archæocidaris sp						×												×				×		×		×	×			×	×													
Eocidaris sp																											×																		
Eupachycrinus sp																×		×								×	×																		
Spirorbis sp																																												×	×
Septopora sp																×								×															×	×			×	×
Fenestella sp		×				×						×		×		×		×		×		×		×		×		×		×				×	×			×	×		×		
Polypora sp		×												×				×				×		×		×				×					×								
Pinnatopora sp														×																														
Fistulipora carbonaria														×												×																		
Fistulipora sp						×		×				×				×		×		×		×		×			×	×							×									
Meekopora sp																															×														
Prismopora serrata		×				×																																						
Rhombopora lepidodendroides		×	×											×						×		×		×		×	×	×		×	×										×			

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh.	Drum ls.	Chanute sh.	Bartlett ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Bartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Cystodictya divisa																																														
Streblotrypa prisca																																														
Thamniscus sp.																																														
Stenopora carbonaria																																														
Stenopora sp.																																														
Lingula carbonaria																																														
Orbiculoidea missouriensis																																													
Crania sp.																																														
Rhipidomella Pecosi																																														
Enteletes hemiplicatus																																														
Derbya crassa																																														
Derbya robusta																																														
Derbya cymbula																																														
Meekella striaticostata																																														
Meekella pyramidalis?																																														
Chonetes flemingi																																														
Chonetes granulifer																																														
Chonetes verneuilianus																																														
Chonetes glaber																																														
Chonetes mesolobus																																														
Productus semireticulatus																																														
Productus cora																																														
Productus nebraskensis																																														
Productus punctatus																																														
Productus pertenuis																																														
Productus norwoodi																																														

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh	Drum ls.	Chanute sh.	Earlton ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Hartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Productus subhorridus?																×																													
Productus sp		×								×		×				×				×		×		×		×								×										
Marginifera wabashensis		×			×		×									×		×		×		×		×		×	×	×													×			
Marginifera splendens							×		×																																			
Marginifera lasallensis?																						×																						
Marginifera muricata	×	×																				×		×																				
Strophalosia sp																																												
Proboscidella sp																×																												
Spirifer cameratus	×	×				×		×		×		×		×		×		×		×		×		×		×	×	×	×	×		×					×						
Squamularia perplexa		×		×		×		×		×		×		×		×		×		×						×																	
Amboccelia planiconvexa		×		×		×														×		×		×			×	×	×					×				×					
Spiriferina kentuckyensis		×				×		×				×		×		×		×		×		×		×		×	×	×			×												
Seminula subtilita	×	×		×		×		×		×		×		×		×		×		×		×		×		×	×	×	×	×		×	×	×			×	×	×				×
Cleiothyris orbicularis		×		×		×																																					
Dielasma bovidens						×		×				×		×		×		×		×		×		×		×												?						
Hustedia mormoni		×		×		×								×				×		×		×		×		×	×	×	×					×				×					
Pugnax utah						×						×		×				×		×						×												×					
Pugnax rockymontana						×																																					
Aulacorhynchus millepunctatum																														×													
Aviculopecten occidentalis		×												×										×		×	×								×			×	×	×	×	×	×	×
Aviculopecten germanus?																																												
Aviculopecten m'coyi																										×																		
Aviculopecten carboniferus												×		×																														
Aviculopecten interlineatus																×																												
Aviculopecten whitei?														×													×	×																
Aviculopecten sp												×										×					×			×									×	×			×		

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh.	Drum ls.	Chanute sh.	Bartlett ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Leecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Hartford ls.	Severy sh.	Howard ls.	Bullingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Streblopteria sp																																														
Euchondria neglecta		×																																												
Entolium aviculatum																														×																
Lima retifera?														×													×																			
Posidonomya? sp																																														
Pseudomonotis hawni												×																																		
Pseudomonotis kansasensis																																														
Pseudomonotis equistriata																×				×																										
Pseudomonotis sp																																								×						
Myalina subquadrata																×						×				×																			
Myalina perattenuata												×																×																	
Myalina aviculoides?																																														
Myalina kansasensis																				×		×						×																	
Myalina swallowi																×																													
Myalina wyomingensis																						×																							
Myalina sp												×																																		
Modiola subelliptica																																														
Bakewellia parva																																														
Pinna? peracuta																																														
Aviculopinna illinoisensis																																														
Yoldia subscitula																																														
Leda bellistriata																																														
Leda arata																																														
Leda sp																																														
Nucula ventricosa																																														
Nucula sp																																														

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Chanute sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Cherryvale sh.	Dennis ls.	Drum ls.	Chanute sh.	Bartlett ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Hartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Edmondia sp		×												×														×																				
Edmondia? sp																																																
Pleurophorus occidentalis																																															
Pleurophorus calhouni																																															
Pleurophorus sp																																															
Allerisma terminale																																															
Allerisma granosum																																															
Sedgwickia altirostrata?																																															
Sedgwickia topekensis																																															
Sedgwickia geinitzi																																															
Sedgwickia sp																																															
Chaenomya leavenworthensis																																															
Chaenomya minnehaha																																															
Chaenomya sp																																															
Schizodus harei																																															
Schizodus sp																																															
Macrodon carbonarius																																															
Astartella vera																																															
Astartella varica																																															
Astartella gurleyi?																																															
Astartella? sp																																															
Clinopistha radiata var. lævis?																																															
Aclis? sp																																															
Platyceras nebraskense																																															
Solemiscus ponderosus																																															
Solemiscus sp																																															

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh.	Drum ls.	Chanute sh.	Bartlton ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Hartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Matfield sh.	Florence flint.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Euomphalus subrugosus						×														×								×												×							
Euomphalus pernodosus?																												×																			
Euomphalus sp																																															
Naticopsis altonensis?				×																																											
Naticopsis sp						×		×								×						×																									
Trachydomia wheeleri																																															
Loxonema sp		×											×														×			×																
Bulimorpha chrysalis																											×	×																		
Bulimorpha sp																											×	×		×																
Trepospira sphærulata		×				×								×													×	×																		
Worthenia tabulata						×								×													×	×																		
Planerotrema grayvillense						×										×											×																			
Euconispira sp												×				×																														
Pleurotomaria (?) sp						×								×						×							×	×																		
Indeterminable gasteropods																																															
Euphemus carbonarius						×																					×																			
Euphemus nodicarinatus																																															
Bellerophon percarinatus ?																																															
Bellerophon crassus						×																																									
Bellerophon stevensianus?																																															
Patellostium montfortianum																																															
Patellostium sp																																															
Bucanopsis meekana																																															
Bucanopsis sp																																															
Bellerophon sp						×																																									
Dentalium sp						×																																									

List of invertebrate fossils from the Carboniferous section of Kansas—Continued.

Species.	Cherokee sh.	Fort Scott ls.	Labette sh.	Pawnee ls.	Bandera sh.	Parsons ls.	Dudley sh.	Hertha ls.	Galesburg sh.	Dennis ls.	Cherryvale sh.	Drum ls.	Chanute sh.	Earlton ls.	Vilas sh.	Iola ls.	Lane sh.	Stanton ls.	Le Roy sh.	Oread ls.	Kanwaka sh.	Lecompton ls.	Tecumseh sh.	Deer Creek ls.	Calhoun sh.	Hartford ls.	Severy sh.	Howard ls.	Burlingame sh.	Barclay ls.	Olpe sh.	Emporia ls.	Admire sh.	Americus ls.	Elmdale form.	Neva ls.	Eskridge sh.	Cottonwood ls.	Garrison form.	Wreford ls.	Florence flint.	Matfield sh.	Fort Riley ls.	Doyle sh.	Winfield form.	Marion form.
Orthoceras rushense						×																																									
Orthoceras sp														×													×	×	×																		
Goniatites sp																						×					×	×	×																		
Nautiloid														×													×	×	×																		
Phillipsia major												×						×				×																									
Phillipsia scitula																											×																				
Phillipsia sp									×																									×												
Leperditia sp																×																														
Ostracoda		×																																											
Chierokee sh.																																														
Fort Scott ls.																																														
Labette sh.																																														
Pawnee ls.																																														
Bandera sh.																																														
Parsons ls.	×																																													
Dudley sh.																																														
Hertha ls.																																														
Galesburg sh.																																														
Dennis ls.																																														
Cherryvale sh.																																														
Drum ls.																																														
Chanute sh.																																														
Earlton ls.																																														
Vilas sh.																																														
Iola ls.																																														
Lane sh.																																														
Stanton ls.																																														
Le Roy sh.																																														
Oread ls.																																														
Kanwaka sh.																																														
Lecompton ls.																																														
Tecumseh sh.																																														
Deer Creek ls.																																														
Calhoun sh.																																														
Hartford ls.																																														
Severy sh.																																														
Howard ls.																																														
Burlingame sh.																																														
Barclay ls.																																														
Olpe sh.																																														
Emporia ls.																																														
Admire sh.																																														
Americus ls.																																														
Elmdale form.																																														
Neva ls.																																														
Eskridge sh.																																														
Cottonwood ls.																																														
Garrison form.														×																																
Wreford ls.																																														
Florence flint.																																														
Matfield sh.																																														
Fort Riley ls.																																														
Doyle sh.																																														
Winfield form.																																														
Marion form.																																														

SUMMARY OF THE FOSSIL PLANTS RECORDED FROM THE UPPER CARBONIFEROUS AND PERMIAN FORMATIONS OF KANSAS.

By DAVID WHITE.

INTRODUCTION.

Being desirous of taking into account all the available data relating to the age and correlation of the formations of the Upper Paleozoic in Kansas, Mr. Adams has requested the preparation of a summary of the fossil plants, together with such correlative conclusions or suggestions as the scanty paleobotanical evidence at hand might seem to warrant. Naturally, within the very limited time for the preparation of this summary it has not been possible to give to some of the specimens the careful comparative study necessary for their final determination and diagnosis, or to enter upon much-needed revisionary work in a number of genera and species from the higher Coal Measures. Systematic discussion with synonymy could not be included, while the collection of fossils from important or critical horizons, however needful at the moment, has, of course, been out of the question. Under these conditions this summary must be regarded merely as an inventory of such fossil-plant material as has come to hand from the Upper Paleozoic of Kansas, wherein are listed the species recorded, with brief annotations and descriptions of a number of new Coal Measures types which have long been in manuscript and which should not be omitted from such an inventory.

Nearly all the specimens here discussed are of Coal Measures (Pennsylvanian) age. But very little plant material from beds of the supposed Permian of Kansas has yet been described. The University of Kansas, in connection with its geological survey of the State, has accumulated more or less fossil-plant material in its paleontological collections. This paleobotanical material, which has been sought with especial regard to the Permian problem, is now being studied by Mr. E. H. Sellards and will probably receive systematic treatment and illustration in one of the proposed volumes of the State university survey. The writer is under obligation to Mr. Sellards and to the university for specimens, particularly of Permian types, submitted for examination or donated to the collections of the United States National Museum. This material, so far as it has anywhere yet been published, is included in this summary; but such species in the material communicated by Mr. Sellards as are new to science or have not previously been discovered in the State obviously could not be

included without unfairly anticipating their full description by him and impairing the originality of his publication. Accordingly, in dealing with the supposed Permian flora in particular, which he has been so successful in discovering, all paleontological discussion of the material is here omitted.

SOURCES AND AMOUNT OF AVAILABLE MATERIAL.

No systematic attempt at the collection of fossil plants in the Paleozoic of Kansas for the purpose of ascertaining the vertical range and stratigraphical characteristics of the species had been made prior to the recent work of the university survey. In fact it is but a few years since Paleozoic fossil plants were regarded by most geologists as curios or as important or interesting only on account of their biological significance rather than as a valuable aid in geological correlation. The collections that have been available, or that have been described, consist largely of material obtained from several horizons selected because the fossils, gathered by commercial collectors and sold to museums or other institutions, were showy. The greater portion of the specimens which have been examined were acquired by the late R. D. Lacoe, were reviewed in the Coal Flora by Leo Lesquereux, and are now in the Lacoe collection in the United States National Museum. The Lacoe collection also contains a considerable amount of material, chiefly from the Cherokee shales (Des Moinian), added to the Lacoe collection after the death of Lesquereux. Small collections from the Cherokee, the shales associated with the Erie limestone, the Le Roy (Lawrence) shale, the Chanute (Thayer) shale, and the Permian, have later been transmitted through the courtesy of the State university survey and its paleobotanist, Mr. Sellards. The development of a Permian flora in Kansas is due almost entirely to the efforts of the geologists of the State university.

A small collection of fossil woods from the Chase formation (Permian?) were sent by Professor Prosser to Sir William Dawson and Professor Penhallow, the latter of whom described three gymnospermic types from that formation.[a]

As will be seen, the materials, even from the horizons best represented, are hardly ample, while from the other horizons at which plants have been found the data are extremely meager or altogether insufficient. From nearly forty of the formations listed by Mr. Adams, including several that are most important stratigraphically or whose correlation is most problematic, no paleobotanical evidence at all is at hand.

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[a] Trans. Royal Soc. Canada, Vol. VI, sec. iv, 1900, pp. 71–76.

HORIZONS AND LOCALITIES REPRESENTED.

The formations that have furnished the data included in this summary are, in ascending order, as follows: Cherokee shales (Des Moinian), Dennis (Bethany Falls-Erie) limestone, Chanute (Thayer) shales, Le Roy (Lawrence) shales, Severy (Osage) shales, Elmdale (Wabaunsee) formation, Chase formation, and Marion formation? (Permian). The relations of these formations, their thickness, intervals, and stratigraphical position in the general section may be seen by referring to the table given by Mr. Adams on pages 65–66.

CHEROKEE SHALES.

Penitentiary shaft at Lansing, near Leavenworth. A collection made by Mr. Oscar Lamm from this deep mine is now in the Lacoe collection. A number of specimens were also sent by the university in 1901.

CHANUTE (THAYER) SHALES.

Thayer, Neosho County. A very small collection identified or described by Lesquereux in the Coal Flora, and now in the Lacoe collection. Also several species sent by the State university.

LE ROY (LAWRENCE) SHALES.

There are a considerable number of specimens from the vicinity of Lawrence, and from Garnett and Ottawa, mostly described by Lesquereux and embracing many types, in the Lacoe collection. The United States National Museum also contains material sent by Mr. E. H. Sellards from a horizon in the upper part of the Lawrence shales at Oak Hill Cemetery and University Hill, Lawrence; at Blue Mounds, 6 miles southeast of Lawrence; and Twin Mounds, 20 miles from Lawrence. The specimens from the vicinity of Lawrence reported on by Lesquereux were given no other locality than "Lawrence." They may have come from University Hill or some point in the upper part of the Le Roy (Lawrence) shales in the neighborhood of the city.

SEVERY SHALES.

A very small collection from Osage in the Lacoe collection, and a few specimens sent by the university from Scranton.

ELMDALE FORMATION.

Several lots from Onaga sent to the United States Geological Survey by Mr. F. F. Crevecoeur.

CHASE FORMATION.

Several specimens of fossil wood from Coon Creek and Cottonwood Township, Chase County, were sent to Sir William Dawson by Prof. C. S. Prosser.

MARION FORMATION?

A collection, consisting largely of new species, from a locality 3½ miles south of Banner City, Dickinson County, was received by the United States National Museum through the courtesy of Mr. E. H. Sellards and the State university. The mode of occurrence and the localities of these supposed Permian plants, which it is thought may have come from the overlying Wellington formation as recognized by the State survey, have been described by Mr. Sellards.[a] Short papers describing a few of the interesting plants of the Permian flora were published in the Kansas University Quarterly in 1900 and 1901.[b]

Following is a brief annotated list of the Coal Measures species in hand, accompanied by short descriptions of several new forms in the Lacoe collection, United States National Museum, together with the enumeration of such species as have been published from the Marion formation of Kansas.

ANNOTATED LIST OF SPECIES, WITH BRIEF DESCRIPTIONS OF SEVERAL NEW FORMS FROM THE COAL MEASURES.

Caulerpites n. sp. Lx. Mss.

A fine alga, figured and described in manuscript by Professor Lesquereux, which will be published later, with other Paleozoic types, in a posthumous work by that author.

Lacoe collection, 25134. Severy shales, Osage.

Excipulites Callipteridis (Schimp.), Kidst.

Found on the pinnules of *Pseudopecopteris squamosa*. They are perhaps to be regarded as glandular rather than as fungoid.

Lacoe collection, 14487. Cherokee shales, Lansing.

Eremopteris solida (Lx.) D. W.

This species, described as *Sphenopteris solida*, is closely related to *E. bilobata* D. W.

Lacoe collection, 14219, 14220. Cherokee shales, Lansing.

Pseudopecopteris squamosa (Lx.) D. W.

Normal form, possibly inseparable from *Sphenopteris neuropteroides* Boulay.

Lacoe collection, 14487, 15048. Cherokee shales, Lansing.

Pseudopecopteris Pluckenetii (Schloth.) Lx.

Contributed in numerous examples by Mr. E. H. Sellards, and in other collections.

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[a] Trans. Kansas Acad. Sci., Vol. XVII, 1900, p. 208.

[b] Vol. IX, Jan., 1900, pp. 63, 64; idem., July, 1900 (published in 1901), pp. 179-189, Pl. XXXVII-XLII; and Vol. X, Jan. 1901, pp. 1-12, pl. I-IV.

Lacoe collection, 15046, 15047. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8615, 7742. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 7727, 8616. Near top of Le Roy (Lawrence) shales, Blue Mounds.

Mariopteris cordato-ovata obtusiloba n. var.

The specimens from Wilkesbarre, Pa., and Ottawa, Kans., described or figured by Lesquereux[a] as *Pseudopecopteris cordato-ovata* Weiss sp., and which are here designated as a variety of that species, differ from the European plant described by Weiss[b] and Zeiller[c] by the greater obtuseness of the lobes, which are less distinctly upward turned. The pinnæ of the Old World plant would seem from the figures to lack the basal heterophylly which led the writer[d] to refer the species to the genus *Mariopteris*. A small specimen exhibiting this Mariopteroid heteromorphy served as the basis of the record[e] of *Mariopteris* ("*Pseudopecopteris*") *muricata* in the beds at Ottawa. The variety *obtusiloba* is intermediate between the European type, the Pennsylvania plant identified by Lesquereux with Brongniart's *Pecopteris Sillimanni*, and *Mariopteris occidentalis* D. W., from Indian Territory. The latter is in general much smaller, and its pinnules are proportionately narrower and more oblong. The plant in hand has a strong likeness in form to *Mariopteris mazoniana* Lx. sp.

Lacoe collection, 13511, 13525. Chanute (Thayer) shales, Thayer.

Lacoe collection, 13512–13525. Le Roy (Lawrence) shales, Ottawa.

U. S. National Museum (E. H. Sellards), 7723, 8617. Le Roy (Lawrence) shales, Blue Mounds.

Sphenopteris pinnatifida (Lx.) D. W.

To this species belongs a very small specimen from Thayer recorded as *Sphenopteris tenella*. The species was also collected from the Lawrence shales by Mr. Sellards.

Lacoe collection, 14321. Chanute (Thayer) shales, Thayer.

U. S. National Museum, 8630. Le Roy (Lawrence) shales, Blue Mounds.

U. S. National Museum, 7738. Le Roy (Lawrence) shales, Twin Mounds.

Sphenopteris denticulata Brongn.

The specimens from Kansas appear to fully agree with examples from Cannelton, Pa., to which the above name was applied by Professor Lesquereux. The form in both regions is possibly due to heterophylly.

Lacoe collection, 14585. Cherokee shales, Lansing.

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[a] Coal Flora, Atlas, p. 7, Pl. XXXVII, figs. 4, 5.

[c] Fl. foss. bassin houill. perm. Autun et Épinac, Vol. I, 1890, pl. 1, figs. 1, 1a, 1b.

[b] Fl. d. jüngst. Steinkohl. u. Rothliegend. d. Saar-Rh. Geb., p. 28, pl. 1, figs. 1, 1a.

[d] Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. III, 1899, p. 481.

[e] Coal Flora, Vol. III, p 881.

Sphenopteris sp.

Lacoe collection, 14466. Cherokee shales, Lansing.

Sphenopteris sp. Sellards.

Marion formation, Dickinson County.

Oligocarpia Gutbieri Goepp.

A large number of specimens from Garnett were published as above by Lesquereux. The same species has been transmitted by Mr. E. H. Sellards. The fragments from Garnett listed in the Coal Flora[a] as *Pecopteris Clintoni* Lx. and *Callipteridium membranaceum* Lx. belong, in my judgment, to the same species.

Lacoe collection, 14075–14089, 14094–14098. Le Roy (Lawrence) shales, Garnett.

U. S. National Museum (E. H. Sellards), 8623. Le Roy (Lawrence) shales, University Hill, Lawrence.

U. S. National Museum (E. H. Sellards), 8622. Le Roy (Lawrence) shales, Twin Mounds.

Oligocarpia n. sp. Sellards.

U. S. National Museum (E. H. Sellards), 8627. Le Roy (Lawrence) shales, Twin Mounds.

U. S. National Museum (E. H. Sellards), 8628. Le Roy (Lawrence) shales, Lawrence.

Aloiopteris Winslovii D. W.

To this species belong also the examples from Thayer listed in the Coal Flora as *Pecopteris erosa* Gutb.

Lacoe collection, 12391–12393, 12396, 12397. Chanute (Thayer) shales, Thayer.

Lacoe collection, 12390. Le Roy (Lawrence) shales, Garnett.

Lacoe collection, 12394, 12395, 12403 (doubtful). Le Roy (Lawrence) shales, Ottawa.

U. S. National Museum (E. H. Sellards), 7723. Le Roy (Lawrence) shales, University Hill, Lawrence.

U. S. National Museum (E. H. Sellards), 8622. Le Roy (Lawrence) shales, Twin Mounds.

Pecopteris cf. *integra* (Andrä) Zeill.

Fragments very close to the species figured by Germar as *Sphenopteris integra* Andrä.

Lacoe collection, 13808, 13809. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 8684. Le Roy (Lawrence) shales. Unknown.

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[a] Coal Flora, Vol III, p. 881.

Pecopteris unita Goepp. Emarginate form.

Lacoe collection, 12484. Cherokee shales, Lansing.

Pecopteris Newberriana F. and I. C. W.

This species, described from the Dunkard formation of the Appalachian trough, is extremely close to the later (Permian) phase of *Pecopteris fœminæformis* (Schloth.) Sterzel, with which the writer was at first disposed to place the specimens in hand.

U. S. National Museum (F. F. Crevecoeur), 8833. Elmdale formation, Onaga.

Pecopteris arborescens (Schloth.) Brongn.

Among the numerous specimens identified and sent by Mr. Sellards under this name are several which have the proportions of *Pecopteris cyathea*, though the nervation appears to be simple. The plant appears to agree well with the species as recognized by most authors and with examples from the English coal fields in our collections. *P. arborescens* is extremely rare in this country, many of the specimens referred thereto being found on close examination of the nervation to represent quite distinct species. The fructification of the Kansas material is of the *Asterotheca* type, with rather small unequal sporangia in fours. Several of the specimens sent by Mr. Sellards closely resemble the examples provisionally referred below to *P. hemitelioides* Brongn. In the latter, however, the rachis and the median nerve are distinctly punctate, while in *P. arborescens* they are smooth.

U. S. National Museum, 7724, 8620, 8624, 8631. Le Roy (Lawrence) shales, Blue Mounds.

U. S. National Museum, 7730, 8621. Le Roy (Lawrence) shales, Twin Mounds.

Pecopteris cf. *hemitelioides* Brongn.

This includes the specimens from Ottawa listed by Lesquereux[a] as *Pecopteris aspidioides* Brongn. In form and size they are intermediate between *P. cyathea* and *P. hemitelioides*. I place them with the latter on account of the distinctly punctate rachis, the punctate strong median nerve, and the villous lamina, slightly punctulate on the nerves. In general, however, the pinnules are hardly so long as in typical examples of the latter species. The name *Pecopteris aspidioides* is inapplicable to this plant, it having been used by Sternberg[b] for a robust, recurvate type, and by Brongniart for a form with forking nervilles referred by Zeiller[c] to *P. Daubreei* Zeill. From *P. arborescens* it differs chiefly by the generally large pinnule and especially by the villosity and punctate character of the nerves and rachis.

[a] Coal Flora, Vol. III, p. 880.

[b] Versuch einer geogn.-geogenetisch-botanischen Darstell. d. Flora d. Vorwelt, Vol. II, fasc 7-8, p. 34, Pl. L, fig. 5.

[c] Fl. foss. bassin perm. Brives, 1892, p. 18.

The Ottawa specimens are closely related to the plants from Rhode Island which were described by Brongniart [a] as *Pecopteris arguta* Sternb., but which, since *P. arguta* was merely a name given by Sternberg [b] to Schlotheim's *Filicites fœminæformis*, Goeppert [c] renamed, copying Brongniart's figure, as *Pecopteris elegans*. The latter species, in which the straight, narrow pinnules are hardly joined at the base, while the rachis appears to be smooth, includes most of the examples from Olyphant, Pa., and from Rhode Island, placed by Lesquereux in *P. arguta*, *P. arborescens*, and *P. elegans*.

Lacoe collection, 12609–12616, 13359. Le Roy (Lawrence) shales, Ottawa.

Pecopteris hemitelioides Brongn.

Specimens apparently agreeing with this species as described from the highest Coal Measures of France have been transmitted by Mr. F. F. Crevecoeur.

U. S. National Museum, 8834. Elmdale formation, Onaga.

Pecopteris squamosa Lx.

Lacoe collection, 12700. Cherokee shales, Lansing.

Pecopteris Candolliana Brongn.

The form of the apex of the pinna as well as the nervation in the fragments referred by Mr. Sellards to this species are very similar to those of *Pecopteris lepidorrhachis*.

U. S. National Museum (E. H. Sellards), 7729. Le Roy (Lawrence) shales, Twin Mounds.

Pecopteris vestita Lx.

Lacoe collection, 13999. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8625. Cherokee shales, Lansing.

Pecopteris villosa Brongn. ?

The specimens represent the Mazon Creek and Cannelton form identified by Lesquereux as above.

Lacoe collection, 13257. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8619. Cherokee shales, Lansing.

Pecopteris oreopteridia (Schloth.) Brongn. ?

Fertile pinnæ doubtfully referred to this species.

U. S. National Museum (F. F. Crevecoeur), 8831. Elmdale formation, Onaga.

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[a] Hist. vég. foss., Vol. L, p. 303.
[b] Tent. Fl. Prim., p. xix.
[c] Syst. Fil. Foss., p. 344, Pl. XV, fig. 10.

Pecopteris cf. *polymorpha* Brongn.

Appears to be inseparable from the form described by Lesquereux as *Pecopteris elliptica* Bunby. The fragments from Lansing are slightly villous. Those communicated by Mr. Crevecoeur seem to represent the typical large *P. polymorpha*. In the specimens submitted by Mr. Sellards the sporangia are uncommonly broad for this species, though they are too small to identify therewith with certainty.

Lacoe collection, 13996. Cherokee shales, Lansing.

U. S. National Musum (E. H. Sellards), 7725. Le Roy (Lawrence) shales, Blue Mounds.

U. S. National Museum (F. F. Crevecoeur), 8830. Elmdale formation, Onaga.

Pecopteris sp. Sellards.

U. S. National Museum (E. H. Sellards), 8103. Marion ? formation, Dickinson County.

Pecopteris pteroides Brongn.

A small fragment contributed by Mr. Sellards appears to agree with the plant as detailed by Brongniart under this name, though it is very different from *Callipteridium pteridium* (Schloth.) Zeill., to which the name was intended by Brongniart to apply. The Kansas fragment conforms to the *P. pteroides* as generally identified by Lesquereux in our American floras. By the form, size, and attitude of the pinnules the specimen closely resembles *Callipteridium oblongifolium* F. & I. C. W.

U. S. National Museum (E. H. Sellards), 8634. Douglas County.

Alethopteris sp.

Resembles *Alethopteris aquilina* (Schloth.) Sternb.

U. S. National Museum (E. H. Sellards), 8138. Cherokee shales, Lansing.

Alethopteris cf. *virginiana* F. & I. C. W.

Pinnules smaller and generally a little more oblique than in *Alethopteris virginiana*, which the Kansas plant strongly resembles.

U. S. National Museum (E. H. Sellards), 8138. Chanute (Thayer) shales, Thayer.

Alethopteris Grandini (Brongn.) Goepp.

Includes the specimens previously listed from Garnett and Ottawa as *Alethopteris pennsylvanica* and a specimen in the Lacoe collection from Garnett labeled as *Alethopteris lonchitica*. The plant can not at most be more than varietally different from the species described by Brongniart.

Lacoe collection, 12212. Chanute (Thayer) shales, Thayer.

Lacoe collection, 12192, 12213–12226. Le Roy (Lawrence) shales, Garnett.

Lacoe collection, 12193–12195, 12201–12211. Le Roy (Lawrence) shales, Ottawa.

U. S. National Museum (E. H. Sellards), 7732, 8134, 8137. Le Roy (Lawrence) shales, University Hill, Lawrence.

U. S National Museum (E. H. Sellards), 8132, 8133, 8136. Le Roy (Lawrence) shales, Blue Mounds.

Callipteridium grandifolium F. & I. C. W. ?

The fragments here referred to appear to differ only by their somewhat smaller pinnules from the plant described by Fontaine and I. C. White from the Dunkard formation of West Virginia and Pennsylvania.

U. S. National Museum (E. H. Sellards), 8635. Locality unknown.

Callipteridium Sullivantii (Lx.) Weiss.

Lacoe collection, 11758, 11759, 12116. Cherokee shales, Lansing.

U. S National Museum (E. H. Sellards), 8633?. Cherokee shales, Lansing.

Callipteris conferta Sternb.

U. S. National Museum (E. H. Sellards), 8111. Marion? formation, Dickinson County.

Callipteris conferta obliqua (Goepp.) Weiss.

E. H. Sellards. Marion? formation, Dickinson County.

Callipteris conferta vulgaris Weiss.

E. H. Sellards. Marion? formation, Dickinson County.

Callipteris n. sp.

U. S. National Museum (E. H. Sellards), 8097, 8103. Marion? formation, Dickinson County.

Glenopteris splendens Sellards.

U. S. National Museum (E. H. Sellards), 8077. Marion? formation, Dickinson County.

Glenopteris simplex Sellards.

U. S. National Museum (E. H. Sellards), 8082. Marion? formation, Dickinson County.

Glenopteris lineata Sellards.

U. S. National Museum (E. H. Sellards), 8084. Marion? formation, Dickinson County.

Glenopteris Sterlingi Sellards.

U. S. National Museum (E. H. Sellards), 8079. Marion? formation, Dickinson County.

Glenopteris? lobata Sellards.

Marion? formation, Dickinson County.

Odontopteris osmundæformis (Schloth.) Zeill.

The name *osmundæformis*, given by Schlotheim, antedates *Schlotheimii*, the name given by Brongniart and employed by Lesquereux for the specimens in hand. To this species probably belong the fragments from Osage (Lacoe collection, 11269) identified by Lesquereux as *Odontopteris Reichiana* Brongn.

Lacoe collection, 10310–10312. Chanute (Thayer) shales, Thayer.

Lacoe collection, 10313–10315, 11269. Le Roy (Lawrence) shales, Osage.

Odontopteris Reichiana Gutb.

Identified by Lesquereux.

Lacoe collection, 11265. Chanute (Thayer) shales, Thayer.

Odontopteris Brardii (Brongn.) Sternb.

U. S. National Museum (F. F. Crevecoeur), 8832. Elmdale formation, Onaga.

Odontopteris (*Lescuropteris*) *Moorii* (Lx.) D. W.

U. S. National Museum (F. F. Crevecoeur). Elmdale formation, Onaga.

Odontopteris sp. Sellards.

U. S. National Museum (E. H. Sellards), 8114, 8007. Marion? formation, Dickinson County.

Odontopteris papilionacea n. sp.

The fragment somewhat doubtfully separated as above is characterized by very distant, opposite or subopposite paired pinnules not very large, 1–2 cm. long, 5–12 mm. wide, ovate to subcuneate, auriculate or subauriculate, irregularly and obliquely lobate or sublobate, the lobes unequal, usually linear or narrow, obtuse, and parted to a variable depth, the nerves being decurrent at the origin, flexed abruptly outward, then arching but slightly, while forking usually three times in passing at an oblique angle to the border, where they usually number about 30 per centimeter. The species seems to be intermediate between *O. cornuta* L. and *O. subcuneata* Bunby., both of which species are possibly founded on heteromorphous pinnae belonging to the *Neuropteris Scheuchzeri* group.

Lacoe collection, 2086. Cherokee shales, Lansing.

Odontopteris? sp.

A very small fragment agreeing in many respects with examples identified by Lesquereux as *Odontopteris alpina* (Sternb.) Gein., and *O. monstruosa* Lx. It possibly only represents a terminal portion with large pinnules belonging to the plant here provisionally listed as *Neuropteris Desorii* Lx.

U. S. National Museum (E. H. Sellards), 8612. Le Roy (Lawrence) shale, Oak Hill Cemetery, Lawrence.

Neuropteris Desorii Lx.?

A number of small fragments, from the vicinity of Lawrence, communicated by Mr. Sellards, are close to the species as identified by Lesquereux from Pennsylvania, though some of the specimens appear to represent a form with large pinnules. The plant described in the Coal Flora under the above name is a very interesting type which should perhaps be referred to *Odontopteris*.

U. S. National Museum (E. H. Sellards), 8611, 8613. Le Roy (Lawrence) shale, Oak Hill Cemetery, Lawrence.

U. S. National Museum (E. H. Sellards), 8632. LeRoy (Lawrence) shale, University Hill, Lawrence.

Neuropteris rarinervis Bunby.

Lacoe collection, 1872–1875. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8644. Cherokee shales, Lansing.

Neuropteris vermicularis Lx.

U. S. National Museum (E. H. Sellards), 8643. Cherokee shales, Lansing.

Neuropteris Lindahli n. sp.

A species of the Alethopteroid (*Neuralethopteris*) group, with very small, linear, narrowly triangular, often somewhat subfalcate pinnules with cordate, auriculate, usually inæquilateral bases and narrowly obtuse apices. The lamina is rather thick and slighly arched, as in *N. Elrodi* Lx., to which the species is very closely related. The median nerve is persistent, the lateral nerves rather coarse, generally regular, moderately close, open at the base, and curving to a right angle toward the margin while forking once or twice. The species resembles the *N. Schlehani* of Stur also, though lacking the smaller basal pinnules while being more distinctly auriculate. The plant was first identified in the Illinois State Geological Museum, in honor of whose curator at that time, Dr. Josua Lindahl, it is named. Later it was found in the Lacoe collection, and more recently it has been communicated in numerous fine examples by Mr. Sellards.

Lacoe collection, 11621–11624. Erie (Bethany Falls) limestone, Kansas City.

U. S. National Museum (E. H. Sellards), 8636. Erie (Bethany Falls) limestone, Kansas City.

Neuropteris ovata Hoffm.

Recorded as *Neuropteris Loschii* Brongn. in the Kansas lists in the Coal Flora, p. 880.

U. S. National Museum (E. H. Sellards), 7741, 8639. Chanute (Thayer) shales, Thayer.

Lacoe collection, 10744–10746. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8638, 18645. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards) 7733, 8640. Le Roy (Lawrence) shales, University Hill, Lawrence.

Lacoe collection, 10740. Le Roy (Lawrence) shales, Ottawa?

Lacoe collection, 10739. Le Roy (Lawrence) shales, Garnett.

A form with short and broader pinnules, approaching the plant from the high Coal Measures in the Appalachian region, provisionally referred to *Neuropteris auriculata*, is found in the Severy shale.

U. S. National Museum (E. H. Sellards), 8641. Severy shale, Scranton.

Neuropteris plicata Sternb.

The plant generally identified by Lesquereux as this species is perhaps a late phase or modification of *N. ovata*, to which it is most closely related. It is also related to the species described below as *N. hastata*.

U. S. National Museum (E. H. Sellards), 7740. Chanute (Thayer) shales, Thayer.

U. S. National Museum (F. F. Crevecoeur), 8839. Elmdale formation, Onaga.

Neuropteris hastata n. sp.

The species here named includes several fragments with broad striate rachis provided with closely placed, alternate to opposite, inæquilateral, more or less distinctly and narrowly triangular pinnules very closely comparable to those of *N. Leberti* Hr., but generally more elongated and acute, and often attenuate at the apex like *N. aspera* Lx. Frequently the proximal angle is prolonged somewhat as in *N. caudata* D. W., to which the close, strongly arched nervation also is, on the whole, very similar. The distal basal angle is often squarrose or but slightly oblique. The species is possibly based on the heteromorphous pinnæ from the lower portion of the fronds of a species of the *Neuropteris ovata* group. The later representatives of the latter species need a careful revision and more complete illustration.

Lacoe collection, 12072–12074 (types). Cherokee shales, Lansing.

Lacoe collection, 12076. Le Roy (Lawrence) shales, Lawrence.

Specimens, hardly typical, accompanying *N. Lindahli* communicated by Mr. Sellards.

U. S. National Museum, 1837. Erie (Bethany Falls) limestone, Kansas City.

Neuropteris auriculata Brongn.?

The specimens here designated are probably quite distinct specifically from the European plant of this name, though apparently agreeing with material from the Dunkard formation of West Virginia, thus identified by Lesquereux.

U. S. National Museum (F. F. Crevecoeur), 8829. Elmdale formation, Onaga.

Neuropteris sp.

Lacoe collection, 12070, 12071. Cherokee shales, Lansing.

Neuropteris Clarksoni Lx.

This species appears to differ but little, save in its greater size, from British examples referred to *N. macrophylla* Brongn., to which the American species is joined by Kidston.

Lacoe collection, 1777–1781. Cherokee shales, Lansing.

U. S. National Museum (F. A. Bollard), 7759. Cherokee shales, Lansing.

Neuropteris Scheuchzeri Hoffm.

Includes *Neuropteris hirsuta* Lx. and *N. angustifolia* Brongn., as the latter is listed from Osage in the Coal Flora.[a] Also the specimen from Lawrence labeled by Professor Lesquereux as *Lesleya microphylla* Lx. is probably but a deformed terminal pinnule of the same species.

Lacoe collection, 11665–11681, 12012–12014. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8648. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8650. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 7720, 7721, 7735, 8646, 8649. Le Roy (Lawrence) shales, Blue Mounds.

U. S. National Museum (E. H. Sellards), 7734, 7736, 8647. Le Roy (Lawrence) shales, University Hill, Lawrence.

Lacoe collection, 11567–11569. Le Roy (Lawrence) shales, Lawrence.

Lacoe collection, 11606, 11607. Severy shales, Osage.

U. S. National Museum (E. H. Sellards), 8651. Americus limestone, Emporia.

The specimens sent by Mr. Crevecoeur to the United States Geological Survey from Onaga represent a large phase of the species with extremely large, long, lingulate, broadly pedicellate, very obtuse, and often heteromorphous leaves, nearly destitute of hairs. It is scarcely different from the Appalachian Dunkard formation type, which, since the hairs are seldom found except in the youngest or terminal pinules,

[a] Vol. III, p. 881.

I have labeled in our collections as the variety *nuda*. On account of its marked difference in proportion from the earlier and normal *Neuropteris Scheuchzeri* it should, perhaps, be treated as a distinct species.

U. S. National Museum (F. F. Crevecoeur), 8837. Elmdale formation, Onaga.

Neuropteris Rogersi Lx. (non Kimball).

This very rare American species has been identified and transmitted in typical examples by Mr. Sellards.

U. S. National Museum, 7737, 8142. Le Roy (Lawrence) shales, Twin Mounds.

Neuropteris sp. Sellards.

A specimen communicated by Mr. Sellards resembles in some respects *N. cordata* Brongn.

U. S. National Museum, 8107. Marion formation, Dickinson County.

Neuropteris carceraria n. sp.

The types of this species include the specimen from Cannelton, Pa., No. 14831 of the Lacoe collection, described and poorly illustrated in the Coal Flora[a] as *Odontopteris monstruosa* Lx., and specimens 10785 from Lansing and 10791 from Mazon Creek, Illinois. The pinnules, as shown in the cited figure, are ovate, becoming constricted at the attachments along the lower portion of the slender rachis. The distal borders are distinctly and coarsely dentate or serrate (not shown in the figure), even more clearly so than in *Neuropteris crenulata*, with which I was for a long time disposed to place the Lansing specimen. The nervation originating from a single decurrent strand is distinct, not especially coarse, the median nerve quickly vanishing, the nervilles being a little strong, semiflabellate, distant, and passing nearly straight while forking usually twice to the border, where each nerville enters one of the teeth of the pinnule. The species is by its general form, the dentition of its pinnules, and its distant nerves related to *N. crenulata*, whose lowest pinnules, so admirably illustrated by Zeiller,[b] it closely resembles, though its slender rachis, dissolving median nerves, the straighter and not very coarse nervilles, and the broadly ovate form of the upper pinnules clearly separate it from the European plant. It is undoubtedly closely connected with the little-known *N. Evenii* Lx., from which, while apparently quite distinct, it may ultimately prove inseparable.

Lacoe collection, 10785. Cherokee shales, Lansing.

[a] Vol. III, p. 741, Pl. XCVII, fig. 3.

[b] Fl. foss. bassin houill. Commentry, Pt. 1, Pls. XXVI, XXVII, figs. 1-5.

Linopteris obliqua (Bunby.) Pot.

Lacoe collection, 11368. Cherokee shales, Lansing.

Lesleya ? microphylla Lx.

The type of this species,[a] from Osage, may be but an example of the somewhat polymorphous terminal pinnules, so common in the later phase of *Neuropteris Scheuchzeri* Hoffm. Its validity as a representative of the genus *Lesleya* is, to say the least, extremely doubtful.

Lacoe collection, 11744. Severy shales, Osage.

Tæniopteris coriacea Goepp.

U. S. National Museum (E. H. Sellards), 8092–8094. Marion ? formation, Dickinson County.

Tæniopteris coriacea linearis Sellards.

U. S. National Museum (E. H. Sellards), 8095. Marion ? formation, Dickinson County.

Tæniopteris Newberriana F. & I. C. W.

Identified and transmitted by Mr. Sellards.

U. S. National Museum (E. H. Sellards), 8087–8091. Marion ? formation, Dickinson County.

Aphlebia filiformis (Gutb.).

Original of record of *Rhacophyllum filiforme* in the Kansas flora.

Lacoe collection, 19468. Le Roy (Lawrence) shales, Garnett.

Aphlebia acuminata (*Rhacophyllum acuminatum* n. sp.) Lx. Mss.

The types of this undescribed species are in the material left by Lesquereux unfinished.

Lacoe collection, 19566–19572, 19574, 19575. Le Roy (Lawrence) shales, Garnett.

Spiropteris sp.

Probably *Pecopteris villosa* Brongn.?

Lacoe collection, 19382. Cherokee shales, Lansing.

Daubreeia sp.

Evidently representing the genus described by Renault and Zeiller from the Commentry Basin. The discovery of this rare Old World genus adds new evidence regarding the common character of the Carboniferous flora in Europe and in America.

U. S. National Museum (F. F. Crevecoeur), 9603–9605. Elmdale formation, Onaga.

[a] Coal Flora, Vol. III, p. 831.

Plinthiotheca angularis Lx. sp.

This species described by Lesquereux[a] as *Lepidocystis angularis* consists of a small peltate or pseudopeltate, densely radiately fibrous leaf, with greatly thickened, transversely ridged mesophyll, the furrows of which are occupied by closely grouped sporangia. This plainly represents the genus recently described by Zeiller[b] as *Plinthiotheca*.

In the American species, which is represented by numerous specimens in the Lacoe collection from the Allegheny formation,[c] the rows of sporangia completely cover one side of the disk and form a marginal fringe, the peripheral sporangia being directed outward. The sporangia of our plant are in fours, and spread out, in the mature specimens, in a way very strongly resembling the sori described by Stur as *Havlea* Corda. In fact, the radiate sporangia, which are attached at the basal end only, and which open longitudinally through their whole length, whether turgid or collapsed, resemble more closely those of the latter genus than *Asterotheca*, with which Professor Zeiller compares his specimens.

From the form and aspect of the specimens I conclude that the sori are on the under side of the leaf, which in most instances they completely cover, though in a few cases a marginal zone of the disk is left uncovered. This zone is precisely like that sometimes present in *Doleropteris* Gr. 'Ey. The young examples of the plant in hand, by their less distinct sporangia and the rows of rounded, puffy, fleshy protuberances, so strongly suggest the fertile leaves of the latter genus as to lead one to question whether the distinctions be less than generic, and whether the *Lepidocystis angularis* Lx. should possibly be referred to *Doleropteris*, or to *Androstachys*, its supposed polliniferous leaf. The writer hopes to make the specimens in hand the subject of a more detailed study, with ample illustrations.

Lacoe collection, 25271. Cherokee shales, Lansing.

Calamites ramosus Artis.

Includes specimens described by Lesquereux in Coal Flora, Vol. III, p. 702, pl. xcii, figs. 1, 2, 3, 4. Some of the fragments placed by Lesquereux in this species should probably be put in *Calamites Suckowii*.

Lacoe collection, 17386–17389 (figured), and 17405, 17406. Apparently from the Le Roy (Lawrence) shales, and probably from Lawrence.

Lacoe collection, 17407. Severy shales, Osage.

Calamites Suckowii Brongn.

Lacoe collection, 17256–17258, 17260–17272. Le Roy (Lawrence) shales, Lawrence.

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[a] Coal Flora, Vol. II, p. 456, Pl. LXIX, fig. 17.

[b] Mém. Soc. géol. France, Pal., No. 21, p. 54, Pl. IV, figs. 18, 18A.

[c] The statement accompanying the description, Coal Flora, p. 457, that some of the types are from the "interconglomerate" [Pottsville] of Campbells Ledge, is erroneous, they having been collected from the lower group of the succeeding anthracite series at Port Griffith, in the Northern Anthracite field.

Calamites Cistii Brongn.

Lacoe collection, 17351–17352. Le Roy (Lawrence) shales, Lawrence.

Calamites cannæformis Schloth.

Lacoe collection, 17373. Le Roy (Lawrence) shales, Lawrence.

Calamodendron cruciatum (Sternb.) Zeill.?

Lacoe collection, 17357. Le Roy (Lawrence) shales, Lawrence.

Asterophyllites equisetiformis (Schloth.) Brongn.

The Blue Mounds examples are robust; the Onaga, dense.

Lacoe collection, 17677. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8656, 8657. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 7728. Le Roy (Lawrence) shales, Blue Mounds.

U. S. National Museum (F. F. Crevecoeur), 8845. Elmdale formation, Onaga.

Asterophyllites sp.

U. S. National Museum (E. H. Sellards), 8658. Unknown.

Annularia stellata (Schloth.) Wood.

Lacoe collection, 17913. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8659. Cherokee shales, Lansing.

Lacoe collection, 17907. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 8661. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 7731. Le Roy (Lawrence) shales, Twin Mounds.

U. S. National Museum (F. F. Crevecoeur), 8844. Elmdale formation, Onaga.

Annularia sphenophylloides (Zenk.) Gutb.

Lacoe collection, 17992–17993, 17953. Cherokee shales, Lansing.

Annularia sphenophylloides intermedia Lx.

A type with elongated leaves, intermediate to *A. stellata*, was designated by Lesquereux as the var. *intermedia* of *A. sphenophylloides*. It is in general characteristic of the higher Coal Measures.

Lacoe collection, 17950, 17952. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 7726. Le Roy (Lawrence) shales, Blue Mounds.

Bruckmannia tuberculata Sternb.?

A fragment of an axis with portions of bracts probably belonging to *Annularia stellata*, though it is possibly referable to *A. sphenophylloides*.

Lacoe collection, 18338. Le Roy (Lawrence) shales, Ottawa.

Calamostachys brevifolia Lx.?

Lacoe collection, 18359. Cherokee shales, Lansing.

Sphenophyllum emarginatum minor D. W.[a]

Besides the normal form of *Sphenophyllum emarginatum* the collections from the lower horizons contain a few fragments of the narrower and somewhat more acutely dentate form, which, in treating the flora of the Lower Coal Measures of Missouri, I have referred to as *S. cuneifolium*. This form, which, as I have since pointed out, is different from the typical Old World *S. cuneifolium*, characteristic of the Pottsville and Lower Kanawha formations in this country, appears on further examination and comparisons to be in reality connected with *S. emarginatum* rather than with S. *cuneifolium*. I therefore propose for this form, which represents an earlier phase of *S. emarginatum*, the varietal term given above. Where the leaves are much dissected or they are narrow with margins incurved and buried in the matrix it is often difficult of distinction from the normal form of the species and from *S. cuneifolium*.

Lacoe collection, 18509. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8665. Cherokee shales, Lansing.

Sphenophyllum emarginatum Brongn.

U. S. National Museum (E. H. Sellards), 8666. Locality unknown.

Sphenophyllum oblongifolium (Germ.) Ung.

Besides the type identified by Lesquereux under this name in the Kansas material, a small form strongly suggestive of the closely related *Sphenophyllum filiculme* Lx. is also present.

Lacoe collection, 18669, 18708. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 8663. Chanute (Thayer) shales, Thayer.

Lacoe collection, 18521, 18522. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 8662. Le Roy (Lawrence) shales, Twin Mounds.

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[a] *Sphenophyllum cuneifolium* (Sternb.) Zeill., D. White, Mon. U. S. Geol. Survey Vol. XXXVII, 1899, p. 174, excluding syn.

Sphenophyllum verticillatum (Schloth.) Zeill.

This very rare species seems to be represented in the Lacoe collection by a single specimen, No. 18610, labeled as *Sphenophyllum Schlotheimii* Brongn.[a] This, with several fragments from Blue Mounds communicated by Mr. Sellards, represents a crenulate, delicate type of leaf, with well-rounded angles, agreeing fairly well with Schlotheim's *Palmacites verticillatus*, though they are slightly more robust and a little broader. In the form of the leaf the specimens in hand approach the papilionate group represented by *S. latifolium* F. & I. C. W., *S. latifolium* R. & Z., *S. papilionaceum* Gr. 'Ey., and *S. Thoni* Mahr.

The Kansas plant differs slightly from that illustrated as *Sphenophyllum Schlotheimii* by Lesquereux in the Coal Flora.[b]

Lacoe collection, 18610. Le Roy (Lawrence) shales, Ottawa.

U. S. National Museum (E. H. Sellards), 8667. Le Roy (Lawrence) shales, Blue Mounds.

Sphenophyllum sp. Sellards.

A member of the papilionate group.

U. S. National Museum (E. H. Sellards), 8121. Marion? formation, Dickinson County.

Radicites capillaceus (L. & H.) Pot.

U. S. National Museum (F. F. Crevecoeur), 8843. Elmdale formation, Onaga.

Knorria compacta Lx.

The types from Kansas on which this species was founded, Coal Flora, Vol. III, p. 839, are sigillarioid in aspect. The species needs a thorough examination.

Lacoe collection, 15800–15803. Chanute (Thayer) shales, Thayer.

Bothrodendron ? n. sp.

A small, somewhat macerated, minutely rugose cortical fragment having numerous distant scars which are similar in form to those of *Bothrodendron minutifolium*, but a little larger, concave on the lower lateral margins and distinctly marked by a deep rounded apical sinus. Nerve trace small, central, transverse; cicatricules vertical, distant along the transverse diameter half way to the lateral angles. With *Alethopteris Grandini*.

Lacoe collection, 12208. Le Roy (Lawrence) shales, Lawrence.

[a] The specific name given by Schlotheim has priority over that applied by Brongniart to the same plant.

[b] Atlas, p. 2, Pl. II, fig. 6.

Lepidostrobus cultriformis Lx.

With *Lepidophyllum cultriforme* Lx.

Lacoe collection, 16092–16097. Cherokee shales, Lansing.

U. S. National Museum (E. H. Sellards), 8668. Cherokee shales, Lansing.

Sigillaria camptotœnia Wood.

A good specimen of this species, labeled as above, has been sent to the National Museum by Mr. Sellards. It should be noted here, however, that the examples from Lawrence, described by Lesquereux under this name as accompanied by *Sigillariostrobus Laurencianus*, the two species being regarded as in union as stem and cone, can not be referable to *S. camptotœnia*. As seen in the original and other specimens from the same locality, the stem fragments (Lacoe collection, 16641, 16642) are coarsely lineate longitudinally, not meshed. The impressions, which seem to be subepidermal, possibly represent a partially decorticuted phase of the plant described below as *Sigillaria suspecta*, or that designated as "*Sigillaria Brardii*, a fine variety," by Lesquereux. To *Sigillaria camptotœnia* belong specimens 18231 and 18233 of the Lacoe collection, labeled by him as *Stigmaria ficoides* var. *stellata* Goepp.

Lacoe collection, 18231, 18232. Chanute (Thayer) shales, Thayer.

U. S. National Museum (E. H. Sellards), 8670. Le Roy (Lawrence) shales, Blue Mounds.

Sigillaria Brardii Brongn

U. S. National Museum (E. H. Sellards), 8686. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 8674. Severy shales, Scranton.

Sigillaria Brardii coriacea n. var.

The specimens which are here varietally reported are marked by the very large size of the leaf scars, which are laterally distinctly acuminate, and distant from one another in the same spiral a little more than their vertical diameter, the intervening surface of the but slightly protuberant cushion being coarsely granular-shagreened. On account of the latter feature specimens of this form were labeled by Lesquereux as *S. reticulata* Lx. The variety *coriacea* may possibly prove inseparable from the type of cortex identified by the same author as *Sigillaria venulosa* Brongn. The latter, or its supposed representatives in this country, seem in turn hardly to differ specifically from the *S. obliqua* as recognized by Lesquereux in material from the Appalachian region. The latter specimens are undoubtedly referable to the *S. Brardii* group.

Lacoe collection, 16604–16609. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 8672, 8673. Le Roy (Lawrence) shales, Blue Mounds.

Sigillaria suspecta n. sp.

Bothrodendroid cortex having small rhomboidal scars, 2 to 3 mm. in diameter, usually 1 cm. or more apart, nearly 1½ times as broad as long, exactly rounded below, a little less than rectangular laterally, arched strongly upward with a very shallow and rather narrow apical sinus. The nerve scar is small, round, and but very little above the center of the scar, the lateral cicatricules being very oblique, very narrow, nearly straight and elongated below the median line of the scar. The interfoliar epidermis is transversely shagreened almost as in *Bothrodendron minutifolium*. In the partially decorticated condition the stems are rather coarsely and distantly but irregularly longitudinally lineate.

Lacoe collection, 16650, 19732 (types). Probably from the Le Roy (Lawrence) shales, of Lawrence.

Sigillaria Laurenciana n. sp. Lx. Mss.

Lacoe collection, 16570, 16571 (types). Le Roy (Lawrence) shales, Lawrence.

Sigillaria rectistriata n. sp. Lx. Mss.

Lacoe collection, 16576, 16577 (types). Chanute (Thayer) shales, Thayer.

Sigillariostrobus quadrangularis Lx. sp.

In structure the cones described by Lesquereux[a] as *Lepidocystis quadrangularis* seem to correspond to the strobili of the *Sigillariæ*.

Lacoe collection, 25280. Le Roy (Lawrence) shales, Lawrence.

Sigillariostrobus clavatus Lx. sp. (*Sigillariostrobus Laurencianus* Lx.)

This interesting species is represented by several fine examples from Kansas, including the types of *Sigillariostrobus Laurencianus* Lx. in the Lacoe collection. After a careful examination of the latter I am unable to discern any conclusive evidence that this strobilus[b] is in union with the specimens identified by Lesquereux as *Sigillaria monostigma*, as was assumed by the author in the original description of *Sigillariostrobus Laurencianus*. The fragments of stem impression, which can hardly be *Sigillaria camptotænia*, appear to be merely superimposed on a portion of a cone. *Sigillariostrobus Laurencianus* was correlated by Lesquereux[c] with *Trochophyllum clavatum* Lx., the specific term of which has priority. *Sigillariostrobus clavatus* differs from the closely related *S. Lacoei* (*Lycopodites Lacoei* Lx.) by its more slender axis and much larger acuminate bracts, with a longer,

[a] Coal Flora, Vol. II, p. 455. [b] Idem, Vol. III, p. 793. [c] Ibid., p. 794.

more open sporangiferous portion. The types of the species are included in—

Lacoe collection, 16640–16648. Le Roy (Lawrence) shales, Lawrence.

U. S. National Museum (E. H. Sellards), 8676. Le Roy (Lawrence) shales, Blue Mounds.

Doleropteris pennsylvanica Dn. sp.

The American specimens described by Dawson [a] as *Dolerophyllum pennsylvanicum* agree in all essential characters with the supposed polleniferous leaves described or figured by Renault [b] and Saporta [c] as *Dolerophyllum* and by Grand 'Eury [d] as *Doleropteris* and *Androstachys*. In several of our examples the "polleniferous" area is bordered by a thick radially fibrous zone much broader than in the example figured by Saporta and Renault. In the Kansas specimens we have the disk completely covered by the polleniferous capsules, which as pointed out by Dawson are apparently a little larger than in the European species, though in other superficial details the agreement with the *Androstachys cebennensis* of Grand 'Eury is equally close. Unfortunately the specimens at hand are not so preserved as to show the internal structure, but the impressions in the soft ferruginous sandstone have the somewhat obscure appearance of rows of squarrose groups of four. The aspect of these specimens strongly suggests very deeply immersed sori, possibly comparable to a certain extent with those of *Plinthiotheca* Zeiller, rather than the irregular, elongated, closed chambers shown in the sections so admirably prepared by Professor Renault. In its general superficial aspect the *Plinthiotheca anatolica* of Zeiller appears to be intermediate between *P. angularis* and *Androstachys*. I have, however, no doubt as to the generic identity of the species described by Dawson as *Dolerophyllum pennsylvanicum* and the fertile material figured by Renault and Saporta as belonging to that genus. If the supposed polleniferous leaves are actually generically identical with the striate leaves described by the same authors under the same name, they should be designated as *Doleropteris*, the name which, though possibly inappropriate, was earlier applied [e] to the genus. On the other hand, if the generic identity of the sterile leaves and the supposed polleniferous leaves is not established, the specimens in hand should be referred to the genus *Androstachys*, which was proposed by Grand 'Eury especially for these fertile leaves. It may be interesting to note in this connection that the types of *Doleropteris pennsylvanica* in the Lacoe collection have the manuscript name *Dolerophyllocarpum* written in Sir William Dawson's hand on the labels.

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[a] Can. Rec. Sci., Vol. IV, No. 1, 1890, p. 7.

[b] Fl. foss. bassin houill. perm. Autun et Épinac, Vol. II, p. 262, Pl. LXXII, fig. 13.

[c] Évol. règ. vég., Phanérog., Vol. 1, 1885, p. 75, f. 35.

[d] Géol. Paléont. bassin houill. Gard, 1890, p. 306, Pl. VIII, figs. 2A, 2A'.

[e] Grand 'Eury, Fl. Carb. Loire, 1877, p. 194.

The genus *Dolerophyllum* was included by Saporta among the transitional types grouped by him in the Progymnosperms. Professor Renault correlates, as the seed of the genus, a fruit which in certain features resembles a large specimen of *Rhabdocarpus mamillatus*. Whether the plants in hand should be definitely referred to the gymnosperms is perhaps still a little doubtful. Inclining to the belief entertained by Dawson and others that these specimens may represent fertile cyclopterid pinnules, some of whose striate fronds may still be known as *Neuropteris*, I am disposed to include them in the group *Cycadofilices* established by Potonié.

Lacoe collection, 19620. Le Roy (Lawrence) shales, Lawrence.

Lacoe collection, 19621. Le Roy (Lawrence) shales, Lawrence.

Cordaites communis Lx.

Specimens under this name transmitted by Mr. Sellards.

U. S. National Museum, 8677. Le Roy (Lawrence) shales, Blue Mounds.

Cordaites squammiferus Lx. n. sp. MSS.

The description of this species will be included in a posthumous work covering a large amount of other material described or studied by Lesquereux.

Lacoe collection, 26421 (type). Severy shales, Osage.

Cordaites illinoisensis Dn.

Described by Penhallow from Chase County.

Dadoxylon Prosseri Penh.

Types from Cottonwood Township, Chase County.

Pityoxylon Chasense Penh.

Coon Creek, Chase County.

Cordaianthus ovatus Lx.

Lacoe collection, 19207. Cherokee shales, Lansing.

Cordaicarpon cinctum Lx.

Lacoe collection, 25351. Cherokee shales, Lansing.

Cardiocarpon kansasiense Lx. n. sp. MSS.

Lacoe collection, 26421 (type). Severy shales, Osage.

Cardiocarpon ellipticum (Sternb.) Lx.

Lacoe collection, 25918. Severy shales, Osage.

Cardiocarpon Branneri Fairch. and D. W.

A single somewhat obscure specimen identified and transmitted by Mr. Sellards.

U. S. National Museum, 8680. Erie (Bethany Falls) limestone, Kansas City.

Cardiocarpon sp. cf. *Cuyahogæ* D. W.

U. S. National Museum (E. H. Sellards), 8678, 8681. Locality unknown.

Rhabdocarpos mamillatus Lx.

Lacoe collection, 26793. Cherokee shales, Lansing.

Rhabdocarpos Beinertianus Goepp. and Berg.

U. S. National Museum (E. H. Sellards), 8682. Locality unknown.

Rhabdocarpos sulcatus (Presl) Kidst.

Lacoe collection, 26535. Le Roy (Lawrence) shales (?), Lawrence (?).

Rhabdocarpos coronatus Lx. n. sp. MSS.

Lacoe collection, 26568 (types). Le Roy (Lawrence) shales, Ottawa.

Rhabdocarpos amygdalæformis Goepp. and Berg.

It is doubtful whether the specimens from Osage labeled and recorded by Lesquereux as above are identical with the seed described under that name by Goeppert and Berger.

Lacoe collection, 26633, 26640. Severy shales, Osage.

Rhabdocarpos Jacksonianus Lx.

U. S. National Museum (E. H. Sellards, 8683). Locality unknown.

Trigonocarpum Starkianum Lx.

Lacoe collection, 26916. Le Roy (Lawrence) shales, Lawrence.
Lacoe collection, 26904?. Le Roy (Lawrence) shales, Ottawa.
Lacoe collection, 26911–26915. Severy shales, Osage.
U. S. National Museum (E. H. Sellards), 8679. Locality unknown.

Trigonocarpum kansaseanum Lx.

Type, Coal Flora, Vol. III, p. 822.
Lacoe collection, 26999–27004. Severy shales, Osage.

Trigonocarpum Adamsii Lx.?

Lacoe collection, 26749–26750. Erie (Bethany Falls) limestone, Kansas City.

Trigonocarpum Hildreti Lx.

Identified by Lesquereux and labeled "Kansas."
Lacoe collection, 26641. Locality unknown.

Carpolithes granularis Sternb.

The original of fig. 20, Pl. CXI, of the Coal Flora, from Osage, described by Lesquereux under the above name, appears to be specifically indistinguishable from the specimens from the same place identified by him as *Cardiocarpon ellipticum.*

Lacoe collection, 25757. Severy shales, Osage.

AGE OF THE BEDS FROM WHICH THE PLANTS WERE COLLECTED.

It is not within the scope of this summary to enter upon a discussion of the horizontal or vertical distribution of the individual species comprising the floras as yet made known from Kansas. Such data, comprising the correlative evidence in detail, are of necessity omitted from this paper. In the following pages but little more than the broader or tentative conclusions as to correlations will be stated; and since also very little information is available as to the floras above the stage of the Cherokee shales in the western interior regions, comparisons must be confined for the most part to the paleobotanically much better-known section of the Appalachian trough.[a]

CHEROKEE FLORA AT THE PENITENTIARY SHAFT, LANSING.

Excipulites Callipteridis (Schimp.) Kidst.
Eremopteris solida (Lx.) D. W.
Pseudopecopteris squamosa (Lx.) D. W.
Pseudopecopteris Pluckenetii (Schloth.) Lx.
Sphenopteris denticulata Brongn.
Sphenopteris sp.
Pecopteris unita Goepp.
Pecopteris squamosa Lx.
Pecopteris vestita Lx.
Pecopteris villosa Brongn. ?
Pecopteris cf. polymorpha Brongn. ?
Alethopteris sp.
Callipteridium Sullivantii (Lx.) Weiss.
Odontopteris papilionacea D. W.
Neuropteris rarinervis Bunby.
Neuropteris vermicularis Lx.
Neuropteris ovata Hoffm.
Neuropteris hastata D. W.
Neuropteris sp.
Neuropteris Clarksoni Lx.
Neuropteris Scheuchzeri Hoffm.
Neuropteris carceraria D. W.
Linopteris obliqua (Bunby.) Pot.
Spiropteris sp.
Plinthiotheca angularis (Lx.) D. W.
Asterophyllites equisetiformis (Schloth.) Brongn.
Annularia stellata (Schloth.) Wood.
Annularia sphenophylloides (Zenk.) Gutb.
Calamostachys brevifolia Lx. ?
Sphenophyllum emarginatum Brongn. var. minor D. W.
Lepidostrobus cultriformis Lx.
Cordaianthus ovatus Lx.
Cordaicarpon cinctum Lx.
Rhabdocarpos mamillatus Lx.

[a] It is hoped that all the Kansas material, together with more extensive data, may be treated in full, with the object of attaining more exact results, in the comprehensive report now in preparation by the State university survey at the hands of Mr. Sellards.

From the composition of this flora, the lowest yet at hand from Kansas, it appears that the horizon of the Lansing plants falls within the Allegheny formation of the Appalachian basin, of which the greater number of the fern species are more or less distinctly characteristic. So far as the vertical range of the plants has yet been ascertained in other basins, it would appear that the presence of *Eremopteris solida*, *Pseudopecopteris squamosa*, *Pecopteris squamosa*, *Callipteridium Sullivantii*, *Neuropteris vermicularis*, *N. carceraria*, *Plinthiotheca angularis*, and the variety of *Sphenophyllum emarginatum* would indicate a close relationship with the Cherokee flora of Henry County, Mo., the Mazon Creek stage of the Illinois Coal Measures, the Cannelton stage of the Pennsylvania bituminous coal fields, or coals C and D of the northern anthracite region. The occurrence of *Pseudopecopteris Pluckenetii*, common at Cannelton, the large pinuled *Pecopteris*, *Neuropteris Clarksoni*, and *Linopteris obliqua* argue against a lower stage than the Kittanning group in the Allegheny formation, while the presence of *Eremopteris solida*, *Pseudopecopteris squamosa*, *Pecopteris squamosa*, *Neuropteris vermicularis*, and the small-leafed *Sphenophyllum* point less strongly to a date not later than, and probably a little earlier than the Freeport group. There can be little doubt that the Lansing coal was deposited within Allegheny time, its horizon falling probably in or near the Kittanning group.

A more extended search at additional localities would no doubt show a very intimate relation between the flora in hand and that of the Cherokee of Missouri, the lower portion of which furnished the greater part of the material described in the flora of the Lower Coal Measures of Missouri.[a]

The Lansing horizon is certainly not lower than and probably not so low as the "lower coal-bearing division"[b] of the Arkansas Coal Measures, though unfortunately the fossil plants in the Arkansas and Indian Territory coal fields have not yet been collected sufficiently to make correlations with a high degree of assurance possible. The flora seems to correspond to that of the Middle Coal Measures of Great Britain, and to the uppermost portion of the latter or to the transition series above the Westphalian of the continent of Europe.

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[a] Mon. U. S. Geol. Survey, Vol. XXXVII, 1899. To the species enumerated in this work are to be added the following from Coon Creek, Owen's and Pitcher's mines in the vicinity of Clinton, Henry County, recently communicated by Dr. J. H. Britts: *Rosellinites Beyschlagii* Pot., *Mariopteris muricata* (Schloth.) Zeill., *Sphenopteris Dubuissonis* Brongn.?, *Desmopteris elongata* (Presl) Stur, *Neuropteris vermicularis* Lx., *N. ovata* Hoffm., *N. capitata* Lx., and *N. Desorii* Lx.

The genus *Desmopteris*, here first reported from this continent, is represented in the Lacoe collection, U. S. National Museum, by several specimens from the Coal Measures of the Appalachian region.

[b] The flora of this division corresponds somewhat closely to that of the roof of the Grady (Hartshorne) coal, described from the McAlester-Lehigh coal field. Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. III, p. 457.

ERIE (BETHANY FALLS) FLORA AT KANSAS CITY.

Neuropteris Lindahli D. W.
Neuropteris hastata D. W.
Cardiocarpon Branneri Fairch. & D. W.
Trigonocarpum Adamsii Lx.?

The material from this important stage is too meager to form a basis for a satisfactory comparison. The matrix, a buff-colored, thin-bedded calcareous shale, is well filled with plant remains, and the locality and horizon, which are somewhat critical from the correlative standpoint, deserves a thorough paleobotanical exploration.

CHANUTE (THAYER) FLORA AT THAYER.

Pseudopecopteris Pluckenetii (Schloth.) Lx.
Mariopteris cordato-ovata (Weiss) D. W.
Sphenopteris pinnatifida (Lx.) D. W.
Aloiopteris Winslovii D. W.
Alethopteris cf. virginiana F. & I. C. W.
Alethopteris Grandini (Brongn.) Goepp.
Odontopteris osmundæformis (Schloth.) Zeill.
Odontopteris Reichiana Gutb.
Neuropteris ovata Hoffm.
Neuropteris plicata Sternb.
Neuropteris Scheuchzeri Hoffm.
Annularia stellata (Schloth.) Wood.
Sphenophyllum oblongifolium (Germ.) Ung.
Knorria compacta Lx.
Sigillaria camptotænia Wood.
Sigillaria rectostriata Lx.

The small amount of collecting, from a single locality only, here represented is not sufficient for more than a mere indication as to the probable stage of the plants. The Chanute flora does not, however, seem to be of an earlier date than the Freeport, the uppermost division of the Allegheny formation; for while it retains several species, such as *Pseudopecopteris Pluckenetii*, *Sphenopteris pinnatifida*, *Aloiopteris Winslovii*, a small form of *Neuropteris plicata* and *Sigillaria camptotænia*, which are more common in the Allegheny, it is characterized by the introduction of a number of later types. Such are *Mariopteris cordato-ovata*, *Alethopteris* cf. *virginiana*, *A. Grandini*, *Odontopteris osmundæformis*, *O. Reichiana*, and *Sphenophyllum oblongifolium*, all of which are more or less distinctly indicative of a higher level. I have, therefore, little hesitation in concluding that the plant horizon of the Chanute shales may be somewhat younger than the Allegheny. How much younger it may be it is impossible to conclude from the intrinsic evidence of the plants, especially since we have no complete standard paleobotanical sections in this country for comparison; but from the apparent age of the Le Roy shales, which, according to Mr. Adams's general section, are about 250 feet above the Chanute, it seems not improbable that the Chanute may lie somewhere within the interval represented by the Conemaugh formation of the Allegheny region, and possibly in the lower portion of that formation. Its stage should be above the Hartshorne sandstone, and the McAlester coal in Indian Territory, and it is probably higher than the entire group of the McAlester shales. As compared with the Old World series, the horizon of the Chanute is probably in the Upper Coal Measures of Great

Britain, and in the lower portion of the Saarbrückian (Stephanian) of continental Europe.

The material from Thayer is notable for the absence of *Pecopteris*, a genus of good time markers which should be found in the much-needed collections from this important horizon.

LE ROY (LAWRENCE) FLORA.[a]

Pseudopecopteris Pluckenetii (Schloth.) Lx.
Mariopteris cordato-ovata (Weiss) D. W.
Sphenopteris pinnatifida (Lx.) D. W.
Oligocarpia Gutbieri Goepp.
Oligocarpia n. sp. Sell.
Aloiopteris Winslovii D. W.
Pecopteris cf. integra (Andrä) Zeill.
Pecopteris arborescens (Schloth.) Brongn.
Pecopteris cf. hemiteliodies Brongn.
Pecopteris Candolliana Brongn.
Pecopteris cf. polymorpha Brongn.
Alethopteris Grandini (Brongn) Goepp.
Odontopteris ? sp.
Neuropteris Desorii Lx. ?
Neuropteris ovata Hoffm.
Neuropteris hastata D. W.
Neuropteris Scheuchzeri Hoffm.
Neuropteris Rogersi Lx.
Aphlebia filiformis (Gutb.) D. W.
Aphlebia acuminata Lx.
Calamites ramosus Artis.
Calamites Suckowii Brongn.
Calamites Cistii Brongn.
Calamites cannæformis Schloth.
Calamodendron cruciatum (Sterb.) Zeill.
Asterophyllites equisetiformis (Schloth.) Brongn.
Annularia stellata (Schloth.) Wood.
Annularia sphenophylloides (Zenk.) Gutb. var. intermedia Lx.
Bruckmannia tuberculata Sternb.
Sphenophyllum oblongifolium (Germ.) Ung.
Sphenophyllum verticillatum (Schloth.) Zeill.
Bothrodendron ? n. sp.
Sigillaria camptotænia Wood.
Sigillaria Brardii Brongn. var. coriacea D. W.
Sigillaria suspecta D. W.
Sigillaria Laurenciana Lx.
Sigillariostrobus quadrangularis (Lx.) D. W. ?
Sigillariostrobus clavatus (Lx.) D. W.
Doleropteris pennsylvanica (Dn.) D. W.
Cordaites communis Lx.
Rhabdocarpos coronatus Lx.
Rhabdocarpos sulcatus (Presl) Kidst.
Rhabdocarpos multistriatus (Presl) Lx.
Trigonocarpum Starkianum Lx.

As will be seen by reference to the foregoing list, nearly one-half of the species collected from the Le Roy flora belong to the filices. The Lepidophytes appear to be represented only by the *Sigillariæ*, though it is not improbable that *Lepidodendron* may be found at some localities. Of the species reported *Sphenopteris pinnatifida*, *Aloiopteris Winslovii*, the fern doubtfully referred to *Neuropteris Desorii*, *N. Rogersi*, *Sigillaria camptotænia*, *Sigillariostrobus quadrangularis* (*?*), and *Rhabdocarpos multistriatus* are, in general, more at home, so far as my observations as to the distribution of the species have extended, in the Allegheny series of the eastern basins. The *Sigillaria* and *Aloiopteris* and *Neuropteris* species just cited are, however, the only ones that are generally considered as to any considerable degree characteristic of the Allegheny, though I have not elsewhere seen a narrow

[a] The localities in the Le Roy are: Lawrence, Blue Mounds, Twin Mounds, Ottawa, and Garnett. Most of the species are from Lawrence.

pinnuled *Neuropteris Scheuchzeri* at so high a level as to be found in association with the later forms in the Le Roy flora. Such later Le Roy forms are *Mariopteris cordato-ovata*, *Pecopteris* cf. *integra?*, *P. arborescens*, *P.* cf. *hemitelioides*, *P. Candolliana*, *P.* cf. *polymorpha*, *Alethopteris Grandini*, *Annularia sphenophylloides* var. *intermedia*, *Sphenophyllum oblongifolium*, *S. verticillatum* and *Trigonocarpum Starkianum*. The presence of typical forms of *Pecopteris arborescens*, *P. hemitelioides*, *Alethopteris Grandini*, *Sphenophyllum oblongifolium* and *S. verticillatum* is strongly indicative of a post-Allegheny age for the flora. On the other hand the plants are clearly older than the Dunkard formation.

For want of a stratigraphic study of the plants of the higher Coal Measures of the interior basins, or of the Conemaugh and Monongahela formations in the Appalachian trough, but little knowledge of the distinctive paleobotanical features of these formations is available. Without such information, which should essentially constitute a paleobotanical section for comparison, it is impossible to arrive with definiteness at any conclusion regarding the age of a flora coming from these parts of our Coal Measures except it be very large or marked by special types. As yet but a small amount of material has been collected or studied from the roof of the Pittsburg coal, which forms the bottom bed of the Monongahela formation. From such material as I have examined from this horizon I am disposed to regard its stage as more strongly marked by the large Pecopterids, including Callipteridioid forms, by the broad Alethopterids and the dilated Neuropterids. The presence of *Alethopteris Grandini*, *Annularia sphenophylloides* var. *intermedia*, and more particularly the *Sphenophyllum oblongifolium*, which is very closely related to *S. filiculme*, seems to point toward a level possibly as high as the Pittsburg coal in the Monongahela formation. But the presence of the forms, which, so far as known, appear to indicate a lower stage, makes it seem improbable that the Lawrence plants are of quite so late a date as the Monongahela formation of the Appalachian trough. Subsequent collecting, either in Kansas or from the Conemaugh and Monongahela formations in the Appalachian trough, may seriously modify this tentative conclusion. The flora of the Le Roy indicates a date within the Stephanian (Saarbrückian) of the European Carboniferous.

SEVERY FLORA AT OSAGE AND SCRANTON.

Caulerpites n. sp. Lx.
Odontopteris osmundæformis (Schloth.) Zeill.
Neuropteris ovata Hoffm.
Neuropteris Scheuchzeri Hoffm.
Lesleya microphylla Lx.
Calamites ramosus Artis.
Sigillaria Brardii Brongn.
Cordaites squammiferus Lx.
Cardiocarpon kansasiense Lx.
Cardiocarpon ellipticum (Sternb.) Lx.
Rhadbocarpos amygdalæformis Goepp. & Berg.
Trigonocarpum Starkianum Lx.
Trigonocarpum kansaseanum Lx.
Carpolithes granularis Sternb.

The flora as yet made known from the Severy shales appears to have included but four ferns, one of which is of doubtful validity, besides not being known definitely elsewhere. No Annularian or Sphenophyllean remains are reported, while three of the gymnosperms, described in Lesquereux's unpublished manuscript, have no recorded distribution. *Odontopteris osmundæformis* is not known in the Dunkard formation,[a] while the phase of *Neuropteris Scheuchzeri*, and possibly of *N. ovata* also, is less advanced than is characteristic of the Dunkard even at its lowest stratum, the roof of the Waynesburg coal, whose flora has been very thoroughly studied by Professors Fontaine and I. C. White. The evidence, therefore, though very scanty, leans slightly toward a stage not higher than the Monongahela formation. The material in hand contains no distinctly Permian species, though no doubt further collections will reveal species that range upward into the Permian. The flora is included in the Stephanian period of the Old World classification.

ELMDALE FLORA AT ONAGA.

Pecopteris Newberriana F. & I. C. W.
Pecopteris hemitelioides Brongn.
Pecopteris oreopteridia (Schloth.) Brongn.?
Pecopteris cf. polymorpha Brongn.
Odontopteris Brardii Brongn.
Odontopteris Moorii (Lx.) D. W.
Neuropteris plicata Sternb.
Neuropteris auriculata Brongn.?
Neuropteris Scheuchzeri Hoffm.
Daubreeia sp.
Asterophyllites equisetiformis (Schloth.) Brongn.
Annularia stellata (Schloth.) Wood.
Radicites capillaceus (L. & H.) Pot.

The thirteen species from Onaga communicated by Mr. Crevecoeur are, as compared with the floras of Lansing and Thayer, obviously of much later age. No species in any way characteristic of the Lower Coal Measures or the Allegheny formation remains. On the other hand, the ferns, either as individual species or as phases of species having wide range, are clearly indicative of a stage at least very high in the Upper Carboniferous (Pennsylvanian). Nearly all the species have been reported from either the Permian of Europe or the Dunkard formation of the United States, though, with the possible exception of *Pecopteris Newberriana*, none are distinctly characteristic of the Permian. Most of the forms present occur in the Dunkard formation, whose flora was fully treated by Professors Fontaine and I. C. White.[b] Yet the small flora from Onaga contains none of the special types or characteristic Permian forms which are present in the Dunkard, and on account of which the greater part of the Dunkard is regarded as Permian.

It would seem, however, that the Onaga flora should be of later date than the Pittsburg coal, since the facies presented by several of the species has not yet been seen at so low an horizon. Thus the very

[a] Next above the Monongahela formation in the Appalachian trough.
[b] Second Geol. Surv. Pennsylvania, Rept. PP, Harrisburg, 1880.

large size of the form referred to *Pecopteris hemitelioides;* the form referred tentatively to *P. polymorpha*, but which seems hardly to differ unless in size from the Dunkard *Callipteridium grandifolium;* the form identified by Lesquereux from the Dunkard as *Neuropteris plicata;*[a] the dilated heteromorphous *N. Scheuchzeri;* and perhaps the type here doubtfully listed as *N. auriculata*, all seem to indicate a stage as high as the roof of the Pittsburg coal, while some of these peculiar phases are present above and are not yet known below the Waynesburg coal, i. e., in the Dunkard. *Pecopteris Newberriana*, which is possibly characteristic of the Dunkard, appears hardly distinguishable from the small phase of *P. fœminæformis*, figured by Zeiller,[b] from the Permo-Carboniferous of France. The normal form of the latter species is reported from the roof of the Pittsburg coal in the Appalachian trough. It is probable that the apparent absence of many of the Dunkard forms in the lower beds is due entirely to the lack of study of the plants in the strata between the roof of the Pittsburg coal, which forms the base of the Monongahela formation, and the Waynesburg coal, the top bed of that formation. The absence of lepidophytes from the material in hand constitutes negative, and, under the circumstances, scarcely important proof, since their failure to be present may be due to chance in preservation or collection.

The evidence presented by this small Onaga flora may, therefore, be construed, so far as it represents the plants of its horizon, as indicating a stage probably within the Monongahela formation of the Appalachian region, or possibly as high as the lowest part of the Dunkard formation, although, with the exception of *Pecopteris Newberriana*, the collection in hand does not contain any species characteristic of the Permian of the Old World, and does not signify a Permian age for the Onaga (Elmdale) beds.

MARION? (WELLINGTON IN PART?) FLORA OF DICKINSON COUNTY.

Sphenopteris sp. Sell.
Pecopteris sp. Sell.
Callipteris conferta Sternb.
Callipteris conferta var. obliqua (Goepp.) Weiss.
Callipteris conferta var. lanceolata Weiss.
Callipteris conferta var. vulgaris Weiss.
Callipteris n. sp.
Glenopteris splendens Sell.
Glenopteris simplex Sell.
Glenopteris lineata Sell.
Glenopteris Sterlingi Sell.
Glenopteris ? lobata Sell.
Odontopteris sp. Sell.
Neuropteris sp. Sell.
Tæniopteris coriacea Goepp.
Tæniopteris coriacea var. lineata Sell.
Tæniopteris Newberriana F. & I. C. W.
Sphenophyllum sp. Sell.

The above list includes only the material published or communicated to the National Museum by Mr. E. H. Sellards, by whom the collection of the State University survey is being elaborated. The

[a] Probably specifically different from the older form, which seems to agree with Sternberg's species and which was placed under the same name by Lesquereux.

[b] Fl. foss. bassin houill. et perm. de Brive, 1892, Pl. IV, fig. 5, 6.

specimens are described by him as coming either from the topmost beds of the Marion formation or possibly from the base of the Wellington formation, next above the Marion. The flora is regarded by Mr. Sellards[a] as of Lower Permian age. I have not had an opportunity to examine the remaining material at the State University, but if the composition of the entire flora proves to be of so young a character as the material described or placed in my hands by Mr. Sellards, his conclusion that the beds are of so late date as the Lower Permian will appear to be fully justified. I am not informed whether any of the gymnospermic species so important in, and so typically characteristic of, the Permian of Europe or Prince Edward Island are present in Kansas. However, such pteridophytic material as has come to me for examination is more nearly typical and characteristic of the Permian than any flora that I have yet seen from another formation in the United States.

If the plants preliminarily listed above are representative of the plant life of the Upper Marion or the Wellington formation, the flora of these beds is probably of a date fully as late as the earlier of the floras generally referred to the Permian in western Europe. In any event a flora containing these species can hardly be older than the topmost Carboniferous, or transitional from the Upper Carboniferous to the Permian.

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[a] Trans. Kans. Acad. Sci., Vol. XVII, 1900 (1901), p. 208.

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PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Bulletin No. 211.]

The serial publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of United States—folios and separate sheets thereof, (8) Geologic Atlas of United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

The Bulletins, Professional Papers, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, Methods of hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports. This bulletin is the sixty-second in Series C, the complete list of which follows (all are bulletins thus far):

SERIES C, SYSTEMATIC GEOLOGY AND PALEONTOLOGY.

3. Fossil faunas of Upper Devonian, along the meridian 76° 30′, from Tompkins County, New York, to Bradford County, Pennsylvania, by H. S. Williams. 1884. 36 pp.
4. Mesozoic fossils, by C. A. White. 1884. 36 pp., 9 pls.
10. Cambrian faunas of North America. Preliminary studies, by C. D. Walcott. 1884. 74 pp., 10 pls.
11. Quaternary and recent mollusca of the Great Basin, with descriptions of new forms, by R. Ellsworth Call. Introduced by a sketch of the Quaternary lakes of the Great Basin, by G. K. Gilbert. 1884. 66 pp., 6 pls.
15. Mesozoic and Cenozoic paleontology of California, by C. A. White. 1885. 33 pp.
16. Higher Devonian faunas of Ontario County, New York, by J. M. Clarke. 1885. 86 pp., 3 pls.
18. Marine Eocene, fresh-water Miocene, and other fossil mollusca of western North America, by C. A. White. 1885. 26 pp., 3 pls.
19. Notes on the stratigraphy of California, by G. F. Becker. 1885. 28 pp. (Exhausted.)
22. New Cretaceous fossils from California, by C. A. White. 1885. 25 pp., 5 pls.
24. List of marine mollusca, comprising the Quaternary fossils and Recent forms from American localities between Cape Hatteras and Cape Roque, including the Bermudas, by W. H. Dall. 1885. 336 pp.
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