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FOSSIL PLANTS FROM THE STANLEY SHALE AND JACKFORK SANDSTONE IN SOUTHEASTERN OKLAHOMA AND WESTERN ARKANSAS

BY

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FOSSIL PLANTS FROM THE STANLEY SHALE AND JACKFORK SANDSTONE IN SOUTHEASTERN OKLAHOMA AND WESTERN ARKANSAS

By DAVID WHITE [1]

ABSTRACT

Notwithstanding the ties between the plant species from the Stanley and Jackfork formations and the lower Pottsville floras of the Applachian trough, I was long disposed to regard these two formations as of very late Mississippian age, largely on account of their close paleobotanic relations to the Culm floras of the Waldenburg and Ostrau series, in the Silesian region, then classed as Lower Carboniferous. The detailed study, completed in 1932, of all the available plant material, including a collection by H. D. Miser of small fern fragments from the upper Stanley near Gillham, Ark., shows that the upper Stanley flora is distinctly later than the flora of the Wedington sandstone member of the Fayetteville shale or than any other known Mississippian flora in eastern North America. The flora is predominantly of lower Pottsville composition.

Meanwhile, the Ostrau-Waldenburg series was in 1927 transferred by the Heerlen Congress to the Upper Carboniferous. The Jackfork and Stanley are paleobotanically older than the coal-bearing shale member in the Morrow group, which is of middle Pottsville age, being post-Lee and post-Raleigh in the Pottsville group of the Appalachian trough. The conclusion that the Jackfork and Stanley may be largely if not wholly equivalent in time to the lower part of the Morrow group finds support in the few plant fragments common to the Hale sandstone.

INTRODUCTION

Since the study of the Stanley shale and the Jackfork sandstone with detailed mapping was begun, 35 years ago, relatively little paleontologic material has been brought to light to show the age of either of these formations. At first both formations were supposed to be Ordovician, fossil shells of that age being found in transported boulders deposited in a formation apparently overlying the Stanley and Jackfork. It is, however, now the belief of all the geologists and paleontologists who have examined the region that both formations are of Carboniferous age, and nearly all, if not all, are in agreement as to the assignment of both formations to the Pennsylvanian series.

Several small collections of very fragmentary and in many specimens very indistinct plant fragments have been gathered from these formations by different geologists since 1902. I gave most of those fragments a preliminary examination some years ago, and my tentative conclusion, quoted by Girty,[2] Ulrich,[3] and Miser,[4] was that the formations were either referable to the latest Mississippian or that they represented a stage in the Pennsylvanian older than any yet known paleobotanically in America. I suggested that the beds might have been laid down during the period of post-Mississippian emergence, which is not represented by plant-bearing deposits yet discovered on this continent. The object of this report is to place this unfortunately meager paleobotanic evidence on record, to attempt an interpretation of its significance as to age, and to encourage the search for additional and more ample floral representations.

THE FORMATIONS

The Stanley shale was described by Taff [5] in 1902, and the type locality, in the Tuskahoma quadrangle, was the village of Stanley, in Pushmataha County, Okla. The formation consists of dark fissile shale, blue black to black when fresh and bluish or greenish when weathered, interbedded with thin to massive, generally fine-grained and micaceous gray or bluish-gray sandstones which in places weather grayish green or drab. The lower part of the formation, which is siliceous and cherty, contains, near the base, beds of tuff said by Miser [6] to be three to five in number and to range from 6 to 85 feet in thickness.

The formation is reported to be 6,000 feet thick in the vicinity of Atoka, Okla., and in Pike County, Ark. Honess [7] reports a thickness of over 10,000 feet in McCurtain County, in southeastern Oklahoma. In both Arkansas and Oklahoma the Stanley rests unconformably either on the Arkansas novaculite (lower part

[1] From the manuscript of the present paper Dr. White abstracted and published in 1934 (Am. Assoc. Petroleum Geologists Bull., vol. 18, no. 8, pp. 1010-1017, August 1934) a paper entitled "Age of Jackfork and Stanley formations of Ouachita geosyncline, Arkansas and Oklahoma, as indicated by plants." The present paper was one of several manuscripts still in his hands at the time of his death, February 7, 1935. The modification of an editorial nature required to place this manuscript in form for publication has been done by some of his colleagues.

[2] Girty, G. H., The fauna of the Caney shale of Oklahoma: U. S. Geol. Survey Bull. 377, p. 8, 1909.

[3] Ulrich, E. O., Fossiliferous boulders in the Ouachita Caney shale and the age of the shale containing them: Oklahoma Geol. Survey Bull, 45, pp. 47-48, 1927.

[4] Miser, H. D., and Honess, C. W., Age relations of the Carboniferous rocks of the Ouachita Mountains of Oklahoma and Arkansas: Oklahoma Geol. Survey Bull. 44, pp. 14-16, 1927.

[5] Taff, J. A., U. S. Geol. Survey Geol. Atlas, Atoka folio (no. 79), 1902.

[6] Miser, H. D., Llanoria, the Paleozoic land area in Louisiana and eastern Texas: Am. Jour. Sci., 5th ser., vol. 2, p. 71, 1921.

[7] Honess, C. W., Geology of southern Le Flore and northwestern McCurtain Counties, Okla.: Oklahoma Bur. Geology Circ. 3, pp. 6-9, 1924.

Devonian, upper part Devonian?), with a very thin basal conglomerate containing novaculite pebbles, or on the Hot Springs sandstone,[8] a thin formation which in turn is unconformable upon the novaculite.

The Stanley shale is ripple-marked and current-bedded at many horizons and is regarded by Honess[9] and by Miser and Purdue[10] as a shoal-water delta deposit laid down by northward-flowing streams. Locally it carries considerable organic debris, mainly of vegetable origin, which evidently had been subjected to prolonged drifting, maceration, and even trituration. Much of the debris is not determinable generically. Good preservation even in very small fragments is rare, though in some localities final burial of the plant detritus was evidently rapid.

The Stanley shale is overlain transitionally and apparently conformably by the Jackfork sandstone.

The Jackfork sandstone, described by Taff,[11] with type locality in Jackfork Mountain, southeastern Pittsburg County, and the adjoining portions of Atoka and Pushmataha Counties, Okla., is a ridge-forming formation consisting of massive, compact fine-grained to coarse-grained dark-gray to light-gray sandstones, micaceous and gritty, especially near the base, including small amounts of shaly sandstone and green, black, or blue arenaceous or argillaceous shale. Many of the sandstones weather brown or drab. The published thicknesses assigned to the formation range from 5,000 to 6,600 feet.

The Jackfork sandstone is said to lie conformably upon the Stanley shale. It is in turn overlain, apparently conformably, by the Johns Valley shale, a deposit with thin intercalated sandstones, locally 1,500 feet thick, formerly designated in most geologic literature the "Caney shale." Locally the marine or true Caney itself rests on the Jackfork. The invertebrate fauna in the upper part of this Caney is classed as Morrow (Pennsylvanian), and that obtained from the lower part is generally correlated with the Moorefield, Batesville, and Fayetteville formations[12]—all of which led to the former view that the Jackfork and Stanley are of Mississippian age, and they were so mapped by Miser[13] and Branner.[14] A recent contention of the opponents of this view is that the shale yielding the Mississippian fossils owes its superposition on the Jackfork to thrust or landslides.

The Jackfork and Stanley formations themselves have yielded very meager marine invertebrate faunas, which have hitherto been viewed as consistent with the lower Caney fauna, though insufficient for definite age determination.[15]

The Johns Valley shale is remarkable for the presence of included exotic boulders, comprising fragments of fossiliferous limestone ranging from small cobbles to masses as great as 370 feet long and containing fossils of Ordovician, Silurian, and Mississippian age. These inclusions, many of which are rounded, subangular, or angular and gouged, scraped, or merely scratched and striated and which are distributed over a considerable area, are regarded as (1) ice-transported, (2) products of submarine rock slides, (3) subaerial escarpment talus, or (4) resulting from thrust-fault drag, according to the view of the geologist interrogated. Most of the regional geologists seem to favor either the second or the fourth hypothesis.

The general geology of the Ouachita Basin has been represented by H. D. Miser on the geologic map of Oklahoma, published by the United States Geological Survey in 1926, and by G. C. Branner on the geologic map of Arkansas, published by the Geological Survey of Arkansas in 1929. Summary descriptions of the geologic formations and of the geologic structure, together with synopses of the evidence and varying conclusions as to ages and rock sequences, have been compiled by Miser and Honess[16] and later by Miser.[17] Miser in his recent paper presents new age interpretations, based by George H. Girty and Bruce H. Harlton on invertebrate faunas, and also presents his revised conclusions as to the structual history. These new interpretations are in essential agreement with the conclusions I reached in the detailed study of the fossil plants completed in 1932. The reader is referred to the papers by Miser[17] and Harlton[18] for further non-paleobotanic information.

SOURCES OF THE PALEOBOTANIC MATERIAL STUDIED

The fossil plants from the Stanley shale and Jackfork sandstone consist mainly of fragments of sandstone bearing impressions of *Lepidodendron* or calamarian stems. These fragments, picked up casually from time to time by different geologists and paleontologists, are generally more or less defaced as the result of weathering, though many of the specimens were badly macerated and not specifically identifiable when they were buried.

A single collection consisting of carbonized plant remains in sandy micaceous shales was obtained by

[8] Purdue, A. H., and Miser, H. D., U. S. Geol. Survey Geol. Atlas, Hot Springs folio (no. 215), 1923.

[9] Honess, C. W., The Stanley shale of Oklahoma: Am. Jour. Sci., 5th ser., vol. 1, pp. 78–79, 1921.

[10] Miser, H. D., and Purdue, A. H., Geology of the De Queen and Caddo Gap quadrangles, Ark.: U. S. Geol. Survey Bull. 808, pp. 133–134, 1929.

[11] Taff, J. A., U. S. Geol. Survey Geol. Atlas, Atoka folio (no. 79), 1902.

[12] Girty, G. H., The fauna of the Caney shale of Oklahoma: U. S. Geol. Survey Bull. 377, 1909. Morgan, G. D., Geology of the Stonewall quadrangle, Okla.: Oklahoma Bur. Geology Bull. 2, p. 56, 1924.

[13] Miser, H. D., Geologic map of Oklahoma, U. S. Geol. Survey, 1926.

[14] Branner, G. C., Geologic map of Arkansas, Arkansas Geol. Survey, 1929.

[15] Miser, H. D., and Honess, C. W., Age relations of the Carboniferous rocks of the Ouachita Mountains of Oklahoma and Arkansas: Oklahoma Geol. Survey Bull. 44, pp. 5, 16, 17, 18, 1927.

[16] Miser, H. D., and Honess, C. W., op. cit., pp. 5–27.

[17] Miser, H. D., Carboniferous rocks of Ouachita Mountains: Am. Assoc. Petroleum Geologists Bull., vol. 18, no. 8, pp. 971–1009, August 1934.

[18] Harlton, B. H., Carboniferous stratigraphy of the Ouachitas—a special study of the Bendian: Am. Assoc. Petroleum Geologists Bull., vol. 18, no. 8, pp. 1018–1049, August 1934.

H. D. Miser from the Whitley cut along the Kansas City Southern Railway, 2½ miles by road south of Gillham, in western Arkansas. In these dark bluish-gray shales the plants are extremely fragmentary, as if triturated, and generally they are badly macerated. Final deposition appears to have been reasonably rapid, however, and most of the impressions are accompanied by thin carbonaceous residues. With the exception of two or three small fragments, this collection is the only one containing remains of ferns or fernlike plants. Most of the fern specimens are less than 1 centimeter in length. Frequently but a part of a lobe of a pinnule is represented on the piece of shale. The identification of the material is therefore a difficult matter, and the determinations are notably subject to revision whenever more complete and better material is found.

A list of the collections, with special reference to their geographic location, is given below. A few of the specimens were collected by Taff and Ulrich in 1902. It is not known whether some of the specimens casually gathered by different geologists and paleontologists were obtained from the upper, lower, or middle portions of the formations.

JACKFORK SANDSTONE

Devils Hollow, near Talihina, Okla., secs. 32 and 33, T. 4 N., R. 21 E., Tuskahoma quadrangle. Lower part of Jackfork as mapped by Taff. Collected by H. D. Miser in April 1927 (lots 8333 and 8340); by H. D. Miser and Charles Miller in June 1927 (lot 8336); by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (lots 8014, 8015, and 8016).

South side of sec. 6, T. 7 N., R. 25 W., Pike County, Ark., 7 miles north of Murfreesboro. Base of the Jackfork sandstone. Collected by Bryan Parks, of the Arkansas Geological Survey, in 1932 (lot 8328).

Parnell Hill, sec. 6, T. 7 S., R. 25 W., Pike County, Ark. Collected by J. P. Hansell, March 1, 1932 (lot 8329).

Stream sandstone boulder from Jackfork sandstone, grounds of Choctaw-Chickasaw Sanitarium, mouth of Devils Hollow, northwest corner of sec. 3, T. 3 N., R. 21 E., Tuskahoma quadrangle, Oklahoma. Collected by Dr. W. E. Van Cleve, superintendent of the sanitarium, in 1927 (lot 8332).

Three miles southeast of Stringtown, Atoka quadrangle, Oklahoma. Collected by H. D. Miser in June 1927 (lot 8334).

St. Louis-San Francisco Railway 5 miles north of Antlers, Antlers quadrangle, Oklahoma. Collected by H. D. Miser, May 9, 1927 (lot 8335).

Crest of mountain 1 mile north of Clayton, Tuskahoma quadrangle, Oklahoma. Collected by H. D. Miser in May 1927 (lot 8337).

Crest of Kiamichi Mountain on old road due south of Talihina, Tuskahoma quadrangle, Oklahoma. Collected by H. D. Miser in 1927 (Miser's lot 02).

Sandstone ridges between Johns Valley and Eubanks, Antlers quadrangle, Oklahoma. Collected by H. D. Miser in 1927 (Miser's lot 03).

JACKFORK SANDSTONE OR ATOKA FORMATION

Fossils in sandstone nearly 2,000 feet above the base of the Jackfork sandstone, southwest corner of sec. 16, T. 4 N., R. 24 E., Windingstair quadrangle, Oklahoma. Collected by J. A. Taff, August 18, 1899? (lot 8331).

SW¼ sec. 10, T. 4 N., R. 23 E., Windingstair quadrangle, Oklahoma. Collected by J. A. Taff, August 19, 1899 (lot 8339).

STANLEY SHALE

Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 2½ miles south of Gillham, De Queen quadrangle, Arkansas. Collected by H. D. Miser in 1914 and 1923 (lot 6874).

Upper part of Stanley shale, 4 miles east of Tuskahoma, Okla. Collected by David White in 1909 (lot 5669).

Bottom of 40-foot well at C. E. Moorland's house, 8 miles east of Atoka, Okla. Collected by David White in 1911 (lot 6240). [The direction should probably be northeast.—Ed.]

JACKFORK SANDSTONE OR STANLEY SHALE

NE¼NE¼ sec. 32, T. 2 N., R. 20 E., Tuskahoma quadrangle, Oklahoma, in creek bed. Lower part of heavy black-shale bed (Stanley?). Collected by E. O. Ulrich, J. A. Taff, C. D. Smith, and M. K. Shaler, August 10, 1904 (lot 3508).

PRESENT AND FORMER VIEWS ABOUT THE AGE OF THE FORMATIONS

The purpose of this paper is to present my conclusions as to the age of the Jackfork and Stanley formations based on the study of the plant material in hand in 1931,[19] when the study was nearly completed.

On the paleobotanic evidence, I refer not only the Jackfork to the Pennsylvanian, but also the upper half and, by implication, the non-plant-bearing lower half of the Stanley as well. Previously I had regarded the Stanley and possibly the Jackfork as uppermost Mississippian, for reasons mentioned beyond.

In 1904 E. O. Ulrich, then accompanying J. A. Taff in the study of the Tuskahoma quadrangle, Oklahoma, found in the upper part of the Stanley (or lower part of the Jackfork?) a few fragments of *Lepidodendron* which he recognized as Carboniferous, probably Pennsylvanian, and on his recommendation both the Jackfork and Stanley were immediately transferred from the Ordovician to the Carboniferous bracket of the geologic column. These specimens, with some additional material collected by me in the same region and east of Atoka, were then interpreted as probably very late Mississippian. In answer to subsequent persistent inquiry, and with more stem casts and seeds collected by H. D. Miser, I expressed the view that the beds might have been laid down in very late Mississippian time or during an early part of the period of post-Mississippian emergence, which is not represented by plant-bearing deposits yet recognized elsewhere on this continent. This opinion was based largely on the parallelism in floral composition and the presence of closely related or identical floral elements in the Jackfork and Stanley and in the very fully elaborated floras of the Waldenburg and Ostrau series

[19] Submission of my report (1931) embodying the descriptive paleobotanic data for publication by the United States Geological Survey awaited the completion of the plant illustrations.

(Culm) of the former Austro-Silesian region, which were then regarded as uppermost lower Carboniferous, though the floras of the Ouachita region had very much in common with those of the lower Pottsville in the Appalachian trough.

Meanwhile, Schuchert[20] put himself on record as in favor of the Pennsylvanian age of the deposits, largely on account of the presence, in a small collection, of *Lepidodendron* and *Calamites*. The same fossils, including a few invertebrates from the Stanley shale, were examined also by Ulrich,[21] who stated: "There is nothing in the collection that may be justly cited as definitely opposed to the correlation of the Stanley with the lower Pottsville or basal Morrow, which conclusion I reached in my 'Revision' (1911)[22] mainly on physical and diastrophic considerations."

It is due to the deep interest and continuing efforts of H. D. Miser toward the solution of the problem that considerable additional plant material, including small fragments of ferns, was discovered in the upper part of the Stanley shale near Gillham, Ark., as well as calamarian, lepidophytic, and seed casts in the Jackfork, most of which have been obtained from Devils Hollow, near Talihina, Okla. My opinion, based on a preliminary inspection of this material and still influenced largely by the supposed late Mississippian age of the Silesian Culm floras, was that the plants from the Stanley, in particular, might be

> of Chester age, but the paleobotanical data available are insufficient to justify their conclusive reference to the Mississippian. The examination suggests the possibility of the deposition of a great thickness of sandstone and shale derived from the north Texas land mass [Llanoria], on the south, during the period of post-Mississippian uplift and deformation and the earliest stages of Pennsylvanian subsidence.[23]

This view is in harmony with that previously expressed by Ulrich,[24] that the Stanley might represent the emergent phase of the Pennsylvanian-Mississippian diastrophic movement, a view that has recently been adopted by Van der Gracht.[25]

The subsequent detailed study of the Jackfork and Stanley fossils that are available in the Survey collections has strengthened—in fact, essentially confirmed—the tentative correlation of the Stanley shale with the upper Culm of Europe, while emphasizing the extremely close relation between the flora of the Jackfork and that of the oldest American Pennsylvanian.

[20] Schuchert, Charles, quoted by Honess, C. W., Geology of the southern Ouachita Mountains of Oklahoma: Oklahoma Geol. Survey Bull. 32, pp. 177-178, 1923.

[21] Ulrich, E. O., quoted by Honess, C. W., op. cit., p. 178.

[22] Ulrich, E. O., Revision of the Paleozoic systems: Geol. Soc. America Bull., vol. 22, pp. 477, 528, 1911.

[23] Miser, H. D., and Honess, C. W., Age relations of the Carboniferous rocks of the Ouachita Mountains of Oklahoma and Arkansas: Oklahoma Geol. Survey Bull. 44, p. 16, 1927.

[24] Ulrich, E. O., Fossiliferous boulders in the Ouachita "Caney shale" and the age of the shale containing them: Oklahoma Geol. Survey Bull. 45, pp. 23-24, 1927.

[25] Van der Gracht, W. A. J. M. van Waterschoot, The Permo-Carboniferous orogeny in the south-central United States: K. Akad. Wetensch. Amsterdam Verh., Afd. Natuurk., 2d sec., deel 27, no. 3, p. 10, Amsterdam, 1931; Am. Assoc. Petroleum Geologists Bull., vol. 15, no. 9, pp. 991-1057, September 1931.

EVIDENCE OF THE PALEOBOTANIC MATERIAL NOW AVAILABLE AS TO THE AGE OF THE STANLEY SHALE AND JACKFORK SANDSTONE

Before discussing the evidence in detail of the fossil plants as to the ages of the Stanley shale and the Jackfork sandstone, it is important to note that since I made the statement quoted in the second paragraph preceding this, as published by Miser and Honess in 1927, two important factors have entered into the problem of the correlation of these formations.

The first of these is the discovery and description of a flora[26] in the Wedington sandstone member, of Chester, probably upper Chester age, of the upper part of the Fayetteville shale in northwestern Arkansas, and the consequent recognition that the flora of the Stanley as well as that of the Jackfork is distinctly younger than the Wedington flora.

The second factor is the revision of the boundary line between the Upper Carboniferous and Lower Carboniferous in portions of western Europe by the Heerlen Congress in 1927 and the transfer from the Lower to the Upper Carboniferous of several well-known plant-bearing formations formerly classed as Culm.[27]

Because many geologists are not familiar with reports submitted to the Heerlen Congress and especially with the conclusions it adopted, a short digression, summarizing several points of importance to the discussion of the floras in hand, will be given before resuming the consideration of the effect on the time classification of the Jackfork sandstone and the Stanley shale of the transfer from the uppermost Lower Carboniferous to the basal Upper Carboniferous of the above-mentioned European plant beds. These European formations, with whose fossil floras the plant associations in the late Lower Carboniferous and oldest Upper Carboniferous of all countries, including our own, have generally been compared, include the Lanarkian of Scotland, the upper Culm of the basin of the lower Loire, the Moravian-Silesian roofing slates, the Ostrau series of upper Silesia, and the Waldenburg series of lower Silesia. The floras of the Ostrau and Waldenburg were described by Stur and are now so well known as to constitute base lines for use in comparison.

REVISION OF THE BOUNDARY BETWEEN LOWER CARBONIFEROUS AND UPPER CARBONIFEROUS IN EUROPE

The "Congress for the advancement of studies of the stratigraphy of the Carboniferous"[28] was held at Heerlen, Holland, June 7 to 11, 1927, under the aus-

[26] White, David, Fossil flora of the Wedington sandstone member of the Fayetteville shale: U. S. Geol. Survey Prof. Paper 186-B, 1937.

[27] It should be kept in mind by the reader of this paper that Dr. White accepted the thesis of the essential equivalence of the American Mississippian and Pennsylvanian, respectively, to the European Lower and Upper Carboniferous, as revised by the Heerlen Congress of 1927.—Editor.

[28] Congrès pour l'avancement des études de stratigraphie carbonifère, Heerlen, 7-11 juin, 1927, Compte rendu, pp. i-liii, 1-852, with plates, charts, and maps, Liége, 1928.

pices of the Minerals Section of the Geological and Mining Society of the Netherlands and Her Colonies. Invitations were extended to geological surveys of countries having Paleozoic coals and to geologists of those countries interested in the stratigraphy and paleontology of the Carboniferous. No geologist of the United States seems to have been present.

The object of the congress was to compare the stratigraphy of the Carboniferous in the different coal-field countries of Europe, with a review of the different methods of investigation and of the correlative criteria, and to establish the more exact identification and correlation of the different stages or members of the Carboniferous.

After the presentation and discussion of reports the congress voted unanimously to use the term "Dinantian" for the Lower Carboniferous and to reject the term "Culm", a term used in different senses, and to designate different stages in different countries. By unanimous action, also, the Dinantian was divided into Visean (=zone of *Glyphioceras*) and Tournaisian (=zone of *Pericyclus*), the upper limit of the Visean being drawn at the summit of the zone containing *Glyphioceras spirale* (*granosum*).

The decision of the congress was unanimous to distinguish three stages in the Upper Carboniferous, for the lowest of which the name "Namurian" was selected, for historical reasons. The name "Westphalian" was reserved for the middle stage, and the upper stage was called "Stephanian."

By unanimous action the Namurian as defined by the congress includes the Millstone grit and a part, at least, of the Carboniferous limestone series in England; the Bruille and Flines beds of France; the Chokier [29] and Andenne beds of Belgium; the beds containing the lower Gulpen flora, with *Eumorphoceras*, and the Epen beds, with *Reticuloceras* and a characteristic flora, in Holland; the lower part of the Barren series (Flözleeres) in Westphalia; the lower part of the Ostrau beds of upper Silesia; and the Waldenburg beds of lower Silesia. The upper limit of the Namurian coincides with the horizon of *Gastrioceras subcrenatum*, which in the Rhenish-Westphalian basin is the roof of the Sarnsbank bed.

The upper limit of the Devonian was drawn at the summit of the zone of *Gonioclymenia*.

The boundary between the Stephanian and Permian is determined principally on a paleobotanic basis, it being recognized that *Walchia* occurs in the upper Stephanian as well as in the Permian, but that *Callipteris* is typically Permian.

The limit between the Stephanian and Westphalian was, by unanimous agreement of the congress, drawn at a level corresponding to the Holz conglomerate of the Saar Basin.

[29] Similarly the Walhorn beds are to be associated with the Chokier in the upper Carboniferous, as also probably the Golonog sandstones of Silesia.

Defined primarily in terms of the distribution of the goniatites, the stratigraphic classification of the Carboniferous accepted by the Heerlen congress is as follows:

Permian		
Upper Carboniferous	Stephanian	
		—Holz conglomerate—
	Westphalian	C. Marine horizon of Petit Buisson-Aegir. B. Marine horizon of Katharina-Poissonnière. A.
		—Horizon of *Gastrioceras subcrenatum* (Sarnsbank)—
	Namurian	Zone of *Reticuloceras* (R. incl. mut. γ, Bisat). Zone of *Homoceras* (H, Bisat) Zone of *Eumorphoceras* (E, Bisat) } Schmidt, IV+IVε(Vα).
		—*Glyphioceras spirale* (*granosum*)—
Lower Carboniferous	Dinantian	Zone of *Glyphioceras*=Visean (Schmidt, IIIα, β, γ). Zone of *Pericyclus*=Tournaisian (Schmidt, II and I).
Devonian		Zone of *Gonioclymenia* at top.

As is immediately obvious, a principal result of the revisions adopted by the Heerlen congress is the lowering of the boundary between Lower Carboniferous and Upper Carboniferous in many regions of Europe and the concomitant transfer of certain formations and zones, mostly classed formerly as Culm, with their floral characteristics, from the Lower to the Upper Carboniferous.

As to the merits of all the consequent changes in the stratigraphic classification adopted by the congress, which included many of the foremost, most experienced, and best informed among the paleozoologists, paleobotanists, and stratigraphers actively engaged in the study of the European coal fields, I am unqualified to judge—all the more because the boundaries are defined largely in accordance with the evidence of the invertebrates. It is to be regretted, however, that the shift in formations brings into the Upper Carboniferous, as revised, several plant types, including especially the *Cardiopteris polymorpha* group and *Lepidodendron volkmannianum*, previously characteristic of the upper Lower Carboniferous of Europe and still unknown above the Chester in the Carboniferous basins of America.

In view of this apparent disparity, we may conclude that in Europe the upper boundary of the Lower Carboniferous is drawn lower than the upper boundary of the American Mississippian, unless the lower part of the Morrow group, which below the coal-bearing shale is paleobotanically almost unknown, contains plant remains representative of and in part, at least, synchronous with the floras of the Namurian of Europe. On the other hand, it is more than possible that the greater part of the Namurian terranes were deposited during a portion of the post-Mississippian diastrophic movement—either the latest phase of the Mississippian recession or the earliest Pennsylvanian poise and regression—not yet stratigraphically or paleobotanically recognized in this country. This explanation, which is in agreement with my views, finds support in the strongly marked contrast between the latest Mississippian and the earliest known Pottsville floras—a contrast that can be due only to a considerable hiatus in time or a notable change in the environment as well as in the plant life. The Parkwood of the Birmingham district of Alabama may be referable to this interval, as has been proposed by Ulrich.

The Pottsville is shown by its floras to be coterminous—very closely, at least—and mainly synchronous with the Westphalian, though the oldest recognized Pottsville, the lower part of the lower Pottsville, in southwestern Virginia and southwestern West Virginia, may extend below the base of the Westphalian as now defined.

PLANTS FROM THE STANLEY AND JACKFORK FORMATIONS

A list of the species recognized in the collections now in the United States Geological Survey and the United States National Museum and described in this report is given below. As some of the forms are very meagerly represented and the preservation of many is very unsatisfactory, the identifications are subject to revision whenever better specimens or material more amply representative of the species is brought to light. For the formational references of the scattered collections, the geologic source of which was not stated by the collectors or as to which there has been doubt, I am indebted to H. D. Miser, who is most familiar with the areal geology of the region and who has himself gathered most of the specimens.

This list, which is alphabetically arranged, includes floras of both formations. The occurrence of species in the Stanley shale is indicated by S and in the Jackfork sandstone by J. All information available as to the plant locality, date of collection, etc., is given on page 45.

Adiantites stanleyanus White. S
Adiantites sp. S
Alloiopteris arkansana White. S
Aphlebia parksii White. J
Aphlebia sp. S
Archaeocalamites coralloides White. S
Archaeocalamites stanleyensis White. S, J
Bothrodendron sp. J
Calymmatotheca sp. S
Calamites inopinatus White. J
Calamites menae White. S, J
Calamites miseri White. S, J
Fern rachides. S
Heterangium? sp. S, J
Lepidodendron subclypeatum White. S, J
Lepidodendron cf. L. wedingtonense White. J
Lepidostrobus peniculus White. S, J
Neuropteris antecedens Stur? J
Neuropteris elrodi Lesquereux. S
Rhabdocarpos (Lyganostoma?) costatulus White. J
Rhabdocarpos secalicus White. S
Rhodea goepperti (Ettingshausen) Stur. S
Rhodea cf. R. tenuis Gothan. S
Rhynchogonium choctavense White. J
Sigillaria (Rhytidolepis) sp. J.
Sphenophyllum arkansanum White. S
Sphenopteridium dawsoni (Stur). S
Sphenopteris sp. S
Sphenopteris cf. S. mississippiana White. S
Palmatopteris subgeniculata Stur? S
Stigmaria sp. S
Trigonocarpum gillhami White. S, J
Trigonocarpum vallisjohanni White. S, J
Wardia suspecta White. S

Of the 34 species in the list, 26 are from the Stanley, 16 are from the Jackfork, and 8 are common to both formations. All but one in the last category are confined to the calamarian, lepidophytic, and seed groups. Nearly all the filicoid forms are from the Stanley, the conditions of deposition of the sandstone of the Jackfork being less favorable both for their preservation and for their ultimate discovery. The presence of seeds, probably of pteridospermic origin, points to the presence of seed-bearing ferns in the Jackfork formation. Also, the fact that of the six seeds described three are common to both the Stanley and Jackfork gives reason to expect that the pteridosperms yet to be found will show as close a relation with the Stanley as is seen in the calamarian and lepidophytic groups. On the whole, basing a calculation on the very scanty data in hand, we may tentatively assume that about one-half of the plant species present in the Jackfork sandstone are also to be found in the Stanley shale. It remains to be seen later whether the plants in the Jackfork point to a stage distinctly younger than those of the Stanley.

Of the combined floras, 15 species are ferns or pteridosperms, 6 are included in or allied to the Calamariales, 7 are lepidophytes, and 6 are seeds of pteridosperms or gymnosperms. The flora, though small, is comprehensive and should collectively be sufficient to determine with reasonable certainty the age, as between Mississippian and Pennsylvanian, both of the Jackfork and of the Stanley.

RELATIONS OF THE STANLEY AND JACKFORK FORMATIONS TO THE MORROW GROUP OF ARKANSAS

In the entire southwestern region of the United States, which embraces the Western Interior basin, there are but two floras as yet described from the upper Mississippian or basal Pennsylvanian with which to make regional comparisons of the plants from the Jackfork and Stanley. One is a meager flora from the Wedington sandstone member of the Fayetteville shale, of Chester (late Mississippian) age, probably late medial Chester, in northwestern Arkansas;[30] the other is the well-known flora of the coal-bearing shale found in the middle or upper portion of the Morrow group, of Pennsylvanian age, in the same region.

The plants from the coal-bearing shale—precisely from the roof of the Washington County coal, which occurs in the shale and which has been exploited at a number of points in Washington County—were recorded at the time of preparation by Lesquereux of the volumes on the coal flora[31] as belonging below the †Millstone grit,[32] and therefore of "subconglomerate" age—that is, Mississippian.

The Hale sandstone and the Brentwood and Kessler limestone members of the Bloyd shale contain highly varied marine invertebrate faunas, in which Mississippian types mingle with others of Pennsylvanian age. My review of the plants from the coal-bearing shale in 1893 led to their reference to the Pottsville (Westphalian) group, and specifically to a stage in the upper part of the middle Pottsville or possibly at the base of the upper Pottsville. The consequent transfer of the coal-bearing shale with the overlying Kessler limestone and the associated upper Bloyd shales and sandstones to the Pennsylvanian was followed by the segregation of the Morrow by Adams and Ulrich,[33] at first as a formation and later by Purdue[34] as a group, of basal Pennsylvanian strata.

In northwestern Arkansas and northeastern Oklahoma the Morrow group rests unconformably upon the Pitkin limestone, sometimes known as the "*Archimedes* limestone" (maximum thickness 100 feet), which is the youngest formation of Mississippian age in the Western Interior basin. The Morrow group, itself 200 to 400 feet thick in the Fayetteville quadrangle, consists, in ascending order, of the Hale formation and the Bloyd shale. The Hale formation comprises mainly shale with some sandstone and thin limestones, in all ranging from 80 to 300 feet in thickness, in the Eureka Springs quadrangle. It carries a marine fauna and a few plants (p. 50). On it rests the Bloyd shale, which reaches a maximum thickness of 75 feet and which includes three members of unusual interest—at the base the Brentwood or †Pentremital limestone, which has a maximum thickness of 80 feet in the Fayetteville quadrangle; next, the coal-bearing shale, 10 to 20 feet thick; and above that the Kessler limestone, which has a maximum thickness of 70 feet in the Fayetteville quadrangle but averages only 2 to 4 feet in the quadrangles to the east. In some places the Kessler limestone forms the top of the Bloyd shale, but in others it is overlain by as much as 50 feet of shale and sandstones, which complete the Morrow group.

Resting with unconformity on the Morrow group lies the Winslow formation, comprising about 6,000 feet of sandstones and shales as developed in the Winslow quadrangle, south of the Fayetteville quadrangle. This formation begins with quartz conglomeratic material, on account of which, together with the mixture of Mississippian and Pennsylvanian invertebrates in the Kessler and lower stages of the Morrow group, it was formerly treated as the base of the †Upper Carboniferous (Pennsylvanian), the "subconglomerate beds", including the coal-bearing shale and other members of the Morrow group below, being then regarded as †Lower Carboniferous (Mississippian).

It is important to remember that the Winslow formation, overlying the Morrow group with slight evidence of unconformity, is laterally continuous with and for the most part, at least, equivalent to the Atoka formation, about 3,000 feet in thickness; also that the Atoka overlies the Wapanucka limestone (300 feet thick), which carries shells classed as of Morrow age.

Paleobotanically the Morrow group (Pennsylvanian), which rests unconformably on the Pitkin limestone, of Chester age, is known almost solely by the flora of the coal-bearing shale, a thin member in the lower part of the Bloyd shale and at about the middle of the group. Next to the shale at Mazon Creek, Ill., the coal-bearing shale of Washington County, Ark., is paleobotanically the most fully explored deposit in the Carboniferous of the United States. In Arkansas about 125 plant species have been found in it, and these clearly and unmistakably indicate correlation of the terrane with the shales above the Lookout sandstone in Alabama and Tennessee; the Norton formation, above the Lee,

[30] White, David, Fossil flora of the Wedington sandstone member of the Fayetteville shale: U. S. Geol. Survey Prof. Paper 186–B, 1937.

[31] Pennsylvania 2d Geol. Survey Repts. P and PP, 1879, 1884.

[32] A dagger (†) preceding a geologic name indicates that the name has been abandoned or rejected for use in classification in publications of the U. S. Geological Survey. Quotation marks, formerly used to indicate abandoned or rejected names, are now used only in the ordinary sense.

[33] Adams, G. I., and Ulrich, E. O., Zinc and lead deposits of northern Arkansas: U. S. Geol. Survey Prof. Paper 24, pp. 28–29, 1904.

[34] Purdue, A. H., U. S. Geol. Survey Geol. Atlas, Winslow folio (no. 154), p. 3, 1907.

in southwestern Virginia; the Sewell formation of central and southern West Virginia; and the lower part of the Upper Lykens group of coals in the southern anthracite region of Pennsylvania. All these are of middle Pottsville age, as also is the Caseyville sandstone of southern Illinois and western Kentucky. A study of the relations and distribution of the elements in the Jackfork and Stanley floras shows that the deposits are distinctly older than the plant life of the coal-bearing shale of the Morrow group, including but two species that have been definitely recognized as present also in the shale.

In view of the middle Pottsville age of the coal-bearing shale of the Morrow group, as shown by the fossil floras, it may be provisionally concluded that the lower portions of the group are more or less fully equivalent to the lower Pottsville of the Appalachian trough. Unfortunately, little is known either as to the flora of that portion of the Morrow group lying below the coal-bearing shale or as to marine faunas in the lower Pottsville of the eastern basins. A few stem casts and impressions of *Lepidodendron* found by Miser in the Hale sandstone, the basal unit of the Morrow group, point toward the complete inclusion of the Morrow in the Pennsylvanian, but these plant remains are not of a nature to permit a more precise reference of the Hale.

The Jackfork is referred to the early Pottsville, earlier than the coal-bearing shale of the Morrow group—specifically the lower Pottsville, which embraces the Lookout sandstone of Georgia and Tennessee, the Lee formation of Virginia, the Pocahontas, Fire Creek, and Raleigh coal groups of West Virginia, and the Lower Lykens coal group of the southern anthracite field in Pennsylvania. Probably the whole of the Stanley shale falls in the same unit of the lower Pennsylvanian.

The Jackfork sandstone has not yet revealed any plant association that can be regarded as Mississippian in age—not to mention a stage so low in the Mississippian as that to which the lower part of the Caney shale is generally referred.

The Atoka sandstone of Oklahoma, also derived from Llanoria, passes laterally into the Winslow formation of Arkansas and is evidently in large part equivalent to it. The Atoka lies on the Johns Valley shale locally and is described as resting on the Caney shale near Wesley and Ti, Okla.; on the Wapanucka limestone (of Morrow age) between Le Flore and Stringtown, Okla.; and even on beds as old as the Woodford chert near Bengal, Okla. The Winslow rests unconformably on the Morrow group and is nowhere seen on any formation of later date, whence it is believed that the Atoka, as well as its near equivalent the Winslow, is, for the most part, at least, of post-Morrow age.

Little paleobotanic material has been gathered from the Atoka, but the small amount examined belongs to a stage as high as the coal-bearing shale of the Morrow, or probably higher. There remains, therefore, no evidence of weight to prove that the Jackfork and Stanley formations are of Mississippian age, except the apparent superposition of Mississippian shale on the Jackfork. That this superposition, observed at only a few points, is normal rather than by thrust I profoundly doubt. Otherwise, there is a marine Chester fauna in beds correlated with the Moorefield shale, the Fayetteville shale, and the Batesville sandstone, overlying Llanoria-derived beds which I can view only as in their entirety Pennsylvanian and as probably not earlier than the earliest known Pottsville of the Appalachian trough. A very rude estimate of the volume of sediments composing the remaining portions of the Jackfork sandstone and the Stanley shale indicates more material than would suffice to construct a mountain range 12,000 feet high, with appurtenant spurs and foothills, reaching from Atoka, Okla., to Little Rock, Ark., a distance of about 200 miles. That such orogenic movement, synclinal deformation, and erosion took place within very late Chester time and constituted a distinct episode completed so shortly before the post-Mississippian uplift without being a part of that uplift is highly improbable.

It may be asked, however, whether we have to do with an adventitious or precocious flora or a hold-over fauna. There is nothing in the general make-up of the flora, in the characters developed, or in the association of the genera and species that appears abnormal or out of order. On the other hand, the few marine invertebrates reported from the lower Pottsville of the Appalachian trough offer little evidence for use in any attempt to correlate lower Morrow or other probably basal Pennsylvanian formations of any other region.

RELATIONS TO THE WEDINGTON AND OTHER CHESTER FLORAS

In general, the fossil land floras of the Mississippian of North America are very imperfectly known. A few species were described by Dawson [35] from the lower Carboniferous of the Canadian maritime provinces. A few have been described by Meek [36] and Lesquereux [37] from the Pocono (basal Mississippian) or from slightly younger stages in the Appalachian trough, and a number of forms have been described by Lesquereux [38] and

[35] Dawson, J. W., Report on the fossil plants of the Lower Carboniferous and Millstone grit formations of Canada, pp. 5-42, Canada Geol. Survey, 1873.

[36] Meek, F. B., Descriptions of new species of fossil plants from Alleghany County, Va.: Philos. Soc. Washington Bull., vol. 2, appendix 8, pp. 1-19, pls. 1-2, 1875.

[37] Lesquereux, Leo, Description of the coal flora of the Carboniferous formation in Pennsylvania: Pennsylvania 2d Geol. Survey Rept. P, vols. 1 and 2, 1880; vol. 3, 1884; atlas, 1879.

[38] Lesquereux, Leo, Paleontological report of the fossil flora of the Coal Measures of the western Kentucky coal field: Kentucky Geol. Survey 3d Rept., pp. 499-556, pls. 6-7, 1857.

Noe [39] from the Chester of Illinois, Indiana, and western Kentucky. Unpublished material from several stages of the Appalachian Mississippian, collected by D. B. Reger in West Virginia and by me in southwestern Virginia and eastern Pennsylvania, is partly described in manuscript.

The only land flora of known upper Mississippian age yet described from the trans-Mississippian portion of the United States is that found in the Wedington sandstone member near the top of the Fayetteville shale of northwestern Arkansas, recently described.[40] This flora, comprising 36 species, consists (*a*) of forms identical with or very closely allied to others characteristic of the upper Chester in other regions; (*b*) of unique forms; and (*c*) largely of plants related more or less closely to Pennsylvanian forms.

In the first category are species of *Rhacopteris*, two forms of *Cardiopteris*, an archaeocalamarian strobilus comparable to *Pothocites*, a *Lepidodendron* nearly inseparable from *L. volkmannianum*, a *Lepidocystis* characteristic of the upper Chester in the Appalachian trough and found also in the Lower Carboniferous limestone at Rothwaltersdorf, Silesia, and a species of *Rhynchogonium*, most closely bound to forms in the uppermost Lower Carboniferous of Scotland and in the Lower Carboniferous of northern Russia and Spitsbergen.

Some of the ferns or fernlike types, such as the *Rhodea*, are identical with or closely related to species described from what was formerly known as the "Culm" of central Europe. The Lepidodendrons not mentioned above are new species, some of which, like the *Lepidostrobus* and *Lepidophyllum*, are Mississippian in general features and nearest relations. The ambiguous group *Lepidodendron veltheimianum*, of both the Culm and the lower Westphalian, is also present. The Archaeocalamariae consist of forms having a large percentage of alternating ribs. Some of the species agree with forms that have usually been included in the Culm species *Archaeocalamites scrobiculatus*, though they are obviously younger than the typical phase of that species, coming from distinctly Lower Carboniferous beds both in Europe and in America.

Some of the forms mentioned above as characteristic of the Chester are present and known only from beds of that age in the Appalachian trough, as well as in Illinois, southern Indiana, and western Kentucky, where the typical *Lepidodendron volkmannianum* also is present. It should be added, however, that *Cardiopteris*, formerly regarded as exclusively Mississippian, is rarely present in Culm beds recently included by European paleobotanists in the Namurian (basal Upper Carboniferous).

[39] Noe, A. C., The flora of the western Kentucky coal field, in Weller, Stuart, Geology of the Princeton quadrangle: Kentucky Geol. Survey, ser. 6, vol. 10, pp. 127–148, text figs. 1–24, 1923.

[40] White, David, Fossil flora of the Wedington sandstone member of the Fayetteville shale: U. S. Geol. Survey Prof. Paper 186–B, 1937.

On the basis of the characteristic Mississippian types already noted, the Wedington flora would readily be referred to the Chester, and probably to the upper Chester, by most if not all paleobotanists. It has no form common also to the Pocono. It is a middle if not an upper Chester flora and is characterized by forms identical with or closely related to the upper Chester floras of the Eastern Interior basin and the northern Appalachian trough.

None of the plants noted as characteristic of the Mississippian are present in the floras of the Jackfork and Stanley formations. No representatives of the genera *Cardiopteris*, *Rhacopteris*, and *Chlamidostachys* (cf. *Pothocites*) are present. No forms of the group represented by *Lepidodendron volkmannianum* and *Lepidocystis chesterianus* have been found. *Rhynchogonium* is represented by a different and considerably larger species, but the genus is present also in the upper Pottsville. The calamarian stems show as frequent or even more frequent alternation of ribs at the joints and are more clearly affiliated with the Pennsylvanian forms than are those of the Wedington, though some of them might be placed in *Archaeocalamites scrobiculatus*, which is by some authors very comprehensively grouped in a collective species to include forms present in the Namurian (Culm) and the lower Westphalian.

A single lepidophyte, *Lepidodendron* cf. *L. wedingtonense*, in the Jackfork is provisionally placed under the name of a Wedington species, but the identification is too uncertain for the attachment of appreciable stratigraphic weight. *Sphenopteris mississippiana*, an early representative of the *Sphenopteris hoeninghausii* group, and *Rhodea goepperti* are common both to the Wedington and to the Jackfork and Stanley floras. *Sphenopteris mississippiana* is perhaps indistinguishable from *Sphenopteris hoeninghausii*, forma typica, of the Namurian (Culm), of which *Rhodea goepperti* appears to be characteristic.

There appears to be no other species yet found in the flora of the Jackfork or the Stanley which is found also in the Wedington flora.

The comparison of the Jackfork and Stanley floras with the flora of the Wedington sandstone member of the Fayetteville shale shows (1) the absence from the Jackfork and Stanley of all clearly Mississippian types present in the Wedington and of all forms yet recognized as characteristic of the Chester in other parts of America, (2) the presence in either the Stanley or the Jackfork of but two or possibly three forms found also in the Wedington, and (3) nothing whatever indicative of an earlier age than that of the Wedington, which is middle Chester if not upper Chester.

The examination and comparisons leave no recourse but to conclude that both the Stanley shale and the Jackfork sandstone are younger than the Wedington sandstone member. The difference is relatively distinct, though the floral representations in hand are unfortunately small. There appears, therefore, to remain little or no doubt that the Stanley as well as the Jackfork is younger than the entire Fayetteville shale and its Mississippian correlatives.

SYSTEMATIC DESCRIPTIONS

Genus ARCHAEOCALAMITES Stur, 1875 [41]

The stems, all with moderately thick woody cylinders, which are referred with some doubt to the genus *Archaeocalamites*, are only with difficulty distinguished from the genus *Calamites*, for many of the ribs of the pith cast are found to alternate at the very compact node. On the other hand, however, the nodes in the carbonized material, such as that shown in *Archaeocalamites stanleyensis*, are hardly apparent except where the carbonaceous residue of the woody cylinder has been removed.

No foliage or fructification of the types recognized as distinguishing *Archaeocalamites*, or *Asterocalamites*, as it is sometimes known, is present in the collection. A solitary stem of the *Sphenophyllum* type is with reasonable certainty correlated with the leaf verticils from the same locality that belong rather clearly to the genus *Sphenophyllum*, though they do not differ widely from certain forms, such as *Sphenophyllum tenerrimum*, referred by Old World paleobotanists as foliage of *Archaeocalamites*.

The thickening of the node from which branches are given off, as in figure 9, plate 13, also seems to aline the species *A. stanleyensis* with the genus *Archaeocalamites* rather than with *Calamites*. On the other hand, the stems from the same locality which I have described as *Calamites miseri* and *Calamites menae*, while distinguished by their broader ribs, well-developed leaf traces, shorter internodes, and thinner wood, show frequent continuity of ribs across the nodes, which in *C. menae*, a ramose type, are constricted, much as in *Archaeocalamites scrobiculatus*.

The stem fragments which I describe as *Calamites menae* are rather definitely related to the species *Calamites miseri*, from the same locality. Both of these might be referred to *Archaeocalamites*, and both are possibly identical with forms referred by authors to that genus. I have separated them therefrom on account of the broader, more frequently alternating ribs, the thinner wood, and the sometimes large, prominent leaf scars at the upper ends of the pith costae.

Archaeocalamites coralloides White, n. sp.

Plate 14, figure 23

Stems rather slender, rigid, segmented in internodes in length measuring about twice the diameter; pith nodes very slightly constricted and very narrow, marked by rather narrow transverse constrictions; costae of pith cast very numerous, 60, more or less, in number, in the internode, rounded, rigid, mostly continuous at the node, with small oval nerve traces.

This species, though represented by a single pith cast, appears to be readily distinguished from other calamarian stems of similar size by the large number of small, rather closely placed, dorsally rounded costae, which number about 60 in the entire circumference. No other stem known to me in the Mississippian or Pennsylvanian of the Southwest is so evenly and narrowly costate. No satisfactory data are at hand relating to the probable thickness of the outer woody and cortical tissues. However, from some of the analogies, including the rather large number of continuous ribs and the narrow vertical depressions between the ribs at the nodes, it seems probable that the stem originally possessed a rather thick outer cylinder and that the characters of the plant were those of *Archaeocalamites* rather than *Calamites*. Through its narrow, fine costae *Archaeocalamites coralloides* is possibly most closely related to the stems tentatively described as *Archaeocalamites gracilentus* from the Wedington sandstone.

Locality: Parnell Hill, sec. 6, T. 7 S., R. 25 W., Pike County, Ark.; collected by J. P. Hansell, March 1, 1932 (U. S. Geological Survey lot 8329).

Figured specimen: U. S. Nat. Mus. 39440.

Archaeocalamites stanleyensis White, n. sp.

Plate 13, figures 7–11

Stems of moderate size, rigid in aspect, with very finely and irregularly striated outer cylinder, which is thick, leaving a dense carbonaceous residue when preserved; pith casts in moderate relief with closely placed, relatively narrow, round-terete, rather coarsely striate costae, the greater number of which alternate or are set somewhat obliquely at the very compact and slightly depressed, very narrow node; nodes apparently rather distant, slightly enlarged or broadly dilated, apparently by development of the woody cylinder, at the branched nodes, which are infrequent; branches 2 or 4 to the node, with relatively large points of insertion on the pith casts and much thickened outer tissues, which taper rapidly upward from the very thick base; fructification and leaves unknown.

The common calamarian type of the Stanley shale from the railway cut near Gillham, Ark., is shown in figure 10, plate 13. When the outer cylinder is preserved as coaly matter or limonitic incrustation, the ribs are with difficulty discernible externally, though occasionally they are obscurely expressed through the very irregular striate cortex, as shown in the figure. Close examination with the lens indicates probable segmentation of the specimen into three internodes, but the ribs are for the most part so nearly continuous

[41] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 1, p. 9, 1875.

that it is difficult to detect the nodes. Scaling of the cortical and woody residue reveals a portion of the node in which most of the ribs are more or less obliquely placed where not distinctly alternating, the node being very close-knit and hardly constricted. In the uncompressed specimens, such as those illustrated in figures 7 and 11, plate 13, there is but slight evidence of constriction of the nodes, two of which are shown in figure 7. The internodes are relatively slightly longer in the pith cast photographically illustrated in figure 11.

In the broadest stem, 3½ centimeters as flattened, found in the collection obtained near Mena, no costation is visible through the impression, to which very little carbonaceous matter now adheres. A slight constriction of the node in the pith is shown in figure 8, plate 13, which is the reverse of figure 10.

An interesting feature of the stem of this species is seen in the marked dilation of the cylinder and cortical tissues at those nodes at which branches are given off, as illustrated in figure 9, plate 13. Two branches originate in this verticil, which forms a part of the only ramose fragment of this species recognized in the collection. Its reference to this genus and species rests upon the thick carbonaceous residue as much as upon other characters.

To the genus *Archaeocalamites* and even to *A. stanleyensis* I refer a number of stems from the coarser Stanley shale or the sandstones of the Jackfork sandstone, in which the costation of the pith is very indistinct or is wholly masked by the external tissues, as in the species above described. At the same time, however, the evidence of regular pith costation is so obscure that doubt remains even as to the generic identification.

Archaeocalamites stanleyensis is distinguished by its relatively narrow, closely placed, rounded and irregularly striate costae, most of which alternate or are set obliquely with sharp ends at the close-knit nodes, which are narrowly lineate, with very slight depression, and which are rather distant from one another, though generally they are hardly visible beneath the outer thick irregular striate woody and cortical tissues, so that frequently the nodes are very difficult to detect beneath the residues of the outer cylinder. It is distinguished from *Archaeocalamites wedingtonensis*, from the Wedington sandstone, by its narrower, more compact costae, which alternate in greater numbers at the node, and by the thickness of the outer tissues, which are so dense as frequently to conceal entirely the nodes of the pith cast. The plant in hand differs from that to be described from the same deposit as *Calamites miseri* by the relatively thin outer cylinder and the relatively short nodes at which the very broad and flatly rounded, distinctly striate costae are marked by large oval-round leaf traces. On the other hand, in *Calamites menae*, later discussed, the nodes are relatively short and may have two or more branches at each node, the nodes being more constricted than in *A. stanleyensis*, their impressions in the pith cast being narrowly and slightly indented, as in some of the forms referred by authors to *Archaeocalamites*. The relatively short costae and the leaf scars are apparent in all the observed specimens of *C. menae*.

Localities: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, DeQueen quadrangle, Ark.; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874). Bottom of 40-foot well at C. E. Moorland's house, 8 miles east of Atoka, Okla.; collected by David White, 1911 (U. S. Geological Survey lot 6240). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014).

Figured specimens: U. S. Nat. Mus. 39435–39439.

Genus CALAMITES (Walch) Schlotheim, 1820 [42]

Calamites inopinatus White, n. sp.

Plate 12, figures 1, 13–15

Stems very short, articulate, apparently of varying diameter and branching irregularly or in irregular series; nodes 3 to 10 millimeters or more in length, close-knit, the ribs being close-set, continuous for the most part, rounded, and practically contiguous; internodes very irregular in length; branch scars not very numerous and not more than two to any node; several intervening nodes may have no branch scars.

Calamites inopinatus is possibly a multiramose or fertile portion of a form described as *Calamites miseri* on account of its relatively wide ribs and short nodes. Intermediate stages between *C. miseri* and the stem in hand, shown in figures 1, 13, and 15, plate 12, are wanting. Figure 15 shows both the irregularity in the length of the internodes and the continuity of most of the ribs, which are truncated by a sharp transverse shallow depression, hardly wider than a knife. Nowhere is it definitely observed that two branch scars originate in the same node. In the fragment shown in figures 1 and 13 a branch scar appearing at the lower left is apparently the only branch scar in this fragment of stem. The ribs and the nodes are well shown in this portion of the pith cast, and the general aspect of the stem impression in the species is indicated in the none too well preserved fragment shown in figures 1 and 13.

Although it is similar in certain respects to some of the stems from the older Pennsylvanian described as *Calamites approximatiformis* and *Archaeocalamites radiatus*, I know of no associated or earlier plant in which the internodes are so short and in which irregularity of diameter of the stem as well as of mode of branching is so obvious as in the stems here illustrated.

Localities: Lower part of Jackfork sandstone, SE¼ sec. 33, T. 4 N., R. 21 E., Tuskahoma quadrangle, Oklahoma; collected

[42] Von Schlotheim, E. F., Die Petrefactenkunde, p. 398, 1820.

by H. D. Miser, April 30, 1927 (U. S. Geological Survey lot 8340). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014).

Figured specimens: U. S. Nat. Mus. 39426–39428.

Calamites menae White, n. sp.

Plate 14, figures 16, 17, 21

Stems rather slender, articulated in relatively short internodes, which are shorter or about one and one-half times longer than wide, with thin outer cylinder, hardly contracted at the nodes, which on the pith cast are marked by narrow, shallow transverse creases, at the upper margins of which are placed the branch scars, usually two in number; pith cast distinctly costate, the ribs being rather closely placed and finely and regularly striate-rounded or slightly angular, obtuse at the ends in the nodes, where most of them alternate more or less distinctly; leaf scars rather small, oval or oblong at the end of the costae or more or less distinctly leading into the angles between the costae.

The salient features of this species are the relatively short internodes, which are of about equal length, being rather less or sometimes one-half more in length than the breadth of the stem. The aspect of the pith impression, as seen in figures 16 and 17, plate 14, is strongly suggestive of *Archaeocalamites*, and the form might be referred to that species, notwithstanding its branch scars and the frequently continuous or nearly continuous costae, on account of the sharp transverse indentation of the node. The leaf scars at the upper ends of the very bluntly terminating ribs are shown more distinctly on some fragments.

Calamites menae, though having points of resemblance to *Calamites miseri*, such as the relative length of node, is apparently separable from *C. miseri* by its narrower ribs, which are closer and very much more close-knit at the nodes, the nodes being transversely creased, somewhat as in some of the forms of *Archaeocalamites*. In fact, the specimens of *C. menae* have a greater resemblance to that genus than those of *C. miseri*. On the other hand, while *C. menae* resembles specifically *Archaeocalamites stanleyensis* in the aspect of the pith nodes and of the ribs, it is distinguished by the narrower costae, which interdigitate or alternate with acute points, with but faint leaf impressions originating from the intercostal sinuses at the nodes, the ribs themselves being relatively narrower. Though both species appear to bear two branch scars on the branching nodes, which are consecutive in some stems of *C. menae*, the latter lacks the great thickening of the outer cylinder and, in particular, the dilation of the woody matter at the base of the branches, which are seen in *A. stanleyensis*. Therefore, in spite of the apparent similarity in number of branches at the ramose nodes, I have little hesitation in describing them as differing not only specifically but generically, with, however, the recognition that other authors may regard them as congeneric.

Localities: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874). St. Louis-San Francisco Railroad 5 miles north of Antlers, Antlers quadrangle, Oklahoma; collected by H. D. Miser, May 9, 1927 (U. S. Geological Survey lot 8335).

Figured specimens: U. S. Nat. Mus. 39433, 39434.

Calamites miseri White, n. sp.

Plate 14, figures 13, 22, 24–26

Stems usually gently curved, of moderate or rather small size, with rather thin outer woody tissue, and articulated in relatively compact nodes which are hardly constricted; ribs of pith cast short, very broad, low-rounded, rather regularly and distinctly lineate longitudinally, alternating or set more or less obliquely, with broad obtuse angles, at the nodes, and with large oval-round and prominent leaf scars usually present and occasional faint root scars at the bases of the costae.

The aspect of the common fragments of this species is shown in the several figures. The intercostal furrows are rounded, distinct, and relatively narrow, and the costae themselves are finer and irregularly rugose-striate externally, the inner impression being coarsely and rather distantly lineate, about 10 lines to the costa, and intermediately finely striate. The leaf scars are obvious on nearly all these specimens, including those shown in figures 13 and 22, plate 14, which represent relatively large though slightly compressed trunks or stems in which the carbonaceous residue is seen to form but a thin film. In several of the specimens the internodes are relatively longer than in the illustrated fragments. The young stem or branch shown in figure 24, of which the reverse or impression is shown in figure 22, evidently belongs to the same species, as is shown by the characters of the nodes, ribs, and leaf scars. Distinct alternation of the nodes is seen in the photographic enlargement of a part of the impression in figure 25.

Though presenting very close-knit and hardly constricted nodes, across which many of the pith ribs appear continuous, the species here described belongs with little doubt to the genus *Calamites* and is associated with a group of species of that genus occurring in beds of lower Pottsville age. By its very wide ribs and not very distant nodes *Calamites miseri* suggests some of the stems commonly identified as *Calamites cannaeformis*, which is sometimes dilated at the nodes. As compared with that species the stems in hand are distinguished by the relatively shorter nodes, across which a larger proportion of the ribs are continuous or nearly so, and by the relatively great width of the costae.

In some respects the fragments of *Calamites miseri* are strongly comparable to the small stems with distinct details shown by Stur [43] and by Kidston and Jongmans [44] as *Calamites haueri* Stur. The form with longer, rigid, and well-rounded ribs approaches closely that illustrated by Kidston and Jongmans [45] as *Calamites schutzeiformis* var. *typicus*.

Localities: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork sandstone as mapped by Taff; collected by H. D. Miser. C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014). Sandstone nearly 2,000 feet above the base of Jackfork sandstone, southwest corner sec. 16, T. 4 N., R. 24 E., Windingstair quadrangle, Oklahoma; collected by J. A. Taff, August 18, 1899(?) (U. S. Geological Survey lot 8331). St. Louis-San Francisco Railroad 5 miles north of Antlers, Antlers quadrangle, Oklahoma; collected by H. D. Miser, May 9, 1927 (U. S. Geological Survey lot 8335). SW¼ sec. 10, T. 4 N., R. 25 E., Windingstair quadrangle, Oklahoma; collected by J. A. Taff, August 19, 1899 (U. S. Geological Survey lot 8339).

Figured specimens: U. S. Nat. Mus. 39429–39432.

Genus SPHENOPHYLLUM Koenig, 1825 [46]

Sphenophyllum arkansanum White, n. sp.

Plate 14, figures 10, 12, 14, 15, 19, 20

Stems curved more or less, rather closely articulate and rather distinctly round-tricostate, the ribs distinctly parallel lineate; nodes 1 to 2 centimeters distant, moderately dilated; leaf verticils joined in a relatively broad collar at the base which is normal to the axis; leaves very open or flaring to nearly a right angle to the axis, six in number, relatively broad, and dorsally rounded at the base, forking at a wide angle about 1 millimeter from the axis, the divisions probably forking again; primary nerves two, one for each of the principal lobes, distinct to the base or very nearly so, forking to give one division for each subordinate lobe, in which it is dorsally depressed.

Although the leaf verticils of this delicate as well as interesting species of *Sphenophyllum* are apparently slightly abraded, the preserved characters readily distinguish it not only in the collection but from other related species. Figure 14, plate 14, photographically illustrates one of the larger stem fragments showing the tricostate stems, the dilation of the nodes, and the rather distinct lineation of the costae. A fragment of the leaf verticil adheres to the lowest node. A more slender fragment with shorter internodes is seen in figure 15, where again shreds of leaves still adhere to some of the nodes. In a single instance only is branching observed. The collections include very slender branches which, but for the costation of the stems and the dilation at the nodes, might readily be mistaken for *Asterophyllites*, so rigid are the remaining vestiges of leaves.

A leaf verticil which appears slightly shriveled at the periphery is shown in figures 19 and 20. In two of the leaves the twin primary nerves are separated very nearly if not quite to the narrow funicular collar that takes part in the formation of the diaphragm of the stem. The primary nerve diverges gently toward the point of bifurcation of the leaf, beyond which each division apparently gives off subordinate nervilles to supply tapering nerves to the ultimate divisions. In this specimen these divisions seem to be reduced or shriveled as if fertile. It is probable that the normal leaf verticil was as much as 1.15 or 1.5 centimeters in diameter, the lobes of the leaf being relatively rigid.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39441–39444.

Genus BOTHRODENDRON Lindley and Hutton, 1933 [47]

Bothrodendron sp.

Plate 13, figures 4, 6

The specimen shown in figure 6, plate 13, is one of two fragments from the Jackfork sandstone that are apparently referable to the genus *Bothrodendron.* At first glance the fragment of axis suggests *Lepidodendron* or *Stigmaria.* Closer examination shows that the emergent rhombic cushions are marked slightly above the middle by roundish or oval leaf traces, which are shown in figure 4. Though the details are indistinct, it is seen that the nerve traces are sigillarioid or bothrodendroid, the lateral parichnoian traces being relatively long and convergent downward. The leaf scar is rather deeply notched at the apex. The superadjacent depression rather plainly seen marks the ligular pit.

The fragment in hand presents points of striking similarity to one from the lower Culm of the lower Loire of France figured by Bureau [48] as *Stigmaria ficoides* Brongniart var. *elliptica* Goeppert.

Locality: Three miles southeast of Stringtown, Atoka quadrangle, Oklahoma; collected by H. D. Miser, June 3, 1927 (U. S. Geological Survey lot 8334).

Figured specimen: U. S. Nat. Mus. 39450.

Genus LEPIDODENDRON Sternberg, 1820 [49]

Lepidodendron subclypeatum White, n. sp.

Plate 12, figures 16, 17; plate 13, figure 5

Leaf cushions large, squarrose to elongate diamond-shaped, ordinarily prominently protuberant, with

[43] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 2, pl. 5, fig. 4, 1877.

[44] Kidston, Robert, and Jongmans, W. J., A monograph of the *Calamites* of western Europe, Atlas, p. 7, pl. 144, figs. 2-3, 1915.

[45] Idem, pl. 68. fig. 1.

[46] Koenig, C., Icones fossilium sectiles, p. 42, 1825.

[47] Lindley, John, and Hutton, William, The fossil flora of Great Britain, vol. 2, pls. 80, 81 (description); pl. 117, p. 97, 1933.

[48] Bureau, Édouard, Bassin de la basse Loire, fasc. 2, atlas, pl. 3, fig. 5, 1913. (In the series "Études des gîtes minéraux de la France.")

[49] Sternberg, Kaspar, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, Heft 1, p. 23, 1820.

narrow rounded keel marked by several transverse frets in the lower part and carinate and deltoid-pitted above the leaf scar, the keels becoming sinuous at the upper and lower extremities; leaf scar distinctly large, generally strongly protruded from some distance above the middle of the bolster, often concealed in part in the flattened impressions by being crushed downward against the flanks of the fields next below them. As compared with the size of the bolster the leaf cushion is large and broad, the proximal borders nearly alined laterally and rounded downward to a rather broad, shallow, medial cusp, the distal lateral borders being turned down somewhat at the lateral angles and a little strongly convex at a slight distance above the angles and less convex or even slightly concave near the upper angle, which is shallowly notched or faintly truncated; nerve trace distinct, generally papillose, located between one-third and one-half of the altitude of the leaf scar and flanked by two rather closely spaced parichnoian traces, which are slightly lower than the leaf trace; lingular pit distinct in deltoid depression above the upper sinus of the leaf scar, parichnoian lobes usually rather indistinct and a little more distant than the parichnoian traces on the leaf trace, oblong-oval or slightly arched laterad.

The species here described is the most common representative of *Lepidodendron* in the Jackfork sandstone. Owing to the highly protuberant leaf scars and the conditions of compression of the cortex, the species presents three most prevalent conditions of preservation. The first and most common is that shown in figure 17, plate 12, in which the bolsters are apparently compressed nearly at right angles to the axis, so that they present a nearly squarrose or slightly rhombic outline in which the upper left is slightly concave, the upper right appearing less so. In this form the lower end of the bolsters is obliquely truncated and the upper end is concealed by overlap. This form provides, however, the most favorable exhibition of the characteristics of the very large leaf scar itself, which at first glance suggests the leaf scar of *Lepidodendron rhodeanum*. In this phase of impression the angles of the leaf scar coincide with the lateral angles of the bolsters to form an extremely broadly ovate pattern which at once suggests a similar phase of *Lepidodendron obovatum* Sternberg. The lower margins of the leaf scar are seen to be either nearly in alinement or rather strongly concave to conform to the rounded cuspate proximal angle of the scar. The distal lateral borders are rather strongly convex upward near the lateral angles, flattening gradually or even becoming slightly concave before reaching the distal angle, which is notched to conform to the ligular pit.

The nerve trace near the center of the vertical diameter of the leaf scar reveals rather distinctly the elongated parichnoian tracts on the bolster. In a few specimens the stage of maceration has preserved remnants of the transpiration envelopes leading from the parichnoian traces of the leaf scar downward through the bolster, where they seem to be united in a large sheath which probably surrounds the nerve trace also.

The stage of preservation and even the bolsters and the leaf scars shown in figure 17, plate 12, are very similar to the common and typical phase described by Lesquereux from the upper Pottsville of Pennsylvania as *Lepidodendron clypeatum*, which was referred by Zeiller, rather questionably as it seems to me, to *Lepidodendron obovatum*. Surely, however, a close relationship exists between *Lepidodendron subclypeatum*, *L. clypeatum*, and *L. obovatum*.

A phase of preservation, or rather of compression, in which the very large bolsters of this species are compressed so as to reveal the upper fields of the leaf cushion, is shown in figure 5, plate 13. Here the true position of the leaf scar in the upper part of the bolster is approximately indicated, though compressive folding results in the partial concealment of the upper portion of the leaf scar itself. Where uncovered, the leaf scar is found to have the same large pyramidal form, with similar orientation of traces, seen in the more squarrosely impressed bolsters shown in figure 17, plate 12. The specimen shown in figure 5, plate 13, in strikingly similar to the corresponding form of *Lepidodendron clypeatum* illustrated by Lesquereux. Fragments of the *Bergeria* stage of preservation in which the tissues immediately beneath the outer horny bark of the bolster are preserved are seen in figures 16 and 17, plate 12, and figure 5, plate 13.

A third phase of compression of the bolster in which the lower portion of the field is more fully preserved than in the specimen shown in figure 17, plate 12, and in which the upper fields are not seen is presented in figure 16 of the same plate. In this example the general aspect of the bolster, the form of the leaf scar, uncovered at the lower left, and the fretted keel suggest both *Lepidodendron aculeatum* and *Lepidodendron obovatum*. The leaf scar, however, is broader than in *L. aculeatum*, and the ropy margins of the bolsters so characteristic of *L. aculeatum* are hardly developed. On the other hand, the leaf scar is much more convex along the upper lateral borders and in general narrower than in *L. obovatum* or in *L. clypeatum*, which is suggested by the profile offered by the impressions of the lower fields and bolsters.

The lateral parichnoian appendages, photographically shown in figure 17, plate 12, are somewhat conspicuously seen in several of the bolsters in figure 5, plate 13, and are much less distinctly indicated in figure 16, plate 12. Forms closely similar to those shown in figure 17, plate 12, and figure 5, plate 13, in particular are illustrated by Stur and others under the name *Lepidodendron veltheimianum,* which, even as restricted by Zeiller, appears to represent a too comprehensive species. The specimen shown in figure 16, plate 12, represents with little doubt one of the types generally referred to *L. veltheimianum.* The parichnoian lobes, however, are easily distinguished on careful examination.

Very close to the species in hand and possibly to be considered as inseparable from it are some of the forms referred by authors to Sternberg's *Lepidodendron obovatum,* especially as that species was redefined by Zeiller.[50] Unfortunately both the use of the name and the recognition of the characters of the Old World plant are greatly—perhaps hopelessly—confused by Sternberg's wrong citation of figures. The real diagnostic features of the species have never been consistently kept clear.

The stem impressions from the Jackfork are perhaps inseparable from the form from the Brookwood coal at Searles, Ala., referred by me to *Lepidodendron obovatum.* They seem, however, to differ from Sternberg's type, and by their somewhat narrower leaf cushions, slightly smaller leaf scars, and the slightly higher positions of the traces on the leaf scar they are distinguished from the true *Lepidodendron clypeatum* of Lesquereux.

Localities: Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser and Charles Miller, June 1927 (U. S. Geological Survey lot 8336), and by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lots 8014 and 8016). Crest of mountain 1 mile north of Clayton, Tuskahoma quadrangle, Oklahoma; collected by H. D. Miser, May 1927 (U. S. Geological Survey lot 8337). Stream sandstone boulder from Jackfork sandstone, grounds of Choctaw-Chickasaw Sanitarium, mouth of Devils Hollow, northwest corner sec. 3, T. 3 N., R. 21 E., Tuskahoma quadrangle, Oklahoma; collected by Dr. W. E. Van Cleve, superintendent of sanitarium, 1927(?) (U. S. Geological Survey lot 8332). Upper part of Stanley shale 4 miles east of Tuskahoma, Okla.; collected by David White, 1909 (U. S. Geological Survey lot 5669). Miser's no. 01, possibly from Caney shale, Johns Valley, Antlers quadrangle, Oklahoma; Miser's no. 03, sandstone ridges between Johns Valley and Eubanks, Antlers quadrangle, Oklahoma; and Miser's no. 02, crest of Kiamichi Mountain on old road due south of Talihina, Tuskahoma quadrangle, Oklahoma.

Figured specimens: U. S. Nat. Mus. 39445–39447.

Lepidodendron cf. L. wedingtonense White

Among the fragments from the Jackfork sandstone is a single specimen which invites comparison with *Lepidodendron wedingtonense,* from the Wedington sandstone member of the Fayetteville shale. The bolsters are rather distinctly diamond-shaped and flat across the lower fields, with extremely prominent and very broad leaf scars borne a little way above the middle. The leaf cushions are flatly carinate, and the keels curve upward and downward tangent to the adjacent bolsters. The leaf scars, one of which is uncovered, have much the form of the scar of *Lepidodendron volkmannianum,* in which the lateral lower borders are slightly concave and prolonged to acute declining points that impart an obovate outline to the impression. The distal angle is low, and the distal lateral margins are nearly straight or slightly convexed. The position of the leaf trace is nearly midway in the height of the leaf scar, and the parichnoian traces are very small and close on each side.

The reference of this specimen to *Lepidodendron wedingtonense* is tentative and by way of comparison. It is based chiefly on superficial resemblance due possibly to the compression of the very highly protuberant cushions. The leaf scars of the Chester form appear to be relatively narrower and much higher in altitude, while the cicatricules are considerably below the middle of the scar. Unfortunately the preservation of the specimen leaves room for doubt as to whether the leaf cushions are corrugated as in *L. wedingtonense.* Should additional material reveal transverse corrugation over the whole width of the bolster, the relation to the Wedington species will be regarded as very much closer.

Locality: Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014).

Genus LEPIDOSTROBUS Brongniart, 1828 [51]

Lepidostrobus peniculus White, n. sp.

Plate 13, figures 1–3

Strobili of moderate length, oblong or linear, about 24 millimeters in diameter, with relatively large axis about 4 millimeters in diameter, marked in very broad and distinct rhombic pattern; sporangiophores close, nearly at a right angle to the axis, 6 to 8 millimeters long, rather narrow, downward-curved or strongly reflexed near the elbow, from which the bract, not over 2 millimeters wide and about 12 to 17 millimeters in length, turns rather sharply upward and slightly inward, while tapering to the slender, relatively delicate apex; sporangium rather narrow, compactly placed between the sporangiophores; character of spores unknown.

A few fragments only represent this species. Two of these, partial counterparts, are shown in figures 1, 2, and 3, plate 13. Figure 1 shows distinctly the inner cast of the axis and the compactly placed sporangia. The details of the cone, though imperfect at best, are, however, better seen in figure 2, a portion of which is enlarged in figure 3. The photograph shows well the origin of the sporangiophores, the ventral creases in

[50] Zeiller, René, Bassin houiller de Valenciennes—Description de la flore fossile, p. 442, 1888. (In the series "Études des gîtes minéraux de la France.")

[51] Brongniart, Adolphe, Prodrome d'une histoire des végétaux fossiles, p. 87, 1828.

them, and the downward turn at the base of the very narrow, relatively delicate, tapering bract, which is traversed by a very thin central nerve.

The species here rather insufficiently described belongs to the comprehensive group referred by various authors to *Lepidostrobus variabilis* Lindley and Hutton. It is clearly distinguished from the British types by its very narrow, relatively fragile, and comparatively long bracts. From *Lepidostrobus occidentalis* the cone in hand is rather readily separated by the well-developed and very broad rhombic cushions on the rather stout axis, by the more closely placed sporangiophores, and by the much longer and more tapering bracts.

Localities: Lower part of Jackfork sandstone, south side sec. 6, T. 7 N., R. 25 W., Pike County, Ark., 7 miles north of Murfreesboro; collected by Bryan Parks, of the Arkansas Geological Survey, 1932 (U. S. Geological Survey lot 8340). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014).

Figured specimens: U. S. Nat. Mus. 39448, 39449.

Genus SIGILLARIA Brongniart, 1822 [52]

Sigillaria (Rhytidolepis) sp.

Among the specimens collected by H. D. Miser from the Jackfork sandstone about 5 miles north of Antlers, Okla., is a portion of a slightly water-worn impression which, though hardly permitting the clear discernment of the leaf scars, apparently represents a slightly decorticated impression of a *Sigillaria* of the *Rhytidolepis* group, in which the leaf-bearing medial zones, about 6 millimeters in width, are unfortunately considerably deformed incidentally with the partial plication and horizontal compression of the ribs.

Oval leaf scars are apparently present at intervals of about 18 millimeters along the vertical rib. The leaf scars, if such they are, are about 5 millimeters in length and nearly 4 millimeters in width, and the nerve traces are located considerably above the middle of the leaf scar, in which the lateral traces are elongated vertically.

I know of no ribbed sigillarioid of the upper Mississippian of the Midcontinent region with which to compare this all too obscure specimen. It may be noted, however, that in the fragment in hand the spiral disposition of the leaves, though at a low angle with the horizontal, is not so nearly horizontal as the leaf scars on the lepidophytic stems from the lower Mississippian. Accordingly, while the specimen has little paleontologic or stratigraphic interest, its characters, so far as they are discernible, point toward Pennsylvanian affinities.

Locality: St. Louis-San Francisco Railroad 5 miles north of Antlers, Antlers quadrangle, Oklahoma; collected by H. D. Miser, May 9, 1927 (U. S. Geological Survey lot 8335).

Genus STIGMARIA Brongniart, 1822 [53]

Stigmaria sp.

Plate 14, figure 18

The genus *Stigmaria* is represented in the Stanley shale by several detached root scars only. These are comparatively small, and some are provided with an areole of short radiating ridges. It is impossible to identify them specifically with confidence, but the small diameter of the root scar and the mere fact that it is bordered by a stellate areole point to the Mississippian stock, centering about *Lepidodendron volkmannianum*, and to a stratigraphic level in the Chester or in the Namurian, the lowest recognized Upper Carboniferous of Europe.

One root fragment with cicatrix is with little hesitation identified as the umbilical scar of *Stigmaria.* Apparently it is separated from the root along the border of the narrowly convex rim of the umbilical scar. A larger fragment, probably of the same nature, shows a dense ragged rim of carbonaceous matter surrounding the inner fracture margin of the vascular strand.

With the stigmarian cicatrices are associated fragments of the inner hard texta of the seeds which in another place are described as *Rhynchogonium choctavense.*

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimen: U. S. Nat. Mus. 39451.

Genus ADIANTITES Schimper, emended, 1869 [54]

Adiantites stanleyanus White, n. sp.

Plate 10, figures 26, 28

Pinnae delicate, fragile, with slender divisions of rachis, which is ventrally sulcate, dorsally terete, and very narrowly alate; pinnules alternate, rather distant, thin, slightly pedicellate, oblique to open, narrowly cuneate, obovate to ovate above the cuneate base, asymmetric, narrowing upward to a rounded or inequilateral obtuse apex or sublobate in the lower part, the lobes obliquely rounded or round-truncate; nervation thin, radiate, nearly parallel, and equidistant; primary nerve passing through the upper half of the larger pinnules, lateral nervilles given off low in the pinnule, at a narrow angle, and passing nearly straight, while forking once or twice, to the margin.

Forms characteristic of the pinnules of this species are shown in figures 26 and 28, plate 10. The plant is obviously closely related to that figured by Stur [55] as *Adiantites oblongifolius* Goeppert. In fact, the relationship appears so close that I was at first disposed

[52] Brongniart, Adolphe, Sur la classification des végétaux fossiles: Mus. histoire nat. Paris Mém., tome 8, p. 222, 1822.

[53] Idem, p. 228.

[54] Schimper, W. P., Traité de paléontologie végétale; tome 1, p. 424, 1869.

[55] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 2, pl. 17, figs. 2-5, 1877.

to refer the fragments from the Stanley shale to the same species. However, close inspection shows that in the American plant the large pinnule is in general more pointed and more narrowly cuneate, the smaller pinnules being distinctly cuneate, notwithstanding their narrowed and obliquely rounded apices. Though the American material is obviously nearer in its characters to that figured from the Austrian Culm by Stur, it differs conspicuously from the more obovate pinnules with rounded apices originally described by Goeppert.[56] Between those pinnules and *Adiantites stanleyanus* the specific distinction is obvious.

The plant in hand is in many respects very close to an unpublished species found in the lower Pottsville (Pocahontas formation) of West Virginia.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimen: U. S. Nat. Mus. 39373.

Adiantites sp.

Plate 11, figures 14, 16, 19

Ultimate divisions of rachis rigid, narrowly alate, ventrally sulcate, with trifoliate pinnules standing higher ventrad than the rachis, narrowly decurrent, broadly rounded or even cyclopterid to obovate, narrowing downward, often trifoliately, ventrally low-rounded, rugose, nervose, sometimes slightly erose; nervation rather flabellate at the base, forking one to three times while passing upward, equidistant, and curving slightly toward the border.

As indicated by the fragments shown in the figures, the plant in hand rather certainly represents a species of *Adiantites* in which the pinnules are short and compact, the lobes broadly united, and the somewhat flabellate nervation nearly straight and equidistant in all parts of the lamina. But for the details of the ultimate rachis and the lamina, including the lobation and nervation of the lamina, the plant in hand might be compared with some of the small forms from the Pottsville included under the generic name *Cheilanthites*.

The example photographed in figures 16 and 19, plate 11, represents one of the short, broadly rounded, and rather distinctly trifoliate forms. That shown in figure 14, not without doubt referred to this group, seems to represent one of the larger trilobate pinnules in the upper part of the frond.

Although I know of no species to which the form in hand is especially closely related, the material seems insufficient to serve as a basis for a new species. The form is quite distinct from the more elongated cuneate types. It is more compactly trifoliate than any form in the Wedington, and not only is the lobation different, but the nervation is nearly twice as close as in *Adiantites stanleyanus*.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39374, 39375.

Genus ALLOIOPTERIS Potonié, 1897 [57]

Alloiopteris arkansana White, n. sp.

Plate 10, figures 3, 10, 11, 13, 20, 21, 23, 27; plate 11, figures 9, 10, 22, 23

Frond rather delicate, upper ultimate pinnae linear, tapering to a narrow point, with rather broadly connate, contiguous pinnules; pinnae of superior order, linear, flexuose or slightly zigzag, with rather narrowly connate pinnules which are contiguous or slightly overlapping, with dorsally sharply round axial nerve, the nerves of the pinnules coming out at an oblique angle, dorsally in relief, and zigzagging strongly at a very open angle to furnish a relatively strong nerville for each of the narrowly angular acute lobes, of which there are usually two and sometimes three in the lower subdivision of the largest pinnules; lamina depressed over the nerves, decurrent on each side of the pinnule at the base of the pinnule, narrowly decurrent along the ultimate rachis, slightly convex ventrad, and marked both over and on each side of the axis and nerves by sparse punctations which, because they appear as depressions in the larger divisions, are possibly to be interpreted as small glands.

The upper ultimate pinnae of this plant, portions of which are shown in figures 21, 23, and 27, plate 10, are by their form, the axial characters, the highly angular, semizigzag character of the median nerve, and the distinct nervation rather clearly referable to the genus *Alloiopteris*. When, however, the pinnules are more fully developed, as in figures 10, 11, and 13, plate 10, the denticulation is distinct, and the pinnules and pinnae are suggestive of *Alloiopteris essingii*. The largest of the pinnules observed are those shown in figures 9 and 10, plate 11. These, like the preceding, are rather closely similar in their form and nervation to the plants described by Stur [58] as *Oligocarpia quercifolia* (Goeppert) and by Gothan [59] as *Alloiopteris quercifolia* (Goeppert). The pinnules are hardly so distinctly asymmetric, however, as in the upper Silesian plant.

As shown in the photographic enlargement, figure 10, plate 11, the apices of the pinnules appear to carry small nearly round sporangia of the *Reinschia* type.

[56] Goeppert, H. R., Systema filicum fossilium: Acad. Caesarea Leopoldino-Carolina Nova Acta, vol. 17, Suppl., p. 227, pl. 21, figs. 4, 5, 1836.

[57] Potonié, Henry, Lehrbuch der Pflanzenpalaeontologie, p. 138, 1897.

[58] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 2, p. 209, pl. 15, figs. 7-12, 1877.

[59] Gothan, Walter, Die oberschlesische Steinkohlenflora, Teil 1, Farne und farnähnliche Gewächse: K. preuss. geol. Landesanstalt Abh., neue Folge, Heft 75, p. 107, pl. 21, fig. 1, 1913.

The details of the fructification are, however, rather obscure.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39378–39383.

Genus APHLEBIA Presl, 1838 [60]

Aphlebia parksii White, n. sp.

Plate 10, figures 17, 22

Small form, strongly excentric in outline, triangular ovate, primarily divided into three lobes, the main or median lobe much longer than the two lateral, which are broader than long, the largest lobe shallowly cut into two or three outward-curved, very short, broad, obtusely rounded or rounded-truncate lobes, those of the middle division slightly sublobate; lamina thick, rugose, finely striate parallel to the nervation, which is derived from thick primary nerves entering the base of each division and forking immediately at a narrow angle into rather distant and rather thick secondary nerves, which fork once to three times in passing outward into the lobes.

The specimen photographed and illustrated in figures 17 and 22, plate 10, is the only example of this form in hand. Its characters are so clear, however, as to justify its description in the hope that it may lead to the discovery of other specimens showing its variations and its relations to the ordinary pinnae of the species to which it was attached. On the evidence of the rather distinct coarse nervation and the broad, entire or but slightly denticulate lobes, it appears probable that *Aphlebia parksii* belongs to a species of *Neuropteris* or possibly a *Sphenopteridium*. As seen in figure 17, the lobes of the lower right-hand division are marked by short, sharp teeth, while the corresponding lobe on the opposite division is entire. Two oblong and deep cavities lying along the primary nerves near the base of the central division very strongly suggest vacant sporangia.

Locality: Base of the Jackfork sandstone, south side of sec. 6, T. 7 N., R. 25 W., Pike County, Ark., 7 miles north of Murfreesboro; collected by Bryan Parks, of the Arkansas Geological Survey, 1932 (U. S. Geological Survey lot 8328).

Figured specimen: U. S. Nat. Mus. 39393.

Aphlebia sp.

Plate 10, figures 29, 30; plate 11, figure 15

Several specimens in the collection represent a small compact plumose type of *Aphlebia* which is rather easily distinguished by the somewhat radiate arrangement of the lobes, their lanceolate form, and the coarse, upward-turned, distant, and dorsally terete nerves, which point into the upper divisions of the frond.

[60] Presl, Karl, in Sternberg, Kaspar, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, p. 112, 1838.

The upper surface of a fragment is seen in figure 29, plate 10. Figure 15, plate 11, shows a specimen from the same locality in which the subdivisions are more linear, narrower, and more nearly erect.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39394, 39376.

Genus HETERANGIUM Corda, 1845 [61]

Heterangium? sp.

Plate 11, figures 21, 28; plate 14, figure 11

Among the fragments of stem and root found in the Jackfork sandstone are several which, like that shown in figure 11, plate 14, are marked by short transverse hacklelike indentations filled with carbonaceous matter suggesting the sclerotic disks of *Heterangium*. However, the evident vascular system and, especially, the relatively narrow vascular axis so evident in many of the Pennsylvanian stems showing *Heterangium* structure are here lacking. Doubt therefore remains as to the generic identification.

The specimen figured is strikingly comparable to the petiolar impression from the upper Culm illustrated by Bureau [62] as *Dactylotheca aspera* Zeiller.

Localities: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014).

Figured specimens: U. S. Nat. Mus. 39404, 39405.

Genus NEUROPTERIS (Brongniart) Sternberg, 1825 [63]

Neuropteris antecedens Stur?

Plate 11, figure 6

The very small fragment shown in figure 6, plate 11, though insufficient for satisfactory specific identification, is so far in agreement with the fragments figured by Stur [64] that it is tentatively referred to his species, although the apex of the terminal is broader and indicative of a probably shorter terminal than appears to be characteristic for Stur's species, which was found in the Moravian-Silesian roof slates. The apparent differences in the form of the terminal pinnule are on the side of *Neuropteris pocahontas*, with which the specimen is possibly in equally close agreement.

[61] Corda, A. J., Beiträge zur Flora der Vorwelt, pp. 22–23, 1845.

[62] Bureau, Édouard, Bassin de la basse Loire, fasc. 2, atlas, pl. 28, fig. 2, 1913. (In the series "Études des gîtes minéraux de la France.")

[63] Brongniart, Adolphe, Mus. histoire nat. Paris Mém., tome 8, p. 233, 1822. Sternberg, Kaspar, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, Tentamen, p. xvii, 1825.

[64] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 1, p. 53, pl. 15, 1875.

With reference to the specimen figured by Stur in plate 15 of his Culm-Flora, I feel constrained to express the conviction that the forms illustrated in figures 5 and 6 are specifically different from those shown in figures 1 to 4, being in some respects, as to their pinnules rather than their pinnae, more nearly related, perhaps, to the form described by Stur as *Neuropteris dluhoschii* and illustrated by him in figure 9, plate 11, of the second part of his Culm-Flora.

The extremely close approach, evident even in this very small fragment, to a species characteristic of the lower Pottsville is significant.

Locality: Base of the Jackfork sandstone on top of the Stanley shale, south side of sec. 6, T. 7 N., R. 25 W., Pike County, Ark., 7 miles north of Murfreesboro; collected by Bryan Parks, of the Arkansas Geological Survey, 1932 (U. S. Geological Survey lot 8328).

Figured specimen: U. S. Nat. Mus. 39408.

Neuropteris elrodi Lesquereux

Plate 10, figures 18, 19; plate 11, figure 8

Pinnules lanceolate-triangular, somewhat falcate, tapering from the base to the obtusely pointed apex, ventrally convex on both sides of the midrib, slightly inflated at the cordate base, with rather strong median nerve deeply depressed on the ventral side, in relief dorsad, persisting very nearly to the extreme apex of the pinnule; lamina minutely rugose; nervilles strong, originating at a very acute angle and forking once or twice, rarely a third time, while arching rapidly and rather closely spaced to the border, which most of the nervilles meet at a right angle.

Though a single pinnule, illustrated in figures 18 and 19, plate 10, is the sole representative of this species in the collection in hand, its agreement with the form from beds of middle Pottsville age described by Lesquereux [65] as *Neuropteris elrodi* is so nearly complete as to justify the expectation that additional specimens, when they are found, will confirm the present tentative identification. *Neuropteris elrodi* is unusually clearly characterized by the narrowly triangular, more or less distinctly arcuate pinnules, cordate at the base, conspicuously round-convex ventrad on each side of the depressed midrib, and bluntly pointed at the apex; the rather irregular nerves, though originating very obliquely, arch outward while forking once or twice, so that through the greater part of the distal half of the lamina on each side of the midrib they pass nearly at a right angle to the border.

The typical form of *Neuropteris elrodi* is rare in the Pottsville of the Appalachian trough, but as variations of subspecies it has a rather wide geographic as well as stratigraphic range, the latest phase, perhaps deserving a distinct specific name, being found in the uppermost Pottsville of northern Pennsylvania. In the middle Pottsville of the Tennessee coal field there is a form with straight, narrowly triangular but much larger pinnules, which was later described by Lesquereux [66] under the same name. This form, specimens of which have been distributed in Europe, differs from the true *Neuropteris elrodi* by the straight pinnules and by the more broadly attached, oval or ovate and slightly flabellate-nerved ultimate lateral pinnules. It is specifically distinct from that originally described under this name by Lesquereux, to which the plant from the Stanley shale is tentatively referred.

The Tennessee plant has been referred, not without reason, by Zeiller [67] and Potonié [68] among other European paleobotanists, to *Neuropteris schlehani* Stur [69] in connection with their reference to that species also of the fragment figured by Stur [70] as *Neuropteris dluhoschii*. Some of the pinnules in the fragment of a pinna shown in Stur's figure under *N. dluhoschii* are seen to be slightly upturned near the apex. Their close approach to the true *Neuropteris elrodi* is unquestionable. On the other hand, the fragments illustrated by Stur in the same plate as *N. schlehani*, while distinctly alethopteroid, have pinnules most of which are even slightly pedicellate and which, though traversed very nearly to the apex by the ventrally depressed and persistent median nerves, are not so evidently narrowed at the apex as the specimen named *N. dluhoschii* or the American material first described as *N. elrodi*. In short, *Neuropteris elrodi* may be identical with *N. dluhoschii* of Stur, but it is assuredly distinct specifically from some of the plants referred by European authors to *N. schlehani*, if not from the type specimens described by Stur as *N. schlehani*.

It is, furthermore, reasonably evident that, while Stur's *Neuropteris dluhoschii* is very closely related to *Neuropteris elrodi* and is possibly quite as closely connected with the fragments illustrated and described by Stur as *Neuropteris schlehani*, it is even further from the plant from the Warrior coal field of Alabama originally described by Lesquereux [71] as *Neuropteris smithii* than is the original *N. schlehani*, under which *N. smithii* also is generally cited—quite erroneously, I believe—in synonymy by Zeiller,[72] Gothan,[73] and other European paleobotanists. As now extended *N. schlehani* is made to include a variety of forms, some of which are large, some small, and some that have oblong or oval ter-

[65] Lesquereux, Leo, Description of the coal flora of the Carboniferous formation in Pennsylvania: Pennsylvania 2d Geol. Survey Rept. P, vol. 1, pp. 107–108, pl. 13, fig. 4, 1880.

[66] Lesquereux, Leo, op. cit., vol. 3, pp. 735–736, 1884.

[67] Zeiller, René, Bassin houiller de Valenciennes—Description de la flore fossile, pp. 280–283, pl. 46, fig. 3; pl. 47, figs. 1–2, 1888. (In the series "Études des gîtes minéraux de la France.")

[68] Potonié, Henry, Die floristische Gleiderung des deutschen Carbon und Perm: K. preuss. Landesanstalt Abh., neue Folge, Heft 21, p. 30, fig. 22, 1876.

[69] Stur, Dionysius, Die Culm-Flora; K. k. geol. Reichsanstalt Abh., Band 8, Heft 2, p. 175, pl. 11, figs. 7 and 8, 1877.

[70] Idem, p. 184, pl. 11, fig. 9.

[71] Lesquereux, Leo, op. cit., vol. 1, pp. 106–107, pl. 13, figs. 1–3, 1880.

[72] Zeiller, René, op. cit., pp. 280–283, 1888.

[73] Gothan, Walter, Die oberschlesische Steinkohlenflora, Teil 1: K. preuss. Landesanstalt Abh., neue Folge, Heft 75, p. 202, pl. 49, figs. 2–3; pl. 53, fig. 3, 1913.

minals and ovoid, nearly flat lateral pinnules, with slightly flexuose nerves springing either in part from the rachis, as in the smaller lateral pinnules, or from a midrib that fades considerably before reaching the apex of the leaf. Some have distant, some close nervation. None of the illustrated European forms seem to agree with the original *N. smithii* as described by Lesquereux from the shales accompanying the Jefferson coal in Alabama or as found in the roof of the Beckley coal in southern West Virginia. A review both of the species appearing in different regions and at different horizons in the Pottsville of the Appalachian trough and of the species of the Old World literature on the paleobotany of the early Upper Carboniferous suggests a necessity for the restudy of the European forms generally referred to *Neuropteris schlehani* as well as the forms from the Appalachian Pottsville still grouped under *N. smithii*. Such a study should lead to the differentiation of several species which will not only present distinctive specific characters but will also prove of immediate practical stratigraphic value.

While I admit the possibility that a sequence of specimens from a single place and bed may show complete intergradation between the forms illustrated by Stur as *Neuropteris schlehani* and *N. dluhoschii*, the differences being relatively slight, it cannot be doubted that several forms referred at one time or another by Lesquereux to *Neuropteris smithii*, as well as the true type of that species, cannot properly be joined specifically with *N. schlehani*.

In passing it may be remarked that the plants illustrated by Zeiller arrange themselves with *Neuropteris schlehani*, some phases approaching a form intermediate between *Neuropteris pocahontas* and the original *Neuropteris smithii*. As illustrated by Potonié, one of whose figures is reproduced by Gothan,[74] *Neuropteris dluhoschii* is included with a form having obtusely rounded pinnules and fairly persistent midrib. The plant from Königshütte, upper Silesia, illustrated by Gothan [75] under the same name, seems to approach *Neuropteris smithii* but is easily distinguished therefrom by the more elongated and apiculate lateral pinnules, the pointed terminals, the more distinct and persistent midribs, and the more alethopteroid nervation. The pinnule from Zabrze, illustrated by Gothan,[76] may profitably be compared with the pinnule from the Stanley shale.

In view of the fact that specimens showing the form of the pinna, the relative positions of the pinnules, and the development of the subordinate lateral pinnules of the ultimate pinna seem not yet to have been brought to light, the characters of the plant shown in figures 5 and 6, plate 15, of the first part of Stur's Culm-Flora, where it is erroneously referred, as I view it, to *Neuropteris antecedens*, deserve reexamination. The form from the Moravian-Silesian roof slates is more distinctly heterophyllous, with notably distant pinnules. It is further illustrated, with enlargement of nervation, by Gothan.[77] The elongated or typical *schlehani* form is illustrated by Bureau [78] from the upper Culm of the basin of the lower Loire.

It should be noted that both the Waldenburg beds in which *Neuropteris schlehani* occurs and the Moravian-Silesian roof slates carrying *Neuropteris antecedens* are now referred by many paleobotanists to the Namurian, the basal Upper Carboniferous. The inclusion of the Westphalian, which covers the Valenciennes occurrence, within the limits of Pottsville time has long been recognized.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).
Figured specimens: U. S. Nat. Mus. 39406, 39407.

Genus PALMATOPTERIS Potonié, 1891 [1893] [79]

Palmatopteris subgeniculata (Stur) Renier [79a]

Plate 11, figures 4, 13, 20, 29, 30

Several of the fragments from the railway cut near Gillham approach so closely, by their geniculate axes, their size, and especially the lobation of their pinnules, the fragments from the Ostrau beds described by Stur [80] as *Diplothmema subgeniculata* that I have little hesitation in referring them to that species. Examples are those shown in figures 4, 13, 20, 29, and 30, plate 11. No other species known to me approaches so closely the fragments in hand.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).
Figured specimens: U. S. Nat. Mus. 39401–39403.

Genus RHODEA Presl, 1838 [81]

Rhodea cf. R. tenuis Gothan

Plate 11, figures 5, 12

The collection from the Stanley shale near Gillham, Ark., contains several very small fernlike fragments, one of which is illustrated in figures 5 and 12, plate 11, in which we have relatively thick and slightly flexuose, rugose-striate rachis faintly bordered by a decurrent lamina. The rugosity is produced by minute, short, sharp, spicule-like scales, which are sparsely scattered

[74] Gothan, Walter, Die oberschlesische Steinkohlenflora, Teil 1: K. preuss. geol. Landesanstalt Abh., neue Folge, Heft 75, p. 202, 1913.
[75] Idem, pl. 49, fig. 2.
[76] Idem, pl. 49, fig. 3–A.
[77] Idem, p. 198, pl. 47, figs. 1, 1–A, 1913.
[78] Bureau, Édouard, Bassin de la basse Loire, fasc. 2, atlas, pl. 13, fig. 2, 1913. (In the series "Études des gîtes minéraux de la France.")
[79] Potonié, Henry, Ueber einige Carbonfarne: K. preuss. geol. Landesanstalt Jahrb., Band 12, p. 1, 1891 [1893].
[79a] Renier, Armand, La flore du terrain houiller sans houille dans le bassin du Couchant de Mons: Soc. géol. Belgique Annales, tome 3, Mém., p. 156, 1906.
[80] Stur, Dionysius, Die Culm-Flora: K.-k. geol. Reichsanstalt Abh., Band 8, Heft 2, p. 136, pl. 12, figs. 8–9, 1877.
[81] Presl, Karl, in Sternberg, Kaspar, op. cit., Hefte 7, 8, p. 109, 1838.

over the surfaces of the pinnules as well as the rachis. The pinnules are alternate, laciniately cut in narrow close lobes nearly erect to the base, and sometimes arching outward. The material, which is insufficient for satisfactory specific characterization and definition, resembles, in the general mode of division and the aspect of the pinnules, so closely that illustrated by Gothan [82] as *Rhodea tenuis* that it is provisionally placed with that species. There is room for doubt, however, even as to the generic identity of the material in hand.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).
Figured specimen: U. S. Nat. Mus. 39392.

Rhodea goepperti (Ettingshausen) Stur

Plate 10, figures 6–9, 12, 14–16; plate 11, figures 7, 25, 26

Trichomanites goepperti Ettingshausen, K. Akad. Wiss. Wien, Math.-naturwiss. Cl., Denkschr., Band 25, p. 25, figs. 10, 11, 1865.

Rhodea goepperti (Ettingshausen) Stur, K.-k. geol. Reichsanstalt Abh., Band 8, Heft 1, p. 41, pl. 11, figs. 2–7, 1875.

Sphenopteroid development with a narrow arcuate or gently curved rachis, becoming flexuose or zigzag, ventrally depressed, dorsally rounded, and always very narrowly alate; pinnules erect, alternate, open, relatively distant, forking at angles of about 60°, the lobes bifurcating once and sometimes a second time at the same angle, with slight diminution in width of the lamina; lamina rather thick, of nearly equal width in all parts of the pinnule, and sparsely provided with short spines along the median nerve and in the bordering regions.

The plant here described was, on account of its general delicacy, the zigzag branching of the segments, and the very small, very open, and nearly equally wide lobes, thought at first to be inseparable from *Sphenopteris gersdorfii*. However, a further close comparison leaves little escape from identifying the plant in hand with *Rhodea goepperti* (Ettingshausen) Stur, which is not uncommon in the lower portion of the Upper Carboniferous in central Europe, as the formations there are now classified. A typical portion of a segment showing the positions of the slightly distant alternate pinnae, the narrow, slightly cuneate lobes, broadly divided, is seen in figure 12, plate 10. The fragment photographically represented in figure 26, plate 11, illustrates the rather distant, slender, narrowly alate upper divisions. The geniculate or reflexed pinnae near the base of the frond are indicated in figure 25, plate 11. Fragments typical of the pinnules and pinnae are seen in figures 6–8, plate 10 (strongly suggesting *S. gersdorfii*), and in figures 9 and 15, plate 10. The fragment shown in figure 16, plate 10, is the most delicate of the series.

This species has been well illustrated by Stur under the name *Rhodea goepperti* (Ettingshausen) sp. Ettingshausen, the author of the species, described it under the generic name *Trichomanites*.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).
Figured specimens: U. S. Nat. Mus. 39384–39391.

Genus SPHENOPTERIDIUM Schimper, 1874 [83]

Sphenopteridium dawsoni (Stur) Potonié

Plate 11, figure 11

Archaeopteris dawsoni Stur, K.-k. geol. Reichsanstalt Abh., Band 8, Heft 1, p. 66, pl. 12, figs. 2–4, 1875.

Sphenopteridium dawsoni (Stur) Potonié, Lehrbuch der Pflanzenpalaeontologie, p. 131, 1897.
Gothan, K. preuss. geol. Landesanstalt Abh., neue Folge, Heft 75, p. 8, pl. 1, figs. 1, 1a, text fig. 1, 1913.

The fragments referred to this species, one of which is illustrated, are hardly sufficient for detailed description of the species, which has been adequately illustrated by both Stur and Gothan.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).
Figured specimen: U. S. Nat. Mus. 39377.

Genus SPHENOPTERIS (Brongniart) Sternberg, 1825 [84]

Sphenopteris cf. S. mississippiana White

Plate 11, figures 17, 18

The fragments here referred to *Sphenopteris mississippiana*, first described from the Wedington sandstone member, which occurs in the upper part of the Fayetteville shale, of upper Mississippian age, are hardly sufficient for independent description, but they seem to agree so closely with the corresponding portions of the Wedington plant, or even the extremely minute early forms of *Sphenopteris hoeninghausii*, as to leave little doubt with regard to the specific reference.

Some of the earliest forms, with relatively delicate ultimate pinnae and minute slightly distant pinnules, sometimes reported as typical of the earliest or the true *Sphenopteris hoeninghausii*, are, in my judgment, very much closer to some of the fragments here figured than they are to the later robust types with relatively elongated cuneate lobes, illustrated and described by different authors under the same name. An example of the type with minute and relatively delicate ulti-

[82] Gothan, Walter, Die oberschlesische Steinkohlenflora, Teil 1: K. preuss. geol. Landesanstalt Abh., neue Folge, Heft 75, pl. 3, figs. 1, 2. 1913.

[83] Schimper, W. P., Traité de paléontologie végétale, tome 3, pp. 487–488, 1874.

[84] Brongniart, Adolphe, Mus. histoire nat. Paris Mém., tome 8, p. 233, 1822. Sternberg, Kaspar, op. cit., Tentamen, p. xv, 1825.

mate pinnules and pinnae comparable to those here figured is seen in the illustration of *S. hoeninghausii*, forma typica, in Gothan's upper Silesian flora.[85] The specimens from the Stanley shale near Gillham deserve close comparison with the fragments from the Wedington sandstone.[86]

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimen: U. S. Nat. Mus. 39372.

Sphenopteris sp.

Plate 10, figures 1, 2, 4, 5

Figures 4 and 5, plate 10, represent the upper surface of a small fragment of a rather compact ultimate pinna, the under surface of which is shown with clear detail in figures 1 and 2. There are several forms that have been described from the beds formerly regarded as Culm of central Europe to which this might be compared—with little profit, however, on account of the lack of adequate detail as well as adequate specimens.

The example shown in figures 1 and 2 is probably fertile, and if so it appears to be comparable to the genus *Discopteris*.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39370, 39371.

Genus WARDIA White, 1904 [87]

Wardia suspecta White, n. sp.

Plate 11, figures 1–3

Seeds of moderate size, ovate, with slightly cuneate base, rather strongly convexly rounded border, the flattened interior portion or nucellus concave, longitudinally distinctly striate, rounded at the base, and narrowly canaliculate just within the upper border.

The proportions and general aspect of the seeds are photographically represented in figures 1–3, plate 11, which represent the mold and the reverse of a seed from Gillham, Ark. The seeds from the Stanley shale are in general form rather closely related to those from the lower Pottsville of the Appalachian trough, but they are not so far elongated or narrowly cuneate toward the base, and the carbonaceous residue is somewhat thicker.

By reason of the proved generic connection between *Wardia* and *Adiantites* in the Appalachian trough, it is probable that the seeds from Gillham are similarly related to the accompanying leaves of *Adiantites*. In fact, it is rather probable that *Wardia suspecta* is the seed of *Adiantites stanleyanus*. In view of the doubt remaining, however, it seems wiser to give the seed a separate specific name.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. nos. 39399, 39400.

Fern rachides

Plate 10, figures 24, 25; plate 11, figures 24, 27

Several types of rachis belonging to fernlike plants appear to be worthy of special note. That shown in figure 27, plate 2, suggests some of the rachiopteroid forms of the Mississippian. It is rather strongly lineate, and the epidermis is provided with minute chafflike or shaggy scales.

On account of the pitted character of the emerging branch, both the relief and the impression of the fragment are shown in the stem seen in figure 24, plate 10. The rachis is distinctly creased in connection with the apparently very wide petiolar opening in the woody cylinder. The deep furrow in the impression is characteristic of some of the fernlike fronds of the older Mississippian.

The fragment seen in figure 24, plate 10, shows a thickened central strand bordered by rather broadly canaliculate lateral areas. The aspect of the stem and of the base of the branch, also shown, are suggestive of a rachis like that of *Rhodea*.

The bifurcating stem invites comparison with the rachis figured by Bureau [88] from the basin of the lower Loire as *Calymmatotheca tenuifolia* var. *linkii*.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. no. 39395–39398.

Genus CALYMMATOTHECA Zeiller, 1883 [89]

Calymmatotheca sp.

Plate 14, figures 1, 9

The carbonized lobe synangium of *Calymmatotheca*, shown in figures 1 and 9, plate 14, is one of several sporangial remains belonging probably to the *C. hoeninghausii* group and probably to the form here identified with a little doubt as *Sphenopteris mississippiana* White. Some of the earlier types referred by authors to *S. hoeninghausii* and regarded as typical of that species are apparently more nearly related to *S. mississippiana* than many of the late forms, with larger and more

[85] Gothan, Walter, Die oberschlesische Steinkohlenflora, Teil 1, Farne und farnähnliche Gewächse: K. preuss. geol. Landesanstalt Abh., neue Folge, Heft 75, p. 58, pl. 13, fig. 1, 1913.

[86] White, David, Fossil flora of the Wedington sandstone member of the Fayetteville shale: U. S. Geol. Survey Prof. Paper 186-B, pl. 4, figs. 4, 5, 11, 13, 14, 15, 17, 18, 20, 21, 22, 23, 30, 36, 39, 1937.

[87] White, David, The seeds of *Aneimites:* Smithsonian Misc. Coll., vol. 47, pt. 3, p. 323, 1904.

[88] Bureau, Édouard, Bassin de la basse Loire, fasc. 2, atlas, pl. 14, 1913. (In the series "Études des gîtes minéraux de la France.)

[89] Zeiller, René, Fructifications de fougères du terrain houiller: Annales sci. nat., Botanique, sér. 6, tome 16, p. 182, 1883.

distinctly cuneate pinnular lobes, are to *S. hoeninghausii.*

The specimens from the Stanley shale are comparable also to the smallest of the sporangia illustrated by Bureau [90] from the upper Culm in the basin of the lower Loire as *Calymmatotheca tenuifolia.*

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimen: U. S. Nat. Mus. no. 39412.

Genus RHABDOCARPOS Goeppert and Berger, 1848 [91]

Rhabdocarpos (Lagenostoma?) costatulus White, n. sp.

Plate 12, figures 9, 10

Fruit fusiform, oval, truncate at both ends, the outer envelope traversed by close, high, erect longitudinal ribs conforming to a more or less distinctly trigonal nucleus; ribs rather narrow, thin, and sharp and persisting the whole length of the envelope.

The fruit is readily distinguished from related pieces of *Rhabdocarpos* by its slender form and the very close parallel, knife-edge sharp ribs traversing the outer envelope. No other fruit of its size is, so far as I have knowledge, so compactly ribbed.

The species is evidently related to the seeds from the upper Pottsville of Ohio described by Newberry [92] as *Trigonocarpum ornatum* and *T. multicarinatum;* with the former it agrees rather closely in general form and size, and with the latter it conforms in the large number of sharp ribs continuing the full length of the fruit.

Localities: Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014). Lower part of Jackfork sandstone, SE¼ sec. 33, T. 4 N., R. 21 E., Tuskahoma quadrangle, Okla.; collected by H. D. Miser, April 30, 1927 (U. S. Geological Survey lot 8340).

Figured specimens: U. S. Nat. Mus. 39416, 39417.

Rhabdocarpos secalicus White, n. sp.

Plate 12, figures 4–7, 11

Seeds very small, elliptical, 5 to 6 millimeters in length and 2½ to 3 millimeters in width, with rather broad basal attachment and narrowed at the apex in short micropylar neck, the external coat rather soft and more or less faintly pluricostate, the inner coat, conforming to the nucellus, rigid, convex, and tricarinate, with each of the three low ribs broadening upward slightly to its union around the micropylar tube.

The aspect of the partly collapsed seed, of which the outer distantly striate coat is collapsed, is shown in figures 5 and 7, plate 12. Figure 7 reveals indistinctly the costae of the nutlet proper. The shape of the nutlet is still better shown in figure 5, plate 12, in which the rib on the right is shown in profile, while the three converging ribs are seen to close in about the slender rodlike micropyle.

A single segment of the nutlet, in which the hard outer portion has been broken away, is shown in figures 4 and 11, plate 12, where again the micropylar tube is in evidence.

The specimens described as *Rhabdocarpos secalicus* are possibly indistinguishable from specimens from the Morrow group of northwestern Arkansas, Lacoe collection 25972, placed by Lesquereux along with *Carpolithes latior,* a much larger fruit. Both the Morrow seed and an undescribed species from the Warrior coal field of Alabama (Lacoe collections 25945 and 25944) are apparently indistinguishable from *R. secalicus.* All, though very small, bear the costae characteristic of *Trigonocarpum.* The species in hand also invites comparison with the American material described by Lesquereux [93] as *Carpolithes minimus* Sternberg, which again is distinctly a *Trigonocarpum.* The Wilkes-Barre seeds referred by Lesquereux to *C. minimus* are rather shorter and less distinctly costate than those from Alabama and Arkansas already cited. The Stanley seeds agree rather closely in their diagnostic characters with the seeds from Campbells Ledge, near Pittston, Pa., described by Lesquereux [94] as *Rhabdocarpos latecostatus.* The chief difference lies in the more oblong outline and more distinct trigonocarpal costation of the specimens from the Stanley. *Rhabdocarpos secalicus* is also comparable with *C. latior* of Lesquereux,[95] especially as that species is represented by specimens identified by Lesquereux from the upper Pottsville at Campbells Ledge.

Locality: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Ark.; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39413–39415.

Genus RHYNCHOGONIUM Heer, 1876 [96]

Rhynchogonium choctavense White, n. sp.

Plate 12, figures 2, 3, 8

Fruits small, oval-oblong to oval-ovate, 1¼ to 1½ millimeters in length, about 8 to 10 millimeters wide, sometimes somewhat fusiform, longitudinally and narrowly costate externally, in about 10 narrow, acute longitudinal wings; inner impression smoother, more or less obscurely triangular, with low, shallow ribs extending nearly the whole length and 6 or 8 inter-

[90] Bureau, Édouard, op. cit., pl. 9, figs. 4, 4 A.

[91] Goeppert, H. R., and Berger, Reinholdus, in Berger, Reinholdus, De fructibus et seminibus ex formatione lithanthracum, p. 20, 1848.

[92] Newberry, J. S., Descriptions of fossil plants: Ohio Geol. Survey Rept. 1, pt. 2, Paleontology, p. 368, pl. 42, fig. 7; p. 369, pl. 42, fig. 8, 1873. See also Lesley, J. P., Dictionary of the fossils of Pennsylvania and neighboring States: Pennsylvania 2d Geol. Survey Rept. P4, vol. 3, pp. 1215–1216, 1890.

[93] Lesquereux, Leo, Description of the coal flora of the Carboniferous formation in Pennsylvania: Pennsylvania 2d Geol. Survey Rept. P, vol. 3, p. 825, pl. 110, fig. 68, 1884.

[94] Idem, p. 816, pl. 110, fig. 34.

[95] Idem, p. 826, pl. 110, figs. 69–70.

[96] Heer, Oswald, Flora fossilis arctica, vol. 4, Abt. 1, p. 19, 1876.

mediate inwardly rounded ribs that grow in strong relief toward the top, where they flare out to form a shallowly funnel-like flaring truncate top, which is about one-half of the greatest diameter of the fruit; apex capped by a broad, very shallowly conical plug.

The species here described is evidently closely related to that from the Wedington sandstone described as *Rhynchogonium fayettevillense.* However, as shown in figure 2, plate 12, it differs from that species by the slightly broader and sharper keels of the outer envelope and by the union of the thick inner teeth, which take part in the micropylar ring. The plug, which was unobserved in the specimens of the Wedington, is here seen to be broad and shallowly conical. The aspect of the nucellus with its round costae, which generally reach the entire length of the seed, is shown in figure 3, plate 12. The chalazal area is rather large, but the chalazal pit is small and slightly concealed in the base of the figured specimen. Figure 2 represents the inner impression of the heavy envelope within which a seed like that shown in figure 3 may have been removed. The nucellus is seated in the thin cavity left by the principal envelope.

Localities: Upper part of Stanley shale, 4 miles east of Tuskahoma, Okla.; collected by David White, 1909 (U. S. Geological Survey lot 5669). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014). Lower part of Jackfork sandstone, SE¼ sec. 33, T. 4 N., R. 21 E., Tuskahoma quadrangle, Oklahoma; collected by H. D. Miser, April 30, 1927 (U. S. Geological Survey lot 8340). Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39409–39411.

Genus TRIGONOCARPUM Brongniart, 1828 [97]

Trigonocarpum gillhami White, n. sp.

Plate 12, figure 12; plate 14, figures 5, 6, 7, 8

Fruits small, distinctly triradiate, mostly less than 7.5 millimeters long and 6 millimeters wide, ovate or oval-ovate, broadly attached at the base, tapering rapidly upward to a narrow micropylar neck less than 2 millimeters in length; angular costae three, narrow, not over 0.5 millimeter in width and running from base to apex; outer envelope leathery, rigid, densely and irregularly striate, as by close bifurcating vascular strands.

This species is rather readily recognized by its strongly convex, rigid shell, which is uniformly ovate or oval-ovate and traversed by three narrow ribs that originate in the rather broad attachment and widen but very slightly in passing upward into the slender, narrow micropylar neck.

Localities: Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874). Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014). Upper part of Stanley shale, 4 miles east of Tuskahoma, Okla.; collected by David White, 1909 (U. S. Geological Survey lot 5669).

Figured specimen: U. S. Nat. Mus. 39418.

Trigonocarpum vallisjohanni White, n. sp.

Plate 14, figures 2–4

Oval tricostate seeds about 15 millimeters in length and 11 millimeters in greatest width, about the middle, with three narrow thin costae a little over 1.5 millimeters in width at the base, a little over 2 millimeters in width at the point of junction about the short, rather acute micropylar neck; nucellar cast smooth, convexly rounded between the costae, very slightly cuneate just above the small chalaza, and rather evenly rounded toward the apex.

Examples of the type shown in figures 2–4, plate 14, are not infrequently met in the jumble of plant fragments occupying a thin pocket with angular fragments of fine-grained blue shale at locality 8014.

The similarity of the seeds of *Trigonocarpum vallisjohanni* to those figured by Parkinson [98] and made the basis of the species *Trigonocarpum parkinsoni* is evident, though the Old World species, both as originally illustrated and as exemplified in specimens in the Lacoe collection from Dysart, Fifeshire, Scotland, are more distinctly oval, slightly smaller, and more distinctly apiculate than the fruits from the Jackfork sandstone.

Trigonocarpum vallisjohanni is distinguished by its near approach to an oval form, by the smooth intercostal spaces, and by the very thin, narrow but persistent ribs which originate at the base, measure nearly 2 millimeters in width, and pass with slight increase into the short, rather acute micropylar crests.

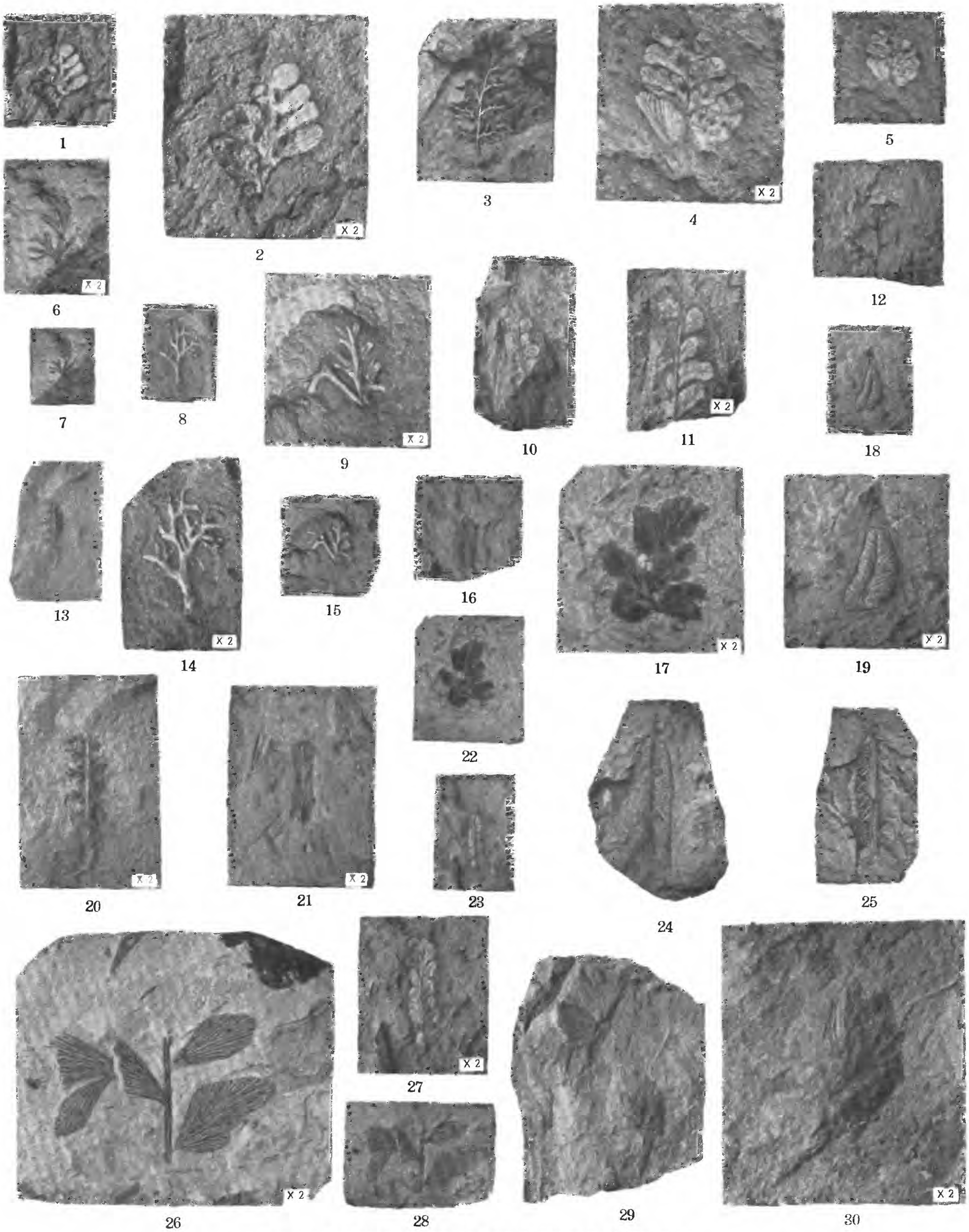
Localities: Devils Hollow, near Talihina, Okla., SE¼ sec. 32, T. 4 N., R. 21 E., Tuskahoma quadrangle; lower part of Jackfork as mapped by Taff; collected by H. D. Miser, C. L. Cooper, and John Fitts, March 29, 1929 (U. S. Geological Survey lot 8014). Upper part of Stanley shale, Whitley cut on Kansas City Southern Railway, 4 miles south of Gillham, De Queen quadrangle, Arkansas; collected by H. D. Miser, October 21, 1914 (U. S. Geological Survey lot 6874).

Figured specimens: U. S. Nat. Mus. 39423–39425.

[97] Brongniart, Adolphe, Prodrome d'une histoire des végétaux fossiles, p. 137, 1828.

[98] Parkinson, James, Organic remains of a former world, vol. 1, p. 458, pl. 8, figs. 6–8, London, 1804.

PLATES 10–14



PLANTS OF STANLEY SHALE AND JACKFORK SANDSTONE.

1, 2; 4, 5. *Sphenopteris* sp.
3; 10, 11; 13, 20; 21; 23, 27. *Aloiopteris arkansana* White, n sp.
6, 7; 8, 14; 9, 15; 12; 16. *Rhodea goepperti* (Ettingshausen) Stur.
17, 22. *Aphlebia parksii* White, n. sp.
18, 19. *Neuropteris elrodi* Lesquereux.
24, 25. Fern rachides.
26, 28. *Adiantites stanleyanus* White, n. sp.
29, 30. *Aphlebia* sp.