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FOSSIL FLORA

OF THE

LOWER COAL MEASURES

OF

MISSOURI

BY

DAVID WHITE

WASHINGTON
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LETTER OF TRANSMITTAL.

Department of the Interior,
United States Geological Survey,
Washington, D. C., October 10, 1898.

Sir: Herewith I transmit a monograph of the fossil flora of the Lower Coal Measures of Missouri. As the first comprehensive presentation of the flora of any zone of the Coal Measures in the trans-Mississippi region, it offers important data for the comparison and correlation of these beds with the Eastern coal fields, and it also furnishes criteria that will be of value in the comparison of other neighboring Coal Measures areas and in the establishment of the floral sequences through the various zones of the Upper Carboniferous in the Western Interior Basin.

Very respectfully,

David White,
Assistant Geologist.

Hon. C. D. Walcott,
Director United States Geological Survey.

FOSSIL FLORA OF THE LOWER COAL MEASURES OF MISSOURI.

By DAVID WHITE.

INTRODUCTION.

Since the publication of the Coal Flora[1] the material collected in Henry County, Missouri, and transmitted to Professor Lesquereux by Dr. J. H. Britts, has been so extensively increased through the continued and most fruitful efforts of the latter gentleman and of the geologists of the United States Geological Survey and of the Geological Survey of Missouri, that it appears highly desirable that the fossils new to science should be published, and that a comparative analysis should be made of the floras with a view to ascertaining both the age of these coals and their relative positions with reference to the typical sections of the Eastern coal fields. It is thought also that such a correlation will have an important bearing on questions concerning the deposition and stratigraphy of the basal portion of the Lower Coal Measures, a subject which has received some attention in the recent publications of the State.

Although by far the greater part of the materials here considered come from a restricted area, Henry County, the collections are so extensive and their accumulation covers so long a period of coal exploitation that they may be safely regarded as a relatively comprehensive representation of the plant life of the zone in the entire basin.

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[1] Second Geological Survey, Pennsylvania. Report of Progress P. Description of the Coal Flora of the Carboniferous Formations in Pennsylvania and throughout the United States. Vols. i–iii, with atlas. Harrisburg, 1880–1884.

ACKNOWLEDGMENTS.

Acknowledgments are due, first of all, to Dr. J. H. Britts, of Clinton, for the use of types and other specimens identified by Professor Lesquereux: also to the Director of the United States National Museum for facilities for the study of the Missouri plants, including a number of types formerly in Professor Lesquereux's private collection, but afterwards secured by Mr. R. D. Lacoe, of Pittston, Pennsylvania, and now become, by the gift of the entire collection of the latter, the property of the National Museum.

COLLECTIONS AND LOCALITIES.

The Paleozoic plant material described from Missouri has generally been recorded with no other localizations than "Clinton" or "Henry County, Missouri"; and while it is of great paleontologic importance, it will in this report be treated geographically as one lot, since, unless otherwise stated, it all came from one horizon in a single district. Out of several boxes of specimens from stated localities in this county forwarded to the United States National Museum in January, 1891, by Dr. Britts, a number of specimens were found which, owing perhaps to fracture, abrasion, etc., have no exact localization, though coming from the same localities as some of the others. These have the "lot catalogue" number 342, U.S.G.S.

Pitcher's coal mine, 3½ miles southeast of Clinton. Collections were made at this mine by Mr. Gilbert Van Ingen, assistant in the United States Geological Survey, and forwarded September, 1890. Mr. Van Ingen's collection, which includes many fine ferns and slabs of Lepidodendron, constitutes lot 407 from United States Geological Survey station 1263 D. Plants from the same locality were sent to the National Museum by Dr. Britts in January, 1891, and became lot No. 340.

Owens's coal mine, 2 miles southeast of Clinton. Many specimens from Owens's coal mine were sent to the National Museum by Dr. Britts in January and in April, 1891. These will be referred to as lot No. 339. Another large consignment, obtained in the process of "stripping" near this coal mine, was forwarded by Dr. W. P. Jenney, of the United States Geological Survey, in October, 1891, while investigating the zinc deposits of southwestern Missouri. These specimens form lot No. 411.

Hobbs's coal mine, in SE. ¼ sec. 13, T. 40, R. 26, 8 miles south and 2 miles east of Clinton. A considerable number of specimens sent by Dr. Britts from this locality in January and April, 1891, comprise lot No. 341.

Deepwater. A large quantity of specimens designated by this name came from a mine 8 miles southeast of Clinton. It is very close to the locality quoted as the Hobbs mine. These plants, forwarded to the United States Geological Survey by Dr. Jemey in June, 1891, form lot No. 408. Another consignment, sent by Dr. Jenney and Dr. Britts in October, 1891, bears the lot number 413.

Gilkerson's Ford, Grand River, 5 miles south of Clinton. Very finely preserved plants in calcareous iron concretions were forwarded to the United States Geological Survey by Dr. Jenney in October, 1891 (lot No. 412), and by Dr. Britts in September, 1892. A small collection from shales in this vicinity was also sent by Dr. Britts. The latter specimens, which were found at a lower horizon than the ironstone concretions, were engraved with "G. F." by the collector and donor. They contain a number of the best-preserved and most interesting plant remains.

Near Jordan's old coal mine, 5 miles south of Clinton, from black shales overlying the coal in the North and Wood shaft. These specimens, consisting of Sigillaria, mostly decorticated, and occurring immediately below the other plant shales, were forwarded by Dr. Britts in April, 1891. They constitute lot No. 404.

Those specimens which I have seen represented only in the Lacoe collection are referred to by the numbers in the special catalogue of that collection.

A number of plants which were sent by Dr. Britts in small special packages were not given lot numbers, and will be localized in full when discussed.

Vernon County. The specimens of Conostichus described in the Coal Flora have no other locality reference than Vernon County, Missouri. From the statements of the geologists of the State it seems probable, however, that the types now in the Lacoe collection, United States National Museum, came from Big Drywood Creek, 5 miles south of Deerfield.[1]

[1] See Broadhead, Am. Geologist, vol. xii, 1893, p. 88.

STRATIGRAPHY OF THE PLANT-BEARING TERRANES.

All the plants treated in the following pages were derived from the Lower Coal Measures of Missouri as defined by the earlier State surveys. More recently the terms Des Moines series[1] and Lower Coal Measures have been applied to the combined Lower and Middle Coal Measures of the earlier nomenclature. The present collections are mostly restricted to the lower division or to the Cherokee as defined by Haworth and Kirk,[2] and used by the Missouri geologists. I employ the term Lower Coal Measures in its original American sense, as it has long been in general use in the northern bituminous basins. It is, under the circumstances, all the more appropriate since the flora in hand is in fact representative of that division of the Carboniferous resting on the Pottsville series in the northern and northeastern coal fields. At the same time, it must be borne in mind that the title refers only to the American application of the term, as commonly used in the reports of the earlier geologists of the Northern States.

It must be remembered that in Missouri, as in Iowa, the Coal Measures (Mesocarboniferous) rest on the eroded surface of the Lower Carboniferous (Eocarboniferous). Along a portion of the margin of the field the floor of the Mesocarboniferous consists, as is largely the case in the latter State,[3] of the deeply cut surface of the St. Louis limestone or other divisions of the Mississippian. In other portions the Coal Measures rest unconformably on other divisions of the Eocarboniferous, on the Devonian, the Upper Silurian, or the Lower Silurian.

The probable epeirogenic movements and the consequent changes of both the level and the attitude of the continent in the region bordering the great coal field have been fully discussed by Winslow[4] and by Keyes, the latter of whom has also given a profile diagram of the oscillations of the shore line in the Missouri-Iowa region during Eocarboniferous and Mesocarboniferous time.[5] The deposition of the lower portion of the Mesocar-

[1] Keyes, Am. Geologist, vol. xviii, 1896, p. 23; Rept. Geol. Surv. Iowa, vol. i, 1893, p. 85; Monthly Review, Iowa Weather Service, vol. iv, 1893, p. 3.

[2] Kans. Univ. Quarterly, vol. ii, 1894, p. 105. Univ. Geol. Surv. Kans., vol. i, 1896, p. 150

[3] Am. Geologist, vol. xii, 1893, p. 99. Hall, Am. Jour. Sci., vol. xxvii, 1857, p. 197.

[4] The Missouri Coal Measures and the conditions of their deposition: Bull. Geol. Soc. Am., vol. iii, 1892, pp. 109–121. See also Am. Geologist, vol. xv, pp. 87–89, and Prelim. Rept. on Coal: Geol. Surv. Mo., 1891, p. 19.

[5] Am. Geologist, vol. xii, 1893, p. 100.

boniferous occurred during a period of terrestrial subsidence and advance of the shore line; the result of which is the theoretically complete concealment of the earliest beds of the Coal Measures beneath the landward overlaps of the succeeding sediments. The maximum thickness of the lower concealed beds is difficult to estimate, since in the borings farther out toward the interior of the basin the upper beds are probably thinner and the means for the identification of the individual terranes of the section are more or less unsatisfactory. In one instance Dr. Keyes[1] observed a body of shales not less than 75 feet in thickness occupying a concealed ravine in the Mississippian series. The nature and extent of the subjacent terranes lying farther out in the basin can be calculated only from the borings or from the analogies furnished by the series in other sections in which the horizons of the lower coals may be approximately ascertained by the study of the paleontologic evidence.

In the region of Henry County, from which most of the material under examination was obtained, the loose surface detritus of the eroded Mississippian is generally covered by an extremely variable sandstone, described in various reports as the "Ferruginous sandstone," "Spring River sandstone," etc., and generally correlated by the Missouri geologists with the "Millstone grit," though its representative in Illinois was regarded by the geologists of that State as a part of the Eocarboniferous. This sandstone, the age of which, so far as I can learn, has not yet been determined from any paleontologic evidence, is never of great thickness, and is described as here and there more or less eroded. It serves largely as a leveling medium, tending to fill the ravines and hollows of the Mississippian, with whose loose cherty subaerial detritus it appears to be somewhat blended. At some points it is reported as entirely wanting, having perhaps been eroded prior to the sedimentation of the coals and sandstones.

Resting either immediately on the somewhat uneven surface of this "Ferruginous sandstone," or in places perhaps directly on the Mississippian detritus, lie the shales, sandstones, limestones, and coals of the Lower Coal Measures, which as originally defined were stated to have a thickness of about 250 feet,[2] including the "Ferruginous sandstone." All the plant

[1] Bull. Geol. Soc. Am., vol. iii, pp. 283-310. Am. Geologist, vol. xii, p. 102.

[2] Broadhead, Rept. Geol. Surv. Mo., 1872, pt. 2, p. 6. Winslow, Bull. Geol. Soc. Am., vol. iii, 1892, p. 115.

material from Henry County, Missouri, comes from shales less than 100 feet above the "Ferruginous sandstone."

The local stratigraphic details of the phytiferous shales at most of the points from which plant collections were made have already been fully given in the State reports prepared by Broadhead and Winslow.[1] The plants from Owens's coal mine, Hobbs's mine, Deepwater, Pitcher's mine, and the shales near Gilkerson's Ford of Grand River are said to have come from the roof of the same coal seam, most commonly known in that region as the "Jordan coal."[2]

The local section at Kinney's mine, which is but a few hundred feet from Owens's mine, is given by Winslow in his Preliminary Report on the Coal Deposits of Missouri.[3] The same report also illustrates[4] the details of the coal in the vicinity of Deepwater, the section at the Blair Diamond No. 2 shaft being essentially the same as that at Hobbs's mine. The stratigraphic conditions at the Stephens and Dunlap strippings, from which many of the plants marked "Hobbs" are said to have come, and which are also described in the report above referred to,[5] are shown in a photograph, which, through the courtesy of Dr. Jenney, I here reproduce as Pl. I. The section of the coal and roof shales at the Pitcher mine is given in Mr. Van Ingen's notes as follows:

Section at U. S. G. S. station No. 1263.

	Feet.	Inches.
4. Sandstones and intercalated shales	5	0
3. Shales with plants	3	4
2. Coal	2	6
1. Fire clay.		

The fire clay grades below into shale, this into shaly sandstone, and that into the "Spring River sandstone" of Dr. Jenney, or the "Ferruginous sandstone." Probably the section given as the Pitcher shaft in Dr. Winslow's report[6] was made from a point near by. The Jordan coal is described in detail by Broadhead in his valuable report for 1872,[7] which also illus-

[1] Descriptive columnar sections of the Coal Measures of Missouri are given by Prof. G. C. Broadhead in Rept. Geol. Surv. Mo., 1872, Iron ores and coal fields, pt. 2, pp. 7, 82, 88; also Ann. Rept. Geol. Surv. Mo., 1894, vol. viii (1895), pp. 360–369.

[2] Rept. Geol. Surv. Mo., 1872, pt. 2, p. 16.

[3] Page 139, text fig. 97.

[4] Page 141, text fig. 99.

[5] Page 142.

[6] Page 140, text fig. 98.

[7] Rept. Geol. Surv. Mo., 1872 (1873), pt. 2, p. 16.

trates the features of the section at Gilkerson's Ford on the Grand River,[1] the source of the interesting large phytiferous ironstone concretions collected by Dr. Jenney and Dr. Britts. A section of the higher terranes is given by Professor Broadhead, thus:

Section at Gilkerson's Ford, Grand River, Missouri.

	Feet.	Inches.
1. Buff shaly sandstone	5	0
2. Blue shales	2	0
3. Coal		2
4. Shales and fire clay	14	6
5. Coal		6
6. Sandstone with Stigmaria	3	0
7. Shales with lenticular phytiferous beds of iron carbonate	2	0
8. Coal in river, reported at	3	0

The plant-bearing ironstones are said by Messrs. Britts and Jenney to lie in No. 2 of Broadhead's section, i. e., above the third coal, instead of the shales (No. 7) over the first coal, the error of record having probably been caused by the position of the talus. The lower coal (No. 8 of the section), correlated with the Jordan coal, is the one from the roof of which the plants in argillaceous shales at Gilkerson's Ford were collected.

From the above details it will be seen that all the plants from Henry County, with the exception of those in clay ironstones from Gilkerson's Ford, were obtained from roof shales, which are regarded by the geologists of the State as overlying the same seam of coal, viz, the Jordan coal. The horizon of the clay ironstones is only about 40 or 45 feet higher.

In some of the broader or deeper marginal basins in the region of Henry County a lower thin coal lies from 12 to 15 feet below the Jordan coal. This coal is exceedingly variable both in quantity and in quality, being sometimes 4 feet thick and of good quality, or full of pyrites and shale, while at other times it is entirely wanting. From pyritiferous concretions in the black shale over this coal at Cheatham's mine, near Clinton, Dr. Britts obtained a number of invertebrate fossils, which have been determined by Prof. Charles Schuchert, Curator of Paleontology in the United States National Museum, as follows:

Entolium aviculatum (Swallow).
Schizodus curtus M. & W.?
Machrocheilus sp.
Lingula umbonata Cox.
Productus longispinus Sowerby.
Productus nebraskaensis Owen.
Spirifer rockymontanus Marcou.
Reticularia perplexa (McChesney).
Dielasma bovidens (Morton).

[1] Op. cit., p. 17, text figs. 2, 3.

Aviculopecten providens (Cox)? was also found in the plant shales over the Jordan coal. *Spirorbis carbonaria* is frequently present. Unfortunately the faunas of the trans-Mississippian Coal Measures have not yet been studied sufficiently to invest these species, most of which are supposed to have a wide vertical range in the Coal Measures, with any definite or available correlative value.

A number of insect fragments have been found among the plant material. Several of these specimens have been described by Professor Scudder[1] as *Paromylacris clintoniana* Scudder, *Etoblattina clintoniana* Scudder, and *Anthracoblattina americana* Scudder. Two or three other fragments have not yet been examined by a specialist in fossil insects.

The proximity of the lower coals from which the plant fossils were obtained to the Ferruginous sandstone, or even to the eroded beds that comprise the Mississippian floor of the Coal Measures, has already been noted. The shore lines of the encroaching Carboniferous sea adapted themselves to the erosional topography of the Mississippian land. The thickness and regularity of the sediments in the bordering marshes or lagoons seem to have varied with the depth and extent of the marginal depressions, the lowest beds being most irregular The Jordan coal, like that beneath it, may be presumed to have been formed in these marginal swamps. It lies in basin-like areas of varying size, some containing but a few acres, others extending many miles. In general it is thickest and best in the interior of the basins, where it lies lowest, while it thins toward the rising margins of the embayments or swamps. Yet, while it thins beyond recognition, and can not be continuously traced in many cases from one embayment or estuary across to the next along the old shore line, it may in the region of Henry County be usually recognized by the constancy of its flora as well as the character of the coal. In Pl. I, from a photograph of the stripping at Hobbs's mine, near Deepwater, the coal is seen to rise and feather out on a rather steep slope of the Ferruginous sandstone. At other points, presumably farther out toward the main basin, a considerable body of shales and sandstones intervenes in the old embayments, although the interval has not yet been observed to reach 100 feet at any point in this part of the State, while landward the coal appears to have

[1] Bull. U. S. Geol. Surv., No. 124, 1895, pp. 53, 66, 129.

essentially fringed directly against the old continent. Even the Ferruginous sandstone appears here and there to have been either overlapped by the coal or eroded prior to the deposition of the latter. Thus, as Dr. Britts informs me, in artesian well No. 2, at Clinton, this sandstone was met at a depth of 40 feet, and was found to be about 20 feet thick; but at well No. 1, about 1 mile distant, no sandstone was found, the cherty Mississippian floor being reached at a depth of 50 feet.

From the foregoing stratigraphic references it appears (1) that the plant collections from Henry County, which furnished by far the greater part of the material herein considered, come from two horizons about 45 feet apart; and (2) that these horizons may be separated from the old Mississippian land surface by an observed thickness of nearly 100 feet of Mesocarboniferous sediments in the direction of deeper water, or that they may, landward, rest practically in direct contact with the old shore line in that region.

It is possible that in that portion of the State farther southwest, as in Barton County, in which the Lower Coal Measures sections can not definitely be correlated as to principal details with those of Henry County or the counties farther north, beds of the Lower Coal Measures and Pottsville series extending for some distance below the horizon of the Jordan coal may come to light along the western flank of the Ozark uplift. It is certain that the Pottsville is developed and is coal-bearing near Fayetteville in Washington County, Arkansas. But in the region of Henry County, at least, the richly phytiferous roof shales of the Jordan coal mark the time when the continental subsidence reached the vicinity of Clinton, and the abundant and varied flora is of a date which approximately marks in this region the close of the period intervening since the uplift of the Mississippian.

PALEONTOLOGIC METHODS EMPLOYED.

In the following notes and discussions it has seemed best to publish the results of a critical study and comparison, constituting essentially a revision of many of the species originally described from Missouri, as well as to give more detailed descriptions of or observations pertaining to other species. The descriptions of the species are based entirely on material from Missouri, and it is hoped that they are generally given in sufficient detail to enable geologists as well as paleontologists to recognize the various forms in the field. In some instances the scope of species has been narrowed and the lines of specific differentiation have been drawn more closely than they have usually been drawn in American literature, for the reason that a greater systematic refinement, if the types are uniform and are satisfactorily differentiated by the descriptions and illustrations, will better serve the purposes of stratigraphic paleontology.

A small number of species recorded by Professor Lesquereux as occurring in Henry County, Missouri, have not been found in the collections to which I have had access. These will be specially enumerated at the close of this report, although there is evidence that the record of several of them is based on geographic errors. Certain others will be met under different and sometimes unfamiliar names. A number of nomenclatural changes have been made in conformity with the rules generally observed by American zoologists or botanists.

The systematic arrangement, like that employed in previous publications, is in part temporary. Many questions of the classification of common Paleozoic species are still under debate, pending the acquisition of further knowledge of the internal structure, fructification, or geologic history of the various types. In the synonymy the references are chiefly confined to illustrated material. Effort has also been made to point out other plants in America or Europe that are closely related to our species, and to indicate the most important specific differences between them.

DESCRIPTIONS OF THE SPECIES.

CRYPTOGAMS.

ALGAE.

Cf. ACETABULARIÆ (?)

CONOSTICHUS Lesquereux, 1876.

Seventh Rept. Geol. Surv. Indiana, 1875, p. 142.

Stipe cylindrical, continuous; frond enlarging from the base upward in the shape of a plate or of a cup, or increasing by successive superimposed layers or concentric laminæ; top cup-shaped, concave.

The above diagnosis, given by Professor Lesquereux in the Coal Flora,[1] while differing greatly from the original, published in 1876, is substantially the same as that contained in the last memoir[2] in which this group of organisms was treated by that distinguished author. So far as I know, no other writer has discussed the nature or affinities of the fossils in the genus. When the genus was first established no further suggestion was offered as to its systematic relation than its inclusion in the title "Fossil marine plants." In the Coal Flora, however, Lesquereux remarks that "these organized bodies, whose reference to plants is questionable, have in their mode of growth a relation to some marine Algæ of our time, the *Acetabulariæ*, which bear, on a continuous stipe, successive umbrella-shaped fronds, the lower rendered solid by incrustation of calcareous matter." The fossils, whose substance appears to have been equally dense throughout, are further compared with *Zonaria*. Comparison is made with certain sponges, such as *Capellia rugosa* Goldf., *Camerospongia fungiformis* Goldf., and

[1] Vol. i., 1880, p. 14.

[2] Principles of Paleozoic Botany: Thirteenth Rept. Geol. Surv. Ind., 1883, pt. 2, p. 34.

Cœloptychium agaricoides Goldf., but the smooth surface and continuous axis in *Conostichus* are regarded by him as prohibiting any such association. In the last publication to which reference is made above, Lesquereux appears to have dismissed all doubt as to their vegetable nature, and we find that the plants of this group are "distantly" related to the living *Acetabulariæ.* The scanty material under my observation enables me to throw no light on this interesting problem. It may be remarked, however, that the superficial aspect of the fossils is somewhat suggestive of sponges. The types of the two following species were obtained from Vernon County, Missouri.

Conostichus Broadheadi Lx.

Pl. II, Figs. 1–5.

1879. *Conostichus Broadheadi* Lesquereux, Coal Flora, Atlas, p. 1, pl. B, figs. 1, 2; text, vol. i (1880), p. 15.

Stipe short, cylindrical, transversely ribbed; frond semiglobular, cup-shaped, concave inside, distinctly tricostate, and deeply wrinkled lengthwise on the outside; substance thick.

The figures 1 and 2 in pl. B of the Coal Flora, from which the above description is taken, represent views of the same specimen, which is now No. 250 of the Lacoe collection in the United States National Museum. So carefully are the illustrations made that there is little to be brought out by the photographic process. The strongly marked triradiate structure with the three main equidistant ridges extending from the mammillate base to the periphery of the cup is a somewhat conspicuous feature, as has been stated by Professor Lesquereux. But in other specimens the ribs are nearly equally prominent on all sides, and are provided with or interlarded with undulate rugose branchlets, suggesting delicate and graceful sculpture on the outer surface of the cup. One of these examples, from Arkansas, is shown in Pl. II, Fig. 4.

The type of fossil known as *Conostichus Broadheadi* appears to have been quite widely distributed in the Carboniferous, where its general occurrence in the Lower Coal Measures seems to bespeak for it a stratigraphic value, though its more exact range is not known to me.

Locality.—Near the base of the Coal Measures, about halfway between Nevada and Fort Scott, Vernon County, Missouri. Nos. 250, 251, Lacoe collection U. S. Nat. Mus. Also sent by Dr. Britts from Vernon County, Missouri; U. S. Nat. Mus., 6035.

CONOSTICHUS PROLIFER Lx.

Pl. II, Fig. 6.

1879. *Conostichus prolifer* Lesquereux, Coal Flora, Atlas, p. 1, pl. B, fig. 3; text, vol. i (1880), p. 16.

The specimen photographed in Pl. II, Fig. 6, is the only example of this curious form that has been found in the recent collections from Missouri or in the other collections in the United States National Museum. The type specimen is said to have come from this State. Although the figure is somewhat suggestive of a concretionary formation, the specimen may well be of the same nature as *Conostichus Broadheadi*, and, judging from the external features, its structure is comparable to what would result were several specimens of the latter species joined closely in longitudinal succession.

Locality.—About halfway between Nevada and Fort Scott, Vernon County, Missouri. Shale near base of the Coal Measures. (Lesq.)

FUNGI.

PYRENOMYCETEÆ.

HYSTERITES Unger, 1841.

Chloris Protogæa, vol. i, p. 1.

To this genus, established by Unger to contain those fossil fungi apparently most closely related to the living *Hysteria*, have been referred a considerable number of species by various authors.[1] Most of these species are of Tertiary age, but several are from the Cretaceous, while one has been reported by Nathorst from the Rhætic. It is interesting to learn that the Rhætic fungus, like the most ancient species with which we have to do, appears to have been parasitic on the leaves of Gymnosperms, *Hysterites Friesii* Nath.[2] having been found on the foliage of *Podozamites distans* (Presl) Fr. Br.

[1] Sixteen species are enumerated by Meschinelli, Sylloge Fungorum Fossilium, Patavii, 1892.

[2] Nathorst, Bidrag till Sveriges Fossila Flora, Stockholm, 1876, p. 11, pl. i, figs. 1, 2.

Hysterites Cordaitis Gr. 'Ey.

Pl. III.

1877. *Hysterites Cordaitis* Grand 'Eury, Fl. foss. carb. Loire, p. 10, pl. i, fig. 7.
1892. *Hysterites Cordaitis* Gr. 'Ey., Meschinelli, Sylloge Fung. Foss. (ex Saccardo: Sylloges Fung., vol. x), p. 37.
1893. *Hysterites Cordaitis* Gr. 'Ey., Potonié, Fl. Rothl. Thüringen, p. 25, pl. i, fig. 5.
1898. *Hysterites Cordaitis* Gr. 'Ey., Meschinelli, Fung. Foss. Iconogr., p. 47, pl. xv, figs. 7, 9 (non fig. 10).

Conceptacles numerous, somewhat massed or scattered upon the leaves of *Cordaites*, on which their existence seems to depend; quite constant in form; usually elongated in the same direction as the leaf, and opening on one face of the latter by a longitudinal vent of dehiscence, which makes them resemble the *Hysteriæ*.

The above diagnosis, quoted from Grand 'Eury's descriptive remarks, gives a general idea of the superficial aspect of this fungus, the anatomical features of which are still unknown. As is shown in Pl. III, Fig. *1a*, the perithecia in all our specimens are of the more or less elongated form characteristic of the species, which, as Grand 'Eury remarks, appears to be peculiar to *Cordaites*.

The Missouri examples of the species, seen on the leaves of *Cordaites communis* Lx., seem to agree well with the description and figures of the original specimens from the basin of the Loire in France. In many cases only the pit remains in the leaf substance, while in others the perithecia are not yet opened. I have seen similar remains on leaves of *Cordaites* from the anthracite regions of Pennsylvania. None of the remains which I refer to this species are of the form seen in the perithecia shown by Germar in his figure of *Neuropteris subcrenulata* The discussion by Grand 'Eury of this figure seems to have led Professor Meschinelli to the erroneous reference to the latter species as the host of *Hysterites Cordaitis*. It is possible that the round, oval, or oblong pits occurring between the nerves in some species of *Neuropteris*, and described by several authors as fern fructifications, may really represent a type of fungus inhabiting the pinnules of *Neuropteris*, and perhaps related to *Hysterites*. The question of the relationship of some of these to the living *Phyllachora*, pertinently suggested by the late Director Stur, is worthy of consideration.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5418.

SPHÆROPSIDEÆ.

EXCIPULITES Goeppert, 1836.

Systema Filicum Foss., p. 262.

Excipulites Callipteridis (Schimp.) Kidst.

Pl. IX, Figs. 4, 4*a*.

1869. *Excipula Callipteridis* Schimper, Traité, Atlas, p. 14, pl. xxii, figs. 6, 7; text, vol. 1, p. 142.
1869. *Excipula Callipteridis* Weiss, Fl. jüngst. Steink. Rothl. Saar-Rh. Geb., p. 19.
1879. ——— ——— Lesquereux, Coal Flora, Atlas, pl. xxxviii, fig. 2 (on *Pseudopecopteris anceps*).
1887. *Excipulites Callipteridis* (Schimp.) Kidston, Foss. Fl. Radstock Ser., p. 339.
1892. *Excipulites Callipteridis* (Schimp.) Kidst., Meschinelli, Syll. Fung. Foss., p. 52.
1898. *Excipulites Callipteridis* (Schimp.) Kidst., Meschinelli, Fung. Foss. Iconogr., p. 75, pl. xxi, figs. 10, 10*a*.

The punctations or dots described and figured by Lesquereux[1] as occurring on the pinnules of *Pseudopecopteris anceps* Lx. have been correlated by Kidston and Meschinelli with the *Excipula Callipteridis* found by Schimper on the pinnules of *Callipteris conferta.* These minute fossils are obscurely noticeable in portions of a specimen of *Pseudopecopteris squamosa* (Lx.), Pl. IX, Fig. 4 (*Pseudopecopteris anceps* Lx.), from Missouri, though they are not so clearly presented as is often the case in the material from Cannelton, Pennsylvania, where they appear as clearly interneural minute pustules situated within the lamina, and giving to the unaided eye the impression of very small dots scattered over the pinnule.

As Kidston remarks,[2] it is a matter of interest that this species should be found in both Europe and America on the same host, *Sphenopteris neuropteroides* Boulay, on which *Excipulites Callipteridis* has been found by Kidston and Zeiller,[3] being recognized by those authors as identical with *Pseudopecopteris anceps* Lx.

Locality.—On a specimen of *Pseudopecopteris squamosa* from Pitcher's coal bank, sent for examination by Dr. J. H. Britts, of Clinton, Missouri.

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[1] Coal Flora, vol. i, p. 207, pl. xxxviii, fig. 2.
[2] Foss. Fl. Radstock Series, p. 339.
[3] Bull. Soc. géol. France, (3) vol. xii, p. 192.

PTERIDOPHYTA.

FILICALES.

TRIPHYLLOPTERIDEÆ.

EREMOPTERIS Schimper, 1869.

Traité pal. vég., Vol. I, p. 416.

In the American Paleozoic flora the genus *Eremopteris* was given a broad interpretation by Professor Lesquereux,[1] so as to include a number of species referred by other authors to *Sphenopteris*, *Asplenites*, and *Rhacopteris*. It appears in a variety of forms at the base of the Mesocarboniferous, or Carboniferous proper, and it seems in its broader application to be directly allied to the Triphyllopterid group, which is characteristic of the base of the Eocarboniferous, and from which it seems to constitute a transition to the Pseudopecopterid group, such as *Ps. obtusiloba* (Brongn.) Lx., through *Eremopteris Cheathami* Lx. and other forms found in the Pottsville series. The division of the genus with more delicately dissected pinnæ appears to lead through the *E. missouriensis* type to the *Diplothmema furcatum* (Brongn.) Stur type. It is possible that the Missouri plants should be placed in the latter genus as restricted by Zeiller, with which they probably agree as to the bifurcation of the frond. But the same character is, I believe, present in the Triphyllopterid group; and the flabellate, bifid, or trifoliate aspect of our forms leads me to adopt the reference made by Lesquereux in placing them in the genus that is closer to *Triphyllopteris* Schimp.

EREMOPTERIS MISSOURIENSIS Lx.

Pl. V, Figs. 1–3; Pl. VI.

1879. *Eremopteris missouriensis* Lesquereux, Coal Flora, Atlas, p. 9, pl. liii, figs. 8, 8*a*; text, vol. i (1880), p. 295.

1880. *Sphenopteris* (*Hymenophyllites*) *splendens* Lesquereux, Coal Flora, vol. i, p. 282 (pars; non pl. lvi, figs. 4, 5).

1884. *Sphenopteris* (*Hymenophyllites*) *spinosa* Goepp., Lesquereux, Coal Flora, vol. iii, p. 880 (pars). Record in list.

1884. An *Sphenopteris* (*Hymenophyllites*) *furcata* Brongn., Lesquereux, Coal Flora, vol. iii, p. 880 (pars)? Record in list.

Fronds lax, intricate, flexuous, once or twice dichotomous, tri- or quadripinnate; rachis of the superior orders flexuous, sometimes subge-

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[1] Coal Flora, vol. i, 1880, p. 292 et seq.

niculate, slender, flat or canaliculate above, round-terete beneath, lineate, bordered on either side by a rugose-lineate lamina nearly equaling the axis in width; primary pinnæ not very large, palmate above the very open-angled dichotomies; secondary pinnæ ovate, deltoid, or triangular, rather dense, often slightly geniculate toward the base to suit the origin of the tertiary pinnæ; tertiary pinnæ alternate, open, the lower at a right angle to the axis or slightly reflexed, the basal ones shorter, close, often slightly overlapping, often flexuous, linear-triangular, acute; pinnules or inferior divisions open near the base, oblique farther up, sometimes a little distant, but generally close or partly overlapping, alternate, variable in size, more or less broadly ovate or triangular, the basal ones palmate, more or less deeply cut in subdivisions or lobes, decurrently alate; lobes or ultimate divisions linear, obcuneate or somewhat narrowly obovate, decurrent, obtusely pointed, obtuse, often truncate-emarginate or shallowly bifid at the apex; nervation thin, often obscured; primary nerve decurrent, forking near the base to supply each division, or again at the base of each lobe, a single nervil entering into and passing to the apex of each lobe or tooth; lamina moderately thick, rugose, with fine, short bristles or very narrow scales appressed parallel to the nervation.

This species, represented by a large suite of specimens, shows considerable variation in the outlines of the ultimate pinnæ or pinnules, according to their position in the frond and the degree of their development. Sometimes the lower basal pinnules in the lower part of the frond present a form resembling *Sphenopteris spinosa*, while those near the end of the upper pinnæ approach *Sphenopteris furcata;* and, in fact, an examination of the specimen on which the record[1] of the occurrence of the latter species in this region appears to be based, shows clearly that it is a part of the marginal portion of a frond of *Eremopteris missouriensis.* I have seen precisely the same form on a rock in direct union with the normal form of the Missouri species. Moreover, I am unable to find any distinctive characters by which specimens from this region labeled *Sphenopteris spinosa* Goepp. and *Sphenopteris splendens* by Lesquereux can be even varietally separated from the fine series of examples of *Eremopteris missouriensis.*

The original description and illustration of *Eremopteris missouriensis,*

[1] Coal Flora, vol. iii, p. 880.

prepared by Professor Lesquereux from a small, badly broken specimen, loaned to me through the courtesy of Dr. Britts, is necessarily insufficient; a careful inspection with a weak glass shows the outline, nervation, and striated surface to be the same as those seen more clearly on the better-preserved specimens, some of which came from the same bed as the original. My comparisons have been further aided by reference to a number of other examples identified by Professor Lesquereux since the publication of the species, and loaned by Dr. Britts, as well as by reference to the Lacoe collection.

The frond of *Eremopteris missouriensis* is tripinnate, if not quadripinnate, appearing bifurcated at the base, the pinnæ long, flexuous, often slightly geniculate, and tapering to an acute point. The lobes of the pinnules, as seen in Pl. V, Figs. 2, 3, are always blunt, usually rounded at the end, and in very many cases have a sinus in a truncate-obcordate apex. The ultimate pinnæ are more deeply divided and more symmetrical than represented in pl. liii, figs. 8, 8*a*, of the Coal Flora, while the nervation, like that seen in many species of *Diplothmema*, consists of a single large flexuous nerve passing into the pinnule and forking to permit a single nervil to pass up into each lobe.

The surface of the entire pinnule is striate with fine dark lines, apparently composed of rows of short, closely appressed hairs or narrow hair-like scales which are parallel to although entirely independent of the nervation, as is strongly shown in slightly macerated specimens, or especially clearly when the impression of the under surface of the limb is exposed. This striation has been mistaken for and inaccurately represented as nervation in the above-mentioned figure. Those specimens which I have seen from the same locality, labeled *Sphenopteris furcata* and *Sphenopteris splendens* by Professor Lesquereux, I have found to be indistinguishable by any character from *Eremopteris missouriensis*.

It is quite possible that *Eremopteris missouriensis* should be placed in the genus *Diplothmema*, between which genus and *Eremopteris* it seems to be intermediate. It would not be at all surprising if the mode of division characteristic of *Diplothmema* were discovered in *Eremopteris missouriensis*. The resemblance of our species to *Diplothmema palmatum* (Schimp.) Stur[1]

[1] Stur, Farne der Carbon-Flora, p. 310, pl. xxvii, fig. 3.

appears so great, at least superficially, as to cause one to question whether there is more than a varietal distinction between the two.

Our species is quite distinct from the smoother, more lax *Sphenopteris furcata*, which has more acute, generally larger lobes, and which, with its very closely related species, *Sphenopteris Royi* Lx., seems to be largely confined to the "Conglomerate series" or Pottsville series. *Sphenopteris splendens* Lx. and *Sphenopteris spinosa* Goepp. are very insufficiently represented in the collections from other localities. Consequently no attempt will be made at this time to point out the differences between these species and *Eremopteris missouriensis.*

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5512, 5513, 5657, 5659, 5681, 5682; Hobbs's coal bank, U. S. Nat. Mus., 5509, 5670; Owens's coal bank, U. S. Nat. Mus., 5514; Deepwater, U. S. Nat. Mus., 5510, 5511; Henry County, Missouri, U. S. Nat. Mus., 5508, 5515.

EREMOPTERIS BILOBATA n. sp.

Pl. IV; Pl. V, Figs. 4–6.

Fronds apparently large, sinuous, quadripinnate; rachis broad, flexuous, canaliculate above, raised beneath, consisting of a compact pithy (?) portion, occupying one-third of the entire width, with broad, flattened vascular borders; primary pinnæ alternate, open, spreading somewhat irregularly, tapering from near the base to the acute apex; secondary pinnæ nearly at right angles below, becoming more oblique above, alternate, corresponding to the bends in the rachis, slightly overlapping, ovate or oblong, acute, terminating in a spiny prolongation of the rachis; secondary rachis somewhat flexuous, sharply striate, bordered by a thick lamina from the decurring pinnules or ultimate pinnæ; pinnules alternate, more or less open, close to one another, often slightly overlapping, decurrent, more or less constricted at the base, usually with very broad attachment, ovate-deltoid when compound, becoming triangular or oblong-triangular and acute in passing into pinnæ, truncate-lobate, or more or less deeply cut into broadly obcuneate, truncate lobes, the latter usually once or twice somewhat bilobate or sub-bilobate, the lobes always broadly cuneate, truncate, emarginate, or sub-bilobate, often thickened at the top, spreading in the process of development; lamina thick, with dull luster, covered, like the rachis, with clear, sharp, irregular, fine intermittent striæ, parallel in general to the nervation, and apparently representing rows of closely appressed trichomes or scales; nervation Pseudopecopteroid, though usually totally obscured in the coriaceous lamina, the nerves originating in a single decurrent bundle and forking twice or more at a moderate angle, while arching to meet the borders nearly at a right angle.

The material before me, while clearly representing a well-defined species, does not exhibit the pinnation sufficiently completely to give an entirely satisfactory diagnosis of the frond. The rachis, with broad, leathery border, a portion of which, seen from beneath, is shown in Pl. IV, is strikingly similar to that seen in a remarkably fine slab of *Mariopteris nervosa* in the Lacoe collection, which affords very interesting evidence of a lax or possibly a prostrate habit of growth for those ferns.

The most remarkable and constant character is the spreading, very broadly cuneate, truncate lobe, dividing once or more according to an unequally bilobate system, as seen in Figs. 5, 6, Pl. V.

This mode of lobation is very nearly like that of *Eremopteris Cheathami* Lx.,[1] or *Sphenopteris solida* Lx.,[2] while the elongation of the rachis into a blunt, spiny production in the process of pinnation is like that seen in the group represented by *Mariopteris* (or "*Pseudopecopteris*") *muricata.* The *Sphenopteris solida* of Lesquereux may at some future time be identified with our species; for the specimen published in the Coal Flora was shown so erroneously, without uncovering the lobes of the pinnules or depicting the rachial characters, that I am not wholly certain that my separation of *Eremopteris bilobata* is really correct. The former should be re-illustrated.

The species seems, notwithstanding its Pseudopecopteroid characters, to be properly included in the genus *Eremopteris*, although constituting one of the several intermediate forms that, in my opinion, show the relation of *Pseudopecopteris* to *Triphyllopteris*, through the Eremopteroid types.

Locality.—Specimens sent by Dr. Britts, in 1892, as a special consignment, from Owens's coal bank; U. S. Nat. Mus., 5659, 5699, 5700, 5701, 6036.

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[1] Coal Flora, vol. iii, p. 769, pl. ci, fig. 3.

[2] Op. cit., p. 770, pl. civ, figs. 2–4. It may, indeed, well be asked whether all these do not belong to the same genus.

PSEUDOPECOPTERIS Lesquereux, 1880.

Coal Flora, vol. i, p. 189.

Before introducing in the same classification the terms *Mariopteris* and *Pseudopecopteris*, concerning the application of which there seems to be some confusion, I wish to explain briefly my interpretation of the scope and relation of the groups originally and properly included under each generic name.

It will be remembered that the genus *Pseudopecopteris*, as first proposed by Lesquereux,[1] was so defined essentially as to contain that portion of Stur's genus *Diplothmema*[2] comprising the species with Pecopteroid and Neuropteroid pinnules. In another place[3] I have already referred to the relations of the genus *Mariopteris* Zeiller,[4] which was founded on a still more restricted portion of Stur's genus. The original scope of the genus *Pseudopecopteris*, as seen by the diagnosis[5] and figures, when compared with the scope of the genus *Mariopteris*[6] which antedates it, shows that the two genera are largely the same, the latter being entirely included in the former, though the essential characters are not similarly defined. It is not improbable that Professor Lesquereux, had he been aware of Professor Zeiller's work, would have either adopted the latter's classification or amended the genus *Mariopteris*, extending it to include the Neuropteroid group of

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[1] Coal Flora, vol. i, 1880, p. 189.

[2] Culm-Flora, vol. ii, 1877, pp. 226, 233.

[3] Bull. U. S. Geol. Surv., No. 98, 1893, p. 46.

[4] Bull. Soc. géol. France, (3) vol. vii, 1878, p. 93. Fl. foss. terr. houill. Fr., 1878, pl. clxvii, fig. 5; text (1879), p. 68. Fl. foss. houill. Valenciennes, text (1888), p. 159.

[5] "Primary rachis forking near the base in diverging branches of equal size, or divaricate and dichotomous; branches polypinnate, ultimate divisions often forked; pinnules connate or separated to the base, of various shape, oblong-obtuse or ovate-lanceolate, oblique or in right angle, decurring to the rachis and bordering it by a narrow wing; lateral veins oblique, generally forking once, the lowest pair twice." Coal Flora, vol. i, 1880, p. 189.

[6] "Fronde composée de pennes quadripartites, à sections bipinnées; le rachis primaire émit des rameaux alternes, nus, qui se bifurquent sous un angle plus ou moins ouvert en deux courtes branches symétriques, dont chacune se bifurque à son tour en deux pinnes bipinnées, la penne extérieure par rapport à la bifurcation principale étant plus petite que celle qui se trouve du côte intérieur. Pinnules plus ou moins rapprochées, tantôt soudées les unes aux autres, tantôt libres et contractées à la base, obliques et un peu décurrentes sur le rachis, entières ou divisées en lobes peu profonds. La pinnule inférieure de chaque penne secondaire est habituellement d'une forme un peu différente de celles qui suivent, lobée au pinnatifide. Nervure médiane nette, se prolongeant presque jusqu'au sommet des pinnules, décurrente à la base sur le rachis; nervures secondaires très-obliques, généralement dichotomes, se divisant sous des angles aigus, naissant pour la plupart de la nervure médiane, mais quelques-unes, à la base, naissant directement du rachis. Fructification inconnue." Vég. foss. terr. houill. Fr., p. 68, 1879.

Sphenopterids; or he might have restricted the genus *Pseudopecopteris* to the species which would remain in it at present after taking out those covered by the characters of *Mariopteris*. Thus it appears that the chief difference—a rather important one—in the original scope of the two genera was the inclusion of the round pinnuled or Neuropteroid Sphenopterids in Lesquereux's genus. The inclusion in *Pseudopecopteris* of certain Pecopteroid species, on account of a supposed method of division in their fronds, is a subordinate feature and need not be considered at present.

In my report on the plants from the Carboniferous outliers,[1] I have referred *Pseudopecopteris mazoniana* Lx. to the genus *Mariopteris* on account of its apparent affinities with the *muricata* group. Although after an examination of the figured specimens from Mazon Creek, Illinois, I am inclined to believe that not all the examples identified by Lesquereux as *Pseudopecopteris mazoniana* belong in reality to the same species, it still seems to me probable that some of the types of that species, which was given first place in the genus *Pseudopecopteris* by its author, belong properly to the *muricata* group. This group, as Zeiller remarks, is very homogeneous, being composed of quadripartite fronds of the *Diplothmemæ* with Pecopteroid pinnules, the well-developed lamina being entire or slightly lobed or denticulate. Naturally in a classification depending largely on the mode of the basal division of the fronds it is often impossible to determine definitely as to this character; and the grouping in such cases is dependent on the features and analogy of the other parts. Thus there seems little doubt of the unity of *Ps. nervosa* (Brongn.) Lx., *Ps. muricata* (Schloth.) Lx., *Ps. latifolia* (L. & H.) Lx., *Odontopteris sphenopteroides* Lx., and *Ps. acuta* (Brongn.) Lx. within the same group; and in most of these species the quadripartite character of the frond has been observed, showing their identity with the genus *Mariopteris* Zeill. I have seen the same mode of division in *Ps. Newberryi* Lx., and it seems probable that it will also be found to exist in *Ps. cordato-ovata* (Weiss) Lx. and *Ps. Sillimanni* (Brongn.) Lx., while several of the forms still included by Zeiller in the genus *Diplothmema* bear signs of a generic relation to *Mariopteris muricata* (Schloth.) Zeill.

In my former remarks on the subject I was disposed to consider the greater portion of the species in *Pseudopecopteris* as having the essential

[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 46.

frond divisions of *Mariopteris*, thus leaving no good reason for the continuance of the former genus. So far as I am aware, however, this mode of division has not yet been seen in the group represented by *Pseudopecopteris obtusiloba* or *Ps. anceps* Lx. (*Sphenopteris neuropteroides* Boulay), which is still included by most European authors in the genus *Sphenopteris*, although it is generally recognized as distinct from the true Sphenopterids. This group is one of considerable solidarity, the line of demarcation between it and the other species of *Sphenopteris* being fully as distinct as that between many of the familiar genera resting on the superficial characters of the sterile fronds in the Carboniferous flora. For this reason, which was largely the cause of its inclusion by Lesquereux in the genus *Pseudopecopteris*, I would, after removing those species which conform to the older genus *Mariopteris*, propose to restrict the genus *Pseudopecopteris* to the very natural group of large-round-pinnuled species[1] typically represented by the *Sphenopteris obtusiloba* of Brongniart.

Although these generic divisions are artificial, and the species now associated in a genus may eventually be found to belong to entirely different orders, I believe that the interests of the study of the Carboniferous flora will be promoted by the maintenance of the genera *Mariopteris* and *Pseudopecopteris*, as above restricted, *Diplothmema* being reserved for the group of dissected forms, of which *D. furcatum* (Brongn.) Stur is a typical example. In this classification *Mariopteris* Zeill. includes the Pecopteroid or Alethopteroid forms, in which the primary pinnæ are divided by a double dichotomy into four divisions of equal rank, while *Pseudopecopteris* may comprise the round-lobed or round-pinnuled[2] species of the type of *Sphenopteris obtusiloba* Brongn. The fronds of this type, to which among others I would refer *S. Schillingsii* Andrä, *S. solida* Lx., and *S. neuropteroides* Boulay, are perhaps dichotomous in the lower part, though a quadripartite habit has not, I believe, been observed.

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[1] The relations of several species, like *Ps. Sheaferi* Lx., placed in the section "Gleichenites" by Lesquereux, but the relation of which to the *obtusiloba* group seems very distant, if observable, can best be treated in a revision in detail of the material included in the genus *Pseudopecopteris*.

[2] Section "Neuropteroides" of Brongniart, in part.

PSEUDOPECOPTERIS OBTUSILOBA (Brongn.) Lx.

Pl. VII, Figs. 1–3; Pl. VIII.

1829. *Sphenopteris obtusiloba* Brongniart, Hist. vég. foss., p. 201, pl. liii, fig. 2.*
1848. *Sphenopteris obtusiloba* Brongn., Sauveur, Vég. foss. terr. houill. Belg., pl. xv, fig. 2.
1853. *Sphenopteris obtusiloba* Brongn., Newberry, Ann. Sci., Cleveland, vol. i, 9, p. 106.
1855. *Sphenopteris obtusiloba* Brongn., Ettingshausen, Steinkohlen-Fl. Radnitz, p. 37, pl. xxi, fig. 2.
1860. *Sphenopteris obtusiloba* Brongn., Lesquereux, Rept. Geol. Surv. Arkansas., vol. ii, p. 315.
1860. *Sphenopteris obtusiloba* Brongn., H. C. Wood, Proc. Acad. Nat. Sci. Phila., vol. xii, p. 440.
1874. *Sphenopteris obtusiloba* Brongn., O. Feistmantel, Verst. böhm. Kohlen-Abl., vol. i, pl. i, fig. 9.
1876. *Sphenopteris obtusiloba* Brongn., Ferd. Roemer, Leth. Geogn., Pal., Atlas, pl. li. figs. 1*a*, 1*b*; text (1880), p. 169.
1878. *Sphenopteris obtusiloba* Brongn., Zeiller, Vég. foss. terr. houill., Atlas, pl. clxiii, figs. 1, 2; text (1879), p. 39.
1879. *Sphenopteris obtusiloba* Brongn., Schimper, in Zittel: Handb. Pal., vol. ii, p. 108, fig. 77.
1881. *Sphenopteris obtusiloba* Brongn., Weiss, Aus d. Fl. d. Steinkohl., pl. xi, figs. 67, 67*a*.
1883. *Sphenopteris obtusiloba* Brongn., Renault, Cours bot. foss., vol. iii, p. 190, pl. xxxiii, figs. 5, 6.
1886. *Sphenopteris obtusiloba* Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, figs. 1, pl. iii, 1*a*, 2, 2*a*; pl. iv, fig. 1; text (1888), p. 65.
1897. *Sphenopteris obtusiloba* Brongn., Potonié, Lehrb. d. Pflanzenpal., p. 137, fig. 131.
1833. *Sphenopteris irregularis* Sternberg, Versuch, vol. ii, fasc. 5–6, p. 63, pl. xvii, fig. 4; fasc. 7 u. 8, p. 132.
1855. An *Sphenopteris irregularis* Sternb., Geinitz, Verst. Steink. Sachsen, p. 14, pl. xxiii, figs. 2–4 (excl. syn.)?
1860. *Sphenopteris irregularis* Sternb., F. A. Roemer, Palæontographica, vol. ix, p. 24, pl. iv, fig. 5.
1866. *Sphenopteris irregularis* Sternb., Andrä, Vorweltl. Pfl. Steink., p. 26, pl. viii, pl. ix, fig. 1.
1869. *Sphenopteris irregularis* Sternb., von Roehl, Foss. Fl. Steink. Westphalens, p. 56, pl. xvi, fig. 2 (?); pl. xxxi, figs. 5, 6.
1836. *Cheilanthites obtusilobus* (Brongn.) Goeppert, Systema, p. 246.
1836. *Cheilanthites irregularis* (Sternb.) Goeppert, Systema, p. 247.
1836. *Sphenopteris latifolia* Lindley and Hutton, Fossil Flora, vol. iii, pl. clxxviii.
1848. *Sphenopteris trifoliolata* (Artis?) Brongn., Sauveur, Vég. foss. terr. houill. Belg., pl. xix, fig. 2; pl. xxi.
1869. *Sphenopteris trifoliolata* (Artis?), von Roehl, Foss. Fl. Steink. Westphalens, p. 65, pl. xvi, fig. 3 (excl. syn.).
1869. *Sphenopteris* (*Aneimioides*) *obtusiloba* Brongn., Schimper, Traité, vol. i, p. 399, pl. xxx, fig. 1.

1869. *Sphenopteris* (*Gymnogrammides*) *irregularis* Sternb., Schimper, Traité, vol. i, p. 373.
1877. *Diplothmema obtusilobum* (Brongn.) Stur, Culm-Flora, vol. ii, p. 124 (230).
1885. *Diplothmema obtusilobum* (Brongn.) Stur, Farne d. Carbon-Fl., pp. 296, 354, pl. xxv, figs. 8*a–c*; pl. xxv*b*, fig. 1.
1888. *Diplothmema obtusilobum* (Brongn.) Stur, Toula, Die Steinkohlen, p. 187, pl. i, figs. 7, 8.
1877. *Diplothmema irregulare* (Sternb.) Stur, Culm-Flora, vol. ii, p. 124 (230).
1885. *Diplothmema irregulare* (Sternb.) Stur, Farne d. Carbon-Flora, p. 296.
1879. *Pseudopecopteris irregularis* (Sternb.) Lesquereux, Coal Flora, Atlas, p. 8, pl. lii, figs. 1–3 (8?); text, vol. i (1880), p. 211.
1884. *Pseudopecopteris obtusiloba* (Brongn.) Lesquereux, Coal Flora, vol. iii, p. 753.
1889. *Pseudopecopteris obtusiloba* (Brongn.) Lx., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 803, text fig.
1893. *Sphenopteris* (*Pseudopecopteris*) *obtusiloba* Brongn., D. White, Bull. U. S. Geol. Surv., No. 98, p. 52.

Fronds tripinnate or quadripinnate below; rachis strong, flat, naked, striated, slightly undulate below, becoming more flexuous toward the tip; primary pinnæ broad, lanceolate, acute, pinnatifid to near the extreme apex; secondary pinnæ at right angles below, becoming oblique above, alternate, distant, contiguous or slightly imbricated, linear-lanceolate, acute, straight or curved, those in the middle and lower portions of the primary pinnæ provided with pinnæ of the third order, those above bearing reduced tertiary pinnæ or pinnatifid pinnules, those still nearer the top being provided with large, broad, rather triangular-ovate pinnules, divided into 3 to 5 more or less deeply separated, round-obtuse lobes; secondary and tertiary rachises narrow, more or less distinctly flexuous to correspond to the insertion of the pinnæ or pinnules, but sometimes appearing nearly straight, sulcate above, rounded on the lower side, finely and evenly striate, bordered by narrow laminæ; tertiary pinnæ distinct, alternate, usually close, sometimes distant, or even overlapping, the lower ones at a right angle to the secondary rachis, the upper somewhat oblique, 12–22 mm. long, 5–12 mm. wide, more or less acutely pointed, provided with 2 to 5 pairs of alternate, sessile, or broad-pedicellate, half-round, ovate, or reniform and dilated, usually more or less distinctly trilobate pinnules, generally close or slightly imbricated, those in the lower part of the frond more distant, slightly decurrent; surface of the pinnules coriaceous, curved backward somewhat near the border, and marked between and parallel to the nerves with close, minute striæ; margins apparently thickened and traversed on the upper side by a narrow furrow or gutter; pinnules of the upper secondary pinnæ broad, more or less deeply dissected into 3, sometimes 4, broad, rounded or truncate-rounded, or obovate lobes, the lowest pair of the pinnules of the pinnæ subpalmately divided into 4 to 6 lobes, one or more of the divisions sometimes elongated, those pinnules toward the top of the pinnæ becoming less distinctly lobed and approaching the proportions of those borne on the tertiary pinnæ; primary nerves originating at a narrow angle and curving outward, dichotomizing, the secondary nerves forking and curving, indistinct, to the border; fructification unknown.

The excellent suite of specimens from Missouri representing *Sphenopteris obtusiloba* Brongn. has already been described somewhat fully.[1] The lines of the differentiation of this species from *Sphenopteris trifoliolata* Artis are still uncertain, although it is quite well recognized that more than one species is included under the two names.

The examination of the originals of the *Pseudopecopteris irregularis* (Sternb.) Lx. figured[2] from the same locality as some of the specimens before me, and a comparison of these with material from the same place, published later by Lesquereux[3] as *Pseudopecopteris obtusiloba* (Brongn.), show that, so far as the specimens from Missouri are concerned, the only difference between the few examples identified by that author is that of size. The more complete representation shows every gradation from the small fragments such as that figured as *Ps. irregularis* in the Coal Flora, or Fig. 1, Pl. VII, and the average proportions, there being no specific distinction between them. The specimens illustrated on Pl. VII, Figs. 2, 3, and Pl. VIII, show well the general aspect of fragments from the various parts of the primary pinnæ. Many of the trilobate pinnules of the form seen in the upper part of Pl. VII, Fig. 3, enlarged in Pl. IX, Fig. 5, somewhat resemble the *Pseudopecopteris anceps* Lx.[4]

The collection of specimens from other American localities identified as *Pseudopecopteris obtusiloba* seems to show several phases of this species, one or more of which may deserve at least varietal distinction, while it is possible that the true *Sphenopteris trifoliolata* of Artis is also present.

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[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 53.

[2] Lesquereux, Coal Flora, vol. i, p. 212, pl. lii, figs. 1, 2.

[3] Op. cit., vol. iii, p. 753.

[4] *Pseudopecopteris squamosa* (Lx.) has priority over *Ps. anceps*, which is identified by Zeiller and Kidston as *Sphenopteris neuropteroides* (Boulay) Zeill.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5440, 5441, 5624, 5625, 5627, 5628, 5629, 5635, 5716, 5717, 5718; Henry County, U. S. Nat. Mus., 5438. Hobbs's coal bank, U. S. Nat. Mus., 5439.

PSEUDOPECOPTERIS SQUAMOSA Lx. sp.

Pl. IX, Fig. 4.

1854. *Sphenopteris squamosa* Lesquereux, Bost. Journ. N. H., vol. vi, No. 4, p. 420.
1858. *Sphenopteris squamosa* Lesquereux, Geol. Pennsylvania, vol. ii, p. 862, pl. x, fig. 3.
1876. *Pecopteris neuropteroides* Boulay (non Kutorga), Terr. houill. n. d. Fr., p. 32, pl. ii, figs. 6, 6*b*.
1879. *Pseudopecopteris anceps* Lesquereux, Coal Flora, Atlas, p. 7, pl. xxxviii, figs. 1–4; text, vol. i (1880), p. 207 (cum syn.).
1889. *Pseudopecopteris anceps* Lx., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 796, text-figs.
1883. *Sphenopteris nevropteroides* (Boul.) Zeiller, Ann. Sci. Nat., (6) bot., vol. xvi, p. 186.
1886. *Sphenopteris nevropteroides* (Boul.) Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. ii, figs. 1, 1*a*, 2, 2*a*; text (1888), p. 349.
1887. *Sphenopteris neuropteroides* (Boul.) Zeill., Kidston, Foss. Fl. Radstock Ser., p. 349.
1897. *Pseudopecopteris squamosa* (Lx.) D. White, Bull. Geol. Soc. Amer., vol. viii, p. 291.
1899. *Pseudopecopteris squamosa* (Lx.) D. White, 19th Ann. Rept. U. S. Geol. Surv., 3, p. 474.

"Frond compound, multifid, dichotomous or quadripinnate; primary rachis broad; pinnæ of the third order, oblique, distant, rigid or flexuous; ultimate pinnæ short, inclined upward, lanceolate or oblong, obtuse, pinnately lobed; pinnules short, round, ovate or subquadrate, connate at the base, the lower generally free, the upper joined to the middle; upper pinnæ simple, undulate by the gradual cohesion of the lobes; veins forking twice, curving to the borders, all derived from a thin midrib of the same size as the veins."

Although this species, familiar to paleontologists as *Pseudopecopteris anceps*, is not rare in the Coal Measures of Pennsylvania, where it is obtained from many localities, it is only recently that it has been collected west of the Mississippi River. Even now it is, so far as I know, represented only by the specimen illustrated, Pl. IX, Fig. 4, which was loaned to the United States Geological Survey by Dr. Britts. Owing, therefore, to the paucity of material from Missouri, the above description is that given by Professor Lesquereux under *Pseudopecopteris anceps* in the Coal Flora. The Missouri plant appears to differ from the type only by a slightly closer arrangement of the nerves.

The identity of *Sphenopteris squamosa* Lx. and *Pseudopecopteris anceps* Lx., signified by the inscription of the former as a synonym preceding the description, is evident from a comparison of the figure of *Sphenopteris squamosa* given in the Geology of Pennsylvania[1] with the fine series, including the types from Cannelton, Pennsylvania., now resting in the Lacoe collection. The equivalence of *Pseudopecopteris anceps* Lx. with the *Pecopteris neuropteroides* of Boulay, first recognized by Zeiller, was soon afterwards corroborated by Kidston,[2] after a comparison of the European material with specimens from Pennsylvania. Those specimens which I have seen from the Radstock coal field or the Department of Pas-de-Calais, seem to represent a form with smaller pinnules than those in our common type, although there appears to be no important difference between them. It is probable that the few fragments in our collections may be below the average in respect to size of the pinnules.

That *Pseudopecopteris squamosa*, as a whole, was very large is shown by many fine fragments of fronds found near Pittston, Pennsylvania, in one of which (No. 3431 of the Lacoe collection) we find a segment of a rachis 15 mm. wide, giving off two opposite branches, each nearly 10 mm. in width. I do not, however, remember noticing dichotomous fronds conforming to the description, the general habit being a pinnate branching like that shown in pl. xxxviii of the Coal Flora.

The punctation seen frequently on the surface of the pinnules of this species, as illustrated in fig. 2 of the Coal Flora, and which is obscurely observable with the aid of a lens in the Missouri specimen, has been identified by Kidston[3] and Meschinelli[4] with the *Excipulites Callipteridis* (Schimp.) Kidst. These dots, which generally show as small pustules, are distinctly interneural, and are strongly suggestive of glands. They are possibly comparable to the cavities occupied by ovoid granules found by Renault[5] in *Alethopteris aquilina*.

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[1] Vol. ii, 1858, p. 862, pl. x, fig. 3.

[2] Foss. Fl. Radstock Ser.; Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 349.

[3] Loc. cit., p. 339.

[4] Sylloge Fungorum Fossilium, 1892, p. 52.

[5] Cours. bot. foss., vol. iii, 1883, pl. xxvii, fig. 10.

Pseudopecopteris squamosa may readily be distinguished from *Pseudopecopteris obtusiloba* by the more regular, compact, oblique pinnules, which are much less constricted at the base, the texture being thinner and not so leathery, and the rugosity, irregularly striate in the direction of the nerves, while the thin and rather close nerves of the former may be observed without the aid of a glass in most of the specimens.

Locality.—From Pitcher's coal bank. Specimen in the cabinet of Dr. J. H. Britts, Clinton, Missouri.

PSEUDOPECOPTERIS sp.

Pl. VII, Figs. 4, 5.

The peculiar specimens figured are the largest of the very few fragments of this plant I have seen among the hundreds of fossils from Owens's bank, Henry County, Missouri. The larger fragment appears to represent the upper portion of a lateral secondary pinna. The rachis is strong, sulcate, and apparently obscurely alate. The lateral pinnæ are alternate or subalternate, straight, rigid, with a rather strong percurrent, narrowly winged rachis, which is produced as a spine. The pinnules are close, generally slightly overlapping, 3 to 5-lobate below, passing into pinnæ, ovate, round, reniform, or obovate above, attached by a very broad subpedicel to the decurrent lamina along the rachis. The limb, which is very thick and coriaceous, is covered by rough striæ or rows of scales or closely appressed hairs radiating in a system parallel to the nervation, which is too much obscured for definite discernment. The other fragment, while conforming with the characters of the specimen just described, is specially notable on account of the well-developed terminal spine.

Although the fragments apparently belong to a hitherto undescribed species, I hesitate to so designate them on account of lack of sufficient material. The more distinctive characteristics of the plant are the very small size of the pinnules, the broad footstalks of the latter, the rounded or semitruncate lobes and pinnules, which are frequently reniform, and the thick, scaly surface. The fragment clearly belongs to the *Pseudopecopteris obtusiloba* group, and is perhaps nearer to *Ps. trifoliolata* or *Ps. nummularia* than to any other known species. The specimens in hand are much more delicate than those figured by Artis, Andrä,[1] or Stur[2] and seem to differ from both by their broad pedicels and percurrent rachises.

Locality.—Owens's coal bank, U. S. Nat. Mus., 5618, 5667.

MARIOPTERIS Zeiller, 1878.

1877. *Diplothmema* Stur, Culm-Flora, vol. ii, p. 226 (pars).
1878. *Mariopteris* Zeiller, Bull. Soc. géol. Fr., (3) vol. viii, p. 93.
1879. *Pseudopecopteris* Lesquereux, Coal Flora, Atlas, p. 6; text, vol. i (1880), p. 190 (pars).

MARIOPTERIS cf. NERVOSA (Brongn.) Zeill.

1832 or 1833. *Pecopteris nervosa* Brongniart, Hist. vég. foss., p. 297, pl. xciv, pl. xcv, figs. 1, 2.
1836. *Alethopteris nervosa* (Brongn.) Goeppert, Systema, p. 312.
1877. *Diplothmema nervosum* (Brongn.) Stur, Culm-Flora, vol. ii, p. 230.
1878. *Mariopteris nervosa* (Brongn.) Zeiller, Vég. foss. terr. houill. Fr., pl. clxvii, figs. 1–4; text (1879), p. 69.
1879. *Pseudopecopteris nervosa* (Brongn.) Lesquereux, Coal Flora, Atlas, p. 6, pl. xxxiv, figs. 1, 2 (non 3?); text, vol. i (1880), p. 197.

The rather comprehensive species, *Mariopteris nervosa* (Brongn.) Zeill., seems to be represented by a single fragment from the vicinity of Clinton. This fragment has a close resemblance to specimens of *M. nervosa* figured by Sauveur,[3] Zeiller,[4] and Stur,[5] or the figures given by the last-named author[6] as *Diplothmema muricatum* (Schloth.) Stur. The specimen from Missouri differs from the common American form, which has very broad, triangular leaves, by the somewhat ovate shape of the latter, which are constricted at the base and turned slightly upward at the point.

On account of the many transitional and polymorphous phases observed in and between *M. nervosa* and *M. muricata*, Professor Zeiller and several others of the most distinguished paleobotanists agree to include all these forms under the latter name. Our American material, however, appears to show a much greater diversity of forms than the European, the extremes being much farther apart, while the stratigraphic series covered by the group is well marked by the difference between the older and the younger

[1] *Sphenopteris nummularia*, Vorweltl. Pfl., p. 35, pl. xi.
[2] *Diplothmema trifoliolatum* (Art.) Stur, Farne d. Carbon-Fl., p. 349, pl. xix, figs. 1–4.
[3] Vég. foss. terr. houill. Belg., pl. xliv, fig. 1.
[4] Vég. foss. terr. houill. Fr., pl. clxvii, fig. 2.
[5] Farne d. Carbon-Fl., pl. xxiv, fig. 2.
[6] Stur, op. cit., p. 393, pl. xxii, figs. 3–5.

forms; thus *M. muricata* is very highly differentiated in, and is confined almost exclusively to, the Pottsville series, while *M. nervosa* is characteristic of the Alleghany series, seldom being found within, and near the top, of the Pottsville series. The relations of the *muricata* and *nervosa* types have been more fully discussed by the writer in the report on the fossil plants from the McAlester, Indian Territory, coal field.[1]

The form in hand is not to be confused with the one that I have compared with *M. muricata*. The latter is most intimately related to a form from the upper part of the Pottsville series.

Locality.—Henry County, Missouri. Received from Dr. J. H. Britts, Clinton, Missouri. Precise locality unknown. U. S. Nat. Mus., 5459

Mariopteris sphenopteroides (Lx.) Zeill.

Pl. IX, Figs. 1, 2; Pl. X.

1879. *Odontopteris sphenopteroides* Lesquereux, Coal Flora, Atlas, p. 4, pl. xxi, figs. 3, 4; text, vol. i (1880), p. 139.

1881. *Alethopteris nervosa* (Brongn.) Goepp., Achepohl, Niederrh.-Westfäl. Steink., p. 42 (pl. xi, fig. 16?)

1883. *Sphenopteris nobilis* Achepohl, Niederrh.-Westfäl. Steink., Ergänzungsbl., iii, fig. 5.

1886. *Mariopteris sphenopteroides* (Lx.) Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xix, figs. 3, 4; text (1888), p. 171.

Fronds quadripinnate, dichotomous, spreading, with a somewhat flexuous rachis; secondary (?) pinnæ alternate, oblong-triangular, acute; tertiary (?) pinnæ alternate, open, triangular-lanceolate, tapering to an acute point or spine; rachis flexuous to correspond to the pinnation, canaliculate above, terete beneath, finely obscurely striate, with a narrow border; ultimate pinnæ open, nearly at right angles below, more oblique above, close, generally slightly overlapping, alternate, oblong-lanceolate, rather acute, usually terminating in a short spine; pinnules alternate, more or less open, generally touching when fully developed, or even overlapping a little, ovate-deltoid, somewhat constricted at the base, more or less deeply divided into lobes or teeth, decurrent to border the usually slightly flexuous rachis, the lower pair on each pinna polymorphous and compound, especially the proximal one, which, in the lower pinnæ, is once or twice divided in the manner characteristic of the genus; lobes or teeth deltoid, obtuse, inclined

[1] Ann. Rept. U. S. Geol. Surv., vol. xix, pt. 3, p. 475.

upward, broader, more deeply dissected in the lower part of the pinnules and higher in the larger pinnules, varying much according to the development of the pinnule, becoming narrower, closer, and more spinous toward the tip, where they often resemble short claws, the terminal one being usually finally developed as a spinous process; limb not very thick, rather coriaceous, arched upward between the nerves, and very finely striate in the direction of the nervation, probably by rows of minute hair-like scales; nervation coarse, rather distant, slightly depressed above, clear and in relief beneath, originating at a single point on the rachis, curving rapidly outward, and forking, often three or four times, rather openly, before reaching the borders, where they are slightly turned upward in entering the lobes or teeth.

In the course of my examinations of the Paleozoic plant types in the Illinois State Museum of Natural History and of the Missouri specimens from the Lesquereux collection, now part of the Lacoe collection, I had opportunities to examine the type specimens from both the Missouri and the Illinois localities and to verify their specific identity, together with a fine series of examples from the Missouri locality. This comparison has convinced me that the apparently anomalous nervation of the pinnules in figs. 3 and 4 of *Odontopteris sphenopteroides* on pl. xxi of the Coal Flora, which are otherwise Sphenopteroid, is due entirely to imperfect drawing, the actual nervation being more truthfully represented in the detail, fig. 3*a*, of the same plate, which is obviously not Odontopteroid. Additional material, labeled perhaps at the time of description or soon after the publication of the species, shows still more clearly the Mariopterid outlines and teeth, often developed into claws or blunt subspines, the terminal, especially in the larger pinnules and pinnæ, passing into nearly naked prolongations of the main nerve or rachis. Thus, in pinnation, flexuosity, outlines, marginal wing, lamina, and nervation, the species is plainly Sphenopteroid, of the group included by Professor Lesquereux in *Pseudopecopteris* or by Zeiller in *Mariopteris*. In the younger pinnules the apex is somewhat obtuse-truncate and cut into narrow and less blunt teeth.

In the mode of development of its pinnules, nervation, and limb, *Mariopteris sphenopteroides* suggests a dentate modification of *Mariopteris nervosa* (Brongn.) Zeill., or *M. latifolia* (Brongn.) Zeill.[1] My own studies

[1] See *Mariopteris muricata* (Schloth.) Zeill., Fl. foss. houill. Valenciennes, pl. xx, figs. 2, 3, 4; *M. acuta* (Brongn.) Zeill., loc. cit., pl. xviii, fig. 2. Also see Stur, Farne d. Carbon-Fl., *Diplothmema pilosum* Stur, pl. xxxiv, fig. 2.

of the stratigraphic changes of the floras in the Coal Measures system of the central portion of the Appalachian trough lead me to conclude that *M. sphenopteroides* is closer to *M. nervosa* than to any other species, both forms, between which there are intermediate stages, having been developed from a polymorphous earlier stock generally referred to *Mariopteris muricata* (restricted) or *Pseudopecopteris muricata* as determined by Lesquereux.

The illustrations of *M. sphenopteroides* given by Zeiller in his beautiful work on the Flora of the Valenciennes Basin[1] appear to me as somewhat doubtfully referable to this species, being in some respects closer to the form commonly identified in the United States as *Pseudopecopteris nervosa* (Brongn.) Lx. From his figures and detailed drawings it would seem that the pinnæ are more obtusely pointed, instead of being spinous, the pinnules being emarginate or crenulate, not deeply dentate or dentate-spinous, and the nerves less distant, coarse, or irregular than in the American form. The characteristic facies of the pinnæ of the latter, and even the nervation, which is relatively more distant and irregular than in *M. nervosa*, or stronger than in *M. latifolia* or *M. acuta*, are shown in the photographs, Pl. X, or the enlargement, Pl. IX, Fig. 1*a*.

Mariopteris sphenopteroides has been found in the western coal region of Arkansas and in the Lower Productive Coal Measures (XIII) at Mazon Creek, Illinois, and near Coalburg, West Virginia; and it thus far seems to be characteristic of a limited zone near the base of the Lower Coal Measures, or Alleghany series.

Localities.—Frequent at Owens's coal bank, U. S. Nat. Mus., 5532, 5707–5711; also at Gilkerson's Ford, U. S. Nat. Mus., 5533; Pitcher's coal bank, U. S. Nat. Mus., 5584 (?).

MARIOPTERIS, sp.

Pl. IX, Fig. 3.

A few small fragments found among the collections represent a phase of a new species generally limited to the upper part of the Pottsville series in the American Coal Measures. This form, being exceedingly rare in the Alleghany series of Missouri, is not present in sufficient material from this

[1] Fl. foss. basin houill. Valenciennes, Atlas, 1886, pl. xix, figs. 3, 4; text (1888), p. 171.

region for a good diagnosis. I have concluded, therefore, to give only a figure of a Henry County specimen (No. 4438) in the Lacoe collection, reserving its full description and illustration until the Pottsville flora is specially treated, when this form will be shown to belong to the group represented by *Mariopteris muricata* (Schloth.) Zeill., as commonly identified in this country. The plant in hand stands near the latter species.

Locality.—The form is from Henry County, Missouri, No. 4438, Lacoe collection, U. S. Nat. Mus. The second specimen is from Owens's coal bank, U. S. Nat. Mus., 5437.

MARIOPTERIS (sp. nov.?).

Pl. VII, Fig. 6.

The specimen illustrated in Pl. VII, Fig. 6, found among the later consignments sent by Dr. Britts, is the only representative in the collections of a form which I have not yet been able to definitely correlate with any described species. As will be observed in the photograph, the pinnatifid pinnules, nearly developed into pinnæ, are close, triangular, and noticeably decurrent. A remarkable feature is the very large proportion of the lower lobes as compared with the few small lobes succeeding them on the pinnule. In fact, the upper part of the pinnule seems undeveloped. The rachis is finely lineate and very narrowly margined. The nervation, shown in Pl. VII, Fig. 6*a*, is decurrent and fairly distinct. The lamina, slightly thickened, is dull, elevated in ridges between the nerves, and bordered by a very narrow gutter. The general form of the pinnules and the features of the lamina are suggestive of *Mariopteris nervosa* (Brongn.) Zeill., while the form of the lobes and the character of the nervation unite to remind one of the *Mariopteris muricata* group. Still, the generic reference of this specimen, which may represent either a new species or an Old World form not understood by me, is considered merely as tentative.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5666.

SPHENOPTERIDEÆ.

SPHENOPTERIS Brongniart, 1822.

1822. *Filicites*-sect. *Sphenopteris* Brongniart, Mém. mus. hist. nat., vol. viii, p. 233.
1826. *Sphænopteris* Sternberg, Versuch, vol. i, tent., p. xv.
1828. *Sphenopteris* Brongniart, Prodrome, p. 28.

SPHENOPTERIS MIXTA Schimp.

Pl. XI, Fig. 3; Pl. XII, Figs. 1, 2; Pl. XIII, Figs. 4, 5.

1866. *Sphenopteris rigida* Brongn., Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, pp. 435, 469, pl. xxxix, figs. 5, 6 (excl. syn.).
1889. *Sphenopteris rigida* Miller, N. Amer. Geol. Pal., p. 143.
1869. *Sphenopteris* (*Cheilanthides*) *mixta* Schimper, Traité, vol. i, p. 382.
1870. *Sphenopteris mixta* Schimp., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 409, pl. xxv, figs. 7, 8.
1879. *Sphenopteris mixta* Schimp., Lesquereux, Coal Flora, Atlas, p. 9, pl. liv, figs. 2 (1, 3?); text, 1 (1880), p. 276.
1883. *Sphenopteris mixta* Schimp., Lesquereux, 13th Rept. Geol. Surv. Indiana, pl. xv, figs. 1 (2, 3?).
1886. *Sphenopteris mixta* Schimp., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xii, fig. 3; text (1888), p. 95.
1889. *Sphenopteris mixta* Schimp., Kidston, Trans. Roy. Soc. Edinb., vol. xxxv, 1, p. 405.
1890. *Sphenopteris mixta* Schimp., Lesley, Dict. Foss. Pennsylvania, vol. iii., p. 987 (text fig. ?).
1870. *Sphenopteris sinuosa* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 409.
1872. An *Sphenopteris* (*Aneimioides*) *pulchra* Marrat, Proc. Liverpool Geol. Soc., February, 1872, p. 101, pl. viii, figs. 1*a b*?
1884. *Pseudopecopteris nummularia* (Gutb.) Lesquereux, Coal Flora, vol. iii, p. 751, pl. ciii, figs. 1–3; 2d type in part (excl. syn.).
1893. *Ovopteris mixta* (Schimp.) Potonié, Fl. Rothl. Thüringen, p. 44.

Fronds tri- or polypinnate, spreading, extremely intricate and delicate; rachis narrow, usually rounded below, shallowly sulcate above, finely striate, punctate by the attachment of rather distant spines or spiny scales, flexuous, sometimes slightly geniculate, and bordered in the smaller divisions by a very narrow decurrent lamina; primary (?) pinnæ oval (?), obtuse, lax, flexuous; secondary (?) pinnæ alternate, very long, linear-lanceolate, very slender, flexuous or slightly subgeniculate, open, generally at a right angle to the primary (?) rachis, close or more often somewhat overlapping, hardly contracted at the base, tapering from above the middle to a very slender, generally flexuous point; ultimate pinnæ alternate, very open, triangular-linear, sometimes extremely elongated or lanceolate-acute, varying as to size according to place in the frond, often somewhat geniculate, usually rather distant, but often contiguous or even overlapping, pinnatifid below; pinnules alternate, open, often very small, sometimes extremely small, ovate at first with a broad basal attachment, becoming ovate-triangular and sublobate to 5 and more ovate close lobes, separated by an angular sinus, which is decurrent as the pinnules become pinnatifid, with narrow attachment and diminishing marginal wing in passing downward; lamina minutely rugose, rather thick, slightly repand at the margin; nervation generally rather indistinct; nerves rather strong near the rachis, thinning in passing upward, a single primary nerve, originating at a rather open angle and branching pinnately at a wide angle nearly opposite each sinus, the lower branches forking again in the larger lobes or pinnatifid pinnules, all the nervation being generally clear on the under surface of the pinnule.

The true species, as first illustrated in the Illinois geological reports,[1] the types of which I had an opportunity to examine in the Illinois State Museum of Natural History, is well represented by a large series of good specimens in the collections in hand. Recently, during a study of a portion of the Lacoe collection, the examples figured in the Coal Flora[2] as *Pseudopecopteris nummularia* (Gutb.) Lx., which came from Henry County, Missouri, were found to have been labeled *Sphenopteris mixta* Schimp. by Professor Lesquereux, a reference which seems to indicate the belief on his part, at the late date when the specimens were catalogued, in the specific identity of the specimens figured under the former name with *Sphenopteris mixta* Schimp. After a careful comparison of the normal specimens of *S. mixta* with these types of *Pseudopecopteris nummularia* I can find no distinguishing specific character between them.

Concerning the specimen purporting to come from the same region, illustrated in the Atlas to the Coal Flora, pl. liv, fig. 1, under this name, I feel constrained to regard it as not the same species. The original of this figure, transmitted to me for study through the kindness of Mr. Lacoe, is on the whole very poorly preserved, while the margins of the apparently some-

[1] Report Geol. Surv. Illinois, vol. ii, 1866, pl. xxxix, figs. 5, 6.
[2] Vol. iii, pl. ciii, figs. 1, 2, 3.

what withered or macerated pinnules are curled under and buried in the matrix. The characters of the detail, fig. 1*a*, loc. cit., I have been unable to confirm in the large specimen, while the rough rachis and the general habit of the pinnæ, which are quite inaccurately illustrated, are strongly suggestive of some specimens of *Sphenopteris Brittsii* Lx. found in the same beds. No intermediate forms, such as might connect this specimen with the type of *Sphenopteris mixta*, have, so far as I know, been found. On the contrary, its characters would seem to indicate such a variation from the normal as might be regarded as more than merely varietal.

The normal form of *Sphenopteris mixta* is well shown in Fig. 4, Pl. XIII, which represents a middle portion of the tripinnate frond. Fig. 1, Pl. XII, shows a lax lateral segment with large pinnules, and Fig. 2, Pl. XII, illustrates a part of a large pinna having the aspect of the figure given in the Illinois report.

Although this species is included by Potonié[1] in the section of the Sphenopterids for which he created the genus *Ovopteris*, I am inclined rather to regard it, on the evidence of its superficial characters, as related to *Sphenopteris quercifolia*, *S. microcarpa* Lx., and the group represented in *S. Hœninghausii* Brongn.

Sphenopteris mixta, which in its habit and even in many details is close to the specimen figured by Stur[2] as *Hapalopteris rotundifolia* (Andrä) Stur, or to *Sphenopteris Laurentii* as figured and described by Andrä[3] and seen by myself in British specimens, is easily distinguished from *Sphenopteris Brittsii* Lx. by the more robust habit, the spiny rachis not so flexuous, the rougher lamina, and the sharp teeth of the latter. The differences between it and *S. Lacoei* are noted in the remarks following the description of the latter.

Localities.—Owens's coal bank, U. S. Nat. Mus., 5713, 5714, 5524, 5527, 5531; Gilkerson's Ford, U. S. Nat. Mus., 5458; Deepwater, U. S. Nat. Mus., 5692, 5521, 5522, 5529; Hobbs's coal bank, U. S. Nat. Mus., 5712, 5715, 6037, 5687, 5522, 5526, 5530.

[1] Potonié, Fl. Rothl. Thüringen, 1893, p. 42.

[2] Farne d. Carbon-Fl., p. 33, pl. xliv, figs. 3, 4.

[3] Urweltl. Pfl. Steinkohlengeb. Pr. Rheinl. u. Westphal., Pt. iii, 1869, p. 39, pl. xiii, figs. 1, 2, 3.

Sphenopteris Lacoei D. W.

Pl. XII, Fig. 3.

1893. *Sphenopteris Lacoei* D. White, Bull. U. S. Geol. Surv., No. 98, p. 56, pl. ii., figs. 5, 6.

Fronds quadripinnate, spreading; primary pinnæ broad, at right angles or somewhat oblique to the rachis; primary rachis finely striated, flat, or slightly arched, naked; secondary pinnæ alternate, close, often somewhat overlapping, oblique above, at right angles in the middle and curving backward below, slender, linear-lanceolate, acute, slightly contracted toward the base, nearly straight or gently flexuous and curving, simply pinnate, or pinnatifid below, the largest divisions being developed as ultimate pinnæ, with the same relations to the secondary pinnæ as those of the latter to the primary pinnæ; secondary rachis rather narrow, slightly flexuous to correspond to the position of the pinnules, and bordered, at least in the upper part, by a very narrow lamina decurring from the pinnules; pinnules coriaceous, dull, flat, alternate, at right angles to the rachis below, oblique above, close, sometimes contiguous, or overlapping, usually with a decurrent attachment to the rachis, cordate-ovate, or somewhat querciform, slightly obtuse at the apex, alternately lobed, more or less constricted at the base, especially on the distal side, the blade connate by a narrow decurrent lamina; the larger pinnules, about 6 mm. long, 3 mm. wide, constricted at the base so as frequently to appear pedicellate, the smaller ones above becoming sessile by the slightly contracted base; lobes in the lower part of the larger pinnules divided to near the midrib, larger than those above, more or less distinctly cuneate toward the base, or rhomboidally rounded or rounded-truncate at the broad top, slightly separated by a narrow, decurrent, rounded sinus, becoming in passing upward more connate and obovate, smaller, more united, and more obtusely rounded, gradually passing into the small indistinct terminal pinnule; lobes of the pinnatifid pinnules broadening, becoming more distant, more pointed and crenate, sessile by the slightly contracting base, then lobate, and finally full-developed pinnules; primary nerves strong, somewhat decurrent, especially in the upper part of the pinnæ, though often appearing slightly inclined or at right angles to the rachis in the lower part, sometimes appearing as a short pedicel; nervation obscure, a primary nerve passing into each lobe, and emitting nervils that usually fork once, but a portion of the nervils in the lower part of the lobes apparently springing directly from the midrib; fructification unknown.

This delicate species, which is closely related to *Sphenopteris mixta*, is represented by several specimens. It appears, however, to differ from the latter in having its lobes more rounded, obovate, truncate, and deeply dissected, the margins less sinuate, and the sinuses more rounded. It is further marked by a greater degree of rigidity in the pinnæ; the rachises are not punctate, the pinnules thinner, smoother, and the nerves thinner and more obscure. The specimen illustrated in Pl. XII, Fig. 3, is that from which the detail published in my report on the Flora of the Outlying Coal Basins was prepared.[1]

Localities.—Owens's coal bank, U. S. Nat. Mus., 5516 (?), 5517; Pitcher's coal bank, U. S. Nat. Mus., 5802; Hobbs's coal bank, U. S. Nat. Mus., 5687.

Sphenopteris Wardiana n. sp.

Pl. XI, Figs. 1, 2.

Frond polypinnate, thin and extremely delicate; rachises of the larger pinnæ slender, very obscurely and very finely striated; secondary (?) pinnæ linear, or linear-lanceolate, slightly flexuous; pinnæ of the next order alternate, open to nearly a right angle, close or slightly touching, triangular to linear-triangular, slightly flexuous, becoming lax in the upper part, which is provided with pinnatifid pinnules above the ultimate pinnæ; ultimate pinnæ alternate, open, the lower ones at a right angle to the rachis, short, oblong-triangular or ovate-triangular, a little distant, sometimes touching or nearly contiguous, and joined along the rachis by an extremely narrow border; pinnules extremely small, alternate, oblique, rarely touching, ovate or obovate when very small, entire, round, attached by the whole base or cohering one-third the way up, or, when larger, crenulate-sublobate, cut into 2 to 5 round or oblong-round oblique lobes, which are connate most of their length, becoming separated by a deeper decurrent sinus when fully matured as pinnules; nervation obscured in the thick texture of the lamina; primary nerve originating at a somewhat open angle and forking to supply a nervil to each lobe or crenulation; fructification unknown.

[1] Bull. U. S. Geol. Surv., No. 98, pl. ii, fig. 6.

This somewhat unique species in our American Coal Measures flora is specially characterized by the extremely small size of its parts and its minute, rounded pinnules, which are round-crenulate or roundish, crenulate-lobate in almost the earliest stage, the lobes being marked as mere scallops or deep crenulations and cohering until a period of deeper dissection, to form simple round or oval pinnules, whereupon the latter begin at once to show 2 to 5 or 7 crenulations, repeating the form of dense coherent clusters.

When first examining the specimens the observer is at once impressed with the similarity in their form, habit, and grosser details to *Sphenopteris* (*Corynepteris*) *coralloides* Gutb.,[1] the species to which *S. Wardiana* is perhaps most nearly related: but a study with the lens of the minute divisions shows differences in form, substance, and nervation as great as those between many of the larger species in the group. The pinnules or lobes in the plant from Missouri, Fig. 2, Pl. XI, are much more ovate, not so truncate, the crenulations fewer and occurring on the sides of the rounded or ovate pinnules, neither so dentate at the top nor so constricted at the base as in the plant figured by Gutbier. In *S. Wardiana* the texture of the pinnule is leathery, the principal nerves of no unusual thickness, and the nervils, which are less fasciculate, are rather thin and difficult to discover. *Sphenopteris canadensis* Du., from the Carboniferous of New Brunswick, is larger, more lax, the divisions more elongated and less crenulate, while the texture is membranaceous. In its general aspect *Sphenopteris Wardiana* suggests a microphotograph of the smaller pinnules of *S. Lacoei* or *S. mixta*. It belongs perhaps to that group of Sphenopterids represented by *Sphenopteris Hœninghausii* Brongn.

This interesting species is named in honor of Prof. Lester F. Ward, whose thoughtful and very thorough methods in the field of correlative and philosophical paleobotany have revolutionized the treatment of fossil plants in this country, while accomplishing a distinct benefit to the science in its broader and more comprehensive aspects.

Localities.—Owens's coal bank, U. S. Nat. Mus., 5617; Pitcher's mine, U. S. Nat. Mus., 5615.

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[1] See in particular the fragments and details given in Gutbier, Abdrücke, p. 40, pl. v, figs. 8, 8*a*; or Zeiller, Fl. foss. houill. Valenciennes, p. 117, pl. x, figs. 4, 4*a*, 5, 5*a*.

SPHENOPTERIS (HYMENOTHECA) BROADHEADI n. sp.

Pl. XIII, Figs. 1, 2.

1897. *Sphenopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 296.

Fertile frond tripinnate; primary pinnæ linear-lanceolate, acute; primary rachis broad, flat above, irregularly finely striate; secondary pinnæ open, somewhat oblique or nearly at a right angle to the primary rachis, subopposite or alternate, rather distant, linear, tapering from the base to a rather acute point; secondary rachis indistinctly striate, more or less rigid; ultimate divisions or pinnules subopposite, oblique, strongly decurrent, either simple, cuneate, rounded above and arching inward, or forking once or more pinnately and divergently, always preserving the cuneate form of lobes with rounded ends, while passing into the pinnæ, which are at first 1 cm. or more in length, with 5 to 7 pinnules, then elongating with divided basal pinnules; lamina moderately thin, slightly rugose. Nervation thin, the primary nerve forking pinnately at the base of each lobe or pinnule, each of which is traversed by a branch. Fructification consisting of oval or round-oval sporangia placed one upon and nearly covering the end of each lobe or pinnule.

Although the sterile form of this species is not definitely known to me, the fertile form possesses so much that is of interest and new to our flora that I describe it here without waiting for the correlation of the fertile and sterile portions of the plant. Owing to the coarsely arenaceous character of the matrix, the detail of the fruiting is not so clear as is desirable, the general appearance of the compressed sporangia being that of granular, carbonaceous matter. In this state it resembles somewhat the *Discopteris Schumanni* of Stur's Carbon-Flora.[1] But at several points the sporangia show a slightly raised ridge or keel parallel to the longer axis, apparently like that of the *Hymenophyllites* figured by Schimper,[2] and still more strongly resembling the *Hymenotheca Dathei* of Potonié.[3] In fact, the relationship of our fern with that described by Potonié is so evident from the details, so far as they are visible, as well as from the form and habit of the frond, that little room for doubt is left as to its actual generic identity,

[1] Page 149, pl. lvi, figs. 2, 3.

[2] Traité, vol. i, p. 415, pl. xxviii, figs. 4–8.

[3] Jahrb. K. Pr. geol. Landesanst. u. Bergakad., 1889 (1892), p. 20, pl. ii, figs. 1*a*, 1*b*, 1*c*.

whatever questions may remain concerning the relationship of the genus *Hymenotheca* to the *Hymenophyllaceæ*.

Sphenopteris Broadheadi seems to differ from the type species of *Hymenotheca* from Schwadowitz by its more ovate lobes, generally more clearly bi- or tripartite, and the larger or more oval sporangia.

The specimen photographed, Figs. 1 and 1*a*, Pl. XIII, represents a segment from the upper part of a supposed primary pinna. It illustrates well the characteristic bi- or trilobation of the pinnules or ultimate divisions, which may be noted also in Fig. 2*a*, drawn from a large segment from the middle of a tripinnate fragment. Unfortunately all the specimens appear to show the upper surface of the fronds, so that the fructifications are seen in the impressions as depressed granular areas, lying within the periphery of the limb, although close up in the apex. The position of the sporangia within the margin of the lamina seems to disagree with the fruit of *Diplothmema* as developed in *Diplothmema Zeilleri* Stur,[1] to the fertile pinnæ of which the smaller divisions of our fossils bear a considerable resemblance. Furthermore, as was remarked above, in a few instances there appears to be a longitudinal line traversing the sporangia in the Missouri specimens. The *Sphenopteris fertilis*, illustrated by Renault,[2] may belong to the same genus.

The general habit of the small pinnules in the upper part of our specimens is much like that seen in *Sphenopteris tenella* Brongn.[3] or in *S. Woodwardii* Kidst.[4] Our species seems also rather close to *Hymenophyllites Humboldtii* as figured by Goeppert,[5] while it is also comparable to Feistmantel's figure[6] of *Hymenophyllites Schimperiana* Goepp.

As remarked in the discussion of *Sphenopteris missouriensis*, that species may, perhaps, represent the sterile fronds of the plant, to the fertile portion of which I have given the name *Sphenopteris Broadheadi*. As stated before, I have separated the fertile fragments on account of the differences in the form of their pinnæ, in the degree of division or incision in proportion to the size of the lobes or pinnules, and the greater simplicity of the larger and more decurrent lobes.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5619, 5620.

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[1] Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xv, figs. 5, 5*a*–*b*.
[2] Cours. bot. foss., vol. iii, pl. xxxiii, figs. 15, 16.
[3] Hist. vég. foss., p. 186, pl. xlix, figs. 1, 1*a*.
[4] Kidston, Trans. Roy. Soc. Edinb., vol. xxxiii, pl. xix, figs. 1, 1*a*–*c*.
[5] Foss. Fl. Uebergangsgebirge, pl. xxxi, figs. 1, 2.
[6] Zeitschr. d. Deutsch. Geol. Gesell., 1873, pl. xv, figs. 13, 13*a*, p. 513.

SPHENOPTERIS MISSOURIENSIS n. sp.

Pl. XIV, Figs. 1, 2.

Primary (?) pinnæ linear or linear-lanceolate, contracted at the base, with broad, very finely lineate rachis; pinnæ of the next order alternate, open, nearly at a right angle to the rachis in the lower part of the superior pinna, becoming more oblique above, oblong-lanceolate or oval-lanceolate, slightly contracted at the base, tapering rapidly in the upper part to a short, acute point, straight or slightly flexuous, close, nearly touching or overlapping a little, slightly dense, the rachis slender, slightly sinuate, appearing on the lower side as a raised strand, with a narrow border; ultimate pinnæ very open, the lower ones nearly at a right angle to the rachis, alternate, rather close, touching or slightly overlapping in the lower portion of the frond, deltoid-oblong, obtuse or obtusely rounded at the apex, broadest at the decurrent base, the lowest inferior one heteromorphous, the uppermost succeeded by pinnatifid and simple pinnules; pinnules alternate, oblique, the angle of their origin averaging about 45°, short and broad, curving outward, close, nearly touching or sometimes overlapping, cuneate, with round or round-truncate apex when small, or becoming obovate and ovate or obovate-deltoid in the pinnatifid stage, ordinarily showing a marked tendency toward a broadly cuneate form, with the apex cut by a shallow sinus into 2 broad, rounded teeth or lobes, which are afterwards more deeply separated, while others are formed from the upper division, so that the pinnule is cut into about 8 or 9 short, broad, obtuse lobes before the lower ones develop the cuneate, shallowly bifid form so common in the plant; lamina not very thick, very minutely striated in the direction of the nervation, apparently by the presence of extremely small appressed hairs; nervation fine, not very distinct, though slightly in relief on the dorsal surface; primary nerve more or less distinctly decurrent, forking low, at a moderate angle, to furnish a single nervil for each lobe.

The general aspect of this beautiful and graceful plant can be inferred from the photograph, Pl. XIV, Fig. 1, prepared from the largest specimen found in the collection. As noted in the description, the conspicuous character of the pinnule is the outward-curved, close, cuneate, more or less bifid form, which after the development of other lobes is quickly reproduced in the latter. The position of the pinnæ on the right in this specimen indicates a point of origin beneath the surface of the rachis as here presented, which probably consists of a central axis with thick lateral laminæ. The pinnæ probably spring from the central axis.

Sphenopteris missouriensis is perhaps most closely related to the *S. tenuifolia* Brongn.,[1] from which it differs by the more open angle of the pinnæ, which are less acute, and the closer pinnules or lobes, which seem to be more broadly cuneate, with more obtusely rounded teeth. It also resembles somewhat the specimens figured by Stur[2] as *Saccopteris grypophylla* (Goepp.) Stur, or as *Sphenopteris formosa* by Achepohl,[3] though these species differ in the details as much as in size.

I am far from certain that the fragments which I have described as *Sphenopteris Broadheadi* are not really the fertile pinnæ of *S. missouriensis.* I have separated them, however, on account of the more slender, distant, acute pinnæ, and the more oblique and much more deeply dissected pinnules and lobes which remain simple or only bifid to a much larger size than in the latter species. While it is possible that the fertile pinnæ represent only modified and somewhat reduced pinnæ of the sterile species, it hardly seems probable that in such a case the individual ultimate divisions would retain the common characters to a greater size while presenting a simpler form of division combined with a greater degree of dissection. The force of this will be seen in a comparison of the fertile pinnæ with the smaller sterile fragment, Fig. 2, Pl. XIV, which probably comes from the upper part of a frond of the same species as the large fragment. Both the fertile and the sterile forms have probably a relation to the *Cheilanthites* (*Sphenopteris*) *grypophylla* Goepp.

The heteromorphous pinna seen at the base of the lower lateral pinna on the right in the large specimen is suggestive of a relationship for our species to the genus *Diplothmema* Stur. The form of the large fragment illustrated is, however, opposed to such a consideration.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5663; Hobbs's coal bank, U. S. Nat. Mus., 5664.

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[1] Hist. vég. foss., p. 190, pl. xlviii, figs. 1, 1*a*.
[2] Farne d. Carbon-Flora, pl. liii, fig. 5.
[3] Niederrh.-Westfäl. Steinkohlengeb., pl. xiv, fig. 8, p. 51.

SPHENOPTERIS PINNATIFIDA (LX.).

Pl. XVIII, Figs. 3, 4; Pl. XIX, Fig. 1.

1866. *Hymenophyllites pinnatifidus* Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 436, pl. xxxiv, figs. 2, 2*a*.

1879. *Sphenopteris* (*Hymenophyllites*) *tridactylites* Brongn., Lesquereux, Coal Flora, Atlas, pl. lv, figs. 9, 9*a–b* (figs. 8, 8*a* ?); text, vol. i (1880), p. 284 (pars).

Fronds polypinnate, delicate, spreading; secondary (?) pinnæ alternate, close, linear-lanceolate, slightly contracted at the base, tapering to a rather acute point; secondary rachis straight or slightly curving, somewhat sulcate above, rounded beneath, minutely irregularly striate, naked; tertiary pinnæ alternate, nearly at a right angle to the superior rachis, nearly contiguous or overlapping somewhat, usually very slightly decurrent at the base, linear-lanceolate, slightly narrowed at the base, tapering from below the middle to an acute tip; tertiary rachis slightly flexuous, minutely winged near the apex; ultimate pinnæ alternate, at a right angle to the rachis, or nearly so, generally slightly distant, sometimes touching or overlapping a little, 8 mm. to 20 mm. or more in length, lanceolate or lanceolate-triangular, sometimes slightly decurrent, terminating in a single oval, obtusely pointed pinnule, and provided with ovate, rounded-obtuse, alternate or subopposite, simple, bi-, tri-, or many-lobed pinnules, the latter becoming 7 to 8 lobed and elongated in passing into pinnæ; lobes or incipient pinnules oblique, decurring along the rachis, more or less deeply divided, according to the degree of development; limb dull, rather thin; nerves slightly flexuous, not very distinct, forking pinnately to permit one nervil to enter each lobe; fructification consisting of groups of crowded sporangia situated on the lobes of the pinnules and covering the surface at or near the ends of the lobes; sporangia ovoid, about .375 mm. in longer diameter, and about .3 mm. in the shorter diameter, apparently composed of cells elongated in the direction of the longer axis, and opening by an apical pore.

It was only after an examination of the type specimen of *Hymenophyllites pinnatifidus* Lx., illustrated in the second volume of the Reports of the Illinois Geological Survey,[1] that it became evident to me that our Missouri specimens belonged to this poorly delineated species, which was afterwards

[1] Pl. xxxiv, figs. 2, 2*a*. p. 436.

referred by Professor Lesquereux to *Sphenopteris tridactylites* Brongn. From the latter, however, so far as that species is illustrated and described in foreign literature, *Hymenophyllites pinnatifidus* differs very much, the analogies being much closer to *Sphenopteris delicatula* Brongn. as figured by Sauveur,[1] *Trichomanites* (*Zeilleria*) *delicatula* illustrated by von Roehl,[2] or the *Sphenopteris* (*Hapalopteris*) *Schützei* Stur, represented by Kidston in the flora from the Lanarkshire coal field.[3]

In Pl. XIX, Fig. 1, is shown a photograph of a portion of the original of figs. 9 and 9*a–b*, on pl. lv, of the Coal Flora, referred to *Sphenopteris tridactylites* Brongn. The enlarged detail, Fig. 1*a*, Pl. XIX, of the sterile pinna in this specimen (No. 4304 of the Lacoe collection), which comes from the same locality as the other specimens before me, and represents precisely the same form, shows the great difference in proportions between *S. pinnatifida* and the original type of the species of which it was made a synonym.

Fig. 9 in the plate of the Coal Flora includes only the middle one of three compound pinnæ borne on the right of a somewhat flexuous rachis 3 mm. in width. Portions of alternately placed pinnæ on the other side are also fertile. Although the laminæ or margins of the divisions of the pinnule are obscure in the fertile frond, even where the sporangia are absent in the lower part of the pinna, enough is clear to show that the form of the sterile pinnules on the same pinna is the same as in the sterile pinna by its side. Fig. 9*a* of the Coal Flora, which seems to agree with fig. 8*a* of the same plate, fails to show either the real character of the division of the pinnule or the open angles and space between the lobes, which are very delicate.

The sporangia seem to present the general aspect shown on the right in Lesquereux's fig. 9*a*, though they are not so round. Under the lens they appear to have a structure like that shown in the genus *Urnatopteris* of Kidston,[4] which, in certain specimens less compressed, ours seems to resemble in ovoid form and apical pore. But *Urnatopteris* has the sporangia in two rows, one on each side of the nerve of the lobe, while in *Sphenopteris pinnatifida* the sporangia seem to be in irregular groups. This compact group-

[1] Vég. foss. terr. houill. Belg., pl. xxiii, fig. 5.

[2] Foss. Fl. Steink. Westphalens, p. 68, pl. xvi, fig. 6B.

[3] Pl. iii, fig. 5.

[4] Quart. Jour. Geol. Soc., vol. xl, 1884, p. 494. Zeiller, Fl. foss. houill. Valenciennes, 1888, p. 33, fig. 20.

ing of the sporangia is suggestive of *Cyclotheca* Kidston,[1] or possibly *Myriotheca* of Zeiller,[2] though in this form also they are described as biseriate. On the other hand, it is generally difficult, if not impossible, to trace the limb of the pinnule beneath or beyond the sporangia, so that in most cases the aspect of the pinnule is much like that of *Hymenophyllites quadridactylites* (Gutb.) Goepp.,[3] or still more the *H. germanica* of Potonié,[4] to both of which our species would also seem related by the characters of the sterile pinna. *Sphenopteris pinnatifida* is, however, in its habit, form, size, and details, so close to the *S.* (*Hymenophyllites*) *quadridactylites* (Gutb.) Goepp. as figured by Zeiller[5] as to make it very strongly probable that the sporangia, the appearance and mode of occurrence of which appear to be the same, are really annulate and are generated from the extremities of the lobes. Still, I have not yet been able clearly to identify a ring in the sporangium. These specimens should be studied more thoroughly in connection with other material representing fertile ferns from the Paleozoic series.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5803, 5807, 5808; very rare at Gilkerson's Ford. The specimen partially figured in the Coal Flora from the same vicinity is No. 4304, Lacoe collection, U. S. Nat. Mus.

SPHENOPTERIS VAN INGENI n. sp.

Pl. XIII, Fig. 3.

1880. An *Sphenopteris Dubuissonis* Brongn., Lesquereux, Coal Flora, vol. i, p. 275 (excl. syn.); vol. iii (1884), p. 880?

Fronds tri- or poly- (?) pinnate, very tenuous and delicate; primary (?) pinnæ slightly flexuous, with a finely striate rachis consisting of a broad axis bordered by thickened, rather narrow laminæ; pinnæ of the next order alternate, very open or even reflexed near the base, more oblique above, close, touching or overlapping considerably, triangular, tapering from the base to the acute or acuminate point, or long-linear, the sides

[1] Annals and Mag. N. H., July, 1888, p. 26, pl. i, figs. 10–12.

[2] Ann. Sci. Nat., (6) bot., vol. xvi, 1883, p. 186, pl. ix, figs. 18–20; Fl. foss. houill. Valenciennes, p. 32, fig. 19.

[3] Goeppert, Systema, 1836, p. 251. See also Zeiller, Fl. foss. houill. Valenciennes, p. 56, fig. 36.

[4] Ueber einige Carbonfarne: Jahrb. K. Pr. geol. Landesanst. u. Bergakad., 1889 (1892), p. 23, pl. iv, figs. 1*a*–*c*.

[5] Fl. foss. houill. Valenciennes, pl. viii, figs. 1, 1*a*, 2, 2*a*, 3. 3*a*, *b*, *c*.

nearly parallel in the lower portion, and tapering from the middle upward, with a slightly flexuous, moderately strong, shallowly canaliculate, extremely narrowly bordered rachis; ultimate pinnæ alternate, open nearly at a right angle near the base, becoming somewhat oblique higher up, close, touching or somewhat overlapping, oblong, triangular, obtuse or slightly obtuse, somewhat rigid, nearly equilateral, constricted at the hardly decurrent base, the lower inferior pinna slightly elongated, and joined along the rachis by a very narrow, often obscure, wing; pinnules or lobes very small, and delicately denticulate or cristate; when small, obovate, oval, or ovate, and obtusely rounded above, cut into 2 to 5 short, rather broad and acute teeth, and attached by nearly the whole width, with a rather broad decurrent wing; when larger, about 2.5–3.5 mm. long and about 1.5–2.5 mm. wide, becoming more deeply dissected in 5 or 6 lobes, the lower ones of which already have each 2 or 3 teeth formed; lamina membranaceous, transparent; nervation very distinct; primary nerves of the pinnules or shorter ultimate pinnæ rather strong, lineate, rigid near the base, tapering in passing, slightly flexuous, to the summit; basal nerve of each pinnule or lobe originating at a very open angle, seldom decurrent, and forking pinnately at a wide angle, one straight or slightly upturned nervil entering and passing to the apex of each tooth.

The specimens to which I have given the above name represent one of the most beautiful and delicate species I have yet seen from the Carboniferous of this country. It is remarkable for the extremely delicate and lace-like effect of its regular pinnæ and transparent limb, traced in a pattern of exquisite daintiness and intricacy. The plant is specially characterized by the smallness and mode of dentition of the divisions and the tenuity of the laminæ.

The general aspect of *Sphenopteris van Ingeni* is at once strikingly suggestive of *Sphenopteris Dubuissonis* Brongn.,[1] under which name it was probably identified by Lesquereux from this region.[2] Although there can be no doubt that it is very closely related to and belongs in the same group with Brongniart's plant, it differs from that species, as will be seen in Fig. 3, Pl. XIII, and the enlarged detail, Fig. 3*a*, in the closer, much wider pinnæ, and the more elongated, less constricted lobes or pinnules, which

[1] Hist. vég. foss., pl. liv, figs. 4*a*, 4*b*, p. 195.
[2] Coal Flora, vol. iii, p. 880.

are more numerously dentate, especially on the lateral margins. *Sphenopteris tenuifolia* Brongn., to which, as figured by Gutbier,[1] it bears some resemblance, is still more deeply dissected, while the details of the same species given by Brongniart[2] and Kidston[3] indicate a quite different plant.

It is perhaps more closely related to *S. Matheti* Zeill.,[4] or *S. minutisecta* F. and W.,[5] from the Upper Barren beds in the Appalachian trough.

I have seen in the collections specimens from Mazon Creek, Illinois, and the Lorway seam of Cape Breton labeled *Sphenopteris cristata* Brongn., that are related somewhat closely to this species. These specimens are involved in the difficulty alluded to in my remarks on *S. chærophylloides*.

Locality.—All the specimens were collected by Mr. Gilbert van Ingen at Pitcher's coal bank, U. S. Nat Mus., 5568, 5616.

SPHENOPTERIS CHÆROPHYLLOIDES (Brongn.) Presl.

1835 or 1836. *Pecopteris chærophylloides* Brongniart, Hist. vég. foss., p. 357, pl. cxxv, figs. 1, 2.
1870. *Pecopteris chærophylloides* Brongn., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 404.
1883. *Pecopteris chærophylloides* Brongn., Renault, Cours. bot. foss., vol. iii, p. 124, pl. xxi, figs. 10, 11.
1838. *Sphenopteris chærophylloides* (Brongn.) Presl, in Sternberg: Versuch, vol. ii, p. 131.
1880. *Sphenopteris chærophylloides* (Brongn.) Presl, Lesquereux, Coal Flora, vol. i, p. 270.
1886. *Sphenopteris chærophylloides* (Brongn.) Presl, Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xi, figs. 1, 1*a*, 2, 2*a–b*; text (1888), p. 90.
1865. *Cheilanthites Brongniartii* Ettingshausen, Farrnkräut. d. Jetzw., p. 73.
1883. *Renaultia chærophylloides* (Brongn.) Zeiller, Ann. Sci. Nat., (6) bot., vol. xvi, p. 185, pl. ix, figs. 16, 17.
1888. *Renaultia chærophylloides* (Brongn.) Zeiller, Fl. foss. houill. Valenciennes, p. 29.
1883. *Hapalopteris typica* Stur, Morph. u. Syst. Culm- u. Carbonfarne, p. 29 (661), fig. 8.
1885. *Hapalopteris typica* Stur, Farne d. Carbon-Fl., p. 27, fig. 8, p. 46, pl. xlii, figs. 3, 3*a*, 4.
1884. An *Sphenopteris Gravenhorstii* Brongn., Lesquereux, Coal Flora, vol. iii, p. 880?
1885. *Hapalopteris chærophylloides* (Brongn.) Stur, Farne d. Carbon-Fl., p. 176.
1888. *Hapalopteris chærophylloides* (Brongn.) Stur, Schenk, Die foss. Pflanzenr., p. 29.
1893. *Ovopteris chærophylloides* (Brongn.) Potonié, Fl. Rothl. Thüringen, p. 44.

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[1] Abdrücke, p. 39, pl. x, figs. 9, 9*a*.
[2] Hist. vég. foss., pl. xlviii, fig. 1, p. 190.
[3] Trans. Roy. Soc. Edinb., vol. xxxiii, pl. xix, figs. 2, 2*a–b*.
[4] Fl. foss. houill. Commentry, vol. ii, pl. i, figs. 3–6, p. 49.
[5] Fontaine and White, Permian Flora, pl. v, figs. 1–4, p. 43.

In the lists at the end of the third volume of the Coal Flora *Sphenopteris chærophylloides* Brongn. is recorded[1] as occurring in the vicinity of Clinton, Henry County, Missouri. But while a few specimens in the collections agree well with one identified by Professor Lesquereux, which Dr. Britts has had the goodness to loan me for comparison, it seems to differ in some respects from the details first illustrated in Brongniart's species. In fact, among the considerable number of American specimens that have been ascribed to this species there would seem to be included representatives of several species, the individuality and characters of which can be developed only by a thorough scrutiny and detailed revision of the group of Sphenopterids, including *S. chærophylloides*, *S. cristata* Brongn., *S. Gravenhorstii* Brongn., and *S. pseudomurrayana* Lx.

It is probable that the material on which the record of *S. Gravenhorstii* Brongn. in the Clinton flora was based is of the same nature as that identified as *S. chærophylloides*. The specimen figured (Pl. XIX, Fig. 2) differs more from the *S. Brittsii* type than any other included under the name *S. chærophylloides*. It perhaps represents the form recorded as *S. Gravenhorstii*. At present I am far from certain that the Missouri specimens of the former, if not of both species, are not really fragments of the smaller and more delicate pinnæ of *S. Brittsii* Lx. Nevertheless, until a thorough revision of the American material in this section of the genus *Sphenopteris* (*Ovopteris*) is made, so as to show the true relations of the forms, I shall record this plant as *S. chærophylloides*, in respect to the identification of Professor Lesquereux.

Localities.—Identified by Professor Lesquereux from Hobbs's bank: Pitcher's coal bank, U. S. Nat. Mus., 5518; Owens's coal bank, U. S. Nat. Mus., 5519.

SPHENOPTERIS CRISTATA (Brongn.) Presl.

1828. *Pecopteris cristata* Brongniart, Prodrome, p. 58.

1835 or 1836. *Pecopteris cristata* Brongniart, Hist. vég. foss., p. 356, pl. cxxv, fig. 4 (5?).

1838. *Sphenopteris cristata* (Brongn.) Presl, in Sternberg: Versuch, vol. ii, p. 131.

1855. An *Sphenopteris cristata* (Brongn.) Presl, Geinitz, Verst. Steink. Sachsen, p. 19, pl. xxiv, figs. 1, 1*a*, 2, 2*a*?

1869. *Sphenopteris cristata* (Brongn.) Presl, von Roehl, Foss. Fl. Steink. Westphalens, p. 60, pl. xxix, figs. 14, 14*a*.

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[1] Coal Flora, vol. iii, p. 880.

1879. *Sphenopteris cristata* (Brongn.) Presl, Schimper, in Zittel: Hand. Palæont., vol. ii, p. 109, fig. 80.
1880. *Sphenopteris cristata* (Brongn.) Presl, Lesquereux, Coal Flora, vol. i, p. 274; vol. iii (1884), p. 761, pl. cii, figs. 1, 1*a* (fig. 1*a* copied from Brongniart).
1890. *Sphenopteris cristata* (Brongn.) Presl, Zeiller, Fl. foss. houill. Commentry, vol. i, p. 64, pl. iii, figs. 1, 1*a*, 2, 2*a*–*b*.
1893. *Ovopteris cristata* (Brongn.) Potonié, Fl. Rothl. Thüringen, p. 44.

The remarks made under *S. chærophylloides* Brongn., referring to the differentiation of the specimens in the United States that have been assigned to that species, apply with equal force to *S. cristata* Brongn. In the collections now in hand are a number of specimens with narrow terete and nonpunctate rachises and a rather thin, smooth limb, on which the veins are clearly seen, the nervation and mode of division of the pinnules being very close to *Sphenopteris cristata* as illustrated by Brongniart[1] and Zeiller.[2] The Missouri specimens also agree well with others from Mazon Creek, Illinois, placed by Lesquereux in the same species.

The relations of the American specimens in *S. cristata* to those identified as *S. chærophylloides* can best be shown in a monographic revision of this section of the Sphenopterids.

Localities.—Hobbs's coal bank, U. S. Nat. Mus., 5504; Owens's coal bank, U. S. Nat. Mus., 5503, 5507; Pitcher's coal bank, U. S. Nat. Mus., 5505.

SPHENOPTERIS SUSPECTA n. sp.

Pl. XXXV, Figs. 1–3.

Frond tri- or polypinnate, rather compact; secondary (?) pinnæ lanceolate, contracted somewhat at the base, acute, slightly flexuous and lax; rachis slender, slightly flexuous in accordance with the bases of the lateral pinnæ, shallowly canaliculate above, terete below, minutely lineate, and very distantly punctate; ultimate pinnæ alternate, open, somewhat reflexed at the base, becoming oblique toward the top, rather close, a little distant or touching, often gently curved, oblong, lanceolate or linear-lanceolate, acute, slightly narrowed at the base; pinnules large, close, usually touching or slightly overlapping, oblique, ovate or ovate-oblong, slightly curved

[1] Hist. vég. foss., p. 356, pl. cxxv, fig. 45. The figure of the enlarged pinnule is copied in Lesquereux's Coal Flora, vol. iii, pl. cii, fig. 1*a*.
[2] Fl. foss. houill. Valenciennes, Atlas, pl. x, figs. 1, 1*a*, 2, 2*a*–*b*.

upward, obtuse, entire, or slightly crenulate before becoming pinnatifid, a little decurrent and narrowly connate; lamina thin, dull, arched gently backward toward the margin; nervation quite distinct, clear on the upper surface of the pinnule, in relief on the lower surface; primary nerve oblique or slightly decurrent in the lower part, which is much nearer to the inferior than to the superior angle of the pinnule, thin, though sometimes appearing double on the lower side of the lamina, slightly geniculate at the bases of the nervils, and passing to near the apex of the pinnule; nervils rather distant, oblique, at a variable angle of divergence, simple and straight in the upper part of the rather small pinnules, generally forking once below the midrib, and, in the larger pinnules, the upper branch usually forking again.

The specimens representing this species are quite uniform in their characters, the most conspicuous of which are the form, compactness, size, and entireness of the pinnules, and the distinctness, thinness, and distance of the nervation.

Fragments of the pinnæ might, at first glance, be taken for some form of *Pecopteris*, e. g., *P. clintoni* Lx., on account of the resemblance in the size and outline of the larger pinnules and isolated ultimate pinnæ. The mode of division and the other features of the rachis, which is here and there marked by punctation, and the nervation are, however; those of *Sphenopteris*.

The relation of this species is with the group represented by *Sphenopteris cristata* Brongn. and *S. chærophylloides* Brongn., the nervation of which is plainly similar. In a few instances, where the backward-arched margin is broken or buried in the matrix so as to render the pinnules more pointed with rough borders, the resemblance to some of the American specimens listed as *S. chærophylloides* is especially strong, and it is not impossible that our plant may have been in certain cases identified as that species.

Sphenopteris suspecta is readily distinguished from *S. chærophylloides* Brongn. and *S. cristata* Brongn. by its more broadly ovate, obtuse pinnules with entire margins. The nervation differs much from *S. integra* Andrä, while the margins, thin lamina, and more slender character of the pinnæ preclude any confusion with partially covered fragments of *S. Brittsii* Lx.

Localities.—Owens's coal mine, U. S. Nat. Mus., 5650, 5651, 5652; Pitcher's coal mine, U. S. Nat. Mus., 5649, with *Cordaites communis* Lx. and *Hysterites Cordaitis* Gr. 'E'y.

Sphenopteris Brittsii Lx.

Pl. XV, Fig. 1; Pl. XVI; Pl. XVII; Pl. XVIII, Figs. 1, 2; Pl. XIX, Fig. 3.

1879. *Sphenopteris Brittsii* Lesquereux, Coal Flora, Atlas, p. 10, pl. lv, figs. 2, *2b*; text, vol. i (1880), p. 277 (vol. iii, 1884, p. 764, pl. cii, figs. 3, 4, *4a*?).
1883. *Sphenopteris Brittsii* Lesquereux, 13th Rept. Geol. Surv. Indiana, p. 216, pl. xv, fig. 3.
1890. *Sphenopteris Brittsii* Lx., Lesley, Dict. Foss. Pennsylvania. vol. iii, p. 983, text fig.
1893. *Oropteris Brittsii* (Lx.) Potonié, Fl. Rothl. Thüringen, p. 44.

Fronds large, tri(poly-?)pinnate; rachis of the various orders well developed, flexuous, sometimes slightly subgeniculate, low-rounded beneath, broadly and shallowly canaliculate on the upper surface, faintly striate, rough, provided with short lax scales or spinous scales; primary (?) pinnæ alternate, very open, often at a right angle to the rachis, or reflexed, standing close, usually overlapping, flexuous or sinuate, lanceolate or linear-lanceolate, acute, more or less lax, contracted toward the base and presenting a rather rough surface and ragged margin on account of the uneven lamina and the slightly repand and sharp-toothed border; pinnæ of the next order alternate, open, somewhat arched backward below, flexuous, close, frequently overlapping, usually curving upward and parallel, but often at a right angle to the rachis, and sinuate, linear, tapering from near the base to the slightly obtuse apex, sometimes very slender, flexuous, and reduced toward the base; ultimate pinnæ alternate, generally rather close, less often touching or slightly overlapping, very open, nearly at a right angle to the rachis in the lower part of the pinna, ovate-triangular, obtusely pointed, wider on the upper side at the base, usually curving upward somewhat, slightly flexuous, with depressed, well-marked punctate-rugose rachis, and joined by a narrow decurrent lamina; pinnules alternate, close, compact, usually slightly overlapping, set obliquely by a broad attachment, ovate or ovate-triangular, arching upward, unsymmetrical, much wider on the upper side at the base, the lower side being slightly reduced, broadly ovate, the upper part pinnately cut in narrow, very short, obtuse, strongly upward-pointed teeth when young, becoming more triangular and pinnately lobed by very shallow narrow sinuses in five or more upward-inclined divisions when larger, the lobes broad, truncate-rounded, bi- or tri- to quinquedentate, increasing to small pinnules, the decurrent sinuses between the latter gradually approaching the rachis but not reaching it; lamina rather thick, rugose, often arched between the nervils, and usually somewhat repand, so as to conceal the teeth in the matrix; nervation generally clear, the primary nerve strong, originating at a moderate angle, but slightly if at all decurrent, slightly subgeniculate near the top, forking pinnately at a rather open angle at the base of each lobe, each secondary nerve in the pinnatifid pinnules forking pinnately again in the middle portion of the lobe to furnish one oblique upward-turning nervil, which passes to the apex of each tooth.

One of the most common species in the flora of the Coal Measures about Clinton is that described by Lesquereux in the first volume of the Coal Flora as *Sphenopteris Brittsii.* Fragments of this species are found scattered over a large proportion of the slabs, and, although its surface is rugose and irregular, often ragged in appearance, the slender sinuous pinnæ are frequently pleasing in general effect.

The semblance of a smooth margin in the lobes of many examples is due to a slight convexity of the pinnules and the consequent concealment of the teeth in the matrix, and is not really so frequent nor so complete as might be inferred from the figure in the Coal Flora. On this account I have sought to represent, by photo-reproduction, figures of portions which will show the margin as well as several phases in the development of the pinnæ. The margins are decurrent in the specimen figured by Lesquereux, as well as in ours. The former also shows the punctate rachis, often slender or somewhat geniculate. The punctations on the stem are found to be the basal scars of short spines. The compound pinnules are always decurrent, bordering the rachis with a narrow wing. Very rarely, when the margins are broken away or concealed, the most slender pinnæ of *Sphenopteris Brittsii* resemble *S. mixta* Schimper, but even in these attenuated pinnæ the species can be readily distinguished by the more rugose, coriaceous texture, the uneven surface of the limb, the much stronger rachis, densely punctate, the broad, compact pinnules, the more ovate lobes, the straighter pinnæ, and the dentition, seen even in the earliest stage of the division.

Sphenopteris Brittsii Lx. belongs naturally to the section of the Sphenopterids represented by *S. chærophylloides* Brongn., or *S. cristata* Brongn., which Potonié[1] separates as a distinct genus, *Ovopteris.* Our specimens

[1] Fl. Rothl. Thüringen, p. 44.

are, in fact, close to *S. cristata*, and seem to have been slightly confused in the Missouri collections with both that species and *S. chærophylloides*. While agreeing in several features with the former, it may be distinguished in small fragments by the thick coriaceous texture, the compact upward-curving pinnules, and the teeth situated on the distal margin of the pinnule or lobes and pointing upward.

The characters last named, combined with the strongly unequilateral pinnules, frequently give the more slender pinnæ an appearance suggestive of *Sphenopteris Essingii* Andrä or *S. inæquilateralis* Lx.[1]

I have seen no fertile pinnæ from Missouri which seem to me to be definitely referable to this species. The specimens from Nelsonville, Ohio, described and figured in the third volume of the Coal Flora,[2] the types of which are in the Lacoe collection, have a smooth rachis, a thin, smooth lamina, much more slender pinnules, and some differences in dentition and nervation, so that it will, I believe, be necessary to regard them at present as varietally if not specifically distinct.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5703, 5706, 5669, 5495, 5497, 5501, 5502, 5626, with abundant *Spirorbis carbonaria*; Deepwater, U. S. Nat. Mus., 5704, 5494, 5498, 5668; Hobbs's coal bank, U. S. Nat. Mus., 5500; Owens's coal bank, U. S. Nat. Mus., 5705.

Sphenopteris cанneltonensis n. sp.

Pl. XV, Fig. 2.

1884. *Sphenopteris hymenophylloides* Brongn., Lesquereux, Coal Flora, vol. iii, p. 764, pl. cii, fig. 2 (excl. syn.).
1897. *Sphenopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 300.

The original of the figure published in the Coal Flora as *Sphenopteris hymenophylloides* Brongn., and which is now No. 4262 in the Lacoe collection, I find to have been labeled later by Professor Lesquereux, together with other specimens of the same form, as *Sphenopteris Gutbieriana* Gein. That the type from Cannelton, Pennsylvania, can hardly represent Brongniart's species[3] appears probable from a comparison of the above-cited figure in the Coal Flora with that given by Brongniart. The American specimens

[1] Coal Flora, vol. iii, p. 765, pl. ciii, figs. 4, 5, 5*a*.
[2] 1884, p. 764, pl. cii, figs. 3, 4, 4*a*.
[3] Hist. vég. foss., p. 189, pl. lvi, figs. 4*a*, 4*b*.

differ in the angle and form of the pinnules, the lobes being much more deeply denticulate, while the nerves are straight and fork in adaptation to a more prevailingly bifid instead of trifid tendency in the system of the division of the lobes. Moreover, *S. hymenophylloides* Brongn. was described from the Oolite of Whitby, in Yorkshire.

Our specimens, including the fragments from Missouri, are characterized especially by the alate pinnules and lobes, bifid in their system of division and traversed by very distinct, strong, straight, rigid nerves. Thus, while it is apparently closely related to *S. Gutbieriana* Geinitz[1] or *S. Picandeti* Zeiller,[2] it seems to me to be hardly admissible to either. Both, especially the former, have the pinnæ more slender, acute, decurrent, and less alate. *Sphenopteris Picandeti* Zeill. has the pinnules narrower at the base, the lobes less often bifid, the nerves more slender. The lower pinnules of the smaller pinnæ of *S. canneltonensis* are often broadly alate, and except for the sharp teeth, nearly truncate at the broad apex. From the form of the pinnation seen in the segments from Cannelton I suspect that the frond has the mode of division illustrated by Zeiller[3] in *Diplothmema Zeilleri* Stur, to which our species is obviously very close, probably more closely related than to any other, though in this, too, we seem to have a much more delicate and elongated system of pinnation, the divisions being narrower and the lobes acuminate. Specimens from Cannelton which are perhaps doubtfully separable from *S. canneltonensis* were identified by Lesquereux as *S. sublobata* Weiss. It is possible that a comparison of specimens or a more complete representation of *S. canneltonensis* may prove its identity with the *Diplothmema Zeilleri* Stur.

For the present, since the American specimens, which deserve further illustration, can hardly be referable to *Sphenopteris hymenophylloides* Brongn., or *S. Gutbieriana* Gein., I name them after the locality in Pennsylvania from which the specimen figured by Lesquereux was obtained. This figured specimen, No. 4672 of the Lacoe collection, is thus the type of the *Sphenopteris canneltonensis*.

Localities.—Hobbs's coal bank, U. S. Nat. Mus., 5665; a very doubtful fragment is from Owens's bank, U. S. Nat. Mus., 5569.

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[1] Gutbier, Abdrücke, pl. iv, fig. 13. Geinitz, Verst. Steinkohlenf. Sachsen, p. 15, pl. xxiii, fig. 10.

[2] Fl. foss. houill. Commentry, vol. i, p. 53, pl. ii, figs. 10-12.

[3] Zeiller, Fl. foss. houill. Valenciennes, p. 151, pl. xv, fig. 5; pl. xvi, fig. 12. Stur, Farne d. Carbon-Flora, p. 329.

SPHENOPTERIS CAPITATA n. sp.

Pl. XV, Fig. 3.

1897. *Sphenopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 300.

Frond tripinnate or polypinnate, delicate; secondary (?) pinnæ alternate, lanceolate, or linear-lanceolate, tapering to a rather obtuse point; rachis slender, somewhat flexuous, round, naked, smooth; ultimate pinnæ oval-lanceolate, alternate, close, rarely overlapping a little, slightly oblique, or nearly at a right angle to the rachis; pinnules alternate, hardly contiguous, often with broad, stalk-like attachment, joined by a narrow wing decurring along the rachis, ovate, sublobate in 3 to 5 more or less distinctly marked, distally directed, rounded or obtusely pointed teeth or lobes; limb thin, dull, minutely rugose, cut in acute decurrent sinuses between the pinnules and lobes; nervation rather indistinct, the median nerve originating at an acute angle with the rachis, curving outward, branching pinnately at a moderate angle, one nervil passing into each lobe or tooth.

The more salient features of this interesting plant are the compact ultimate pinnæ and the more or less distinctly broadly ovate pinnules or lobes which are slightly incised by very broad, shallow sinuses or crenulations to form broad, rounded, erect lobes, the lower being inclined so obliquely as to give the pinnule a slightly stalked appearance. The pinnules are more or less oblique, with a notably broad attachment with the marginal wing. The nerves, which are incorrectly delineated in Fig. 3*a*, are slender and flexuous, forking at a moderate angle to furnish one nervil for each lobe. They are mostly obscured in the smooth or very minutely rugose, dull, opaque lamina. The mode of division and lobation of this specimen is suggestive of that shown by Gutbier[1] in his *Sphenopteris rutæfolia* [non (Eichw.) Schimp.], though the members of the latter, which is referred to the *Sph. gracilis* type, are smaller and more deeply dissected.

The texture, surface, obscure nervation, and the more compact pinnules, provided with but few very broadly rounded crenulations or teeth, are characters by which the form before us can readily be distinguished from corresponding portions of *Sphenopteris Brittsii* Lx., in which the margin

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[1] Abdrücke, pl. x, figs. 10, 11, p. 42.

may be broken or buried in the matrix so as to present a somewhat similar outline.

Locality.—Near Clinton, Henry County Missouri; precise locality unknown; U. S. Nat. Mus., 5662.

SPHENOPTERIS ILLINOISENSIS n. sp.

Pl. XIX, Fig. 4; Pl. XLIV, Fig. 1.

1870. *Alethopteris hymenophylloides* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 393, pl. x, figs. 2, 3, 4 (non fig. 1).
1874. *Alethopteris hymenophylloides* Lx., Schimper, Traité, vol. iii, p. 500.
1878. *Alethopteris hymenophylloides* Lx., Andrews, Elem. Geol., p. 177, fig. 323.
1879. *Pseudopecopteris hymenophylloides* Lesquereux, Coal Flora, Atlas, p. 10, pl. lvi, figs. 3, 3*a–b* (non fig. 2); text, vol. i (1880), p. 196 (pars).

Fronds tri- or poly-(?) pinnate, lax, rather delicate; form of primary pinnæ not sufficiently known for description; secondary (?) pinnæ oblong-lanceolate, or lanceolate, acute, rather dense though delicate, the rachis being rather slender, finely lineate, rounded beneath, shallowly canaliculate on the upper side, with narrow thread-like central strand in relief on the back, giving off thread-like branches for the pinnæ of the next order, and bordered by a wide lamina; ultimate pinnæ alternate, oblong-lanceolate or oblong-triangular, broadest at the base, rather blunt pointed, open or somewhat oblique, close, usually slightly overlapping, provided with simple or pinnatifid pinnules in the lower portion, becoming pinnatifid, and crenulate-lobate by the confluence of the pinnules near the top, and joined at the base of the decurrent lamina; rachis of the ultimate pinnæ thread-like, terete on the back, nearly straight and often decurrent at the base to meet the superior rachis at a very narrow angle; pinnules alternate, oblique, usually at an angle of nearly 45° of divergence from the rachis, close, usually touching or slightly overlapping, generally curving slightly upward, either when small, short, oblong, 2–2.5 mm. long, .75–1.5 mm. wide, obtuse or obtusely pointed at the top, connate up to near the middle, or, when larger, becoming ovate and oblong-ovate, obtuse, and developing at first 1 to 3 very erect, narrow, obtuse teeth above the middle, later bearing 4 to 6 short broad teeth, and, becoming cut into 6 to 9 longer obtuse teeth, soon passing the lobate stage into pinnules, the lower pair of which are usually quite oblique, although the lowest inferior pinnule is sometimes heteromorphous; lamina thin, smooth, slightly arched; nervation moderately clear; nerves narrow, straight or nearly straight, somewhat rigid, slightly depressed or obscure on the upper surface, distinct and somewhat in relief on the back; primary nerve emitted at an angle of about 45°, very rarely decurrent at the base, and giving off simple branches at an angle of nearly 40°, one nervil to pass into each lobe or crenulation, the dentate pinnules having but one simple, slightly upward turning, rigid nerve to enter each of the few teeth, the younger pinnules having a single nervil, which gives off a branch for each incipient crenulation or developing lobe; fructification unknown.

The smaller type, illustrated in the Fourth Illinois Report[1] as *Alethopteris hymenophylloides* Lx., and in the Coal Flora[2] as *Pseudopecopteris hymenophylloides* Lx., is represented in the Missouri collections by several specimens, two of which are shown in Pl. XIX, Fig, 4, and Pl. XLIV, Fig. 1. The latter, which shows a section from the upper part of a compound pinna, is comparable to fig. 3 of the plate in the Coal Flora, while the former, which includes the apex of a slender pinna similar to the upper part of the same type, agrees precisely with a specimen (No. 3984 of the Lacoe collection) from Mazon Creek, the type locality, identified under the above name by Professor Lesquereux. Other fragments agree with the details and lower portions of Lesquereux's fig. 3, and leave, in fact, no doubt as to the identity of our plant with the small original type of *Pseudopecopteris hymenophylloides* Lx.

The more salient characteristics in the examples from both States are the thread-like, wide-bordered axis in the rachises, from which the strands turn off to the subordinate pinnæ, the rather smooth, oblique pinnæ provided with relatively few pinnules, the small pinnules or connate lobes generally very oblique and distant, and the simplicity and apparent rigidity of the nervation, the nervils being regular in the angle of their divergence and seldom forking in the pinnule or lobe or small pinnule until a tooth is in process of formation. The usual form of the pinnule is seen in the larger fragment, Pl. XLIV, Fig. 1. It is especially difficult to distinguish the pinnules from pinnæ, owing to the early passage to a pinnatifid arrangement in the lower portion of the pinnules. The formation of the first tooth on the lobe, or of the first lobe on the pinnule, whichever term is applied

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[1] 1870, p. 393, pl. x, figs. 2, 3, 4.

[2] Atlas, p. 10, pl. lvi, figs. 3, 3*a*–*b*, copied from Rept. Geol. Surv. Illinois, vol. iv.

to these divisions, is marked by an outward pushing of the lamina on the proximal margin above the middle so as to form a step-like offset in the margin, which is gradually cut into a rather blunt, broad lobe or tooth by the descent of an oblique sinus. Another characteristic of the species is the upward direction of the divisions, which, except when the lower inferior lobe is polymorphous, brings the points of the lower lobes or teeth a considerable distance from the base of the pinna or pinnule.

As will be seen from the above notes and a comparison with the original figures, the smaller type illustrated by Lesquereux is very different in form, division, and nervation from the larger type shown in fig. 1, pl. x, of the Illinois Report, copied as fig. 2 of the plate in the Coal Flora. In short, it does not seem possible that pinnæ with the type of large, lax, rather broadly confluent, crenulate pinnules with a flexuous, rather narrowly bifurcated and outward-curving system of nervation illustrated in this figure could have belonged to the same species as that described above. Accordingly, I find myself impelled to separate this larger form, fig. 1 of the Illinois Report or fig. 2 of the Pennsylvania Report, from the small species lying before me; and since this smaller species from Illinois and Missouri seems in its form, mode of division, and nervation to be a *Sphenopteris* rather than either a *Pseudopecopteris* or a *Pecopteris*, I am constrained, though not without regret, to give it a new name, there being already a *Sphenopteris hymenophylloides* Brongn.

Should the mode of division in the frond of our species be found to be that of *Pseudopecopteris*, then either the specific name *hymenophylloides* Lx. may be restored, in which case it will be necessary to furnish some other designation for the large species from Mazon Creek, Illinois, or the name *illinoisensis* may be continued, the species represented by the large type being still known by its original appellation.

Locality.—Hobbs's coal bank, U. S. Nat. Mus., 5564, 5661, [illegible]7.

SPHENOPTERIS (CROSSOTHECA) OPHIOGLOSSOIDES (LX.).

Pl. XX, Figs. 3, 4.

1879. *Sorocladus ophioglossoides* Lesquereux, Coal Flora, Atlas, p. 8, pl. xlviii, fig. 11; text, vol. i (1880), p. 329.

Fronds large, quadripinnate or polypinnate; primary pinnæ rather dense, rough, and somewhat rigid; secondary pinnæ oblique, alternate, overlapping, parallel, lanceolate; tertiary pinnæ open, alternate, rigid, overlapping a little, lanceolate, or lanceolate-triangular, rather obtuse, with stout, roughly striate rachis, which is shallowly canaliculate on the ventral surface; ultimate pinnæ alternate, open, somewhat flexuous, nearly touching or slightly overlapping, rather dense, ovate-oblong or lanceolate, obtuse, with irregular surface; pinnules alternate, when very small broadly ovate, close, and decurrent, becoming confluent and obliterated toward the top of the pinna, or, when larger, crenulate and cut in rounded or ovate, decurrent, outward-curved lobes in the lower part, crenulate and ovate-rounded above, the largest ones ovate-triangular, very obtuse and pinnatifid, with a broad attachment sometimes slightly elongated to form a broad, very short, decurrent footstalk with narrow borders decurring along the rachis; lamina coriaceous, slightly furrowed over the primary nerve in the larger pinnules, repand; nervation quite distinct, coarse, and usually slightly salient on the upper surface, giving the pinnule a very rough aspect; primary nerve strong, originating obliquely, curving, often quite decurrently, flexuous, more or less distinctly subgeniculate in adaptation to the secondary nerves at the bases of the lobes or crenulations; secondary nerves, one for each lobe or crenulation, given off at a rather open angle, and forking once or twice at a wide angle, all the divisions, especially the upper branches, curving strongly outward, and each forking once or twice again, according to the stage of the development of the lobe, the nerves of each lobe or very small pinnule having a fasciculate appearance, and strongly arched upward, the ultimate nervils passing parallel to the margin, which, in the larger lobes, they reach at nearly a right angle to the midrib; fertile pinnæ very different from the sterile pinnæ, in the lower or middle portion of which they are probably borne; consisting primarily of oblong or oblong-ovoid, more or less curved, fleshy pinnules about 8–12 mm. long and 2–3 mm. in width, borne alternately and apparently sessile on a broad rachis; sporangia fusiform, about 1.75 mm. long, and .75 mm. in width near the base, tapering to an acute point, apparently arranged pendent or somewhat inflexed in a close or crowded fringe about the margin of the fertile pinnule.

Among the specimens last transmitted by Dr. Britts from Clinton are several fragments of sterile pinnæ which, almost without doubt, belong to the same plant as the fertile specimens described from the same beds nearly twenty years ago by Professor Lesquereux under the name *Sorocladus ophioglossoides*.[1] The extremely close relationship of the sterile pinnæ from Missouri with others from Mazon Creek, Illinois, which the unpublished manuscript and drawings of Professor Lesquereux show in direct connection with *Sorocladus sagittatus* Lx.,[2] the identity of structure which on examination of the type specimens I find to exist between *Sorocladus ophioglossoides* and *Sorocladus sagittatus*, and the surprising and impressive analogy of both the fertile and the sterile segments of the American species to the corresponding portions of *Sphenopteris Boulayi* Zeill., and *Sphenopteris Crepini* Zeill., from the Valenciennes basin, place beyond doubt the relationship of the sterile fragments from Missouri to the group represented by *Sorocladus sagittatus* Lx. And since the remarkable affinities between the Missouri and the Illinois sterile forms compel us to expect a fertile pinna for the Missouri species very similar to that described from the other State, we can hardly avoid the conclusion that *Sorocladus ophioglossoides*, which completely satisfies these conditions and fulfills the analogies, is really the fertile portion of the species to which the fragment illustrated in Pl. XX, Figs. 3, 4, which comes from the same region, belongs.

It would manifestly be unjust to anticipate the publication of any data included in the manuscript report of Professor Lesquereux, however interesting might be the comparison of the details therein contained. Consequently no further reference will be made to the sterile specimens from Illinois.

The Missouri specimens before me are specially characterized by the irregular appearance of the surface of the pinnæ, the system of crenulate lobation, and the ragged aspect of the nervation, which appears fasciculate at the base of the lobes, and arches strongly upward.

The types of *Sorocladus ophioglossoides* Lx., from Henry County, now in the Lacoe collection (Nos. 4170–4172) in the United States National Museum, bear a very striking and interesting resemblance in their form, in the characters of the fleshy lamina, and the fringe of sporangia about the latter, suggesting, as Zeiller remarks, fringed epaulets, and even in the superficial characters of the sporangia, to the type of *Sphenopteris Boulayi*

[1] Coal Flora, vol. i, p. 329, pl. xlviii, fig. 11.

[2] Coal Flora, vol. i, p. 329, pl. xlviii, figs. 10–10*b*; vol. iii, p. 760, pl. C, figs. 4, 5. Through a misunderstanding a very incomplete drawing of one of the specimens examined by Professor Lesquereux was included in Lesley's Dict. Foss. Pennsylvania, vol. ii, p. 606.

Zeill., illustrated in figs. 4 and 4*a*, pl. iv, of the magnificent atlas to the Valenciennes Flora. In a few examples the surface of the pinnules when exposed is shown to be barred pinnately on either side of the midrib so as to resemble some of the figures of fertile pinnules of *Danæites* Goepp.[1] This feature, shown in both the Coal Flora and in Zeiller's figures, is regarded by the latter as corresponding to lobation of the lamina.

The genus *Sorocladus* of Lesquereux[2] was presented as a substitute for *Staphylopteris* Presl, to include "all agglomerations of sporanges of various forms, either borne upon separate segments of a fern, like those of *Botrychium* without visible remains of leaves, or whose connection to frond-bearing leaves can not be traced and is unknown;" or "for the description of ferns of the coal represented by fructifications whose relation is unknown." Naturally the fructifications included in the genus may be, and actually are, of widely different relations. Thus *Sorocladus stellatus* Lx., placed by Lesquereux at the head of the list of species in this genus, is quite equivocal, while *Sorocladus asteroides* Lx., which follows it, would seem to belong to the genus Calymmotheca Stur.[3] *Sorocladus sagittatus* and *Sorocladus ophioglossoides* fall within the genus Crossotheca of Zeiller,[4] and *Sorocladus Wortheni* represents a fertile type perhaps included in *Hawlea* Corda[5] or *Asterotheca* Presl.[6]

The differences between the sterile portions of *Sphenopteris ophioglossoides* and *Sphenopteris Boulayi* or *S. Crepini* may readily be learned from a comparison of the descriptions and figures.[7]

The fertile pinnules of the American form are not so large nor so pedicellate as in *Sphenopteris Boulayi* Zeill. *Sorocladus ophioglossoides* differs from *Sorocladus sagittatus* by the narrower and more slender form of the fertile pinnules of the former, which are not dilated at the base nor distinctly and broadly pedicellate. The forms included in the genus

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[1] Cf. *Danæites saræpontanus* Stur, Morph. Syst. Culm- u. Carbon-Farne, p. 146; or *Danæites Emersoni* Lesquereux, Coal Flora, pl. xxviii, fig. 2.

[2] Coal Flora, Atlas, 1879, p. 8, pl. xlviii; text, vol. 1, 1880, p. 327.

[3] Culm-Flora, vol. ii, 1877, p. 255. Zeiller, Fl. foss. houill. Valenciennes, 1888, p. 34, pl. xii, figs. 2, 2*a–b*.

[4] Ann. Sci. Nat., bot., (6) vol. xvi, August, 1883, p. 180=*Sorotheca* Stur, Morph. Syst. Culm- u. Carbon-Farne, December, 1883, p. 175. See Zeiller, Fl. foss. houill. Valenciennes, p. 34.

[5] Fl. d. Vorwelt, 1845, p. 89.

[6] In Corda: op. cit., p. 89.

[7] Zeiller, Fl. foss. houill. Valenciennes, p. 115, pl. iv, figs. 4*a–c*; p. 112, pl. xiii, figs. 1-3.

Sorocladus deserve a detailed description along with other material comprising fertile ferns from the American Coal Measures.

Localities.—The sterile forms come from Pitcher's coal bank, U. S. Nat. Mus., 5536, 5698. The original specimens of *Sorocladus ophioglossoides* Lx. from Henry County, without more exact locality, are Nos. 1227 and 4272 of the Lacoe collection, U. S. Nat. Mus.

SPHENOPTERIS SUBCRENULATA (LX.).

Pl. XX, Fig. 5.

1866. *Alethopteris crenulata* (Brongn.) Goepp., Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 439, pl. xxxix, figs. 2–4.
1870. *Alethopteris crenulata* (Brongn.) Goepp., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 393, pl. xiii, figs. 14, 15.
1879. *Pseudopecopteris subcrenulata* Lesquereux, Coal Flora, Atlas, p. 6, pl. xxxvii, figs. 7, 8; text, vol. i (1880), p. 193.

The specimen figured in Pl. XX, Fig. 5, agrees in so many respects with several examples from Cannelton, Pennsylvania, and Mazon Creek, Illinois, labeled *Pseudopecopteris subcrenulata* by Professor Lesquereux, as to leave little doubt as to its proper inclusion in that somewhat variable species. The lamina of the pinnules is thin, though minutely rugose, with the margins more or less distinctly retracted between the tips of the nerves, the crenulation being less marked on the sides than near the apex of the pinnules. The nerves, which in the specimen in hand are viewed from the back side of the frond, are clear and in relief. The midrib is rather slender and decurrent, the nervils pinnate, for the most part nearly straight and very oblique. The nervils are themselves striate, often appearing double, as is the case in the specimens from Mazon Creek.

The specimens from Illinois and Pennsylvania, referred to above, represent a form similar to that given in fig. 8, pl. xxxvii, of the Coal Flora. It would seem at first that this should be quite distinct from the type illustrated in fig. 7 of the same plate. But the variation in the size and nervation in the entire suite of specimens from Mazon Creek is, as Professor Lesquereux remarked,[1] so great that it is difficult to establish any satisfactory line of demarcation among them, although more than one species seems to be represented. In the specimen from Missouri the two or three

[1] Coal Flora, vol. i, p. 193.

lower inferior nerves in the pinnules near the base of the segment are found to bifurcate at a variable distance from the median nerve, but the superior nerves, as well as all those of the smaller pinnules, are undivided.

In none of the specimens identified as this species have I found the distinctive characters of the genus *Pseudopecopteris*. On the other hand, all the details seem to be those of *Pecopteris* or *Sphenopteris*. M. Zeiller has referred this species to *Pecopteris*, at the same time inscribing[1] *Pseudopecopteris subcrenulata* Lx. as a synonym of *Pecopteris crenulata* Brongn. It is true that the specific separation, perhaps at the suggestion of Schimper,[2] of the American species, which was at first correlated with the European form, was largely based on the insufficiency of Brongniart's diagnosis and illustrative material. But while many of the Illinois specimens appear to be referable to Brongniart's species,[3] so excellently as well as authentically elaborated by Zeiller[4] after a comparison of Brongniart's original, the more simple American type does not seem to me to be included therein. It is also quite clearly different from the plant illustrated as *Pecopteris crenulata* by Potonié,[5] who also unites *Pseudopecopteris subcrenulata* as a synonym of Brongniart's plant. The Thuringian specimen would seem to be a true *Pecopteris*. The Old World plant seems to differ from that from Missouri by the thicker lamina and the much more open, frequently obscured nerves, which in the apparently corresponding portions are once forked, instead of remaining simple.

The oblique position of the slightly connate pinnules, the rather strongly decurrent median nerve, the thin lamina, crenulate or erose above, and decurring to form a marginal wing along the superior rachis between the lateral pinnæ, and the relatively narrow flexuous rachis led me to temporarily regard the form in hand, which should, perhaps, be separated from the common American type, as a representative of the genus *Sphenopteris*. It may, like the *Pseudopecopteris spinulosa* Lx.[6] to which it is related, be regarded as one of the intermediate forms, so far as outline and nervation merely are concerned, between *Pecopteris* and *Sphenopteris*. It appears to be very

[1] Fl. foss. houill. Valenciennes, p. 192.
[2] Traité, vol. iii, p. 500.
[3] Hist. vég. foss., p. 300, pl. lxxxvii, figs. 1, 1*a*.
[4] Fl. foss. houill. Valenciennes, p. 192, pl. xxv, figs. 1–4.
[5] Fl. Rothl. Thüringen, p. 65, pl. vi, figs. 1–4.
[6] Coal Flora, p. 195, pl. lvi, figs. 1, 1*a*.

closely related to the European *Pecopteris crenulata*, with which some of the material from Mazon Creek, Illinois, is either identical or at least so similar as to seem to justify Professor Zeiller's remark as to the interest in the occurrence of this type both in Illinois and in probably contemporaneous beds in the upper part of the Valenciennes series, or at Geislautern.

Locality.—Pitcher's coal bank, Henry County, Missouri. Loaned by Dr. J. H. Britts, Clinton, Missouri.

SPHENOPTERIS sp.

Pl. XXXV, Fig. 6.

The fragment represented in Pl. XXXV, Fig. 6, is the only example of this peculiar form in the collection. The shape of the decurrent half-stalked pinnules with sinuate or sinuate-dentate margins is different, I believe, from any yet described. Most of the characters found in the specimen are seen in the photograph or the detail, Fig. 6*a*. The rachis is very finely lineate and is bordered in the lateral pinnæ by a narrow decurring wing. The substance of the pinnule is not very thick, and is dull, though smooth, and flat, or nearly flat. The nervation is fairly clear, the midrib rather strong at the base, tapering in passing upward and vanishing at the apex.

It is hoped that the accompanying figures and notes will facilitate the recognition and identification of the species, which appears to have been one of considerable grace and beauty.

Locality.—Henry County, Missouri; U. S. Nat. Mus., 5654.

SPHENOPTERIS BILOBATA Lx. ined.

The type of this species is described among the unpublished manuscript of Professor Lesquereux. Pending its publication with other similar material in due form, further consideration in this memoir is waived.

Locality.—Vicinity of Clinton, Henry County; Nos. 5703, 5704, Lacoe collection, U. S. Nat. Mus.

OLIGOCARPIA Goeppert, 1841.

Gattungen, Lief. 1 u. 2, p. 3.

OLIGOCARPIA MISSOURIENSIS n. sp.

Pl. XX, Figs. 1, 2; Pl. XXI, Figs. 1?, 2?, 3, 4.

1897. *Oligocarpia* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, pp. 296, 300.

Fronds tri- or polypinnate, lax, spreading, rather delicate; rachis very slender, narrow, sulcate above, terete below in the subordinate divisions, finely lineate, dull, flexuous, those of the last order being very thin and sinuate; secondary (?) pinnæ alternate, originating at an open angle to the primary rachis and curving outward, close, or slightly overlapping, flexuous, lanceolate or linear-lanceolate, contracted toward the base, and tapering above the middle to the acute apex; ultimate pinnæ open, often at a right angle to the rachis, alternate, rather distant, flexuous, linear-triangular, tapering from near the base to the slender, narrow apex; pinnules alternate, ovate, becoming crenulate in passing to the pinnatifid stage, distant, open, at a right angle to the rachis in the lower portion of the longer pinnæ, obtusely rounded at the summit, with rounded margin on the lower side, the upper side straighter, giving the pinnule an upward turn, attached by the whole or nearly the whole base until becoming pinnatifid, and separated nearly to the rachis by a broad sinus, which is usually round or squarish, and sometimes slightly decurrent at the lower angle; lamina dull, not very thick; nervation rather coarse, often obscure on the upper surface; primary nerve decurrent, rather strong, striated, arching with the pinnule, flexuous, and forking pinnately at a rather open angle, the lower nervils forking again or even a second time as the pinnule becomes pinnatifid; fructification within the margin, in 1 to 7 round depressions, in each of which appears one or more sporangia, apparently of the type of *Oligocarpia*, although the characters are obscure.

The sterile examples incompletely shown in Figs. 1, 2, Pl. XX, and Fig. 3, Pl. XXI, from Owen's coal bank, appear to form a fairly distinct species, closely related to *O. alabamensis* Lx. and *O. Gutbieri* Goepp. The general aspect of the large pinnæ illustrated in Fig. 1, Pl. XX, will at once be noted as quite similar to the figure of *O. alabamensis*[1] given by Lesquereux. But the latter has the rachis opposite or subopposite, while the pinnules are close and much more open, instead of being distant and curved upward, as in the species from Owen's. Furthermore, the primary nerves in the Alabama type are much less decurrent. The fertile pinnæ in the large specimen bear also some resemblance to *Oligocarpia Brongniartii* Stur.[2]

My reference of the plant to the genus *Oligocarpia* is based on the strikingly similar conformation of the vegetative part and that of other species

[1] Coal Flora, vol. i, p. 266, pl. xlvii, figs. 1 *a–b*.

[2] Farne d. Carbon-Flora, p. 131, pl. lvii, figs. 2, 3. See also Zeiller, Fl. foss. bassin. houill. Valenciennes, p. 97, pl. xi, figs, 3, 3*a–c*, 4, 5, 5*a–c*.

referred to this genus. I have seen specimens from Morris, Illinois, labeled *O. alabamensis*, which should perhaps be included in this species.

The clearest definition of the fruit dots that I am able to secure on this specimen fails to give any conclusive proof of the generic identity of this species, although the general aspect and the position of the dots on the pinnules are very similar to those shown by Geinitz[1] or Schimper[2] in *O. Gutbieri* Goepp., except that ours are perhaps not so near the margin. Under the lens the depressions and irregular disklike bodies within are seen to strongly resemble those published in Stur's photograph of *Oligocarpia Beyrichi*.[3]

The above description is based on fragments of sterile fronds or those in which only a part is fertile. I have also referred, with doubt, to this species several fertile fragments. The first of these, Pl. XXI, Fig. 4, from Pitcher's bank, shows a segment of a macerated pinna in which the outlines of the pinnules are in many instances quite uncertain, although the position of the sporangia is well shown. Here the circular depressions seem either to be vacant, except for a slight mammillate point in the center, or to contain a flattened disk with thickened, rather irregular margin. When viewed with a stronger lens this margin or rim seems to be bordered with large, thick cells, thus appearing to present conditions resembling the fruit of *O. Brongniartii* as illustrated by Zeiller[4] or Kidston.[5]

The specimen (No. 4468 of the Lacoe collection) illustrated in Pl. XXI, Fig. 2, seems also to belong to *Oligocarpia missouriensis*. The same form is also present at Mazon Creek, Illinois. But of the identity of the specimen illustrated in Pl. XXI, Fig. 1 (No. 4467 of the Lacoe collection), I am not quite so sure, on account of the compactness of the pinnules, although it seems to be connected with the sterile forms through the two specimens just discussed. Both 4467 and 4468 show only the upper surface of the limb, so that only the inflations above the sporangia or sori are seen. It will be noted that, while in most of the pinnules only two rows of fruit dots are seen, still, in the lobes of the lower and more pinnatifid pinnules additional dots make their appearance. It is hoped that this and other

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[1] Verst. Steink. Sachsen, p. 17, pl. xxxiii, fig. 7.
[2] Traité, Atlas, pl. xli, fig. 8.
[3] Farne d. Carbon-Flora, p. 137, pl. lxiii, fig. 1.
[4] Fl. foss. houill. Valenciennes, p. 53, fig. 35.
[5] Trans. Geol. Soc. Glasgow, vol. ix, 1889, pl. i, fig. 15*b*.

fruiting forms from our Coal Measures series may be made the subject of a special study.

A small and very fragile *Aphlebia* is presented at the base of the upper pinna on the left of the specimen shown in Pl. XX, Fig. 1.

Localities.—Owen's coal bank, U. S. Nat. Mus., 5567, 5694; also in a recent collection from Pitcher's coal bank, U. S. Nat. Mus., 4468, 5565, 5566, 5696; near Clinton, Henry County, Missouri, U. S. Nat. Mus., 5719; Lacoe collection, 4467, 4468, U. S. Nat. Mus.

OLIGOCARPIA cf. ALABAMENSIS Lx.

Although appearing to differ in some minor particulars from the characters of *Oligocarpia alabamensis* as originally described by Lesquereux,[1] several specimens from Deepwater so strongly resemble others from Illinois identified by that author as *O. alabamensis* that I provisionally refer them to that species, the type of which I have not seen.

Locality.—Deepwater, U. S. Nat Mus., 5719.

OLIGOCARPIA cf. GUTBIERI Goepp.

The fragment which I temporarily place among the specimens referred by Lesquereux to this species comprises about three-fourths of a compound pinna, which, though a little larger, has the form and superficial characters of the example from Illinois figured in the Coal Flora.[2]

The specimen from Hobbs's bank is, however, preserved in a sandy, micaceous shale that hardly permits a satisfactory analysis of the nervation, which in the type from Illinois is very clear, the lamina being extremely thin. Still, such traces of nerves as may be seen appear to agree with those of the figured specimen, and although the lamina is dull and black in the Missouri fragment, I think it probable that the plant should be referred to the same species as that from Illinois. The latter, however, as illustrated in the Coal Flora appears to differ from the type of Goeppert[3] or Geinitz,[4] some of the details of whose figures were copied by Lesquereux,[5] by the smaller, narrower, more oblique, and more deeply dissected pinnules, with

[1] Coal Flora, vol. i, Atlas, pl. xlvii, figs. 1, 1*a*–*b*.
[2] Vol. i, p. 266, pl. xlviii, figs. 1, 2.
[3] Gattungen, vol. i (3), p. 37, pl. iv, figs. 1, 2.
[4] Verst. Steink. Sachsen, p. 30, pl. xxxiii, figs. 6, 7; pl. xxxv, fig. 9.
[5] Coal Flora, pl. xlviii, figs. 3*a*–*b*.

more distant and flabellate nerves. The examination of a number of specimens from the same locality as the one figured throws considerable doubt on the identity of the European and American plants.

The Missouri specimen is quite different from the form referred by Lesquereux to *O. alabamensis* Lx., or that described in this report as *O. missouriensis*, being distinguished from both by the form of its pinnæ, the broader confluent pinnules, and the more flabellate nervation. It resembles in some respects some of the more slender pinnæ of *Pseudopecopteris Pluckenetii* (Schloth) Lx.

Locality.—Hobbs's coal bank, U. S. Nat. Mus., 5570.

ALOIOPTERIS Potonié, 1894.

Jahrb. d. k. Pr. geol. Landesanst. u. Bergakad., vol. xiv, 1893, Mittheil., p. xlviii. Abh. d. k. Pr. geol. Landesanst., n. F., No. 21, 1896, p. 24.

ALOIOPTERIS EROSA (Gutb.).

Pl. XXIII, Fig. 6; Pl. XXIV, Fig. 3*a*.

1843. *Pecopteris erosa* Gutbier, in Naumann, Cotta, Geinitz, et al.: Gäa v. Sachsen, Flora, p. 81.
1879. *Pecopteris erosa* Gutb., Lesquereux, Coal Flora, Atlas, p. 8, pl. xliv, figs. 1, 1*a*, 3. text, vol. i (1880), p. 255.
1843. *Pecopteris* (*Cyatheites*) *linearis* Gutbier (nec Rost, nec Stb., necque Old. et Morr.), in Naumann, Cotta, Geinitz, et al.: Gäa v. Sachsen, Flora, p. 83.
1855. *Alethopteris erosa* (Gutb.) Geinitz, Verst. Steink. Sachsen, p. 29, pl. xxxii, figs. 7–9, 7*a*, 9*a*.
1869. *Alethopteris erosa* (Gutb.) Gein., von Roehl, Foss. Fl. Steink. Westphalens, p. 81 (pl. xxi, fig. 11 ?)
1877. *Prepecopteris erosa* (Gutb.) Grand'Eury, Fl. Carb. Loire, p. 63.
1884. *Grand'Eurya erosa* (Gutb.) Zeiller, Ann. Sci. Nat., (6) bot., vol. xvii, p. 9.
1885. *Saccopteris erosa* (Gutb.) Stur, Farne d. Carbon-Fl., p. 159.
1887. *Corynepteris erosa* (Gutb.) Kidston, Foss. Fl. Radstock Ser., p. 381.
1888. *Corynepteris erosa* (Gutb.) Kidst., Zeiller, Fl. foss. houill. Valenciennes, p. 43.

The illustration of a fragment of a long compound pinna of this species published in the Coal Flora[1] gives a good general idea of the long, slender, close, extremely open pinnæ characteristic of this species. It also shows the more delicate habit of the American plant, the outlines of which differ somewhat from the European type, which is still inscribed by some authors in the genus *Alethopteris*.

[1] Atlas, pl. xliv, figs. 1, 1*a*.

The specimen shown in Pl. XXIII, Fig. 6, is of the same character as the large fragment figured by Professor Lesquereux. Some of the slender pinnæ of this type attain a length of 6 cm. or more. The pinnules in the middle of the pinna often show two well-developed sharp teeth, though the latter are not so cristate as in the preceding species. The small fragment of a young compound pinna seen in Pl. XXIII, Fig. 1, strongly resembles this species; but by its nervation and the development of the pinnules it belongs more properly to *A. Winslovii*, next to be described.

The rock fragment, from the vicinity of Clinton, photographed in Pl. XXIV, Fig. 3, shows two segments (No. 2386 of the Lacoe collection) identified by Professor Lesquereux as *Pecopteris erosa*, the larger of which approaches *A. Winslovii*, while the other preserves the apex of a compound pinna. But although the lateral pinnæ on the larger segment are nearly of the size frequently found in the *A. Winslovii* with which it has been thought it might perhaps belong as a younger stage, they show fairly well the difference in the pinnules and the margins.

In the American specimens of *Aloiopteris erosa* the pinnules are broader in proportion to the size of the pinna, and not so constricted; the upper border is much more nearly truncate, the sinuses not so deep proportionately, while the nerves, which are not so distinct in the rather thicker lamina, fork near the base at a narrower angle, and arch, especially the upper branch, rather strongly upward in passing to the margin, approaching in this respect the *P. serrula* Lx. When the pinnule has three teeth the upper nervil forks again at a rather narrower angle than in *A. Winslovii*.

I have not observed any fertile pinna that seems referable to this species among the material from Missouri. One fertile specimen from Morris, Illinois, identified under this name by Professor Lesquereux, has the same general aspect as the fertile pinnæ of *A. Winslovii*, though the pinnæ are narrower and the marginal filaments do not appear. It would seem, as in the latter species, to represent more probably *Corynepteris*, to which genus it has been referred by Kidston.[1]

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5562, 5563, 5614, 5721; Gilkerson's Ford, U. S. Nat. Mus. 5561.

[1] Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 381.

ALOIOPTERIS (CORYNEPTERIS?) WINSLOVII n. sp.

Pl. XXII, Figs. 1–3; Pl. XXIII, Figs. 1–5.

1843. Cf. *Pecopteris* (*Diplazites*) *cristatus* Gutbier, in Naumann, Cotta, Geinitz, et al.: Gäa von Sachsen, p. 80.
1848. Cf. *Pecopteris cristata* Gutb. (non Brongn.), Goeppert, in Bronn: Index Palæont., p. 915.
1879. *Pecopteris cristata* Gutb., Lesquereux, Coal Flora, Atlas, p. 8, pl. xliv, figs. 2, 2*a*; text, vol. i (1880), p. 256.
1854. An *Asplenites Sternbergii* Ettingshausen, Foss. Fl. Radnitz, pl. xx, figs. 2, 3, 4, p. 42 (pars) ?
1855. Cf. *Alethopteris cristata* (Gutb.) Geinitz, Verst. Steink. Sachsen, p. 29, pl. xxxii, fig. 6.
1885. Cf. *Saccopteris* (*Alethopteris*) *cristata* (Gutb.) Stur, Farne d. Carbon-Fl., p. 164.
1897. *Pecopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, pp. 296, 300.
1899. *Aloiopteris*, *Winslovii* D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 487.

The doubt expressed by Professor Lesquereux[1] as to the equivalence of the American form identified as *Pecopteris cristata* with the species figured by Geinitz[2] appears to me well founded. Our specimens differ from that figured in the "Versteinerungen" by the narrower divisions, the nerves originating, as may be seen in the photograph (Pl. XXIII, Fig. 2) of a slightly macerated and abraded specimen, at a much wider angle, straight or nearly so instead of curving, not forking below the middle, and forking once or twice at a very wide angle into short, straight divisions. It seems evidently distinct from that species.

In its general aspect and features our plant is very similar to the specimen described by Ettingshausen[3] as *Asplenites Sternbergii*, but, although some of the pinnæ in our specimens are very much like those seen in Zeiller's figure of the same species,[4] the detail in this figure, as well as in Ettingshausen's illustrations, indicates a more slender form, with broader midrib and blunter teeth. Some of Stur's photographic figures of *Saccopteris Essinghii* (Andrä)[5] are, however, so like the ordinary specimens of our plant, as seen in Pl. XXII, Figs. 1 and 2, that it seems far from improbable that the specimens he had in hand should be included in the same

[1] Coal Flora, p. 256.
[2] Verst. Steink. Sachsens, p. 29, pl. xxii, figs. 6, 6*a*.
[3] Steinkolenfl. Radnitz, 1855, p. 42, pl. xx, figs. 2, 3.
[4] *Sphenopteris Sternbergii* (Ett.) Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. ix, figs. 5, 5*a*, p. 128.
[5] Farne d. Carbon-Flora, pl. lii, figs. 2–6, p. 166.

species as those from Missouri. But Andrä's original figures,[1] as well as those given later by Weiss[2] and Zeiller,[3] seem to represent a plant with more oblique pinnules, comparable to those of *Sphenopteris inæquilateralis* Lx., which are much more dissected. In the comparatively very few specimens from Missouri in which the pinnules have elongated to a length of 1 cm. or more the lamina is still but little dissected, and the pinnules, which may be considered as pinnatifid, are constricted but slightly at the base. Imperfect fragments of such pinnæ are illustrated in Pl. XXII, Fig. 3, and Pl. XXIII, Fig. 4. Were this pinnatifid stage common in the development of the species, we should see many such fragments in the collections mingled with the attending segments of various degrees of maturity, including portions of rachises, 1 cm. or more in width, provided on both sides with alternating pinnæ of the usual form. The relation of the small fragments of a young compound pinna (Pl. XXIII, Fig. 1) to this species is shown by both the nervation and the peculiar angular dentition.

The fertile pinnæ, which seem to have been borne directly on the primary pinnæ, do not, as shown in Pl. XXIII, Figs. 4 and 5, differ in general form and arrangement from the sterile pinnæ. The sporangia, which are oblong or oval, .75 to 1.25 mm. long, .4 to .6 mm. wide, rounded at one end and rather obtuse at the other, are borne, in groups apparently, on the lower surface of the slightly reduced pinnules, which are so crushed in the shale as to make them seem entirely covered by the flattened sporangia. In a few cases it may be seen that the sporangia are attached by the ends in round groups, perhaps of 5 to 7 sporangia each, the members of which are sometimes spread apart at the top.

The question of the systematic position of the group, including *Pecopteris cristata* Gein., *Asplenites Sternbergii* Ett., *Pecopteris erosa* Lx., *P. georgiana* Lx., and *P. serrula* Lx., is one that has perhaps not yet reached its final settlement. Ettingshausen's *Asplenites Sternbergii*, to choose a typical example, has been referred by various authors to *Pecopteris*,[4] *Oligocarpia*,[5] *Sphenopteris*,[6] and *Saccopteris*,[7] while other species, no doubt congeneric,

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[1] *Sphenopteris Essinghii* Andrä, Vorweltl. Pfl. Steink., 1866, pl. vii, figs. 2, 3, p. 20.
[2] Aus d. Fl. d. Steink., 1881, pl. xii, fig. 76.
[3] Fl. foss. houill. Valenciennes, Atlas, 1886, pl. ix, figs. 1, 2; text, 1888, pp. 122, 125, fig. 41.
[4] Schimper, Traité, vol. i, 1869, p. 526.
[5] Stur, Culm-Flora, vol. ii, 1877, p. 294.
[6] Weiss, Aus d. Fl. d. Steink., 1881, p. 12.
[7] Stur, Farne d. Carbon-Fl., 1883, p. 165.

have been described as *Alethopteris* or referred thereto. On the whole, this group of species constitutes a division or section quite distinct from the other sections of the genus *Pecopteris*, which should either be transferred to some other genus, if that is found practicable, or separated as the basis of a new genus. By most recent authors they are referred to the genus *Sphenopteris*, and it would indeed seem that they are most closely related to and congeneric with *Sphenopteris Essinghii* Andrä, which binds them to *Sphenopteris inæquilateralis* Lx. *Sphenopteris Sternbergii* (Ett.) Weiss was placed in the fertile genus *Saccopteris* by Stur, and *Saccopteris* (= Grand 'Eurya Zeiller) is regarded[1] as identical with Baily's *Corynepteris*.[2] Thus most of these species like *Sphenopteris Essinghii* have found places in *Corynepteris* or its synonyms. The close resemblance of the fertile pinnæ from Missouri, obscure specimens of which are found in Pl. XXIII, Fig. 5, to the specimens figured by Zeiller[3] as *Sphenopteris* (*Corynepteris*) *coralloides* Gutb., is at once apparent, even the narrow dichotomous filaments extending out from the slightly reduced limb being similar in both species. This circumstance, together with the demonstration by Zeiller[4] of the same type of fruit in *Sphenopteris Essinghii*, leaves little room for doubt that the fructification of our American plant is probably of the *Corynepteris* type. Our specimens, though badly crushed, seem to confirm this view; but while the sporangia are shagreened and would seem to be grouped in a manner similar to *Corynepteris*, I have not yet been able to distinguish the zone of the thickened cells found in the sporangia of that genus.

Localities.—Frequent at Pitcher's bank, U. S. Nat. Mus., 5551, 5610, 5611, 5613, 5721; Owen's coal bank, U. S. Nat. Mus., 5609, 5613; Deepwater, U. S. Nat. Mus., 5552, 5689; Hobbs's coal bank, U. S. Nat. Mus., 5690; Gilkerson's Ford.

PECOPTERIDEÆ.

PECOPTERIS Brongniart, 1822.

1822. *Filicites* sec. *Pecopteris* Brongniart, Mém. mus. hist. nat., vol. viii, p. 233.
1826. *Pecopteris* Sternberg, Versuch, vol. i, tent., p. xvii (pars).
1828. *Pecopteris* Brongniart, Prodrome, p. 54.

[1] Kidston, Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 381.
[2] Explan. sheet 142, maps, Geol. Surv. Ireland, 1860, p. 16.
[3] Fl. foss. houill. Valenciennes, Atlas, pl. x, figs. 1, 2.
[4] Op. cit., text, p. 125.

PECOPTERIS (DACTYLOTHECA) DENTATA Brongn. (non Will.).

Pl. XXIV, Figs. 1, 2; Pl. XXV; Pl. XXVI, Figs. 2-4; Pl. XXVII.

1828. *Pecopteris dentata* Brongniart, Prodrome, pp. 58, 170.
1834. *Pecopteris dentata* Brongniart, Hist. vég. foss., p. 346, pls. cxxiii, cxxiv.
1835. *Pecopteris dentata* Brongn., Lindley and Hutton, Foss. Flora, vol. ii, pl. cliv.
1870. *Pecopteris dentata* Brongn., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 404.
1876. *Pecopteris dentata* Brongn., Ferd. Roemer, Leth. Geogn., vol. i, Atlas, pl. lii, figs. 1*a*–*b*; text (1880), p. 176.
1878. *Pecopteris dentata* Brongn., Zeiller, Vég. foss. terr. houill., Atlas, pl. clxviii, figs. 3, 4; text (1879), p. 86.
1879. *Pecopteris dentata* Brongn., Lesquereux, Coal Flora, Atlas, pl. xliv, figs. 4, 4*a*; text, 1 (1880), p. 240.
1880. *Pecopteris dentata* Brongn., Fontaine and I. C. White, Permian Flora, p. 66, pl. xxii, figs. 1, 2 (3–5?).
1883. *Pecopteris dentata* Brongn., Renault, Cours. bot. foss., vol. iii, p. 121, pl. xxi, figs. 4, 5.
1887. *Pecopteris dentata* Brongn., Lesquereux, Proc. U. S. Nat. Mus., vol. x, p. 25.
1893. *Pecopteris dentata* Brongn., D. White, Bull. U. S. Geol. Surv., no. 98, p. 60.
1899. *Pecopteris dentata* Brongn., D. White, 19th Ann. Rept. U. S. Geol. Surv., p. 488.
1828. *Pecopteris plumosa* (Artis?) Brongniart, Prodrome, pp. 58, 171.
1835 or 1836. *Pecopteris plumosa* (Artis?) Brongniart, Hist. vég. foss., p. 348, pls. cxxi, cxxii.
1858. *Pecopteris plumosa* (Artis?) Lesquereux, Geol. Pennsylvania, vol. ii, pt. 2, p. 867.
1866. *Pecopteris plumosa* (Artis?) Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, Pal., p. 442.
1869. *Pecopteris plumosa* (Artis?) von Roehl, Foss. Fl. Steink. Westphalens, p. 58, pl. xxxiii, fig. 4.
1881. *Pecopteris plumosa* (Artis?) Weiss, Aus d. Fl. d. Steink., pl. xvii, figs. 104, 104*a*.
1888. *Pecopteris plumosa* (Artis?) Howse, Trans. N. H. Soc. Northumberland a. Durham, vol. x, 1, p. 89.
1828. *Pecopteris triangularis* Brongniart, Prodrome, pp. 58, 171.
1832. An *Sphenopteris caudata* Lindley and Hutton, Foss. Flora, vol. i, pl. xlviii ?
1833. *Cyatheites dentatus* (Brongn.) Goeppert, Systema, p. 325.
1855. *Cyatheites dentatus* (Brongn.) Goepp., Geinitz, Verst. Steink. Sachsen, p. 26 (pars), pl. xxix, figs. 10–12; pl. xxx, figs. 1, 2.
1869. *Cyatheites dentatus* (Brongn.) Geopp., von Roehl, Foss. Fl. Steink. Westphalens, p. 87, pl. xxxiii, fig. 6.
1876. *Cyatheites dentatus* (Brongn.) Geopp., Heer, Fl. Foss. Helv., p. 30, pl. xi; pl. xii, figs. 1–5.
1838. *Pecopteris Brongniartiana* Presl, in Sternberg: Versuch, vol. ii, 7–8, p. 160.
1848. *Cyatheites plumosus* (Artis?) Goeppert, in Bronn: Index Palæont., p. 365.
1869. *Cyathocarpus dentatus* (Brongn.) Weiss, Foss. Fl. jüngst. Steink. u. Rothl. Saar-Rh. Geb., p. 86.
1869. *Pecopteris* (*Cyatheides*) *dentata* Brongn., Schimper, Traité, vol. i, p. 508.
1877. *Senftenbergia dentata* (Brongn.) Stur, Culm-Flora, vol. ii, p. 187 (293).

1888. *Senftenbergia* (*Pecopteris*) *dentata* (Brongn.) Stur, Toula, Die Steinkohlen, p. 188, pl. i, figs. 21, 22.
1877. *Prepecopteris dentata* (Brongn.) Grand 'Eury, Fl. Carb. Loire, p. 63.
1877. *Senftenbergia plumosa* (Artis?) Stur, Culm-Flora, vol. ii, p. 187 (293).
1885. *Senftenbergia plumosa* (Artis?) Stur, Farne d. Carbon-Fl., p. 92 (pars), pl. li, figs. 1, 2, 3.
1879. *Pecopteris pennæformis* Brongn., Lesquereux, Coal Flora, Atlas, p. 8, pl. xlv, figs. 1, 1*a* (figs. 2, 2*a*?); text, vol. i (1880), p. 239 (pars, excl. syn.).
1883. *Dactylotheca dentata* (Brongn.) Zeiller, Ann. Sci. Nat., (6) bot., vol. xvi, p. 184, pl. ix, figs. 12–15.
1888. *Dactylotheca dentata* (Brongn.) Zeiller, Fl. foss. houill. Valenciennes, p. 30, figs. 16*a–b*.
1890. *Dactylotheca dentata* (Brongn.) Zeiller, Fl. foss. Autun et Épinac, vol. i, p. 21, figs. 17*a–b*.
1897. *Dactylotheca dentata* (Brongn.) Zeill., Potonié, Lehrb. d. Pflanzenpal., p. 92, figs. 63 A, B; p. 108, fig. 96.
1884. *Prepecopteris plumosa* (Artis?) Bureau, Comptes rendus, vol. xcix, p. 1036.
1885. *Senftenbergia acuta* (Brongn.) Stur, Farne d. Carbon-Fl., vol. i, p. 96, pl. li, figs. 4, 5.
1886. *Pecopteris* (*Dactylotheca*) *dentata* Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xxvi, figs. 1, 1*a*, *b*, 2, 2*a–e*; pl. xxvii, figs. 1, 1*a*, *b*, 2, 2*a*, 3, 3*a*, 4; pl. xxviii, figs. 4, 5, 5*a*; text (1888), p. 196.
1890. *Pecopteris* (*Dactylotheca*) *dentata* Brongn., Zeiller, Fl. foss. Autun et Épinac, vol. i, p. 66, pl. ix*a*, figs. 3, 3*a*.
1886. *Dactylotheca plumosa* (Artis?) Kidston, Cat. Pal. Foss. Pl. Brit. Mus., p. 128.
1896. *Dactylotheca plumosa* (Artis?) Kidston, Trans. Roy. Soc. Edinb., vol. xxviii, pt. 1, p. 205, pls. i–iii.
1887. *Dactylotheca plumosa* (Artis?) Kidst. var. *dentata* (Brongn.) Kidston. Foss. Fl. Radstock Ser., p. 382.

Fronds large, tripinnate, quadripinnatifid below; primary rachis large, 5–12 mm. wide, finely trichomatose; secondary rachis 1–5 mm. broad, grooved on the upper surface and finely punctate; primary pinnæ alternate, at right angles or oblique, often reflexed in the lower part of the frond, usually overlapping slightly, 3.5–11 cm. apart, oval-lanceolate, 18–50 cm. or more long, 3.5–12 cm. wide at the middle, somewhat contracted at the base, the sides of the larger ones parallel in the middle portion, and tapering to a sharp point above; secondary pinnæ alternate, 6–12 mm. apart, usually overlapping somewhat, the upper ones oblique, the middle nearly at right angles, the lower ones often reflexed and shorter, often flexuous, linear-lanceolate, the larger ones 2.5–6 cm. long, 5–25 mm. wide, tapering to an obtusely acuminate point; pinnules alternate, more or less triangular, somewhat arched, generally obtusely pointed or rounded, sometimes acuminate at the tip or appearing oblong, somewhat oblique, sessile, contiguous, and slightly connate at the base, those in the middle of the secondary pinnæ 35 mm. long, averaging about 2 mm. in width at base, the margins generally more or less reflexed so as to make them appear sharply triangular, the laminæ arching between the nervils, either entire or with a few rounded, usually indistinct lobes; the lower basilar pinnule of each secondary pinna generally shorter and lobate, sometimes appearing auriculate; pinnules toward the top of the secondary pinnæ gradually becoming confluent, passing to the entire or slightly lobed apex of the pinnæ; pinnules of the lower secondary pinnæ near the base of the frond, 5–13 mm. long, 2–4 mm. wide, pinnatifid, or perhaps pinnate, the divisions being about 1.5 mm. long and 1 mm. wide, the uppermost secondary pinnæ with pinnules becoming united and passing into primary pinnules, pinnatifid below in rounded lobes, the succeeding ones crenulate, then entire; nerves usually quite distinct, the median nerve passing to the top, but very slightly if at all decurrent, emitting nervils at a wide angle, the lower nervils forking, the upper ones simple, those of the large pinnatifid pinnules giving off other simple nervils in the lower lobes.

Although both *Pecopteris dentata* Brongn. and *P. pennæformis* Brongn. are recorded as having been found in the vicinity of Clinton, I have not yet seen any specimens that seem to me referable to the latter species. On the contrary, all the examples from Henry County, including the large one shown on Pl. XLV of the Coal Flora, that were labeled *Pecopteris pennæformis*—concerning the characters of which there is much confusion apparent in the identifications in this country—seem to agree well, most of them perfectly, with specimens of *P. dentata* from France and England. The comparison of our American with the foreign material fully confirms the views expressed in the remarks on this species in my report on the flora of the outlying basins of Missouri.[1]

The common and typical phases of the species are shown in Pl. XXV, Fig. 1; Pl. XXVI, Fig. 3, and Pl. XXVII, the details of the nervation being illustrated in the enlarged photographs, Pl. XXIV, Figs. 1*a*, 1*b*, or in Pl. XXVI, Fig. 4. A number of specimens from Pitcher's coal mine are very delicate, approaching the form distinguished by some authors as *Pecopteris*

[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 60.

plumosa.[1] Generally, however, the pinnules are fully up to the typical size, agreeing in form, nervation, and limb with the European species. A few examples, from Pitcher's mine, show the pinnules rather more crowded, larger, broader, and smoother, the lamina being hardly raised between the nerves. This form, which approaches nearer than the other to *P. pennæformis*, should perhaps receive some distinctive appellation.

Although a number of the specimens are fertile, the sporangia are not sufficiently clearly preserved to give any important details as to structure or arrangement.

Localities.—Collected in fine specimens from Pitcher's bank, U. S. Nat. Mus., 5641, 5642, 5643, 5655, 5738, 5739, 5743; Owen's coal bank, U. S. Nat. Mus., 5621, 5742; Gilkerson's Ford, U. S. Nat. Mus., 5740.

PECOPTERIS cf. ARBORESCENS (Schloth.) Brongn.

Pl. XXXVI, Fig. 3; Pl. XLIV, Fig. 3; Pl. XLVII, Fig. 6?.

Among the material last transmitted by Dr. Britts are several fragments of *Pecopteris*, the size, form, and nervation of whose pinnæ and pinnules seem to be fairly comparable with those of *Pecopteris arborescens* as described by Brongniart[2] and further differentiated by Zeiller.[3] Portions of the pinnæ as well as the general form of the pinnules present even more strongly the aspect illustrated by Zeiller[4] as *P. cyathea* (Schloth.) Brongn., but the

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[1] Since the preparation of this report and synonymy the writer has had the opportunity to consult Mr. Kidston's most interesting and thorough elaboration of the *Pecopteris plumosa* (Artis) Brongn., as the result of which the identity of the *Filicites plumosus* with *Sphenopteris crenata* L. & H., *S. caudata* L. & H., *Aspidites silesiacus* Goepp., etc., is very satisfactorily demonstrated. The specific inseparability of the plant described by Artis from most of the material later described by various authors as *P. dentata* is also evident. An inquiry into the geologic horizons of the *plumosa* forms, including *S. crenata*, *A. silesiaca*, and the fine series from the Middle Coal Measures illustrated by Kidston, seems, however, to show that, in general, in Europe as well as in America the delicate plumose type is more characteristic of lower stages of the Coal Measures, while the more robust type with broader, more obtuse pinnules and a stronger nervation is essentially characteristic of higher beds. The writer is therefore fully convinced of the desirability of retaining a varietal distinction for the later form, illustrated in this report, whose differences from the forms illustrated by Kidston are quite apparent. The form which I have treated as *P. dentata* should probably be designated as *Pecopteris plumosa* var. *dentata*, the combination proposed by Kidston in 1887, since it appears that *P. plumosa* (Artis) Brongn. has priority over *P. dentata* Brongn. The very full synonymy given by Kidston (Trans. Roy. Soc. Edinb., vol. xxviii, pt. 1, 1896, p. 205, pls. i–iii) includes the *Aphlebia adnata*, which he shows to be peculiar to *Pecopteris* (*Dactylotheca*) *plumosa*.

[2] Hist. vég. foss., p. 310, pl. cii, figs. 1, 2.

[3] Fl. foss. houill. Commentry, p. 111, pl. xi, figs. 1, 2.

[4] Op. cit., p. 119, pl. xii, figs. 1–4.

nervils seem to be always simple, and the rachis is punctate. In fact, I should have but little hesitation in referring the fragments to the former species were it not for a slight decurrence of the midrib and the distinctly villous upper surface of the fertile pinnules. So well marked, however, are these characters that a definite reference of our specimens to that species is plainly not allowable. Still, not wishing on the evidence of the material before me to add to the nomenclature of this already highly differentiated group, I leave the fragments from Missouri, one of which is seen in Pl. XXXVI, Fig. 3, with a reference that is both tentative and comparative.

Considerable difference as to the punctation of the rachises exists between the specimens from different regions or horizons described by different authors as *Pecopteris arborescens*. In the specimens from Missouri a rachis less than 4 mm. in length is provided with rather distant, very open, upward-curving spines, round at the base, and nearly 2 mm. in length.

To the form described above probably belongs a specimen from the same region[1] labeled by Professor Lesquereux as *Pecopteris æqualis* Brongn. The pinnules in this specimen, Pl. XLIV, Fig. 3, 3^a, are, however, more than twice as long as, and broader at the top than, those of one of Brongniart's types[2] which, in verification of Brongniart's intimation, has been referred by Schimper and Zeiller to *P. pennæformis*.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 5588, 5595, 5596.

A doubtful fragment which, the nervation being obscure, may belong to *P. vestita* Lx., is from Pitcher's coal bank, U. S. Nat. Mus. 5686.

PECOPTERIS (ASTEROTHECA) HEMITELIOIDES Brongn.?

Pl. XXXV, Fig. 5.

Among the hundreds of fragments of *Pecopteris* from Hobbs's bank is a single specimen, which, though failing to show certain important diagnostic characters with sufficient clearness to make positive its identification as *Pecopteris hemitelioides* Brongn., seems nevertheless to coincide so far with that species in its visible features as to justify its provisional designation by the same name. This fragment, some idea of the outlines of whose pinnæ

[1] No. 4873 of the Lacoe collection, U. S. Nat. Mus.

[2] Hist. vég. foss., p. 343, pl. cxviii, figs. 1, 2.

and pinnules can be gained from Fig. 5, Pl. XXXV, represents a segment of a spinous rachis 8 mm. in width, to which are attached three fertile pinnæ, the lower surface of which is presented to the observer. The rachises of these pinnæ are provided with well-marked, distinct, upward-inclined, acute spinous scales.

The sporangia, a sketch of which is shown in Fig. 5*a*, are situated in a row on each side of the midrib, the attachment being rather nearer the margin. The sporangia, nearly 1 mm. long and about .2 mm. in width, tapering to an acute apex, are apparently arranged in fours and inclined inward, so that when compressed they lie pointing more or less directly toward the midrib, and covering the greater portion of the pinna. In most cases the outer pair of sporangia are developed to a very much larger size than the inner ones, the result being that in the flattened, carbonized material they only are seen. This condition is very similar to that illustrated in *Pecopteris euneura* by Grand 'Eury[1] and Zeiller.[2]

In the specimen before me the nervation is obscured by the sporangia, except in the uppermost small pinnules, where the nervils are simple. This character, together with the striking resemblance of the pinnæ and pinnules in form and arrangement to those illustrated by Zeiller in the flora of the Commentry Basin,[3] led me to apply, though not without doubt, the same name, *Pecopteris hemitelioides* Brongn., to the plant from Missouri.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5594.

PECOPTERIS JENNEYI n. sp.

Pl. XXXVI, Figs. 1, 2.

1897. *Pecopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 296.

Frond robust, dense; secondary (?) pinnæ alternate, open, lanceolate or linear-lanceolate, acute; rachis strong, rigid, irregularly striate and provided with narrowly lanceolate, acute, upward-curved, scaly spines, leaving, where broken away, rounded scars; ultimate pinnæ alternate, open, close, usually touching or slightly overlapping in the lower part of the superior pinnæ, often slightly curved upward, linear, the sides parallel in

[1] Fl. carb. Loire, pl. vii, fig. 3.
[2] Fl. foss. houill. Commentry, pl. xi, fig. 4*a*.
[3] Op. cit., pl. xi, figs. 6, 6*a*, 7, 7*a*, p. 133.

the lower and middle portions, converging near the top to form the obtusely pointed apex; ultimate rachis strong, broadly canaliculate above, rounded beneath, sparsely punctate; pinnules alternate, close, usually nearly contiguous, often crowded, open, generally at or nearly at a right angle to the rachis, ovate when small, becoming oblong, rounded at the apex, slightly irregular, very slightly decurrent at the base, the small pinnules joined for a little distance, with a decurring sinus, the large ones distinct to the base, more or less constricted on the upper side of the base by the decurrent sinus, the largest ones frequently somewhat contracted in the inferior angle also; lamina not very thick, dull, arched near the margin, and marked on the ventral surface by a row of rather distant minute mammillate points in each interneural space; nervation coarse, generally distinct; median nerve rather strong and but slightly if at all decurrent in the large pinnules, depressed slightly, minutely and irregularly lineate, passing nearly to the apex of the pinnule, decurrent in the small pinnules; lateral nerves originating at a very oblique angle, curving at once outward, and forking near the base, normally at a rather open angle, the upper division sometimes forking again in the lower portion of the very large pinnules, in passing with slight upward curvature to the margin, which they reach at an angle of 60°–75°; fructification unknown.

In a portion of the specimen illustrated in Pl. XXXVI, Figs. 1 and 1*b*, the substance of the pinnules is so macerated that the rather coarse nervation stands out in relief. The conditions of preservation have also imparted a rather greater degree of obliquity to the nerves in most of the pinnules than is seen in those specimens in which the lamina is spread out more evenly in the matrix. The punctations, which are quite distinct in the rachises of the larger pinnæ, are sparsely scattered in the fragment of a smaller pinna seen in Pl. XXXVI, Fig. 2. In one of the fragments sent by Dr. Britts we have a segment of rachis 30 cm. in length, 10 mm. in width at the base, and 8 mm. at the upper end, on which the upward-curved, chaffy spines are as much as 3 mm. in length. This rachis is provided with pinnæ a little larger than those seen in Fig. 1, or of nearly the size and appearance of those shown in fig. 3, on pl. xiv, of Zeiller's Flora of the Commentry Basin. Unfortunately this slab is not suited for photographic illustration. The pinnules are generally not so close as in our Fig. 1. The nerves, generally coarse and rather stiff in appearance, usually visible on the upper surface, are always clear on the lower surface, where they are like fine wires, sometimes appearing double, as in a portion of the specimen from which the detail, Pl. XXXVI, Fig 1*a*, is drawn.

The specimens which I have described under the above name belong to the complex of *Pecopteris* species, among which *Pecopteris oreopteridia* (Schloth.) Brongn. and *P. lepidorachis* Brongn. are the most familiar. In fact, I was at first disposed to identify them as the latter species, for, while apparently distinct from the unequivocal type[1] figured by Brongniart, in which the pinnules are narrower, the upper division of the nervils in the larger pinnules in most cases forking again, the fragments from Missouri present a general aspect, form, and arrangement of the pinnæ and pinnules so strikingly like those of the specimens illustrated by Zeiller[2] or Potonié[3] as to argue strongly, especially in the presence of a similar system of nervation, in favor of their specific identity. But a more minute comparison seems to show in the American plant a tendency to greater decurrence in the midribs and sinuses; the pinnules, which appear slightly broader in proportion to their length, often contracted on the upper side at the base: nervation distinctly constricted on the lower side also; the midrib rather stronger, and the nervils slightly closer and usually more oblique. In respect to the decurrence of the midrib, the form of the smaller pinnules, the contraction of the larger pinnules, and the nervation, our plant is somewhat intermediate between *P. lepidorachis* and *P. oreopteridia*. In the latter, however, the upper nervil is more apt to fork again, even in the smaller pinnules, while the rachis is always smooth. Still, the resemblance to that species as generally figured is very strong. *Pecopteris Jenneyi*[4] has much in common also with *P. densifolia* Goepp. and *P. Daubreei* Zeill.,[5] but in the former the pinnules are apparently even more constricted at the base, and,

[1] Hist. vég. foss., p. 313, pl. ciii, fig. 1. Figure 5 of the same plate is also referred to this species by Brongniart in the text of *P. lepidorachis*, but it is also similarly assigned on the opposite page (312) to *P. platyrachis*, with which reference the explanation of the pl. ciii agrees. M. Zeiller (Fl. foss. houill. Commentry, vol. i, p. 127) is disposed, on account of the coarsely punctate rachis, to consider it as perhaps one of the types of *P. lepidorachis*, although the nervils are delineated as simple. Lesquereux, however, copied this figure in pl. xli of the Coal Flora (figs. 5, 5*a*) and gives it as the illustration of *P. platyrachis*, a species described as having a smooth rachis.

[2] Fl. foss. houill. Commentry, pl. xiii, fig. 5; pl. xiv, figs. 1–3.

[3] Fl. Rothl. Thüringen, p. 72, pl. v, figs. 2, 2*b*.

[4] The small pinnules of *P. Jenneyi* are usually rather wider proportionately, with more oblique nervation than in the latter species, as illustrated by Potonié, Fl. Rothl. von Thüringen, pl. vii, figs. 1*a*, 1*b*, p. 68.

[5] Fl. foss. houill. Commentry, pt. 1, p. 147, pl. xv, figs. 1–5.

as in *P. oreopteridia*, the rachis is smooth, while in the latter the surface is villous.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5590, 5597, 5598; Hobbs's coal bank, U. S. Nat. Mus., 5599.

PECOPTERIS CANDOLLIANA Brongn.[1]

1828. *Pecopteris Candolliana* Brongniart, Prodrome, p. 56.
1833 or 1834. *Pecopteris Candolliana* Brongniart, Hist. vég. foss., p. 305, pl. c, figs. 1, 1*a*.
1833 or 1834. *Pecopteris affinis* Brongniart [non (Schloth.) Stb.], Hist. vég. foss., p. 306, pl. c, figs. 2, 3.
1883. *Pecopteris affinis* Brongn., Renault, Cours. bot. fos., vol. iii, p. 109, pl. xvii, fig. 6.
1836. *Cyatheites Candolleanus* (Brongn.) Goeppert, Systema, p. 321.
1855. *Cyatheites Candolleanus* (Brongn.) Goepp., Geinitz, Verst. Steink. Sachsen, p. 24, pl. xxviii, figs. 12, 13.
1857. *Cyatheites Candollianus* (Brongn.) Goepp., Meneghini, Pal. Sardaigne, p. 156, pl. D^{v4}.
1869. *Cyatheites Candolleanus* (Brongn.) Goepp., Von Roehl, Foss. Fl. Steink. Westphalens, p. 83 (pl. xii, fig. 3*b* ?).
1876. *Cyatheites Candolleanus* (Brongn.) Goepp., Heer, Fl. Foss. Helv., p. 28 (pl. viii, figs. 9, 9*b* ?).
1853. *Pecopteris Candolleana* Brongn., Andrä, in Germar: Verst. Steinkohlenf. Wettin u. Löbejün, p. 108 (pl. xxxviii, figs. 1–3 ?).
1877. *Pecopteris Candolleana* Brongn., Grand 'Eury, Fl. Carb. Loire, p. 69, pl. viii, fig. 8.
1880. *Pecopteris Candolleana* Brongn., Fontaine and I. C. White, Permian Flora, p. 63 (pl. xx, figs. 1–3 ?).
1883. *Pecopteris Candolleana* Brongn., Renault, Cours. bot. foss., vol. iii, p. 109, pl. xvii, figs. 7, 8, 8 *bis*.
1869. *Pecopteris* (*Cyatheides*) *Candolleana* Brongn., Schimper, Traité, vol. 1, p. 500.
1869. *Cyathocarpus Candolleanus* (Brongn.) Weiss, Foss. Fl. jüngst. Steink. u. Rothl. Saar Rh. Geb., p. 85.
1879. *Pecopteris Candollei* Brongn., Zeiller, Vég. foss. terr. houill., p. 84.
1883. *Scolecopteris Candolleana* (Brongn.) Stur, Zur Morph. System. Culm- u. Carbon-Farne, p. 123.
1888. *Pecopteris* (*Asterotheca*) *Candollei* Brongn., Zeiller, Fl. foss. houill. Commentry, vol. i, p. 128, pl. xi, fig. 3.
1890. *Pecopteris* (*Asterotheca*) *Candollei* Brongn., Zeiller, Fl. foss. houill. perm. Autun et Épinac, p. 47, pl. viii, figs. 5, 6.

The specimen which I refer to this rare species is by its form, the outlines of the pinnules, and its nervation so closely related to the Old World plant that its reference to the same species seems quite justified.

[1] Strict adherence to the law of priority requires the use of the orthography given by Brongniart in the "Prodrome" and the "Histoire."

Although the stratigraphic position of the beds near Clinton would seem to be rather low for this form, it has already been reported in specimens,[1] which seem to me questionable, from beds no younger at Mazon Creek, Illinois, as well as from Mount Hope, Rhode Island.[2]

Locality.—Pitcher's coal mine, U. S. Nat. Mus., 5653.

PECOPTERIS SQUAMOSA Lx.

1870. *Pecopteris squamosa* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 400, pl. xii, figs. 1–4, pl. xiii, figs. 10, 11.

1879. *Pecopteris squamosa* Lesquereux, Coal Flora, Atlas, p. 7, pl. xxxix, figs. 12, 13, 13*a*; text, vol. i (1880), p. 235.

1899. *Pecopteris squamosa* Lx., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 494.

The species from Mazon Creek, Illinois, described by Lesquereux under the above name is one of the smallest of the genus *Pecopteris.* It is, as seen in numerous specimens from Cannelton, Pennsylvania, somewhat conspicuously characterized by the rigid, close, narrowly linear, very open pinnæ, tapering from the base to the slender, acute apex, and the small, narrow, open, crowded, villous pinnules. The uppermost pinnæ and pinnules are extremely small and delicate. The nervils are very open, simple in the smaller pinnules, forking once in the lower part of the larger ones.

The specific details of this plant are given with unusual fullness by its author in the Coal Flora,[3] and should be carefully consulted by anyone making a comparison of the species with other forms. Unfortunately, illustrations of the ordinary and typical fragments are still lacking.

The specimens sent by Dr. Britts from Missouri are in perfect agreement with those from Mazon Creek and Cannelton. One fragment of a tripinnate frond from the last-named locality contains a segment of a rachis 16 mm. in width, provided with close, linear-lanceolate acuminate pinnæ 48 cm. in length. The obliquity of these lateral pinnæ with reference to the rachis would seem to indicate a position for them in the upper part of the frond, which, in that case, must have been of great size. A number of examples from the same place show the pinnæ well preserved in nervation. It should be remarked that while the features of the pinnæ and pinnules remain the same in both the old and the young specimens, the squamose character is often less obvious in some of the large segments.

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[1] Lesquereux, Geol. Surv. Illinois, vol. iv, 1870, p. 401.

[2] Am. Nat., vol. xviii, 1884, p. 922.

[3] Vol. i, p. 235.

The sori, although insufficiently clear to show the sporangia, are small, situated near the margin, and a little distant.

Pecopteris squamosa, which is perhaps intermediate between the groups represented by *P. arborescens* or *P. cyathea* on the one hand and *P. vestita* on the other, is easily distinguished from the other plants from Henry County by the size and rigidity of the very slender tapering pinnæ and the small, very narrow, open, crowded, thick pinnules, in which the nervils are usually totally obscured.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 5816–5818; Henry County, Missouri, U. S. Nat. Mus., 5600.

PECOPTERIS PSEUDOVESTITA n. sp.

Pl. XXVIII, Figs. 1, 2, 2*a*; Pl. XXIX, Pl. XXX, Pl. XXXI, Figs. 1, 2, 3?; Pl. XXXII, Figs. 1, 2.

1879. *Alethopteris ambigua* Lesquereux, Coal Flora, Atlas, p. 6, pl. xxxi, figs. 2, 3 (4?); text, vol. i (1880), p. 182 (pars).
1879. *Pecopteris clintoni* Lesquereux, Coal Flora, Atlas, p. 8, pl. xlii, figs. 5, 5 *a–b;* text, vol. i (1880), p. 251 (pars).
1879. *Pecopteris vestita* Lesquereux, Coal Flora (Atlas, p. 8, pl. xliii, figs. 5, 5*a*?); text, vol. i (1880), p. 252 (pars).
1897. *Pecopteris* n. sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 300.

Frond very large, long, tri- or quadripinnate; primary (?) pinnæ very long, linear-lanceolate, contracted toward the base, the sides nearly parallel in the middle, acute or acuminate at the apex; rachis broad, rigid, straight, dull, finely but irregularly lineate; pinnæ of the next order alternate, at a right angle to the rachis below, becoming somewhat oblique above, the higher ones often curving somewhat upward, close, generally slightly overlapping, especially in the lower part of the frond, oblong-linear or linear-lanceolate, contracted a little at the base, the sides slightly convex in the middle portion, and somewhat abruptly converging near the point to form an acute or acuminate apex, the rachis being broad and rigid; ultimate pinnæ alternate, very open, the middle and lower ones at a right angle to the rachis or slightly reflexed, the upper ones frequently nearly at a right angle or but slightly oblique, somewhat irregular, seldom parallel, with a tendency to curve slightly upward, often a little distant, but usually close, and sometimes touching or slightly overlapping, oblong-lanceolate or linear-lanceolate, the sides nearly parallel below and in the middle, rapidly converging near the top to an obtuse apex, which consists of an ovate terminal pinnule; ultimate pinnæ succeeded near the apex of the superior pinnæ by diminishing pinnatifid and simple pinnules; pinnules alternate, open, generally at or nearly at a right angle to the rachis, hardly decurrent except near the apex or in the youngest pinnæ, irregular, slightly unequal, seldom parallel, sometimes slightly upward curved, a little distant, close, or sometimes touching, oval or ovate, and cut to near the rachis by a slightly decurrent sinus when small, becoming oblong, or linear, the sides parallel, usually uneven, the apex round, separated to the rachis or even slightly constricted at the base by the decurrent sinus before becoming pinnatifid; lowest pinnules of the pinna slightly reduced, the uppermost pinnules partially united with the ovate terminal pinnule; lamina dull, generally opaque or minutely rugose, often rather broadly canaliculate over the midrib, arching upward between the midrib and the margin, where it is often flattened to form a narrow shallow gutter; nervation not very distinct; midrib rather strong, sometimes slightly decurrent at the base, faintly lineate, depressed to near the apex in the well-preserved fragments; lateral nerves originating at a moderate angle, forking at a wide angle near the midrib, the lower branch curving to the margin, the upper branch arching strongly near the midrib and forking again, the nervils passing out nearly at a right angle to the border, the middle nervil forking again as the pinnule approaches the crenulate stage, those in the lobes of the pinnatifid pinnules being rather close, curving strongly outward, and forking again as the lobes become more deeply dissected; fertile pinnæ of the same form as the sterile pinnæ, a little more distant or slightly reduced; sori in a row, situated within the border of the pinnule or lobe, often appearing as rather large, noncontiguous, roundish, pustular elevations of the lamina on the upper surface of the pinnule, or, when mature and crushed, seeming to cover the lower surface; sporangia oblong or lanceolate, obtuse or rounded at the base, tapering above to an acute point, opening by a ventral cleft, and attached apparently by or near the base in groups of four or more.

When the first consignment of fossils from Henry County, Missouri, was received at the United States National Museum, several years ago, I attempted the identification of the species of *Pecopteris*, but found myself entirely unable to distinguish, in practical usage, the three species described and figured in the Coal Flora from this region. In fact, it immediately became quite plain that not only were the same forms referred to both *Pecopteris clintoni* Lx. and *Callipteridium membranaceum* Lx., but it also appeared that forms belonging to more than one species had been included under each name. Afterwards, when additional collections had come, and the series of allied forms was represented by nearly a thousand specimens, it was evident that a revision would be necessary. Pending, however, the removal of the Lacoe collection to Washington, all further study of this group in the material from Missouri was postponed. Since that time the consummation of the gift of Mr. Lacoe's invaluable collection of Paleozoic plants to the United States National Museum has given me the opportunity to study the magnificent series of Pecoterids therein, including the types of species contained in the Missouri material. Accordingly, in the following discussions of the species concerned, I shall make reference to the specimens identified by Professor Lesquereux, some of which are herein illustrated.

Among the collections there are several hundred specimens representing a well-defined species, which is distinguished from the other forms present by the close oblong pinnæ, with smooth rachises and very slightly rugose, opaque, nearly smooth lamina in which the nerves are generally fairly well shown. The Tertiary pinnæ are oblong-linear or oblong, slightly contracted at the base, the sides nearly parallel, and somewhat abruptly contracted at the top in an acute point terminated by an ovate pinnule

The pinnules are close, open nearly at a right angle to the rachis, proportionately narrow, hardly decurrent, and very uneven in their position. The lamina is depressed rather strongly over the midrib and repand at the margin. The nerves differ from those of the other species by their more erect position near the midrib and the more strongly arched nervils, which pass more nearly at right angles to the margin, besides being irregular or somewhat crooked and closer.

A large slab containing segments of parallel primary pinnæ of this plant, the broad section of whose rachises indicates a very great size for the species, is shown in Pl. XXIX. These segments are interesting from the fact that the parallelism of their position seems to indicate a relationship of both the contained segments as subdivisions of a pinna of a still higher order, a condition still more strongly suggested by a section of a fertile frond on another slab. In this fertile specimen a section of a pinnate rachis of nearly the size seen in the larger slab is seen in union at an oblique angle with a still larger rachis, the entire width of which is unfortunately not shown in the specimen.

The segments on the large slabs are also of importance as showing in direct connection on the same pinna the acute or acuminate apices of the lateral compound pinnæ, some variation in the obtuseness of the ultimate pinnæ, and, in particular, the presence of slightly macerated portions in which the pinnules are flattened and spread out, in contrast to the well-preserved portions, in which the lamina is arched and broadly canaliculate over the midrib, so as to give the pinnæ an Alethopteroid aspect. The superficial characters seen in the upper lateral pinnæ in the center of the large slab will at once be recognized in Fig. 1, Pl. XXXI, one of the figured types[1] of *Alethopteris ambigua* Lx. (No. 3093, Lacoe collection), and the detail of the nervation in the latter (Pl. XXXI, Fig. 1*a*) agrees equally well. The original (No. 3094, Lacoe collection) of fig. 3 of the same plate in the Coal Flora presents precisely the same features, both in the form and in the details, as is seen in the type of fig. 2, both specimens[2] being unquestionable representatives of the species illustrated in Pl. XXIX.

The reference of Nos. 3093, 3094, 3095, 3096, and a number of other Missouri specimens of this form to *Alethopteris* was presumedly due to the irregularity of the pinnules and the rather strongly depressed midrib, suggestive of *Alethopteris ambigua*, as well as to the scarcity of the smaller and pinnatifid fragments of the latter species in the author's hands at the time the description was written. The real difference of the nervation of the two species, which will be illustrated in Pls. XXVIII, XXXIII, and XXVI, Fig. 1*a*, is indicated even in figs. 1*a* and 3*a* of the plate in the Coal Flora.

The same conclusion as to specific identity is to be drawn from the details of No. 3174, Fig. 1, Pl. XXVIII, which was one of the types used in Professor Lesquereux's original description of *P. clintoni*. No. 3179 and several other examples from Missouri in the same collection are also fragments of the same plant, being quite easily distinguishable from the other form originally included in the species last mentioned.

The pinnæ seen in Pl. XXX are presumably from the middle or lower portions of the frond. Toward the extremity of the large pinnæ corresponding to those on the large slab, the rachis tapers quite rapidly, the

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[1] Coal Flora, vol. i, p. 182, pl. xxxi, fig. 2.

[2] Unfortunately the original of fig. 3 of pl. xxxi of the Coal Flora is not suited to illustration by photography.

ultimate lateral pinnæ being succeeded by very small pinnæ or pinnatifid pinnules. An intermediate stage is seen in the illustration of No. 3179,[1] Pl. XXVIII, Fig. 2, while the pinnatifid higher stage is shown in Pl. XXX, and Pl. XXXII, Fig. 1, the enlarged details of the pinnules being given in Pl. XXX, Figs. 1*a–c*, though the pinnæ are often more obtuse. Still lower, however, than the pinnæ shown in the large slab, the lateral pinnæ become considerably broadened, the pinnules also assuming a crenulate phase, though both the outlines and the details are conformable to the type.

The characters of the fertile pinnæ, as noted in the above description, are quite uniform. When first appearing in specimens showing the upper surface of the lamina, the sori appear as small pustular, noncontiguous elevations, arranged in a row nearly midway between the midrib and the margin in the pinnules and lobes, which are slightly reduced and rather more coriaceous than in the sterile pinnæ. In Fig. 2, Pl. XXXI, of No. 3097,[2] in the Lacoe collection, chosen for illustration on account of its better adaptation to photography, the sori are expressed faintly through the fertile portion of the fragment. At a later stage they seem to occupy most of the surface of the pinnule, from beneath which, when crushed, as is usually the case, the sharp apices of the sporangia may protrude in a manner observed in the genus *Scolecopteris* Zenk. Pl. XXXII, Fig. 2, shows a fragment from a portion of a frond which is also referable to this species, probably corresponding nearly to the position seen in the large slab, Pl. XXIX. It represents the upper surface of the pinnules, a portion of which show traces of the sporangia.

It is very rarely possible to gain an adequate idea of the sporangia when the lower surface of the pinna is exposed, since they are in every case badly crushed. Still it seems fairly certain that the sporangia are usually in groups of four attached by the obtuse base, the upper, pointed, free ends being erect, on which account they are generally broken down or matted in the impression so as to obscure the arrangement. Fig. 3*a* on Pl. XXXI will serve to illustrate the appearance of the sporangia in one of the specimens which I somewhat doubtfully refer to this species, although the view (ventral surface) of the pinnule presented is not suitable for detailed illustration.

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[1] Identified by Professor Lesquereux as *Pecopteris clintoni;* in the Lacoe collection.

[2] Identified by Professor Lesquereux as *Alethopteris ambigua.*

As I was somewhat uncertain as to the generic reference of the fertile pinnæ, a few fragments were sent to Prof. R. Zeiller, who is preeminently experienced in the determination of carbonized fertile Paleozoic ferns. This distinguished author, who has had the kindness to examine these fragments, writes that he considers them as somewhat intermediate between *Asterotheca* and *Scolecopteris*, though probably much nearer the *Asterotheca* type, especially as that is seen in *Pecopteris* (*Asterotheca*) *hemitelioides* Brongn. My own observations lead me to accept Professor Zeiller's conclusion, for the sporangia appear to me to be attached by the base, without pedicels, while at the same time they are larger, broader, and less acute than in any described species of *Scolecopteris*. They appear in part considerably like the figure given by Stur[1] as *Hawlea Miltoni*. It is hoped that additional details may be brought out in future in the course of a more leisurely study of this and other fertile species in this flora.

The original (No. 3173 of the Lacoe collection) of fig. 5 on pl. xlii of the Coal Flora, described as the fruit of *Pecopteris clintoni*, appears to me to be indistinguishable from the fertile pinnæ of *Pecopteris pseudovestita* seen in many fragments from Pitcher's coal bank. The oval bodies delineated as sporangia are the protuberances of the upper surface of the slightly macerated lamina over the sori. The sporangia themselves appear to belong to the type described above. It should be noted that the fertile pinnules do not taper as much as represented in the artist's drawing, nor are the sterile pinnules above so broad and compact. Very good examples of the fertile pinnæ of our species are seen in Nos. 3142 and 3127, labeled *P. vestita*, of the Lacoe collection, while 3140 is typical of *P. pseudovestita*. However, in No. 3097 of the Lacoe collection, mentioned above, we have a well-preserved segment labeled *Alethopteris ambigua* in which a portion is fertile, the sporangia being expressed on the upper surface of the lamina. Several other fossil specimens, also labeled *Alethopteris ambigua*, agree in all respects with the fertile pinnæ of our species and should be referred thereto.

Among the Old World species, *Pecopteris pseudovestita* is perhaps most similar to the smallest pinnæ of *P. abbreviata* Brongn. In the latter species, however, the corresponding parts are very much larger and the pinnæ much more oblique, while the nervation is not so dense. From *P. oreopteridia*

[1] Farne d. Carbon-Fl., p. 106, figs. 17*b*–*c*.

Brongn., which it resembles in its lateral pinnæ and terminal pinnules, our species differs by its irregular, flexuous, and generally more open pinnæ, the irregular pinnules, and the more compact, outward-arched nervils.

Besides the differentiating characters of form, texture, and nervation, mentioned at the outset of these remarks, *Pecopteris pseudovestita* can further be distinguished from *P. clintoni* Lx. and *P. vestita* Lx. by the irregularity of the pinnæ and pinnules, the latter being slightly unequal, and the sporangia, which are longer and more pointed than in *P. clintoni*, and much broader, more crowded, and larger than *P. vestita*. The most striking distinctions for our species, however, are the obtuseness of the lateral pinnæ, the smooth rachis, the absence of villosity in the sterile pinnæ, and the quite different nervation.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5644, 5648, 5725, 5775, 5776, 5780, 5781, 5784, 5786, 5788, 5790, 5791, 5794, 5799, 5800, 5809; Hobbs's coal bank, U. S. Nat. Mus., 5778, 5789. Owen's coal bank, U. S. Nat. Mus., 5777, 5783, 5793?, 5797?, 5798, 5801; Henry County, Missouri, Lacoe collection, U. S. Nat. Mus., 3093, 3097, 3174, 3179; Deepwater, U. S. Nat. Mus., 5779?.

Pecopteris vestita Lx.

Pl. XXXIII, Figs. 1–6; Pl. XXVI, Fig. 1.

1879. *Pecopteris vestita* Lesquereux, Coal Flora, Atlas, p. 8, pl. xliii, figs. 1–7 (5?); text, vol. i (1880), p. 252 (pars).

1883. *Pecopteris vestita* Lesquereux, 13th Rept. Geol. Surv. Indiana, pt. 2, pl. xiv, figs. 1, 1*a*.

1889. *Pecopteris vestita* Lx., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 612, text fig.

Frond rather large, spreading, somewhat dense; primary (?) pinnæ lanceolate or linear-lanceolate, slightly lax; rachis rather slender, slightly flexed at the bases of the secondary pinnæ, sparsely punctate; secondary pinnæ alternate, open, the lower ones at a right angle to the rachis or reflexed, the upper ones somewhat oblique, usually touching or overlapping a little, linear-lanceolate, acute or acuminate, the rachis being rather slender, straight or slightly curved, generally rigid, slightly rounded on the dorsal side, minutely lineate, with rather distant and not very large punctations; ultimate pinnæ alternate, very open, the lower ones slightly reflexed, close or touching, the upper ones becoming more distant, but slightly decurrent, oblong, or oblong-triangular when small, becoming lanceolate-triangular and very long linear-triangular when large, tapering nearly the whole length, the sides converging rather more rapidly in approaching the rather slender tip; ultimate rachis slightly terete beneath, sulcate on the ventral surface, rather slender, rigid, or slightly curved; pinnules alternate, close, usually nearly touching, sometimes a little distant, open, the lower ones nearly at a right angle to the rachis, decurrent; when young, oval, curving outward, and connected halfway up, becoming oblong or oblong-ovate, narrowing slightly from the base up toward the obtusely rounded tip, separated to near the rachis by a very narrow decurrent sinus that cuts to near the midrib on the upper side of the largest pinnules; lamina of moderate thickness, depressed over the midrib, arched slightly backward at the margins, narrowly decurrent from the bases of the pinnules, either rather densely covered with short scales or scaly hairs lying parallel to the nervation, or, when macerated, appearing brownish or transparent, the scaly covering usually remaining, however, in portions of the specimen; nervation clear on the dorsal surface of the pinnule, or more or less distinct in the macerated specimens; midrib rather slender, more or less decurrent, and tapering to near the apex of the larger pinnules; lateral nerves fine, originating at a rather wide angle and either, in the smallest pinnules, turning upward, simple, or, in the larger pinnules, forking near the base, and passing, with slight curvature, quite obliquely to the margin, the upper branch forking again in the largest simple pinnules; fructification in small sori situated a little distant in a row a little within the margin of the pinnules or lobes; sporangia 4 to 6 in the sori, small, lanceolate, acute at the upper end, attached at or near the larger rounded lower end.

Pecopteris vestita Lx., which was originally described from the vicinity of Clinton, Missouri, is represented among the collections in hand by a fine series of typical specimens. The species is in general fairly well marked by the long, tapering, slender pinnæ, the pinnules broadest near the base and decurrent, the upper surface densely covered by short scalelike hairs or very minute chaffy scales arranged parallel to the nerves, which they generally obscure, and the slender oblique nervation.

The fossil shown in Pl. XXXIII, Fig. 2, presumably a secondary pinna, corresponds in size and in details to one of the lateral pinnæ arranged alternately along a slightly flexuous rachis. about 6 mm. in diameter, on one of the larger slabs. The pinnæ in Fig. 5, especially in the upper part, are comparable to those seen in fig. 6, pl. xliii, of the Atlas to the Coal Flora. In this case the specimen is macerated enough to permit the satisfactory discovery of the nervation over a considerable portion of its area, although in the darker portions traces of the villosity are expressed on this, the dorsal, aspect. The lowest pinnules of the fragment are slightly crenulate, representing the beginning of the transition to the pinnatifid stage illustrated in Fig. 2, the further development of which is seen in Fig. 3, Pl. XXVI. The phase shown in Fig. 2, Pl. XXXIII, is the most common aspect of the fragments in the collections. Specimens with pinnatifid pinnules as small as those shown in fig. 7 of the plate in the Coal Flora are very rare in the collection. In Fig. 4, Pl. XXXIII, are shown the small lateral pinnæ of a villous fragment in which the course of the nerves can be dimly discerned among the crowded scalelike hairs.

Simple pinnæ of the type seen in Fig. 1, Pl. XXXIII, and Fig. 6 or Fig. 7, are not rare in the collection. In the last figure, which is somewhat suggestive of *Pecopteris arborescens* Brongn., the position of the immature sori is indicated on the upper surface by a row of small, rather distant points on either side of the midrib.

Fertile pinnæ of *Pecopteris vestita* are not rare in the recent collections from Henry County, though I have seen none that show the details of the sporangia structure. As noted in the descriptions, the groups of sporangia are a little distant and well within the margin. The sporangia, which are somewhat smaller than in *P. pseudovestita*, are usually four to the sorus, oval-lanceolate, acute, about 1 mm. long and .4 mm. wide in the lower part From their deep-seated position on the lamina and the apparent absence of pedicels, I am inclined to regard them as referable to the *Asterotheca* type. A number of specimens of the form described above, identified as this species by Lesquereux, are in the Lacoe collection, Nos. 3141 and 3146 being among the clearest and best. Many fertile fragments labeled as this species by Professor Lesquereux should be referred to *Pecopteris pseudovestita*, as is remarked in the discussion of that species.

Pecopteris vestita may nearly always be quite easily distinguished from *P. pseudovestita* by the more slender, more rigid, and much more tapering pinnæ, hardly contracted at the base; by the much more regular, parallel, and decurrent pinnules, tapering more from the base upward, with apices not so rounded; by the lamina, clothed on the upper surface with minute scales or scaly hairs, which may generally be discovered even in some portions of the most macerated specimens; by the more oblique, straighter, fewer, and more even nerves, and by the rather more distant sori and the smaller sporangia. From the form described by Lesquereux from Mazon Creek, Illinois, and from other localities as "*Pecopteris villosa* Brongn.?," to which it is more closely related than to any other species, the Missouri plant seems to differ by the less robust pinnæ, the more decurrent pinnules, and the more oblique nervation in the pinnatifid pinnules. The rachis in the plant so common at Mazon Creek is rather more densely and conspicuously punctate. The Lacoe collection contains examples from the Radstock coal field and the Forest of Dean, in England, which seem hardly separable from the forms identified by Lesquereux as "*Pecopteris villosa* Brongn.?" *P. vestita* differs from *P. clintoni* by its smaller size, more acute lateral pinnæ, narrower and much more regular pinnules, not narrowed at the base, rather closer and a little coarser nervation, and its small, acute sporangia.

Localities.—Most common at Owen's coal bank, U. S. Nat. Mus., 5646, 5647, 5683, 5684, 5685, 5688, 5745, 5754, 5755, 5758, 5760, 5766, 5767, 5770, 5773, 5808, 5822; Hobbs's coal bank, U. S. Nat. Mus., 5746, 5748, 5753, 5765, 5769, 5771, 5773?, 5774; Pitcher's bank, U. S. Nat. Mus., 5747, 5752, 5753, 5756?, 5759, 5761, 5762, 5763, 5768; Henry County, Missouri, U. S. Nat. Mus., 5656, 5749, 5757.

Pecopteris clintoni Lx.

Pl. XXXIV; Pl. XXXV, Fig. 4.

1879. *Pecopteris Clintoni* Lesquereux, Coal Flora, Atlas, p. 8, pl. xlii, figs. 1–3, 3*a*, 4, 4*a* (non figs. 5, 5*a*–*b*); text, vol. i (1880), p. 251 (pars).

1879. *Callipteridium membranaceum* Lesquereux, Coal Flora, Atlas, p. 6, pl. xxvii, figs. 5, 5*a* (non figs. 6, 7, 8); text, vol. i (1880), p. 172 (pars).

Frond large, tri- or polypinnate; secondary (?) pinnæ lanceolate or linear-lanceolate, acute, lax, somewhat polymorphous, and provided near the apex with confluent pinnatifid pinnules; rachis broad, lineate, flat, lax; lateral pinnæ alternate, open, at a right angle to the rachis at the base, becoming oblique above, generally rather distant, sometimes close or contiguous, irregular, lax, flexuous, lanceolate, linear-lanceolate, the lower ones often slender and acute, the upper ones more obtuse; pinnules alternate, very open in the middle, generally close, often contiguous, decurrent, polymorphous, oval, ovate or oblong, obtuse, sometimes irregularly lobed when becoming pinnatifid, connate for some distance, especially in the younger pinnæ, dissected by a narrow, deeply decurrent sinus when large; lamina rather thin, villous, generally flat, or nearly so; nervation usually obscure; median nerve more or less decurrent, strong at the base, and vanishing in the upper part of the pinnule; nervils distant, fine, originating at a rather narrow angle, forking once near the base, the upper branch, sometimes both branches in the larger pinnules, forking again, and passing very obliquely to the margin; sporangia oval, averaging .5 mm. in length and .4 mm. in width, arranged 5 to 7 in the sorus, which, when crushed, nearly covers the lower surface of the pinnule.

This species as described and illustrated by Lesquereux[1] is not infrequent in the Missouri material, especially in that from Hobbs's coal bank. In these specimens, as well as in the many examples from this region in the Lacoe collection labeled with this name by Lesquereux, the most striking features which appear on first glancing at the specimens are the variability in the size of the pinnæ and pinnules, the lax and the irregular attitude of the pinnæ, and the frequent occurrence of a heteromorphous development near the apices of some of the pinnæ.[2] In many specimens this is much more marked than is shown in the specimen given in fig. 1 of the plate in the Coal Flora. The decurrent bases of the pinnules, forming a marginal wing even in the larger pinnules, and the degree of the connation of the pinnules in the smaller pinnæ, are suggestive of a Sphenopterid relation.

In some of the examples, like that illustrated, Pl. XXXIV, the leaf substance is so macerated that it is possible, especially on the lower side, to see the nervation, which in better-preserved fragments, such as the one shown in Fig. 4, Pl. XXXV, is very much if not totally obscured beneath the villous covering. Traces of the villosity are, however, to be seen in nearly all the specimens.

A number of macerated and semitransparent specimens of this type, from the same region, were labeled by Lesquereux as *Callipteridium membranaceum* Lx. Among the examples of such a reference in the Lacoe

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[1] Coal Flora, vol. 1, p. 251, pl. xlii, figs. 1–4, 4*a* (not figs. 5, 5*a*–*b*).

[2] This, of course, does not apply to the small specimens of the smooth plant with different form and nervation, which I have described as *Pecopteris pseudovestita*.

collection are Nos. 3182, 3184, 3185, and 3191, all of which show the form and nervation, as well as the villosity, of *Pecopteris clintoni.*

Similarly, as might be suspected from a comparison of figs. 4 and 6 on pl. xxvii in the Coal Flora, with figs. 4 and 6, respectively, of pl. xlii of the same work, Nos. 3181 and 3183, the originals, respectively, of these figures, fail, so far as I am able to discover, to present an Alethopteroid nervation, and after a careful examination, being unable to discern the nervation delineated by the artist, I do not hesitate to refer both of them to the *Pecopteris clintoni.*

An obscure fertile segment which seems referable to this species is also present in the collection. The flattened sporangia are generally oval, often squarrose, or obovate-squarrose, and usually crowded on the surface of the pinnule. Five, six, or seven are usually grouped in the sorus, the arrangement being apparently about a short central column; but in many cases in which the group contains seven or six sporangia, one of the latter appears to occupy a central position. The cells of the sporangium wall, which seems to open by a cleft extending downward from the apex, are elongated in the direction of the longer axis of the sporangium.

As has already been stated, the sporangia seen in the original of fig. 5 on pl. xlii of the Coal Flora are, though obscure, probably of the type found in connection with the *Pecopteris pseudovestita*, to which the somewhat erroneously delineated sterile portions of the specimen seem also referable.

Although *Pecopteris clintoni* presents rarely in the upper pinnæ a form similar to *Callipteridium membranaceum* Lx., it is easily distinguished by the nervation when the latter is seen, as well as by the almost constantly present villosity. In reality the general aspect of the pinna of this species is Pecopteroid or slightly Sphenopteroid, quite in contrast to the Alethopteroid phase of the *Callipteridium.* The pinnæ of our species are considerably larger, more obtuse, more irregular and lax than those of *P. vestita*, while the rachis is not punctate. The nervation also in *P. clintoni* is more distant and generally more oblique. With *P. pseudovestita P. clintoni* is not likely to be confused, on account of the greater size, more open arrangement of the pinnæ, the much larger, decurrent, polymorphous, tapering, villous pinnules, the distant fine, relatively straight, very oblique, and more simple nerves, and the much smaller and more rounded sporangia in the latter.

From the closely resemblant species *Sphenopteris integra*, as figured in Germar's "Versteinerungen,"[1] our species is distinguished by the more open divisions, the pinnules usually not curved so much upward, with bases not so rhombic, while the midrib is not so slender or flexuous.

Localities.—Hobbs's coal bank, U. S. Nat. Mus., 5730, 5732, 5737, 5751?; Pitcher's coal bank, U. S. Nat. Mus., 5505, 5506, 5729, 5733, 5735, 5750?; Owen's coal bank, U. S. Nat. Mus., 5608?, 5728, 5731, 5734; Henry County, Missouri, U. S. Nat. Mus., 5823.

PECOPTERIS sp. indet.

Among the obscure and specifically indeterminate Pecopteroid fragments are two specimens showing a delicate, translucent, oblique pinnuled plant, somewhat suggestive of some of the unillustrated examples from Mazon Creek, Illinois, referred by Professor Lesquereux to *Pecopteris serpillifolia.* The Missouri form has, however, the sides of the pinnules more nearly parallel and the nervils more open and forking once in the larger pinnules.

The material appears insufficient to justify an attempt at a more complete description or comparison.

Locality.—Owen's coal mine, U. S. Nat. Mus., 5601, 5602.

PECOPTERIS MERTENSIDES Lx. MSS.

Another new species of *Pecopteris* was distinguished and described by Professor Lesquereux in manuscript, which it is hoped may be published at an early date. The quotation of the *nomen nudum* in this place is sufficient to indicate the presence in our flora of this species, which was named *Pecopteris mertensides.*

Locality.—Henry County, Missouri, No. 4869 of the Lacoe collection, U. S. Nat. Mus.

INCERTÆ SEDIS.

BRITTSIA gen. nov.

Frond (?) consisting of broad, pinnate, dilate, palmate-open, lax-nerved, somewhat fleshy expansions of the rachial lamina, on the upper surface of which are placed the more or less distinctly imbricated pinnules. Type, *Brittsia problematica.*

[1] Page 67, pl. xxviii, figs. 1–4.

BRITTSIA PROBLEMATICA n. sp.

Pl. XLVII, Figs. 1–5; Pl. XLVIII, Figs. 1–3.

Primary pinnæ small, oval or round, consisting of a short, broad, lax, flattened axis, from which radiate, distichously, lingulate crenulated thalloid (?) branches or secondary pinnæ, each of which is provided with two rows, one on each side of the rachis, of alternate, denticulate, imbricated scales or pinnules; main axis rather coarsely and irregularly striate, as if to correspond to the course of lax vascular bundles, 4 to 8 cm. long or longer, 2 to 5 mm. or more in width at the base, expanded and relaxed to a much greater width in the middle, dissolving somewhat rapidly at the top, and bordered on either side by a rather thick lamina which extends along the lateral pinnæ, joining them near their bases; lateral pinnæ alternate, close, usually somewhat overlapping, the lowest much reflexed, the middle ones at a right angle to the axis, the upper ones becoming more oblique, so as to impart a somewhat radial effect, lingulate, 1 to 5 cm. long, 7 to 10 mm. broad, slightly narrower at the base, often broadest in the upper part, obtusely rounded at the apex, each pinna composed of a broad, sinuate, bandlike, lax rachis at a right angle to, or but slightly decurrent to, the principal axis, 1.5 to 3 mm. wide, giving off short, oblique branches alternately and regularly at intervals of from 2.5 to 5 mm. on the same side, which pass through and out of the rachial lamina or border close to the rachis to enter the pinnules; border of the lateral rachises continuous with that of the main axis, not very thick, minutely coriaceous, 2 to 5 mm. wide on either side, the margin obscure, apparently broken irregularly or crenulate-erose, depressed in shallow pits, or gathered slightly at the vascular base of each pinnule; pinnules alternate, originating one from each of the vascular pits in the rachial lamina, asymmetric, ovate, or obovate-cuneate, 8 to 12 mm. long, 5 to 8 mm. wide, apparently narrow at the point of attachment, arching outward at first, then broadening and spreading over the rachial lamina, inclined upward, imbricating, the margin incised in sharp or rather broad, not very long teeth; leaf substance of pinnules not very thick; nervation coarse, broad, flabellate from the base of the pinnule in a broad fascicle, the wide strands forking two to four times at a narrow angle and arching somewhat in their passage to the extremities of the teeth.

A general idea of the form and habit of this somewhat problematic plant may be gained from an inspection of the forms shown in Pl XLVII, Fig. 3, and Pl. XLVIII, Figs. 1 and 3. All of the pinnæ are of the same type and agree in the expansion of the flat axis above the base in the middle portion of the pinna, the surface being marked by coarse, irregular striæ corresponding to the vascular bundles which are spread out in broad, lax, sinuate bands in the lateral pinnæ. The marginal lamina of the main axis is continuous with that of the lateral rachises, forming lingulate expansions about the latter. A marked feature in the lateral pinnæ, however, is the position of the pinnules in a different plane from the lamina. The pinnules originate, apparently with much constricted bases, at alternating points on the lamina close to the rachis, the roundish, pitlike vascular cicatrices, when the pinnules are fallen or removed, giving the general effect of sori or sporangia on the lamina. This character is seen in Fig. 3, Pl. XLVII, or Fig. 3 on Pl. XLVIII, in which, as in most of the specimens, the pinnules are wholly removed and only the marginal lamina is left. It is difficult to determine whether these pits marking the passage of the vascular bundles to the pinnules are actually within the margin of this rachial lamina or not. In a number of cases the broad expanse of the lamina seems continuous around the cicatrice, as though the pinnule emerged from its surface. Nevertheless, it is quite possible, and would be more natural, for the pinnules to spring from very deep sinuses on the lamina, whose greatly dilated broad expansions on the same side overlap so compactly as to have every appearance of a continuous limb. These expansions, one of which is shown in Fig. 4, Pl. XLVII, not only lie in the approximate plane of the rachis, but they may clearly be traced distinctly separate from the pinnules opposite them; and, although the margins are generally obscure and apparently erose or crenulate, the attachment of the pinnules is evidently quite narrow.

The pinnules themselves are borne in two rows on each of the lateral pinnæ. From the point of attachment, marked by the cicatricial pits in the depinnuled pinnæ, they curve outward slightly, then inward so that those on one side of the rachis overlap those on the other side, alternately imbricating, the combined expanse of both rows being much greater than the rachial lamina. In Fig. 1, Pl. XLVIII, is shown the greater part of a frond (?) in the lower left of which the pinnules are still in place, as is better illustrated in Fig. 1*a*. Fig. 2, the photographic enlargement, 2*a*, and the details, Fig. 2*b*, show the double series of broken pinnules still in their normal arrangement, the rachis and rachial lamina together with the bases of the pinnules having been lifted away. It seems probable that these pinnules are somewhat convex, curving out away from the lamina, and that normally they are somewhat raised, oblique to the plane of the rachis. The nerves are broad and flat, forking dichotomously and passing somewhat flabellately into the not very long, rather blunt teeth.

It is a noteworthy fact that the surface of the primary (?) pinnæ in most of the specimens is concave or convex, the ends, the lateral pinnæ, being reflexed or rolled back from the side bearing the pinnules. Thus in one fragment the lateral pinnæ are rolled halfway back, Fig. 1, Pl. XLVII, representing the axial side, while Fig. 2 shows the opposite sides of the body nearly covered by the reflexed pinnæ. The pinnules formerly covering what is now the outer surface are entirely lost.

Among the Paleozoic plants thus far made known the form which seems most nearly related to this species is the *Schizopteris pinnata* of Grand 'Eury[1] or the *Androstachys frondosus* of the same author,[2] both of which have been referred by Zeiller[3] to *Zygopteris*, since Renault[4] had already discovered in the fronds of *Schizopteris pinnata* the structure characteristic of Corda's genus.[5] *Araucarites spicæformis* Germar[6] has several points of strong resemblance, especially the characters of the axis and the arrangement of the lateral pinnæ, and it perhaps belongs, as Grand 'Eury and Zeiller have suggested, in the same group. The rachises of both orders in our plant are much more lax apparently than in the examples figured by Grand 'Eury or Zeiller,[7] while the rachial lamina, which is so prominent a feature in the Missouri fossil, seems hardly represented in *Zygopteris pinnata*, the pinnules of which are lateral, though perhaps not in the same plane, with lax fibrovascular bundles passing out through the limb from the whole width of the pinnule. In our plant, on the contrary, the broad lateral lamina is not striated by the passage of any bundles, the vascular branches being confined to the bands which pass from the rachis of the lateral pinnæ to the cicatrices seen in the rachial lamina.

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[1] Fl. carb. Loire, 1877, p. 200, pl. xvii, fig. 1.
[2] Op. cit., fig. 3.
[3] Fl. foss. houill. Commentry, vol. i, p. 77.
[4] Ann. Sci. Nat., (6) bot., vol. iii, p. 23, pl. i, figs. 12, 13.
[5] Flora d. Vorwelt, 1845, p. 81.
[6] Verst. Steink. Löbejün u. Wettin, p. 94, pl. xxxiii, figs. 1, 2.
[7] Fl. foss. houill. Commentry, vol. i. Atlas, pl. xxxii, figs. 5–7.

No sporangia appear in any of the specimens of *Brittsia problematica*, although the reflexion of the pinnæ, as in Fig. 1, Pl. XLVII, is possibly evidence of fertility. The discovery of specimens showing the fructification and the degree of continuity of the lamina about the base of the pinnules is greatly to be desired.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5554, 5555, 5693, 5723, 5724, 5811. Additional specimens from the same locality also sent recently by Dr. J. H. Britts, of Clinton, Missouri. One specimen comes from Hobbs's bank, U. S. Nat. Mus., 5722.

SPIROPTERIS Schimper, 1869.

Traité, vol. i, p. 688.

Spiropteris sp.

Among the fern fragments from Owen's mine are three pinnæ in vernation. These lie close together and are parallel, thus indicating their probable origin from a single frond. The rachises are quite strong and prominently striate-ribbed, not punctate nor scabrous. The characters, so far as they appear, of the inrolled pinnæ, less than a centimeter in diameter, favor a reference to *Alethopteris ambigua*, with which correlation the characters of the rachis are in agreement.

Locality.—Owen's coal mine, U. S. Nat. Mus., 6174.

CAULOPTERIS Lindley and Hutton, 1832.

1820. *Lepidodendron* Sternberg, Fl. d. Vorwelt, vol. i, fasc. 1, pp. 20, 23; tent. (1825), p. xii (pars).
1828. *Sigillaria* Brongniart, Prodrome, p. 63 (pars).
1832. *Caulopteris* Lindley and Hutton, Foss. Fl. Gt. Brit., vol. i, pl. xlix.
1836. *Sigillaria*—sect. *Caulopteris* Brongniart, Hist. vég. foss., vol. i, p. 417.
1845. *Stemmatopteris* Corda, Fl. d. Vorwelt, p. 76.

Caulopteris ovalis (Lx. MSS.).

The above name, although a *nomen nudum*, will serve in this report to record the presence in the Lower Coal Measures of Missouri of a new species of fern stem, described in the unpublished manuscript on the American Coal Flora, by Professor Lesquereux. Although the specimen is referred by the latter to *Stemmatopteris*, the details of the scar are quite clear and unobscured by ramentum, so that there seems to be no reason why the species should not be placed directly in the genus *Caulopteris*.

Locality.—Henry County, Missouri; Lacoe collection, U. S. Nat. Mus.

CAULOPTERIS? ACANTOPHORA Lx.

1870. *Caulopteris acantophora* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 458, pl. xxvi, figs. 3, 4. ("*Caulopteris ? acantophora*" in expl. pl.)
1884. *Ulodendron punctatum* L. and H., Lesquereux, Coal Flora, vol. iii, p. 405 (syn.).

A number of specimens appear to agree well with this species, first described by Professor Lesquereux from Illinois. In these, however, as well as in the type specimen, now in the Illinois State Museum of Natural History, I am unable to find any clear evidence of any attachment of fossil petioles, such as to warrant its generic reference. On the contrary, in the specimen figured in the Illinois Report, vol. iv, pl. xxvi, fig. 3, the concentric markings on the left appear to be due entirely to slickensides, while the curved zone on the right is extraneous. An examination of a large number of similar specimens from Morris and Colchester, Illinois, fails to show a single scar that, in my opinion, can satisfactorily be regarded as belonging to *Caulopteris*.

The peculiar and characteristic spines of the species are present and clearly visible. It may not be impossible that these remains are the petioles of some spinous *Pecopteris*, such as *Pecopteris villosa*, *P. vestita*, or *P. lepidorrachis*, one of which is represented abundantly at both Clinton in Missouri and the region of Morris in Illinois.

Locality.—Owen's coal bank, U. S. Nat. Mus., 6272.

MEGAPHYTON Artis, 1825.

Antediluvian Phytology, pl. xx.

MEGAPHYTON GOLDENBERGI Weiss.

1860. *Megaphytum Goldenbergi* Weiss, Zeitschr. d. deutsch. geol. Gesell., vol. xii, p. 511, text fig.
1869. *Megaphytum Goldenbergii* Weiss, Schimper, Traité, vol. 1, p. 713, pl. liv, figs. 1, 2.
1872. *Megaphytum Goldenbergi* Weiss, O. Feistmantel, Abh. k. böhm. Gesell., (6) vol. v, p. 7, pl. i, fig. 1.
1874. *Megaphytum Goldenbergi* Weiss, O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 142, pl. xxii, fig. 1.
1879. *Megaphytum Goldenbergii* Weiss, Lesquereux, Coal Flora, Atlas, p. 13, pl. lxi, fig. 4; text, vol. i (1880), p. 349.
1881. *Megaphytum Goldenbergi* Weiss, Aus d. Fl. d. Steink., p. 17, pl. xix, fig. 112.

The inscription of this species of *Megaphyton* in the flora of the lower coals of Missouri rests wholly on the determination of the specimen from Henry County, described and figured by Lesquereux in the Coal Flora.[1] Although this specimen appears from its description to differ somewhat from the type established by Weiss, it constitutes for the present the American type, and consequently the standard of characters for the species in this country.

A small specimen before me, collected by Dr. Jenney, presents a smaller trunk, whose partly effaced and obsure scars may be in agreement with the type referred to above, though the characters are not sufficiently clear to admit of a satisfactory identification. The general facies and proportions of the segment are strongly suggestive of the *M. approximatum* as illustrated by Lindley and Hutton[2] and Zeiller.[3] In fact, but for the obscurity of its characters, which make its accurate identification impossible, and the circumstance that the *M. Goldenbergi* was found in the same vicinity or perhaps at the same locality, I should have compared the specimen in hand with the species of Lindley and Hutton rather than with that described by Weiss and Schimper.

Locality.—The type illustrated in the Coal Flora, and donated to the United States National Museum by Dr. J. H. Britts, is from the vicinity of Clinton, Henry County, Missouri, U. S. Nat. Mus., 6198. The small, doubtful fragment is from the Deepwater mine, U. S. Nat. Mus., 6206.

APHLEBIA Presl, 1838.

1835. *Fucoides* Germar and Kaulfuss, Acta Acad. C. L. C. Nat. Cur., vol. xv, 2, p. 230 (pars).
1838. *Aphlebia* Presl, in Sternberg: Fl. d. Vorwelt, vol. ii, fasc. 7–8, p. 112.
1888. *Aphlebia* Zeiller, Fl. foss. bassin houill. Valenciennes, p. 300.
1838. *Schizopteris* Brongn., Presl, in Sternberg: Fl. d. Vorwelt, vol. ii, fasc. 7–8, p. 111 (pars).
1854. *Pachyphyllum* Lesquereux, Proc. Boston Soc. N. H., vol. vi, No. 4, p. 421.
1858. *Pachyphyllum* Lesquereux, in H. D. Rogers: Geol. Pennsylvania, vol. ii, p. 863.
1869. *Rhacophyllum* Schimper, Traité pal. vég., vol. i, p. 684.

[1] Vol. i, p. 349, pl. lxi, fig. 4.
[2] Fossil Fl. Gr. Brit., vol. ii, pl. cxvi.
[3] Fl. foss. bassin houill. Valenciennes, p. 310, pl. lii, fig. 1.

APHLEBIA HAMULOSA (Lx.).

1879. *Rhacophyllum hamulosum* Lesquereux, Coal Flora, Atlas, p. 10, pl. lviii, fig. 3; text, vol. i (1880), p. 321.

The type specimen, No. 9445 of the Lacoe collection, illustrated in the Coal Flora, is the only example of this curious species that I have seen from Missouri. In form it is somewhat suggestive of a *Sphenopteris* of the group represented by *S. patentissima* Ett. This similarity is more apparent in some specimens from Mazon Creek, Illinois.

The nervation is broad and dense, comparable to *Aphlebia spinosa* or *A. crispa*, to the former of which *A. hamulosa* is closely related, although differing from that species, as was pointed out by Lesquereux, by the bifurcation of the branches, the recurvation of the divisions, and the slender, long, acuminate points of the lacineæ.

Locality.—Henry County, Missouri, No. 9445 of the Lacoe collection in the U. S. National Museum.

APHLEBIA SPINOSA (Lx.).

1879. *Rhacophyllum spinosum* Lesquereux, Coal Flora, Atlas, p. 10, pl. lviii, figs. 4, 5; text, vol. i (1880), p. 320.
1887. *Rhacophyllum spinosum* Kidston, Foss. Fl. Radstock Ser., p. 309, pl. xx, fig. 3.

The main axes and branches of this species are characterized chiefly by the dense, fibrous structure, and the almost totally reduced lamina. The divergent pinnate lateral branches are more regular than in most species of this group, and the ultimate lobules are rendered spinescent by the thick traversing bands of parallel, fasciculate, vascular tissue. One or two of the fragments indicate for this plant a large size, with a well-defined, uniform, and rigid rachis.

The specimen from Radstock, England, figured by Kidston,[1] although slightly more robust and less fibrous than the specimen from Missouri, seems to constitute another of the many forms in common between the flora at present under consideration and that so excellently elaborated from the Radstock series.

The fragments of this species, which is, next to *Aphlebia Germari* Zeill., the most frequent in the coals of this region, can easily be distinguished

[1] Foss. Fl. Radstock Ser., p. 309, pl. xx, fig. 3.

from the other associated forms by the narrow, regularly pinnatifid and rigid, thick, fibrous divisions, ending in very slender spinous lobes.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 5572, 5573, 5575; Deepwater mine, a doubtful fragment, U. S. Nat. Mus., 5574.

APHLEBIA CRISPA (Gutb.) Presl.

1835. *Fucoides crispus* Gutbier, Abdrücke, p. 13, pl. i, figs. 11, 11*a* (pl. vi, fig. 18?).
1838. *Aphlebia crispa* (Gutb.) Presl, in Sternberg: Versuch, vol. ii, fasc. 7–8, p. 112.
1886. *Aphlebia crispa* (Gutb.) Presl, Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. li, figs. 1, 2; text (1888), p. 304.
1838. *Schizopteris Lactuca* Presl, in Sternberg: Versuch, vol. ii, fasc. 7–8, p. 112.
1855. *Schizopteris Lactuca* Presl, Geinitz, Verst. Steink. Sachsen, p. 19, pl. xxvi, fig. 1.
1869. *Schizopteris Lactuca* Presl, von Roehl, Foss. Fl. Steink. Westphalens, p. 47, pl. xviii.
1881. *Schizopteris Lactuca* Presl, Weiss, Aus d. Fl. d. Steink., p. 17, pl. xviii, fig. 111.
1869. *Rhacophyllum Lactuca* (Presl) Schimper, Traité, vol. i, p. 684, pl. xlvi, fig. 1 (nec fig. 2, necque pl. xlvii, figs. 1, 2); vol. iii (1872), p. 524 (excl. syn.).
1878. *Rhacophyllum Lactuca* (Presl) Schimp., Andrews, Elem. Geol., p. 176, fig. 317.
1880. *Rhacophyllum Lactuca* (Presl) Schimp., Lesquereux, Coal Flora, vol. 1, p. 315 (pars).
1869. *Rhacophyllum speciosissimum* Schimper, Traité, vol. 1, p. 685.
1885. *Hawlea Miltoni* (Brongn.) Stur, Farne d. Carbon-Fl., p. 108 (pars), pl. lx, figs. 3, 4.
1890. An *Schizopteris rhipis* Grand 'Eury, Géol. pal. basin houill. Gard, p. 299, pl. xix, fig. 10?

The type of *Aphlebia*, to which the names *Fucoides crispus*, *Rhacophyllum Lactuca*, and *R. speciocissimum* were applied by Gutbier, von Roehl, and Schimper, respectively, is represented by several fairly good specimens transmitted by Dr. Britts to the National Museum. All show the typical characters of the species, the best illustration of which was given by Major von Roehl.[1] Von Roehl's figure is important not only for its size and perfection of expression, but because of its representation of the variation between the basal and distal portions in the same individual.

Specimens from Missouri, probably belonging to this species, are found among the manuscript material left by Professor Lesquereux under the label "*Rhacophyllum Lactuca* var. *crispum* Gut." The species occurs also in fine specimens over the coal at Buchtel, Ohio.

Aphlebia crispa is not difficult of distinction from the other species of

[1] Foss. Fl. Steinkohlenf. Westphalens, p. 47, pl. xviii.

this genus in Henry County, on account of the thick, flexuous, fibrous divisions, which, although somewhat deeply dissected, have a slightly twisted appearance, the ultimate lobules or lacineæ being more or less fasciculate and frequently approaching parallelism.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 5548, 5549; Owen's coal bank, U. S. Nat. Mus., 5547; Hobbs's coal bank, U. S. Nat. Mus., 5550.

APHLEBIA GERMARI Zeill.

Pl. XLVI.

1847. *Schizopteris Lactuca* Presl, Germar, Verst. Steink. Wettin u. Löbejün, p. 44, pl. xviii, figs. 1*a*, 1*b*; pl. xix, figs. 2, 3.
1854. *Pachyphyllum Lactuca* (Presl) Lesquereux, Bost. Journ. N. H., vol. vi, p. 422.
1858. *Pachyphyllum Lactuca* (Presl) Lesquereux, in Rogers: Geol. Pennsylvania, p. 863, pl. viii, figs. 4, 5.
1869. *Rhacophyllum Lactuca* (Presl) Schimper, Traité, vol. i, p. 684, pl. xlvi, fig. 1 (non xlvii, figs. 1, 2).
1880. *Rhacophyllum Lactuca* (Presl) Schimp., Lesquereux, Coal Flora, vol. i, p. 315 (pars).
1889. *Rhacophyllum Lactuca* (Presl) Schimp., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 872, text fig.
1888. *Aphlebia Germari* Zeiller, Fl. foss. houill. Commentry, vol. i, p. 289, pl. xxxiv, figs. 1, 1′.

The most abundant of the forms of *Aphlebia* found in the region about Clinton appears to be identical with that illustrated by Germar[1] and included by other authors as *Schizopteris* or *Rhacophyllum Lactuca* Presl. On account, however, of the identity of Presl's species[2] with Gutbier's *Fucoides crispus*,[3] first pointed out by Gutbier, the specific term *Lactuca* was no longer admissible. Accordingly, in 1888, when describing the *Aphlebiæ* from the Commentry Basin, Professor Zeiller[4] gave to the form published by Germar as the species *Lactuca*, but which is now considered distinct from Gutbier's *F. crispus*, the name *Aphlebia Germari*.

Both *Schizopteris Lactuca*, including the form illustrated by Germar, and *Fucoides crispus* were inscribed by Lesquereux[5] in the synonymy of *Rhacophyllum Lactuca*. Thus the Lacoe collection contains, under the last name,

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[1] Verst. Steinkohl. Wettin u. Löbejün, 1847, p. 44, pl. xviii, figs. 1*a*, 1*b*; pl. xix, figs. 2, 3.
[2] *Aphlebia Lactuca* Presl, in Sternberg: Versuch einer Flora d. Vorwelt, vol. ii, fasc. 7–8, 1838, p. 11[?]
[3] Gutbier, Abdrücke u. Versteinerungen, 1835, p. 13, pl. i, figs. 11, 11*a*.
[4] Fl. foss. houill. Commentry, vol. i, p. 289, pl. xxxiv, figs. 1, 1′.
[5] Coal Flora, vol. 1, 1880, p. 315.

a number of specimens identified by Professor Lesquereux, among which Nos. 9389, 9391, and 9392 are of special interest, since they appear to represent the form separated as *Aphlebia Germari* Zeill.

The specimens from Missouri show considerable variation in the form of the frond, though the general outline seems to be lanceolate or oval. The incomplete example illustrated in Pl. XLVI is, however, somewhat remarkable on account of its size and the rather broadly oval or slightly obovate form. The analogies of its lower divisions render it hardly probable that the apex extended more than 10 or 12 cm. beyond the present line of fracture. The principal lateral divisions in this robust specimen are hardly so slender or so contracted at the base as in some of the other fragments or in the fine examples illustrated by Zeiller. A well-preserved and nearly complete specimen, oblong or oblong-lanceolate, loaned by Dr. Britts, of Clinton, Missouri, shows the divisions very similar to those in the Commentry specimens.

There is, perhaps, room for doubt as to the relation of the specimens which I have referred to *Aphlebia Germari* and the fragment from the same region described and illustrated by Lesquereux[1] as *Rhacophyllum hirsutum*. The figure in the Coal Flora, the original of which I have not seen, appears to illustrate a much rougher plant, with rather more elongated, slender, and more distant branches, provided rather sparsely throughout with short bristles or hairs. It may be noted, however, that portions of some of the specimens, including a part of the lacineæ of the example shown in Pl. XLVI, are sparsely bordered with small, short, spicule-like hairs, which, though not so regular nor so long as those figured in the Coal Flora, are apparently of the same character as those seen in certain specimens from Rhode Island referred by Lesquereux to *Rhacophyllum hirsutum*. Nevertheless, the latter specimens are considerably more slender, while Professor Lesquereux's identification of our specimens with *R. Lactuca* shows that he considered them distinct from *R. hirsutum* (Lx.) Schimp.

The specimens referred above to *Aphlebia Germari* Zeill. differ from the *A. crispa* by the less conspicuously fibrous texture, the less flexuous divisions, and the more diffused lacineæ.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 5544, 5546; Henry County, Missouri, U. S. Nat. Mus., 5545.

[1] Coal Flora, Atlas, pl. lvii, fig. 2; text, vol. i, p. 318.

APHLEBIA HIRSUTA (Lx.)

1854. *Pachyphyllum hirsutum* Lesquereux, Bost. Jour. N. H., vol. vi, 4, p. 421.
1858. *Pachyphyllum hirsutum* Lesquereux, in Rogers: Geol. Pennsylvania, vol. ii, p. 863, pl. viii, fig. 3.
1869. *Rhacophyllum hirsutum* (Lx.) Schimper, Traité, vol. i, p. 687.
1879. *Rhacophyllum hirsutum* (Lx.) Schimp., Lesquereux, Coal Flora, Atlas, pl. lvii, fig. 2; text, vol. i, (1880), p. 318.
1889. *Rhacophyllum hirsutum* (Lx.) Schimp., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 871, text fig.

Among the collections from Missouri now in the National Museum or the Geological Survey, I have seen no example that seems satisfactorily referable to this species, which has thus far, I believe, been known from this region only by the fragment illustrated in fig. 2, pl. lvii, of the Coal Flora. The differences in the proportionate length, flexuosity, mode of division, and width of the ultimate divisions between the figure above referred to and the original type figured[1] from a high coal in the southern anthracite field in Pennsylvania are somewhat striking, and, notwithstanding the known variations within the same frond in this genus, may, it seems to me, reasonably be considered as of at least varietal importance. In my remarks on *Aphlebia Germari* I have referred to occasional smaller, sparse, spicule-like bristles found in portions of some of the specimens of that species. It is not improbable that some form of villosity may have existed in several of our species of *Aphlebia*.

Pachyphyllum affine Lx.,[2] inscribed by Lesquereux[3] in the synonymy of *Rhachophyllum hirsutum*, appears by its more slender falcate, acute lobules, traversed by a distinct central strand, to be more harmoniously referable to the *Pachyphyllum fimbriatum* of the same author.[4]

Locality.—Henry County, Missouri, U. S. Nat. Mus., 5520.

APHLEBIA cf. FILICIFORMIS (Gutb.) Sterzel.

Many paleobotanists, including Geinitz,[5] Schimper,[6] Lesquereux,[7] and Kidston,[8] have agreed in referring the specimens published by Gutbier as

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[1] Geol. Pennsylvania, vol. ii, 1858, p. 863, pl. viii, fig. 3.
[2] Geol. Pennsylvania, vol. ii, pl. viii, fig. 1.
[3] Coal Flora, vol. i, p. 318.
[4] Geol. Pennsylvania, vol. ii, pl. viii, fig. 2.
[5] Verst. Steinkohlenform. Sachsen, 1855, p. 19, pl. xxv, figs. 11–14.
[6] Traité pal. vég., vol. i, 1869, p. 685.
[7] Coal Flora, vol. i, 1880, p. 316.
[8] Foss. Flora Radstock Series: Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 388.

Fucoides filiciformis[1] and by Presl[2] as *Rhodea Gutbieriana* to the same species, for the designation of which Geinitz, while including several other forms, employed the name given by Presl. To the writer it seems highly improbable that all, even among the figures given by Gutbier, Geinitz, or Schimper under these two names, really represent but a single species. Certainly the differences between figs. 6 and 7 on pl. i of Gutbier's "Abdrücke," on the one hand, and fig. 14, or even fig. 13, on pl. xxv of the "Versteinerungen," on the other, are very striking if not specific. Accordingly, it has seemed best to treat the illustrations included under the specific designation *filiciformis* Gutb. or *Gutbieriana* Presl as belonging to a group with which I have compared the American specimens in hand. The latter agree most closely with the fig. 13 of the "Abdrücke," though not so scaly along the axis, or figs. 11 and 12 in the "Versteinerungen."[3]

Lesquereux[4] recognized fig. 14 (*Fucoides crenatus* Gutb.) in the "Abdrücke," and fig. 13 in the "Versteinerungen," as representatives of a variety "*Gutbierianum*," between which and the normal *Rhacophyllum filiciforme* there were no intermediate forms. Many of the specimens in the Lacoe collection identified by him as the latter species or its variety *Gutbierianum* are closely, perhaps inseparably, related to others in *Rhacophyllum Clarkii* (Lx.) Schimp., although the latter should have the distal portions of its broadly connate divisions greatly thickened and fleshy. No doubt, however, the latter species has much in common with the comprehensive *Rhacophyllum filiciforme*. Specimen No. 9548 of the Lacoe collection, which bears the label "*Rhacophyllum Gutbierianum* Gein.," I am disposed to include with the other examples from Henry County. It seems less improbable that the appellation was simply the temporary, perhaps inadvertent, employment by Lesquereux of the name used by Geinitz, who is cited as the authority, rather than that it resulted from the omission of the specific term, the intention having been to label the specimen as the variety.

Localities.—Hobbs's mine, U. S. Nat. Mus., 5577; Owen's mine, U. S. Nat. Mus., 5578, 5580–5582; Pitcher's mine, U. S. Nat. Mus., 5579, 5580.

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[1] Abdrücke u. Versteinerungen d. Zwickauer Schwarzkohlengeberges, 1835, p. 11, pl. i, figs. 3, 6, 7, 8, 13.
[2] Sternberg, Versuch einer Flora d. Vorwelt, vol. ii, fasc. 7–8, 1838, p. 111.
[3] Figs. 5 and 4, pl. xlviii, of the Atlas to Schimper's Traité.
[4] Coal Flora, vol. i, p. 316.

APHLEBIA SUBGOLDENBERGII n. sp.

Pl. XLVII, Fig. 7.

1897. *Aphlebia* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 297.

Frond pinnate, lanceolate (?) or linear-lanceolate (?), membranaceous, rachis broad, rigid, densely but unevenly and finely striate, and bordered by a decurrent lamina; lateral divisions oblique, alternate or subopposite, lanceolate or linear-lanceolate, acute (?) at the apex, somewhat constricted at the strongly decurrent base, pinnatifid; lobules or ultimate divisions very oblique, alternate, lanceolate, obtuse, more or less distinctly outward curved, connate for some distance above the decurrent base, each lobule traversed by a strong, clear, flat nervil; lamina membranaceous, transparent, uniting the lobules in the lower portions and decurring with narrow, very acute sinuses to form a narrow border along the main (?) rachis; nervils alternate, a single one passing strong to the apex of each lobe, more or less distinctly dilated in the middle portion, sometimes in the upper part also, and curving in and decurring near the base so as to join the lateral rachises at a very broad angle; lateral rachises strong and flat, broadest in the curve at the base of the pinna, and narrowing in the long descent before joining the main rachis.

The specimen, No. 9599 of the Lacoe collection, on which I have ventured to found this species came from the vicinity of Clinton, Henry County, Missouri, and was identified by Professor Lesquereux as *Rhacophyllum membranaceum* Lx. A comparison made with the types of that species[1] shows, however, not very much in common except the delicately membranaceous lamina. It differs from the latter species by the well-defined axis in both the main and lateral divisions; the arrangement of the pinnæ, constricted at the base; the regularly alternate lobules, which curve outward, and are more deeply dissected and obtuse, and the broad, much stronger, flat nervation, which is simpler and not flabellate.

The salient features of our specimen, Fig. 7, Pl. XLVII, are the general form of the frond and arrangement of the pinnæ, very similar to those illustrated by Schimper[2] from the type of *Rhacophyllum Goldenbergii*

[1] Coal Flora, vol. i, p. 312, pl. lviii, figs. 1, 2.

[2] Traité, pl. xlvi, fig. 2, vol. i, p. 686.

Weiss. from Saarbruck, and especially to those so admirably delineated by Kidston from the specimen from the Radstock coal field.[1] In fact, so far does the specimen from Missouri agree with the example from Pucklechurch that the differences may almost be accounted for as coming within the modifications of different portions of the same plant or as individual variation. The American, like the British, specimen is membranaceous; the lateral pinnæ are similar in form and position, connate and very decurrent; the lobules oblique, alternate, connate, decurrent, each being traversed by a single distinct nerve; the midribs of the pinnæ, too, are curved near the base and pass down a long distance before joining the main rachis. It is probable, also, that the lower lobules may become bifid. But our fragment, which seems to correspond in size, position, and development with the specimens both from the Radstock field and from Saarbruck, differs, as will be seen from the illustrations, from that figured by Kidston by the much broader dilated nerves and midribs of the lateral pinnæ, the obtuse lobules, which are considerably larger and recurved, while none of them are yet bifid, and the more narrowly acute sinuses at the bases of the pinnæ. Nevertheless, the differences between the British and the American plants are of such minor rank and importance as to seem to justify at most no greater distinction than a varietal separation, if any.

On the other hand, the points of difference between the fragment from Missouri and that from Saarbruck, to which Weiss gave the name of *Rhacophyllum Goldenbergii*, are obvious from a comparison of the figure given by Schimper. The latter has not even the appearance of being membranaceous, and is not so described. In the American specimen the pinnæ are broader and much more constricted, relatively, at the base, the lobes not so erect and straight, not narrowly slender and tapering and acute. Schimper does not describe the nervation, and the figure seems to indicate a thick and rather coriaceous lamina in which either the nervation is not very clear or it is diffuse.

Notwithstanding, therefore, the high degree of variation known to exist in the species of *Aphlebia*, even in different portions of the same individual, it has not seemed to me to be proper to record our specimen in the same species with that from Saarbruck. I have, accordingly, ventured to assign

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[1] Foss. Fl. Radstock Series, pl. xxvii, fig. 2, p. 388.

to it a new name, although the British specimen, which is in some respects intermediate between it and the German type, is perhaps not more than varietally different.

The distinction between *Aphlebia subgoldenbergii* and *A. membranacea*, the only species with which it might be compared, has already been noted.

Locality.—Clinton, Henry County, Missouri, No. 9599 of the Lacoe collection, U. S. Nat. Mus.

APHLEBIA MEMBRANACEA (LX.).

1879. *Rhacophyllum membranaceum* Lesquereux, Coal Flora, Atlas, p. 10, pl. lviii, figs. 1, 2; text, vol. i (1880), p. 312.

The species described as *Rhacophyllum membranaceum* by Lesquereux is, as was remarked by its author,[1] somewhat unique among the forms included in that genus. The originals[2] of the figures published in the Coal Flora show an extremely delicate, transparent lamina, traversed by the distinct, rather broad brown lines of the nervation. The nerves, which are of varying width, are in some cases slightly fasciculate, one nervil passing to the apex of each very oblique, acute lobule. One of the fragments of this species recently obtained has a portion of the lateral divisions broken away, so that the effect is very similar to the type *Rhacophyllum truncatum* from the Upper Devonian of the Susquehanna Narrows, above Pittston, Pennsylvania.

Aphlebia membranacea is easily distinguished by its extremely delicate texture and relatively slender nerves from all the associated species except *A. subgoldenbergii*, which is much more Sphenopteroid, the lobules being regularly pinnate and recurved and the nerves comparatively stronger.

Localities.—Henry County, Missouri, Nos. 9465 and 9466 of the Lacoe collection, U. S. Nat. Mus.; Pitcher's coal mine, U. S. Nat. Mus., 5583.

APHLEBIA sp.

Pl. XLV, Fig. 1.

One among the fragments of *Aphlebia* from Missouri deserves special mention. This specimen, a rather unsatisfactory photograph of which is seen in Fig. 1, Pl. XLV, comprises a segment of a rather coarsely and

[1] Coal Flora, vol. i, p. 313. [2] Nos. 9465 and 9466 of the Lacoe collection, U. S. Nat. Mus.

irregularly striated stem nearly 10 cm. in length and about 2.5 cm. in width, to the upper part of which are apparently attached a well-developed pinna and one, or perhaps several, smaller pinnæ comparable to *A. Germari* or *A. filiciformis.* But what is remarkable in the specimen is the circumstance that the large fragment of rachis is somewhat densely clothed with large leaflike scales. The latter are rather thin, not rigid, 7 to 11 mm. or more in length, 3 to 5 or 6 mm. in width, ovate or oblong-ovate, somewhat variable in form, constricted to a narrow attachment at the base, obtuse at the top, inclined upward, and dorsally convex. The ventral surface of these foliaceous scales is marked, when viewed with a rather strong lens, by fine striæ apparently consisting of rows of very small, oblong, imbricated, scalelike cells, but no distinct traces of nervation are seen. This striation is more distinct in the scales than in the larger lamina of the *Aphlebia.* The attachment of the scales is not clear. It is perhaps crescentic, or possibly even oval. No evidence of either a fleshy composition or a flaccid nature is apparent.

The specimen seems, on the whole, to represent a segment of a large rachis, perhaps belonging to one of the scabrous Pecopterids, which is rather closely covered with very large, ovate or oval, semi-membranaceous scales, among which several pinnæ of *Aphlebia* seem to have their attachment.

The nature of these large scales may be the same as that of the chaffy scales seen in the segment of a smaller rachis on the same slab, just above the specimen described. The smaller rachis is like that seen in direct connection with the pinnæ of *Pecopteris Jenneyi.*

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5727, 6041.

MEGALOPTERIDEÆ.

ALETHOPTERIS Sternberg, 1826.

Versuch, vol. i, tent., p. xxi.

ALETHOPTERIS AMBIGUA Lx.

Pl. XXXVII, Figs. 3, 4; Pl. XLI, Fig 9.

1879. *Alethopteris ambigua* Lesquereux, Coal Flora, Atlas, p. 6, pl. xxxi, figs. 1. 1*a*, (non 2, 3); text, vol. i (1880), p. 182.

Fronds tripinnate; primary pinnæ rather delicate, lanceolate, acute; rachis rather slender, distinctly striate, slightly flexuous; secondary pinnæ alternate or subopposite, open, linear-lanceolate, somewhat contracted at the base, close or slightly overlapping, provided with tertiary pinnæ below, pinnatifid near the apex; ultimate pinnæ subopposite, subalternate or alternate, close, rarely touching, very open, linear-lanceolate, very long, usually slightly narrowed at the base, the sides nearly parallel in the middle portion, tapering gradually to an acute apex, 1.5 to 20 cm. or more in length, .5 to 3 cm. in width, becoming connate at the base by a narrow decurrent lamina and succeeded by diminishing pinnatifid pinnules in passing upward; pinnules subopposite, subalternate or alternate, very open, seldom touching, irregular in angle and length on the same pinna, 3 to 18 mm. long, 2 to 4 mm. wide, but very little if at all contracted near the base, the sides nearly parallel, obtusely rounded or round at the apex, the upper surface strongly convex and bordered often by a marginal shallow canal or gutter; lamina thick, dull, and always uniting the pinnules at the base, the sinus being rounded, and slightly decurrent only between the largest pinnules; midrib strong, hardly decurrent, deeply depressed on the upper side, broad and striate beneath, and terminating abruptly at a distance from the apex nearly equal to the average width of the lateral lamina; nerves few, very distant, often obscure on the upper surface, more distinct beneath, originating from both rachis and midrib, nearly straight or arching slightly in the larger pinnules, oblique in the smaller pinnules, simple or sometimes forking at or near the base, rarely forking above the middle, and passing nearly at a right angle to the margin, where they number about 30 to the centimeter.

A typical example of the mature portions of this well-marked and characteristic species in the fossil flora of Missouri is illustrated by Professor Lesquereux in fig. 1, pl. xxxi, of the Coal Flora. As there shown, the irregular character of the open, parallel-sided connate pinnules, with the very distant nerves springing from the disproportionately thick midribs, is well brought out.

As remarked in the original description, the nerves of the thick pinnules sometimes appear more numerous than they really are. Frequently the flattened border is not distinct, though it often is so developed as to form a shallow gutter or canal about the margin of the pinnule, as seen from above, or a marginal band as it appears from below. The midrib, which is hardly decurrent, is strongly depressed above, broad, and conspicuously striate below, passing, strong, to near the apex of the pinnule, where it abruptly terminates. The nerves, more of which spring from the rachis than is indicated in the figure in the Coal Flora, are often obscure on the upper surface, but distinct beneath, generally arching slightly, and forking at or near the base, quite rarely forking above the middle. A large proportion of the nerves are simple, and all of them are nearly straight for the greater portion of their length, usually meeting the margin at nearly a right angle and numbering about 30 per centimeter.

The pinnules of all the specimens are somewhat variable in form, especially the basal pair, conspicuous for their irregularity in length, generally arching backward a little, the lowest ones on the pinna sometimes slightly narrowed at the base, but always connected by a narrow lamina. Usually they are near together but not touching, the distance between them being about 1 mm., the borders nearly parallel, the apices obtusely rounded.

When first studying this species I was impressed by the differences in the pinnules, midribs, and nervation between figs. 2 and 3 (3*a*), of pl. xxxi of the Coal Flora on the one hand, and fig. 1 of the same plate on the other hand, the nervation of the former in particular being much closer, more oblique, the nervils often forking a second time, thus constituting conditions somewhat contradictory to the relations usually existing between the mature and immature specimens. On subsequent examination of the types of figs. 2 and 3, one of them loaned by Dr. Britts, the others having passed with the Lacoe collection into the National Museum, I found that in the division of the pinnæ, in the development of the pinnules, and in nervation these types were Pecopterid—the specimens belonging in fact to *Pecopteris*. The nervils of the latter, all of which spring from the midrib, are very oblique at their origin, close and arching obliquely to the border, all of them forking once, the upper division forking again before reaching the border, where they are fully as much closer than those of the real *Alethopteris ambigua* as they appear in a comparison of figs. 1*a* and 3*a* of the plate in the Coal Flora. The midribs of fig. 3 of this plate are found to have been somewhat exaggerated by the draftsman both as to size and as to abruptness of termination.

There are, however, in the collections a number of specimens showing the pinnatifid division of the true species, and these, as is seen in Fig. 3, Pl. XXXVII, or Fig. 9, Pl. XLI, present the same distinctive characters as the mature pinnæ. The nerves are mostly simple, never forking more than once, nearly straight, and very open and distant, the midrib thick, and the pinnules very irregular, all the diagnostic features being those characteristic of the ordinary pinnæ. On the back of the rock containing the original of the figure of *Alethopteris Serlii* Brongn., fig. 2, pl. xxix, of the Coal Flora, there is a fine specimen of *Alethopteris ambigua*, so labeled by Professor Lesquereux, containing the upper segment, about 18 cm. in length, of a primary pinna of the true form. Here we have the long pinnæ, like those on the left of the type of fig. 1, pl. xxxi, of the Coal Flora, succeeded in passing upward by pinnæ of the character of our Fig. 3, Pl. XXXVII, while at the top we have the long, slightly pinnatifid and crenulate pinnules, like those in the lower right-hand pinnæ of the figure in the Coal Flora.

Another specimen, apparently belonging to this species, loaned by Dr. Britts, covers the surface of a slab 26 cm. long and 25 cm. wide. In this we have a rachis 7 mm. wide, slightly flexuous, and giving off alternating compound pinnæ at intervals of 3–8 cm. on each side, some of these secondary pinnæ being shown in their entire length. The whole segment comes apparently from some distance below the apex of a primary pinna. Unfortunately the specimen is somewhat shriveled throughout most of its extent.

That the ultimate pinnæ of this species were often long and slender is shown by the fact that it is very difficult to obtain entire specimens, although some incomplete fragments were found measuring 18 cm. or more in length and less than 25 mm. in width.

One fragment which seems inseparable from this species presents in the appearance of its flattened border, as well as by its ensemble of characters, a striking resemblance to the figure of *Alethopteris Gibsoni* Lx. given in fig. 6, pl. xxviii, of the Coal Flora, and I am not at present sure that the latter does not represent a specimen belonging more properly to our species.

Alethopteris ambigua is easily distinguishable, by the characters recited above, from *Alethopteris aquilina*, which is, with the exception of *Alethopteris Gibsoni*, probably the nearest related species of *Alethopteris*, and the only one with which it is likely to be confused.

Localities.—Common at Owen's coal bank, U. S. Nat. Mus., 3590, 5490; rare at Gilkerson's Ford, U. S. Nat. Mus., 3592, 5488; Deepwater, U. S. Nat. Mus., 3591, 3593; Pitcher's coal bank, U. S. Nat. Mus., 3634.

ALETHOPTERIS SERLII (Brongn.) Goepp.

Pl. XXXVII, Fig. 1.

1804. ——— ——— Parkinson, Organic Remains, vol. 1, pl. iv, fig. 6.
1828. *Pecopteris Serlii* Brongniart, Prodrome, p. 57 (*nomen nudum*).
1832 or 1833. *Pecopteris Serlii* Brongniart, Hist. vég. foss., p. 292, pl. lxxxv.
1837. *Pecopteris Serlii* Brongn., Lindley and Hutton, Fossil Flora, vol. iii, pl. ccii.
1840. *Pecopteris Serlii* Brongn., Jackson, Rept. Geol. Agricult. Rhode Island, 1839, p. 288, pl. iii, fig. 6.
1876. *Pecopteris Serlii* Brongn., Heer, Fl. Foss. Helv., p. 32, pl. xii, fig. 8.
1836. *Alethopteris Serlii* (Brongn.) Goeppert, Systema Fil. Foss., p. 301, pl. xxi, figs. 6, 7.
1840. *Alethopteris Serlii* (Brongn.) Goepp., Teschemacher, Jour. Bost. Soc. N. H., vol. v, p. 380, pl. xxxv, fig. *aa*.
1860. *Alethopteris Serlii* (Brongn.) Goepp., F. A. Roemer, Beitr. z. Kenntn. n-w. Harzgeb., p. 32, pl. viii, fig. 9.
1861. *Alethopteris Serlii* (Brongn.) Goepp., Lesquereux, 4th Rept. Geol. Surv. Kentucky, Atlas, pl. i, fig. 3 (plate not published).
1869. *Alethopteris Serlii* (Brongn.) Goepp., von Roehl, Foss. Fl. Steinkohlenf. Westphalens, p. 76, pl. x, figs. 8, 9*b*.
1869. *Alethopteris Serlii* (Brongn.) Goepp., Schimper, Traité, vol. i, p. 555.
1876. *Alethopteris Serlii* (Brongn.) Goepp., Ferd. Roemer, Lethaea. Geogn., Pal., Atlas, pl. lii, figs. 2*a*, 2*b*; text (1880), p. 181.
1878. *Alethopteris Serlii* (Brongn.) Goepp., Zeiller, Vég. foss. terr. houill. Fr., Atlas, pl. clxiii, figs. 1, 2; text (1879), p. 75.
1879. *Alethopteris Serlii* (Brongn.) Goepp., Lesquereux, Coal Flora, Atlas, p. 6, pl. xxix, figs. 1–5; text, vol. i (1880), p. 176.
1881. *Alethopteris Serlii* (Brongn.) Goepp., Weiss, Aus d. Fl. d. Steinkohl., p. 15, pl. xvi, fig. 97.
1883. *Alethopteris Serlii* (Brongn.) Goepp., Renault, Cours. bot. foss., vol. iii, p. 157, pl. xxvii, fig. 7.
1883. *Alethopteris Serlii* (Brongn.) Goepp., Lesquereux, 13th Rept. Geol. Surv. Indiana, pl. xii, fig. 2.
1886. *Alethopteris Serlii* (Brongn.) Goepp., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xxxvi, figs. 1, 2; pl. xxxvii, figs. 1, 1*a*, 2; text (1888), p. 234.
1888. *Alethopteris Serlii* (Brongn.) Goepp., Toula, Die Steinkohlen, p. 189, pl. 1, figs. 31, 32.
1889. *Alethopteris Serlii* (Brongn.) Goepp., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 14, text figs.
1899. *Alethopteris Serlii* (Brongn.) Goepp., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 499.
1848. *Alethopteris Hannonica* Sauveur, Vég. foss. terr. houill. Belg., pl. xxxviii.
1854. *Alethopteris Sternbergii* (Goepp.) Ettingshausen, Steink.-fl. Radnitz, pl. 42, p. xviii, fig. 4.
1865. *Pteris Serlii* (Brongn.) Ettingshausen, Farnkräuter d. Jetzw., p. 109.
1879. *Alethopteris lonchitica* (Schloth) Brongn., Schimper, in Zittel: Handb. Pal., vol. ii, p. 118, fig. 93, 1, 1*b*.

The general phase of the Henry County, Missouri, specimens of *Alethopteris Serlii* (Brongn.) Goepp., is already familiar to paleontologists through figs. 2 and 4 given by Lesquereux on pl. xxix of the Coal Flora. Of the many fragments in the recent collections one, probably belonging to a primary pinna, shows a segment of a rachis 11 mm. wide, slightly flexuous, with a moderately thick striated covering of coaly matter, revealing, where the carbonaceous residue is removed, distinct impressions of spines or spinous scales of considerable size passing from the back of the rachis into the matrix. The midrib is irregularly striate in the larger pinnules. The lower pinnæ are pinnatifid, even developing as tertiary pinnæ, all of the broad, blunt-pointed form referred to above and common in our lower coals of both the anthracite and the bituminous series.

Alethopteris Serlii var. missouriensis n. var.

Pl. XXXVII, Fig. 2; Pl. XLII, Fig. 5.

Although the normal form of the *Alethopteris Serlii* is frequent among the fossils from this region of Missouri, the greater number of the specimens, especially from one of the localities, which should be included under that name quite uniformly present an aspect or phase more or less distinct from any form I have yet met in the literature or in other collections.

The normal form occurs more commonly in a fine-grained reddish-gray shale from Owen's coal bank; and the specimens figured by Professor Lesquereux have every appearance of coming from the same stratum if not from the same place. The other form is found, with the exception of the ferruginous concretions from Gilkerson's Ford, in a rather coarse, dark dove or ash-colored shale having a slight tendency to check with a conchoidal fracture in drying.

Commonest among these specimens are large numbers of long secondary (?) pinnæ strewn about on the shales, somewhat overlapping when parallel, and clothed generally for their entire length with long simple, rather distant pinnules averaging 2 mm. apart, though frequently exceeding 4 mm., always joined at an acute angle by the decurrent lamina, and generally largest above the middle, and terminating in a more or less obtusely acute point. The aspect presented is much like that indicated in Ettingshausen's fig. 4, *Alethopteris Sternbergii* Goepp., on pl. xviii of the Flora of

Radnitz. A striking feature is the rarity of small pinnate pinnæ of the proportions common in *A. Serlii*, but very few of such small size being seen, though the collection contains three large slabs representing segments of primary (?) pinnæ with rachises as wide as 16 mm., provided on both sides with these slender secondary pinnæ bearing pinnules comparable in dimensions to the figure to which reference has just been made, or to those replacing the pinnatifid divisions at the tips of pinnæ of a superior order in the normal form of *Alethopteris Serlii*.

Frequently there is no contraction toward the bases of the pinnules, and often, especially in the largest, sometimes exceeding 4 cm. in length and measuring 5 to 7 mm. in width, the borders are folded in under, causing the pinnules to appear to taper to an acute point. Several examples from Missouri labeled *Alethopteris lonchitica* I have found, by removing the matrix from the border, to belong to the form in question, and these cases, in fact, comprise the only specimens from this region that I can find in any collection to have been referred to the latter species.

As in other species of *Alethopteris*, where well preserved, the veins may be seen to spring from a raised threadlike irregular line traversing the center of the canal along the upper surface of the midrib. They are quite coarse, in relief on the rather coriaceous lamina, and pass, moderately straight, to the border In the largest pinnules the midrib also is seen to be punctate, while the nervation becomes rather more distant, counting 28 to 34 per centimeter at the margin, its characters remaining otherwise the same. The general aspect of the plant, as seen in Fig. 5, Pl. XLII, is much like the illustration of *A. Serlii*, given by Zeiller in fig. 1, pl. xxxvii, of the Valenciennes flora.

The varietal distinction of this Missouri form, which I have thought might be of stratigraphic utility, must be regarded as tentative, the question of its survival or elimination depending on the results of further study of material from other portions of the American Carboniferous. However, the phase should at least be illustrated in our American literature.

The diagnosis of the variety *missouriensis* is as follows:

Fronds tripinnate, quadripinnatifid or quadripinnate near the base, very long, spreading; main rachis reaching a width of 45 mm. or more, both it and its divisions rather coarsely striate, and thinly set, especially on the dorsal surface, with very distinct short spines or spinous scales; primary pinnæ very long, open, linear-lanceolate, somewhat contracted at the base; secondary pinnæ open, alternate, subopposite or opposite, oblique above, somewhat reflexed below, simple except near the base of the largest primary pinnæ, straight or slightly flexuous, sometimes slightly decurrent, 3–6 cm. distant on the same side, more or less overlapping, linear-lanceolate, or oblong-lanceolate, rather acute, averaging about 2 cm. in length and 4.5–9 cm. in width where simply pinnate, sometimes slightly contracted at the base and tapering to a rather oblong-lanceolate obtusely acute terminal pinnule; secondary rachis, like the midribs of the pinnules, distinctly finely striate; pinnules normally open, nearly at right angles to the rachis, more or less distant, rarely touching, linear-lanceolate, generally broadest in the middle, obtusely acute at the apex, decurrent along the rachis with an acute sinus, and always distinctly united by a decurrent lamina of considerable width, the surface of the pinnule somewhat convex, the borders frequently folded beneath; midrib large, usually slightly decurrent, often straight, deeply depressed, finely striate, and passing nearly to the extreme apex; nervils quite coarse, salient, sometimes distinctly striate under the lens, springing at a generally wide angle from a line in the center of the groove on the dorsal surface of the pinnule and curving rapidly, often passing nearly straight from the midrib and extending, almost directly parallel and rather close, to the border, which they meet at a right angle, forking generally once close to the point of origin, the upper branch usually forking again, though often remaining simple, and numbering 28 to 42 per centimeter at the margin.

Localities.—Normal form at Owen's coal bank, Mus. Reg. 3596; Henry County, Missouri, U. S. Nat. Mus., 5486. The variety is from Owen's coal bank, Mus. Reg. 3594, 5473, 5487.

CALLIPTERIDIUM Weiss, 1870.

Zeitschr. d. deutsch. geol. Gesell., vol. xxii, pp. 858, 876; Lesquereux, Coal Flora, vol. i, 1880, p. 164.

CALLIPTERIDIUM MEMBRANACEUM Lx.

Pl. XXXVIII, Figs. 1–5.

1879. *Callipteridium membranaceum* Lesquereux, Coal Flora, Atlas, p. 6, pl. xxvii, figs. 5, 5*a* (non 6, 8); text, vol. i (1880), p. 172 (pars).

Frond tripinnate, rather lax, Alethopteroid; secondary pinnæ linear-lanceolate or oval, acute or acuminate, alternate, open, reflexed below, a little distant; secondary rachis strong, broad, rather coarsely striate, the rachises of the tertiary pinnæ originating from a little within the border on the ventral surface; tertiary or ultimate pinnæ alternate, open, at a right angle to the rachis, or reflexed below, a little distant, not decurrent, linear or linear-lanceolate, hardly constricted at the base, the sides parallel in the middle and converging near the pinnatifid or crenulate apex, which is acute in the larger pinnæ, obtuse in the smaller; ultimate rachis fairly strong, irregularly striate, rounded on the back, shallowly canaliculate on the upper surface, on which the pinnules are attached a little within the border; pinnules alternate, very open, usually close or nearly touching, or slightly overlapping, but sometimes a little distant or appearing quite distant on account of the reflexed margins, irregular in position, sometimes curving upward, sometimes curving outward, somewhat polymorphous, oval or oval-round, attached by the whole base and connate for a very short distance, the sinus acute and slightly decurrent when young, or becoming oblong or oblong-lanceolate, the obtusely rounded apex often directed slightly upward, the base cut to the rachis and even constricted, both above and below, to a narrow attachment at the base of the pinnæ; lamina thin, dull, often preserved brownish, somewhat depressed over the midrib, arched slightly backward, sometimes to a considerable extent, at the margin; nervation generally rather distinct; midrib of moderate strength, depressed above, rounded below, only slightly, if at all, decurrent, usually originating at a very open angle to the rachis and passing, strong, two-thirds or more of the way up the pinnule; nervils thin, parallel, rather close in the older portions of the plant, originating at a rather open angle, forking once near the base in the pinnules of moderate size, or both branches forking again in the larger pinnules and arching but little in passing to the margin, which they reach quite obliquely, the lower nervils springing directly from the rachis.

The pinnules of this species, first described from Henry County, are somewhat polymorphous, those on the same pinna often showing a considerable degree of irregularity. An illustration of this feature is seen in Fig. 4, Pl. XXXVIII, a photograph of the original of Professor Lesquereux's fig. 5, pl. xxvii, of the Coal Flora, now No. 3182 of the Lacoe collection. The lamina is dull and black, although rather thin, as is the case also with No 3192 and No. 3187 of the same collection, both labeled *Callipteridium membranaceum* by the author of the species, of whose private collection they formerly were a part. So far as I have observed, the specimens are perhaps no oftener preserved brown or translucent than are the fragments, when somewhat macerated, of *Pecopteris clintoni* Lx. Even *P. vestita* and *P. pseudovestita* are frequently macerated so as to present a similar brown and membranaceous appearance, though some traces of the villosity are usually present.

I very much regret being obliged to separate from *Callipteridium membranaceum* one of the originals used by Professor Lesquereux in the description of this species. But the careful examination of the specimen (No. 3181 of the Lacoe collection), a part of which is given in fig. 4, on pl. xxvii, in the Coal Flora, shows clearly that we have to do with a *Pecopteris*, while a comparison of its details shows it to be referable to *P. clintoni* as figured in pl. xlii, fig. 3, of the atlas to the above-named work, although the nervation is rather obscure. Similarly, the original of fig. 6 of the same plate agrees well with many specimens labeled *P. clintoni* by the author of that species, the villosity so prevalent in the latter species being equally well marked in portions of the original in question. The nervation, too, is plainly that of *P. clintoni*, seemingly, so far as concerns any rachial nerves, in contradiction to the published detail. The reference of this specimen to *P. clintoni* will not seem surprising after a comparison of fig. 6, on pl. xxvii, with fig. 4, on pl. xlii, of the Coal Flora, the latter representing one of the types of *P. clintoni*. Similar examples of villous Pecopteroid forms, of the type of the latter species, found in Nos. 3185 and 3191 labeled *C. membranaceum* and in the same collection, are also to be placed with *P. clintoni* Lx.

The type of the restricted *Callipteridium membranaceum* is that illustrated in Lesquereux's fig. 2, a detail of which is shown on our Fig. 4*a*., Pl. XXXVIII. The same characters, including those of the nervation, are seen in No. 3192, referred by that author to this species, except that the nervation is a little more open, being similar in this respect to that seen in Fig. 3, Pl. XXXVIII, the enlarged detail of which is shown in Fig. 3*a*.

The specimens from Pitcher's coal bank, seen in Figs. 1 and 2, Pl. XXXVIII, are doubtfully referable to this species. Their narrow, distant, obtuse pinnules suggest *Callipteridium inæquale* or *C. grandini*, to both of which our form is related, although the pinnules differ from both by the more acute points and the more complete separation at the base. The distant and narrow appearance of the pinnules is due mostly to the reflexion of the margin, which is consequently buried in the rock.

Localities.—The original types from Henry County, Missouri, without precise locality, Lacoe collection, U. S. Nat. Mus., 3182, 3187; doubtful specimens from Pitcher's coal bank, U. S. Nat. Mus., 5591, 5603, 5604, 5625, 5691, 5807; typical fragments from Deepwater, U. S. Nat. Mus., 5592, 5810?.

Callipteridium inæquale Lx.

Pl. XXXIX, Fig. 4; Pl. LXI, Fig. 1*d*; Pl. LXII, Fig. *d*.

1879. *Callipteridium inæquale* Lesquereux, Coal Flora, Atlas, pl. xxxiii. figs. 2–5; text (1880), vol. i. p. 168.

A few fragments seem to agree in all respects with the corresponding portions of the species from Cannelton, Pennsylvania, described and illustrated by Professor Lesquereux in the Coal Flora as *Callipteridium inæquale*. In size, form, nervation, and arrangement of the pinnules, which have a tendency to opposition on the rachis, some of the specimens are close to fig. 2, of pl. xxxiii, in the above-named work.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 5483.

Callipteridium cf. Mansfieldi Lx.

The specimens which I compare with this species, known only from Pennsylvania,[1] are far from typical. My reason for the provisional reference is their agreement with certain specimens found to have been assigned to *Callipteridium Mansfieldi* by the author of the species.

The Missouri specimens are very close to others from Cape Breton, Nova Scotia, and from Shenandoah, Pennsylvania, which I am unable to separate from a compact dilated obtuse form of *Alethopteris Serlii* Brongn. The nerves are rather straight and open for *C. Mansfieldi*, while the midrib is slender for *A. Serlii*.

Locality.—Deepwater, U. S. Nat. Mus., 5484.

Callipteridium Sullivantii (Lx.) Weiss.

Pl. XXXIX, Figs. 1–3; Pl. XLI, Figs. 1–3.

1854. *Callipteris Sullivantii* Lesquereux. Bost. Journ. N. H., vol. vi, no. 4, p. 423.
1858. *Callipteris Sullivantii* Lesquereux, Geol. Pennsylvania, vol. ii, p. 866, pl. v. fig. 13.
1881. *Callipteris Sullivantii* Lx., C. A. White, Rept. Geol. Surv. Indiana, 1880, p. 153. pl. ix, fig. 4.
1881. *Callipteris Sullivantii* Lx., Calvin, Pop. Sci. Missouri, vol. xviii, p. 619, fig. 1.
1883. *Callipteris Sullivantii* Lx., Chamberlain, Geol. Wisconsin, vol. i, p. 216, fig. 67*c*.
1889. *Callipteris Sullivanti* Lx., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 108, text fig.
1891. *Callipteris Sullivantii* Lx., Le Conte, Elements Geol., p. 363, fig. 472.
1869. *Alethopteris Sullivanti* (Lx.) Schimper, Traité, vol. i, p. 561.

[1] Lesquereux, Coal Flora, vol. i, p. 166, pl. xxvii, figs. 1, 2.

1870. *Callipteridium Sullivanti* (Lx.) Weiss, Zeitschr. d. deutsch. geol. Gesell., vol. xxii, p. 876, pl. xxi, figs. 1–3.

1880. *Callipteridium Sullivantii* (Lx.) Weiss, Lesquereux, Coal Flora, vol. i, p. 164.

1883. *Callipteridium Sullivantii* (Lx.) Weiss, Lesquereux, 13th Rept. Geol. Surv. Indiana, p. 210, pl. xii, fig. 1.

1889. *Callipteridium Sullivanti* (Lx.) Weiss, Miller, N. Amer. Geol. Pal., p. 111, fig. 22.

1889. *Callipteridium Sullivanti* (Lx.) Weiss, Lesley, Dict. Foss. Pennsylvania, vol. i, p. 107, text fig.

1899. *Callipteridium Sullivantii* (Lx.) Weiss, D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 501.

In the specimens that I have seen of this peculiar species the pinnules are generally rather less narrow, proportionately, near the base than in those figured in the early Pennsylvania and Illinois geological reports. The rachises and the midribs of the full-sized pinnules are both finely striated, the midribs being very slender in the immature pinnules. None of the examples before me show the midrib terminating very abruptly. The lateral nerves are fine, not very close, and occasionally they fork a third time in arching to the margin.

As a rule the lowest pinnules at the base of pinnæ of all orders are contracted at the base so as to bear considerable resemblance to *Neuropteris* in form as well as in nervation, thus conforming apparently to the requisite characters of the genus *Neurodontopteris* of Potonié.[1] This similarity of the two genera, seen in Figs. 1, 2, Pl. XLI, is still more marked in the specimen shown in Fig. 1, Pl. XXXIX, and in the *Callipteridium neuropteroides* Lx., illustrated in fig. 3, pl. xxvii, of the Coal Flora.

Our species exhibits, in habit and superficial appearance, a great similarity to the *Danæites Emersoni* Lx., the apparently Marattiaceous fruiting of which seems to be quite in conformity with the supposed relation of the *Neuropterideæ* to the *Marattiaceæ*.

The Odontopteroid aspect of *Callipteridium Sullivantii* Lx., which led Weiss, in his studies of *Odontopteris*, to associate it with the latter, is well shown in a phase illustrated in Pl. XLI, Fig. 1, of two pinnæ, belonging apparently to a secondary rachis, which are in outline especially suggestive of *Odontopteris genuina* Gr 'Eury, or *O. obtusiloba* Naum. The reference of the species by Weiss to *Callipteridium* was made apparently on account of the form and nervation of the upper pinnæ. It seems as a whole to be

[1] Flora Rothliegenden v. Thüringen, 1893, p. 124.

referable to the *Neurodontopteris* of Potonié, which, as Sterzel remarks,[1] is largely identical with the *Mixoneura* of Weiss. Without discussing the relations of these two genera, it may be remarked that the genus *Callipteridium* as now employed seems to include two quite different groups. *C. Sullivantii* (Lx.) Weiss belongs to the Neurodontopteroid group, and is probably entirely distinct from the later, Pecopteroid, group, some of the representatives of which, including several fertile forms, are, in my opinion, genetically bound to the closely resemblant forms of *Pecopteris*.

I have not seen any rachial pinnules intermediate to the pinnæ, such as are characteristic of the genus according to Zeiller's definition, although several fragments are present in which the pinnæ are still alternately connected with the broad striated rachis.

The nervation and common form of the pinnules, which frequently overlap, are finely illustrated in Figs. 1. 2, Pl. XXXIX, and in Weiss's "Studien über Odontopteris."[2]

Localities.—Owen's coal bank, U. S. Nat. Mus., 3587, 3589; Pitcher's coal bank, U. S. Nat. Mus., 3588, 5660, 5674; Gilkerson's Ford, U. S. Nat. Mus., 3598.

ODONTOPTERIS Brongniart, 1822.

1822. *Filicites* sect. *Odontopteris* Brongniart, Mém. mus. hist. nat., vol. viii, p. 234.
1826. *Odontopteris* Sternberg, Versuch, vol. i, tent., p. xxi.
1828. *Odontopteris* Brongniart, Prodrome, p. 60.
1870. *Odontopteris* Weiss, Zeitschr. deutsch. geol. Gesell., vol. xxii, p. 859 (pars).
1870. *Mixoneura* Weiss, Zeitschr. d. deutsch. geol. Gesell., vol. xxii, p. 864.
1870. *Xenopteris* Weiss, Zeitcher. d. deutsch. geol. Gessell., vol. xxii, p. 865.

ODONTOPTERIS? BRADLEYI Lx.

Pl. XLII, Fig. 2.

1870. An *Odontopteris Bradleyi* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 390, pl. viii, fig. 1?
1880. *Odontopteris Brardleyi* Lesquereux, Coal Flora, vol. i, p. 140.

The specimen illustrated in Fig. 2, Pl. XLII, is an interesting example of the heteromorphous Neuropteroid or Odontopteroid fragments at present included among the American species of *Odontopteris*. As seen in the figure, we have a broad, somewhat lax, striated axis, on the left of which is a

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[1] Fl. Rothl. Oppenau; Mitth. Grossherzl. Badenschen Geol. Landesanst., vol. iii, 2, 1895, p. 283.
[2] Zeitschr. d. deutsch. geol. Gesell., vol. xxii, 1870, p. 876, pl. xxi, figs. 1–3.

segment of Neuropteroid limb, such as is not uncommon in *Neuropteris* or *Odontopteris*, sublobate at the top and succeeded by several obtusely pointed or obtuse, decurrent, more or less ovate and obovate pinnules, extending up to the lanceolate obtuse terminal. On the lower right are several ovate-triangular acute pinnules with broad decurrent attachments, the lower ones auriculate, succeeded above by pinnules similar to those alternating on the other side. The nerves are rather thick and fairly distinct, though the lamina is moderately thick. The nervation of the large segment is close, Neuropteroid, arching to meet the apex at a right angle. That of the other pinnules is essentially flabellate and Odontopteroid, the nerves entering by the whole width of the attachment of the pinnule and curving somewhat toward the margin, where they turn slightly upward. A coarse strand, passing from a little below the sinus on the upper side of the base of the pinnule to the apex, supplies the nervils for the upper side of that pinnule.

Although this fragment appears undoubtedly to belong to the group of heteromorphous species represented typically in *Odontopteris Wortheni* Lx., *O. subcuneata* Bunb., *O. cornuta* Lx., *O. deformata* Lx., and *O. Bradleyi* Lx., its identity with any of them is questionable. The four of these species first named and *O. affinis* Lx. all may, and do in some of the examples identified by the author of those species, have large basal segments on one or both sides of the axis. But while strongly resembling especially the *O. Wortheni* or *O. subcuneata* Bunb. by the large basal lobe and the terminal portions, the pinnules of these species are characteristically obtuse, the upper ones being obovate-cuneate; and in all examples except a single individual (No. 384 of the Lacoe collection) from Mazon Creek, Illinois, in the United States National Museum, identified by Professor Lesquereux as *O. Wortheni*, the nervation is coarser and much more distant than in our specimen.

Odontopteris Bradleyi Lx., with which the specimen is temporarily left, is an ambiguous species which was first described from a small fragment of a single pinnule. But one of the specimens in the Lacoe collection (No. 1256), examined and identified by Lesquereux prior to the publication of the Coal Flora, is a segment of a pinna in which the pinnules have nearly the same characters as in our specimen, except that they are much more constricted at the base, with finer nervation, while the rachis is less lax. Nevertheless, no large basal lobes are present in this specimen. It is quite possible that the fragment should be placed in *Odontopteris subcuneata* Bunb. Specimen No. 1256 comes from St. Clairsville, Ohio, and is probably one of those mentioned in the description given in Coal Flora, vol. i, p. 140.

It is interesting to note in this connection that nearly all of the above-named species are more or less distinctly hirsute, as is the condition of the specimen from Missouri, though the fine, short, bristle-like hairs are delicate and quite obscure, compressed upon the fleshy lamina of the pinnules. The strongly Neuropteroid characters present in some of the specimens placed by Lesquereux in *Odontopteris Wortheni*, *O. subcuneata*, and *O. affinis*, together with the fact that these species have, so far as I can learn, very rarely been reported from beds in which one of the long-pinnuled species of *Neuropteris*, such as *N. Scheuchzeri* Hoffm., *N. decipiens* Lx., or *N. hirsuta* Lx., was not also present, afford a basis for the suspicion that these particular specimens, if not the entire species to which they are referred, should be regarded as anomalous or heteromorphous pinnæ and pinnules of the genus *Neuropteris*. This suspicion is fostered by the great difficulty in some instances encountered in deciding as to which of the two genera certain specimens should be referred. For example, the fact that the pinnules of these species of *Odontopteris* from Mazon Creek, Illinois, have a coarser, more distant nervation than those from other regions placed in the same species, just as *Neuropteris decipiens* or *N. fasciculata* from Mazon Creek differs from the forms of *N. Scheuchzeri* in other localities, seems to indicate a certain coordination or agreement in nervation between the species from the same locality placed in both genera. In many cases it would seem that neither the nervation of the large basal segments or lobes, when the latter are present, nor the presence of hairs affords a satisfactory criterion for a generic distinction of the forms.

Locality.—Owen's coal bank, U. S. Nat. Mus., 5623.

NEUROPTERIS Brongniart, 1822.

Classification vég. foss., p. 33.

The definite systematic relationship of the Neuropterid group is still not wholly established. Although within the last few years a number of new species have been discovered, and some interesting studies of the structure of the petioles in certain members of the family have been made, the new evidence derived from the morphologic observations tends to confirm the intimate relations of the genus *Neuropteris* to *Linopteris*,[1] *Odontopteris*, and *Callipteridium*, while the structure seems to confirm their inclusion among the synthetic forms with highly organized petioles having some characters intermediate between the ferns and the cycads.

The opinion advanced by the late Director Stur, that *Neuropteris* may belong to the Cycadeæ, is briefly reviewed by Seward[2] in his admirable volume on the Mesozoic Cycads, without admission of the evidence on either side of the question as conclusive. It is true, as Seward points out, that the specimen regarded by Kidston[3] as a fertile fragment of *Neuropteris heterophylla* Brongn. seems hardly to furnish all the characters for a satisfactory conclusion. I have seen similar fruiting fragments from the Coal Measures of West Virginia with reduced pinnules, probably of an Adiantitoid type, still attached. On the other hand, the oblong interneural pits with slightly raised borders, described by various authors as the fruit of this genus, are now generally admitted to be the work of fungi. They might be compared with *Hysterites*, or even, as Stur suggested, with the recent *Phyllachora*. If, however, we accept Zeiller's identification of certain fertile pinnæ in the Commentry flora[4] as belonging with the sterile forms of *Linopteris Schützei* (Roem.), the fruit of a typical species of *Linopteris* (*Dictyopteris*) bears a strong superficial resemblance to that of *Pecopteris polymorpha*, i. e., to *Scolecopteris*. *Neuropteris* and *Linopteris* are among the most closely related of the artificial genera in the Paleozoic flora, the anastomosis of the nerves constituting the only distinction between the latter and the group represented by *Neuropteris gigantea* Stb.

In my earlier discussion of the relations of *Tæniopteris missouriensis* I urged the genetic relation of *Neuropteris*, *Dictyopteris*, *Odontopteris*, *Callipteridium*, and the pinnate Tæniopterids from the same type as the Devonian *Megalopteris*, designating this early ancestry as the "megalopteris stock."[5] The superficial characters of certain material subsequently examined tends strongly to support this view. But at the same time I should expressly state that the *Megalopteris* forms as yet discovered can not be so ancient as

[1] *Dictyopteris* Gutb.
[2] Cat. Mesozoic Foss. Pl. Brit. Mus., pt. 2, 1895, p. 5.
[3] Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 150, pl. viii, fig. 7.
[4] Fl. foss. houill. Commentry, vol. i, 1888, p. 273, Atlas, pl. xxx, figs. 6–10; pl. xxxi, figs. 2–5.
[5] Bull. Geol Soc. Amer., vol. iv, 1893, pp. 119–132, pl. i.

has been supposed. My studies, during several years, of the floras of the Devonian and older Carboniferous, particularly the fossil plants of the Pottsville series,[1] reveal so close a relationship and so great a proportion of identical species at once in the latter series and in the "fern ledges" about St. John, New Brunswick, the only locality of supposed Devonian age at which *Megalopteris* has been found, as to leave no room for doubt as to the Carboniferous age of the St. John plant beds. On the other hand, representatives of other characteristically Carboniferous genera so common in the beds at St. John, such as *Neuropteris*, *Alethopteris*, *Odontopteris*, and *Pecopteris*, which make the flora of that locality so unique and unparalleled among the floras of other Devonian localities, have never been discovered at any other Devonian locality. Typical forms of *Megalopteris* have been collected at a number of points in the Pottsville series of the Appalachian trough from Tennessee northward. The exceedingly strong affinity of some of these with the St. John type is but an illustration of the common character and intimate general relationship of the associated Pottsville flora and that at St. John, a relationship so close as not only to render it certain that the latter is Carboniferous in age, but also indicate that it may well be late in the Lower Carboniferous, if not even coexistent with some of its Pottsville representatives. *Megalopteris*, while possibly less ancient than certain of the early Callipteridioid *Neuropteris* species, may, nevertheless, be taken as an example of the archaic composite type of Neuro-Alethopteroid fern life.

In connection with the subject of the genetic relationship of this group it may be remarked that Potonié[2] has proposed to include the forms with mixed characters of *Neuropteris* and *Odontopteris*—i. e., those forms in which some *Neuropteris* pinnules are found on the same plant with a greater number of Odontopteris pinnules—in a distinct genus, *Neurodontopteris*, which is largely identical with the *Mixoneura* of Weiss. Still more recently Sterzel[3] proposed the genus *Neurocallipteris* for those Neuropteroid species in which the pinnules of the upper portions have the Callipteroid nervation predominating while the basal pinnules of the pinnæ have the nervation of the true *Neuropteris*.

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[1] Equivalent in part to the Millstone grit.

[2] Flora d. Rothl. Thüringen, 1893, p. 124.

[3] Fl. Rothl. Oppenau; Mitth. Grossherz. Badischen Geol. Landesanst., vol. iii, 2, 1895, p. 283.

NEUROPTERIS RARINERVIS Bunb.

1847. *Neuropteris rarinervis* Bunbury, Quart. Jour. Geol. Soc., vol. iii, p. 425, pl. xxii, figs. 1, 1*a–b*.
1858. *Neuropteris rarinervis* Bunb., Lesquereux, Geol. Pennsylvania, vol. ii, p. 859.
1863. *Neuropteris rarinervis* Bunb., Dawson, Can. Nat., vol. viii, p. 443.
1866. *Neuropteris rarinervis* Bunb., Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 428, pl. xxxiii, figs. 1–5; pl. xxxiv, figs. 1, 1*a*.
1869. *Neuropteris rarinervis* Bunb., Schimper, Traité, vol. i, p. 440.
1870. *Neuropteris rarinervis* Bunb., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, 2, p. 386, pl. viii, figs. 1–6.
1871. *Neuropteris rarinervis* Bunb., Dawson, Rept. Geol. Struct. Min. Res. P. E. I., p. 44, pl. ii, fig. 19.
1879. *Neuropteris rarinervis* Bunb., Lesquereux, Coal Flora, Atlas, p. 6, pl. xv, figs. 2–5; text, vol. i (1880), p. 109.
1881. *Neuropteris rarinervis* Bunb., Lesquereux, Rept. Geol. Surv. Indiana, 1879–80, p. 152, pl. x, figs. 1, 2, 3.
1886. *Neuropteris rarinervis* Bunb., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xlv, figs. 1, 1*a*, 2, 3, 4, 4*a*; text (1888), p. 268.
1893. *Neuropteris rarinervis* Bunb., D. White, Bull. U. S. Geol. Surv., No. 98, p. 85 (pl. v, figs. 7, 6?).
1878. *Neuropteris heterophylla* Brongn., Zeiller, Vég. foss. terr. houill., Atlas, pl. clxiv, fig. 2; text (1879), p. 49.

This species, several fragments of which have been found in the collections, may be easily distinguished from *Neuropteris missouriensis* Lx. by the coarse, rather distant, arching veins forking at a wider angle, while the pinnules are rather more distant, longer proportionately, narrower, often with a slightly sinuous margin, and generally dilated somewhat at the base. The species is described at length in my report on the flora of the outlying coal basins of Missouri.[1] *Neuropteris rarinervis* Bunb. is possibly indistinguishable from *Neuropteris coriacea* Lx., with which the specimens in hand seem to agree equally well.

Localities.—Hobbs's coal bank, U. S. Nat. Mus., 5475; Deepwater, U. S. Nat. Mus, 5476.

NEUROPTERIS MISSOURIENSIS Lx.

Pl. XLI, Figs. 4, 5; Pl. XLII, Fig. 4; Pl. XLV, Fig. 3.

1879. *Neuropteris missouriensis* Lesquereux, Coal Flora, Atlas, p. 3, pl. vii, figs. 5–6, 6*a*; text, vol. i (1880), p. 104.
1899. *Neuropteris missouriensis* Lx., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 507.

[1] Bull. U. S. Geol. Surv., No. 98, p. 85.

Fronds bi- or tripinnate, dense, the divisions alternate, open at a right angle, or nearly so, to the rachis, the rachis being broad and striate; pinnæ usually close, contiguous, or overlapping, sometimes slightly narrowed at the base, the sides parallel in the middle, often somewhat rounded at the tip; pinnules alternate, rather thin, open, the lateral ones ovate when small, becoming oval and oblong, rounded at the top, close, usually slightly imbricated, nearly bilaterally symmetrical, slightly subfalcate, entire to the subterminal lobe, sessile by the base of the broad midrib, the sides nearly equally rounded at the base; terminal pinnule large, very long in the young pinnæ, oblong-deltoid, oblong-ovate, or rarely deltoid-ovate, obtusely rounded at the apex, with not more than one connate basal lobe; midrib distinct, broad, striate in the large pinnules, dissolving above the middle; nerves distinct near the midrib, sometimes immersed in the lamina, originating at a narrow angle, forking at or near the base, often with three subsequent dichotomies at a narrow angle while arching gradually to meet the margin nearly at a right angle, where they number 34 to 40 per centimeter.

This species, which is very nearly related to *Neuropteris flexuosa* Stb. and *N. vermicularis* Lx., is distinguished chiefly by its open pinnæ, the oblong or oval rather thick pinnules, slightly imbricated, sessile, and nearly equally rounded at the base, with the midrib distinct, the lateral nerves distant and large near the midrib, forking several times in passing to the border, which they meet obliquely. The illustration given in the Coal Flora,[1] as well as our Fig. 4, Pl. XLII, well expresses the characteristic form of the smaller pinnæ and of the pinnules. The terminal pinnules of the longer pinnæ are, however, not always so oblong and obtusely rounded, as is shown in Fig. 3, Pl. XLV. The appearance of the larger pinnules is illustrated in the same figure, or in Fig. 4, Pl. XLI. The specimens in hand agree well with the type, kindly loaned for comparison by Dr. J. H. Britts, as well as with other examples determined by Professor Lesquereux and now included in the Lacoe collection. The fact that *Neuropteris missouriensis* so much resembles *N. flexuosa* perhaps accounts for the inclusion of the latter species in the list of the fossils of Missouri published by Mr. Hambach.[2] I have not seen any representative of the latter species from Henry County, the locality given by that author.

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[1] Pl. vii, fig. 5.

[2] Hambach, Bull. Geol. Surv. Missouri, No. 1, 1890, pp. 60–85.

The fronds of *Neuropteris missouriensis* were evidently of considerable size, some of the fragments of attached rachis measuring as much as 9 mm. in width. The large Cyclopterid leaves described as *N. dilatata* (L. & H.) Lx., if they really belong to this genus, are probably rachial pinnules of *N. missouriensis*. So far do they agree, however, in the essential superficial features with those of similar form and dimensions placed by foreign authors in the genus *Doleropteris* that a generic identification with the latter tends to affect the systematic status of the Neuropterid group.

Localities.—Abundant at Pitcher's coal bank, U. S. Nat. Mus., 5472, 5630, 5631; Hobbs's coal bank, U. S. Nat. Mus., 5632; Deepwater, U. S. Nat. Mus., 5474.

NEUROPTERIS FASCICULATA Lx. ?

1879. *Neuropteris fasciculata* Lesquereux, Coal Flora, Atlas, p. 5, pl. xxiv, figs. 5, 6; text, vol. i (1880), p. 93.

A single broad, ovate, acute pinnule in the collections appears to be identical with *Neuropteris fasciculata* Lx., as seen in specimens from Mazon Creek, Illinois. It has much in common also with *N. acuminata* (Schloth.) Brongn., both in nervation and in general form. There ference of the fragment to this species is merely tentative.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 5477.

NEUROPTERIS SCHEUCHZERI Hoffm.

Pl. XXXVII, Fig. 4; Pl. XLII, Fig. 3; Pl. LXIV, Fig. *d*.

1691. *Phyllites mineralis* Luidius, Lithophyl. Brit., p. 12, pl. v, fig. 190.
1723. *Phyllites mineralis* Luid., Scheuchzer, Herb. Dil., p. 48, pl. x, fig. 3.
1826. *Neuropteris Scheuchzeri* Hoffmann, in Keferstein: Teutschland, vol. iv, p. 157, pl. I*b*, figs. 1*b*–4.
1830. *Neuropteris Scheuchzeri* Hoffm., Brongniart, Hist. vég. foss., p. 230, pl. lxiii, fig. 5.
1840. *Neuropteris Scheuchzeri* Hoffm., Jackson, Rept. Geol. Agricult. Surv. Rhode Island, 1839, p. 288, pl. v, fig. 10.
1857. *Neuropteris Scheuchzeri* Hoffm., Kimball, Fl. Appal. Coal Field, p. 9, pl. i, fig. 1.
1886. *Nerropteris Scheuchzeri* Hoffm., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. xli, figs. 1, 1*a*, 2, 3; text (1888), p. 251.
1887. *Neuropteris Scheuchzeri* Hoffm., Kidston, Foss. Fl. Radstock Ser., p. 356, pl. xxiii, figs. 1, 1*a*, 2.
1893. *Neuropteris Scheuchzeri* Hoffm., D. White, Bull. U. S. Geol. Surv., no. 98, p. 69.

1899. *Neuropteris Scheuchzeri* Hoffm., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 503.

1830. *Neuropteris angustifolia* Brongn., Hist. vég. foss., p. 231, pl. lxiv, figs. 3, 4.

1869. *Neuropteris angustifolia* Brongn., Geinitz, Dyas, vol. ii, p. 139, (pl. xxvii, fig. 9?).

1869. *Neuropteris angustifolia* Brongn., von Roehl, Foss. Fl. Steinkohlenf. Westphalens, p. 33, pl. xiv, fig. 7.

1870. *Neuropteris angustifolia* Brongn., Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 467.

1879. *Neuropteris angustifolia* Brongn., Lesquereux, Coal Flora, Atlas, p. 3, pl. viii, figs. 2, 3, 6, 8, 10, 11; text, vol. i (1880), p. 89.

1883. *Neuropteris angustifolia* Brongn., Lesquereux, 13th Rept. Geol. Surv. Indiana, 2, p. 52, pl. x, fig. 1.

1884. *Neuropteris angustifolia* Brongn., Lesquereux, Coal Flora, vol. iii, p. 734.

1889. *Neuropteris angustifolia* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 451, text fig.

1832. *Neuropteris cordata* Brongn., Lindley and Hutton, Fossil Flora, vol. i, p. 119, pl. xli.

1847. *Neuropteris cordata* Brongn., Bunbury, Quart. Jour. Geol. Soc., vol. iii, p. 423, pl. xxi, figs. 1, 1*a–b*.

1865. *Neuropteris cordata* Brongn., Goeppert, Foss. Fl. Perm. Form., p. 100 (pl. xi, figs. 1, 2?).

1878. *Neuropteris cordata* Brongn., Dawson, Acad. Geol., 3d ed., p. 446, fig. 166*b*.

1880. *Neuropteris cordata* Brongn., Lesquereux, Coal Flora, vol. i, p. 91 (pars).

1888. *Neuropteris cordata* Brongn., Dawson, Geol. Hist. Pl., p. 126, fig. 51*b*.

1889. *Neuropteris cordata* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 452, text fig.

1836. —— —— Morton, Amer. Jour. Sci., vol. xxix, pl. xi, fig. 26.

1841. *Neuropteris*, Hitchcock, Geol. Massachusetts, vol. ii, p. 542, pl. xxi, fig. 1.

1847. *Neuropteris cordata* Brongn. var. *angustifolia* (Brongn.) Bunbury, Quart. Jour. Geol. Soc., vol. iii, p. 424.

1866. *Neuropteris cordata* Brongn. var. *angustifolia* (Brongn.) Bunb., Dawson, Quart. Jour. Geol. Soc., vol. xxii, p. 154.

1854. *Neuropteris hirsuta* Lesquereux, Boston Jour. Nat. Hist., vol. vi, 4, p. 417.

1857. *Neuropteris hirsuta* Lesquereux, Rept. Geol. Surv. Kentucky., vol. iii, pp. 434, 556, pl. vi, fig. 4.

1858. *Neuropteris hirsuta* Lesquereux, Geol. Pennsylvania, vol. ii, p. 857, pl. iii, fig. 6; pl. iv, figs. 1–16.

1869. *Neuropteris hirsuta* Lx., Schimper, Traité, vol. i, p. 445.

1875. *Neuropteris hirsuta* Lx., Dana, Manual, Geol., 2d ed., p. 327, fig. 635.

1879. *Neuropteris hirsuta* Lesquereux, Coal Flora, Atlas, p. 3, pl. viii, figs. 1, 4, 5, 7, 9, 12; text, vol. i (1880), p. 88.

1880. *Neuropteris hirsuta* Lx., Fontaine and White, Permian Flora, p. 47, pl. viii, figs. 7, 8.

1881. *Neuropteris hirsuta* Lx., C. A. White, Rept. Geol. Surv. Indiana, 1879–80, p. 152, pl. ix, figs. 1, 2, 3.

1882. *Neuropteris hirsuta* Lx., Le Conte, Geol., p. 365, fig. 473.

1883. *Neuropteris hirsuta* Lx., Chamberlain, Geol. Wisconsin, vol. i, p. 216, fig. 67*b*.

1889. *Neuropteris hirsuta* Lx., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 460–462, 16 text figs.

1889. *Neuropteris hirsuta* Lx., Miller, Geol. Pal. N. Amer., p. 128, fig. 54.

1857. *Neuropteris Rogersii* Kimball (non Lx.), Fl. Appal. Coal Field, p. 10, pl. i, fig. 1.

1884. *Neuropteris angustifolia* Brongn. var. *hirsuta* Lesquereux, Coal Flora, vol. iii, p. 885.

Few species among our Paleozoic ferns present a greater stratigraphic range than that familiar in American paleontologic literature under the name *Neuropteris hirsuta* Lx. To the discussion of the identity of this species with the *N. angustifolia* Brongn. and *N. cordata*, figured by Lindley and Hutton, and its relations to other species given at length in my report on the flora of the outlying carboniferous basins of southwestern Missouri[1] I have but little to add, and that is generally of a confirmative nature.

Since the publication of those observations I have had the opportunity of closely examining, in the Lacoe collection, several hundred specimens, mostly identified by Professor Lesquereux, and coming from nearly every region of this country where Coal Measures ferns have been collected, and after a painstaking comparison, side by side, of the specimens in *Neuropteris hirsuta* and *N. angustifolia*, together with a few others labeled since the publication of the Coal Flora, as *N. Scheuchzeri* Hoffm., I am unable to find any essential character that seems to satisfactorily sustain a differentiation of specific rank.

As may in many cases be observed in the lists published by localities, the species *N. hirsuta* and *N. angustifolia* are both, if either, generally reported from the same localities. Usually I not only find both forms from the same locality, but in several instances, probably the result of hasty determination, counterparts have been found under the two names. During the comparison of details I have not been able to find any greater difference of nervation between the pinnules of the two forms described as characteristic of the two species than may frequently be found among the pinnules of species with great vertical range, while the essential characters of basal auriculation, attachment, and hirsuteness occur in both groups. In a series from the Lower Productive Coal Measures (No. XIII) a gradation from the smaller, more slender pinnules with acute tips to those of average size with more rounded apices may usually be observed if the material is ample. In

[1] Bull. U. S. Geol. Survey, No. 98, 1893.

short, when dealing with specimens from the Lower Productive Coal Measures, though when but a few specimens are in hand it is frequently possible to separate them into two groups according to a single character, such a division, when the series is large or a number of localities of close stratigraphic relation are represented, is usually difficult, if not wholly impossible.

Concerning the name to be employed for this species there is still slight uncertainty. Although the specimens from the United States agree well with material in the Lacoe collection from Cape Breton, Nova Scotia, and the Bristol coal field in England, and are no doubt the same species, I am not now fully assured that they are specifically identical with the more triangular pinnules from the Valenciennes Basin, published by Professor Zeiller; and accordingly, if Zeiller's form is certainly the same as that poorly described and illustrated by Hoffman, it seems probable that the type, with broader and more lingulate pinnules, might deserve an independent specific designation, in which case Lesquereux's name, *N. hirsuta*, would have priority. The examination and publication of additional specimens from Hoffman's locality is much to be desired.

With regard to variation in a species, *Neuropteris Scheuchzeri* is one of the most interesting of American Paleozoic ferns. Ranging, as it does, from near the base of the Lower Productive Coal Measures, or Alleghany series, to the highest plant beds of the "Permian" or Dunkard Creek series, it presents a valuable illustration of the modification of a species found at many horizons in a thick series of probably continuously deposited sediments. So far as my observations have extended in collections from American localities and horizons, it may be noted that, in general, both in the anthracite and in the bituminous fields, the earliest representatives of the species, in the lowest coals, are prevailingly smaller, narrower, and more triangular and pointed, the hairs fine, short, and often invisible. A little higher, as, for example, in the E or F veins, as numbered in the northern anthracite field by the Pennsylvania geological survey, the narrow, acute forms become rare and the proportion of broader, more obtuse pinnules increases, the pinnules becoming large at the same time and more conspicuously hirsute, while at the horizon of the Pittsburg coal and of the higher anthracite coals the leaflets are mostly broad and lingulate, the hairs less plain; and again, those pinnules from the Waynesburg and Washington coals, in the so-called Permian, are almost exclusively broad, very large, rounded at the top, more broadly auriculate at the base, distinctly and rather broadly pedicellate, while the hairs are usually very obscure, if not absent. Thus the sequence from the earliest to the latest form, the series between two types that would if considered independently be properly regarded as distinct species, is marked by so many intermediate or transitional phases that it seems at present entirely impracticable to attempt to draw any lines of a specific grade. Yet the differences between the types prevailing at stages vertically distant are great enough to easily constitute varieties, if one does not attempt to carry the varietal distinction all the way through the intervening series. And since these phases or forms are more or less peculiar to different portions of the vertical section, they possess a stratigraphic and correlative value, and deserve, therefore, some reference term and definitive distinction. Some system of nomenclature will be necessary if the unquestionable geologic utility of these phases are to be rendered available.

Accordingly, for the common early form that is characterized in general by its smaller size, narrow or triangular form, with small auricles squared on the quarter, the median nerve slender, the pedicel short and narrow, the hairs being delicate, often short or found with difficulty, I would use, in a varietal sense, the name *angustifolia*, which was applied by Lesquereux to most of the pinnules of this character from Henry County, Missouri. I think it not unlikely that this is the same form to which Bunbury gave the name *Neuropteris cordata* Brongn. var. *angustifolia* in the flora of Cape Breton, in which case the varietal designation should be credited to him. This form or variety, illustration of which is given in Fig. 3, Pl. XLII, and Fig. 4, Pl. XXXVII, is the common phase of *Neuropteris Scheuchzeri* in the plant collections from Henry County, Missouri. I intend at another time to more fully illustrate the variations of this species within the Carboniferous series of the Appalachian Basin.

Though *N. Scheuchzeri* has not yet been reported from below the true Coal Measures, or Alleghany series, in the United States, it is not improbable that representatives of it may yet be found in what has been described as the "conglomerate series," or, better, as the "Pottsville series," or formation.

Localities.—Owen's coal bank, U. S. Nat. Mus., 5468, 5633; Gilkerson's Ford, U. S. Nat. Mus., 5469.

NEUROPTERIS DILATATA (L. and H.) LX.

Pl. XLI, Fig. 6; Pl. XLII, Fig. 1; Pl. XLIII; Pl. XLIV, Fig. 2.

1833. *Cyclopteris dilatata* Lindley and Hutton [non (L. & H.) Stb.], Foss. Fl., vol. ii, pl. xci B.
1849. *Nephropteris dilatata* (L. and H.) Brongniart, Tableau d. gen., p. 16 (65).
1869. *Nephropteris dilatata* (L. and H.) Brongn., Schimper, Traité, vol. i, p. 430.
1879. *Dolerophyllum dilatatum* (L. and H.) Schimper, in Zittel: Handb. Palæont., vol. ii, pp. 142, 252.
1880. *Neuropteris dilatata* (L. and H.) Lesquereux, Coal Flora, vol. i, p. 78.
1893. *Neuropteris dilatata* (L. and H.) Lx., D. White, Bull. U. S. Geol. Surv., No. 98, p. 96.

The specific correlation of these large Cyclopterid pinnules is still uncertain. The nomenclatural confusion arising from determinations influenced by such characters as size, or distance of nerves along a broken edge, or obscurity of nervation near the margin, is slightly increased by the reference by some paleobotanists of these Cyclopterids to *Dolerophyllum*, or *Doleropteris*, on the basis of a relation to a higher gymnospermic type.

Through the courtesy of Dr. J. H. Britts, of Clinton, Missouri, I have represented in Pl. XLIII the specimen described by Professor Lesquereux in the Coal Flora, page 78, and again by myself with others from the zinc region of the same State[1] A good series of specimens was also gathered by Mr. Van Ingen from the same locality. These American specimens I have carefully compared with material in the Lacoe collection from Lindley and Hutton's type locality, Felling Colliery, Newcastle, England, and this comparison seems to confirm Professor Lesquereux's identification.

The leaf substance, which is not particularly thick, shows the same intermediate fibers or ducts between the main nerves in the examples from both England and Missouri. These fibers, as we may for convenience term them, in the plant from the "outliers" in the zinc region, are present in all the well-preserved specimens In fact, the better the preservation of the leaf the more clearly the filaments may in general be seen, although they are sometimes immersed in the parenchyma. The details given in Fig. 1*a*, Pl. XLII, fail to do justice to the continuity or distinction of these filaments or ducts, though they sometimes seem to lack continuity, owing, apparently, to a vertical undulation in the parenchyma of the limb. Fig. 6*a*, Pl. XLI,

[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 96.

shows the appearance of the filaments near the base of the leaf; Fig. 1*a*, Pl. XLII, represents the aspect between the same nerves nearer the margin. While these intermediate filaments are sometimes not so distinct at the base of the leaf, their presence can usually be discerned in the region where the main nerves are distant.

In the absence of a knowledge of the anatomical structure of our material any argument as to the systematic position of these Cyclopterids will lack conclusiveness. A similar condition as to intervening filaments may, I believe, be less clearly seen on some of the other asymmetrical auriculate Cyclopterids, with marginal attachments, which are probably rachial pinnules of *Neuropteris*, and, whether they represent independent vessels or only dissociated nerves, or even supposing them to be resin vessels or some analogous structures, such a condition would not perhaps be out of accord with the complicated and anomalous structure observed in some types of Paleozoic fern stems.

Doleropteris pseudopeltata, a large Cyclopteroid leaf regarded by its author, Grand 'Eury,[1] as a gymnosperm (*Dolerophyllum* of Saporta[2]), agrees in size, form, including the overlapping auricles, and even in the aspect of the nervation so closely with our species as to create the strongest suspicion that both belong to the same genus. The only apparent important difference indicated in the description or figure is a more coriaceous texture in the French specimen. Moreover, the companion species, *Cyclopteris obliqua* Brongn. and *C. orbicularis* Brongn., have been referred to the gymnospermic genus, while Schimper[3] and Schenk were disposed to believe that *Cyclopteris dilatata* L. and H. should also be referred to *Dolerophyllum*.

M. Grand 'Eury is of the opinion that the *Pachytesta* of Brongniart, a type of fossil fruit probably represented by *Rhabdocarpos Mansfieldi* Lx. in this country, is the fruit of *Doleropteris*. The supposed male, pollen-bearing disks or leaf scales of the same plant, identified by the former as *Androstachys*,[4] are no doubt of the same nature as the fossils described by

[1] Géol. paléont. bassin houill. Gard., 1890, p. 306, pl. viii, fig. 1.

[2] *Dolerophyllum*, made by Saporta the type of the *Dolerophylleæ*, and placed by him, together with the *Cordaiteæ*, etc., in the group "Proangiosperms." Saporta et Marion, Évol. règ. vég., Phanerogames, vol. 1, 1885, p. 68.

[3] Zittel, Handb. Palæont., vol. ii, pp. 142, 252.

[4] *A. cebennensis* Grand 'Eury, op. cit., p. 307, pl. viii, figs. 2A, 2A'. "Appareil mâle ou Androphylle des Dolerophyllées," Saporta, Évol. Règ. Vég., Phanerog., vol. i, p. 71, fig. 35.

Dawson[1] as *Dolerophyllum pennsylvanicum.* These, too, are Cyclopteroid, though smaller, thicker, and more fibrous than any of the other Cyclopterids. These fertile or polleniferous disks are now known from several localities in this country, and the fact that Cyclopteroid specimens of the same nature as *N. dilatata* are present in the same beds justifies the anticipation that should specimens showing the organization of the leaf be found, these would prove generically identical with the similar forms from the Old World.

Localities.—Hobbs's coal bank, U. S. Nat. Mus., 5471; Pitcher's coal bank, U. S. Nat. Mus., 5470, 5658, 5672.

LINOPTERIS Presl, 1838.

1835. *Dictyopteris* Gutbier (non Lamour.), Abdrücke, p. 62.
1838. *Linopteris* Presl, in Sternberg: Versuch, vol. ii, facs. 7–8, p. 167.
1897. *Linopteris* Presl, Potonié, Lehrb. d. Pflanzenpal., p. 153.

LINOPTERIS GILKERSONENSIS n. sp.

Pl. XLI, Figs. 7, 8; Pl. LXI, Fig. 1*f*.

1897. *Dictyopteris* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, pp. 297, 300.
1899. *Dictyopteris gilkersonensis* D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 510.

Pinnules open, rather distant, alternate, sessile by a narrow attachment to a slender striate rachis, 5 mm. to 2 cm. or more in length, 4 to 7 mm. in width, oblong-ovate, tapering from near the base toward the round summit, nearly straight, hardly subfalcate, the base nearly equilateral, of rather thick texture and sparsely punctate; midrib of moderate strength, irregular above the middle; nerves very coarse, but few primary nerves, very oblique, anastomosing near the bifurcations, touching the margin obliquely; areoles comparatively few, very broad in proportion to the length, trapezoidal, roundish at the distal end, very long and oblique near the midrib, and becoming shorter and more rhomboidal near the margin.

The material from Gilkerson's Ford contains many detached pinnules of a "*Dictyopteris*" which I at first thought might be a variety of one of the species already described; but a comparison with the literature and specimens representing the described American species leaves little doubt as to

[1] Can. Rec. Sci., vol. iv, 1890, p. 8.

the distinction and validity of the form to which I have consequently given the above specific name.

The name *Dictyopteris*, for which Presl substituted *Linopteris*, should no longer be employed in the terminology of fossil ferns, since, as Potonié points out, the same name, which was earlier applied by Lamouroux (1809) to a genus of living Algæ, is still recognized in the family *Dictyotaceæ*

The essential characters of *Linopteris gilkersonensis* are the nearly straight and rather small pinnules, the sides converging slightly or nearly parallel, the apex rounded with almost bilateral symmetry; the coarseness of the nerves, the general direction of which is very oblique to the margin; the relatively small number of the areoles, which are proportionately very broad and consequently few in number, the inner angles being unusually open. It differs from the group represented by *L. obliqua* Bunb., *L. sub-Brongniartii*, or *L. Brongniartii* (Eichw.) by the straighter pinnules, the coarse veins, and the relatively few and broad meshes. Although resembling in form and size some of the specimens figured by Kidston[1] and Zeiller[2] as *Dictyopteris Münsteri* Roem., the strong nervation, rigid and open-angled nerves, with shorter meshes at the margin, make it improper to associate the specimens in hand with that species.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 5485.

TÆNIOPTERIS Brongniart, 1828.

Prodrome, p. 61; Hist. vég. foss., vol. i, 1831 or 1832, p. 262.

TÆNIOPTERIS ? MISSOURIENSIS D. W.

Pl. XL, Figs. 1–7.

1893. *Tæniopteris missouriensis* D. White, Bull. Geol. Soc. Am., vol. iv, p. 119, pl. i.

Fronds bipinnate (tripinnate ?), the larger divisions linear-lanceolate, acute, composed of pinnatifid pinnules near the base, above which are simple pinnules; primary rachis broad, shining, marked by somewhat irregular lines, and consisting of a thickened central portion, broadly but shallowly canaliculate above, half round below, and of thinner marginal laminæ; pinnules opposite, subopposite, or alternate, slightly distant, at right angles or reflexed below, becoming more oblique above, ribbonlike, gradually taper-

[1] Foss. Fl. Radstock Series, 1887, p. 361, pl. xxi, figs. 6*a*–*b*.

[2] Fl. foss. houill. Valenciennes, Atlas, 1886, pl. xliv, figs. 2, 2*a*; see also figs. 1, 3, 4, 5.

ing from the lower part, with borders straight or slightly undulate and nearly parallel, to a rather acute tip, long, sometimes reaching a length of 8 cm. or more, and measuring 6–13 mm. in width, the lower ones slightly narrowed toward the cordate, nearly symmetrical base with its narrowed attachment which overlaps the marginal lamina of the rachis, the higher ones becoming attached by the whole base, those near the top of the pinnæ becoming shorter, more distinctly decurrent and confluent, the margins more rapidly converging; limb of the pinnules rather thick, dull, broadly canaliculate along the midrib, somewhat convex near the borders, overlapping the marginal laminæ of the rachis, constricted to a rather narrow attachment in the lower and middle pinnules, spreading and uniting those near the apex of the pinnæ, where it forms a wing incised by acute and decurring angles at the confluence of the pinnules; nervation Tæniopteroid; midrib strong, depressed, broad and striate beneath, broadly canaliculate above, originating from the central portion of the rachis, passing along the middle of the lamina and tapering to the apex of the pinnule; lateral nerves rather fine salient above, distinct beneath, originating at an oblique or sometimes nearly a right angle from a slender cordlike bundle often distinctly in relief traversing the center of the canal, usually forking at or near the midrib, rarely simple, curving quickly if oblique, and passing fairly straight and generally parallel perpendicularly to the border, usually forking again at a varying distance in the lamina, and counting 24 to 28 per centimeter at the margin; basal nervils of the upper decurrent pinnules springing from the rachis; those of the uppermost Alethopteroid pinnules rather more oblique in passing to the margin.

Among the known Paleozoic plants are several species described as *Danæites*, *Alethopteris*, *Tæniopteris*, and *Desmopteris* which have many characters in common with *Tæniopteris ? missouriensis*. Of the American forms, *Danæites* (*Alethopteris*) *macrophylla* Newb. sp , *Alethopteris maxima* Andr., the types ranged under *Orthogoniopteris* and *Protoblechnum*, and an unpublished species of *Callipteridium* described by Lesquereux deserve comparison. Newberry's *Alethopteris macrophylla*,[1] the fully developed pinnules of which are somewhat similar to those of our specimens, is Alethopteroid in arrangement, only the lowest, so far as I have observed, becoming contracted to

[1] Geol. Surv. Ohio, Pal., I, p. 383, pl. xlviii, figs. 3, 3*a*.

the obliquely cordate base. Besides its more delicate habit, it further differs by the obliquity of the narrowed bases of the distinct pinnules, the more slender upper, confluent pinnules, and the closer nervation. There is perhaps no generic difference between the two plants. *Alethopteris maxima* Andr.,[1] as seen in a specimen from Rushville, Ohio, determined by Professor Lesquereux, is an Alethopterid, though the difference between it and *Protoblechnum* may not be of generic rank. At probably nearly the same stage a form perhaps somewhat similar existed in the *Alethopteris ingens* Daws.,[2] the pinnules of which, more than 1 inch in width and 3 inches or more in length, have the *Danæites* nervation. The *A. discrepans* Daws.,[3] also from the beds of supposed Middle Devonian age, but undoubtedly, as shown by the peculiar composition and distribution of the flora, belonging to the Carboniferous, at St. John, New Brunswick, the long, ribbon-like, open pinnules of which are united, however, by a narrow decurrent wing, should also be taken into comparison. So far as the form and development of the pinnules, and to some extent the nervation, are concerned, a closer resemblance obtains in the cases of *Pseudodanæopsis reticulata* Font.,[4] from the Upper Trias at Clover Hill, Virginia, or the forms of *Tæniopteris Münsteri* Goepp. (*Angiopteris*, fide Schenk), from the Lias of Bornholm[5] The upper pinnules of the Virginia species are united, as figured by Fontaine, while the lower ones are long, ribbonlike, and distinctly and nearly equally rounded at the base, as in our plant from Missouri. Perhaps its nearest affinity is, however, with the *Tæniopteris jejunata* of Grand 'Eury,[6] from the Upper Carboniferous and Permian of France. In this species, of which the upper parts of the pinnæ are, I believe, unknown, the pinnules are sometimes short-pediceled, the lamina thin, and the nerves generally more oblique near the midrib and more regular, as figured, in passing to the margin than in our species.[7] In form the Missouri species is also close to

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[1] Geol. Surv. Ohio, Pal., II, p. 421, pl. 1, figs. 3, 3*a–b*.

[2] Foss. Pl. Dev. Sil. Form. Can., pl. xviii, fig. 206, p. 54.

[3] Op. cit., p. 54, figs. 203–205.

[4] Older Mes. Fl., U. S. Geol. Surv. Monogr., vol. vi, p. 59, pl. xxx, figs. 1–4.

[5] Bartholin: Botanisk Tidsskr., vol. xviii, hft. i, Kjøbenhavn, 1892, p. 23, pl. ix, fig. 9.

[6] Fl. carb. Loire, p. 121. Zeiller, Fl. foss. Commentry, pt. 1, p. 280, Atl., pl. xxii, figs. 7–9. Zeiller, Fl. foss. Autun, Épinac, p. 162, pl. xii, fig. 6. Potonié, Fl. Rothl. Thüringen, p. 145. pl. xvii, fig. 3.

[7] The nervation seen in the figures of *T. missouriensis* is drawn with fidelity in detail from the originals.

certain species referred by Stur[1] and Zeiller[2] to *Desmopteris* Stur, which has a somewhat different nervation, though it appears to be allied to the Alethopteroid group. It also bears a strong resemblance to *Alethopteris magna* Grand 'Eury.[3] In the latter, however, the mode of division is more irregular, the pinnules more heteromorphous and not so contracted at the base, while the nervation is much more distinctly Alethopteroid.

My reference of the Missouri species to *Tæniopteris* is provisional. The fern is in its habit, and to some extent its nervation, evidently closely related to *Alethopteris.* As suggested above, it should perhaps be included in the same genus with *Danæites* (*Alethopteris*) *macrophylla* (Newb.) Lx.; but from the character of the rachis, midrib, form of pinnules and the nervation, and from the observed development of the upper part of some of the Tæniopteroid forms in the older Mesozoic and Carboniferous, I have been led to place it among the *Tæniopterideæ*; and, notwithstanding the high degree of its superficial identity with the Marattiaceous forms comparable in their fructification to *Danæa* or *Angiopteris,* it seems better, in default of all knowledge of the fruiting of our species, to refer it to the genus *Tæniopteris,* the former resting place of many of the Mesozoic species, rather than to the equivocal genus *Danæites.* It is certainly ineligible to admission in the *Danæites* of Goeppert and Stur. The name *Danæites,* in the sense in which it is employed by Heer and Schimper, should, if used at all, perhaps be applied to those species only of which either the fruiting is known or the generic identity with other contemporaneous fruiting species is by other evidence satisfactorily proved, leaving their apparent representatives from the Paleozoic, the fruiting of which is not known, in the convenient and noncommittal genus *Tæniopteris,* without presupposing any direct genetic relation to any particular fruiting genus

The broader application by European paleobotanists of the name *Tæniopteris* to pinnate forms with narrower leaves, as well as the resemblance, in many respects, of our plant to the *Tæniopteris jejunata,* has further influenced me in placing this form, which has so close an affinity with *Alethopteris,* in the above-named genus. Perhaps it belongs more properly in *Alethopteris.*

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[1] Carbon.-Fl. Schatzlarer Sch., vol. i; see *D. belgica* Stur, p. 181, pl. lii, figs. 7–9.

[2] Fl. Foss. houill. Valenciennes, p. 216, pl. xxxviii, figs. 3–5. See Ettingshausen, Fl. Radnitz, p. 40, pl. xvi, figs. 2–4.

[3] Géol. pal. bassin houill. Gard, p. 290, pl. xx, figs. 5, 6.

The relationship of *Tæniopteris missouriensis* and of other supposed Paleozoic representatives of the Marattiaceæ was considered somewhat in full by me in a special publication on the subject.[1]

Localities.—Hobbs's bank, U. S. Nat. Mus., 5556–5560, 5568. Also one specimen from Deepwater, U. S. Nat. Mus., 5591.

EQUISETALES.

CALAMARIEÆ.

CALAMITES Suckow, 1784.

Acta Acad. Theod. Palat., vol. v, p. 357. Schlotheim, Petrefactenkunde, 1820, p. 398.

The brilliant results obtained in late years by the English, French, and German investigators of the internal structure of the Calamarian types have thrown great light on the relations of this class of vegetable remains.

While at first it seemed that the study of the anatomical features of this group would lead to its division into several sections of generic, or at least subgeneric rank, some of these sections being referred to orders far apart in the vegetable world, the widespread interest and increased attention to the subject consequent upon the earlier developments tend latterly to show the relative unity of the Calamarian group, though it is characterized within itself by remarkable diversity and complexity, such as have rendered enigmatic so many of the Paleozoic types.

From large stems with thin walls like *Calamites Suckowii* or *C. ramosus*, whose superficial structure is interpreted[2] as indicating a close relation to the recent *Equiseta*, there seems to be a progression to the thick, complex walled species with well-developed secondary woody growth of the *Calamodendron* or *Arthropitus* types.

Of great interest in this connection are the observations and conclusions of Mr. Cormack[3] who has found in *Equisetum maximum* that the older nodes possess much more highly developed woody structure than the young nodes, with new radially disposed elements and what seem to be cambial cells between the bark and the wood. From a comparison of the structure of the recent plant with that of *Calamodendron* it would appear that the

[1] Bull. Geol. Soc. Am., vol. iv, 1893, p. 119 et seq.
[2] Saporta, Révue gén. bot., vol. i, p. 584.
[3] Annals of Botany, vol. vii, 1893, pp. 63–82, pl. vi.

difference between the modern *Equisetum* and the Paleozoic type is largely a matter of degree rather than fundamental.

Quite in accord with this conclusion are the observations of Mr. Thomas Hick, who finds in *Calamostachys Binneyana* an axial structure agreeing in its details with the *Arthropitus* type, while the sporangiophores are dilated at the summit to form a shield, much as in *Equisetum*, with the anatomical characters of which the fossil has much that is in common or similar.[1]

The relation of some Annularian forms to the *Equiseta* and *Calamites* will be mentioned in connection with the *Annulariæ*.

CALAMITES RAMOSUS Artis.

1825. *Calamites ramosus* Artis, Antedil. Phytol., pl. ii.
1828. *Calamites ramosus* Artis, Brongniart, Hist. vég. foss., p. 127, pl. xvii, fig. 5 (non 6).
1835. *Calamites ramosus* Artis, Gutbier, Abdrücke, p. 18, pl. ii, fig. 6.
1848. *Calamites ramosus* Artis, Sauveur, Vég. foss. terr. houill. Belg., pl. ix, fig. 2; pl. x, figs. 1, 2.
1877. *Calamites ramosus* Artis, Grand 'Eury, Fl. carb. Loire, p. 20, pl. ii, fig. 4.
1879. *Calamites ramosus* Artis, Lesquereux, Coal Flora, Atlas, p. 1, pl. i, fig. 2; text, vol. i (1880), p. 22.
1882. *Calamites ramosus* Artis, Renault, Cours. bot. foss., vol. ii, p. 163, pl. xxiv, figs. 8, 9.
1884. *Calamites ramosus* Artis, Lesquereux, Coal Flora, vol. iii, p. 702, pl. xcii, figs. 1–4.
1886. *Calamites ramosus* Artis, Zeiller, Fl. foss. Valenciennes, Atlas, pl. lv, fig. 3; pl. lvi, fig. 3; text (1888), p. 345.
1887. *Calamites ramosus* Artis, Stur, Cal. Schatzlar. Sch., p. 96, pl. xii, figs. 1–6; pl. xii*b*; pl. xiii, figs. 1–9; pl. xiv, figs. 3–5; text figs. 1, 2, 28, 29, 31, 32.
1888. *Calamites ramosus* Artis, Toula, Die Steinkohlen, p. 205, pl. v, fig. 24.
1851. *Calamites communis* Ettingshausen (pars), Beitr. Fl. Vorw., p. 73 (ex parte syn.).
1877. *Calamites nodosus* Schloth., Lebour, Illustr., pls. ii, iii.
1884. *Calamites* (*Eucalamites*) *ramosus* Artis, Weiss, Steink.-Cal., vol. ii, p. 98, pl. ii, fig. 3; pl. v, figs. 1, 2; pl. vi; pl. vii, figs. 1, 2; pl. viii, figs. 1, 2, 4; pl. ix, fig. 1; pl. x, fig. 1; pl. xx, figs. 1, 2.
1886. *Calamites* (*Eucalamites*) *ramosus* Artis, Kidston, Foss. Pl. Lanarksh., p. 51.
1893. *Calamites* (*Eucalamites*) *ramosus* Artis, D. White, Bull. U. S. Geol. Surv., no. 98, p. 17.
1887. *Eucalamites* (*Calamites*) *ramosus* (Artis) Kidston, Foss. Fl. Radstock Ser., p. 341.
1889. *Eucalamites* (*Calamites*) *ramosus* (Artis) Kidston, Foss. Pl. Ravenhead coll., p. 400.
1888. *Eucalamites ramosus* (Artis) Kidst., Schenk, Die foss. Pflanzenr., p. 125.
FOLIAGE AND FRUCTIFICATION: see *Annularia ramosa* Weiss (*Calamostachys ramosa* Weiss).

[1] Proc. Yorksh. Geol. Polytech. Soc., vol. xii, 1893, pt. iv, pp. 279–293, pls. xiv–xv.

But little appears to have been added to our knowledge of this interesting and relatively well-known species since the preparation of the review of its status in my report on the flora of the outlying Carboniferous basins of southwestern Missouri.[1]

Both stems and branches (*Annularia ramosa*) of this species are not rare in the collections. The examples from Owen's bank and Deepwater seem to present the general characters of the species, though the branch scars, of which there is one at nearly every node, are usually small, and are occasionally accompanied by still smaller cicatrices at some of the joints. The thin scale of carbonaceous matter shows the woody zone to have been thin. The fluting, which appears less distinct on the outside of the carbonaceous residue, is nearly obliterated from the cast of the pith in several greatly compressed specimens. It should be remarked that the ribs, which are rather less sharply defined than usual in this species, are finely striate throughout.

Localities.—Deepwater, U. S. Nat. Mus., 5421; Owen's bank, U. S. Nat. Mus., 5420; Gilkerson's Ford, U. S. Nat. Mus., 5419.

CALAMITES SUCKOWII Brongn.

1828. *Calamites Suckowii* Brongniart, Hist. vég. foss., p. 124, pl. xiv, fig. 6; pl. xv, figs. 1–6; pl. xvi.
1835. *Calamites Suckowii* Brongn., Bronn, Lethæa Geogn., vol. i, 2, p. 18, pl. vi, figs. 1*a*–*b*.
1835. *Calamites Suckowii* Brongn., Gutbier, Abdrücke, p. 17, pl. ii, figs. 1, 2, 1*a*.
1842. *Calamites Suckowii* Brongn., Kutorga, Beitr. Pal. Russl., p. 5, pl. ii, fig. 1.
1845. *Calamites Suckowii* Brongniart, in Murchison, Verneuil, and Keyserling: Géol. d. l. Russie, vol. ii, 3, p. 11, pl. D, figs. 1*a*, 1*b*.
1848. *Calamites Suckowii* Brongn., Sauveur, Vég. foss. terr. houill. Belgique, pl. iii, pl. iv, pl. xi, fig. 3.
1850. *Calamites Suckowii* Brongn., Mantell, Pictorial Atlas, p. 47, pl. vi, figs. 1, 2.
1855. *Calamites Suckowii* Brongn., Geinitz, Verst. Steink. Sachsen, p. 6, pl. xiii, figs. 1–3, 5, 6 (?).
1855. *Calamites Suckowii* Brongn., Phillips, Man. Geol., p. 235, fig. 112.
1865. *Calamites Suckowii* Brongn., Heer, Urwelt Schweiz, p. 8, fig. 5*a*.
1869. *Calamites Suckowii* Brongn., Schimper, Traité, vol. i, p. 312 (excl. syn.) (pl. xviii, fig. 1 ?).
1869. *Calamites Suckowii* Brongn., von Roehl, Foss. Fl. Steink. Westphalens, p. 9, pl. i, fig. 6; pl. ii, fig. 2.
1871. *Calamites Suckowii* Brongn., Weiss, Foss. Fl. Saar-Rh. Geb., p. 117, pl. xiii, fig. 5.
1872. *Calamites Suckowii* Brongn., Balfour. Palæont. Bot., p. 57, fig. 45*a*.

[1] Bull. U. S. Geol. Surv., No. 98, 1893, pp. 17–25.

1874. *Calamites Suckowii* Brongn., O. Feistmantel, Verst. böhm. Kohlenabl., vol. i, p. 102, pl. ii, figs. 3, 4; pl. iii, figs. 1, 2; pl. iv, figs. 1, 2; pl. v, fig. 1.
1876. *Calamites Suckowii* Brongn., Weiss, Steinkohlen-Cal., vol. i, p. 123, pl. xix, fig. 1.
1877. *Calamites Suckowii* Brongn., Grand 'Eury, Fl. carb. Loire, p. 14, pl. i, figs. 1–4.
1878. *Calamites Suckowii* Brongn., Dawson, Acad. Geol., 3d ed., p. 442, fig. 163A, [illegible], p. 195, fig. 39.
1879. *Calamites Suckowii* Brongn., Zeiller, Vég. foss. terr. houill., p. 12, pl. clix, fig. 1.
1879. *Calamites Suckowii* Brongn., Heer, Urwelt Schweiz, 2d ed., p. 15, fig. 17*a*.
1879. *Calamites Suckowii* Brongn., Rothpletz, Abh. Schweiz, pal. Gesell., vol. vi, no. 4, p. 2, pl. ii, figs. 1, 2.
1879. *Calamites Suckowii* Brongn., Lesquereux, Coal Flora, Atlas, pl. i, fig. 3 (4?); text, vol. i (1880), p. 20.
1880. *Calamites Suckowii* Brongn., Ferd. Roemer, Leth. Geogn., Pal., p. 142, pl. l, fig. 1.
1880. *Calamites Suckowii* Brongn., Schimper, in Zittel: Handb. Pal., vol. ii, p. 164, fig. 124, *a*, *b*.
1880. *Calamites Suckowii* Brongn., Dawson, Chain of Life, p. 104, fig. 96*a*.
1881. *Calamites Suckowii* Brongn., Weiss, Aus d. Fl. d. Steink., p. 9, pl. vii, fig. 43.
1882. *Calamites Suckowii* Brongn., Renault, Cours bot. foss., vol. ii, p. 159, pl. xxiv, figs. 3, 4, 5, 6.
1882. *Calamites Suckowii* Brongn., Twelvetrees, Quart. Journ. Geol. Soc. Lond., vol. xxxviii, p. 495, pl. xx, fig. 3.
1883. *Calamites Suckowii* Brongn., Lapparent, Géol., p. 735, fig. 275.
1883. An *Calamites Suckowii* Brongn., Lesquereux, 13th Rept. Geol. Surv. Indiana, pl. v, fig. 5?
1884. *Calamites Suckowii* Brongn., Weiss, Steinkohlen-Cal., vol. ii, p. 129, pl. ii, fig. 1; pl. iii, figs. 2, 3; pl. iv, fig. 1; (pl. xxvii, fig. 3 ?).
1886. *Calamites Suckowii* Brongn., Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. liv, figs. 2, 2*a*, 3; pl. lv, fig. 1; text (1888), p. 333.
1887. *Calamites Suckowii* Brongn., Stur, Calamar. d. Carbon-Fl., p. 145, pl. iii, figs. 3, 4; pl. v, figs. 5, 6; (pl. ix, fig. 2 ?); pl. xiv, fig. 1; (pl. xvi, fig. 1 ?).
1887. *Calamites Suckowii* Brongn., Credner, El. Geol., p. 471, fig. 236*c*.
1888. *Calamites Suckowii* Brongn., Toula, Die Steinkohlen, p. 202, pl. v, figs. 1, 2, 9.
1888. *Calamites Suckowii* Brongn., Renault, Pl. foss., p. 185, fig. 12.
1888. *Calamites Suckowii* Brongn., Dawson, Geol. Hist. Pl., p. 123, fig. 46*a*; p. 124, figs. 49 *a–c*.
1889. *Calamites Suckowii* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 105, text fig.
1889. *Calamites Suckowii* Brongn., Miller, N. Amer. Geol. Pal., p. 110, fig. 20.
1890. *Calamites Suckowii* Brongn., Grand 'Eury, Géol. pal. Gard., p. 216, pl. iii, fig. 24; pl. xvii, fig. 3.
1890. *Calamites Suckowii* Brongn., Renault, Fl. foss. Commentry, vol. ii, p. 385, pl. xliii, figs. 1–3; pl. xliv, figs. 4, 5.
1890. *Calamites Suckowii* Brongn., Saporta, Rév. gén. bot., vol. 1, p. 584, pl. xxv, figs. 1, 1*a*, 1*b*.
1833. An *Calamites cannæformis* Schloth., Lindley and Hutton, Foss. Fl., vol. i, p. 217; pl. lxxix?
1877. An *Calamites cannæformis* Schloth., Lebour, Illustr., pl. 1?
1833. An *Calamites*—base of stem, Lindley and Hutton, Foss Fl., vol. ii, p. 39, pl. xcvi?

1848. *Calamites Artisii* Sauveur [non (Goepp.) Ett.], Vég. foss. terr. houill. Belgique, pl. vii, fig. 1 (2?).
1848. *Calamites nodosus* Schloth. (non Stb.), Sauveur, Vég. foss. terr. houill. Belgique, pl. xii, fig. 3.
1851. *Calamites communis* Ettingshausen, Beitr. Fl. Vorw., p. 73 (ex parte syn.).
1882. *Calamites irregularis* Achepohl (non Kutorga), Niederrh.-Westfäl. Steink., pt. 6, p. 89, pl. xxviii, fig. 2.
1884. *Calamites* (*Stylocalamites*) *Suckowii* Brongn., Weiss, Steinkohlen-Cal., vol. ii, Atlas, pl. ii, fig. 1; pl. iii, figs. 2, 3; (pl. iv, fig. 1?); pl. xvii, fig. 3.
1884. *Stylocalamites Suckowii* (Brongn.) Weiss, Steinkohlen-Cal., vol. ii, Atlas, pl. ii, fig. 1; pl. iii, figs. 1, 3; pl. xxvii, fig. 3.
1887. *Stylocalamites Suckowii* (Brongn.) Weiss, Kidston, Foss. fl. Radstock Ser., p. 342.
1820. An *Calamites decoratus* Schloth. (non Eichwald), Petrefactenkunde, p. 401?
1822. An *Calamites decoratus* Schloth., Brongniart, Mém. mus. hist. nat., vol. viii, p. 217, pl. xii, fig. 2?
1825. An *Calamites decoratus* Schloth., Artis, Antedil. Phytol., pl. xxiv?
1828. An *Calamites decoratus* Schloth., Brongniart, Hist. vég. foss., p. 123, pl. xiv, figs. 1–5?
1828. An *Calamites decoratus* Schloth., Bronn, in Bischoff: Krypt. Gewächse, p. 60, pl. vi, fig. 11?
1850. An *Calamites decoratus* Schloth., Mantell, Pictorial Atlas, p. 51, pl. xvii?
1854. An *Calamites decoratus* Schloth., Mantell, Med. Creation, 2d ed., p. 107, figs. $14_{1,2}$?
1861. An *Calamites decoratus* Schloth., Lesquereux, Geol. Surv. Kentucky, vol. iv, p. 435 (pl. iii, fig. 4, not published)?
1897. An *Calamites* typ. *Suckowii* Brongn., Potonié, Lehrb. d. Pflanzenpal., p. 192, figs. 188, i, ii; p. 193, fig. 189?

This species, reported by Professor Lesquereux from Henry County, Missouri, is represented in the collections before me by a single long fragment. While the characters of the ribs and rib cicatrices seem to agree with those of the ordinary specimens of the species, the ramification, noticed at intervals of every two or three nodes, appears to be more profuse, perhaps, than the European form.

The carbonaceous residue of the vascular tissue constitutes a very thin, filmy pellicle, and seems to indicate for this species a very thin-walled structure, possibly approaching the living type of *Equisetum*. It is probable that some of the thick-walled or more Calamodendroid specimens referred in this country to this species are really more closely related to *C. varians* and other species. The thin tissue of *C. Suckowii* has been especially emphasized by the late Marquis Saporta.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5425.

CALAMITES CISTII Brongn.

1828. *Calamites Cistii* Brongniart, Hist. vég. foss., p. 129, pl. xx.
1848. *Calamites Cistii* Brongn., Sauveur, Vég. foss. terr. houill. Belgique, pl. xi, fig. 1 (2?); pl. viii, fig. 3; pl. ix, fig. 1.
1853. *Calamites Cistii* Brongn., Marcou, Geol. Map N. Amer., p. 38, pl. v, fig. 1.
1855. *Calamites Cistii* Brongn., Geinitz, Verst. Steink. Sachsen, p. 7, pl. xi, fig. 7 (8?); pl. xii, fig. 4 (5?); pl. xiii, fig. 7.
1865. *Calamites Cistii* Brongn., Heer, Urwelt Schweiz, p. 8, fig. 4*a* (*b*?).
1869. *Calamites Cistii* Brongn., Schimper, Traité, vol. 1, p. 313, Atlas (1874) (pl. xviii, fig. 3 ?).
1871. *Calamites Cistii* Brongn., Dawson, Rept. Geol. Struct. P. E. I., p. 44, pl. ii, figs. 10, 11.
1876. *Calamites Cistii* Brongn., Heer, Fl. Foss. Helv., p. 47, pl. xx (figs. 1, 2, 4?), 3.
1877. *Calamites Cistii* Brongn., Grand 'Eury, Fl. carb. Loire, p. 19, pl. ii, figs. 1, 2, 3.
1878. *Calamites Cistii* Brongn., Dawson, Acad. Geol., 3d ed., p. 442, fig. 163B; p. 194 (fig. 38?).
1879. *Calamites Cistii* Brongn., Heer, Urwelt Schweiz, 2d ed., p. 15, figs. 16*a–b*.
1879. *Calamites Cistii* Brongn., Lesquereux, Coal Flora, Atlas, p. 1, pl. i, fig. 6; text, vol. i (1880), p. 27.
1880. *Calamites Cistii* Brongn., Rothpletz, Abh. Schweiz. pal. Gesell., vol. vi, no. 4, p. 3, pl. ii, fig. 3.
1880. *Calamites Cistii* Brongn., Dawson, Chain of Life, p. 104, fig. 96B.
1882. *Calamites Cistii* Brongn., Renault, Cours bot. foss., vol. ii, p. 162, pl. xxiv, fig. 7.
1883. *Calamites Cistii* Brongn., Lesquereux, 13th Rept. Geol. Surv. Indiana, p. 40, pl. v, fig. 4.
1886. *Calamites Cistii* Brongn., Sterzel, Fl. Rothl. n.-w. Sachsen, p. 12 (pl. i, fig. 8?); pl. ii (figs. 1?, 2?) 3; (pl. iii, fig. 1; pl. vii, fig. 2?).
1886. *Calamites Cistii* Brongn., Zeiller, Fl. foss. Valenciennes, Atlas, pl. lvi, figs. 1, 2; text (1888), p. 342.
1887. *Calamites Cistii* Brongn., Credner, El. Geol., 6th ed., p. 472, fig. 233*b*.
1888. *Calamites Cistii* Brongn., Dawson, Geol. Hist. Pl., p. 123, fig. 46B (fig. 48?).
1889. *Calamites Cistii* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 104, text fig.
1890. *Calamites Cistii* Brongn., Renault, Fl. foss. houill. Commentry, vol. ii, p. 389, pl. xliii, fig. 4; pl. xliv. figs. 1, 2; pl. lvii, fig. 4.
1890. *Calamites Cistii* Brongn., Grand 'Eury, Géol. pal. Gard., p. 217, pl. xv, fig. 1 (2?).
1891. *Calamites Cistii* Brongn.,Raciborski, Permokarb. Fl., p. 13, pl. i (fig. 1?), (fig. 2?).
1835. *Calamites tuberculosus* Gutbier, Abdrücke, p. 24, pl. ii, figs. 4, 14; pl. iiiA, fig. 4.
1843. An *Calamites Durrii* Gutbier Mss., in Neumann, Cotta, Geinitz, et al.: Gaea v. Sachsen, p. 69?
1849. An *Calamites Durrii* Gutbier, Verst. Rothl. Sachsen, p. 8, pl. i, fig. 6?
1849. An *Calamites leioderma* Gutbier, Verst. Rothl. Sachsen, p. 8, pl. i, fig. 5?
1864. An *Calamites leioderma* Gutb., Goeppert, Foss. Fl. perm. Form., p. 34, pl. iii, fig. 1?
1851. *Calamites communis* Ettingshausen, Beitr. Fl. Vorw., p. 73 (ex parte syn.).
1854. *Calamites tenuifolius* Ettingshausen, Foss. Fl. Radnitz, p. 27 (pars), pl. iii, fig. 4.
1862. *Calamites infractus* Gutb. var. *leioderma* (Gutbier) Geinitz, Nachtr. z. Dyas, vol. ii, p. 135, pl. xxv, fig. 3.

The characters of this species, including the very thin vascular zones, the rarity of rameal cicatrices, the long internodes, the low, narrow, obtusely keeled ribs bearing elongated scars at the upper ends and obscure or punctiform cicatrices at the lower extremities, and the shallow furrows, clearly striate, are so clear and diagnostic in the material at hand as to leave no doubt as to its identity with the species described by Brongniart from the Northern Anthracite field in Pennsylvania. The vascular arrangement at the nodes is remarkably clear, considering that the stems are compressed somewhat in a shale matrix.

In this country *Calamites Cistii* seems to have been slightly confused with several forms possibly referable to *C. nodosus* Schloth. or *C. varians*. The species probably appeared in the upper beds of the Pottsville, and was perhaps in its typical phase during the Lower Coal Measures, or Alleghany series. Although it has been published by several authors from the Permian, an inspection of the figures gives the idea that the younger forms depart considerably from the normal type. Possibly it would be proper to place these Permian specimens, with much greater proportionate breadth of rib, and with varying nodal diameter and lax aspect of the stem, under a separate varietal or specific name, which might at least be of some stratigraphic value. Illustrations of this phase are given by Raciborski,[1] Sterzel,[2] and Gutbier. The *Calamites infractus*, and *leioderma* of Gutbier appear to be closely related to these, although they are frequently inscribed as synonyms of *Calamites Cistii*.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5424.

ASTEROPHYLLITES Brongniart, 1822.

1822. *Asterophyllites* Brongniart, Mém. mus. hist. nat., vol. viii, p. 210 (pars).
1828. *Asterophyllites* Brongniart, Prodrome, p. 159.
1820. *Casuarinites* Schlotheim, Petrefactenkunde, p. 397 (pars).
1823. *Schlotheimia* Sternberg, Versuch, vol. i, fasc. 2, p. 32.
1823. *Myriophyllites* Sternberg, Versuch, vol. i, fasc. 3, p. 39 (pars).
1826. *Bornia* Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxviii (pars).
1826. *Brukmannia* Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxix (pars).
1826. *Bechera* Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxx (pars).
1836. *Hippurites* Lindley and Hutton, Foss. Fl., vol. iii, p. 105 (pars).
1869. *Calamocladus* Schimper, Traité, vol. i, p. 323.
1880. *Asterophyllum* Schimper, in Zittel: Hand. Pal., vol. ii, p. 175.

[1] Permokarb. Fl., 1891, p. 13 (365), pl. v, figs. 1, 2.
[2] Foss. Fl. Rothl. n.-w. Sachsens, 1886, p. 12, pl. i, fig. 8; pl. ii; pl. iii; pl. vii.

ASTEROPHYLLITES EQUISETIFORMIS (Schloth.) Brongn.

Pl. LIX, Fig. 1*c*.

1720. *Equisetum minimum*, etc., Mylius, Memorabilia Sax. Subterr., p. 30, pl. xix, fig. 12.
1720. *Polygonum fœmina*, etc., Mylius, Memorabilia Sax. Subterr., p. 30, pl. xix, fig. 7.
1720. *Equisetum majus*, etc., Mylius, Memorabilia Sax. Subterr., p. 30, pl. xix, figs. 3, 5.
1723. *Equisetum palustre*, etc., Scheuchzer, Herb. Dil., pl. i, fig. 3; pl. ii, fig. 1.
1723. *Equisetum diluvianum* Scheuchzer, Herb. Dil., pp. 15, 70, pl. i, fig. 5.
1804. ——— ——— Schlotheim, Fl. d. Vorw., pl. i, fig. 2; pl. ii, fig. 3.
1820. *Casuarinites equisetiformis* Schlotheim, Petrefactenk., p. 397.
1825. *Bornia equisetiformis* (Schloth.) Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxviii.
1841. *Bornia equisetiformis* (Schloth.) Sternb., Steininger, Geogn. Beschr., Nachtr., p. 12, fig. 13.
1828. *Asterophyllites equisetiformis* (Schloth.) Brongniart, Prodrome, p. 159.
1837. *Asterophyllites equisetiformis* (Schloth.) Brongn., Germar, Isis, col. 428, pl. ii, fig. 3.
1841. *Asterophyllites equisetiformis* (Schloth.) Brongn., Hitchcock, Geol. Massachusetts, vol. ii, p. 541, pl. xxi, fig. 2.
1845. *Asterophyllites equisetiformis* (Schloth.) Brongn., Germar, Verst. Steink. Wettin u. Löbejün, p. 21, pl. viii.
1846. *Asterophyllites equisetiformis* (Schloth.) Brongn., Teschemacher, Foss. Veg. Amer., p. 380.
1855. *Asterophyllites equisetiformis* (Schloth.) Brongn., Geinitz, Verst. Steink. Sachsen, p. 8, pl. xvii, fig. 1.
1858. *Asterophyllites equisetiformis* (Schloth.) Brongn., Lesquereux, Rept. Geol. Surv. Kentucky, vol. iv, p. 436, pl. iv, figs. 1, 1*a*.
1864. *Asterophyllites equisetiformis* (Schloth.) Brongn., Goeppert, Foss. Fl. perm. Form., p. 36, pl. i, fig. 3.
1869. *Asterophyllites equisetiformis* (Schloth.) Brongn., von Roehl, Foss. Fl. Steink. Westphalens, p. 22, pl. iii, fig. 5.
1871. *Asterophyllites equisetiformis* (Schloth.) Brongn., O. Feistmantel, Steinkohlenf. Kralup, p. 17, pl. i, fig. 1.
1871. *Asterophyllites equisetiformis* (Schloth.) Brongn., Weiss, Foss. Fl. jüngst. Steink. u. Rothl., p. 126 (pl. xii, fig. 2?).
1873. *Asterophyllites equisetiformis* (Schloth.) Brongn., O. Feistmantel, Zeitschr. deutsch. geol. Gesell., vol. xxv, p. 471 (pl. xiv, fig. 6?).
1874. *Asterophyllites equisetiformis* (Schloth.) Brongn., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 116, pl. x, figs. 1, 2; pl. xi; pl. xii, fig. 2.
1876. *Asterophyllites equisetiformis* (Schloth.) Brongn., Heer, Fl. Foss. Helv., p. 48, pl. xix, figs. 1, 2.
1876. *Asterophyllites equisetiformis* (Schloth.) Brongn., Ferd. Roemer, Leth. Geogn., Pal., pl. l, fig. 4; text (1880), p. 146.
1879. *Asterophyllites equisetiformis* (Schloth.) Brongn., Saporta, Monde d. Plantes, p. 175, fig. 11, *3*, *4*.
1879. *Asterophyllites equisetiformis* (Schloth.) Brongn., Zeiller, Vég. foss. terr. houill., p. 19, pl. clix, fig. 3.

1879. *Asterophyllites equisetiformis* (Schloth.) Brongn., Heer, Urwelt Schweiz, 2d ed., p. 16, fig. 19.
1879. *Asterophyllites equisetiformis* (Schloth.) Brongn., Lesquereux, Coal Flora, Atlas, p. 1, pl. ii, figs. 3, *3a;* pl. iii, figs. 5–7; text, vol. i (1880), p. 35.
1881. *Asterophyllites equisetiformis* (Schloth.) Brongn., Weiss, Aus d. Fl. d. Steink., p. 9, pl. ix, fig. 45.
1882. *Asterophyllites equisetiformis* (Schloth.) Brongn., Renault, Cours bot. foss., vol. ii, p. 122, pl. xviii, fig. 1; pl. xix, fig. 3.
1883. *Asterophyllites equisetiformis* (Schloth.) Brongn., Schenk, in Richthofen: China, vol. iv, p. 235, pl. xxxvii, figs. 2, 3.
1883. *Asterophyllites equisetiformis* (Schloth.) Brongn., Lesquereux, 13th Rept. Geol. Surv. Indiana, pl. vi, figs. 1, 2.
1886. *Asterophyllites equisetiformis* (Schloth.) Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lviii, figs. 1–7; text (1888), p. 368.
1888. *Asterophyllites equisetiformis* (Schloth.) Brongn., Toula, Die Steinkohlen, p. 205, pl. v, fig. 27.
1888. *Asterophyllites equisetiformis* (Schloth.) Brongn., Renault, Pl. foss., p. 202, fig. 15.
1889. *Asterophyllites equisetiformis* (Schloth.) Brongn., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 46, text fig.
1890. *Asterophyllites equisetiformis* (Schloth.) Brongn., Renault, Fl. foss. houill. Commentry, vol. ii, p. 409, pl. xlviii, figs. 3, 4, 5.
1893. *Asterophyllites equisetiformis* (Schloth.) Brongn., Grand 'Eury, Géol. pal. houill. Gard., pp. 156, 173, pl. xvii, fig. 4.
1893. *Asterophyllites equisetiformis* (Schloth.) Brongn., Potonié, Fl. Rothl. Thüringen, p. 176, pl. xxiv, fig. 8.
1899. *Asterophyllites equisetiformis* (Schloth.) Brongn., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 513.
1836. *Hippurites longifolia* Lindley & Hutton, Foss. Fl., vol. iii, pls. cxc, cxci.
1844. *Asterophyllites Neumannianus* Goeppert, in Wimmer: Fl. v. Schlesien, vol. ii, p. 199.
1848. *Asterophyllites Lindleyanus* Goeppert, in Bronn: Index Pal., p. 122.
1851. *Calamites Cistii* Brongn., Ettingshausen, Fl. d. Vorw., p. 75 (ex parte syn.).
1865. *Calamites Cistii* Brongn., Heer, Urwelt Schweiz, p. 8, fig. 4c.
1855. *Asterophyllites grandis* L. & H., Geinitz, Verst. Steink. Sachsen, pl. xvii, fig. 5.
1855. *Calamites equisetiformis* (Schloth.) Ettingshausen, Steinkohlenfl. Radnitz, p. 28.
1869. *Calamocladus equisetiformis* (Schloth.) Schimper, Traité, vol. 1, p. 324, pl. xx, figs. 1–3, 4.
1898. *Calamocladus equisetiformis* (Schloth.) Schimp., Seward, Foss. Plants, vol. 1, p. 334, fig. 87.
1869. *Annularia calamitoides* Schimper, Traité, vol. 1, p. 349, pl. xxii, fig. 4.
1876. *Calamocladus binervis* Boulay, Terr. houill. nord Fr., p. 22, pl. ii, fig. 1.
1876. *Calamostachys germanica* Weiss, Steinkohlen Cal., vol. 1, p. 47, pl. xvi, figs. 3, 4.
1883. *Calamostachys germamica* Weiss, Schenk, in Richthofen: China, vol. iv, p. 233, pl. xxxvi, fig. 5.
1878. *Calamostachys equisetiformis* (Schloth.) [Bigsby?], Bigsby, Thesaurus Dev.-carb., p. 145.
1880. *Asterophyllum equisetiformis* (Schloth.) Schimper, in Zittell: Handb. Pal., vol. ii, pp. 174, 175, fig. 131.
1881. *Asterophyllites annularioides* Crepin, in Mourlon: Géol. Belgique, vol. ii, p. 59.

There are in the collections but a few fragments referable to this species, which must have been relatively rare in this region at the time of the deposition of the lower coals. Two or three of the fragments are, by the marked obliquity of the very narrow leaves, the short nodes, and the general delicacy of form, closely related to *Asterophyllites erectifolius* Andr. This phase of *A. equisetiformis* is not rare in the Appalachian Basin, where it is found near the base of the Productive Coal Measures, or Alleghany series. The leaves on a branch 2 mm. wide are more than three times the length of the internode, which is about 4 mm.

From the habit of some of the larger stems I am strongly inclined to believe that some of the segments of large stems referred by authors to *A. longifolius* or *A. rigidus* may be merely portions of the main stems or principal branches of *A. equisetiformis.*

The Lacoe collection in the United States National Museum contains a fine example (No. 7689) of the latter species from Cannelton, Pennsylvania, in which we see a stem segment 43 cm. long, 17 mm. wide at the lower end, and 10 mm. wide at the top, provided with 14 verticils of branches. Four, and sometimes five, branches, the longest of which is not over 12 cm., can be seen at nearly every node. The surface is nearly smooth, being only minutely lineate where decorticated, and is much smoother where the carbonaceous material remains intact. It is worthy of mention that, notwithstanding the size of the stem, the leaves on the latter are not over 1.5 cm. in length. In this respect it differs much from certain specimens from Mazon Creek ascribed by Professor Lesquereux to this species, as well as from that figured under the same name by Von Roehl.[1]

It is possible that the distinctions between the different species of *Asterophyllites* have not in numerous cases been consistently established or followed.

Localities.—Gilkerson's Ford; Owen's coal bank, U. S. Nat. Mus., 5423.

ASTEROPHYLLITES LONGIFOLIUS (Stb.) Brongn.

Pl. XLIX, Figs. 2–4.

1825. *Brukmannia longifolia* Sternberg, Versuch, vol. i, tent., p. xxix, fasc. 4, pl. lviii, fig. 1.
1828. *Asterophyllites longifolius* (Stb.) Brongniart, Prodrome, p. 159.

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[1] Foss. Fl. Steinkohlenf. Westphalens, pl. iii, fig. 5.

1832. *Asterophyllites longifolius* (Stb.) Brongn., Lindley and Hutton, Foss. Fl., vol. i, pl. xviii.
1855. *Asterophyllites longifolius* (Stb.) Brongn., Geinitz, Verst. Steink. Sachsen, p. 9, pl. xviii, figs. 2, 3.
1869. *Asterophyllites longifolius* (Stb.) Brongn., Von Roehl, Foss. Fl. Steink. Westphalens, p. 25, pl. iv, fig. 16; (pl. xii fig. 1c?).
1874. *Asterophyllites longifolius* (Stb.) Brongn., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 123, pl. xiv, fig. 6; pl. xv, fig. 1.
1876. *Asterophyllites longifolius* (Stb.) Brongn., Heer, Fl. Foss. Helv., p. 50 (pl. xix, fig. 3?).
1876. *Asterophyllites longifolius* (Stb.) Brongn., Weiss, Steink.-Cal., vol. i, p. 50, pl. x, figs. 1, 2, 3.
1881. *Asterophyllites longifolius* (Stb.) Brongn., Weiss, Aus d. Fl. d. Steink., pl. ix, fig. 46.
1886. *Asterophyllites longifolius* (Stb.) Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lix, fig. 3; text (1888), p. 374.
1890. *Asterophyllites longifolius* (Stb.) Brongn., Renault, Fl. foss. houill. Commentry, vol. ii, p. 415, pl. xlvii, fig. 4; pl. xlviii, figs. 1, 6.
1893. *Asterophyllites longifolius* (Stb.) Brongn., Potonié, Fl. Rothl. Thüringen, p. 178, pl. xxxiii, fig. 4.
1848. *Asterophyllites elegans* Sauveur, Vég. foss. terr. houill. Belgique, pl. lxviii, fig. 1.
1851. *Calamites tenuifolius* (Stb.) Ettingshausen, Beitr. Fl. Vorw., p. 76 (syn.).
1854. *Calamites tenuifolius* (Stb.) Ettingshausen, Steinkohlenfl. Radnitz, p. 27 (pl. ii, fig. 1?).
1869. *Calamocladus longifolius* (Stb.) Schimper, Traité, vol. i, p. 323.
1886. *Calamocladus longifolius* (Stb.) Schimp., Kidston, Cat. Pal. Pl. Brit. Mus., p. 41.
1876. *Asterophyllites* cf. *rigidus* (Stb.) Brongn., Weiss, Steinkohlen-Cal., vol. i, pl. xii, fig. 1B.
1876. *Calamostachys* sp. Weiss, Steinkohlen-Cal., vol. i, p. 56, pl. xii, fig. 1A.
1876. *Calamostachys longifolius* (Stb.) Weiss, Steinkohlen-Cal., vol. i, p. 50, pl. x, fig. 1.
1884. *Calamostachys longifolius* (Stb.) Weiss, Steinkohlen-Cal., vol. ii, p. 171, pl. xx, fig. 6; pl. xxi, fig. 11.
1886. *Calamostachys longifolius* (Stb.) Weiss, Kidston, Trans. Geol. Soc. Glasgow, vol. iii, p. 54 (pl. iii, fig. 4?).
1879. *Asterophyllites tenuifolius* (Stb.) Brongn., Zeiller, Fl. foss. terr. houill., p. 20.

To this apparently equivocal species I have referred a number of specimens which seem to agree with the descriptions and figures of European examples. The finely but distinctly striated nodes range from 13 to 30 mm. in length, while the leaves, counting 30 to 40 in the verticil, are from one and one-half to three times the length of the internode. The verticils vary greatly in their angle of divergence from the axis, some of them being erect, while others spread out very open, according to the distance from the apex of the branch. The leaves are generally rigid, though curving out from an axis not parallel to the stem, narrow, somewhat rounded or thick in transection, with a strong midrib, which is striate, carinate on the back, and marked on the inner surface by two parallel lines. Where the carbonaceous matter is removed from one of the specimens, broken contiguously to the nodal diaphragm, the leaves, which go out at an angle of about 45° with the stem, seem to be united at the bases in a sheath a little over a millimeter in width.

The occurrence of *Asterophyllites longifolius* at the coal banks near Clinton has already been recorded by Professor Lesquereux.[1] But an examination of the specimens from the same localities now in the collections of the United States National Museum reveals several that were identified as *A. rigidus* by the same author. It is clear that confusion exists as to the distinction between these two species in our American material, and it would seem that the differentiation was perhaps not always plain or consistent in the descriptions or figures of the Old World specimens. All the material in both the Museum and the Geological Survey collections from the vicinity of Clinton, appears, in my judgment, like the example shown in Fig. 4, Pl. XLIX, to agree with the *A. longifolius* as figured by Sternberg,[2] Sauveur,[3] or Zeiller,[4] although there is a strong resemblance to the *A. rigidus* illustrated by Lesquereux in the fourth volume of the reports of the geological survey of Illinois, while there are some points in common with the figures of Old World material. Ottokar Feistmantel, who gave more attention than most authors to the species of *Asterophyllites*, explains[5] that *A. rigidus* is distinguished from *A. longifolius* by the shorter internodes, the joints not so swollen, the leaves generally shorter and slightly broader, lying parallel to the stem, a short distance above their bases, and especially characterized by a certain rigidity. Sternberg's type is represented[6] with these characters, though the leaves in his *Brukmannia longifolia*[7] are also soon turned upward, parallel to the axis, and, to judge by his figure, are even more rigid. Mr. Kidston refers the specimen illustrated by Schimper as *Calamostachys typica* in fig. 1, pl. xxiii, of the Atlas to the latter's "Traité,"

[1] Coal Flora, vol. iii, p. 879.
[2] Versuch einer Flora der Vorwelt, vol. i, pl. lviii, fig. 1.
[3] Vég. foss. terr. houill. Belgique, pl. lviii, fig. 1.
[4] Fl. foss. bassin houill. Valenciennes, p. 374, pl. lix. fig. 3.
[5] Verst. böhm. Ablagerungen, vol. i, 1874, pp. 123–125.
[6] Versuch, vol. i, pl. xix, fig. 1.
[7] Op. cit., vol. i, pl. lviii, fig. 1.

von Roehl's figure[1] of *Volkmannia elongata*, and one of the examples[2] identified by Weiss as *Calamostachys Ludwigii* to *Asterophyllites longifolius*. The variation in the size of the strobili and the width of the bracts in the fructifications described under this name furnish another example of the uniformity of the vegetation as compared with the reproductive organs in the *Calamariæ*.

The specimens of *Asterophyllites longifolius* from the mines near Clinton agree fairly well with examples of that species from the Bristol coal field in England.

Localities.—Gilkerson's Ford, U. S. Nat. Mus., 5432; Owen's coal bank, U. S. Nat. Mus., 5423, 5677; Pitcher's coal bank, U. S. Nat. Mus., 5673, 5676.

CALAMOSTACHYS Schimper, 1869.

Traité, vol. i, p. 328.

CALAMOSTACHYS OVALIS Lx.?

1858. Cf. *Asterophyllites ovalis* Lesquereux, in Rogers: Geol. Pennsylvania, vol. ii, p. 851, pl. i, fig. 2.
1884. Cf. *Calamostachys ovalis* Lesquereux, Coal Flora, vol. iii, p. 717 (pl. lxxxix, figs. 3, 4?).

Among the *Calamariæ* in the Lacoe collection in the National Museum is a fragment, No. 8056, from Henry County, Missouri, which was identified by Professor Lesquereux as *Calamostachys ovalis* Lx. The specimen comprises a segment of a compressed spike 45 mm. long and 11 mm. wide, the distinctly ribbed axis being 1.75 mm. wide, with internodes 4 to 5 mm. in length.

The bracts, of which there appear to be between 15 and 20 to the verticil, are slender, narrow, carinate, tapering from near the base to the very slender apex, and are at first somewhat reflexed, then curved outward and slightly upward, although the tip of the bract seldom reaches the height of the next node.

Unfortunately, the fragment does not reveal the mode of arrangement of the sporangia with sufficient clearness to assure one of even its generic relationship. But the entire absence of any trace of scars of the sporangiophores in the middle or upper portions of the internodes, as well as the

[1] Foss. Fl. Steinkohlen-Form. Westphalens, pl. vii, fig. 1.
[2] Steinkohlen-Calamarien, vol. ii, pl. xviii, fig. 2.

appearance of the bases of the internodes and the position occupied by several fragments of sporangia, makes it seem probable that the specimen belongs to the genus *Palæostachya* Weiss As such, it might be compared with *P. pedunculata* Will., although the internodes are rather long for that species.

The inclusion of this fragment in the species bearing the above name is made entirely in deference to the great knowledge and experience of Professor Lesquereux, who seems to have identified it without question as *Calamostachys ovalis*. A comparison of the original figure[1] with the later figures[2] published by him as this species shows two quite different plants; and while the fragment in hand differs much from the specimens from the Pottsville series illustrated in the Coal Flora, it agrees hardly better with the figure of the early type, the internodes being almost twice as long. The precise generic relationship of either of the illustrated plants is hardly determinable from the figures.

Locality.—The specimen comes from the vicinity of Clinton, Henry County, Missouri, No. 8056 of the Lacoe collection, U. S. Nat. Mus.

ANNULARIA Sternberg, 1823.

Versuch einer Flora der Vorwelt, vol. i, fasc. 2, p. 36.

That certain among the Annulariæform types represent foliate parts of some *Calamites* is now generally accepted, the case of *Annularia ramosa* having been amply developed almost simultaneously by both Weiss and Stur. The more recent researches of Dr. Potonié go far in showing the relations of *Annularia* to both the *Equisetum* and Calamodendroid types. As the result of his study of well-preserved material from the Rothliegende of Thüringia, Potonié[3] demonstrates that the leaves of *A. stellata* are joined at their bases in a narrow, spreading sheath, comparable to *Equisetum*, while their superficial structure is in all respects essentially the same as that of the leaves of *Equisetites zeæformis* (Schloth.) Andrä and *Calamites varians* Stb. Moreover, in certain verticils of *Equisetites zeæformis* he finds the leaves

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[1] In Rogers: Geology of Pennsylvania, vol. ii, 1858, pl. i, fig. 2.

[2] Coal Flora, vol. iii, 1884, pl. lxxxix, figs. 3, 4.

[3] Der äussere Bau der Blätter von *Annularia stellata* (Schlotheim) Wood mit Ausblicken auf *Equisetites zeæformis* (Schlotheim) Andrä und auf die Blätter von *Calamites varians* Sternberg: Ber. d. Deutsch. bot. Gesell., vol. x, 1882, p. 561–568. Die Flora des Rothliegenden von Thüringen: Abh. d. k. Preuss. geol. Landesanst., N. F., Hft. 9, Th. ii, 1893, pp. 170, 179.

becoming entirely separated and free as the stems increase in thickness, instead of remaining united in the sheath, thus reproducing on a smaller scale the features seen in foliate portions of *Calamites varians* Stb. (*Calamitina* of Weiss). So close is *A. stellata* to the *Calamites* group that Dr. Potonié appears to regard its relation as branch or twig of some *Calamites* as not very improbable.

Fragments of *Annularia stellata* with leaves still joined to larger stems have been described by Professor Zeiller and Mr. Lacoe.[1]

ANNULARIA RAMOSA Weiss.

1828. *Annularia radiata* Brongn., Prodrome, p. 156 (pars.)
1848. *Annularia radiata* Brongn., Sauveur, Vég. foss. terr. houill. Belg., pl. lxvii, fig. 2.
1855. *Annularia radiata* Brongn., Geinitz, Verst. Steinkohl. Sachsen, p. 11, pl. xviii, figs. 6, 7.
1869. *Annularia radiata* Brongn., von Roehl, Foss. Fl. Steinkohlenf. Westphalens, p. 28, pl. iv, fig. 3.
1874. *Annularia radiata* Brongn., O. Feistmantel, Verst. böhm. Abl., vol. i, p. 130, pl. xvii, figs. 2, 3, 4.
1878. *Annularia radiata* Brongn., Zeiller, Vég. foss. terr. houill., Atlas, pl. clx, fig. 1; text (1879), p. 24.
1886. *Annularia radiata* Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lix, fig. 8; pl. lxi, figs. 1, 2; text (1888), p. 394.
1877. An *Calamites nodosus* Schloth., Lebour, Illustr., pl. iii?
1881. *Annularia ramosa* Weiss, N. Jahrb. f. Min., vol. ii, Brief., p. 273.
1884. *Annularia ramosa* Weiss, Steinkohlen-Cal., vol. ii, p. 98, pl. v, figs. 1, 2; pl. vi, figs. 1–7; pl. x, fig. 1; pl. xx, figs. 1, 2.
1893. *Annularia ramosa* Weiss, D. White, Bull. U. S. Geol. Surv., No. 98, p. 17.
1887. *Annularia ramosa* Weiss, Stur, Calamar. Schatzlar. Sch., p. 106, pl. xii*b*, figs. 2, 3, 4, 6; pl. xiii, figs. 1, 3–9; pl. xiv, figs. 3–5.
1886. *Calamites* (*Eucalamites*) *ramosus* Artis, Kidston, Foss. Pl. Lanarksh., p. 51, pl. iii, fig. 1.

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1884. *Calamites* (*Eucalamites*) *ramosus* Artis, Weiss, Steinkohlen-Cal., vol. ii, p. 98, pl. v, fig. 2; pl. vi, figs. 2, 3, 4, 6, 7; pl. xx, figs. 1, 2.
1884. *Calamostachys ramosa* Weiss, Steinkohlen-Cal., vol. ii, p. 180, pl. xx, figs. 1, 2.
1887. *Calamites ramosus* Artis, Stur, Calamar. Schatzlar. Sch., vol. ii, p. 96, (pl. xii, figs. 5, 6); pl. xii*b*, figs. 2, 3, 4, 6.

Considerable variation is to be found among the leaves of this species, which, as was demonstrated by both Weiss and Stur,[2] includes the foliate

[1] See Zeiller, Fl. foss. bassin houiller de Valenciennes, 1888, p. 399; also Bull. U. S. Geol. Surv., No. 98, 1893, p. 27.

[2] See the résumé on the relations of this species in Bull. U. S. Geol. Surv., No. 98, 1893, p. 23.

branches of *Calamites ramosus.* It is frequently difficult to distinguish it from *Annularia radiata* Brongn., by which name it was formerly usually known. No. 7839 of the Lacoe collection, from Henry County, Missouri, identified by Lesquereux as *Annularia radiata*, appears indistinguishable from the ordinary leaves of this species. It is possible that other species of *Annulariæ* represent the ultimate branches of different species of Calamites.

Locality.—Deepwater, U. S. Nat. Mus., 5460.

ANNULARIA STELLATA (Schloth.) Wood.

Pl. XXIV, Fig. 3*b*.

1699. *Apparinæ densius foliatæ* Luidius, Lithophyl. Brit., p. 12, pl. v, fig. 201.
1723. *Apparinæ densius foliatæ* Scheuchzer, Herb. Diluv., p. 19, pl. iii, fig. 3.
1723. *Galium album vulgare* Tourn., Scheuchzer, Herb. Diluv., p. 63, pl. xiii, fig. 3.
1771. *Galium album latifolium* Rupp., Walch, Naturgesch. Verst., vol. iii, p. 117, pl. ω, fig. 2.
1804. ——— ——— Schlotheim, Flora d. Vorw., pl. i, fig. 4.
1804. *Equisetum?* Parkinson, Organic Rem., p. 428, pl. v, fig. 11.
1809. An *Phytolithus stellatus* Martin, Petrificata Derb., pl. xx, fig. 4?
1820. *Casuarinites stellatus* Schlotheim, Petrifactenkunde, p. 397.
1832. *Casuarinites stellatus* Schlotheim, Merkwürdige Verst., p. 5, pl. i, fig. 4.
1823. *Annularia spinulosa* Sternberg, Versuch, vol. 1, fasc. 2, pp. 28, 32; pl. xx, fig. 4; tent., p. xxxi.
1826. *Bornia stellata* Sternberg, Versuch, tent., p. xxviii.
1826. *Annularia fertilis* Sternberg, Versuch, vol. i, fasc. 4, p. 43, pl. li, fig. 2; tent., p. xxxi.
1837. *Annularia fertilis* Stb., Bronn, Lethæa Geogn., p. 44, pl. viii, fig. 8.
1859. *Annularia fertilis* Stb., Eichwald, Lethæa Rossica, p. 187, pl. xiv, fig. 9.
1828. *Annularia longifolia* Brongniart, Prodrome, p. 156.
1845. *Annularia longifolia* Brongn., Germar, Verst. Wettin u. Löbejün, p. 25, pl. ix, figs. 1–3.
1852. *Annularia longifolia* Brongn., Ettingshausen, Steinkohlenfl. Stradonitz, p. 8, pl. i, fig. 4.
1855. *Annularia longifolia* Brongn., Geinitz, Verst. Steink. Sachsen, p. 10, pl. xix, figs. 3–5.
1866. *Annularia longifolia* Brongn., Lesquereux, Geol. Surv. Illinois, vol. ii, Pal., p. 444.
1869. *Annularia longifolia* Brongn., Schimper, Traité, vol. i, p. 348 (pars), pl. xxii, fig. 5; pl. xxvi, figs. 2, 3, 4.
1869. *Annularia longifolia* Brongn., von Roehl, Foss. Fl. Steink. Westphalens, p. 28, pl. iv, fig. 6.
1870. *Annularia longifolia* Brongn., Unger, Sitzb. Akad. Wiss. Wien, Math.-nat. Cl., vol. lx, 1, p. 783, pl. i, fig. 8.
1874. *Annularia longifolia* Brongn., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 127, pl. xv, fig. 3; pl. xvi, fig. 1.

1876. *Annularia longifolia* Brongn., Ferd. Roemer, Lethaea Geogn., vol. i, Atlas, pl. l, fig. 8; text (1880), p. 150.

1876. *Annularia longifolia* Brongn., Heer, Fl. Foss. Helv., p. 51, pl. xix, figs. 4, 5.

1879. *Annularia longifolia* Brongn., Lesquereux, Coal Flora, Atlas, p. 2, pl. ii, figs. 1, 2, 2*a*; text, vol. i (1880), p. 45.

1881. *Annularia longifolia* Brongn., Lesquereux, Rept. Geol. Surv. Indiana, 1879–80, p. 153, pl. xi, fig. 1.

1882. *Annularia longifolia* Brongn., Renault, Cours bot. foss., vol. ii, p. 126, pl. xx, fig. 1.

1883. *Annularia longifolia* Brongn., Lesquereux, 13th Rept. Geol. Surv. Indiana, pt. 2, p. 44, pl. vii, figs. 1, 2.

1883. *Annularia longifolia* Brongn., Schenk, in Richthofen: China, vol. iv, p. 232, pl. xxxix.

1884. *Annularia longifolia* Brongn., Lacoe, in Lesquereux: Coal Flora, vol. iii, p. 706.

1888. *Annularia longifolia* Brongn., Toula, Die Steinkohlen, p. 205, pl. v, fig. 29.

1889. *Annularia longifolia* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 26, text fig.

1891. *Annularia longifolia* Brongn., Raciborski, Rozpraw. Wydz. mat. przyrod. Akad. Umiej., Krakow., vol. xxi, p. 359, pl. v, figs. 17–19.

1834. *Asterophyllites equisetiformis* (Schloth.) Brongn., Lindley and Hutton, Foss. Fl., vol. ii, pl. 124.

1835. *Equisetum stellifolium* Harlan, Trans. Geol. Soc. Pennsylvania, vol. i, p. 260, pl. xiv, fig. 4.

1836. *Asterophyllites ?* Morton, Am. Jour. Sci., vol. xxix, p. 151, pl. ix, fig. 30.

1840. *Asterophyllites*, Jackson, Rept. Geol. Surv. Rhode Island, 1839, p. 288, pl. vi.

1841. *Annularia*, Hitchcock, Final Rept. Geol. Massachusetts, vol. ii, p. 754, fig. 266, pl. xxii. fig. 3; pl. xxiii, fig. 1 (center).

1860. *Annularia stellata* (Schloth.) Wood, Proc. Acad. Nat. Sci., Phila., vol. xii, p. 236.

1878. *Annularia stellata* (Schloth.) Wood, Zeiller, Vég. foss. terr. houill., Atlas, pl. clx., figs. 2, 3; text (1879), p. 26.

1886. *Annularia stellata* (Schloth.) Wood, Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxi, figs. 4–6; text (1888), p. 398.

1887. *Annularia stellata* (Schloth.) Wood, Kidston, Foss. Fl. Radstock Ser., p. 343.

1887. *Annularia stellata* (Schloth.) Wood, Stur, Calamar. Carbon-Fl., p. 55, pl. xiii*b*, fig. 3.

1890. *Annularia stellata* (Schloth.) Wood, Renault, Fl. foss. houill. Commentry, vol. ii, p. 398, pl. xlv, figs. 1–7; pl. xlvi, figs. 1–6.

1891. *Annularia stellata* (Schloth.) Wood, Raciborski, Permokarb. Fl. Karmiowick. Wapienia, p. 7, pl. v, figs. 17–19.

1892. *Annularia stellata* (Schloth.) Wood, Potonié, Naturw. Wochenschr., vol. vii, no. 51, p. 520, figs. 1, 2.

1893. *Annularia stellata* (Schloth.) Wood, Renault, Fl. Foss. Autun et Épinac, vol. ii, Atlas, pl. xxviii, figs. 1, 3, 5–15; text (1896), p. 67.

1893. *Annularia stellata* (Schloth.) Wood, Potonié, Fl. Rothl. Thüringen, p. 162, pl. xxiv, figs. 1–6.

1893. *Annularia stellata* (Schloth.) Wood, D. White, Bull. U. S. Geol. Surv., No. 98, p. 25.

1896. *Annularia stellata* (Schloth.) Wood, Potonié, Abh. k. Pr. geol. Landesanst.. N. F., Hft. 21, p. 37, fig. 32.
1897. *Annularia stellata* (Schloth.) Wood, Potonié, Lehrb. d. Pflanzenpal., p. 200, fig. 195.
1898. *Annularia stellata* (Schloth.) Wood, Seward, Foss. Pl., vol. i, p. 265, fig. 58D; p. 339, fig. 88.
1868. *Asterophyllites longifolius* (Stb.) Brongn., Binney, Obs. Struct. Foss. Pl. Carb., pt. i, p. 28, pl. vi, fig. 3.
1870. *Annularia* sp. Ferd. Roemer, Geol. v. Oberschlesien, p. 117, pl. ix, fig. 9.
1883. *Annularia mucronata* Schenk, in Richthofen: China, vol. iv, p. 226, pl. xxx, fig. 10.
1887. *Annularia Geinitzii* Stur, Calamar. Schatzlarer Sch., p. 215, pl. xvi*b*, figs. 1, 2, 3.
1888. *Annularia Geinitzii* Stur, Toula, Die Steinkohlen, p. 209, pl. v, fig. 14.
1887. Au *Annularia westphalica* Stur, Calamar. Schatzlarer Sch., p. 213, pl. xiii*b*, fig. 2?
1887. *Asterophyllites westphalicus* Stur, Calamar. Schatzlarer Sch., p. 216, pl. iv*b*, fig. 4.

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1826. *Brukmannia tuberculata* Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxix (Pars?), pl. xlv, fig. 2.
1882. *Bruckmannia tuberculata* Stb., Renault, Cours bot. foss., vol. ii, p. 129, pl. xxi, figs. 1–6 *bis*.
1828. *Asterophyllites tuberculata* (Stb.) Brongniart, Prodrome, p. 159.
1876. *Annularia longifolia* Brongn., Ferd. Roemer, Lethaea Geogn., vol. i, Atlas, pl. l, fig. 9; text (1880), p. 150.
1877. *Annularia longifolia* Brongn., Grand 'Eury, Fl. carb. Loire, p. 44, pl. vi, fig. 4.
1879. *Annularia longifolia* Brongn., Heer, Urwelt d. Schweiz, p. 16, fig. 22.
1879. *Annularia longifolia* Brongn., Lesquereux, Coal Flora, Atlas, pl. iii, fig. 10 (non 11, 12).
1882. *Annularia longifolia* Brongn., Renault, Cours bot. foss., vol. ii, p. 126, pl. xxi, figs. 1–7.
1883. *Annularia longifolia* Brongn., Schenk, in Richthofen: China, vol. iv, p. 232, pl. xxxiv, figs. 4–7; pl. xxxv, fig. 7; pl. xxxvi, figs. 1–4; pl. xxxix; pl. xli, fig. 6.
1876. *Stachannularia tuberculata* (Stb.) Weiss, Steinkohlen-Cal., vol. i, p. 17, pl. i, figs. 2–4; pl. ii, figs. 1–3; pl. iii, figs. 3–10, 12.
1879. *Asterophyllites* fruit, Lesquereux, Coal Flora, Atlas, p. 2, pl. iii, fig. 10.
1884. *Calamostachys tuberculata* (Stb.) Weiss (non Lx.), Steinkohlen-Cal., vol. ii, p. 178.
1886. *Annularia stellata* (Schloth.) Wood, Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxi, figs. 3, 3*a*; text (1888), p. 398.
1890. *Annularia stellata* (Schloth.) Wood, Renault, Fl. foss. houill. Commentry, vol. ii, p. 398, pl. xlv, figs. 1–3; pl. xlvi, figs. 4–6.
1893. *Annularia stellata* (Schloth.) Wood, Sterzel, Fl. Rothl. Plauensch. Grund, p. 99, pl. ix, fig. 9.
1899. *Annularia stellata* (Schloth.) Wood, D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 515 (pl. lxviii, fig. 10?).

An excellent suite of specimens from Henry County represents this species, which is more familiar to geologists as *A. longifolia*. A somewhat extensive summary of its characters was given in my report on the Flora of the Outlying Carboniferous Basins of Southwestern Missouri.[1] In the material from the vicinity of Clinton is a rock on which one fine verticil of this species includes as many as twenty-seven leaves. Another fragment, from Hobbs's bank, contains portions of a plant in which the leaves are nearly 5 cm. in length. The same piece of shale bears a small Lamellibranch, but the valves of the latter are unfortunately crushed too much to admit of its determination. Many of the specimens, especially those from Deepwater, show the mucrons clearly developed at the apices of the shagreened leaves. In some examples the upper surface of the leaves is well arched upward, the midrib being so faint as to suggest the form named *A. inflata* by Professor Lesquereux, but on the under surface of these leaves the midrib is in strong relief. It is possible the rugose or shagreened effect is due to the presence of very short hairs similar to those described by Dr. Potonié. I have not yet been able clearly to discern the transpiration zones noted by Potonié on each side of the central nerve.

In many of the Henry County specimens the leaves present a lax, slightly flexuous habit, suggesting the phase seen in the earliest precursors of the species in the upper part of the Pottsville series. There are also present a number of strobili, some of which are so broken as to show the characters of the axis, the sporangiophores, attached near the middle of the internode, and the sporangia. A description of the fruit, which agrees with the "*Asterophyllites*" figured by Lesquereux in fig. 10, pl. iii, of the Atlas to the Coal Flora, may be found in the above-mentioned report on the flora of the outlying basins of this State.

The systematic relation of *Annularia stellata* has been referred to above in my remarks on the genus *Annularia*.

Localities.—Pitcher's coal bank, U. S. Nat. Mus., 5434, 5436, 5443; Hobbs's coal bank, U. S. Nat. Mus., 5444, 5537, 5586; Owen's coal bank, U. S. Nat. Mus., 5433, 5445; Deepwater, U. S. Nat. Mus., 5442, 5446, 5538; Gilkerson's Ford, U. S. Nat. Mus., 6229.

ANNULARIA STELLATA (Schloth.) Wood var. ANGUSTIFOLIA Lx.?

1884. *Annularia longifolia* var. *angustifolia* Lesquereux, Coal Flora, vol. iii, p. 879 (*nomen nudum*).

1890. *Annularia angustifolia* (Lx.) Hambach, Bull. Geol. Surv. Missouri, No. 1, p. 83.

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[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 25.

Several specimens appear to represent a variation, perhaps of varietal rank, which is presumably that designated by Lesquereux in the list of plants from Henry County, Missouri,[1] as *Annularia longifolia* var. *angustifolia*. The verticils, which have the diameter of the normal type, seem to be rather fewer leaved, the leaves being more slender and tapering from the middle upward to an acute point. The midrib is quite distinct. In form it approaches very close to *A. radiata* Brongn., though really bound by its essential characters to *A. stellata*.

At first I was disposed to regard this form as a case of inrolled margins in the latter species, as indeed seems to be the condition in some of the specimens labeled with the name of this variety in the collections of the United States National Museum; but a more careful examination leads me to the conclusion that the continuance of its varietal distinction may serve a useful purpose. Though somewhat larger, it strongly resembles the figures of *Annularia elegans* given by Grand 'Eury in his most interesting work on the flora of the basin of Gard.[2] The plant listed by Mr. G. Hambach[3] as *Annularia angustifolia* in the enumeration of the Missouri fossil flora is probably this variety.

Localities.—Deepwater, U. S. Nat. Mus., 5448; Pitcher's coal bank, U. S. Nat. Mus., 5447.

ANNULARIA SPHENOPHYLLOIDES (Zenk.) Gutb.

1699. *Rubeola mineralis* Luidius, Lithophyl. Brit., p. 12, no. 202.
1771. *Rubia sylvestris* Volkmann, Walch, Naturgesch. Verst., vol. iii, p. 117, pl. ω, fig. 1.
1804. *Rubia sylvestris* Parkinson, Org. Rem., p. 428, pl. v, fig. 3.
1828. *Annularia brevifolia* Brongniart, Prodrome, p. 156.
1849. *Annularia brevifolia* Brongniart, Tableau, p. 53.
1853. *Annularia brevifolia* Brongn., Newberry, Annals Science, Cleveland, vol. 1, p. 97.
1876. *Annularia brevifolia* Brongn., Heer, Fl. Foss. Helv., p. 51, pl. xix, figs. 6–9.
1880. *Annularia brevifolia* Brongn., Ferd. Roemer, Lethaea Geogn., vol. 1, p. 150, fig. 7.
1880. *Annularia brevifolia* Brongn., Schimper, in Zittel: Handbuch Palæont., vol. ii, p. 167, fig. 127.
1883. *Annularia brevifolia* Brongn., Schenk, in Richthofen: China, vol. iv, p. 233, pl. xl.
1887. *Annularia brevifolia* Brongn., Stur, Calamar. Schatzlar. Sch., p. 223, pl. xvi*b*, figs. 3, 4.
1888. *Annularia brevifolia* Brongn., Toula, Die Steinkohlen, p. 204, pl. v, fig. 14.

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[1] Coal Flora, vol. 3, p. 879.
[2] Géol. pal. bassin houill. Gard, 1890, p. 201, pl. xvii, fig. 6.
[3] Bull. Geol. Surv. Missouri, No. 1, 1890, p. 83.

1833. *Galium sphenophylloides* Zenker, N. Jahrb. f. Min., p. 398, pl. v, figs. 6–9.
1837. *Annularia sphenophylloides* (Zenk.) Gutbier, Isis v. Oken., col. 436.
1854. *Annularia sphenophylloides* (Zenk.) Gutb., Lesquereux, Bost. Journ. N. H., vol. vi, p. 415.
1855. *Annularia sphenophylloides* (Zenk.) Gutb., Geinitz, Verst. Steinkohl. Sachsen, p. 11, pl. xviii, fig. 10.
1858. *Annularia sphenophylloides* (Zenk.) Gutb., Lesquereux, Geol. Pennsylvania, vol. ii, p. 852, pl. i, figs. 5, 5*a*.
1860. *Annularia sphenophylloides* (Zenk.) Gutb., Roemer, Palæontogr., vol. ix, p. 21, pl. xi, fig. 1.
1869. *Annularia sphenophylloides* (Zenk.) Gutb., Schimper, Traité, vol. i, p. 347, pl. xvii, figs. 12, 13.
1870. *Annularia sphenophylloides* (Zenk.) Gutb., Unger, Sitzb. Acad. Naturw. Wien, Math.-nat. Cl., vol. lx, pt. i, p. 783, pl. i, fig. 8.
1874. *Annularia sphenophylloides* (Zenk.) Gutb., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 129, pl. xvii, figs. 5, 6.
1878. *Annularia sphenophylloides* (Zenk.) Gutb., Zeiller, Vég. foss. terr. houiller, Atlas, pl. clx, fig. 4; text (1879), p. 25.
1879. *Annularia sphenophylloides* (Zenk.) Gutb., Lesquereux, Coral Flora, Atlas, p. 2, pl. ii, figs. 8, 9; text (1880), vol. i, p. 48.
1881. *Annularia sphenophylloides* (Zenk.) Gutb., Weiss, Aus d. Fl. d. Steink., pl. ix, fig. 47.
1882. *Annularia sphenophylloides* (Zenk.) Gutb., Renault, Cours bot. foss., vol. ii, p. 133, pl. xx, fig. 3.
1882. *Annularia sphenophylloides* (Zenk.) Gutb., Sterzel, Zeitschr. d. deutsch. geol. Gesell., vol. xxxiv, p. 685, pl. xxvii, figs. 1–10.
1883. *Annularia sphenophylloides* (Zenk.) Gutb., Lesquereux, 13th Ann. Rept. Geol. Surv. Indiana, pt. 2, p. 45, pl. vii, figs. 3, 4, 5.
1886. *Annularia sphenophylloides* (Zenk.) Gutb., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lx, figs. 5, 6; text (1888), p. 388.
1888. *Annularia sphenophylloides* (Zenk.) Gutb., Dawson, Geol. Hist. Pl., p. 122, fig. 45*b*.
1888. *Annularia sphenophylloides* (Zenk.) Gutb., Renault, Pl. foss., p. 193, fig. 13.
1889. *Annularia sphenophylloides* (Zenk.) Gutb., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 28, 5 text figs.
1889. *Annularia sphenophylloides* (Zenk.) Gutb., Miller, Geol. Pal. N. Amer., p. 106, fig. 7.
1890. *Annularia sphenophylloides* (Zenk.) Gutb., Renault, Fl. foss. houill. Commentry, vol. ii, Atlas, pl. xlvi, figs. 7–9.
1893. *Annularia sphenophylloides* (Zenk.) Gutb., D. White, Bull. U. S. Geol. Surv., No. 98, p. 30.
1893. *Annularia sphenophylloides* (Zenk.) Gutb., Renault, Fl. Foss. Autun et Épinac, vol. ii, Atlas, pl. xxviii, fig. 2; text (1896), p. 71.
1898. *Annularia sphenophylloides* (Zenk.) Gutb., Seward, Foss. Plants, vol. i, p. 340, figs. 89A, B.
1899. *Annularia sphenophylloides* (Zenk.) Gutb., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, 518.

1860. *Annularia microphylla* Ferd. Roemer (non Sauveur), Palæontogr., vol. ix, p. 21, pl. v, fig. 1.
1863. *Annularia galioides* Dawson [non (L. and H.) Kidst.], Can. Nat., vol. viii, fig. 441.
1866. *Annularia galioides* Dawson, Quart. Jour. Geol. Soc. Lond., vol. xxii, p. 152.
1868. *Annularia galioides* Dawson, Acad. Geol., 3d ed., pp. 129, 149.
1887. *Annularia sarepontana* Stur, Calamar. d. Carbon-Fl., p. 221, pl. xiii*b*, fig. 1.

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1882. *Annularia sphenophylloides* (Zenk.) Gutb., Sterzel, Zeitschr. d. deutsch. geol. Gesell., vol. xxxiv, p. 685, pl. xxviii, figs. 1–4.
1888. *Annularia sphenophylloides* Seward, Foss. Plants, vol. i, p. 340, figs. 89A, B.
1876. An *Stachannularia calathifera* Weiss, Steinkohlen-Cal., vol. i, p. 27, pl. iii, fig. 11?
1880. *Stachannularia calathifera* Ferd. Roemer, Lethaea Geogn., vol. i, p. 157.
1884. *Calamostachys* cf. *Calathifera* Weiss, Steinkohlen-Cal., vol. ii, p. 178.

The representatives, rare in the collections, of this well-known species are fully up to the average in size, very clear, and slightly mucronate. A portion of a fruiting cone from the same locality has, so far as can be observed from its external characters, the same size, divisions, bracts, and arrangement of parts as the *Stachannularia calathifera* of Weiss, shown by Sterzel[1] to be the fruit of *Annularia sphenophylloides.*

Localities.—Deepwater, U. S. Nat. Mus., 5449, 5451; Gilkerson's Ford, Mus. Reg.; Owen's coal bank, U. S. Nat. Mus., 5450.

VOLKMANNIA Sternberg, 1825.

Versuch, vol. i, tent., p. xxix. Lesquereux, Coal Flora, vol. iii, 1884, p. 719.

VOLKMANNIA PRÆLONGA Lx.

1880. *Calamostachys prælongus* Lesquereux, Coal Flora, vol. i, p. 59.
1884. *Volkmannia prælonga* Lesquereux, Coal Flora, vol. iii, p. 720, pl. xc, fig. 2.

A comparison of the single example of this species found in the Missouri material with the type specimen from "Coal C" at the Ontario Colliery, near Pittston, Pennsylvania, leaves little doubt as to the specific identity of these peculiar cones. The Missouri specimen, which comprises about 15 cm. from the upper part of a strobilus, the base being lost, is 9 to 10 mm. in width, internodes being 2.5 to 3 mm. long. Both this and the type seem to be provided with short, delicate, narrow bracts, closely impressed upon the verticils of sporangia or sporangium groups. Though

[1] Zeitschr. d. deutsh. geol. Gesell., vol. xxxiv, 1882, p. 685, pl. xxviii, figs. 1–4.

the axis and the arrangement of the parts of the cone are not visible, the fossil as a whole strikingly resembles the *Macrostachya Hauchecornei* of Weiss.[1]

Locality.—Hobbs's bank, U. S. Nat. Mus., 5452.

CYCLOCLADIA Lindley and Hutton, 1834.

1834. *Cyclocladia* Lindley and Hutton, Fossil Flora Gr. Brit., vol. ii, p. 137, pl. cxxx.
1868. *Cyclocladia* L. and H., K. Feistmantel, Abhandl. k. böhm. Gesell., (6) vol. ii, no. 6, p. 5, pl. i.
1874. *Cyclocladia* L. and H., O. Feistmantel, Verst. böhm. Kohlen-Abl., vol. i, p. 95, pl. i, fig. 8.
1855. *Equisetites* (in part) of authors, Geinitz, Verst. Steinkohlenform. Sachsen, p. 3, pl. x, fig. 5.
1869. *Macrostachya* Schimper, Traité paléont. vég., vol. i, p. 333 (pars).
1876. *Calamitina* Weiss, Steinkohlen-Calamarien, vol. i, p. 126.

The stems referred by various authors to *Macrostachya* or *Calamitina* appear to furnish an excellent illustration of the similiarity of the trunks in several Calamarian types as compared with the diversity of foliate forms and organs of reproduction. A comparison of the figures and descriptions given by Bronn, Stur, Geinitz, and others under the names *Equisetum*, *Equisetites*, *Cyclocladia*, *Macrostachya*, *Calamitina*, and *Calamites*, in some of which the fertile spikes are represented as found still in association with the parent stem, shows well the difficulty in distinguishing from the superficial characters of the trunks the numerous species founded on the structure or arrangement of the parts of the strobili, and *vice versa*. It is hard to avoid the conclusion either that the number of species founded on the spikes is too greatly multiplied or that it is practically impossible in many cases, except from abundant material, to distinguish species of this genus by means of the superficial aspect of fragments of the stems.

It is perhaps better to follow the practice of some authors in this group, and of many authors in other groups, of employing different generic names for stems and for cones than to countenance so often the probability of both members of the same plant resting under different specific names in the same genus, or, what is no better, the inclusion of the stem of one plant with the cone of another species under the same specific name. Accordingly it may be advantageous to use the terms *Macrostachya* and *Huttonia* in the sense in which they were employed by Bronn, Brongniart, and Germar

[1] Steinkohlen-Calamarien, vol. ii, 1884, p. 176, pl. xix, figs. 4–4*a*.

as applying to the fruiting spikes, while some other name, conforming to the prevailing rules of nomenclature, is used for the stem, especially when the particular form of spike exclusively produced on that stem is not yet known.

The genus *Macrostachya* was founded by Schimper[1] on the *Equisetum infundibuliforme* Bronn,[2] two of whose figures (representing cone fragments), previously given by Brongniart[3] as "*Equisetum*," are again copied by Brongniart in his "Histoire."[4] Recognizing the relations pointed out by Geinitz, in 1855,[5] of these strobili to stems of the *Calamites verticillatus* type, Schimper, in 1869, included the stems in his diagnosis of the new genus *Macrostachya* with two figures of stem fragments,[6] the better one of which was copied from Geinitz. But most of the plant remains to which Schimper's name has been given by various authors are fragments of spikes, many of the stems continuing to be referred to *Calamites* or *Calamitina*.

The name *Cyclocladia*, which, it seems to me, should be adopted if any separate designation is used for this group of Calamarian stems, was given by Lindley and Hutton in 1834[7] to a stem of this type, *Cyclocladia major* L. and H., from the Jarrow colliery; and this name, as we learn from both Kidston and Howse, seems to have been applied by the authors originally and exclusively to the same type. Geinitz introduces the figure given by the English authors into his discussion of *Equisetites*, making *C. major* L. and H. doubtfully a synonym of *E. infundibuliforme*.[8] In 1868 Karl Feistmantel[9] illustrated Lindley and Hutton's species and discussed the characters and application of the genus. The younger Feistmantel, in 1874, further elaborated the genus and gave additional illustrations.[10] Thus it will be seen that *Cyclocladia* has distinct priority in its application to the Calamarian stems to which the *Macrostachya* cones belong.

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[1] Traité, vol. 1, 1869, p. 333.

[2] Bischoff, Kryptogämische Gewächse, 1828, vol. i, p. 52, pl. vi, figs. 4, 9, 10.

[3] Classification vég. foss., 1822, p. 90, pl. iv, fig. 4.

[4] Histoire des végétaux fossiles, vol. i, p. 119, pl. xii, figs. 14–16.

[5] Verst. Steinkohlenform. Sachsen, p. 3.

[6] Traité paléont. vég., vol. i, p. 333, pl. xxiii, figs. 13, 14. These fragments seem to agree with the figures given by Lesquereux in Coal Flora, pl. iii, fig. 14, and the 13th Rept. Geol. Surv. Indiana, 1883, pt. 2, pl. v, fig. 7.

[7] Foss. Fl. Gr. Brit., vol. ii, p. 137, pl. cxxx.

[8] Verst. Steinkohlenform. Sachsen, p. 3.

[9] Abh. k. böhm. Gesell., (6) vol. ii, no. 6, p. 5, pl. i.

[10] "Genus CYCLOCLADIA Lindley and Hutton. *Caulis articulatus, cortice glabro rarius sensim striato: in articulationibus omnibus tuberculis oblongis (cicatriculæ foliorum), saepius adhuc cum foliis insidentibus; in articulationibus singulis tuberculis vel cicatricibus majoribus (cicatrices ramorum).*" Verst. böhm. Ablag., vol. 1, p. 95, pl. i, fig. 8.

However, a new generic appellation was given in 1876 by Weiss[1] to this group, the principal characters of the genus *Calamitina* being the same as those already published for *Cyclocladia*. Just as other paleobotanists had referred to the latter genus as a synonym of *Equisetites* or *Macrostachya*, so Weiss quotes it in the discussion of his new genus, and it is interesting to note that Kidston, who uses Weiss's name for the Macrostachian stems, in his valuable report containing the results of his examination of the Paleozoic types published by Lindley and Hutton in the "Fossil Flora," identifies[2] the type of *Cyclocladia major* L. and H. as "probably *Calamitina varians*, Sternb. sp., var. inconstans, Weiss." But in a footnote Mr. Kidston states that while *Cyclocladia* "is the oldest name for these fossils," the type is so imperfect that from it satisfactory generic characters can not be obtained." This, together with the fact that the name was independently applied to an altogether different class of plants by Goldenberg, led him to conclude that "under the circumstances it is perhaps better not to resuscitate the genus *Cyclocladia*." Still, although the same name was used by Goldenberg,[3] I know of no case in which a paleobotanist has referred the figure in the Fossil Flora to any other group of stems than those included in *Macrostachya* and *Calamitina*. Mr. Richard Howse, in his Catalogue of the Fossil Plants from the Hutton Collection,[4] in which *Cyclocladia major*, *Macrostachya infundibuliforme*, *Calamites verticillatus*, and others are combined with *Hippurites gigantea* L. and H., describes five stems labeled as *Cyclocladia major*, of which the four specimens not figured are clearly of the Macrostachian stem type, all of the five being generically identical, though the one figured is very poor.

From the foregoing review it appears (1) that *Cyclocladia* was the first name to be applied by its authors originally and exclusively to this type of Calamarian remains, and that its generic identity as such has since been generally recognized by paleontologists; also (2) that prior to the foundation of either *Macrostachya* or *Calamitina* its characters had been described and illustrated, and its generic value as representing the Macrostachian group of stems had been developed.

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[1] Steinkohlen-Calamarien, vol. i, p. 126.

[2] Notes on the Palæozoic species mentioned in Lindley and Hutton's "Fossil Flora:" Proc. Roy. Phys. Soc. Edinb., vol. x, 1891, p. 371.

[3] Flora saraepontana fossilis, pt. i, 1855, p. 19.

[4] 1888, p. 17.

Under these conditions, according to the rules of nomenclature now generally obtaining in both botany and paleontology, *Cyclocladia* should have priority over *Calamitina* or any other name proposed since 1834 as a designation for the stems of this group. It is unfortunately true that convenience, usage, appropriateness of etymology, or even personality, have had as much influence on nomenclature in paleobotany as in any other allied science.

For the use of a dual nomenclature, such as the employment of *Cyclocladia* for the stems of the Macrostachian or *Calamites verticillatus* type and *Macrostachya* or *Huttonia* for the fruiting spikes, there is abundant precedent in paleobotany, even within the Calamarian family itself.

Cyclocladia Brittsii n. sp.

Pl. XLIX, Fig. 1.

1897. *Cyclocladia* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 297.

Stems attaining a width of 10 cm. or more, divided into short internodes, of which about one in eight is occupied exclusively by large scars; fructification or rameal verticils 2.5 to 3.5 cm. distant from border to border, consisting of a transverse compact row of rounded or oval disk-like depressions, each 1.5 to 2 cm. in longitudinal diameter and about 1.75 cm. transversely, provided with an inner cicatrice about 5 mm. in diameter; foliate nodes 7 to 9 in number between two nodes with large cicatrices, 10 to 3 mm. distant, the internodes becoming uniformly shorter in passing upward, and marked by narrow transverse bands containing the leaf scars; internodal surface finely lineate longitudinally; leaf scars transversely oval, not contiguous, 1.5 to 2 mm. in greater diameter, 1 mm. in longitudinal diameter, and about 4 mm. from center to center, the central points being punctate or slightly mammillate.

The general characters of this species, of which I have seen but a few fragments, can better be learned from the figure, Pl. XLIX, Fig. 1, than from a description. Both the figured specimen and another example are slightly distorted by pressure. The back of the larger fragment, which shows a portion of a verticil of large scars at the top, preserves the other side of the stem. This back portion has still a third verticil of large scars, the entire interval and character of the intervening nodes with leaf scars being the same as on the front of the rock.

The aspect of the fossils is much like that of the figures given by Geinitz,[1] Schimper,[2] and Lesquereux[3] as stems of *Equisetites* or *Macrostachya infundibuliformis*, though the leaf internodes are shorter and closer. All the cicatrices in the verticils of large scars are of the same size. In the nodal system the specimens are more comparable to the *Calamites Goepperti* Ett.[4] (*Calamitina Goepperti* (Ett.) Weiss[5]), while the relation to *Calamitina Solmsii* of Weiss[6] (*Macrostachya Solmsii* (Weiss) Schimper[7]) is even more striking. But the leaf scars in our specimens are not so nearly contiguous as in *C. Solmsii* or the *M. infundibuliformis* of various authors, being, in part, disposed like those shown in some examples identified as *C. varians*, or the *Cyclocladia major* figured by O. Feistmantel.[8]

The carbonaceous covering is rather thick and finely striated longitudinally, though no distinct traces of ribs are present. Eight or nine very short foliate nodes occur between two verticils of large scars. Distinct leaf traces can be seen in portions of the specimens, where they are found to be transversely oval, the longer diameter being about 1.5 mm., while the punctate or slightly mammillate centers are nearly 4 mm. apart.

In all the verticils of large scars, three consecutive rows of which may be seen on one specimen, the cicatrices are uniform in size, and it therefore appears that either all the large scars for three consecutive rameal, or strobilar, verticils are of the same kind, or that the rameal and cone scars, if both present, are alike and of the same size. With respect to the distance between the leaves in the same verticil and the aspect of the large scars, our example resembles the *Calamites Germarianus* Goepp. figured by Stur.[9]

Cyclocladia Brittsii is distinguishable from other species by the very broad and rather distant leaf scars and the short foliar internodes, 7 to 9

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[1] Verst. Steinkohlenform. Sachsen, 1855, p. 3, pl. x, fig. 5.
[2] Traité paléont. vég., vol. i, p. 333, pl. xxiii, figs. 13, 14.
[3] Coal Flora, pl. iii, fig. 14.
[4] Ettingshausen, Steinkohlenfl. v. Radnitz, 1855, p. 27, pl. i, fig. 34.
[5] Steinkohlen-Calamar., vol. i, 1876, p. 127.
[6] Op. cit., p. 129.
[7] Zittel, Handbuch Palæont., vol. ii, p. 172.
[8] Verst. böhm. Ablag., vol. i, pl. ii, figs. 1, 2.
[9] Calamarien d. Carbon-Fl., p. 176, pl. xiv*b*, fig. 5.

of which intervene between two verticils of the large cicatrices, all of the latter being, so far as known, large and equal.

Localities.—Owen's bank; also one from the same locality loaned by Dr. Britts; still another from Henry County, Missouri, without precise locality, U. S. Nat. Mus., 5466.

MACROSTACHYA Schimper, 1869.

Traité paléont. vég., vol. i, p. 333 (pars).

MACROSTACHYA LONGIFOLIA Lx. MSS.

A good specimen in the recent collections appears to belong to a new species with the above name represented in the manuscript material of Professor Lesquereux, now in my hands for preparation for publication.

Not wishing to anticipate its publication, along with many other interesting forms included in the unpublished work of the distinguished paleobotanist, I give here the *nomen nudum* merely as a matter of geological and geographical record.

It is possible that the stems from the same locality referred to Cyclocladia may belong to the same plant.

Locality.—Owen's coal bank, U. S. Nat. Mus., 5467.

INCERTÆ SEDIS.

RADICITES Potonié, 1893.

1825. *Hydatica* Artis, Antediluvian Phytology, pl. i (pars), pl. v.
1834. *Pinnularia* Lindley and Hutton (non Ehrenb.), Fossil Flora Gt. Brit., vol. ii, p. 81, pl. iii.
1847. *Rhizolithes* Braun, Flora, N. R., vol. v, No. 6, p. 86 (pars?).
1893. *Radicites* Potonié, Flora Rothl. Thüringen, p. 260.

In noting the occurrence of rootlets of the type commonly known as *Pinnularia* in the outlying coal basins of southwestern Missouri,[1] I took occasion to point out the fact that Lindley and Hutton's name is objectionable, having been preoccupied by Ehrenberg for a genus of diatoms, many species of which have been found fossil. Among the names previously employed to designate such remains, *Hydatica* and *Myriophyllites* of Artis appear to be either too comprehensive in their scope or too uncertain in

[1] Bull. U. S. Geol. Surv., No. 98, 1893, p. 43.

their application, unless we include all forms of small ramose roots in the same genus.

It is possible that *Rhizolithes*, used by Braun,[1] Unger,[2] and Lesquereux,[3] might be available for this type of rootlets, though, while there is no doubt as to the generic identity in Lesquereux's plant, the application of the name proposed by Braun is at present equivocal, while Unger's figure of the specimen from the Dyas leaves us still in uncertainty.

The name *Radicites* is proposed by Potonié explicitly for this type of roots, and, for the present at least, answers well the purpose.

RADICITES CAPILLACEA (L. and H.) Pot.

1834. *Pinnularia capillacea* Lindley and Hutton, Fossil Flora, vol. ii, pl. cxi.
1858. *Pinnularia capillacea* L. and H., Lesquereux, in Rogers: Geol. Pennsylvania, vol. ii, p. 878, pl. xvii, fig. 22.
1869. *Pinnularia capillacea* L. and H., von Roehl, Foss. Fl. Steinkohl. Westphalens, p. 27, pl. i, fig. 7*b*; pl. ii, fig. 5*a*; pl. iv, figs. 1, 11.
1874. *Pinnularia capillacea* L. and H., O. Feistmantel, Steink. Perm. Abl. n.-w. Prag., p. 72 (pl. i, fig. 2?).
1874. *Pinnularia capillacea* L. and H., O. Feistmantel, Verst. böhm. Kohlen-Abl., vol. i, p. 137, pl. xix, figs. 8 (7?).
1877. *Pinnularia capillacea* L. and H., Lebour, Illustrations, pls. lix (lx?).
1889. *Pinnularia capillacea* L. and H., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 647, text fig.
1840. *Fucoides filiformis* Steininger, Geogn. Beschr. Land zw. Saar u. Rheine, p. 36, fig. 1.
1893. *Radicites capillacea* (L. and H.) Potonié, Fl. Rothl. Thüringen, p. 261, pl. xxxiv, fig. 2.

There appears to be some lack of agreement as to what shall be included under the specific name in this group. Many authors seem disposed to construe the species named by Lindley and Hutton in a broad sense, considering it as inseparable from *Hydatica columnaris* Artis. *Pinnularia columnaris* (Artis) Zeiller seems to be much more robust than *Radicites capillacea* (L. and H.) Pot., with striated divisions more densely provided with rootlets. I follow the example of Kidston and Potonié in restricting the species to the type of *Pinnularia capillacea* L. and H.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 5585.

[1] Flora, 1847, vol. i, p. 86.
[2] Ueber zwei dyadische Pflanzen, N. Jahrb. f. Min., 1863, p. 528, pl. vii.
[3] Rept. Geol. Surv. Arkansas, vol. ii, 1862, p. 313, pl. v, fig. 9.

RADICITES PALMATIFIDA (Lx.).

1860. *Rhizolithes palmatifidus* Lesquereux, Rept. Geol. Surv. Arkansas, vol. ii, p. 313, pl. v, fig. 9.
1879. *Rhizolithes palmatifidus* Lesquereux, Coal Flora, Atlas, p. 16, pl. lxxv, fig. 9; text, vol. i (1880), p. 518.
1880. *Pinnularia palmatifida* Lesquereux, Coal Flora, vol. i, p. 518.
1889. *Pinnularia palmatifida* Lx., Miller, Geol. Pal. N. Amer., p. 126.

The specimens referred to this species are rather larger than that originally illustrated from the coals of Arkansas. The rootlets are thin in texture and apparently flaccid. They are larger and more lax than those referred to *Radicites capillacea*.

Locality.—Owen's coal mine, U. S. Nat. Mus., 5587.

SPHENOPHYLLALES.

SPHENOPHYLLEÆ.

SPHENOPHYLLUM Brongniart, 1828.

1822. *Sphænophyllites* Brongniart, Mém. mus. hist. nat., vol. viii, p. 209.
1822. *Sphenophyllites* Brongniart, Mém. mus. hist. nat., vol. viii, p. 234.
1823. *Rotularia* Sternberg, Versuch, vol. i, fasc. 2, p. 33; tent., 1825, p. xxxii.
1828. *Sphenophyllum* Brongniart, Prodrome, p. 65.

FRUCTIFICATION.

1871. *Bowmanites* Binney, Obs. Struct. Foss. Pl. Carb. Str., pt. ii, p. 59.
1898. *Sphenophyllostachys* Seward, Foss. Pl., vol. i, p. 402.

The systematic affinities of the genus *Sphenophyllum* are now somewhat definitely known through the study of the anatomical characters of the various organs of the plant. Most important among the recent correlations is the recognition on the part of Professor Zeiller of *Bowmannites*, so thoroughly analyzed by the late Professor Williamson, as the fruiting spike of *Sphenophyllum*. In *Bowmannites Dawsoni* (Will.) Zeiller found the details obscurely revealed to him in his study of the *S. cuneifolium* (Stb.) Zeill., from the Valenciennes Basin, to which I have previously made reference.[1] As now demonstrated,[2] the ovoid or oval sporangia are pluriseriate in each

[1] Bull. U. S. Geol. Surv., No. 98, p. 39.

[2] R. Zeiller, Sur la constitution des épis de fructification du Sphenophyllum cuneifolium: Comptes Rendus, vol. cxv, 1892, pp. 141–144. Étude sur la constitution de l'appareil fructificateur des Sphenophyllum: Mém. Soc. Géol. Fr., Paléont., vol. iv, mém. 11, 1893, pp. 1–39, pls. i–iii.

verticil, each sporangium being supported at the upper end by a pedicel arising from the ventral surface of the bract and curving outward, upward, and finally inward to the point of union to the sporangium. Each pedicel is traversed by a vascular bundle, which is regarded by M. Zeiller as a ventral lobe of the bract, presenting an arrangement analogous to the fertile fronds of the *Marsileaceæ* or the *Ophioglossaceæ*. A similar arrangement is described by the same author in *Sphenophyllum oblongifolium* and *S. gracilis*.

Taking into account, then, the structure of the cones, Professor Zeiller would make the *Sphenophylleæ* constitute a distinct class among the vascular cryptogams, comparable to the *Marsileaceæ* and *Ophioglossaceæ*.

It would seem as though the fertile specimens of *Sphenophyllum trichomatosum* Stur described and illustrated by Mr. Kidston[1] might differ in structure from *S. cuneifolium* only by the single circle of sporangia, attached, perhaps, though not necessarily, by the base to a short pedicel, the position on the inner surface of the bracts being the same.

In an earlier reference to the nature of the genus *Sphenophyllum*, I have expressed an inclination to regard it as belonging to the Calamarian family.[2] This view now seems untenable.

With reference to the systematic position of the genus, I may add that Dr. Potonié, after discussing the details collated by Zeiller, reaches the conclusion[3] that the *Sphenophyllum* should be ranked in the group *Pteridales* of Prantl, near the *Salvineæ*. In the genera *Sphenophyllum*, *Trizygia*, *Salvinia*, and *Azolla*, Dr. Potonié would detect a genetic as well as a geologic sequence.

SPHENOPHYLLUM CUNEIFOLIUM (Stb.) Zeill.

1823. *Rotularia asplenioides* Sternberg, Versuch, vol. i, fasc. 2, p. 30, pl. xxvi, figs. 4*a*–*b*.
1823. *Rotularia cuneifolia* Sternberg, Versuch, vol. i, fasc. 2, p. 33, pl. xxvi, figs. 4*a*–*b*.
1826. *Rotularia pusilla* Sternberg, Versuch, vol. i, fasc. 4, tent., p. xxxii.
1826. *Rotularia polyphylla* Sternberg, Versuch, vol. i, fasc. 4, p. 42; tent., p. xxxii, pl. l, fig. 4.
1828. *Rotularia dichotoma* Germar and Kaulfuss, Nova Acta Acad., C. L. C. nat. cur., vol. xv, pt. 2, p. 226, pl. lxvi, fig. 4.
1828. *Sphenophyllum fimbriatum* Brongniart, Prodrome, p. 68.
1828. *Sphenophyllum dentatum* Brongniart, Prodrome, p. 68.
1850. *Sphenophyllum dentatum* Brongn., Unger, Gen. et Species, p. 70.

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[1] On the Fructification of *Sphenophyllum trichomatosum* Stur, from the Yorkshire Coal Field: Proc. Roy. Phys. Soc. Edinb., vol. xi, 1892, pp. 56–62, pl. i.

[2] Bull. U. S. Geol. Surv., No. 98, 1893, p. 36.

[3] Ueber die Stellung der Sphenophyllaceen im System: Ber. d. Deutsch. bot. Gesell., vol. xii, 1894, Hft. 4, pp. 97–100.

1855. *Sphenophyllum dentatum* Brongn., Phillips, Manual Geol., p. 234, fig. 110.
1831. *Sphenophyllum erosum* Lindley and Hutton, Foss. Flora, vol. i, pl. xiii.
1847. *Sphenophyllum erosum* L. and H., Bunbury, Quart. Jour. Geol. Soc., vol. iii, p. 430, pl. xxiii, figs. *3a*, *3b*.
1864. *Sphenophyllum erosum* L. and H., Coemans and Kickx, Monogr. Sphen., p. 149, pl. i, figs. *5a–e*.
1869. *Sphenophyllum erosum* L. and H., Schimper, Traité, vol. i, p. 341.
1869. *Sphenophyllum erosum* L. and H., Von Roehl, Foss. Fl. Steink. Westphalens, p. 30, pl. iv. fig. 19.
1869. *Sphenophyllum erosum* L. and H., Dawson, Acad. Geol., 3d ed., p. 444, fig. 165*c*.
1880. *Sphenophyllum erosum* L. and H., Lesquereux, Coal Flora, vol. i, p. 55.
1881. *Sphenophyllum erosum* L. and H., Weiss, Aus d. Fl. d. Steink., pl. x, figs. 57, 57*a*.
1888. *Sphenophyllum erosum* L. and H., Dawson, Geol. Hist. Pl., p. 122, fig. 45*c*.
1891. *Sphenophyllum erosum* L. and H., Newberry, Jour. Cincinnati Soc. N. H., p. 215, pl. xix, figs. 1–4.
1836. *Rotularia erosa* (L. and H.) Goeppert, Foss. Farrnkr., p. 431.
1848. *Sphenophyllum pusillum* (Stb.) Sauveur, Vég. foss. terr. houill. Belg., pl. lxiv, fig. 4.
1848. *Sphenophyllum saxifragæfolium* (Stb.) Goeppert, in Bronn: Index Pal., vol. i, p. 1166.
1854. *Sphenophyllum saxifragæfolium* (Stb.) Goepp, Geinitz, Fl. Hain.-Ebersdorf., p. 37, pl. xiv, figs. 7–10.
1869. *Sphenophyllum saxifragæfolium* (Stb.) Goepp., von Roehl, Foss. Fl. Steink. Westphalens, p. 31, pl. iv, fig. 17.
1878. *Sphenophyllum saxifragæfolium* (Stb.) Goepp., Zeiller, Vég. foss. terr. houill., pl. clxi, figs. 4, 5; text (1879), p. 31 (pars).
1848. *Sphenophyllum multifidum* Sauveur, Vég. foss. terr. houill. Belg., pl. lxiv, figs. 1, 2.
1852. *Sphenophyllum Schlotheimii* Brongn. var. *β dentatum* (Brongn.) et var. *ζ erosum* (L. & H.) Ettingshausen, Steinkohlenfl. Stradonitz, p. 6, pl. vi, fig. 6.
1855. *Sphenophyllum Schlotheimii* Brongn. var. *β dentatum* (Brongn.) et var. *ζ erosum* (L and H.) Ettingshausen, Steinkohlenfl. Radnitz, p. 30, pl. xi, figs. 1–3.
1854. *Sphenophyllum trifoliatum* Lesquereux, Boston Journ. N. H., vol. vi, no. 4, p. 415.
1858. *Sphenophyllum trifoliatum* Lesquereux, Geol. Pennsylvania, vol. ii, p. 853, pl. i, fig. 7.
1855. *Sphenophyllum Schlotheimii* Brongn., Geinitz, Verst. Steink. Sachsen, pl. xx, fig. 6.
1873. *Sphenophyllum Schlotheimii* Brongn., O. Feistmantel, Zeitschr. d. deutsch. geol. Gesell., vol. xxv, p. 594, pl. xviii, fig. 13.
1864. *Sphenophyllum erosum* L. and H. var. *saxifragæfolium* (Stb.) Coemans and Kickx, Monogr. Sphen., p. 151, pl. i, figs. *6a–d*.
1869. *Sphenophyllum erosum* L. and H. var. *saxifragæfolium* (Stb.) C. and K., Schimper, Traité, vol. i, p. 342, pl. xxv, figs. 10, 11–14.
1880. *Sphenophyllum erosum* L. and H. var. *saxifragæfolium* (Stb.) C. and K., Schimper in Zittel: Handb. Paläont., vol. ii, p. 179, fig. 135, $_{3,4}$.
1874. *Sphenophyllum emarginatum* Brongn., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 134, pl. xviii, figs. 2 (5, 6?).
1874. *Sphenophyllum Schlotheimii* Brongn. var. *saxifragæfolium* (Stb.) O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 134, pl. xviii, fig. 4.

1877. *Sphenophyllum dichotomum* (Germ. and Kaulf.) Ung., Stur, Culm-Flora, vol. ii, p. 119 (225).
1887. *Sphenophyllum dichotomum* (Germ. and Kaulf.) Ung., Stur, Calamar. d. Carbon-Fl., p. 233, fig. 43, pl. xv, figs. 5*a*, *b*, *c*; pl. xii*b*, fig. 2.
1888. *Sphenophyllum dichotomum* (Germ. and Kauf.) Ung., Toula, Die Steinkohlen, p. 204, pl. v, figs. 16, 21.
1878. *Sphenophyllum cuneifolium* (Stb.) Zeiller, Vég. foss. terr. houill., pl. clxi, fig. 1; text (1879), p. 30 (pars).
1882. *Sphenophyllum cuneifolium* (Stb.) Zeill., Renault, Cours bot. foss., vol. ii, p. 87, pl. xiii, fig. 10.
1886. *Sphenophyllum cuneifolium* (Stb.) Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxiii, figs. 1–3, 6, 7 (3, 4, 5, 10, fruit); text (1888), p. 413.
1893. *Sphenophyllum cuneifolium* (Stb.) Zeill., D. White, Bull. U. S. Geol. Surv., No. 98, p. 36.
1893. *Sphenophyllum cuneifolium* (Stb.) Zeiller, Mém. Soc. géol. Fr., Pal., vol. iv, No. 11, p. 12, pl. i; pl. ii, figs. 1–3; pl. iii, figs. 1–2.
1894. *Sphenophyllum cuneifolium* (Stb.) Zeill., Potonié, Ber. d. deutsch. bot. Gesell., vol. xii, 4, p. 99, figs. 3*a*–*b* (fig. 1 fruit).
1896. *Sphenophyllum cuneifolium* (Stb.) Zeill., Potonié, N. Jahrb. f. Min., 2d Abth., p. 142, fig. 1; p. 143, figs. 2*a*–*b*; p. 152, fig. 8.
1897. *Sphenophyllum cuneifolium* (Stb.) Zeill., Potonié, Lehrb. d. Pflanzenpal., p. 176, fig. 171; p. 179, fig. 177.
1886. *Sphenophyllum cuneifolium* (Stb.) Zeill. var. *saxifragæfolium* (Stb.) Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxii, fig. 1; pl. lxiii, figs. 4, 5, 9, 10; text (1888), p. 413.
1893. *Sphenophyllum cuneifolium* (Stb.) Zeill. var. *saxifragæfolium* (Stb.) Zeill., D. White, Bull. U. S. Geol. Surv., No. 98, p. 37.
1888. *Calamites Sachsei* Stur, Toula, Die Steinkohlen, p. 205, pl. v, fig. 22.
1888. An *Sphenophyllum* (*Calamites*) *Sachsei* Stur, Toula, Die Steinkohlen, p. 204, pl. v, fig. 20?
1898. *Sphenophyllostachys Dawsoni* (Will.) Seward, Foss. Pl., vol. i, p. 400, figs. 107A, G; p. 402, fig. 108.

This species, represented by the normal form with narrow, concave-sided, cuneate leaves and sharp teeth, appears to be well represented in the collections, though the specimens are rather more robust and rigid than in examples from other regions. Besides the more common form, there are certain specimens with leaves a little broader, spreading more, the teeth seeming not quite so acute, which I have doubtfully referred to *S. emarginatum* Brongn.

As usual in this species, the tips of the leaves are generally buried in the matrix, a circumstance which probably gives rise to the inclusion of *Sphenophyllum Schlotheimii* Brongn. in Professor Lesquereux's list of the Henry County, Missouri, plants.

Specimens with entire or dissected leaves are frequently found mingled, the dissection often reaching to near the base of the leaves, approaching *S. bifurcatum* Lx. in appearance, though this latter species, found in the "conglomerate" or "subconglomerate" coals, I have not seen in any material from Missouri. Obscure fragments of cones, probably belonging to this species, are found mingled with the specimens of stems and leaves.

To *Sphenophyllum cuneifolium* doubtless belongs the specimen from Clinton recorded in the Coal Flora[1] as *S. filiculme* Lx. In this specimen, which was collected by Dr. Britts and was formerly in Professor Lesquereux's private collection, and which is now No. 8679 of the Lacoe collection in the U. S. National Museum, it is clear that the cleavage of the shale has broken away the ends of all except the highest leaves in the verticil, so that the broken edges are all within a single curve, the line of fracture being distinctly oblique to the venation of the leaves. There is no evidence of any inequality in the arrangement of the leaves other than is common in *S. cuneifolium*, while, at the same time, there is no pairing of the four outer leaves or separation of the two middle ones.

The principal characters of the fruit of this species, so well worked out by Professor Zeiller, are stated in the discussion of the genus.

Localities.—Owen's coal bank, U. S. Nat. Mus., 5454, 5456, 5475?; Pitcher's coal bank, U. S. Nat. Mus., 5455; also found at Gilkerson's Ford.

SPHENOPHYLLUM EMARGINATUM Brongn.

Pl. LIX, Fig. 1*d*.

1822. *Sphenophillites emarginatus* Brongniart, Classif. vég. foss., p. 234, pl. ii, figs. 8, 8*a–b*.
1822. *Rotularia marsileæfolia* Sternberg, Versuch, vol. i, fasc. 2, p. 33 (pars).
1825. *Rotularia marsileæfolia* Sternberg, Versuch, vol. i, tent., p. xxxii (pars).
1828. *Rotularia marsileæfolia* Sternberg, Bronn, in Bischoff: Kryptogäm. Gewächse, p. 89, pl. xiii, figs. 1*a–b*.
1838. *Rotularia marsileæfolia* Sternberg, Presl, Verh. Gesell. Mus. Böhmen, p. 29, pl. ii, figs. 2–4.
1828. *Sphenophyllum emarginatum* Brongniart, Prodrome, p. 68.
1835. *Sphenophyllum emarginatum* Brongn., Bronn, Leth. Geogn., vol. i, p. 32, pl. vii, fig. 10.
1855. *Sphenophyllum emarginatum* Brongn., Geinitz, Verst. Steinkohl. Sachsen, p. 12, pl. xx, figs. 1–4 (5–7?), (pl. xxxiv, fig. 4 ?).

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[1] Vol. 1, p. 59.

1864. *Sphenophyllum emarginatum* Brongn., Coemans and Kickx, Monogr. gen. Sphen., p. 144, pl. i, fig. 2; (pl. ii figs. 1–3?).

1869. *Sphenophyllum emarginatum* Brongn., von Roehl, Foss. Fl. Steinkohlenf. Westphalens, p. 30 (pars), (pl. iv, fig. 12?).

1869. *Sphenophyllum emarginatum* Brongn., Schimper, Traité, vol. i, p. 339, (pl. xxv, fig. 18?).

1874. *Sphenophyllum emarginatum* Brongn., O. Feistmantel, Verst. böhm. Ablag., vol. i, p. 134 (pars), pl. xviii, fig. 5? (non fig. 3).

1876. *Sphenophyllum emarginatum* Brongn., Heer, Fl. Foss. Helv., p. 53, pl. xix, fig. 15.

1879. An *Sphenophyllum emarginatum* Brongn., Heer, Urwelt d. Schweiz., 2d ed., pl. i, fig. 10?

1880. *Sphenophyllum emarginatum* Brongn., Lesquereux, Coal Flora, vol. i, p. 53.

1880. *Sphenophyllum emarginatum* Brongn., Schimper, in Zittel: Handb. Paläont., vol. ii, p. 179, fig. 135, .

1880. *Sphenophyllum emarginatum* Brongn., Ferd. Roemer, Leth. Geogn., Pal, p. 153, pl. l, fig. 6.

1881. *Sphenophyllum emarginatum* Brongn., Saporta and Marion, Évol. règ. vég., crypt., p. 198, fig. 82, A′ (*a*, *c*?).

1881. *Sphenophyllum emarginatum* Brongn., Weiss, Aus d. Fl. d. Steink., pl. x, fig. 58.

1886. *Sphenophyllum emarginatum* Brongn., Sterzel, Fl. Rothl. n.-w. Sachsens, p. 23 (pars), pp. 26, 27, figs. 18 (19?); (pl. xxiii, figs. 2–5?).

1886. *Sphenophyllum emarginatum* Brongn., Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxiv, figs. 3–5; text (1888), p. 409.

1891. *Sphenophyllum emarginatum* Brongn., Raciborski, Permokarb. Fl., p. 26 (378) (pars).

1893. *Sphenophyllum emarginatum* Brongn., Zeiller, Mém. Soc. géol. Fr., Pal., vol. iv, no. 11, p. 24, pl. ii (iv), figs. 4, 4*a*.

1898. *Sphenophyllum emarginatum* Brongn., Seward, Foss. Plants, vol. i, p. 407, fig. 109.

1832. *Sphenophyllum Schlotheimii* Brongn., Lindley and Hutton, Foss. Fl., vol. i, pl. xxvii, figs. 1–2.

1848. *Sphenophyllum Schlotheimii* Brongn., Sauveur, Vég. foss. terr. houill. Belg., pl. lxiv, fig. 3.

1876. *Sphenophyllum Schlotheimii* Brongn., Ferd. Roemer. Leth. Geogn., vol. i, Atlas, pl. l, fig. 6.

1880. *Sphenophyllum Schlotheimii* Brongn., Lesquereux, Coal Flora, vol. i, p. 52 (pars).

1881. *Sphenophyllum Schlotheimii* Brongn., Lesquereux, Rept. Geol. Surv. Indiana, 1879–80, p. 374, pl. xliii, fig. 2.

1890. *Sphenophyllum Schlotheimii* Brongn., Lesley, Dict. Foss. Pennsylvania, vol. iii, p. 980, text fig.

1841. *Sphænophyllum* Hitchcock, Geol. Massachusetts, vol. ii, p. 542, pl. xxii, fig. 2.

1860. *Sphenophyllum Osnabrugense* F. A. Roemer, Beitr. z. Kenntn. n.-w. Harzgeb., p. 21, pl. v, figs. 2*a*–*b*.

1864. *Sphenophyllum emarginatum* Brongn. var. *β Brongniartianum* Coemans and Kickx, Monogr. gen. Sphen., p. 144, pl. i, fig. 3.

1869. *Sphenophyllum emarginatum* Brongn. var. *β Brongniartianum* C. and K., Schimper, Traité, vol. i, p. 340, pl. xxv, figs. 15, 16, 17.

1869. *Sphenophyllum emarginatum* Brongn. var. *β Brongniartianum* C. and K., von Roehl, Foss. Fl. Steinkohlenf. Westphalens, p. 30, pl. xxvi, fig. 2; pl. xxxii, fig. 6A.
1879. *Sphenophyllum cuneifolium* (Stb.) Zeill., Vég. foss. terr. houill., p. 3 (pars).
1882. An *Sphenophyllum truncatum* Brongn., Renault, Cours bot. foss., vol. ii, p. 87, pl. xiii, figs. 8, 9?

I have referred, though in part provisionally, to *Sphenophyllum emarginatum*, a number of specimens in which the large broad leaves, the slightly rounded or even faintly cordate apex, the nervation, and the blunt teeth seen in some cases seem to be characteristic of the species, American representatives of which were first published by Brongniart[1] from Wilkesbarre, Pennsylvania. Some of these specimens, in which the teeth are broken away or buried, probably constituted the basis for the identification and enumeration of *S. Schlotheimii* Brongn. in the list of plants from Missouri. But notwithstanding the identification of the common form in Pennsylvania by Brongniart, the species is badly confused in our American material. The examination of a large number of examples in different collections shows that in most cases, including the specimens from Missouri in the Lacoe collection, and the other collections in the U. S. National Museum, the fossils labeled *S. Schlotheimii* by Lesquereux[2] have the characters of *S. emarginatum*.

Plants referable to the *Palmacites verticillatus* of Schlotheim,[3] the specific name of which Kidston has justly restored, are extremely rare in the American Carboniferous flora, so far as it has yet been made known. This species differs greatly from the true *S. emarginatum* by the rounded, not cordate, summit, which, as I interpret the figures, is smooth or slightly crenulate, often giving the leaf a narrowly obovate form, while the nerves, 15 to 20 in number, dichotomize several times from a single original nerve. The common form in Missouri has, on the contrary, usually but 7 to 15 nervils to the leaf, which is not rounded, but, like most of the common representatives of the species from other localities in this country, seems to belong to the variety *Brongniartianum* as figured by Coemans and Kickx[4] and others.

[1] Prodrome 1828, p. 172.

[2] The specimen figured by this distinguished and justly honored paleobotanist in the Rept. Geol. Surv. Indiana, 1880, p. 374, pl. xliii, fig. 2 (copied by Lesley in Dict. Foss. Pennsylvania, vol. iii, p. 980), as *S. Schlotheimii* belongs with others to the *S. emarginatum*, while, on the other hand, fig. 3 of the same plate (Lesley, op. cit., p. 978) belongs very probably to the group represented by *S. filiculme* Lx.

[3] Flora d. Vorwelt, 1804, pl. ii, fig. 24.=*Sphenophyllum Schlotheimii* Brongn.

[4] Monogr. d. genre Sphenophyllum d'Europe: Bull. Acad. Roy. Belgique, (2) vol. xviii, 1864, p. 139, pl. i, fig. 3.

Some of the larger specimens, especially those from the anthracite region, are difficult to distinguish from the form figured by Stur[1] as *Sphenophyllum Crepini.* Many of the large dissected leaves have the aspect of those figured by O. Feistmantel.[2]

The structure of the fertile spike of *Sphenophyllum emarginatum* has been partly worked out by Zeiller,[3] who finds the bracts, united at the base for a short distance, bearing several verticils of sporangia, the latter probably pedicellate and agreeing in essential details with the better-known species *S. cuneifolium* (Stb.) Zeill. The cones of *S. emarginatum* illustrated by Zeiller are somewhat larger than those of the former species, and do not in their superficial aspect appear very unlike the more imperfect specimens figured by Presl[4] in 1838 as *Rotularia marsileæfolia* Stb.

Although it is a species of long duration, *Sphenophyllum emarginatum* seems to have been considerably modified in time. And while the earlier forms in America are generally smaller, the species soon becomes of the size and characters of the variety *Brongniartianum*, the still later forms being much more lax, proportionately less distinct at the base, and more irregular or rounded at the top. A separation of these later forms as varieties, if not as species, would, I believe, serve a useful purpose in correlative work, and therefore be desirable. Many of the forms figured by Sterzel and Raciborski[5] appear closely related to the *S. Fontaineanum* Mill. (*S. latifolium* F. and W., nec Wood, necque Ren.)

Localities.—Owen's coal bank, U. S. Nat. Mus., 5457; Pitcher's coal bank, U. S. Nat. Mus., 6137.

SPHENOPHYLLUM MAJUS Bronn.

Pl. L, Figs. 5, 6*a*; Pl. LI, Fig. *a*; Pl. LXXIII, Fig. 3.

1828. *Rotularia major* Bronn, in Bischoff: Kryptogäm. Gewächse, vol. ii, p. 89, pl. xiii, figs. 2*a*–*b*.
1835. *Sphenophyllum majus* Bronn, Leth. Geogn., vol. i, p. 32, pl. viii, figs. 9*a*, 9*b*.
1886. *Sphenophyllum majus* Bronn, Zeiller, Fl. foss. houill. Valenciennes, Atlas, pl. lxiv, figs. 1, 1*a*, 2, 2*a*; text (1888), p. 420.

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[1] Calamar. d. Carbon-Fl., p. 232, pl. xv*b*, fig. 4.
[2] Verst. böhm. Ablag., vol. i, 1874, p. 134, pl. xviii, figs. 3, 5.
[3] Fl. foss. houill. Valenciennes, p. 410, pl. lxiv, fig. 5. Étude s. l. constitution d. l'appareil fruct. d. Sphenophyllum: Mém. Soc. géol. Fr., Pal., vol. iv, no. 11, 1893, pl. ii, figs. 4, 4*a*.
[4] Verh. d. Vaterl. Mus. Böhmen, 1838, p. 29, pl. ii, figs. 2–4.
[5] Permokarb. Fl., p. 26, pl. v, figs. 20–30; pl. vii, fig. 23.

1893. *Sphenophyllum majus* Bronn, D. White, Bull. U. S. Geol. Surv., No. 98, p. 40.
1848. *Sphenophyllum multifidum* Sauveur, Vég. foss. terr. houill. Belgique, pl. lxiv, figs. 1, 2.
1855. *Sphenophyllum longifolium* (Germ.) Gein. et Gutb. (non Sauveur), Geinitz, Verst. Steink. Sachsen, p. 13, pl. xx, figs. 15, 16, 17.
1869. *Sphenophyllum longifolium* (Germ.) Gein. et Gutb., Schimper, Traité, vol. i, p. 340, pl. xxv, fig. 22 (non 23).
1880. *Sphenophyllum longifolium* (Germ.) Gein. et Gutb., Lesquereux, Coal Flora, vol. i, p. 53.
1883. *Sphenophyllum longifolium* (Germ.) Gein. et Gutb., Lesquereux, 13th Rept. Geol. Surv. Indiana, 2, p. 46, pl. vii, figs. 10, 11.
1884. *Sphenophyllum longifolium* (Germ.) Gein. et Gutb., Lesquereux, Coal Flora, vol. iii, p. 726, pl. xci, fig. 6.
1855. *Sphenophyllum saxifragæfolium*, (Germ.) Gein. et Gutb., Geinitz, Verst. Steink. Sachsen, p. 13. pl. xx, figs. 8, (9?).
1866. An *Sphenophyllum latifolium* Wood (nec Font. et White, necque Ren. et Zeill.). Trans. Amer. Phil. Soc., vol. xiii, p. 347, pl. viii, fig. 3?

In the discussion of this species from the outlying basins in southwestern Missouri[1] I have stated at length my reasons for accepting Bronn's name as the proper designation of this form, in preference to the name given to the larger form by Germar. The material in the present collections presents a number of fine examples, which I refer to this species, although they show rather less tendency to dissection than appeared in the others. The photographs seen in Pl. L, Fig. 5 and Fig. 6, an enlargement of which is given in Pl. LI, Fig. *a*, show undersized specimens of this beautiful species. As was remarked in the report above mentioned, the form, not rare in America, is quite different from that with long leaves and with nerves not confluent at the base and sparsely forking, figured by Schimper,[2] Coemans and Kickx,[3] Weiss,[4] von Roehl,[5] Renault,[6] and Renault and Zeiller,[7] while I have seen but a single specimen, from Ohio, representing the type of Germar.[8] The plant illustrated by Raciborski[9] under this name would seem to be more closely related to the *S. Fontaineanum* Miller.

Sphenophyllum majus is represented in the Lacoe collection in the U. S.

[1] Bull. U. S. Geol. Surv., No. 98, p. 41.
[2] Traité, vol. i, 1869, pl. xxv, fig. 23 (copied from Germar), p. 340.
[3] Monogr. d. genre Sphenophyllum, Bull. Acad. Roy. Belg., (2) vol. xviii, 1864, p. 147, pl. i, fig. 4.
[4] Aus der Flora d. Steinkohlenformation, 1881, pl. x, fig. 60.
[5] Foss. Fl. Steink.-Form. Westphalens, 1869, p. 31, pl. iv, fig. 14.
[6] Cours bot. foss, vol. ii, 1882, p. 88, pl. xiii, fig. 18 (from Coemans and Kickx).
[7] Fl. foss. bassin houill. Commentry, vol. ii, Atlas, pl. l, figs. 12–17.
[8] Isis, 1837, col. 426, pl. ii, fig. 2. Verst. Kohlenf., p. 17, pl. vii, fig. 2.
[9] Permokarboniska Fl., 1891, p. 29 (381), pl. v, figs. 14, 15.

National Museum by a number of specimens from the vicinity of Clinton, Missouri, labeled *S. longifolium* by Professor Lesquereux. This type, as seen in Pl. L, Fig. 5, closely resembles the leaves found on the robust branches of *S. emarginatum*, while, when dissected, the leaves are quite suggestive of *S. bifurcatum*. The nervation of this specimen, studied by Lesquereux, is shown in the photographic enlargement, Pl. LI.

The presence of two undescribed species with very large leaves in the Pocono and the Middle Pottsville gives to the large, wide-leafed group a much greater antiquity than has been supposed.

Localities.—Owen's coal bank, U. S. Nat. Mus., 5462, 5671, 5679, 5680; Deepwater, U. S. Nat. Mus., 5465; Pitcher's coal bank, U. S. Nat. Mus., 5463; Gilkerson's Ford, U. S. Nat. Mus., 5461.

SPHENOPHYLLUM LESCURIANUM n. sp.

Pl. L, Fig. 6*b*; Pl. LI, Fig. *b*; Pl. XXIV, 3*c*.

1897. *Sphenophyllum* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, p. 297.

Stems slender, delicate, branching freely; internodes long in proportion to the width of the axis, the ribs being narrow, distinct, and angular; nodes but slightly enlarged; leaves six to the verticil, of equal length, the middle pair nearly at a right angle to the stem, the upper and lower pairs open and at equal angles to the stem, narrowly obcuneate, 3 to 5 mm. long, 1 to 1.75 mm. wide near the top, of rather thin texture, very small at the point of attachment, the lateral margins slightly convex, generally divided by a shallow angular or rounded sinus into two obtuse or obtusely pointed teeth, but sometimes, in the lower portions of the plant, divided into three or four teeth of the same type; nervation consisting of one slender nerve, simple to one-third or one-half the way up, then forking at a moderate angle, each of the two branches entering a tooth, or, where more than two teeth are present, one or both nerves forking again near the top of the leaf; fructification unknown.

Among the specimens in the Lacoe collection labeled *Sphenophyllum angustifolium* Germ. by Professor Lesquereux, one example, No. 8711, from the vicinity of Clinton, Missouri, is so different not only from all the remaining specimens under that name, but also from the figures of foreign specimens described as characteristic of that type, that I have felt constrained to exclude it from that species and place it under another name, after searching in vain for a satisfactory place for it among the many existing species.

The plant is of a delicate type, the branches slender and graceful, the internodes relatively long, the ribs narrow, angular, while the segment of a larger stem at the left in Fig 6*a*, Pl. L, is distinctly lineate. While in its general aspect and especially in the outlines of the leaves our form, which is photographed twice the natural size in Pl. LI, resembles the *Sphenophyllites angustifolius* of Germar,[1] the difference in the minor characters, particularly the details of the nervation, as shown in the description and figures of *S. angustifolium* (Germ.) Goepp. given by Coemans and Kickx,[2] Renault,[3] and Weiss,[4] or of the var. *bifidum* Gr. 'Eury by Renault,[5] in all of which we find long, slender, acute-pointed pinnules more deeply dissected and with the nerves separate and distinct from the base in the bidentate forms, is too great to permit its union under the same name. In fact, the essential characters are probably nearer *S. oblongifolium*, especially as that species is figured by the same authors,[6] though in the form of the leaves and their attitude in the verticil it is quite different from that species.

Sphenophyllum Lescurianum is not easily confused with the younger species, *S. filiculme* Lx., *S. tenuifolium* F. and W., or *S. densifolium* F. and W., all of which differ by the disposition of the leaves in the verticil, by the nervation, and by the margins.

Locality.—Near Clinton, Henry County, Missouri, precise locality not known; Lacoe collection, No. 8711, U. S. Nat. Mus.

SPHENOPHYLLUM (ASTEROPHYLLITES?) FASCICULATUM (LX).

Pl. L, Figs. 1–4.

1879. *Asterophyllites fasciculatus* Lesquereux, Coal Flora, Atlas, p. 2, pl. iii, figs. 1–4, 4*a*; text, vol. 1 (1880), p. 41.

Stems 1 to 7 mm. wide, branching freely, dichotomously, or oppositely (?), with about 3 to 6 rounded, obscurely lineate-rugose, hardly striate, non-alternating ribs dilated at the nodes; branches irregular, flexuous, forking

[1] Verst. Steink. Wettin u. Löbejün, p. 18, pl. vii, figs. 4–7. Schimper, Traité, vol. i, pl. xx, figs. 1–4. Von Roehl, Foss. Fl. Steinkohleuf. Westphalens, pl. iv, fig. 18.

[2] Bull. Soc. Roy. Belg., (2) vol. xviii, 1864, pl. i, figs. 7*a-c*.

[3] Cours bot. foss , vol. ii, 1882, pl. xiii, figs. 19, 20, 21.

[4] Aus d. Flora d. Steinkohl., 1881, pl. x, fig. 61.

[5] Fl. foss. bassin houill. Commentry, vol. ii, p. 485, pl. l, figs. 6, 7.

[6] Coemans and Kickx, loc. cit., figs. 8*a-c*. Schimper, op. cit., 1, p. 343, pl. xxv, figs. 5–9. Renault, op. cit., vol. ii, pl. xiii, figs. 15, 16, 17. Weiss, op. cit., pl. x, fig. 59.

equally or unequally at a narrow angle, leafy, tapering plumose to the tufted apex; nodes prominent, generally very short, 1 to 6 mm. distant, frequently crowded near the base of the branch, each provided with a verticil of leaves; leaves 6 to 12 in the verticil, united usually in six pairs in the smaller twigs, the members of each pair being joined for a distance from the base by their laminæ, or even the pairs joined to one another for a short distance when young, and separating with the increased growth of the axis, lanceolate, 2.5 to 8 mm. long, tapering from near the base to the acute apex, slightly carinate, not regularly alternate from node to node, minutely rugose, oblique, or erect when young, at the point of attachment, then curving outward, often more or less reflexed according to age and position, then turning upward and sometimes slightly inward, approaching a semi-uncinate form, somewhat thickened at the slightly constricted base, nearly smooth or obtusely carinate on the arching dorsal surface; median nerves of each pair of leaves simple at the base, or distinct and separate, converging to contiguous points of origin, relatively broad, dorsally lineate-rugose under the lens; strobili borne on the branches, 6 to 25 mm. long, 5 to 7 mm. wide, divided into nodes about 2 mm. apart, the axis being 1.25 mm. wide, ribbed like the branch, each node bearing a verticil of bracts slightly longer than the preceding leaves, somewhat strongly reflexed, then curving upward at the middle and finaly turned inward; sporangia slightly oval, the greater diameter being a little less than 1 mm.

A number of typical specimens, some of which are from the type locality, bring to our attention new features in this unique and interesting species.

The common aspect of the plant is indicated in pl. iii, fig. 1, of the Coal Flora by Professor Lesquereux, though the habit of the leaves is not there shown so well as in our Pl. L., Figs. 2 and 3. On my first examination of the species I was disposed to regard the dichotomous fasciculate specimens as specifically distinct from the form illustrated in fig. 2 of the Coal Flora plate. I have seen no other specimen from this region with such an aspect of rigidity, which is exaggerated in the figure, and with the appearance of opposite branching, except the original of that figure, now No. 8292 of the Lacoe collection in the United States National Museum. This original differs, furthermore, from the figure by the much more falcate character of the leaves, which are more open at the base, then curving gradually upward and slightly inward, while each joint of the main stem is provided with a verticil of leaves within which the branches have their origin. But, although by this character of the main stem, the internodes of which are much longer in proportion to their width than in other specimens, and by the angle and habit of the branches this individual specimen is so different from all others examined, being in effect very similar to *Asterophyllites gracilis* Lx., still the characters of the leaves and branches are so concordant with those in the dichotomous form that I am not at present prepared to establish any separation of the two, especially in the absence of additional details as to the internal organization or fruit of the latter.

The following remarks, however, pertain entirely to the remaining suite of specimens, all of which are more or less distinctly of the type of fig. 1 of the plate in the Coal Flora.

The stems of the common (dichotomous or fasciculate) type, some of which are nearly 1 cm. in diameter, are usually more or less flexuous, especially the smaller ones, while the delicate twigs are often sinuous and plumose, the branching being irregular and not in the same plane. In fact, the general aspect of the plant and the more obvious characters of the stems of all ranks are so strongly similar to those of the stems and branches of common Sphenophylla, such as *Sphenophyllum emarginatum* Brongn., that it is only after a glance at the leaves that one pauses to inquire whether it belongs to some other group. The ribs are few, broad, broadly rounded or flattened, and separated in the larger segments by a rounded furrow. Toward the upper end of the internode each rib is somewhat swollen. Confluent with the upper ends of these ribs are the slightly thickened bases of the leaves, which are inclined upward as is common in *Sphenophyllum*, so that just above the node, or within the verticil, the stem is reduced in size. These features may be indistinctly seen in Pl. L, Fig. 3.

In the larger and older stems the leaf traces show indistinctly as roundish or transversely oval scars more or less distinctly paired according to the size of the stem. In such advanced stems the leaves are so open that they are seldom seen except in profile. However, in the younger portions, and particularly near the ends of the branches, the leaves may often be seen at a right angle to their planes, in which cases they are found to be united, two by two, for a distance (sometimes nearly one-third of their length), while in still other cases the pairs are more narrowly united into what is perhaps essentially a sheath, as shown fragmentarily in Fig. 1, Pl. L, which represents a portion of No. 8296 of the Lacoe collection, from Henry County, identified by Professor Lesquereux. This character of the pairing, which constitutes bifurcation of the leaves in effect, and which is also illustrated in Pl. L, Figs. 2 and 4, and in the enlarged details, accentuating the Sphenophylloid nature of the plant, is further accompanied, in some cases at least, by a corresponding bifurcation of the single basal nerve, one of whose divisions passes to each lobe.[1] From the preservation of the older portions of the stems it would seem that these bifurcated (or paired) leaves gradually part and become distinct in the older stems, as Potonié has noticed occasionally in the leaves of *Equisetites zeæformis* (Schloth.) Andrä, and that both forked and simple leaves may occur on the same stem. In some cases there appear to be but three leaf pairs on the young twigs, but this incomplete observation may be erroneous. The young twigs with bifurcated leaves are frequently united with the larger stems, in which, so far as I am able to discover, the leaves are separate quite to the base.

Among several fertile spikes attached to the branches of this species I have not yet seen any with the structure illustrated in the Coal Flora, though the original of pl. iii, fig. 3, of that work lies before me. All the specimens are too poorly preserved to enable me to discover the mode of attachment or even the normal place of the sporangia between the verticils. The bracts are more slender and rather longer than the leaves below, and are more strongly reflexed before curving outward, upward, and, finally, slightly inward. The sporangia, a number of which are scattered irregularly among the verticils in some of the specimens, are slightly oval and nearly 1 mm. in greater diameter.

As a species of *Asterophyllites* this form is unique. In its general composition and make-up it is a *Sphenophyllum*. Its habit, the broadly ribbed stems, the inflated joints, the verticils, which appear to be confluent with the upper ends of the ribs, giving the leaves a decurrent effect, the bifurcated character of the leaves, at least in the younger stages, all combine to make us question whether we are not in reality dealing with a type more nearly related to *Sphenophyllum*, in which most of the nerves are simple to the base of the leaf, so as to allow the lobes to grow apart with the enlargement of

[1] In most cases, however, both the leaves and the nerves appear to be simple, especially in the lower portions of the stems or branches.

the axis. Owing to the unfortunate lack of material so preserved as to show the internal structure of the stems, we are left to search for fruiting cones in which the arrangement of the sporangia will be discernible. I anticipate that the cones will be found to show the characters of *Sphenophyllum*, and I have very little hesitation in unequivocally referring it to that genus. Should additional material substantiate such a reference it is probable that the type of fig. 2 of pl. iii of Coal Flora will be placed in or near *Asterophyllites gracilis* Lx., or *A. grandis* Stb., with which in many respects it agrees.

I am not sure whether or not a specimen of *Asterophyllites fasciculatus* was the basis of the identification by Lesquereux of *Sphenophyllum furcatum* Lx. in the Missouri flora, but I am inclined to believe that the enrollment of the latter species in the list from Henry County was based by him on fragments of *S. emarginatum* Brongn., in which the leaves are sometimes dissected nearly to the base. The true *S. bifurcatum*, as described from the "coal-bearing shales" of Washington County, Arkansas, is quite different from anything I have yet seen from the Missouri Coal Measures, and apparently constitutes a good species of some stratigraphic value.

Localities.—Owen's coal bank, U. S. Nat. Mus., 5539, 5542, 5622, 5637, 5639, 5675; Deepwater, U. S. Nat. Mus., 5540, 5658; Gilkerson's Ford, U. S. Nat. Mus., 5541; Hobbs's coal bank, U. S. Nat. Mus., 5543.

LYCOPODIALES.

LEPIDODENDREÆ.

LEPIDODENDRON Sternberg, 1820.

1820. *Lepidodendron* Sternberg, Fl. d. Vorw., vol. i, fasc. 1, p. 25; tent. (1825), p. x.
1822. *Sagenaria* Brongniart, Mém. mus. hist. nat., vol. viii, p. 239.

Of the five species of this genus occurring in the Lower Coal Measures in the region of Henry County, Missouri, two, *Lepidodendron Brittsii* Lx. and *L. lanceolatum* Lx., belong to older types of the genus, the former having been probably derived from *L. Volkmannianum* of the culm or some related species, while the latter is most intimately connected with the *L. Sternbergii* as identified by Professor Lesquereux from the Pottsville series.

The study of the internal structure of a large number of the species of this genus shows a very great diversity of organization, especially with reference to secondary or exogenous growth, some of the stems or branches presenting only the primary growth, while others contain a very elaborate and complicated secondary or exogenous development.[1] The examination of the structure of certain dolomitized bolsters of *Lepidophloios* by Dr. Potonié[2] shows that the two lateral appendages below the leaf scar in *Lepidodendron* and *Lepidophloios* are the aerial terminations, beneath greatly thinned bolster walls, of strands of thin-walled parenchyma cells, apparently with intercellular spaces. These strands or ducts, whose function is regarded by Potonié as transpiratory, pass through the leaf scar by way of the lateral cicatricules and correspond with the two similar tracts found by Felix[3] in the cross section of the leaf of *Lepidodendron selaginoides*. Potonié follows Stur[4] in designating the trace on the bolster above the leaf scar in the *Lepidodendreæ* as the "ligular pit," on account of its supposed homology with the ligule of the recent *Selaginella*. The propriety of this correlation has, however, been doubted by a number of paleobotanists, among whom is Mr. Kidston.[5]

Lepidodendron Brittsii Lx.

Pl. LII, Figs. 1, 2; Pl. LIII, Fig. 1; Pl. LIV, Figs. 1, 2.

1879. *Lepidodendron Brittsii* Lesquereux, Coal Flora, Atlas, p. 11, pl. lxiii, figs. 1, 2; text, vol. ii (1880), p. 368.

1883. *Lepidodendron Brittsii* Lesquereux, 13th Rept. Geol. Surv. Indiana, 2, pl. xvii, figs. 4, 4*b*.

1889. *Lepidodendron Brittsii* Lx., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 313, 2 text figs.

Stems of considerable size, slightly rigid, freely branching at a rather narrow angle in both equal and unequal dichotomies, the branches becoming slender, tapering slowly, flexuous, and plumose; bolsters contiguous, rhomboidal-oval, acute both above and below, sometimes nearly one-half as broad as long in the old stems, but generally fusiform, very slender, the

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[1] Detailed descriptions of the structure of a number of species may be found in the series of memoirs published in the Philosophical Transactions of the Royal Society, by the late Prof. W. C. Williamson, or in the painstaking studies of Professors Renault and Bertrand. A very short résumé relating to the development of the Lepidodendroid stem was given by the author in Science, 1896, vol. iii, pp. 754–759.

[2] Anatomie der beiden "Male" auf dem unteren Waugenpaar und der beiden Seitenuärbchen der Blattnarbe des Lepidodendreen-Blattpolsters: Ber. d. deutsch. bot. Gesell., vol. xi, 1893, Hft. 5, pp. 319–326, pl. xiv.

[3] Untersuchungen über den inneren Bau Westfälischer Carbon-Pflanzen: Abh. d. k. Preuss. Geol. Landesanst., vol. vii, 1886, Hft. 3, pl. ii, fig. 3.

[4] Die Culm-Flora d. Ostrauer u. Waldenburger Schichten: Abh. d. k.-k. Geol. Reichanst., vol. viii, 1877, Hft. 2, p. 327 (231), pl. xxxvi (xix), fig. 1.

[5] Trans. Royal Society of Edinb., vol. xxxvii, pt. iii, 1893, p. 537.

length being more than ten times the breadth, tapering to very slender, flexuous tips in moderate relief, convex, the lower half and the upper portion above the foliar cicatrice distinctly marked by irregular, rather coarse transverse corrugations; leaf cicatrices a short distance above the middle of the bolsters, moderately protuberant, broad, crescentic, very narrow vertically, concave-convex upward in plan, the upper margin round-convex, slightly mucronate at the top in correspondence with the base of the midrib, the lower margin concave, forming an imperfect arc of from 130° to 160°; ligular trace obscure, mammillate, close above the leaf cicatrice; appendages oblong, close on either side of the base of the midrib, and inclined somewhat outward; leaves thin, linear-lanceolate, tapering from near the broad base, which is nearly the whole width of the bolster, to the slender acuminate apex, 10 to 60 mm. or more in length, thin, ventrally concave at the base, which is open, or often reflexed, then outward curved, generally turning upward, giving a plumose aspect to the slender twigs, and often adhering to stems of considerable size: midrib distinct, rather narrow, dorsally round, diminishing gradually to the apex.

This well-marked representative of an ancient group is excellently represented among the abundant material collected by Mr. Van Ingen from Hobbs's mine, where it is especially common. This is perhaps the type locality. The mine from which the originals described by Professor Lesquereux were obtained is not stated. It is certain that all the specimens came from the vicinity of Clinton. The distinct, irregular, transverse wrinkles, which ornament the rounded surface of the bolster both below and above the leaf, and which constitute the most conspicuous specific character, as will be seen in Pl. LII, Fig. 3, are present and observable in even the small twigs. The bolsters are usually very slender and acuminate, though often broadened somewhat, approaching nearer the *L. Volkmannianum* in the older stems. In the form of the leaf scar, also, it shows its relation to the latter species, for, instead of being "transversely oval" as originally described and figured,[1] they are more or less regularly crescentic, the horns of the crescent reaching nearly to the sides a little above the middle of the bolsters. The upper convex border of the scar generally forms a sweeping curve of about 160°, with a slight interruption of the line over the vascular scar. The latter often forms a narrow keel, especially in the older branches,

[1] Lesquereux, Coal Flora, vol. ii, p. 368, pl. lxiii, figs. 1, 1*a*, 1*b*, 2.

or where the bases of the leaves are reflexed or compressed downward. Sometimes, however, it is nearly even, or appears rarely slightly emarginate, in which case the profile of the vascular trace stands out more strongly in the arch of the inward curve that marks the attachment of the lower side of the leaf. Frequently, where the leaf bases were directed upward, the compressed specimens show both edges of the scar as fairly even curves. The latter are always very close, so that the broken epidermis of the upper and lower surface of the leaf appears as a single line on the outer sides beyond the appendages. Even in the central portion of the scar I have not been able to find more than a very small transversely rhomboidal trace, such as is seen in Pl. LIII, Fig. 1*a*, the vertical diameter of which seems to be no more than that of the midrib of the leaf. In all the specimens of this easily distinguished species, including the types and other specimens from Henry County, Missouri, identified by Professor Lesquereux and now in the Lacoe collection, the leaf scar is of the same form. The examination of the original of fig. 1, pl. lxiii of the Coal Flora, shows clearly the crescentic line, which describes a rather larger arc than is indicated in fig. 1*a*. The latter figure, too, conveys a better idea of the transverse corrugations which diminish and vanish some distance below the leaf scar. Although in portions of the originals and in many of the specimens collected later the epidermis of the bolster is excellently preserved, I have not been able to discover in a single bolster a line of separation or epidermal fracture which can be construed as marking a lower border of the leaf scar. The somewhat indefinite lines marked in portions of fig. 2, loc. cit., are merely conventionalized and extended from the uppermost, short, faint, corrugations of the lower field. Here, too, a similar liberty is taken in introducing a central point in several of the supposed leaf scars, though generally only the two subcicatricial appendages are shown. The appendages are made to come within the scar by the false lower boundary of the latter. These features are not introduced in figs. 1, 1*a*, and 1*b*, of the Coal Flora, unless the singular curved line in fig. 1*b* may be so interpreted. On the other hand, in most of the fragments, including some of considerable size, in which the leaves are preserved still in union with the bolsters, the union of the lower surface of the leaf to the bolster is clearly seen to be along the upward-arching line described above. The true position and attitude of the oval or oblong respiratory appendages are shown in the lowest bolster in fig. 1*a*.

Usually when the base of the leaf is not inclined somewhat downward in the fossil state, the base of the midrib is expressed as a low, rounded ridge vanishing quickly in passing a short distance downward from the base of the leaf scar. This feature, which is indicated in fig. 1*b*, loc. cit., is well shown in our Fig. 2, Pl. LII, or Fig. 1*a*, Pl. LIV. The respiratory appendages generally lie rather close to the vascular scar and have been drawn conventionally in the Coal Flora as the lateral mammillæ of the leaf scar. In none of the specimens, including those studied by Professor Lesquereux, have I been able to discover these lateral traces within the leaf scar. This is probably on account of the very close proximity of the broken carbonized upper and lower boundaries of the leaf cicatrix.

The "ligular scar" is not generally apparent in the average specimens, but may frequently be found by a careful search of the bolsters on which the epidermis is well preserved. In No. 5489 of the Lacoe collection,[1] in which the bolsters were drawn downward in the process of fossilization, the leaf scars being consequently somewhat straightened, we find it clearly preserved a little over .5 mm. above the leaf scar as a minute mammilla in a slight depression. Any other appendicular markings or generic characters are either wanting or they are obscured by the transverse wrinkles in the upper field.

An example of the smaller and more slender leafy twigs is shown in Pl. LII, Fig. 1, while a fragment of a more robust branchlet is illustrated in Pl. LIV, Fig. 1. Branches of this size strongly resemble in their general aspect the corresponding portions of *Lepidodendron Haidingeri* Ett. or *L. lanceolatum* Lx. The leaves are thin, concave beneath at the base, near which they are usually bent backward more or less before curving outward or upward. Frequently in the larger branches, like that photographed in Pl. LIII, Fig. 1, the slender tapering tips are hardly so high as the bases. Occasionally they are found adhering to stems of considerable size, such as that shown in fig. 2, pl. lxiii, of the Coal Flora.

It would be very interesting to know the strobili of this species. It is possible that *Lepidophyllum* or *Lepidostrobus Jenneyi*, which is not rare in these beds, may belong to the branches in hand. The facts that each is the most abundant representative of its respective genus here, and that neither has, so far as I know definitely, been found elsewhere, warrant a suspicion that they may be portions of the same tree.

[1] Identified and labeled by Professor Lesquereux, from "Clinton, Missouri."

Lepidodendron Brittsii is easily distinguished from all other species of this genus, except *L. Wortheni* and *L. Volkmannianum*, by its generally elongated, fusiform bolsters, which are rounded and transversely corrugated, and by its thin crescentic leaf scars. The narrow form of its leaf scars and its more acute bolsters separate it from the older species. The chief distinctions between it and *L. Wortheni*, as figured by Lesquereux,[1] seem to lie in the much broader, more oval leaf scars of the latter, and the continuation of the distinct corrugation up to the base of the leaf. Unfortunately I have seen no really good representative of the Illinois species for comparison Professor Zeiller has, however, figured two specimens from the Valenciennes Basin,[2] in which the details as well as the general appearance are strikingly similar to *L. Brittsii.* In fact, whatever may be its relation to *L. Wortheni*, the branch on the right in fig. 1, pl. lxxi, of the Valenciennes Flora is perhaps nearer in its characters to that of *L. Brittsii*, shown in our Pl. LIII, Fig. 1, than many of the fragments referred by various authors to the same species. While there can be no doubt of the very close relation of the two plants, the more truncate bolsters in the latter species, the higher place of the leaf scar in the bolster, the less conspicuous nerve scar, and the apparently longer leaves, seem to furnish characters ample for a differentiation of varietal if not specific rank. From *L. Cliftonense* Dn.[3] our species may at once be distinguished by the distinctly diamond-shaped leaf scars of the former, whose twigs are larger, the leaves being several times as long.

Localities.—Pitcher's mine, U. S. Nat. Mus., 5640, 6042; Deepwater mine, U. S. Nat. Mus., 6040; Hobbs's mine, U. S. Nat. Mus., 6039.

Lepidodendron lanceolatum Lx.

Pl. LIII, Fig. 2.

1879. *Lepidodendron lanceolatum* Lesquereux, Coal Flora, Atlas, p. 11, pl. lxiii, figs. 3–5, 5*a*; text, vol. ii (1880), p. 369.

1887. *Lepidodendron lanceolatum* Lesquereux, Kidston, Foss. Fl. Radstock Ser., p. 394, pl. xxvii, fig. 5; pl. xxviii, figs. 3, 4.

1884. *Lepidodendron* (*Bergeria*) *marginatum* Presl, Lesquereux, Coal Flora, vol. iii, p. 784 (pars); pl. cvii, fig. 3.

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[1] Geol. Surv. Illinois, vol. ii, 1866, pl. xlix, figs. 4, 5, p. 452. Copied in Atlas to Coal Flora, 1879, pl. lxiv, figs. 8, 9, p. 388.

[2] Fl. foss. bassin houill. Valenciennes, Atlas, 1886, pl. lxxi, figs. 1, 2, p. 467.

[3] Bull. Geol. Soc. Am., vol. ii, 1890, p. 533, pl. xxii, figs. 5–8; pl. xxi, fig. 4.

Trunks of moderate size; branches somewhat rigid, forking rather infrequently; leaves slender, erect at the point of attachment, curved outward near the base, very open, straight or turned slightly upward toward the tips, narrow, tapering gradually to the very slender point; bolsters rhomboidal or rhomboidal-oval, acuminate at the ends, nearly symmetrical, the lower portion from the leaf downward consisting of a diamond-shaped or rhomboidal-clypeate surface, the upper borders nearly straight, the lateral angles usually well marked, the lower margins generally very slightly concave, the longer axis traversed throughout by a low, narrow keel, high at the upper end where it joins the midrib, very distinct throughout, and rising slightly toward its union in the somewhat protruding angle at the base of the leaf; foliar cicatrices more than halfway from the middle to the top of the bolster, extremely narrow vertically, angular, small, apparently narrowly triangular in the vertical sense, and usually obscure; respiratory appendages close to the midrib, oblong, and usually obscure.

Among the collections in hand there is but a single good fragment of this rare species, which is hardly known from any other locality in the United States. The specimen, Pl. LIII, Fig. 2, from Dr. Britts's collection agrees in all its details with others identified by Professor Lesquereux in the Lacoe collection, differing only in the better preservation of its bolsters. The latter, as is shown in Fig. 2*a*, are of the type more familiar in *Lepidodendron Sternbergii* or *L. lycopodioides*. The general form of the bolsters is rhombic, acute, and nearly bilaterally symmetrical. The conspicuous feature is, however, the diamond-shaped, slightly raised dorsal shield, which stands slightly in relief, especially at the slightly outward-curved upper end. As a whole the aspect of the shield is suggestive of *L. ophiurus*, although the lateral angles are more pronounced than in that species, while the nearly straight upper margins converge to an acute point which seems to invest the lower boundary of the narrow leaf scar. In most cases the apex of this shield is broken, and the effect is a somewhat irregular, usually concave fracture, like that seen in fig. 5 on pl. lxiii of the Coal Flora. Where preserved, however, it usually shows little evidence of a leaf scar except a very small deltoid area of broken carbonaceous matter at the upper end of the keel, with short lateral lines which are continuous with the upper margins of the shield. Fig. 5*a*, in the above-mentioned plate, shows the scar extending downward, erroneously in my judgment. The midrib of the leaf, which seems continuous with the keel of the bolster, is sometimes slightly compressed at the point of attachment, so as to convey the idea of a small, flat, triangular area somewhat like that figured, but I have not yet seen any distinct cicatricial evidence connected with it. Usually, on the other hand, the keel passes to the point, as seen in our figure, so that the vertical width of the scar is not much greater than in *Lepidodendron lycopodioides*. It differs from the latter, however, by the straight or nearly straight sides forming an angle. The surface of the shield is divided from apex to base by the medial narrow keel, which is distinct, though low. The lower lateral margins of the bolster are slightly raised and separated from the nearest field of the next bolster by a narrow zone in which is occasionally seen the narrow, faintly depressed line of the suture of the bolsters.

The two halves of each shield are generally slightly concave, perhaps on account of the constantly raised upper end of the keel. The latter in the decorticated or abraded specimens is marked by a rounded apex, in the center of which is a pore corresponding to the passage of the vascular strand. This condition I find in Nos. 5461–5464 of the Lacoe collection, which come from the same locality and were labeled as *Lepidodendron* (*Bergeria*) *marginatum* Presl by Professor Lesquereux. I fail to find the slightest reason for separating from *Lepidodendron lanceolatum* either these specimens or No. 5460 from the same vicinity, which is illustrated in fig. 3 on pl. cvii of the Coal Flora. Apparently the last-mentioned specimen is but the *Bergeria* condition of the species with which we are engaged.

All the examples labeled as the former species are older and larger stems with larger bolsters. Most of the fragments referred to the latter species are smaller branches and twigs. The leaves in all the fragments before me are slender and taper from near the base to an acute point. At the base they are directed upward, but a little higher they are flexed outward at a very open angle, from which they pass with a slight upward turn, or often straight, to the apex. Most of them are at an angle of 70° or more to the axis of the branch or twig. The central zone is frequently concave on the ventral surface, while the margins are slightly turned backward. The slender midrib usually forms a very narrow, low, round keel on the dorsal surface, and meets the apex of the keel on the shield of the bolster. The oblong respiratory appendages, which are occasionally seen, lie close to the apex of the keel and are but slightly outward inclined.

In his admirable memoir on the flora of the Radstock series Mr. Kidston figures[1] and describes stem, twig, and cone fragments which he regards as belonging to *L. lanceolatum.* The aspect of the larger fragment and its bolsters, shown in fig. 3, pl. xxviii, of his memoir, is very close to that of our species, and perhaps really represents it, though from his figure it would appear that the shields are rather less distinctly diamond shaped. As in the American specimens, the leaf scars are obscure. The larger twigs, fig. 4, which he refers to the same species, have much shorter and blunter subfalcate leaves, while the leaves of the cone-bearing branchlet, represented in fig. 5 of pl. xxvii, are very small, crowded, and upward curved. These twigs seem to sustain a much closer relation to a form known in Professor Lesquereux's works as *Lepidodendron Sternbergii.* In fact, to judge by the figures on Kidston's pl. xxviii, it seems to me probable that the Radstock plant would have been labeled by Lesquereux under the latter name. The small twig on Kidston's pl. xxvii would also seem to deserve comparison with the *Lepidodendron Sternbergii* of Lesquereux or the *L. lycopodioides* of Europe. However, the recognized danger of identifying species of this genus from figures and too brief descriptions becomes doubly great when the characters of the leaf scar are so little known.

Lepidodendron lanceolatum is not difficult of distinction from the other species of the flora from the Henry County region. It is easily separated from *L. Brittsii* Lx. by the smooth carinate shield below the leaf scars and the more slender leaves. *L. scutatum* Lx. has well-developed leaf scars placed lower in the shorter bolsters, which have fretted keels, while the leaves of the latter species are shorter, closer, more rigid, and are curved outward and upward. *Lepidodendron Sternbergii* (as interpreted by Lesquereux), to some of whose forms *L. lanceolatum* is most closely related and from which our plant is probably derived, has its bolsters less angular at the sides, the leaves being shorter, tapering less, and distinctly more or less subfalcate.

Localities.—Pitcher's coal mine, No. 377 of Dr. Britts's private collection. The specimens Nos. 5580–5583 of the Lacoe collection come from the same place or vicinity from which apparently come Nos. 5460–5465, Lacoe collection, labeled *L. marginatum* Presl.

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[1] Trans. Roy. Soc. Edinb., vol. xxxiii, 1887, p. 394, pl. xxvii, fig. 5; pl. xxviii, figs. 3, 4.

LEPIDODENDRON RIMOSUM Stb.

1820. *Lepidodendron rimosum* Sternberg, Versuch, vol. i, fasc. 1, pp. 21, 23, pl. x, fig 1; tent. (1826), pl. xi.
1848. *Lepidodendron rimosum* Stb., Sauveur, Vég. foss. terr. houill. Belg., pl. lxii, fig. 1.
1866. *Lepidodendron rimosum* Stb., Dawson, Quart. Jour. Geol. Soc., Lond., vol. xxii, pl. ix, fig. 42.
1869. *Lepidodendron rimosum* Stb., Von Roehl, Foss. Fl. Steink. Westphalens, p. 132, pl. viii, fig. 1.
1870. *Lepidodendron rimosum* Stb., Schimper, Traité, vol. ii, p. 33, pl. lx, fig. 8.
1879. *Lepidodendron rimosum* Stb., Lesquereux, Coal Flora, Atlas, p. 12, pl. lxiv, fig. 11; text, vol. ii (1880), p. 392.
1881. *Lepidodendron rimosum* Stb., Weiss, Aus d. Fl. d. Steink.. p. 7, pl. iv, fig. 28.
1882. *Lepidodendron rimosum* Stb., Renault, Cours bot. foss., vol. ii, p. 15, pl. v, figs. 6, 7.
1883. *Lepidodendron rimosum* Stb., Lesquereux, 13th Ann. Rept. Geol. Surv. Indiana, 2, pl. xvii, fig. 3.
1884. An *Lepidodendron rimosum* Stb., Kidston, Ann. Mag. Nat. Hist., (5) vol. xiv, p. 115, pl. v, fig. 5?
1886. *Lepidodendron rimosum* Stb., Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. lxvii, figs. 4, 5, 5*a*; text (1888), p. 449.
1889. *Lepidodendron rimosum* Stb., Lesley, Dict. Foss. Pennsylvania, vol. i, p. 321, text fig.
1838. *Sagenaria rimosa* (Stb.) Presl, in Sternberg: Versuch, vol. ii, fasc. 7 and 8, p. 180, pl. lxviii, fig. 15.
1855. *Sagenaria rimosa* (Stb.) Presl, Geinitz, Verst. Steink. Sachsen, p. 35, pl. iii, fig. 13 (non pl. ii, figs. 1, 3, 4; pl. iii, fig. 15; pl. x, fig. 2).
1859. *Sagenaria rimosa* (Stb.) Presl, Eichwald, Lethæa Ross., vol. i, Atlas, p. 1, pl. vii, fig. 7; text (1860), p. 125.
1875. *Sagenaria rimosa* (Stb.) Presl, O. Feistmantel, Verst. böhm. Kohlen.-Ablag., vol. ii, p. 36 (pars), pl. xix, fig. 1.
1848. *Lepidodendron dissitum* Sauveur, Vég. foss. terr. houill. Belg., pl. lxi, fig. 6 (pl. lix, fig. 3 ?).
1860. An *Lepidodendron dicrocheilus* Wood, Proc. Acad. Nat. Sci. Phila., vol. xii, p. 239, pl. vi, fig. 1?
1866. *Lepidodendron dicrocheilum* Wood, Trans. Amer. Phil. Soc., vol. xiii, p. 346, pl. ix, figs. 6, 6*a*.

LEPIDODENDRON RIMOSUM Stb. RETOCORTICATUM, nov. var.

Pl. LIV, Figs. 3, 4.

Among the numerous fragments of *Lepidodendron* recently collected one clearly belongs to this well-marked type. This specimen, as will be seen in Pl. LIV, Fig. 3, represents the impression of the cortex of a stem that seems to be in a Ulodendroid condition. The bolsters, the details of which are shown in Pl. LIV, Fig. 3*a*, are, even for this species, very slender, tapering into long, slender, filamentous tips that are lost in the meshes of the cortex. The leaf scars situated just above the middle of the bolsters are about one-half of the width of the bolsters, rhomboidal, the vertical and lateral diagonals being nearly equal. The upper margins, which are a little longer than the lower, are sometimes slightly concave, the upper, slightly acute angle, being round or obscurely and narrowly emarginate, while the lower margins are nearly at a right angle, the lateral and lower angles being slightly rounded. A little above the leaf scar the ligular scar can sometimes be seen The three cicatricules within the leaf scar lie at the same level, distinctly below the middle of the scar, the vascular cicatrix being punctiform or slightly V-shaped, while the respiratory traces are round-oval or oval, the lower ends inclined slightly inward. Traces of respiratory appendages are not seen.

A prominent feature of the fragment of stem, which seems wide in proportion to the size of the bolsters, is the loosely and irregularly meshed surface lines traversing the broad border. These lines, which are irregular in interval and uneven in direction, mark the impressions of the bark as sharp, nearly longitudinal, ridges. Although at first glance they appear to lie in a general direction of parallelism to the borders of the bolsters, they may readily be seen to consist of two oblique systems of ridges crossing at a very acute angle. Thus, many of those from the upper margins of each bolster appear to pass obliquely to the lower margins of the proximate bolsters, higher on either side as is seen in Fig. 3*a*. The irregularity of the size of the meshes is largely due to the variation in the distance between the ridges and the somewhat irregular lines, combined with the interruptions caused by the very long apices of the bolsters.

Another specimen, said to have come from Clinton, Missouri, is illustrated in Pl. LIV, Fig. 4. This fragment, No. 5280 of the Lacoe collection, was identified as *Lepidodendron rimosum* by Professor Lesquereux. This impression in sandstone shows well the aspect of the bolsters and meshes of the cortex, and the low keels in the lower and upper fields. No transverse lines mark the cauda. The photograph leaves nothing to add as to the leaf scars, which are imperfect and without satisfactory details.

The form represented by these two specimens appears to merit a varietal differentiation. The new variety *retocorticatum* may therefore be distinguished by the narrow bolsters, the proportionately greater altitude of the leaf scars, the low position of the interior cicatrices, the absence of transverse ridges in the cauda, and especially by the netted surface of the broad border. The habit of the two oblique systems of cortical ridges is suggestive of *Sigillaria camptotænia* Wood. The normal species is generally represented as having the margin striated parallel to the sides of the bolsters, the apices of the bolsters less attenuated, the foliar cicatrices proportionately broader and more obtuse at the base.

Localities.—The smaller specimen is probably from Owen's mine, U. S. Nat. Mus., 6043; the other, No. 5280 of the Lacoe collection, U. S. Nat. Mus., is said to have come from the same vicinity.

Lepidodendron scutatum Lx.

Pl. XLV. Fig. 4; Pl. LIV, Fig. 5; Pl. LV, Figs. 1, 2; Pl. LXXII, Fig. 4.

1879. *Lepidodendron scutatum* Lesquereux, Coal Flora, Atlas, p. 11, pl. lxiii, figs. 6, 6*b–c;* text, vol. ii (1880), p. 269.
1880. *Lepidodendron setifolium* Lesquereux, Coal Flora, vol. ii, p. 370.

But little that is definite is known of this species, the types of which were communicated to Professor Lesquereux by Dr. J. H. Britts. The largest of the types shown by Lesquereux, in fig. 6, pl. lxiii, of the Coal Flora, is now No. 5448 of the Lacoe collection. The original figure shows the general form of the bolsters, the position of the leaf scar, and the aspect of the vanishing cauda with its slight transverse grooves. It also gives a correct impression of the aspect of the cicatricial portion in many of the bolsters. While, however, the bolster shows in most instances an irregular conchoid, roundish, mutilated or torn spot in place of the leaf scar, as seen in the illustration, there are a number of cushions in which the lower and lateral angles of what appear to be transversely rhomboidal leaf scars are seen. Traces of oval appendages are also visible at a little distance on either side of the lower rounded angle. On the other hand, I have observed no distinct supracortical evidence to warrant the detail delineated in fig. 6*a* of the same plate. The same fragment of shale shows another section of stem, agreeing in every detail of size and character, and apparently, from its position and proximity, constituting the other branch in an equal dichotomy. The counterpart of this is No. 5600 of the Lacoe collection.

The present repository of the original of the two smaller figures given, without details, by Professor Lesquereux is not known to me. My identification, therefore, of the more recently collected material with *Lepidodendron scutatum* is not without doubt, since it is based much more on the high degree of agreement of the newer specimens with those two figures than on the characters of the type of fig. 6. In fact, it will be seen that the specimens in the later collections can hardly be of the same species as the latter type. Yet, being far from certain that they are not specifically identical with the figs. *6b* and *6c* in the Coal Flora, I have assumed that Professor Lesquereux may have included two distinct plants in *L. scutatum*, and that the material in hand belongs with figs. *6b* and *6c*, on pl. lxiii, of his great work. It may in fact have come from the same locality. Nevertheless, while I refer all the stems and branches to the same specific division, I trust that the figures and following description of the recently collected material will be sufficient both to enable geologists to recognize the plant on meeting it, and also to serve as a line of differentiation, if it is ultimately found desirable to divide the material placed at present under the above name.

The description of the later collected material is, briefly, as follows:

Stems rather small, branching freely at a narrow angle; branches and branchlets generally straight, rigid, and robust, the smaller ones rather thickly set with leaves; bolsters small, close, rhomboidal or rhomboidal-oval, 4 to 12 times as long as wide, acute or acuminate at the end, sometimes foreshortened by pressure, the lateral angles well rounded, marked by a low, narrow carinate and generally inconspicuous cauda, which extends from the lower angle nearly up to the leaf scar, and a few quite obscure, short, transverse frets in the lower portion; foliar cicatrices in the upper part of the bolsters, placed so that the lower angle frequently reaches the middle of the bolster, rather more than one-half the width of the latter, slightly protruding, transversely rhomboidal, the upper margins usually a very little longer than the lower and very slightly concave, the lower borders nearly straight, the upper angle rounded, the lateral acute angles blunt or slightly rounded in the twigs, the lower angle well rounded; transpiratory vents, a short distance on either side of the median line, oval and generally quite obscure; vascular trace punctiform, situated a little way below the middle of the scar; lateral cicatricules rather close, punctiform or vertically oval and small; ligular scar punctiform in a V-shaped depression a short distance above the apex of the leaf scar; leaves close, 12 to 35 mm. long, open at the base, arching outward and curving upward, very narrow, tapering to an acuminate, nearly erect tip, somewhat angular on the dorsal surface, often markedly so; midrib threadlike, in rounded relief on the dorsal surface; lateral grooves usually slightly marked on the dorsal surface.

The fragment of stem shown on Pl. LV, Fig. 2, with the detail (Pl. LIV, Fig. 5), is a good example of the larger portions of stem seen, while the leafy branch shown in Pl. LXXII, Fig. 4, is rather more slender and sparsely leaved than the average specimen. The good suite of fragments is very uniform in the specific characters, there being hardly any variations except in the ends of the bolsters, which are sometimes deformed or foreshortened by pressure, or the slight inward or outward curve of the borders of the leaf scar. Prevailingly, however, the upper borders are very slightly concave, while the lower are nearly straight or very slightly convex. The ligular mammilla is in a small triangular depression on the imperfectly developed keel in the upper field, while still higher in a few specimens may be seen another small deltoid area. The largest of the fragments present is not more than 5 cm. in diameter. The ramose habit of the species is shown in Pl. LV, Fig. 1.

The specimens described above bear the closest relation in the details of the bolsters and leaf scars to certain material from the Appalachian region referred by Professor Lesquereux to *Lepidodendron dichotomum* Stb. It even seems probable that they should be combined under the same name, as may eventually be done. But since the specimens included under the latter name appear to represent branches of several species involving the thorough revision of that and several other related species, time and space necessitate the postponement of this difficult task to a future work. As has been noted above, the reference of the material to *L. scutatum* rests on the apparent agreement with the meager description and figures of the two small branch fragments given by Professor Lesquereux. I am inclined to regard it as specifically distinct from the larger fragment illustrated in the Coal Flora, to which the name *Lepidodendron scutatum* should probably adhere. Eventually the systematic relation and nomenclature of the form before us should be treated in connection with the revision of the American material now resting under *Lepidodendron dichotomum* Stb.

The species described above is easily separated from the other species of *Lepidodendron* found in the Henry County region by the shorter bolsters, the imperfect, transversely marked cauda, the well-developed tripunctate leaf scars, much broader vertically than in the species previously discussed, and the still more slender, often carinate leaves.

Localities.—Owen's coal mine, U. S. Nat. Mus., 6045, 6046; Pitcher's mine, U. S. Nat. Mus., 6044, 6074; Gilkerson's Ford, Township of Clinton, U. S. Nat. Mus., 6117.

LEPIDODENDRON CLYPEATUM Lx.

1854. *Lepidodendron clypeatum* Lesquereux, Jour. Bost. Soc. Nat. Hist., vol. vi, p. 429.
1858. *Lepidodendron clypeatum* Lesquereux, in H. D. Rogers: Geol. Pennsylvania, vol. ii, 2, p. 875, pl. xv, fig. 5; pl. xvi, fig. 7.
1879. *Lepidodendron clypeatum* Lesquereux, Coal Flora, Atlas, p. 12, pl. lxiv, figs, 16, 16 *a–b* (non figs. 17, 18); text, vol. ii (1880), p. 380.
1889. *Lepidodendron clypeatum* Lx., Lesley, Dict. Foss. Pennsylvania., vol. i, p. 315, text fig.
1895. *Lepidodendron clypeatum* Lx., Dana, Man. Geol., 4th ed., p. 668, fig. 1034.

The single specimen representing a mold in sandstone, which I refer to this species, is, by the characters of the bolster and the form of the very large leaf scar, nearer the fossils from the Boston mine, near Pittston, Pennsylvania, which were labeled by Professor Lesquereux under the above name, than to any other *Lepidodendron* known to me. In fact, it differs from the Pittston fossils only by the rather less acute lateral angles of the leaf scars and the often higher position of the interior traces. The specimens from the Boston mine are probably varietally different from the original types figured in the Geology of Pennsylvania,[1] in which the leaf scars are proportionately much smaller. That type appears from the figure to be closer to the specimens from Cannelton in western Pennsylvania, recorded under this name, which are undoubtedly distinct from the form in hand.

In his memoir on the plants from the Ayrshire coal fields, Mr. Kidston[2] records *Lepidodendron clypeatum* Lx. in the synonymy of *L. obovatum* Stb., and, in addition, remarks on the specific identity of specimens, presumably from Pittston, communicated to him by Mr. Lacoe. While I confess I should hardly have identified the specimens from the Boston mine with the European figures by which alone *L. obovatum* is known to me, it is necessary to note that our specimens from that mine are very different from the American specimens referred by Professor Lesquereux to the last-named species. Compared with other material from this country, the form from the Boston mine is most intimately related to a form in the upper part of, and somewhat characteristic of, the Pottsville series, generally recorded in our literature as *L. Veltheimii* Stb. It bears a close resemblance to the *L. Rhodeanum* figured by Stur in the Ostrau-Waldenburg Flora.

Locality.—Four miles south of Clinton, Missouri, from a horizon about 60 feet above the Jordan coal. Collected by Dr. Britts.

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[1] Vol. ii, pt. 2, 1858, pl. xv, fig. 5.

[2] On the fossil plants of the Kilmarnock, Galston, and Kilwinning coal fields, Ayrshire: Trans. Roy. Soc. Edinb., vol. xxxvii, 2, 1893, No. 16, p. 336.

LEPIDOPHLOIOS Sternberg, 1825.

1825. *Lepidophloios* Sternberg, Flora d. Vorwelt, vol. 1, tent., p. xiii.
1833. *Halonia* Lindley and Hutton, Foss. Flora, vol. ii, p. 14.
1836. *Pachyphlœus* Goeppert, Foss. Farrnkr., p. 468 (pars).
1838. *Zamites* Presl, in Sternberg: Flora d. Vorwelt, vol. ii, fasc. 7–8, p. 195 (pars).
1855. *Cyclocladia* Goldenberg (non L. and H.), Fl. Saræp. Foss., vol. i, p. 19.
1867. *Lomatophloios* Corda, Flora d. Vorwelt, p. 17.

Arborescent lycopods with dichotomous ramification. Stems and branches bearing much developed scalelike leaf cushions, at or near whose summit is placed the leaf cicatrice. Leaf cushions imbricated, pedicel-like, upright or deflexed; exposed portion with straight sides or rhomboidal in outline, smooth or carinate; sometimes provided with a small tubercle immediately beneath the leaf cicatrice. Leaf cicatrices transversely oval, rhomboidal or rhomboidal-elongate, lateral angles rounded or acute, upper and lower angles generally rounded, sometimes pointed; within leaf cicatrice are three punctiform cicatricules, of which the central is largest and sometimes subtriangular in form. Fructification consisting of cones, stalked (? or sessile), borne on specialized branches which show, when decorticated, spirally arranged protuberances (*Halonia*); in corticated condition the Halonial scars rise little above or are on a level with the bark, and are represented by a rosette of deflected leaf cushions. Medulla of delicate cells surrounded by a primary vascular axis composed of scalariform vessels which diminish in size from within outward, exogenous vascular zone only developed in specimens advanced in age; bark consisting of three zones—the innermost of small cells, the middle of larger and irregular dense cells, and the outer composed of narrow, dense, prosenchymatous tissue.

In his admirable memoir,[1] from which the above generic diagnosis is quoted, Mr. Kidston, after reviewing in a most painstaking manner both the literature and many of the specimens of the previous authors, enters into a detailed examination of the British material for the purpose of definitely determining the relations of *Lepidophloios*, *Lomatophloios*, and *Halonia*. As a result of this invaluable study we learn (1) that the Sternbergia pith, originally described as proper to *Lomatophloios*, is not organically united to the cortex described under the latter name; (2) that *Lepidophloios* and *Loma-*

[1] On Lepidophloios and on the British species of the genus: Trans. Roy. Soc. Edinb., vol. xxxvii, pt. iii, No. 25, 1893, pp. 529–563, pls. i, ii.

tophloios, which, though united by many paleobotanists, have been kept separate by others on the ground that the leaf scar in the latter is at the top of the bolster instead of at the base, as in the former, are really identical, since the bolsters may be inclined (and so compressed) upward, especially in the smaller branches of certain species, or downward, according to the species, or even to the part of the tree, the leaf being situated, morphologically, at the apex and always rising upward; (3) that the tuberculate branches described as *Halonia* and regarded as a distinct genus of trees, as roots or rhizomes of *Lepidodendron*, as branches of *Ulodendron*, and (especially more recently) as branches of *Lepidophloios*, are unquestionably merely the fructiferous branches of the last-named genus, since they have the same bolsters and are found in actual union: (4) that the fruit is in the form of cones, originating, whether sessile or pedicellate, from the Halonial tubercles.

The identity of *Lepidophloios* and *Halonia* was independently and almost simultaneously demonstrated by Potonié.[1] The latter author also discovered, while studying the organization of some dolomitized bolsters of *Lepidophloios* from Langendreer, that the two lateral cicatricules in the leaf scar were cross sections of cavernose tracts of thin-walled parenchyma. These tracts pass downward within the bolster and coincide with the appendages on the bolster at the base of the leaf, the walls of the bolster being very much thinned at those points. There appears little room for doubting Potonié's conclusions that the tracts of thin-walled parenchyma are transpiratory ducts, while the appendages in the bolsters of *Lepidodendron* and *Lepidophloios* are "transpiratory openings."[2] Potonié follows Stur in regarding the vertical trace above the leaf on the bolster in the Lepidodendra as the "ligular pit."

Although the genus *Lepidophloios* is relatively rare in our American Coal Measures, the species described therein offer a complex of unique features that promise an interesting if small field to the monographer. The only species yet found in the Missouri flora that unquestionably belongs to this genus is described below as *L. Van Ingeni*. The superficial cortical features of the trunk of this tree are usually well presented in numerous

[1] Die Zugehörigkeit von Halonia: Ber. d. deutsch. bot. Gesell., 1893, vol. xi, Hft. 8, pp. 484–493, pl. xxiii.

[2] Anatomie der beiden "Male" auf dem unteren Wangenpaar und der beiden Seitennärbschen der Blattnarbe des Lepidodendreen-Blattpolsters: Ber. d. deutsch. bot. Gesell., 1893, vol. xi, Hft. 5, pp. 319–326 pl. xiv.

specimens, supplemented by a large number of detached and only partially compressed bolsters. Associated with this species are also certain leaves which, to judge by circumstantial evidence, are not likely to have grown on any other type of cortex.

As fructifications of this genus fragments of cortex, cones, scales, or sporocysts, and Cordaianthus-like racemes, have been described by various authors. Of these supposed fruits I have seen only certain Lepidocystes or Polysporia, and the singular remains figured by Lesquereux[1] as belonging to *L. dilatatus*, a species very closely related to *L. Van Ingeni*. The originals of the figures of the supposed fruits, now in the Lacoe collection in the United States National Museum, are certainly both problematical and interesting; but while they no doubt represent a single type by themselves, there hardly seems to be sufficient reason for considering them as pertaining to *Lepidophloios*, and I shall not therefore further discuss their structure or relation in this place.

The fragments of cone described by Goldenberg[2] and Von Roehl[3] probably belong to some large species of *Lepidophyllum*, such as *L. majus*. The similarity of the bracts of these cone fragments to the leaves on the branch of the *Lepidophloios acerosus* L. and H., illustrated by Kidston,[4] is at least very suggestive. In another place I have described as *Lepidophyllum* (*Lepidostrobus*) *missouriensis*, a species frequently found associated with fragments of the *Lepidophloios*. The fragment, Pl. LX, Fig. 1, apparently representing a cone of this species, which I am inclined to consider as referable to the *Lepidophloios*, merits a comparison with the bracts or leaves figured by Goldenberg and Kidston. It is perhaps a significant fact that generally in the American Coal Measures some large *Lepidophyllum* is reported from the same locality as one of these species of *Lepidophloios*. Examples are *Lepidophloios dilatatus* and *Lepidophyllum Mansfieldi* from Cannelton, Pennsylvania, *Lepidophloios auriculatus* and *Lepidophyllum auriculatum* from Morris, Illinois. Caution, however, must always be used in considering the argument of coincidental occurrence.

Quite unlike any described Paleozoic Lycopodineous fruit are the

[1] Atlas to Coal Flora, pl. lxviii, figs. 6, 7; text, vol. iii, p. 781, pl. cv, fig. 1.

[2] Fl. Saræp. Foss., vol. i, 1855, pl. iii, figs. 13*a*, 13*b*, p. 21; vol. iii, pl. xv, fig. 5, pp. 33, 34.

[3] Foss. Fl. Steink. Westphalens., pl. xiii, figs. 1*a*, 1*b*, p. 149. A portion of fig. 1*a* is copied by Lesquereux in Coal Flora, pl. lxviii, fig. 1.

[4] Op. cit., pl. i, fig. 1.

Cordaianthus-like, racemose fructifications springing from rosettes among the leaf bases of a short subtruncate-conical stem figured by Grand 'Eury.[1]

Judging from the figure, it seems to the writer that the fossil in M. Grand 'Eury's hands may rather be the trunk of some Gymnosperm related to the Cycads. The irregular and sometimes intercalated areolation, which seems to circumscribe by rigid, prominent walls the deeply sunken leaf bases or bolsters, is quite like that about the leaf bases in the *Cycadeoideæ* group, while the racemose organs of fructification, resembling *Cordaianthus*, will at once reinforce this idea by the suggestion of *Bennettites*. The presence of well-preserved Cycadaceous fronds described as belonging to the Mesozoic genera *Pterophyllum* and *Zamites*, in the Upper Coal Measures in several of the European basins, seems to fully warrant an inquiry as to whether Grand 'Eury's specimen which has so great superficial resemblance, even in the smaller areolation about the inflorescence pedicels, to the Cycadeoidean group represented by *Cycadeoïdea*, is not Cycadaceous in its affinities. Unfortunately the author gives no information, either by description or enlarged detail, as to the characters of the sunken leaf bases.

The internal structure of *Lepidophloios* described by Williamson and others as bearing the closest relation and similarity to that of *Lepidodendron* favors a predisposition to search for the fruit of the former, manifested in some form comparable if not identical with *Lepidostrobus*.

Lepidophloios Van Ingeni n. sp.

Pl. LVI, Figs. 1–8; Pl. LVII; Pl. LVIII, Fig. 1?; Pl. LXI, Fig. 1*c*; Pl. LXII, Fig. *f*; Pl. LXIII, Fig. 5.

Trunks of large size, showing, when decorticated and compressed, the outlines of the diagonal rows of bolsters marked by rather long incision-like longitudinal pits, the lower ends of which correspond to the ventral traces on the bolsters; bolsters transversely rhomboidal, nearly twice as broad as long, the lateral angles well rounded, the proximal or lower sides more or less concave and apparently forming a well-rounded angle at the base, the lower margins being nearly straight, or slightly concave near the middle, including an angle of about 135°, not carinate, protruding moderately, imbricated so that each bolster overlaps somewhat on the one next below, the leaf scar being at or close to the lower border of the exposed

[1] Géol. et pal. bassin houill. Gard, 1890, p. 234, pl. vi, fig. 17.

surface, and therefore directed downward; exposed surface of the bolsters on the compressed specimens rather narrowly transversely rhomboidal, very acute at the sides, the lateral angles very slender and often curving slightly downward in passing around the median arch of the next bolster below and to the left, the four sides being nearly straight, though really sinuate, and unsymmetrical on the upper border by reason of the phyllotaxy; lower borders of the exposed surfaces generally slightly concave, though very nearly straight except when passing around the median arch of the preceding bolster in the next spiral to the left; leaf scar usually in the lower angle of the compressed bolster, transversely rhomboidal, the lateral angles very slender and acute; lower borders of the scar slightly concave near the lateral angles, nearly straight in the middle, at an angle of about 135°, and rounded at the base of the scar; upper borders of the scar somewhat concave and rounded near the median line to a flat or sometimes distinctly emarginate upper angle; inside cicatricules below the middle of the leaf scar; vascular trace always below the middle of the leaf scar, round or slightly elongated horizontally, the lateral cicatricules being very small, punctiform, rather distant from the center and situated very close to the lower margin of the scar; ventral trace very close to the leaf scar, small, broadly triangular, and situated at the distal end of a low-rounded, vanishing longitudinal ridge.

On entering upon the study of the specimens of *Lepidophloios* from Missouri described above, it seemed probable that among the material, which fortunately had been collected in good quantity, would be found some representatives of *Lepidophloios dilatatus* Lx., a number of the originals of which are said to have come from the same beds in the same region. But although the discovery in the Lacoe collection of several fragments from the vicinity of Clinton labeled with the latter name by Lesquereux made it seem certain, especially since they are specifically identical with those before me, that this anticipation would be realized, very careful examination and comparison of all the Missouri specimens to which I have had access with the description and figures given by Professor Lesquereux[1] have led me to the conclusion that the figured originals, all of which are said to have come from Cannelton, Pennsylvania, are specifically distinct from the examples from Missouri, even those labeled by the author.

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[1] Coal Flora, vol. iii, p. 781, pl. cv, figs. 1–4.

In Pl. LVII, and Pl. LVI, Figs. 1 and 2, I have shown several specimens which illustrate the general characters of the compressed stems of the species before me. As seen in the enlargements, Pl. LVI, Fig. 2*a*, 2*b*, and Pl. LVII, Fig. 1*a*, the exposed surface is rhomboidal, the sides being fairly straight, the lateral wings very acute and often prolonged and sinuate. The lower angle is rounded at the median line, while the borders on either side are usually slightly concave, though sometimes very nearly straight. The leaf scar, as described above, is remarkable for the prolongation of the lateral angle, its great width as compared with its altitude, the rather broadly rounded base, and the generally flat or often distinctly emarginate upper angle.

In the form of the compressed cushions and of the leaf scars, our specimens agree so closely with fig. 2, pl. cv, of the Coal Flora as to suggest that both fragments might have been found in the same locality. Furthermore, this suggestion is emphasized by the fact that in No. 5943 of the Lacoe collection, which was marked by Professor Lesquereux as the original of fig. 2 in the Coal Flora, and which came unquestionably from Cannelton, as was originally stated, the lower borders of the bolsters are generally very much more rounded than is shown in the figure. A comparison, however, of the cicatricules and ventral trace shows that in the specimens from Missouri the central cicatricule or vascular scar is generally distinctly below the middle of the leaf scar, the lateral cicatricules being very close to the basal margin, and the ventral trace close to the upper border of the scar, while in the figure in the Coal Flora the vascular trace is close to the upper margin of the scar, the lateral traces being situated about midway in the altitude of the scar, while the ventral trace is generally nearer the borders of the bolster next above. In bolsters of about the same size the ventral trace is seen to be only about one-half as far above the leaf scar as in the type from Cannelton. Moreover, while the cicatricules on the type of fig. 2 are often obscure, there seems to be good reason for representing them as is done in the figure. Finally, the real form of the uncovered bolster in the original from Cannelton shows a very much rounder type, its form being nearly intermediate between *L. Van Ingeni* and *L. auriculatus* Lx. Hence, notwithstanding the close resemblance in the form of the exposed part of the bolster and leaf scar in the type of fig. 2 and in the Missouri tree, I feel constrained to regard them as belonging to different species. For the Cannelton type of bark the name *Lepidophloios dilatatus* may be retained, especially since there is doubt as to the generic identity of the supposed fructifications also described under that name. It seems doubtful whether the latter represent any portion of a tree of *Lepidophloios*. To the Cannelton species probably belongs also the original, which I have not seen, of fig. 4 in the Coal Flora. The points of resemblance and difference in the exposed portion of the compressed bolsters may be noted by a comparison of Fig. 2, Pl. LVI, representing No. 5944 of the Lacoe collection, or Pl. LVII, which is more compressed, with fig. 4 in the Coal Flora. So, too, fig. 2 of the Coal Flora may with interest be compared with the photograph given in Pl. LVII of a small portion from a large trunk. This fragment, 42 cm. long, 28 cm. wide, compressed to a thickness of 2 cm., fails to give an adequate idea of the probably great diameter of the trunk, since neither lateral margin is shown. Before leaving the discussion of the compressed stems we may note that the gash-like impressions on the decorticated surface of the trunk appear to nearly correspond in position to the ventral trace. The lower vanishing ends of the furrows hardly reach the profile of the upper border of the foliar scars in the compressed specimens, while the middle part is slightly below the line of the ventral traces.

An interesting feature of the more recent collections from Missouri is the occurrence of isolated or small groups of detached bolsters found in relatively large numbers, especially at Gilkerson's Ford. Several of these are shown in their association with other plants in Fig. 1*c*, Pl. LXI; Fig. *f*, Pl. LXII, and Fig. 5, Pl. LXIII. The chief details of these may be seen in the photographs. Most of these detached bolsters from this locality appear as casts of the spongy tissue, to which are attached patches of dull carbonaceous crust, attaining a thickness of about 5 mm., which probably represents cortical tissue as well as the real epidermis. In general it will be noted that the greater inflation of the bolsters is toward or at the side opposite the leaf scar. This side is usually, as shown in Figs. 4 and 7, and Pl. LVI, somewhat collapsed and wrinkled, or even slightly infolded. The infolding is specially strong near the lateral angles, which in profile often appear quite sharp (Fig. 5). In Figs. 1 and 2, Pl. LVI, it is plain that the bolsters imbricate for a considerable distance on those below. It also appears that a portion of the dorsal surface of the upper bolster must lie beneath it and upon the upper ventral borders of the bolsters partly underlying it. If any such expansion exists, however, it must be greatly constricted at the point of attachment. None of the isolated bolsters are so preserved as to show a dorsal surface of any considerable size. Such as are preserved so as to show the carbonized cortex concave seem to represent merely an inner surface conforming to the wall shown convex in the other instances, and without trace of the leaf scar, though the ventral cicatrix is distinct. A conspicuous character of all the bolsters from which the cortical residue has been removed is the large and deep pit, often vertically elongated, corresponding to the ventral trace. The ventral trace is prominent also on the under surface, as may be seen in Fig. 5, Pl. LVI, or Figs. 3 and 6. A not uncommon wrinkling in a generally longitudinal direction of the interior (?) casts of the leaf cushions, which is probably due to the flattening of the bolster, is best seen in Pl. LVI, Fig. 4, in which the interior casts of the lateral cicatricules or transpiratory tracts are seen to be very large and prominent. In Fig. 7 the wrinkling is very slight.

Several other detached bolsters deserve illustration. One of these, Pl. LVI, Fig. 8, from Pitcher's coal mine, represents the impression or mold of a large detached bolster, 47 mm. broad and over 25 mm. in altitude. In this specimen the outline of the foliar side and of the widely rounded lateral angles is well shown, as is also the inflation in the side opposite the leaf scar. This inflation, which corresponds to that seen in the specimens from Gilkerson's Ford, has here caused the wall to turn up nearly vertical, producing wrinkling, the precise extent of which can only be estimated from the comparison of the other bolsters. The margins on either side of the leaf scar are regular and natural, though slightly abraded along the central portion of the foliar scar. The position of the ventral cicatrix, relatively close to the leaf scar, is very clear.

In arranging the figures on the plates and in my taxonomic references I have conformed to the generally accepted conclusion that the flatter or more emarginate border of the leaf scar is its upper margin, the small deltoid or subtriangular pit or trace being thus ventral. Nevertheless, the apparent outlines of the detached bolsters, the marginal position of the leaf scars, together with the general form of the side opposite the scars, seem entirely incompatible with a pronounced bulbil or stalklike form or habit in these bolsters, as in *L. crassicaulis* Gold., or *L. scoticus* Kidst. It is evident that either the leaf scar was at the summit of a relatively thin, shell-like or scale-like cushion or leaf base, attached along a portion of the margin of the compressed fossil opposite the leaf scar, an hypothesis at variance with the aspect of the decorticated trunks and the area apparently occupied by each bolster, or that the attachment was by the entire periphery of the detached bolsters, in which case the latter were but slightly protuberant. To explain the areolation of the decorticated trunk and the slight imbrication of the bolsters, as shown in Fig. 2, photographically enlarged with reversed light in Fig. 2*a*, Pl. LVI, it is necessary to assume that the bolsters were short and but slightly protuberant, and that they were attached by the whole border shown in the separated examples, the imbrication being but slight.

To *Lepidophloios Van Ingeni* belong, I believe, the scales and cone described in another part of this report as *Lepidophyllum* (*Lepidostrobus*) *missouriense*. The relation of such cones to *Lepidophloios* has been referred to in my remarks on the genus. The association of the scales in the same matrix with the bolsters, e. g., Pl. LXI and Pl. LXII, as well as the fact that this is the only satisfactory species of *Lepidophloios* yet found in these beds, point to mutual relations of stem and cone in the remains described under the two names.

Likewise it is probable that the very broad Lycopodineous leaves described as *Lepidophloios* sp., Pl. LVIII, Fig. 1, may safely be cited as the leaves of *L. Van Ingeni*. To this species should also be assigned a large, slightly obscure impression, No. 2267 of the United States National Museum collection, enrolled by Professor Lesquereux in the register as *Sigillaria Defrancii* Brongn.

Lepidophloios Van Ingeni differs from *L. auriculatus* and *L. macrolepidotus* Gold. by the straight lower margins of the bolsters. *L. laricinus* has the upper angle of the ordinarily exposed surface acute, not rounded, the leaf scar being of greater altitude in proportion to its breadth, the upper angle smaller, and the cicatricules near the center and in a row. The large specimen of cortex from Cannelton, Pennsylvania, described as *L. dilatatus*, has the bolsters more rounded at the top, the sides when exposed more rounded, the ventral trace farther from the leaf scar, and the cicatricules near or above the center.

Localities.—Clinton, Henry County, Missouri, Nos. 5944, 5947, 5951, 5953, 5954, of the Lacoe collection; Gilkerson's Ford, U. S. Nat. Mus., 6048–6052, 6075; Pitcher's coal mine, U. S. Nat. Mus., 6047, 6053; Henry County, Missouri, Old Museum collection, No. 2267.

LEPIDOPHLOIOS (?) cf. VAN INGENI.

Pl. LVIII, Fig. 1.

Among the specimens from Pitcher's coal mine and Gilkerson's Ford are numerous fragments of large Lycopodineous leaves, reaching a width of 12 mm. or more at the base and a length of 24 cm. or more, tapering gradually from the base to the very slender, acute apex. Portions of two of these leaves, associated with twigs of *Lepidodendron Brittsii*, are illustrated in Pl. LVIII, Fig. 1. In the broader segment, the dorsal surface of which is presented, the median nerve is rather prominent and angular in the lower middle portion, though flattened and rounded toward the base. On either side, and at a distance of about 2 mm. from the median line, is a narrow zone, depressed in portions of its length, marked distinctly at some points by a double line. This I interpret as the stomatiferous zone. Both between and outside of these zones there are other parallel lines or striæ which resemble filaments or slender vascular strands. The feature of most interest in the specimen is the impression of the upper part, if not the whole, of the leaf scar. This scar, in which the midrib and lateral lines vanish, occupies the whole breadth of the leaf base, and was evidently of very little altitude. It appears to agree with the foliar cicatrices of *Lepidophloios Van Ingeni*, to which I believe the leaves to belong.

The reasons for regarding these leaves as pertaining to the trunks of *Lepidophloios Van Ingeni* are: (1) The great width of the leaf bases, which are much wider even than the leaf scars of *Sigillaria camptotænia* Wood; (2) the similarity in proportions between the impressions on some of the leaf bases and the foliar scars on the cortex of *L. Van Ingeni*, there being no other trunk known from this region with leaf scars of this size and approximate form; (3) the considerable distance between what appear to be the stomatiferous zones, which accords with that between the lateral cicatricules in the *Lepidophloios*, but which is much greater than in the *Sigillaria* above mentioned, and (4) the coincident occurrence of these leaves and the trunks of *Lepidophloios* at the same localities and in the same beds.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 6061; Gilkerson's Ford, U. S. Nat. Mus., 6072.

LEPIDOSTROBUS Brongniart, 1828.

Prodrome, p. 87.

LEPIDOSTROBUS PRINCEPS Lx.

Pl. LXII, Fig. *h*; Pl. LXIII, Figs. 1, 2; Pl. LXIV, Fig. *a*.

1866. *Lepidostrobus princeps* Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 455, pl. xlv, figs. 1–4.
1880. *Lepidostrobus princeps* Lesquereux, Coal Flora, vol. ii, p. 434.

Cones linear, 40 cm. or more in length, 6 to 8 cm. in width, narrowed slightly toward the base, somewhat abruptly contracted at the top to a slightly acuminate apex; axis rugose, 12 to 15 mm. in width, with fusiform areolations 5 to 7 mm. long and about 1.75 mm. wide, the central scar being about .75 mm. in diameter; sporangiophores usually nearly at a right angle, sometimes slightly reflexed, but often, especially in the upper part of the cone, oblique, narrow, slightly concavely cuneate, nearly 20 mm. long, 5 to 7 mm. wide at the distal end, with a clear though not very prominent central strand; bracts usually nearly erect, though often slightly open, generally arching outward a little, slender, 4 to 5 cm. long, 6 to 9 mm. wide at the base, tapering to a long, slender acuminate point, the sides being slightly concave, especially near the base; median nerve broad near the base though not conspicuous, marked on the ventral surface by a low-rounded ridge on either side of a flat, very slightly depressed zone, or forming a broad, low keel on the dorsal surface, tapering and very slender toward the apex; sporangia and spores not definitely known.

Unfortunately the numerous specimens which I refer to the above species are so compressed as to give little or no data as to the nature of the sporangium or its contents. The sporangiophores show, when the cone is broken along the axis, as is seen in Pl. LXIII, Fig. 1, little but a mass of densely compressed strands and marginal laminæ, which are often distorted and apparently somewhat macerated. Occasionally, but very sparsely, both macrospores and microspores are found among the bracts and between the sporangiophores; but, in view of the readiness of these objects to lodge in such recesses, one can not be certain that they were ever a part of the cone, though the presence, now and then, of one close to the axis argues for its origin near at hand.

That these cones were very long is indicated by the fact that none of the fragments show the full length, although I have been able to join fragments so as to construct segments over 40 cm. in length without including both extremities. The base of the cone is slightly narrowed, then abruptly rounded. The upper part tapers somewhat, then rounds very obtusely to a relatively small, acuminate apex. The specimens before me differ only by the slightly narrower and shorter bracts from a number of specimens from Mazon Creek, Illinois, identified by Professor Lesquereux as *Lepidostrobus princeps*.[1] The bracts in one specimen are, however, a little longer in proportion to the width of the base than in the specimens from Duquoin, Illinois, figured in the Coal Flora, while the whole width of our cones, as well as those from Mazon Creek, is rather greater than that indicated in the original figure.

It is quite uncertain as to what arboreal species *Lepidostrobus princeps* was joined. Were it not for the description by Lesquereux[2] of a quite different cone as the fruit of *Sigillaria camptotænia* Wood (*S. monostigma* Lx.) we might be justified in inquiring as to whether one was not the cone of the other. In those cones from Mazon Creek, in which the bracts had been removed from the slightly compressed sporangiophores, the serried ends of the latter are more than a little suggestive of *Lepidophloios*. *Lepidostrobus princeps* is very near to certain American material recorded as *L. Goldenbergii* Schimp.[3] It differs, however, by the greater width of the cones, the longer, more slender, acuminate bracts, and the narrower axis. *L. prælongus* Lx. has the bracts much smaller and narrower, while the cones are more slender, though nearly as long. The bracts and sporangiophores of *L. latus* are much more slender.

Localities.—Gilkerson's Ford, U. S. Nat. Mus., 6057, 6071; Hobbs's coal bank, U. S. Nat. Mus., 6286.

LEPIDOSTROBUS sp.

A small cone about 5 cm. long and 18 mm. wide, having slender, tapering, acute bracts, with fine distinct median nerves, comes from Pitcher's

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[1] Rept. Geol. Surv. Illinois, vol. ii, 1866, p. 455, pl. xlv, figs. 1–4.

[2] Coal Flora, vol. iii, 1884, p. 793.

[3] Schimper, Traité, vol. ii, p. 61, pl. lxi. Brongniart, Hist. vég. foss., vol. ii, pl. xxiv, fig. 6 (non pl. xxiii, figs. 4, 5).

coal bank. It is too poorly preserved to show the arrangement of the parts or admit of a satisfactory identification by the superficial characters.

Locality.—Pitcher's coal bank, U. S. Nat. Mus., 6196.

LEPIDOPHYLLUM Brongniart, 1828.

1822. *Filicites* sect. *Glossopteris* Brongniart, Mém. mus. hist. nat., vol. viii, p. 232.
1828. *Lepidophyllum* Brongniart, Prodrome, p. 87.

LEPIDOPHYLLUM JENNEYI n. sp.

Pl. LIX, Figs. 1–3; Pl. LXIII, Fig. 6.

1897. *Lepidophyllum* sp., D. White, Bull. Geol. Soc. Amer., vol. viii, pp. 298, 300.

Cones short, oval or slightly ovate, about 4 cm. in length and 2.5 cm. in width; scales oblong-lanceolate, 12 to 22 mm. long, 7 to 12 mm. wide, expanded in broad rounded auricles at the bases of the blades; blades ovate-triangular, acute or acuminate, 7 to 12 mm. long, and nearly as wide across the semiangular or rounded dilations or auricles at the point of union to the sporangiophore, the dilation being inclined slightly downward; midrib slender, quite inconspicuous; texture rather thin; sporangiophore broadly cuneate, 5 to 10 mm. in length or nearly as long as the blade, rather wide at the base, the axis narrow and broadening rapidly near the top, the lateral laminæ rather lax, with nearly straight margins, and often more or less infolded; sporangia oblong, rounded or round-cylindrical, with rather dense walls.

The small scales described above are quite abundant in the shales from Henry County. The essential, and at the same time striking, characters are the nearly equal length of the blade and the sporangiophore and the conspicuous, often auriculate, dilations at the base of the blade, which is ovate-triangular. These characters clearly distinguish the species from *Lepidophyllum hastatum* Lx. or *L. ovatifolium* Lx., whose blade is similar except for the absence of the basal dilation, or from *L. brevifolium* Lx., which, as seen in pl. lxix, fig. 33, of the Coal Flora, or my report on the plants from the McAlester coal field,[1] has a long but narrow sporangiophore, while the blade is shorter. The general aspect of the bracts is fairly well seen in Pl. LIX, Figs. 1*b*, 2, and Pl. LXIII, Fig. 6.

[1] 19th Ann. Rept. U. S. Geol. Surv., pt. 3, 1899, p. 529, pl. lxviii, figs. 15–18.

The larger portion of a cone about which a number of bracts are scattered is illustrated in Fig. 1*a*, Pl. LIX. The contraction at the base indicates that we have nearly the full length of the strobile, which may be immature, the bracts near the top being small and short, while those near the base of the specimen show blades having all the characters of those described above. Although the details of the interior of the cone are totally obscured by the mass of compressed sporocysts and sporangiophores through which the spores are at a few points dimly expressed, the diameter of the cone is such as to require sporangiophores of the length seen in the detached bracts; and there is hardly room for doubt that we have before us the cone or *Lepidostrobus* of *Lepidophyllum Jenneyi*, the upper small and immature bracts still adhering to the axis. While the contraction toward the base, especially noticeable on the right, suggests an oval or ovate form for the cone, this individual specimen does not warrant definite conclusions on that point.

In Fig. 2, Pl. LIX, an illustration is given of one of two specimens in which the margins of the sporangiophores appear to be completely folded over inward.

In the same shales are found a number of partially compressed subcylindrical, rounded sporangia whose size and mode of occurrence indicate their origin in cones of the type illustrated. These sporangia, which may be designated as *Lepidocystis Jenneyi*, appear distinct from any other that I recollect having seen. An example is shown in Fig. 3, Pl. LIX. The sporangium wall appears rather thick and shining, the impression of the contents being very obscure. From the surface of the flattened cone, however, it appears that some at least of the Lepidocysts contain rather small macrospores. The characters of the surface of the spores are too obscure for description.

To the distinctions between *Lepidophyllum Jenneyi* and the most nearly related species, *L. ovatifolium* Lx., already indicated, may be added the generally shorter and more obtuse blades, as well as the shorter sporangiophores of the latter. The frequency of *Lepidophyllum Jenneyi* at Owen's coal bank, a locality at which *Lepidodendron Brittsii* is abundant, suggests a possible specific identity between those two types.

Localities.—Owen's coal bank, U. S. Nat. Mus., 6054, 6079, 6080; Pitcher's coal bank, U. S. Nat. Mus., 6078.

Lepidophyllum missouriense n. sp.

Pl. LVIII, Fig. 2; Pl. LX, Figs. 1–3; Pl. LXI, Figs. 1*a*–*b*; Pl. LXII, Figs. *a*, *b*, *c*, *d*, *e*; Pl. LXIII, Figs. 3, 3*a*.

Cones large, probably oblong or oval; bracts very large, 11 to 13 cm. long, 17 to 25 mm. wide above the middle; blades rather thick, very finely striated, oblong-lanceolate, broadest generally near the top of the middle third of the length, acuminately prolonged at the apex, slightly contracted 5 to 8 mm. above the base which is dilated or auriculate at the point of union, at a very open angle, to the sporangiophores; sporangiophores 23 to 26 mm. long, nearly as wide as the lower part of the blade, triangular, thick, very narrow at the base, and glossy, the sides of the axis strongly concave toward the top, nearly straight at the base, the lateral margins generally nearly straight or slightly concave up to the base of the lateral projection or auricle; midrib 2 mm. wide at the base, strong, passing distinct into the apex, bordered on either side on the ventral surface by a rounded furrow, or two rather close parallel lines, the surface of the blade being marked by fine parallel, longitudinal, rather faint lines, 15 to 18 of which fall within a millimeter; sporangia, or *Lepidocystes*, 18 to 25 mm. long, 8 to 12 mm. wide, rather narrower at the base, with truncate-rounded ends, consisting of a thin-walled sack, smooth and shining, granular under the lens, breaking longitudinally, and usually seen spread in a trapezoidal form averaging about 2 cm. in length, 18 mm. in width at one end, 15 mm. at the other, the corners rounded and often slightly ruptured; macrospores (*Triletes*) apparently round, a little more than 1 mm. in diameter, and marked by a prominent triradiate keel, the surface of the spore wall being dull and smooth.

This species, abundant at Gilkerson's Ford, presents some variation in the width of the blade, Fig. *a*, Pl. LXII, representing the narrowest I have seen, while Fig. 2, Pl. LVIII, shows a bract rather above the average in width. In a few specimens the mucronate apex is slightly prolonged. In general, however, great uniformity prevails in both the size and the form of the bracts, as well as in the pronounced dilation or auriculation at the point of union of the blade with the sporangiophore. The broadest portion of the blade is always above the middle, sometimes considerably above it. The surface of the bract appears polished, even under a weak lens, though it is really very finely lineate, the longitudinal lines or rows of cells numbering about seventeen within the millimeter. In one specimen the bract is shown in profile to be at a right angle to the sporangiophore.

On one of the slabs lately sent by Dr. Britts are what appear to be three cone fragments, shown in Fig. 1, Pl. LX. The largest, illustrated in the upper part of Fig. 1, is somewhat remarkable for its size and is interesting as showing the aspect of the imbricated bracts *in situ*. None of the fragments show either the base or the tip of the cones, all of them representing segments that fail to show even the entire width of the organ. From these fragments we may infer that the cones were very broad. The photograph shows a strong general similarity to the fragments illustrated by Goldenberg,[1] Von Roehl,[2] or Lesquereux.[3]

As was stated in my remarks under this genus, I am disposed to follow Goldenberg in regarding these very large Lepidophylla and their cones, *Lepidostrobus*, as pertaining to the genus *Lepidophloios*. If such is the true relation, *Lepidophyllum (Lepidostrobus) missouriense* most probably represents the fructification of *Lepidophloios* Van Ingeni. In the most intimate association with these bracts are numerous sporangia, or Lepidocysts, most of which are broken and spread out in smooth black trapezoidal forms, about 20 to 25 mm. long, and having a width of about 12 mm. at one end and 18 mm. at the other end, the corners being slightly rounded and the margins of the ends occasionally ruptured. Examples of these collapsed vacant or displayed sporangia are seen in Pl. LXI, Fig. 2, or Pl. LXII, Fig. *b*, while the unruptured, somewhat compressed sporangia with their macrospores are illustrated in Pl. LXII, Figs. *c* and *d*. These sporocysts are perhaps specifically indistinguishable from examples of *Lepidocystis fraxiniformis* (Goepp.) Lx., from Cannelton, Pennsylvania. The latter are found in place on the bracts of *Lepidophyllum Mansfieldi* Lx. It is probable, however, that the spore sacs of several of the large species of Lepidophylla are not distinguishable by superficial macroscopic characters.

In *L. missouriense* the macrospores, shown enlarged in Figs. 3 and 3*a*, Pl. LXIII, are perhaps a little over 1 mm. in diameter when uncompressed. They appear minutely granular under a strong lens. The triradiate crests,

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[1] Fl. Foss. Sarep., vol. i, pl. iii, figs. 13*a*, 13*b*.

[2] Foss. Fl. Steink. Westphalens, pl. xiii, figs. 1*a*, 1*b*.

[3] Coal Flora, pl. lxviii, fig. 1 (copied from Von Roehl, op. cit., fig. 1*a*).

characteristic of the *Triletes* of Reinsch and Kidston, are sharp and prominent, extending across one side of the flattened spore.

The scales which I have described under the above name represent a larger type, I believe, than any heretofore illustrated. Among the Old World species it is comparable to *Lepidophyllum majus* Brongn.[1] It appears, however, to differ specifically from the latter by the broader apex of the sporangiophore, the prominently dilated or auriculate base of the blade, the proportionately very much greater expansion of the upper half of the bract, and the contracted, acuminate apex. *Lepidophyllum auriculatum* Lx., which is not well known, has a blade that tapers gradually from the middle upward. The same difference exists in *L. acuminatum*, which has a proportionately much larger sporangiophore. Finally, *L. Mansfieldi*, to which both the blades and the sporocysts of our species bear the closest resemblance, and which is undoubtedly its nearest relation, has the auricles much less developed at the base of the blade, while the latter is broader in proportion above the base, and is almost invariably transversely wrinkled in the lower half, as though thicker and very much arched.

Localities.—Most abundant at Gilkerson's Ford, U. S. Nat. Mus., 6060, 6062, 6065, 6066, 6072, 6081; Pitcher's coal mine, U. S. Nat. Mus., 6058; Owen's coal mine, U. S. Nat. Mus., 6059?. The large cone fragment, loaned to the United States National Museum by Dr. J. H. Britts, is from Pitcher's coal mine.

OMPHALOPHLOIOS D. White, 1898.

Bull. Geol. Soc. Amer., vol ix, p. 336.

OMPHALOPHLOIOS CYCLOSTIGMA (Lx.) D. W.

Pl. LXV; Pl. LXVI, Figs. 1–5; Pl. LXVII, Figs. 1, 2; Pl. LXVIII, Figs. 1, 2.

1870. An *Lepidodendron mammillatum* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 432, pl. xxv, fig. 1?

1879. *Lepidodendron cyclostigma* Lesquereux, Coal Flora, Atlas, p. 11, pl. lxii, fig. 5; text, vol. ii (1880), p. 394.

1898. *Omphalophloios cyclostigma* (Lx.) D. White, Bull. Geol. Soc. Amer., vol. ix, pp. 329–342, pls. xx–xxiii.

Stems or trunks of considerable size, the larger ones covered by more or less clearly defined Lepidodendroid bolsters; bolsters contiguous, sometimes partially obscure, especially in the young or badly compressed branches,

[1] Prodrome, 1828, p. 87. Geinitz, Verst. Steink. Sachsen, 1855, p. 37, pl. ii, fig. 5.

rhomboidal and acute, laterally rounded, or squarrose-rhomboidal, or often reduced and truncated by compression, somewhat prominent, rounded, without caudæ or corrugation, marked near the apex by a punctate mammilla, and surmounted over or at a little distance above the middle by a large, interior, more or less roundish or ovate-triangular, slightly concave, prominent boss, at the lower verge of which is situated a transverse cicatrix, probably the leaf scar; central boss of the partially decorticated stem usually conspicuous, often appearing as an oval, slightly concave elevation, frequently traversed by two somewhat indefinite vertical low ridges, and marked between the latter by a minute central trace; or, in the impressions, often appearing as convex and roundish or narrowed in either direction by the partial infolding of the surrounding tissue of the bolster in the course of compression; foliar cicatrices situated at or a little below the middle of the bolster and on the lower border of the large boss or cushion, nearly one-half the width of the bolster, of very little altitude, slightly raised, angular or slightly crescentic, the sides slightly inclined upward, subangular or broadly crescentic above, or flatly deltoidal in the center, the lateral angles being continued for a distance as diminishing ridges, which are either straight and vanishing short of the margin or curving upward and blending with the base of the large central boss, within which, close above the foliar cicatrix, lies a smaller oval or slightly ovate boss containing an interior depression and punctiform trace; oval boss situated upon the large boss close within the ventral curve of the leaf scar, the longer, vertical axis being nearly one-half the altitude of the concave field of the larger boss, the horizontal diameter nearly two-thirds as long as the vertical, the lower end generally obscure, nearly or quite tangent to the leaf cicatrix and either partly or wholly inclosing a minute punctiform mammilla, which appears nearly contiguous to the foliar cicatrix and may be a part thereof; interior of the oval boss occupied by an oval depression, sometimes obscure, usually clearly defined, about .5 mm. within the outer border of the oval boss, the interval being a flat oval zone, the upper and deeper end of the depression containing a minute umbilicate mammilla; vascular trace of the leaf well developed, the lateral traces being obscure; basal appendages either absent or very obscure.

The extensive collections from the Des Moines series of Missouri, sent during the last few years to the United States National Museum or the

United States Geological Survey, contain a series of specimens which throw much light on the unique and somewhat problematic species described by Professor Lesquereux as *Lepidodendron cyclostigma*.[1]

Pitcher's coal mine, in Henry County, the source of most of the new material, seems, as indicated both by the associated species and by the matrix, to have been the source of the types of the original species, now Nos. 5501 and 5502 of the Lacoe collection in the National Museum. In any event it is certain, as is shown by the records and labels, that the fossils described by Lesquereux came from the same vicinity. The species has not been found elsewhere.

Since the recently acquired material includes examples exhibiting many new characters and features, whose interpretation is subject to differences of opinion, as well as a remarkable variation in the forms of cortical impression, the descriptions of the important specimens will be repeated in order to present all the available evidence as to the organs or appendages of the tree and its systematic position. It is unfortunate that in this, as well as in most other peculiarly American types of Carboniferous plants, no material is at hand to show the internal organization of the tree, which is represented only by somewhat flattened casts of trunks and branches, or by cortical impressions revealing only superficial details.

The bolsters of these compressed trunks are, as was stated by Lesquereux, variable in form as well as size. Illustrations of these varying forms, which sometimes suggest the *Lepidodendron clypeatum* of Lesquereux,[2] are seen in Pl. LXV and Pl. LXVI, Figs. 1, 2; also Pl. LXVII, Fig. 2. The fragmental impression, a portion of which is seen in the first plate, is 31 cm. in length and 13 cm. in width, the entire breadth of the trunk being unknown. It is probable, however, that some of the trunks of this species grew to a considerable diameter. The figured fragment shows the impression or mold, over most of which the outer very thin cortex or epidermis still adheres. Nevertheless, that phase in which the bolsters are represented at their longest and in their more distinctly Lepidodendroid aspect is well seen, the fine separative lines of the rhomboidal, acute bolsters being clear, while the general features of the subtriangular or somewhat circular central convex areas, which, as we shall see, represent large, compressed, roundish bosses,

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[1] Coal Flora, vol. ii, 1880, p. 394, pl. lxii, fig. 5.
[2] Geol. Pennsylvania, vol. ii, 2, p. 875, pl. xv, fig. 5; pl. xvi, fig. 7. Coal Flora, vol. ii, p. 380, pl. lxiv, fig. 16.

are in agreement with the original figured by Lesquereux.[1] It will be observed that the bolsters are low, rounded, and destitute of keel or caudal ornamentation, either above or below the scar; that the central convex area as compressed varies from round to more or less distinctly triangular, and that the boundary of the latter is often a sharp, clear furrow, from the lateral angles of which short, quickly vanishing lines pass outward toward the curved bolster margin, which they fail to reach. Other compressed specimens, mostly impressions, to which reference will be made, show the great variability in the aspect of these central areas. The photograph of the example under consideration fails to show a punctiform mammilla situated near the center of the convex area or but a very little nearer the lower border. This, which we may temporarily designate as the central trace, is visible to the unaided eye, as are also, in a few instances, two rather indefinite, rounded, low, vertical grooves, crossing the central area, one on either side of the central trace. The figure of this specimen is so placed on the plate that the central, obscurely subtriangular area comes generally at a little above the middle. Thus the transverse side, which is seen in many cases either to be crescentic or to contain a very obtuse angle, is made to constitute the base. This arrangement, which seems to conform with that of Fig. 1, Pl. LXVII, is made largely for the sake of preserving the morphologic similarity of the bolsters of this tree with those of the conventional type of *Lepidodendron*, as represented, for example, in *L. clypeatum*. I confess, however, a lack of assurance as to the actual attitude of some of the stems. I have attempted to make them conform in position to other better-preserved fragments, the orientation of which will be discussed farther on.

Passing now to the originals, described by Lesquereux, we find that the figure given in the Coal Flora represents a small portion of an irregular fragment 27 cm. in length and 15 cm. in width. In this fragment, which, like the one described above, is a mold or impression, the Lepidodendroid form of the bolsters is clear. In a portion of the slab one end, presumably the lower, of the bolsters is slightly truncated by pressure in fossilization. The convex central areas or compressed central bosses are mostly ovate-triangular or ovate, as is shown in the original figure, though many are round and some are transversely oval. The lateral angles, as well as the short, vanishing, lateral furrows, are distinctly indicated in most cases,

[1] Coal Flora, Atlas, pl. lxii, fig. 5. No. 5501 of the Lacoe collection, U. S. Nat. Mus.

while generally the central trace in the roundish area is more or less clearly shown. This is also true where the outermost cortical tissue still adheres to the matrix, even in the area represented by the shaded portion in the original figure.

Another of the types described by Lesquereux is a small slab, No. 5502 of the Lacoe collection, representing, like the other, a mold or impression of the stem. In a portion of this fragment, too, we have bolsters and inside areas like those in the originally figured type, No. 5501. But here we have also a variety of distortions, due to pressure, in which the central areas or compressed bosses often appear more than twice as wide as long, while in some cases they are partially covered on all sides by the infolded lateral areas about the flattened bosses. It may be noted in passing that the central areas in this fragment, photographed in Pl. LXVI, Fig. 1, are much broader in proportion to their altitude when the bolsters themselves are correspondingly dilated. In addition to these features, this specimen shows not only the central traces, but also, in a few cases, the obscure vertical furrows, which in several instances seem to unite below the upper margin of the central areas in a loop or long horseshoe, between the sides of which are the central traces. This character, as well as certain other more obscure details, will be considered in the description of the surface of the lately collected stems.

Another incomplete slab about 25 cm. wide, showing the mold or external impression of the stem, is partially illustrated in Pl. LXVI, Fig. 2. In this specimen, chosen because it represents the more elongated bolsters with the central convex areas slightly displaced, we find in many of the latter the two vertical grooves, about 2 mm. apart, passing across the compressed boss and forming, as in the specimen just described, a loop or elongated horseshoe, within which the vascular trace is seen in all cases to lie. Occasionally a second trace is observed at the apparently open end of the horseshoe. The same interior characters are seen in Mus. Reg. 6030, another impression of a fragment with short, squarish bolsters, illustrated in Pl. LVIII, Fig. 2.

The specimens described above are all impressions or molds of stems, in some of which the epidermis may have been wanting. We will now proceed to the consideration of several segments of stems on which the cortex is still preserved. The first of these, Mus. Reg. 6029, is a flattened branch, nearly the full width of which is seen in Pl. LXVII, Fig. 2. Here we see again a type of foreshortened, truncated bolster, comparable in form to that of *Lepidodendron clypeatum* Lx. Within the bolsters we have a very obtuse-angled prominence occupying a position at the base of the large boss. This transverse or flatly deltoid scar may be regarded as representing the horizontal side of the oval-triangular central area in the specimens previously noted. Within this angle, the thickened walls of which are suggestive of the leaf scar, we see the horseshoe-shaped loop, including one or two small cicatrices. Indications of the more orbicular or prominent development of the large boss are seen on the cortex on the left or in the partially decorticated area on the lower right.

A better understanding of this fragment, which has been removed from the left branch of the trunk illustrated in Pl. LXVII, Fig. 1, may, however, be reached by an inspection of the opposite side of the same specimen, which is shown enlarged to twice the natural proportions in Pl. LXVIII, Fig. 1. The conditions seen on the surface of the cortex of this specimen are as follows: Within a broad, diagonally truncated bolster, suggestive of those of certain Lepidodendra, we have, as before, near the middle, a prominence in the form of a very obtuse angle, opening upward.[1] The protruding walls of this angle rise slightly and increase in thickness in approaching the center, where they in some instances form a very low deltoid area. The periphery of this transverse area exhibits for a distance of from 1.75 to 2.5 mm. on either side of the center a rugose surface of carbonaceous matter, surrounded apparently by a line of separation. The area inclosed by this fractured carbonaceous rim can hardly be anything else than the leaf cicatrix. And I may add in this connection that none of the other specimens on which the outer tissue is preserved seem to show any other definite evidence of fracture or separation on the surface of the bolsters. From the lateral angles of these leaf scars, which are often slightly crescentic, pass narrow, vanishing ridges, which may lie in the same direction as the corresponding side of the cicatrix "angle," or they may curve somewhat upward before vanishing in the border of the large boss which they help to define. The vanishing ridges and crescentic prolongations probably play an important

[1] The orientation of the figure is based on the place of the fragment in the dichotomous trunk, Pl. LXVII, Fig. 1. The interpretation of this prominence as leaf scar, though somewhat tentative, preserves the Lepidodendroid analogy in the bolsters.

part in preserving the roundish, distinct outline of the boss seen in the impressions earlier described. It must be remembered that on the cortex of the stems the interior surface of the large bosses is slightly concave. A resemblance to the impressions is seen in several of the bolsters in the abraded and partly decorticated portion on the right in the figure. There is, however, when the entire cortex is preserved, no line of displacement or break in the continuity of the epidermis beyond the leaf scar along this large subcircular or subtriangular boss that, in my judgment, can be construed as marking the separation of any appendage or organ.

Proceeding to the observation of the characters above and within the angle of the leaf scar, we note, as seen in the photographic enlargement, Pl. LXVIII, Fig. 1, an oval or slightly ovate area, the vertical diameter of which is about 2.5 mm., the transverse diameter being about 1.75 mm. The surface of this oval area is slightly raised as a boss above the concave surface within the large convex, rounded boss, and is bordered in many cases by a very narrow, low, and sometimes obscure rim, or by a narrow adjacent furrow. One or both of these conditions are possibly merely the result of pressure on the surface of the smaller, oval boss, since there is occasionally seen hardly more than the sharply defined change of level in passing across its margin down to the large boss. I am inclined, however, to regard the narrow bordering rim, which is generally present, as normal. The lower end of this oval rim appears to become nearly contiguous to if not actually united with the leaf scar; and at the lowest point it seems, in a few bolsters, to die out below, and partly inclosing, a small punctiform mammilla, which, in one instance, it appears to completely inclose. It is possible that this mammilla, which is in many cases discernible, should be regarded as belonging to the vascular trace of the leaf; but in the specimens before me it seems to be distinct from the leaf, if not, in fact, separated therefrom by a continuation of the oval rim. Within the oval boss just described is a small concave oval area, which is sometimes obscure in the lower part. This depression, the margin of which is nearly parallel to the outer border of the oval boss, the distance between being but little more than .5 mm., is deepest near the upper end, where it surrounds a minute bordered pit or umbilicate trace. The latter is the "trace" observed in the central area of the impressions and decorticated stems first described. The true vascular trace of the leaf is frequently defined in the carbon at the margin of the ovate-triangular, concave areas, representing the compressed large bosses in those specimens.

It remains also to note a minute mammilla, sometimes slightly depressed, occasionally seen a little above the upper margin of the large boss. This trace lies within a loop of the low, round, vertical ridges sometimes crossing the large boss. Though these ridges are sometimes clear in the molds or impressions, appearing as grooves or furrows, they are usually rather obscure on the surface of the cortex, and may be entirely subcortical.

Concerning the cicatricial traces within the leaf scar itself little can yet be said. What appears to be a vascular trace is observable in many instances. Also certain obscure depressions in the bolster, which occupy the position of the respiratory appendages at the base of the leaf, seem to be present; but I am far from certain that these appearances may not really be due to accident or other causes.

In the slab, Mus. Reg. 5636, photographed in Pl. LXVII, Fig. 1, we have a large forked segment showing on the left the full width of the branch, the cast of the lower portion of which is still in place. The upper part or impression is the mold or counterpart of the fragment, Pl. LXVIII, Fig. 2, just discussed. The similarity of the preservation on the lower left to that found in the lower right on the same slab is at once apparent. The middle portion of the branch on the right presents, however, the same characters as the lower portion of the other branch. In fact, we have at once on this specimen impressions of the large central convex boss of the type originally described as *Lepidodendron cyclostigma*, the quadrangular compressed bolsters, and the flattened bosses, showing distinctly the details noted on the surface of the preserved stem. I am not absolutely certain whether in this slab we have a dichotomizing stem or trunk, or whether possibly two trunks are superimposed. The facts that the bolsters below are in accordance as to direction, that those on the right of the angle change the direction of curve, as is natural at a dichotomy, and that I find no intercalated or separative zone or material, save numerous plications of the cortical tissues, make it seem most probable that the two branches are in actual union. Such plications are usually found in the angle of compressed Lepidodendroid stems, and they are especially to be looked for in those in which the cortical tissues are evidently spongy and therefore subject to displacement under pressure.

The above notes cover the essential details of the species, so far as I can discern them, in the compressed specimens before me. But mention should be made of a number of other peculiarities in this singular as well as problematic tree.

To illustrate one of these I have partially represented in Pl. LXVI, Fig. 3, an impression or a mold to which the epidermis adheres. The margins of the outer boss appear to come nearly in contact with the margins of the bolsters in the upper part, although the latter can easily be traced to their apex, then curving inward and slightly downward, while becoming obscure, to meet the oval boss a little below its apex, thus producing a somewhat cordate effect. This aspect of the bolster and bosses is surprisingly like that figured as the type of *Lepidophloios obcordatus* by Professor Lesquereux.[1] It is possible that both are referable to the same species. The oval bosses, as well as the central mammillæ, are very clear in this specimen.

Another fragment, a part of which is photographed in Pl. LXVI, Fig. 4, shows but a faint and fragmentary trace of the bolsters here and there. The surface is nearly flat, the larger bosses being nearly obliterated, only the leaf angle and the oval bosses being left in slight relief. Both the inner and the outer borders of the oval boss are defined, as is imperfectly seen in the photograph. This stem, the epidermis of which is in part preserved, is further ornamented by several large, shallow pits of two sorts. The larger ones, in the lower portion of the specimen, are nearly circular, and nearly equal in size the larger bosses of the other specimens. The details of their interiors are obscure. They show, however, traces of the two low, rounded, vertical ridges passing across them, with a central oval trace. These shallow, rounded pits, which are possibly caused by collapse of the large bosses, may conform with the convex areas in the bolsters in the types studied by Lesquereux, the vertical furrows and trace agreeing perhaps with the ridges and trace in No. 5502 of the Lacoe collection. The other form of depression seen in Fig. 4 is often elliptical, traversing vertically the obscurely indicated and wrinkled outline of the large boss. These elliptical pits are evidently coincident with the area and position of the vertical, rounded furrows seen in the round pits on the same fragments. The leaf angle and oval boss are wholly obscured. This elliptical or horseshoe appearance of the vertical ridges crossing the larger bosses, while never conspicuous in any of the

[1] Rept. Geol. Surv. Illinois, vol. ii. 1866, p. 457, pl. xli. fig. 1 (not fig. 2, 2*a*).

specimens, is present and faintly visible in many of the bolsters of the fragment, Fig. 5, Pl. LXVI. Although but little wider than the oval boss, it is much longer, extending in this case a little beyond the large boss and including as usual the upper punctiform trace near the truncated upper margin of the bolster. In some respects the large, shallow depressions in this specimen are perhaps analogous to the abnormal or strobiliferous scars seen in some of the *Sigillariæ*.

The difficult task of the interpretation of the details and of the ascription to the structures of their appropriate functions is largely a matter of speculation and hypothetical analogy. I shall attempt only to prove some of the homologies between the trunk in hand and others of the Lepidodendroid type, hoping that other paleobotanists more familiar with the *Lycopodineæ*, both living and fossil, will furnish more accurate and valuable correlations.

The type of cortex before us appears to be one characterized superficially by rather strongly protuberant, noncarinate bolsters, exhibiting in outline the general variations characteristic of the Lepidodendroid type. These bolsters have large, roundish or ovate triangular bosses, on which are placed the leaf scars and certain other structures. The large bosses were probably highly prominent in the uncompressed stems, and were presumably composed, like the other portions of the bolster, largely of soft tissue that has proved very susceptible to distortion and variation under the conditions of compression. Their prominence and lack of support well accounts for their partial concealment beneath the folds of the adjacent portions of the bolsters in the flattened impressions, as well as for their displacement toward the sides of the bolsters in many cases. The degree of deformation of the bolsters in this trunk exceeds the greatest variations from pressure I have seen in the bolsters of *Lepidodendron Veltheimianum* Stb. or *L. clypeatum* Lx. Pressure in a direction probably nearly vertical to the large boss evidently produced the rounded impressions described and figured from the originals by Lesquereux as *Lepidodendron cyclostigma.* From the lower and more prominent part of the large flattened boss two nearly parallel obscurely defined, broad, rounded, perhaps subcortical ridges pass upward across the boss, and apparently a little beyond it, then apparently unite in a horseshoe curve or rounded angle. Within the apex of this loop, and apparently a short distance above the boss, is situated a rarely visible punctiform trace. I am unable to state whether this long, obscure, vertical loop is closed at the base to form an ellipse, though it slightly affects that appearance in the pits figured in Pl. LXVI, Fig. 4. It may proceed on either side from the lateral wings of the leaf scar at the base of the boss. There is nothing on the specimens before me to indicate an attachment of any vegetative organ along its surface or margin.

Certain very important points as to the relations of the second, or oval, boss to the leaf scar remain to be determined. At present it is not definitely ascertained whether the oval boss, which in a few instances appears to be closed at the base and barely contiguous with the transversely angular or deltoid cicatrice, which I have called the leaf scar, is actually distinct from that "scar" or whether it is organically connected therewith. The analogies with the other Paleozoic *Lycopodineæ*, especially some of the Sigillarioid types, would, at first glance, lead us to inquire as to whether this oval boss does not itself represent a part if not the whole of the foliar cicatrix. The evidence in support of such a supposition lies largely in the presence of the generally clear, narrow, very low, marginal rim of the boss and its naturally suggestive similarity to the form of the cicatrices in some of the *Bothrodendra*. Continuing the parallel with the Bothrodendroid or Sigillarioid scar, it appears that in this case the trace at the upper end in the central oval depression may be the vascular trace, while, by reversing the position of the specimen, the punctiform trace, which now seems either close within or partly between the vanishing ends of the lower curves of the oval, might be correlated with the trace just above the foliar cicatrices in *Sigillaria* and *Bothrodendron*. On the other hand, in opposition to the above hypothesis, the interior details of the oval, the basal angular or deltoid scar, and the superior trace in the bolster, as well as the form of the bolster itself, seem to be arraigned. The oval boss comprises an outer zone about 5 mm. in width inclosing an oval depression. I have found no traces within the latter except the umbilicate trace generally near the upper end, and this shows on the cortex as a minute pit bordered by a raised carbonaceous rim. In the impressions this trace causes a minute projecting point. Next, the slightly raised transverse cicatrix at the base of the oval boss and on the lower edge of the large boss showing a surface of separation, appears to be supplied with a vascular trace, and occupies the position of a leaf in the Lepidodendroid bolster. There are in a few instances even slight, though quite uncertain and perhaps worthless, signs of the subfoliar appendages. Much depends on the relation of the oval boss to the transverse scars, which I have designated as leaf cicatrices, and these relations can perhaps be ascertained only by the discovery of additional material. On those bolsters the cortical tissue of which appears best preserved and intact the rim of the oval boss would seem in some cases, as shown in the photograph, Pl. LXVIII, Fig. 1, to be nearly but not quite tangential to the transverse scar, the punctiform trace being slightly within the outer oval boundary. In this matter the evidence of other bolsters would, however, seem somewhat conflicting. It should be remarked that in those bolsters in which the base of the oval is most clearly defined the vertical diameter of the transverse, or leaf, scar seems considerably foreshortened in the course of fossilization. It is quite possible that better or uncompressed material will show a confluence of the oval rim with the transverse scar, in which case the punctiform trace may represent some expression or development of the vascular strand of the leaf.

If it be found, as seems to be indicated in some instances, especially where the protruding leaf scar is abraded, that the rim of the oval boss is really in union by a narrow connection with what is here, perhaps erroneously, interpreted as the leaf scar, the conditions will be perhaps best satisfied by assuming that the oval boss was the seat of some expansion or unfamiliar structure on the ventral surface at the base of the leaf, of which it would form a part. In such an arrangement the trace above the large boss might be the homologue of the so-called "ligule" scar, while the small umbilicate trace in the central depression would constitute a new basis for speculative analogy. However, while far from conclusive, the signs at hand appear to point to a lack of such a union. In either case, assuming that I am not mistaken in treating the transverse basal scar as proper to the leaf rather than as a mere fracture or abrasion, we would seem to have a cortex marked by prominently bossed Lepidodendroid bolsters, in the axils of whose leaves was situated either some organ or appendage attached to the oval boss, or else, as appears more probable, an oval plaque in the depression of which was a minute umbilicate trace, the purpose of which is unknown. In accordance with such an hypothesis the punctiform trace near the upper edge of the main boss might be homologized with the upper appendage trace or pit of the typical *Lepidodendron*, while the minute trace close above the base of the leaf, if it proves to be distinct from the latter, may be analogous to if not homologous with the so-called "ligular pit" in those stems.

Whatever the interpretation offered, the superficial characters of these stems seem to be quite different from those of any of the existing Lycopodineous genera. Consequently, in an earlier publication I proposed for those trees with this type of embossed cortex the generic name *Omphalophloios*. The diagnosis of the genus, of which *O. cyclostigma* is the type, is postponed until the relations between the oval boss and the leaf cicatrix are more clearly demonstrated.

A specimen which I regard as representing a decorticated or *Knorria* state of this type strongly resembles the *Knorria* of *Bothrodendron*, to which genus ours is perhaps most closely allied.

Localities.—The originals described by Lesquereux from Clinton, Henry County, Missouri, are Nos. 5501 and 5502 of the Lacoe collection, U. S. Nat. Mus. Later accessions are from Deepwater, U. S. Nat. Mus., 6077?; and from Pitcher's coal mine, U. S. Nat Mus., 5636, 6024, 6030. The *Knorria* fragment, of doubtful identity, is from Gilkerson's Ford.

SIGILLARIEÆ.

SIGILLARIA Brongniart, 1822.

1820. *Palmacites* Schlotheim, Petrefactenk., p. 393 (pars).
1820. *Lepidodendron* Sternberg, Flora d. Vorw., vol. i, fasc. 1, pp. 20, 25 (pars).
1820. *Syringodendron* Sternberg, Flora d. Vorw., vol. i, fasc. 1, p. 23.
1822. *Sigillaria* Brongniart, Mém. mus. hist. nat., vol. viii, p. 209.
1822. *Clathraria* Brongniart, Mém. mus. hist. nat., vol. viii, p. 209.
1823. *Rhytidolepis* Sternberg, Flora d. Vorw., vol. i, fasc. 2, p. 36.
1826. *Favularia* Sternberg, Flora d. Vorw., vol. i, tent., p. xiii.
1826. *Catenaria* Sternberg, Flora d. Vorw., vol. i, tent., p. xxv.
1841. *Calamosyrinx* Petzholdt, De Balano et Calamos., p. 28.
1860. *Asolanus* H. C. Wood, Proc. Phila. Acad. Sci., vol. xii, p. 237.
1877. *Pseudosigillaria* Grand 'Eury, Fl. carb. Loire, p. 142.
1890. *Sigillaria-Camptotænia* Grand 'Eury, Géol. et pal. bassin houill. Gard, p. 262.

SUBSIGILLARIÆ.

SIGILLARIA (ASOLANUS) CAMPTOTÆNIA H. C. Wood.

Pl. LXIX; Pl. LXX, Figs. 1, 3, 4,; Pl. LXI, Fig. 1*g*?; Pl. LXII, Fig. *i*?; Pl. LXIV, Fig. *e*?.

1857. An *Sigillaria rimosa* Goldenberg, Fl. Saraep. Foss., vol. ii, p. 22, pl. vi, fig. 1 (2–4?)?
1869. *Sigillaria rimosa* Gold., Von Roehl, Foss. Fl. Steink. Westphalens, p. 93, pl. xxx, fig. 5.
1888. *Sigillaria rimosa* Gold., Schenk. Foss. Pflanzenreste, p. 82, fig. 41.

1894. *Sigillaria rimosa* Gold., Nathorst, Pal. Fl. Arkt. Zone, p. 64, pl. xvi, figs. 9, 10.
1860. An *Lepidodendron barbatum* F. A. Roemer, Beitr. z. Kenntn. n-w. Harzgeb., pt. iv, p. 196, pl. xxxi, fig. 12?; Palæontographica, vol. ix, p. 40, pl. viii, fig. 12?
1860. *Asolanus camptotænia* H. C. Wood, Proc. Phila. Acad. Nat. Sci., vol. xii, p. 238, pl. iv, fig. 1.
1866. *Sigillaria camptotænia* H. C. Wood, Trans. Amer. Phil. Soc., vol. xiii, p. 342, pl. ix, fig. 3.
1886. *Sigillaria camptotænia* Wood, Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. lxxxviii, figs. 4–6; text (1888), p. 588.
1866. *Sigillaria monostigma* Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 449, pl. xlii, figs. 1–5.
1870. *Sigillaria monostigma* Lesquereux, Geol. Surv. Illinois, vol. iv, p. 446, pl. xxvi, fig. 5.
1879. *Sigillaria monostigma* Lesquereux, Coal Flora, Atlas, p. 15, pl. lxxiii, figs. 3–6; text, vol. ii (1880), p. 468; vol. iii, p. 793 (pars?).
1870. *Lepidodendron cruciatum* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 432, pl. xxv, fig. 2.
1877. *Pseudosigillaria monostigma* (Lx.) Grand 'Eury, Fl. carb. Loire, p. 144.
1890. *Pseudosigillaria monostigma* (Lx.) Grand 'Eury, Géol. et pal. bassin houill. Gard, pp. 173, 260, pl. ix, figs. 4, 5, 6.
1890. *Pseudosigillaria dimorpha* Grand 'Eury, Géol. et pal. bassin houill. Gard, pl. ix, figs. 7, 8.
1890. *Sigillaria-Camptotænia monostigma* (Lx.) Grand 'Eury, Géol. et pal. bassin houill. Gard, p. 262, pl. ix, figs. 4–7.
1890. *Sigillaria-Camptotænia gracilenta* Grand 'Eury, Géol. et pal. bassin houill. Gard, p. 262, pl. ix, fig. 6 (pl. xxii, fig. 1?).
1894. *Asolanus dimorpha* (Grand 'Eury) Potonié, Jahrb. k. Pr. geol. Landesanst., 1893, p. 36.

FRUCTIFICATION.

1884. An *Sigillariostrobus Laurencianus* Lesquereux, Coal Flora, vol. iii, p. 794?

ROOTS.

1870. *Sigillarioides stellaris* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 450, pl. xxix, fig. 3.
1879. *Stigmaria stellaris* Lesquereux, Coal Flora, Atlas, p. 15, pl. lxxiv, fig. 7 (fig. 5?); text, vol. ii (1880), p. 516.
1883. *Stigmaria ficoides* Brongn. var. *stellata* Goepp., Lesquereux, Rept. Geol. Surv. Indiana, vol. xiii, pt. 2, p. 96, pl. xix, fig. 4.
1890. *Stigmaria ficoides* Brongn. var. *stellata* Goepp., Lesley, Dict. Foss. Pennsylvania, vol. iii, p. 1074, text fig.

Trunks large, branching rarely if at all, noncostate; surface of the cortex marked between the usually distant foliar cicatrices by rough, irregular, ropelike striæ or strands, especially distinct where the outer cuticle has been removed, in relief or semirelief, nearly covering the intermediate cortex, very coarse in the older trunks, somewhat meshed in irregular longitudinal areoles, flexuose, and coursing from either of the four sides of every rhomboidal leaf scar toward the proximal side of the corresponding leaf scar, so that the principal and most conspicuous strands radiate from each leaf scar to the four nearest scars, the intermediate strands in the rhomboidal areas thus formed tending toward parallelism with the border that is nearest; foliar cicatrices borne on small bolsters, more or less distant, usually quite distant, probably in vertical rows, though plainly affecting a spiral arrangement, varying greatly in angle even in the same segment, transversely rhomboidal, with the lateral angles very acute and more or less prolonged, varying in altitude, the margins more concave in the vertically broader scars, or nearly straight in the vertically narrow forms, rounded below, often more or less distinctly emarginate at the upper edge, which is bordered above by a narrow, smooth, somewhat crescentic zone nearly one-half the altitude of the leaf scar, the convex, truncate-rounded margin upward, the wings or lateral angles tapering to the lateral angles of the scar, the upper border indented by a V-shaped depression which reaches nearly to the upper margin of the leaf scar and includes the suprafoliar punctiform trace; bolsters fusiform-triangular in a longitudinal sense, the broader end, narrower than the superimposed leaf scar, being upward and more prominent, while the lower end vanishes as an oblique section of a cylinder at the level of the cortex; surface of the bolster below the leaf scar and contiguous thereto bearing a thin, downward-rounded apronlike field, the lower margin of which is nearly semicircular; vascular trace small, situated near to or a little above the middle of the leaf scar, punctiform or slightly elongated horizontally; lateral cicatricules a little distant on each side, narrow, linear-crescentic, nearly meeting both above and below the vascular trace, often having the appearance of, if not actually forming a ring or slightly obovate cicatricule, reaching nearly to the upper and lower margins of the leaf scars; partially decorticated stems, showing the rough striations less distinctly, substriate, and presenting only the somewhat linear-triangular outlines of the bolsters, marked by the cicatricular ring, the leaf scar and its superior and inferior fields being removed with the cuticle, or, when further stripped, revealing a *Knorria* form, the blunt, slightly prominent upper ends of the narrow, distant elevations corresponding to the vascular traces, while the intermediate surface is minutely and irregularly striated.

The peculiar type of *Sigillaria* described in 1860 by Dr. Wood as *Asolanus camptotænia* and by Professor Lesquereux in 1866 as *Sigillaria monostigma* is now one of the more familiar and most easily recognized species in the Coal Measures of the United States. Therefore little need be added by way either of description or of illustration to the material published by the latter author in the Reports of the Geological Survey of Illinois and the Coal Flora.[1]

However, some additional details ascertained during the course of a critical examination of the leaf scars in the materials lately received, as well as in the older collections in the United States National Museum, are worthy of a brief consideration.

As generally seen, the fragments of *Sigillaria camptotænia* show well enough the characters of the interfoliar cortical surface, but the leaf scars are presented in the published figures in a variety of aspects, some of which have been erroneously described as superficial, owing to the relative delicacy and consequent general absence of the tissue surmounting the narrow bolster or cushion. Thus the lateral angles of the foliar scars which seem to be most fragile are often first to be lost, leaving an apparently rounded, narrow leaf scar against which the cortical striations abut, the latter appearing, in fact, continuous over the surface originally covered by the leaf-scar angles. Suggestions of this phase are seen in the photographs, Pl. LXIX and Pl. LXX, Fig. 4. It is also well shown in Weiss's fig. 25, pl. iv, vol. ii, of the "Sigilliarien," though the striations in the cortex of the fragments illustrated are hardly typical of the species. When still further decorticated or abraded the leaf cushions often have the appearance shown in fig. 4 of pl. lxxiii of the Coal Flora. But in the best-preserved fragments we find the round, narrowly obovate-triangular or obovate-fusiform bolster, which does not even protrude so far as to become semicylindrical as it rises to the support

[1] The general aspect of the decorticated and *Knorria* stages is seen in Rept. Geol. Surv. Illinois, vol. iv, 1870, pl. xxvi, fig. 5; op. cit., vol, ii, 1860, pl. xlii, fig. 4; Coal Flora, pl. lxxiii, figs. 5, 6. Partially decorticated fragments are illustrated, Rept. Geol. Surv. Illinois, vol. iv, pl. lxxiii, figs. 2, 5; Coal Flora, pl. lxxiii, figs. 3, 4, 5, 6. The same conditions as well as the supracortical aspects are figured by Weiss, Sigillarien, vol. ii, 1893, pl. iv; and Grand 'Eury, Géol. et pal. bassin houill. Gard, pl. ix, figs. 4, 6, 7, and 8.

The facies of the outer cortex is well represented by Wood, Proc. Acad. Sci. Phila., vol. xii, 1860, pl. iv, fig. 1; Trans. Amer. Phil. Soc., vol. xiii, 1866, pl. ix, fig. 3. The form of the leaf scars is seen in Lesquereux's figures, Rept. Geol. Surv. Illinois, vol ii, 1866, pl. xlii, figs. 1, 3, and 5; Coal Flora, pl. lxxiii, fig. 3, and in the figures cited under Zeiller in the above synonymy. The details of the foliate scars illustrated by Weiss, op. cit., pl. iv, are the most complete and satisfactory yet published.

of the leaf, surmounted by (1) the leaf scar, the lateral angles of which project sharply beyond the borders of the cushion; (2) a thin apron or surplice-like area or shield which extends downward from the leaf scar, and is more or less round or sometimes even nearly semicircular in its lower outline. In some instances the boundary of this appears to correspond with the impression of the bolster, as illustrated in fig. 3 of the second volume of the Illinois reports. This area, which is dimly indicated in the partially decorticated fragment, Fig. 4, Pl. LXX, and further in Fig. 3, is well delineated by Weiss. In addition to this field the bolster supports another narrow transverse field contiguous to the upper border of the leaf scar. This vertically narrow field, which in its widest portion near the median line is nearly one-half the altitude of the leaf scar, rounds on either side of the middle to tapering acute lateral angles lying against the angles of the leaf scar, which is but little wider horizontally. This superior field, the lower border of which is the upper outline of the leaf scar, seems in a few cases to have been misinterpreted and misfigured as a part of the foliar cicatrix, an error easy to understand after a comparison of the photographs, Fig. 3 or Fig. 1, Pl. LXX. In Fig. 3, however, which represents a specimen on which a portion of the epidermis is preserved, it is clearly seen. Here it is found in most cases to be interrupted at the median line by a V-shaped depression, which penetrates from the upper border nearly across the field to the leaf scar. In the angle or depression thus formed is situated the suprafoliar, punctiform cicatrix or "ligular scar." In many of the specimens this depression resembles a V-shaped incision, but in reality the details of this field agree with interesting precision with material illustrated by Weiss and Sterzel.[1]

In most of the stems and impressions, especially those from which the epidermis or a portion of the subjacent tissues have been removed, the lateral cicatricules of the leaf scar present what appears to be a slightly ovate or subannulate structure encircling and often obscuring the vascular trace. In the figure above referred to, which represents most of the cuticle, these cicatricules are linear-crescentic, and, while in one scar they appear to unite above, they are distinctly separate at the base. The close scrutiny of others convinces me, however, that they are a little distant at the top also. These details agree substantially with those illustrated in fig 23A on the

[1] Op. cit., pl. iv, figs. 22*a*, 25*a*.

interesting plate published by Weiss. Some of our leaf scars show evidence of ornamentation near the lower border between the lower ends of the lateral traces, but it is too obscure for satisfactory description or delineation.

The homology of these extensively developed traces with the lateral cicatricules of the leaf scar in *Lepidodendron* or *Lepidophloios*, which are regarded by Potonié as the cross sections of transpiration strands, leads us to conclude that, if the hypothesis is not incorrect, the transpiration tissue of *Sigillaria camptotænia* was extensively developed, occupying a considerable portion of the interior of the leaf.

Another interesting feature in the species before us is the presence of interfoliate scars similar to those of other species of *Sigillaria*, especially the *Tessellata* and *Favularia* groups. The specimen (Fig. 3) from which the details of the bolster and leaf scar described above are taken is a portion of a slender stem or branch 46 cm. long and about 8 cm. wide, flattened and lenticular in section. Scattered somewhat irregularly on the lower 11 cm. of this fragment are seen a number of rounded or oval pits, which, when the epidermis is preserved, are found to be bordered by a smooth, irregularly rounded zone containing a rather large central trace. These scars are quite independent of the leaf scars, which are complete and regularly disposed in the phyllotaxy, though perhaps slightly dwarfed. It is possible that they represent adventitious roots. But it seems more probable that they are the homologues of the interfoliate scars supposed to represent the cicatrices of the fallen strobili in other species of *Sigillaria*.

As yet neither the cones nor even the mode of branching of *Sigillaria camptotænia* is definitely known. The cone described by Lesquereux[1] as *Sigillariostrobus Laurencianus* and referred by him to the species in hand is not in actual union with the cortex contiguous to it in the fossil state. While appearing to represent a true *Sigillariostrobus*, its specific reference appears to be based solely on the circumstance of commingled fragments in the material from Kansas.[2]

To *Sigillaria camptotænia* probably belongs the *Lepidodendron cruciatum* described in 1870[3] from a single decorticated specimen with coarse, oblique

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[1] Coal Flora, vol. iii, pp. 793, 794.

[2] The specimens now in the Lacoe collection in the United States National Museum are, as Professor Lesquereux pointed out, loc. cit., p. 794, clearly congeneric if not specifically identical with the cones earlier described by him as *Trochophyllum clavatum*, Coal Flora, p. 65, pl. iii, fig. 21.

[3] Rept. Geol. Surv. Illinois, vol. iv, p. 432, pl. xxv, fig. 2.

striæ intersecting at the obscure scars. Likewise the *Sigillaria Grand'Euryi* of Lesquereux,[1] which was separated from *S. camptotænia* on account of the close leaf scars and the smooth cortex, is perhaps of doubtful specific value. The type specimen, which is comparable to fig. 8 (*Pseudosigillaria dimorpha*) on pl. ix of Grand 'Eury's admirable work on the flora of the basin of Gard, is certainly extremely closely related. The leaf scars are close and obscure, the cortex being partly removed or wholly wanting in portions of the fragment. The fact that it is found at Cannelton, Pennsylvania, where *S. camptotænia* is present in great numbers, necessitates great caution in discussing its specific individuality.

After examining all the material at my disposal I am convinced that the roots or rhizomes described as *Sigillarioides stellaris*[2] and later referred by Lesquereux to *Stigmaria*[3] belong to the subterranean or subaqueous portions of *Sigillaria camptotænia.*

Although *Sigillaria camptotænia* is now known in most of the coal fields of Europe, there still remain some differences of opinion as to the identity of Dr. Wood's tree with that described by Goldenberg as *Sigillaria rimosa.* Thus, while Zeiller,[4] Grand 'Eury,[5] and Weiss[6] express their assurance that the two species are identical, in which view Potonié[7] and Kidston[8] concur, Lesquereux and Nathorst[9] have questioned the propriety of the union. It is true that the quite distinct separation of the lateral cicatricules, which constituted the principal difference, in the judgment of Professor Lesquereux, between *S. rimosa* Gold. (non Sauv.) and *S. monostigma* Lx., have been shown to be due to error, since the cicatricules of the original type of fig. 1 on pl. vi of the Flora Saræpontana Fossilis has been shown by Weiss and Nathorst, each of whom has refigured a part of the original, to agree, perhaps indistinguishably, with those of specimens whose identity with our species is indubitable. The extreme obliquity of the interfoliar cortical striæ in Goldenberg's figure, which, as Nathorst points out, do not pass so

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[1] Coal Flora, vol. iii, p. 795.
[2] Rept. Geol. Surv. Illinois, vol. iv, 1870, p. 450, pl. xxix, fig. 3.
[3] Coal Flora, vol. ii, p. 516, pl. lxxiv, fig. 7.
[4] Fl. foss. bassin houill. Valenciennes, 1888, p. 590.
[5] Géol. et paléont. bassin houill. Gard, 1890, p. 261.
[6] Sigillarien d. Pr. Steink. u. Rothl., pt. 2, 1893 (1894), p. 68.
[7] Jahrb. d. k. Pr. geol. Landesanst. u. Bergakad, 1893 (1894), p. 35.
[8] Trans. Roy. Soc. Edinb., vol. xxxvi, pt. 1, 1891, p. 16.
[9] Zur paläozoischen Flora der Polarländer, 1894, p. 64.

directly nor meet the four neighboring scars as in *S. camptotænia*, is hardly less apparent in Weiss's or Nathorst's figures of portions of the type specimen. The difference is still more marked in the small sketch given by Schenk.[1] For my own part I can say only that among several scores of specimens from the Coal Measures of Missouri, Illinois, Ohio, and Pennsylvania, I have not seen any with striæ arranged in this manner. This form, together possibly with the phases illustrated by Weiss, op. cit., figs. 24 and 28, appears to represent a variation tending toward the other *Leiodermariæ*. At least they are not typical of the American form, though their departure therefrom may be less than varietal in importance. I regard fig. 2 of Goldenberg's plate as quite different from the species in hand, as may also be figs. 3 and 4 of the same plate. The *Lepidodendron barbatum* of Roemer[2] seems to be near these, though it may be merely a fragment of *Sigillaria camptotænia* in which the leaf scars are abraded or partially decorticated.

The reference of Grand 'Eury's *Sigillaria camptotænia gracilenta* to Dr. Wood's species, made by Sterzel,[3] and more recently by Potonié,[4] in his very interesting studies on the zone variations in *Sigillaria*, may be fully substantiated by an examination of the American material, while phases, such as that named *Pseudosigillaria dimorpha* on Grand 'Eury's plate,[5] are well illustrated in the fine series from Cannelton, now a part of the Lacoe collection in the United States National Museum.

The discovery almost simultaneously by Weiss[6] and Zeiller[7] on the trunks of *Sigillaria Brardii* Brongn. of both the typical form and arrangement of the scars of that species and other distantly disposed scars referable to *S. spinulosa* Germ. has since been supplemented by abundant evidence, thus proving the impracticability of longer attempting to maintain the distinction of *Clathraria* or *Cancellata* and *Leiodermaria*. Accordingly, most

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[1] Die fossilen Pflanzenreste, 1888, p. 82, fig. 41.

[2] Beitr. z. geol. Kenntn. n.-w. Harzgebirges, p. 40, pl. viii, fig. 12.

[3] J. T. Sterzel, in Weiss: Sigillarien d. Preuss. Steinkohl. u. Rothl., pt. ii, p. 67, footnote.

[4] Die Wechsel-Zonen-Bildung der Sigillariaceen: Jahrb. d. k. Pr. geol. Landesaust. u. Bergakad., 1893 (1894), p. 36.

[5] Géol. et pal. bassin houill. Gard, pl. ix, figs. 7, 8. Fig. 7 is also cited in the text as *Sig. campt. monostigma*.

[6] Beobachtungen an Sigillarien von Wettin und Umgegend: Zeitschr. d. deutsch. geol. Gesell., vol. xli, 1889, p. 376.

[7] Sur les variations de formes du *Sigillaria Brardii* Brongniart: Bull. soc. géol. Fr., (3) vol. xvii, p. 603, pl. xiv.

paleobotanists are now agreed in treating the forms previously distributed in the above sections as a single group or subgenus of Sigillariæ. Thus they were made by the late C. E. Weiss the subject of an elaborate and admirable discussion, since completed with conscientious efficiency and delicacy by Dr. Sterzel, under the title *Die Subsigillarien*.[1] This term for the group was adopted by Potonié,[2] who for the *Rhytidolepis*, *Tessellata*, and *Favularia* sections (or *Rhytidolepis* in the broadest sense) employs the group name *Eusigillariæ*. M. Grand 'Eury, who at first ranged the species grouped about *Sigillaria camptotænia* in a genus which he named *Pseudosigillaria* and placed in the *Lepidodendreæ*,[3] has since restored them to the *Sigillariæ* under the comprehensive group term *Sigillariæ-camptotæniæ*,[4] which cumbersome and inconvenient term he adopts, in the singular, for generic use, employing for the type described by Wood the name *Sigillaria-camptotænia monostigma* Lesq. Potonié rightly points out the propriety of retaining for Wood's genus, amended, the original name *Asolanus*.

It is interesting to note that Nathorst[5] particularly remarks on the characters in common between *Sigillaria rimosa* and *Bothrodendron* (*Cyclostigma*) *Kiltorkense* Haught. sp., which he regards as probably related, while Weiss[6] includes in the *Subsigillariæ* both the *Cyclostigma* (*Bothrodendron?*) *Kiltorkense*, and the genus *Bothrodendron*, the latter being enrolled as a subgenus of *Sigillarieæ*. To the writer the group of species centered about *S. camptotænia* Wood, *S. corrugata* Lx., or *Bothrodendron*, seems to stand on the side of the *Sigillarieæ* that is nearest the *Lepidodendreæ*, between which and the *Sigillarieæ* it helps to bridge the gap.

Sigillaria camptotænia is distinguished from other species in the group *Subsigillariæ* by the concave lateral margins of the distant leaf scars, the attenuated lateral angles, the very long, linear, crescentic, lateral cicatricules, extending nearly the whole height of the scar and apparently forming an oval or obovate ring, and especially by the ropy, meshed cortical striations extending from each leaf scar to the four scars nearest thereto.

Localities.—Pitcher's coal mine, U. S. Nat. Mus., 6064; Gilkerson's Ford, U. S. Nat. Mus., 6063.

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1 Die Sigillarien der Preussischen Steinkohlen und Rothliegendengebiete, vol. ii; Die Gruppe der Subsigillarien: Abh. d. k. Pr. geol. Landesanst., N. F., Hft. 2, Berlin, 1893, pp. xvi, 255. Atlas, pl. i–xxviii.

2 Loc. cit., p. 24.

3 Fl. carb. Loire, 1877, p. 142.

4 Géol. et pal. bassin houill. Gard, 1890, p. 260.

5 Op. cit., p. 64.

6 Op. cit., p. 60.

SIGILLARIA (ASOLANUS) SIGILLARIOIDES (LX.).

Pl. LXX, Fig. 2.

1879. *Lepidophloios? sigillarioides* Lesquereux, Coal Flora, Atlas, p. 13, pl. lxviii, figs. 8, 8*a*.
1880. *Lepidophloios sigillarioides* Lesquereux, Coal Flora, vol. ii, p. 425.

Trunks large, the epidermis finely longitudinally shagreened over the traces of broad, low, irregular, diagonal or longitudinal, irregularly meshed, strandlike, very obscure ridges of the cortex; bolsters usually distant, apparently spirally arranged, small, very broadly obovate or obovate-triangular, smooth, nearly covered by the leaf scar and two vertically narrow fields, one superior and one inferior to the leaf scar; leaf scar on the upper part of the small bolster, transversely rhomboidal, laterally acute, the transverse diameter being greater than the width of the bolster, subangular at the apex, slightly acute at the lower angle, the margins on either side of the latter being distinctly concave; inferior field contiguous to the lower borders of the leaf scar, equal or nearly equal to the latter in transverse diameter, and having the lower margin rounded or nearly semicircular; superior field very narrow vertically, extending nearly the whole width of the scar, the middle portions of the sides nearly straight, the medial angle rounded-truncate or even slightly emarginate, marked just above the center by a minute punctiform trace; vascular cicatricule near or a little above the middle of the foliar cicatrix, transverse, short; lateral cicatricules linear-crescentic, arching outward, the upper ends close, near the margin of the scar, the lower portions approaching nearly to the vascular trace; subcortical phases and cones unknown.

While examining the specimens in the Lacoe collection in the United States National Museum I was much interested at finding three specimens from the vicinity of Clinton, Missouri, which had been identified by Professor Lesquereux as *Sigillaria fissa* Lx. The inspection of one (No. 6660) of these specimens revealed at once the general very close resemblance of the parts connected with the leaf scar to the corresponding portions of *Sigillaria camptotænia* Wood. But my attention was at once engaged by the similarity of the impression of certain portions of the cortex, in which the bolsters were so flattened in the course of fossilization as to partially cover the scars, to the structure figured in the Coal Flora from the type of *Lepidophloios ? sigillarioides* Lx.[1] Later I received from Dr. Britts, through whose unfailing courtesies I have had the opportunity to study many of the paleobotanical types from the Missouri Coal Measures, the original type described and illustrated by Lesquereux. A comparison of this type with the material labeled *Sigillaria fissa*, mentioned above, shows at once not only that they all belong to the same species, but that the fragments belong to the same individual, since No. 6660 is merely the adjoining and contiguous segment of stem fitting against the type partially illustrated as *Lepidophloios sigillarioides*. The two fragments were either separated at the time of collection or one was afterwards misplaced. Both of these fragments, which may be treated as one, represent the impression of a trunk 12 cm. or more in width on the matrix. No. 6659, a portion of which is shown in Pl. LXX, Fig. 2, is a fragment of that portion of the flattened stem itself which made the impression just described, and when placed in its original position it is found to lie across the line of fracture between No. 6660 and the type of the *Lepidophloios*, covering, in fact, a portion of both.

The intimate relationship of the species in hand to *Sigillaria camptotænia* is very obvious. The bolsters are distant and similar, though shorter and proportionately wider in the material under consideration, there being but little trace of the bolster below the inferior field. The outer surface of the stem is finely shagreened, the longer axes being longitudinal. There are even slight traces of an irregular, ropy striation comparable to *S. camptotænia*, but the broad strands are low, when present, faint and nearly vertical. As in the latter species, the leaf scars project beyond the bolster, and are apparently epidermal in their connection; but the scar is more angular above, and, especially, rather narrowly angular below, so that the vertical diameter is proportionately much greater, the lower margins being much more convex. The superior and inferior fields are much broader vertically in *S. camptotænia*. In *S. sigillarioides* the lateral cicatricules are higher in the leaf scar, distinctly separate, and more arched.

Sigillaria fissa Lx., as described and figured from the Southern Anthracite field of Pennsylvania,[2] has the cortex marked in "narrow, undulate, smooth lines," its scars "cordate," emarginate, and its punctiform vascular

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[1] Coal Flora, Atlas, p. 13, pl. lxviii, figs. 8, 8*a*; text, vol. ii, p. 425.

[2] Lesquereux, Proc. Boston Soc. N. H., vol. vi, 1854, p. 426; Geol. Pennsylvania, vol. ii, 2, 1858, p. 871, pl. xiii, fig. 4.

trace near the center of a triangular-obovate, raised placque, or possibly a ring. The figure of the species is quite unsatisfactory, but we may infer from its details that it represents a species belonging to the *Subsigillariæ*. It is, however, impossible to identify the character of the leaf scar, as given in both the figure and the description of *S. fissa*, with those seen in the type of *Lepidophloios sigillarioides*. Hence, notwithstanding the unpleasant features of the binomial, there seems, in compliance with the laws of nomenclature, no alternative to the preservation of the earlier specific appellation, and the consequent designation of the species as *Sigillaria sigillarioides*.

Localities.—Near Clinton, Henry County, Missouri. The portion figured by Lesquereux is in the collection of Dr. J. H. Britts, of Clinton. Fragments of the same specimen are Nos. 6659 and 6660 of the Lacoe collection in the United States National Museum. Hobbs's coal mine, U. S. Nat. Mus., 6173.

EUSIGILLARIÆ.

SIGILLARIA TESSELLATA (Steinh.) Brongn.

1818. *Phytolithus tessellatus* Steinhauer, Trans. Amer. Phil. Soc., vol. i, p. 295, pl. vii, fig. 2.
1835. *Phytolithus tessellatus* Steinh., Holland, Hist. Descr. Foss. Fuel, p. 94, text fig. 5.
1820. An *Palmacites variolatus* Schlotheim, Petrefactenkunde, p. 393, pl. xv, fig. 3*a*, *b*?
1828. *Sigillaria tessellata* (Steinh.) Brongniart, Prodrome, p. 65.
1836. *Sigillaria tessellata* (Steinh.) Brongniart, Hist. vég. foss., vol. i, p. 436, pl. clxii, figs. 1–4; pl. clvi, fig. 1.
1850. *Sigillaria tessellata* (Steinh.) Brongn., Mantell, Pict. Atl., p. 27, pl. v, fig. 8.
1855. *Sigillaria tessellata* (Steinh.) Brongn., Geinitz, Verst. Steinkohl. Sachsen, p. 44, pl. v, figs. 6–8.
1857. *Sigillaria tessellata* (Steinh.) Brongn., Goldenberg, Fl. Foss. Saræp., vol. ii, p. 29, figs. 14, 15.
1879. *Sigillaria tessellata* (Steinh.) Brongn., Schimper, Traité, vol. i, p. 8 (pars), pl. lxviii, fig. 2 (figs. 1, 3?).
1875. *Sigillaria tessellata* (Steinh.) Brongn., W. H. Bailey, Figs. Char. Brit. Foss., pl. xxxiv, figs. 5, 5*b*.
1876. *Sigillaria tessellata* (Steinh.) Brongn., O. Feistmantel, Verst. böhm. Kohlen-Abl., vol. iii, p. 7 (pl. i, figs. 1, 2?).
1878. *Sigillaria tessellata* (Steinh.) Brongn., Zeiller, Vég. foss. terr. houill., p. 132, pl. clxxiii, fig. 2.
1879. *Sigillaria tessellata* (Steinh.) Brongn., Lesquereux, Coal Flora, Atlas, p. 14, pl. lxxii, fig. 2 (3?, 4?); text, vol. ii (1880), p. 481 (pars).
1881. *Sigillaria tessellata* (Steinh.) Brongn., Weiss, Aus d. Fl. d. Steink., p. 4, pl. i, fig. 4.

1886. *Sigillaria tessellata* (Steinh.) Brongn., Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. lxxxv, figs. 1–4, 4*a*, 5–9, 9*a*; pl. lxxxvi, figs. 1–6; text (1888), p. 561.
1886. *Sigillaria tessellata* (Steinh.) Brongn., Weiss, Sig. d. Pr. Steink., vol. i, p. 56, pl. xv, figs. 9, 10, 32 (21, 26?).
1888. *Sigillaria tessellata* (Steinh.) Brongn., Toula, Die Steinkohlen, p. 199, pl. iv, fig. 9.
1890. *Sigillaria tessellata* (Steinh.) Brongn., Grand'Eury, Géol. et pal. bassin houill. Gard, p. 252, pl. x, fig. 10.
1833. *Favularia tessellata* (Steinh.) Lindley and Hutton, Foss. Fl., vol. i, p. 205, pl. lxxiii, pl. lxxiv, pl. lxxv.
1836. *Sigillaria Knorrii* Brongniart, Hist. vég. foss., p. 444, pl. clvi, figs. 2, 3; pl. clxii, fig. 6.
1857. *Sigillaria Knorrii* Brongn., Goldenberg, Fl. Foss. Saræp., vol. ii, p. 28, pl. vii, fig. 18.
1876. *Sigillaria Knorrii* Brongn., O. Feistmantel, Verst. böhm. Kohlen-Abl., vol. iii, p. 9, pl. i, figs. 7, 8.
1836. An *Sigillaria alveolaris* (Stb.) Brongniart, Hist. vég. foss., vol. i, p. 443, pl. clxii, fig. 5?
1841. *Calamosyrinx Zwickaviensis* Petzholdt, De Bal. et Cal., p. 28, pl. ii, figs. 1, 2.
1842. *Calamosyrinx Zwickaviensis* Petzholdt, N. Jahrb. f. Min., p. 183, pl. v.
1848. *Sigillaria Zwickaviensis* (Petz.) Goeppert, in Bronn: Index Pal., p. 1145.
1848. *Sigillaria Morandii* Sauveur, Vég. foss. terr. houill. Belg., p. lvii, fig. 4.
1887. *Sigillaria Morandii* Sauv., Weiss, Sigill. d. Pr. Steink., vol. i, p. 60, pl. xv, fig. 24.
1848. *Sigillaria sexangula* Sauveur, Vég. foss. terr. houill. Belg., pl. liii, fig. 1 (fig. 2?).
1848. *Sigillaria contigua* Sauveur, Vég. foss. terr. houill. Belg., pl. lii, fig. 1.
1870. *Sigillaria lalayana* Schimper, Traité, vol. ii, p. 84, pl. lxvii, fig. 2.
1880. *Sigillaria lalayana* Schimper, in Zittel: Handb., vol. ii, p. 205, fig. 155.
1874. *Sigillaria Dournaisii* Brongn., Schimper, Traité, Atlas, p. 24, pl. lxviii, fig. 2.
1879. *Sigillaria mammillaris* Brongn., Lesquereux, Coal Flora, Atlas, p. 14, pl. lxxii, fig. 5 (fig. 6?); text, vol. ii (1880), p. 483 (pars).
1883. *Sigillaria alternans* L. and H., Achepohl, Niederrh.-Westfäl. Steink., p. 24, pl. v, fig. 3.

A few fragments of the carbonized cortex of this species were found among the fragments of black laminated "bone" from Jordan's coal mine. The leaf scars, which are very close vertically, are separated horizontally by a faintly flexuose, lineate furrow, so that our specimens very closely resemble, both in size and in aspect, the enlargements of *Sigillaria cumulata* var. *paucistriata* given by Weiss[1] in his elaboration of the *Favulariæ*. The form in hand probably represents the variety γ of Brongniart.

Although *Sigillaria tessellata* is kept separate from *S. elegans* Brongn. by

[1] Die Sigillarien d. Preuss. Steinkohlen: Abh. d. geol. Specialk. Pr. u. Thüring. St., vol. vii, 3, p. 30, pl. ix, figs. 34 *a*, *b*.

many paleontologists, among whom is Professor Zeiller,[1] the two species are united by most authors, including Professor Lesquereux. The latter, however, seems to have so interpreted the character of the species as to make it include a number of forms placed by European paleobotanists in other species, while assigning to *S. mammillaris* Brongn. certain types which appear to harmonize better with the European *S. tessellata.*

The genus *Sigillaria* offers perhaps the best illustration of the difficulty of identifying the fossils of one continent in accordance with the insufficient descriptions, imperfect or often misleading figures, and frequently erroneous nomenclature and synonymy in the earlier literature of another and somewhat distant continent. It is no cause for wonder if many of the identifications of material in America made in dependence on the European literature of the first three-quarters of this century are found on a comparison of specimens to be faulty.

Locality.—Jordan's coal mine, U. S. Nat. Mus., 6214.

SIGILLARIA OVATA Sauv.

1848. *Sigillaria ovata* Sauveur, Vég. foss. terr. houill. Belg., pl. li, fig. 2.
1886. *Sigillaria ovata* Sauv., Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. lxxix, figs. 4, 5, 5*a*, 6, 7 (fig. 3 ?); text (1888), p. 522.
1883. *Sigillaria Essenia* Achepohl, Niederrh.-Westfäl. Steink., p. 118, pl. xxxvi, fig. 9.

Several fragments of stems belonging to the subgenus *Rhytidolepis* exhibit oval scars of the proportions illustrated by Sauveur under the above name. They are also closely related to forms determined by Professor Lesquereux as *S. mammillaris* var. *latior* and *S. orbicularis*, or still more closely to a new species[2] from the Anthracite series of Pennsylvania.

Until the American material in this genus is somewhat revised it seems impracticable to attempt to point out the specific differences between examples referred to the above-named species and others found in this country.

Locality.—Jordan's coal mine, U. S. Nat. Mus., 6215.

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[1] Fl. foss. bassin houill. Valenciennes, p. 561.
[2] In unpublished MSS.

STIGMARIA Brongniart, 1822.

Mém. Mus. hist. nat., vol. viii, p. 228.

STIGMARIA VERRUCOSA (Martin) S. A. Miller.

1804. ——— ——— Parkinson, Org. Rem., vol. i, pl. iii, fig. 1.
1809. *Phytolithus verrucosus* Martin, Outlines, p. 203.
1809. *Phytolithus verrucosus* Martin, Petrificata Derb., pls. xi, xii, xiii*; Syst. arrangement, p. 23.
1818. *Phytolithus verrucosus* (Martin) Steinhauer, Trans. Amer. Phil. Soc., vol. i, p. 268, pl. iv, figs. 1–4 (5, 6?).
1820. *Variolaria ficoides* Sternberg, Fl. d. Vorw., vol. i, fasc. 1, p. 24, pl. xl, figs. 1–3
1822. *Stigmaria ficoides* (Stb.) Brongniart, Mém. Mus. hist. nat., vol. viii, pp. 228, 239, pl. l, fig. 7.

This ubiquitous species, ranging through the greater part of the Carboniferous epoch, is too well known to all geologists to require further description in order to secure its recognition. Besides the figures to be found in nearly all text-books and general paleontologic works, it has been specially illustrated in many papers. Of particular importance among the latter is "A Monograph on the Morphology and Histology of Stigmaria Ficoides," by the late Prof. W. C. Williamson, published by the Palæontographical Society.[1] No attempt is here made to cite the numerous descriptions, the multitudes of figures by Goeppert and others, or the somewhat varied synonymy, beyond reference to the earlier binomial appellations.

The specific identity of the specimens figured by Parkinson, Steinhauer, and Martin with those illustrated by Sternberg and Brongniart, on which most paleobotanists agree, involves a nomenclatural situation of no little embarrassment. Steinhauer, whose specific terms are as far as possible respected by most authors, cites Parkinson's excellent figure,[2] while adopting the binomial designation proposed for this type and both defined and illustrated by Martin.[3] There is no doubt as to the specific identity of Parkinson's illustration, and it is generally inscribed in the

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[1] London, 1887, pp. iv, 1–62, pls. i–xv.

[2] Organic Remains of a Former World, etc., 1804, pl. iii, fig. 1.

[3] The construction and scope of the name *Phytolithus verrucosus* are clearly and explicitly defined in Martin's "Outlines of an attempt to establish a knowledge of extraneous fossils on scientific principles." Macclesfield, 1809. See Sect. v, "Principles of nomenclature," pp. 198–205. See "Petrificata Derbiensia," 1809, Systematic Arrangement, p. 23, pls. xi, xii, xiii*.

synonymy[1] of *Stigmaria ficoides*, as are also the reduced figures given by Martin and Steinhauer. We appear, therefore, to have had in use for this *Stigmaria* a sufficiently defined and illustrated binomial appellation of earlier date than the name proposed by Sternberg. Hence, if this is true, we should, in the consistent observance of laws generally just and tending to uniformity and precision in paleontologic nomenclature, employ the earlier name of the species, although conscious of the annoyance or disadvantage to geologists and others not in close touch with paleobotanical literature resulting from the reference to this most familiar fossil under an entirely unfamiliar specific name.

Among the specimens in the present collection is one with rather distant pits, the intermediate surface being rugose and irregularly wrinkled longitudinally. It is difficult to say, however, to what extent these characters may be due to the pressure the fragment has evidently undergone.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 6271; also in shale from the same region, transmitted by Dr. J. H. Britts.

STIGMARIA EVENII LX.

1866. *Stigmaria Evenii* Lesquereux, Rept. Geol. Surv. Illinois, vol. ii, p. 448, pl. xxxix, fig. 9.

1879. *Stigmaria Evenii* Lesquereux, Coal Flora, Atlas, p. 16, pl. lxxv, fig. 1.

1886. *Stigmaria Evenii* Lx., Zeiller, Fl. foss. bassin houill. Valenciennes, Atlas, pl. xci, fig. 7; text (1888), p. 618.

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[1] Examples are:

1832. Lindley and Hutton, Foss. Flora, vol. i, p. 92, pl. xxxi.

1841. Unger, Chloris Protogæa, p. liii; Synopsis, 1845, p. 116, and (as *Stig. anabathra*) Gen. Sp. Pl. Foss., 1850, p. 228.

1841. Goeppert, Gattungen, p. 47; Zeitschr. d. deutsch. geol. Gesell., vol. iii, 1851, p. 279. Uebergangsgebirge, 1852, p. 245. Foss. Fl. perm. Form., 1864, p. 198.

1853. Geinitz, Preisschrift, p. 59.

1862. Goldenberg, Fl. Saræp. Foss., vol. iii, p. 19 (syn. *S. anabathra*).

1869. Von Roehl, Foss. Fl. Steink. Westphalens, p. 119 (syn. *S. anabathra*).

1871. Weiss, Foss. Fl. Steink. u. Rothl. Saar-Rh. Geb., p. 169.

1872. Schimper, Traité, vol. ii, p. 114.

1875. Binney, Obs. Struct. Foss., pt. iv, p. 139

1876. O. Feistmantel, Verst. böhm. Kohlen-Ablag., vol. iii, p. 41.

1880. Lesquereux, Coal Flora, vol. ii, p. 514.

1886. Kidston, Cat. Pal. Pl., p. 203; Yorkshire Carb. Flora, pt. i, p. 7.

1887. Williamson, Monogr. Stig. ficoides, p. 2.

1888. Howse, Cat. Foss. Pl. Hutton Coll., p. 107 (123).

1880. Zeiller, Fl. foss. bassin houill. Valenciennes, p. 611 (cites Parkinson).

1890. Renault, Fl. foss. bassin houill. Commentry, vol. ii, p. 552 (cites Parkinson).

"I have not thought it necessary to refigure the common aspects of *Stigmaria ficoides* with its attached rootlets. Every geologist is familiar with these forms. Such figures have been well supplied by Martin under the name of *Phytolithus verrucosus;* by Artis as *Ficoidites furcatus, verrucosus,* and *major;* by Lindley and Hutton and by Corda as *Stigmaria ficoides.*" (Williamson, Monograph of *Stigmaria ficoides*, 1887, p. 2.)

1890. *Stigmaria Evenii* Lx., Grand 'Eury, Géol. et pal. bassin houill. Gard, pl. xiii, figs. 7 B′, 13.
1880. *Stigmarioides Evenii* Lesquereux, Coal Flora, vol. i, p. 333, pl. lxxv, fig. 1.
1890. *Stigmarioides Evenii* Lx., Lesley, Dict. Foss. Pennsylvania, vol. iii, p. 1077, text fig.
1890. *Stigmariopsis Evenii* (Lx.), Grand 'Eury, Géol. et pal. bassin houill. Gard, p. 243, pl. xiii, figs. 7, 13.

Although the scars on the specimens which I refer to this species are slightly smaller than those illustrated in fig. 1, pl. lxxv, of the Coal Flora, they are in perfect agreement with material from Mazon Creek, Illinois, labeled by Professor Lesquereux under the above name. One of the specimens from Missouri is 26 cm. in length, over 15 cm. in width, and nearly flat, thus indicating for the root a great size as compared with the very small umbilical scars. The latter appear to be proportionately smaller than in the specimens figured by Zeiller and Grand 'Eury. M. Grand 'Eury illustrates[1] a most interesting erect trunk of an unmistakable *Sigillaria* (*S. Mauricii*) of the *Rhytidolepis* group, 150 cm. long, in which the lower portion for nearly 75 cm. between the ribbed portion and the point of origin of the roots is slightly dilated, cylindrical, and Syringodendroid in its sculpture. The rapidly tapering roots which diverge, apparently radially, from the base of this trunk are identified as *Stigmaria Evenii*, which name is engraved on the plate, although the figure is cited in the text as *Stigmariopsis Evenii* Lx. The latter genus is used by Grand 'Eury to designate the usually relatively short, tapering roots at the base of Sigillarioid trunks, while the *Stigmariæ* are regarded by him as floating or submerged independent rhizomes capable of transformation and the development of *Sigillariæ* whenever they might encounter favorable conditions or the proper environment.

Stigmaria Evenii Lx. is easily distinguished from the other species described from this country by its small scars quite irregularly and unevenly arranged.

Locality.—Mine at Deepwater, U. S. Nat. Mus., 6272.

Stigmarioid impression.

Pl. LXX, Fig. 5.

The fragment illustrated in Pl. LXX, Fig. 5, is one of two specimens, apparently impressions, to which the epidermis or a portion of the cortical layers still adheres in the form of a thin carbonaceous residue. The surface,

[1] Géol. et pal. bassin houill. Gard, 1890, Atlas, pl. xiii, fig. 7B′.

as will be observed in the figure, is marked by irregularly flexuose, subparallel, distantly anastomosing, narrow, sharp, rugose ridges. The fragments appear to belong to some root or rhizome. The suggestiveness of the sculpture of the cortical striation of *Sigillaria camptotænia*, which is found at this locality, leads me to suspect that it may be a part of that tree, although the specimens have no trace of a rhomboidal arrangement or of cicatrices.

Locality.—Pitcher's coal mine, U. S. Nat. Mus., 6067.

INCERTÆ SEDIS.

TÆNIOPHYLLEÆ.

TÆNIOPHYLLUM Lesquereux, 1878.

1878. *Tæniophyllum* Lesquereux, Proc. Am. Phil. Soc., vol. xvii, p. 331; Coal Flora, vol. ii, 1880, p. 461.

1878. *Desmiophyllum* Lesquereux, Proc. Am. Phil. Soc., vol. xvii, p. 332; Coal Flora, vol. ii, 1880, p. 556.

TÆNIOPHYLLUM LATIFOLIUM n. sp.

Pl. LXIII, Fig. 4; Pl. LXXI.

Axis attaining a diameter of 10 cm. or more, simple (?), straight, or flexuose, concealed in compressed specimens by a thick mat of the decurrent leaf bases, and marked in the decorticated impressions by numerous oval or linear-oval umbilicoid small scars among lax, variable, subparallel vascular striæ; leaves (?) crowded at the strongly decurrent narrowed bases, curving outward and radiating parallel, linear, straight, or lax, appearing in compound specimens as ribbonlike, fine-nerved, delicate impressions, 8 to 35 cm. or more in length, 3 to 20 mm. in width, the sides parallel except near the base, with a very thin carbonaceous residue marked here and there at distant points by very small oval umbilical scars, and covering a longitudinal fascicle of strands 1 to 3 mm. wide, and either straight or winding irregularly with slight curves within the borders; uncompressed leaves probably oval or cylindrical, lax, and consisting of a central (?) fascicle or a vascular axis, between which and the outer sheath the tissue is either lacuneous or very delicate and perishable, so that the central fascicle is usually relaxed as if in a cavity during fossilization; the small oval umbilicoid scars occurring generally remotely on the leaves correspond to the irregular points of origin of other smaller leaves (?) extending out, generally at a very open angle, from the larger ones; nervation usually obscure but often distinct in portions of the same leaf; nerves parallel, close, rounded, numbering about 40 to the centimeter; epidermis marked with rows of longitudinal cells or fine striæ numbering about 18 to the millimeter.

The fragments collected at Deepwater by Dr. Jenney, of the United States Geological Survey, and by Dr. Britts, furnish some interesting details as to the superficial characters of *Tæniophyllum*, although the generic type still remains unique and somewhat anomalous among Paleozoic plants. The general form of the organism, as seen in a number of specimens, comprises a great number of streamer-like, rather delicate leaves whose decurrent and crowded bases cover and conceal a thick, somewhat rigid axis several centimeters in diameter. On one large slab, which is 80 cm. long and 48 cm. wide, there is near the left border a portion of a trunk or branch about 5 cm. in diameter, its surface covered by the matted and carbonized compressed decurrent bases of the leaves, which pass off, nearly parallel, to the right, becoming somewhat crinkled in the matrix, but apparently as wide at the broken ends as at any point in the remaining portions. Most of the leaves are large, some of the incomplete segments being 30 cm. long and generally 15 to 17 mm. in width. Mingled with these leaves are portions of small leaves somewhat irregularly disposed. The general aspect of the segments of these organs, which for the sake of convenience I shall call leaves, is better seen in Pl. LXXI. This specimen shows the usual very thin pellicle of coaly residue, with its minute striation or rows of cells, while here and there the rather fine nervation is visible to the unaided eye, although it is more often scarcely to be distinguished with a lens beneath the striated epidermis.

Showing clearly through the compressed wall of the leaf is seen the loose fascicle of parallel longitudinal vascular strands, about 2 or 3 mm. in width, passing straight or with a sinuous course at various oblique angles to the nervation. This fascicle or axis is seen in nearly all the leaves, and branches pass from it into the smaller leaflets. It is clear that these lie in the interior of the leaf. In their form and mode of occurrence they are suggestive of the axis of the *Stigmaria* rootlet and may be the homologue of the latter. Here and there on the leaves small umbilicoid or Stigmarioid cicatrices are found. They are never frequent, but are usually rather distant, and, so far as I have observed, they are without a regular system of phyllotaxy. These cicatrices, several of which are indicated in the figure last mentioned, are the points of origin of small leaflets, fragments of which are noticed on the large slab. Usually these leaflets are found still attached to the larger leaf. The form of the scars of the small leaves, as well as the irregular sinuosity of the axis within the larger leaves, suggests that the latter, when uncompressed, are cylindrical or rounded, a suggestion that is demonstrated by a number of cross fractures, two of which are obliquely seen in Pl. LXXI. It is probable that the main body of the tissue within the relatively thin wall of the leaf is composed of delicate material, such as thin-walled parenchyma cells, perhaps with cavities, environing the central fascicle or axis, so that during the maceration attending fossilization the interior often became hollow or partially so, thus releasing the unsupported axis, which lies somewhat flexuose between the walls of the collapsed leaf. In No. 644 these axial fascicles, which may also be found in the leaflets, are plainly seen, as is also the nervation. Specimen No. 645 shows a rather slender segment of what appears to be a slender branch, 10 cm. long and 8 mm. wide near the base, bearing several leaflets, seemingly without system, and terminating in a tuft of leaves.

The mutual relation of the leaflets is better indicated in Fig. 4, Pl. LXIII. Here we find a segment which seems by its texture, nervation, striation, the presence of the rather lax fascicle, and its size to represent an isolated leaf or small axis from which pass several leaflets. The latter have the characters of the larger leaflets. At both upper points of division we see the bases of two leaves, apparently originating at the same or approximate points. This feature, as well as the general aspect of the large segment, may be compared with the figure of *Desmiophyllum gracile* given by Lesquereux in the Coal Flora.[1] The type of the latter species and genus is now No. 9251 in the Lacoe collection, it having formerly rested in the Lesquereux collection. As noted by Lesquereux,[2] the round points showing scars of bundles of leaves are seen all along the stem. This fasciculate habit of the leaves in some places, while at other points they were single, seemed anomalous to him. In fact, this character appears to have constituted the essential basis for the separation of this type from *Tæniophyllum*, with the leaves of which the leaves of *Desmiophyllum* were said to

[1] Pl. lxxxii, fig. 1. Proc. Amer. Phil. Soc., vol. xvii, 1878, pl. liii, fig. 1, p. 333.
[2] Coal Flora, vol. ii, p. 556.

agree. A close examination of the axis of *Desmiophyllum* shows, however, that the leaves come from scars closely, although irregularly, situated, as in the Missouri specimen. The scars, which are likewise umbilicoid, are scarcely arranged in nodes, though an approximation to grouping is seen in both specimens. Finally, the nature of the leaf, with thin walls, an internal lax vascular fascicle, and small umbilicate scars, is, as Professor Lesquereux remarked, apparently the same as in *Tæniophyllum.* In short, the re-examination of the original of *Desmiophyllum* and the comparison of the latter with the Missouri specimen of *Tæniophyllum* now under consideration leave, in my judgment, no generic distinction between the two plants, the essential differences, such as the greater frequency of the scars on the main segment and the finer and more obscure nervation in the former, being of merely specific value. Accordingly I have little hesitation in uniting the genus *Desmiophyllum* to *Tæniophyllum*, which preceded it in the literature.

The compressed condition of the main axes, which are covered with a thick mask of flattened carbonized leaf bases, conveys but little information that is satisfactory regarding the mode of attachment of the larger leaves. Portions, however, of two fragments, Nos. 647 and 648, exhibit what appear to be impressions of segments of the axes. These, which are slightly rugose, striated, and covered with rather coarse vascular lines, are marked, generally indistinctly, by rather close, small, Stigmarioid scars, narrowly obovate, or nearly V-shaped at the base. The mode of arrangement of these scars, which plainly correspond to those of the leaflets on the leaves, is not at all clear, owing perhaps to imperfect exposure or deformity of the axis itself, but here and there they have at least the appearance of being spirally arranged. If this is the case, the scars may be 3 or 4 mm. distant in the same spiral, the distance between the spirals being about 5 mm. Additional material is needed in order to definitely ascertain their true relations.

The generic identity of the specimens from Missouri with the specimens from Cannelton described as *Tæniophyllum* is at once apparent on an examination of the original specimens described by Professor Lesquereux. The thin-walled, cavernose character of the compressed leaves of *Tæniophyllum* and their decurrent bases were described by the author of the genus. The material from Cannelton in the Lacoe collection well illustrates the contraction of the leaf bases, and the lax, flexuose, fascicular axis. In fact, the leaves of *T. decurrens*, which is nearest to the species from Missouri, differ only by the rather small size, the greater infrequency of the branching, and the slightly finer, usually more obscure, nervation.

The leaf scars on the main axes appear also to be umbilical though very narrow, being, in fact, linear-ovate. This is the case on all the segments of main axis found, including No. 9256 of the Lacoe collection, a part of which is seen in fig. 1 on pl. lxxxi of the Coal Flora. The V-shaped traces delineated in that figure erroneously represent merely the round lower ends of the leaf scars. The generic identity of the plants from Missouri and Pennsylvania is strong and most unequivocal.

With regard to the relations of the plants in the genus *Tæniophyllum*, little that is conclusive can yet be said. When first describing the genus[1] Professor Lesquereux was disposed, on account of the form and supposed mode of attachment of the leaves, to associate it with the Gymnosperms, though regarding it as perhaps constituting a family distinct from the *Cordaiteæ*. Later, in the second volume of the Coal Flora,[2] he describes the occurrence of spores in the cavernose leaves, and ranks the genus with the *Lycopodiaceæ*, with a suggested comparison with *Isoetes*, a comparison and presumed relation that are emphasized in the third volume[3] of the same work. These spores are present in two or three of the specimens in the collection. They are undoubtedly macrospores of the *Triletes* type, and, since I am unable to find any of them actually within the leaves, their position being, on the other hand, in groups or singly scattered irregularly about among the leaves,[4] I am led to regard them as extraneous. It seems probable that, as frequently happens with these bodies, they were lodged or drifted among the leaves of the *Tæniophyllum*, just as were the pinnules of *Linopteris* and fragments of *Pecopteris* found associated with the group of spores in one of the specimens from Cannelton, and should not therefore have great influence in any speculation as to the affinities of the genus.

A circumstance of considerable interest, if not significance, is the association, described in one specimen by Lesquereux,[5] of the leaves of *Tæniophyllum* with the Caulopteroid fern trunks published by him as *Stemmatopteris Schimperi*. The specimen, No. 9250 of the Lacoe collection,

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[1] Trans. Amer. Phil. Soc., vol. xvii, 1878, p. 330. [2] P. 463. [3] P. 788.

[4] In *Tæniophyllum brevifolium* Lx. they are not described as found within the leaves. See Coal Flora, vol. iii, p. 788.

[5] Coal Flora, vol. ii, pp. 462, 463.

discussed in the Coal Flora, shows, as there remarked, a segment of *Stemmatopteris*, about 70 cm. long, the upper part of which is clear, while the lower part is so associated with the leaves of *Tæniophyllum*, which stream downward at an angle of about 25° to the trunk, that it seems impossible to decide whether they are not organically united to the trunk. The presence of the *Triletes* among the leaves seems to have constituted the essential reasons for his conclusion that the leaves of the *Tæniophyllum* were foreign to the fern trunk. For my own part, after a close scrutiny of the trunk I am unable to show that the leaves were not joined to the trunk, although they are found streaming down from one side only. No. 9260, identified by Lesquereux under the same name, shows another unmistakable fragment of trunk, associated in the same way with the typical leaves of *Tæniophyllum* with *Triletes* and other plant fragments mingled therewith. So also Nos. 9257, 9262, 9265, labeled as *T. decurrens*, and No. 9272, and apparently 9275, marked as *T. contextum* Lx., present the same phases of association of the leaves with the fern trunk in such a relation as to leave one uncertain as to their union. The circumstantial evidence, including (1) the partial or total obscurity of the Caulopteroid scars in the lower parts of the trunks beneath the bases of the leaves; (2) the apparent impossibility of following any of the leaves from one side of the trunk across and beyond on the other side; (3) the angle of contact of the leaf with the mass of matted bases on the trunk; (4) the direction of the leaves downward, though generally outward, and not always on the same side; (5) the similarity of the compressed fragments of axes of *Tæniophyllum* on which no Caulopteroid scars are visible with the interpetiolar surfaces of the *Stemmatopteris*, which are apparently indistinguishable; (6) the blending of the carbonaceous residue of the leaves with that of the superficial tissue of the fern trunk, and (7) the occurrence in No. 9265 of unmistakable *Tæniophyllum* leaf scars and good leaves on different portions of a long segment of trunk showing what can hardly be else than somewhat masked scars of *Stemmatopteris*, are strongly in favor of an organic relation of the leaves with the trunks.

Against an hypothesis which may presuppose a ramental function for the *Tæniophyllum* would, on the contrary, seem to stand the branching habit of the leaves, as shown in Pl. LXIII, Fig. 4, which I can hardly explain as penetrative rootlets of *Stigmaria*. Even the epidermal features of the leaf itself seem to argue against such a view. Nevertheless, the habit of these thin-walled cylindrical "leaves," with loose axial fascicle within cavities of secondary, if not primary, origin, and the irregularly disposed leaflets, which, like the larger leaves, are contracted at the base to a small oval or linear-oval, more or less distinctly umbilicate point of origin, may be construed as perhaps indicating a radical homology. But while in some respects the affinities of *Tæniophyllum* seem to be strongest with *Stigmaria* or *Stigmariopsis*, its association with *Stemmatopteris*, although it may be only circumstantial, is so remarkable as to command a consideration as possibly representing appendicular organs of the latter. The impression gained from the examination of the specimens from Missouri is that they were suited to an extremely humid habitat, if they were not subaqueous in their growth. It is, however, quite possible that material will be found that will show *Tæniophyllum* to be a Stigmarioid type.

Localities.—Deepwater, U. S. Nat. Mus., 6070; Owen's coal mine, U. S. Nat. Mus., 6068; Hobbs's coal mine, U. S. Nat. Mus., 6069.

LEPIDOXYLON Lesquereux, 1878.

Proc. Am. Phil. Soc., vol. xvii, p. 333; Coal Flora, vol. ii, 1880, p. 557.

LEPIDOXYLON ANOMALUM Lx.

1878. *Lepidoxylon anomalum* Lesquereux, Proc. Am. Phil. Soc., vol. xvii, p. 334, pl. liv, fig. 5; pl. lv, figs. 1, 1*a*.

1879. *Lepidoxylon anomalum* Lesquereux, Coal Flora, Atlas, p. 17, pl. lxxxiv (pl. lxxxiii, fig. 5?); text, vol. ii (1880), p. 557 (excl. ref. "*Schizopteris anomala* Brongn.?").

Axis linear, robust, attaining a diameter of 5 cm. or more, giving origin on all sides to numerous, apparently irregularly disposed, rather distant, lax, linear, flat or flaccid leaves or leaflike appendages, and rather densely clothed with short, linear, upward-curving, chaffy scales, or densely and irregularly lineate when decorticated; scales irregularly disposed, 1 to 4 distant, linear or linear-lanceolate, 9 to 15 mm. long, 1 to 1.5 mm. wide, thin, very finely lineate in probable correspondence to the longitudinal rows of cells, tapering upward from near the base to a slender acute apex, slightly convex dorsally, very oblique, nearly erect or closely imbricated, narrowed at the point of origin to a slightly prominent discoid attachment about 1 mm. in diameter; leaves or appendages slender, rather distant, open, lax, linear, probably cylindrical or cavernous, narrowed near the downward-curving base, glossy in the compressed state, minutely lineate, about 6 or 7 lines to the millimeter, the primary leaves 4 to 8 mm. wide, branching irregularly at very variable distances, usually singly, sometimes nearly fasciculately, and traversed in the fossil condition by a longitudinal, flexuous, somewhat irregular vascular band or lax strand, about .75 to 1 mm. in width, which gives off a division to pass through the small, somewhat oval, Stigmarioid attachment into and along each more slender branch, 2 to 3 mm. in width, of the primary leaf.

The sole type on which the above description is based is the large fragment, a portion of the upper part of which is illustrated in pl. lxxxiv of the Atlas to the Coal Flora. The original specimen, recently presented to the United States National Museum by Dr. J. H. Britts, of Clinton, Missouri, longitudinally traverses a slab 40 cm. in length and 22 cm. in width. The axis is compressed to a thin and somewhat uneven interior cast, which, on account of its variances from the cleavage surface, is so fractured as to expose portions of the fossil at all its levels, although it is difficult at any point to ascertain its precise width. Thus, as is very imperfectly indicated in the plate just referred to, the upper surface, covered with the imbricated appressed scales, is shown in places, or the impression of the epidermis on the lower side of the stem is exposed, revealing the bases of the scales or their cicatrices, as happens to be the case over the most of the surface included in the figure, while cleavage from the smooth surface of the leaves on the back side of the trunk, or at an angle slightly oblique to the plane of the latter, shows the leaves behind or the matrix beneath the trunk. Such a fracture by a cleavage plane oblique to the axis has, naturally, produced a rounded profile, shown in the figure, at one point in the upper part of the specimen, and this circumstance appears to have given rise to the description of the stems or branches as "tapering up to a conical point."[1] Three centimeters farther the broken surface of the slab returns to the level of the upper surface of the stem, which is again found continuing in its normal position and direction, clothed with the appressed scales. The apparent width of the trunk is about 6.5 cm. at the base (assuming that the scales and "leaves" are directed upward) and nearly the same near the upper end of the segment, indicating no positive diminution. The margin

[1] Coal Flora, vol. ii, p. 557.

on the right is more or less crumpled. No leaves are shown to the right of the profile of the stem.

The scales are very much longer and closer than shown in fig. 1*b* in the Coal Flora, and form by this imbrication a dense thatch. I am unable to detect any trace of a median nerve in their thin, slightly dorsally convex lamina. The minute, roundish, irregularly disposed, slightly prominent cicatrices, ranging from 1 to 3 mm. distant, may be seen in the lower part of the trunk segment to correspond to the positions of the inflated scale bases. The enlarged detail of these scars, which should be marked by a minute central punctation, is disproportionate as compared with the scales in the published figure.

The leaves, which are relatively few, are generally inclined slightly downward near the trunk. None of the leaves on the slab, except a few erect bases near the top, issue from the upper surface of the trunk, and I am unable to find any that fork, the dichotomies illustrated in the type figure being cases of crossing or mere superposition, as is shown by carefully uncovering them. The figure fails to show that the leaves on the left and the larger ones at the top of the portion delineated in the Coal Flora come from beneath the trunk and are exposed within its profile, at a slightly lower level, by reason of the cleavage of the shale from their glossy surface.

As to the characters of the leaves or appendages themselves, it is sufficient to say that there seems to be no essential distinction between those of the type segment and those of *Tæniophyllum.* In the large segment of *Lepidoxylon anomalum* they are apparently joined by a narrowed base to small Stigmarioid cicatrices, the texture is very finely lineate, perhaps by the longitudinal rows of cells, the lax, often wrinkled, and apparently cylindrical, or possibly cavernous, interior is traversed by a loose, flexuose, often slightly twisted, band of nerve bundles, which is parted to supply a strand for each of the irregularly occurring smaller leaflets or branch appendages, and the latter are likewise continued linear, with the same features, except the smaller size, from their Stigmarioid points of origin. Usually these irregularly disposed branchlets are extremely distant, but in a few cases two or three originate close together, while in one case, low on the left, four spring close together from the parent leaf in a manner extremely suggestive of the *Desmiophyllum*, mentioned in the remarks on *Tæniophyllum latifolium.*

So far as I am able to detect from the examination of the large type described by Professor Lesquereux, the only distinctions between the genera *Lepidoxylon* and *Tæniophyllum* are the presence of the foliaceous scales, and the more open, distant, and ramose habit of the leaves in the former. That both types are extremely intimately related is evident, the question being merely as to whether the differentiation is of more than specific importance. Both genera are found as segments of robust longitudinal axes of large size, about which are gathered, usually at an acute angle and a uniform orientation, ribbonlike, delicate, collapsed leaves or appendages, agreeing in texture, apparent mode of origin, the loose central vascular ribbon or strand, the irregular branching, with Stigmarioid traces, etc. While entertaining little doubt as to the generic identity of the type in hand with the genus *Tæniophyllum*, I leave it under its original generic designation in deference to the judgment of its author. It is not improbable that the other fragment, figured by Professor Lesquereux as fig. 5, on pl. lxxxiii, is generically distinct from *Tæniophyllum*.

As to the systematic position of the type in hand, there is little to add to what has been said of *Tæniophyllum*. That both types belong to a form of vegetation as far advanced as the higher Cryptogams there is little doubt. It seems, however, that whether we assume that they be Stigmarioid or filicoid in nature, they should perhaps better be oriented so as to permit the leaves, which, although the form of their distal extremities is unknown, are very strongly suggestive of *Stigmaria*, and the foliaceous scales, likewise suggestive of fern ramentum, to decline. It is highly probable that the small area of cicatrices described from one of the trunks of *Tæniophyllum latifolium* corresponds to the epidermal impressions in the type in hand, since they are similar in size, form, and distance, and it is not difficult to discover here and there, in small areas, a spiral arrangement in the accidental local grouping of the cicatrices in the specimen in hand. The features of the impression of the stem showing only the small scale cicatrices are perhaps indistinguishable from the type described as ? *Caulopteris acantophora* Lx., or the large segments occurring in the E vein at the Butler mine near Pittston, Pennsylvania, which have been regarded as derived from portions of the cortex of a squamose fern trunk or from a true Stigmarioid form.

Locality.—The type illustrated in pl. lxxxiv of the Coal Flora is from Pitcher's coal mine, U. S. Nat. Mus., 6082.

PHANEROGAMS.

GYMNOSPERMS.

CORDAITALES.

CORDAITACEÆ.

CORDAITES Unger, 1850.

1822. *Flabellaria* Sternberg, Fl. d. Vorw., vol. i, fasc. 1, p. 32 (pars).
1849. *Pychnophyllum* Brongniart (non Rémy), Tabl. d. Gen., p. 65.
1850. *Cordaites* Unger, Gen. et Spec. Pl. Foss., p. 277.

The study of the structure of the plants long known as *Cordaites* has revealed an organization having some of the characters of the Cycads, some in common with the *Taxineæ*, yet presenting an ensemble quite foreign to either. Hence they have more recently been set apart as constituting a distinct family, which, while it may have been ancestral to other later types, is without direct relation to any known living plants.

Recognizing from the great diversity of fruits in the Carboniferous, that can hardly have been produced by any other group of associated plants, that several genera must exist in this family, Grand 'Eury divided the original genus, as we have known it in our American literature, into three genera, viz, *Cordaites*, *Dorycordaites*, and *Poacordaites*.[1] Still another type, *Scutocordaites*,[2] was later differentiated by Renault and Zeiller, while the discovery of a peculiar form in the Devonian of Pennsylvania about the same time led to the description of a fifth genus, *Dictyocordaites*, by Sir William Dawson.[3] The characters of the leaves of these genera may be briefly summarized as follows:

Cordaites.—Leaves thick and transversely enlarged at the point of attachment, simple, sessile, entire, lanceolate, spatulate, rounded at the summit or obovate, 20 to 90 cm. long, usually very large, coriaceous, traversed for nearly their whole length by fine, equal, or unequal parallel nerves, which dichotomize several times. To this section or genus belong some of the species of wood described as *Dadoxylon*, *Cordaioxylon*, and *Araucarites* or *Araucarioylon*, the bark, *Cordaifloyos*, the fragments of pith

[1] La flore carbonifère de la Loire, 1877, pp. 208-227.
[2] Comptes Rendus, vol. C, 1885, p. 869; Fl. foss. bassin houill. Commentry, pt. 2, 1890, p. 203.
[3] Amer. Jour. Sci., (3) vol. xxxviii, 1889, p. 2; Canad. Rec. Sci., vol iv, 1890, p. 2.

known as *Artisia*, and the leafy branches named *Cordaicladus*, while the flowers are included in the *Antholithi* or *Cordaianthi*. *Cordaicarpus* is referred by Grand 'Eury to this type as the fruit.

Dorycordaites.—Leaves of variable length, according to age, always lanceolate, much thinner, and less fleshy than in the preceding genus, terminating in a point, and marked by very much crowded, slender, equal, or nearly equal parallel nerves. To this genus Grand 'Eury[1] refers the thin-winged *Cardiocarpi*, or *Samaropsis*, and *Botryoconus*.

Poacordaites.—Leaves very long, narrow, perhaps as long as 40 cm., while only 1 cm. wide, linear, tapering slightly and obtuse at the summit, rather fleshy, borne on slender branches, the scars being transverse, slightly arched, and much narrower than in *Cordaites*. The nerves are simple, equal, parallel, all springing from the base of the leaf. The fruit of this genus, according to Grand 'Eury, is *Taxospermum*.

Scutocordaites.—Leaves for a long time persistent on semicircular salient cushions, rounded and contracted at the base, finally divided into numerous narrow, erect, rigid, stringlike strips. Nerves strong and prominent in the lower part of the leaf, separated by fine, parallel striæ

Dictyocordaites.—Leaves persistent, long, ribbonlike, probably truncate or uneven at the apex, nerves sharp, forking at an acute angle and occasionally anastomosing to form linear, acute, somewhat irregular areoles. Fructification terminal on the branches.

Professor Renault, to whom more than any other we owe our knowledge of the anatomy of the members of this family, has recently given a most excellent summary of this knowledge in his magnificent report on the plants from the Permian basin of Autun and Épinac, in which he includes the results of his late extensive examination of the rich materials from these localities of world-wide fame for the exquisite preservation of their abundant silicified vegetable remains. For the detailed account of the internal organization of the pith, wood, bark, root, leaves, inflorescence, pollen, and seeds the reader is referred to his concise and admirable descriptions.[2] Many of the details there given are of great interest to the student of recent plants as well as the investigator of the structure of fossil stems. Among

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[1] Géol. et pal. bassin houill. Gard, p. 314.

[2] Études des gîtes minéraux de la France. Publiées sous les auspices de le Ministre des Travaux Publics. Bassin houiller et Permien d'Autun et d'Épinac, fasc. iv, Flore fossile, 2me partie, par B. Renault. Atlas, 1893; text, 1896. See pp. 332–352.

the salient points of more general interest may be mentioned the absence of primary wood in the trunks, the presence of both the primary and secondary development in the roots, while the vascular strands of the nerves in the leaves comprise a triangular primary axis partially surrounded by a secondary growth. The trees of the *Cordaiteæ* grew rapidly to a considerable height, branching only near the top. The flowers were diclinous and aperianthous, but whether the unisexual flowers were monœcious or diœcious is not yet known. Both sorts were mingled in the fossil state. The female flowers are monocarpal, for although, like the male flowers, they are cone shaped in general aspect, they are solitary, each female flower being surrounded by an involucre of bracts. The male flowers are in small cones spirally arranged in the axils of bracts about a rather robust axis. Each flower is composed of two or three stamens, each comprised of a filament bearing three or four longitudinally dehiscent anthers, which are free above and united at their bases. The pollen grains are ellipsoidal in section and very abundant. In the anther of one species the grain measures 90μ in longer and 50μ in shorter diameter, while in the pollen chamber, which is constantly present in and forms an interesting feature of the seed, it measures 121μ and 72μ, respectively. The seeds, including among others the *Cordaicarpus*, have two envelopes. The external envelope (Sarcotest) is fleshy and is sometimes traversed by elongated fibrous cells mingled with canals containing gum or tannin. The internal covering (Endotest) is formed of densely lignified cells and suggests the shell of a nut. The ovules are orthotropous and erect. A pollen chamber, relatively little developed, is always found in the summit of the nucleus, and the pollenic canal is always attached to the micropylar tube of the outer envelopes. The archegonia are in pairs. No embryo has yet been found in any of the fruits, although the latter appear to have been fully developed. Renault points out that in *Cordaites*, as in the living *Ceratozamia*, the embryo was probably not developed until the seed had been placed some time in the soil. To the *Cordaites* Renault seems to refer the fossil seeds which are rather flat and bilaterally symmetrical. In his Cours de Botanique Fossile[1] he refers to the *Cordaiteæ* the genera *Cardiocarpus*, *Diplotesta*, *Sarcotaxus*, *Leptocaryon*, *Taxospermum*, and *Rhabdocarpus*, while M. Grand 'Eury has since[2] included *Hypsilocarpus*, *Cyclocarpus*, and *Samaropsis* in the same category.

[1] Vol. i, p. 102.

[2] Géol. et pal. bassin houill. Gard, 1890, p. 312.

All the material from Missouri, with the possible exception of the doubtful fragments referred to as *Cordaites diversifolius?* belong to the group *Eucordaites* of Grand 'Eury, i. e., to the genus *Cordaites* restricted.

Cordaites communis Lx.

Pl. III, Fig. 1; Pl. XVI; Pl. XLVI.

1878. *Cordaites communis* Lesquereux, Proc. Amer. Phil. Soc., vol. xvii, p. 320.
1880. *Cordaites communis* Lesquereux, Coal Flora, vol. ii, p. 534.
1893. *Cordaites communis* Lx., D. White, Bull. U. S. Geol. Surv., No. 98, p. 105.
1899. *Cordaites communis* Lx., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 533.

The species originally described from Missouri is represented in the collection by numerous specimens, some of which probably come from the type locality. The general form of the leaf, as seen in part in Pl. XVI, is spatulate. From the broadest point, in the upper part, it narrows gently to the thickened base, which is slightly crescentic when compressed, and is not infrequently as much as 2 cm. wide in the full-grown examples. The apex of the leaves is rather broadly truncate-rounded and slightly oblique. The nervation of this species, as seen from the examination of the types of the species now in the Lacoe collection, is very irregular in character and apparent density. Even on the same leaf it may be found composed in one area, especially near the base, of moderately strong nerves close together or separated by from one to three or four less prominent, or, in another area it comprises distant, quite prominent nerves, perhaps 15 to 20 to the centimeter, separated by from four to six smaller nerves. The difficulty of arriving at a satisfactory numerical characterization of the nerves is further increased by the irregular disappearance or immersion of the intermediate nerves in the thick tissue of the leaf and the fine striation, perhaps due to the rows of cells, which is often more conspicuous than the depressed intermediate nervation. These rows or striæ number about twelve to the millimeter in some specimens.

The inflorescence described as *Cordaianthus ovatus* Lx. belongs almost certainly to this species, to which I am also disposed to refer the *Cordaicarpus cerasiformis* as the fruit. *Cordaites communis* is, in the Missouri flora, the host of *Hysterites Cordaitis* Gr. 'Ey., the bordered peritheciæ of which are frequently found in its leaves.

The distinction between the leaves described as *Cordaites communis* and certain forms referred to other species, such, for instance, as the leaves from Cannelton recorded as *C. borassifolius* (Stb.) Ung., is not clear to me. From *C. lingulatus* Gr. 'Ey., the leaves of which are somewhat similar, *C. communis* differs by the greater distance of the prominent nerves in most portions of the leaf and by the less rounded apices.

Localities.—Deepwater mine, U. S. Nat. Mus.; Pitcher's coal bank, U. S. Nat. Mus., 5418, 5702; Gilkerson's Ford, a small fragment, U. S. Nat. Mus., 6282; also a specimen of doubtful specific identity from Jordan's coal bank, U. S. Nat. Mus., 6281.

CORDAITES DIVERSIFOLIUS Lx.?

1870. *Cordaites angustifolius* Lesquereux (non Dawson), Rept. Geol. Surv. Illinois, vol. iv, p. 420 (pars?).
1878. *Cordaites diversifolius* Lesquereux, Proc. Amer. Phil. Soc., vol. xvii, p. 320, pl. xlviii, figs. 3, 3*a* (pars).
1879. *Cordaites diversifolius* Lesquereux, Coal Flora, Atlas, pl. lxxvii, figs. 3, 3*a*; text, vol. ii (1880), p. 535 (pars).

There are among the ironstone nodules from Gilkerson's Ford a few fragments of doubtful specific relations which I should hardly venture to refer to this species but for the facts that it is recorded[1] from the same vicinity by Professor Lesquereux, and that such characters as are shown by the specimens in hand appear to agree with material labeled under the same name by the author of the species. It should be noted, however, that the specimens assigned at various times by Lesquereux to *C. diversifolius* are not all of one species, since some of the fragments may belong to *Dorycordaites*, while others from Arkansas are apparently specifically inseparable from the material from the Boston mine near Pittston, Pennsylvania, labeled as *C. borassifolius* (Stb.) Ung. My identification of the specimens in the ironstone is both temporary and questionable. The fragments before me are nearer the *Dorycordaites* group, and may, in conformity with the views expressed by Grand 'Eury, belong to the *Samaropsis* type of fruit. It is quite possible that the leaf fragments in hand may have been borne on the same tree with the *Cardiocarpus* (*Samaropsis*) *Branneri* Fairch. and D. W., to be described further on.

Locality.—Gilkerson's Ford.

[1] Coal Flora, vol. ii, p. 536.

CORDAIANTHUS OVATUS Lx.

Pl. LXXII, Figs. 1, 2.

1878. *Cordaianthus gemmifer* Gr. 'Ey., Lesquereux, Proc. Am. Phil. Soc., vol. xvii, p. 326, pl. xlvii, fig. 5.

1879. *Cordaianthus gemmifer* Gr. 'Ey., Lesquereux, Coal Flora, Atlas, p. 16, pl. lxxvi, figs. 5, 5*a*; text, vol. iii (1884), p. 914.

1880. *Cordaianthus ovatus* Lesquereux, Coal Flora, vol. ii, p. 545, pl. lxxvi, figs. 5, 5*a*.

The axis of this species, as seen in the original type, No. 9187 of the Lacoe collection,[1] is robust, distinctly and rather coarsely striate. The gemmules are open, ovate or ovate-oval, close at the apex, and apparently arranged four to a complete turn of the spiral. The scales are ovate or ovate-lanceolate, acute, rather fleshy toward the base, and distinctly carinate toward the top, the keel being somewhat prominent in the almost mucronate apex. Usually they are erect and fairly clearly defined, numbering perhaps 40 to 50 to the gemmule. The bracts are very broad at the base, contracting rapidly with a concave margin to a narrow lineate rigid spine of variable length, though always longer than the gemmule. The enlarged detail, 5*a* on pl. lxxvi of the Coal Flora, appears to have been drawn from some specimen other than the original of fig. 5. The same features are seen in No. 9192, another of the specimens originally studied, and in No. 9202, illustrated in Pl. LXXII, Fig. 2, and No. 9210, which show better the fragments of bracts, often exceeding twice the length of the gemmule to the point of fracture, while the gemmules themselves vary somewhat as to their distance along the axis.

In No. 9209, a specimen from Missouri labeled with the above name by Lesquereux, we find a smooth axis bearing rather large crowded gemmules with long scales. So far as the character of the latter have weight the specimen would seem rather to belong to *Cordaianthus dichotomus* Lx., if, indeed, that species is really distinct from the one under consideration. The striation of the axis is not, however, constantly visible in the specimens of *C. ovatus*, since it seems to depend on the degree of compression, and shows only in those portions of the stem that are slightly decorticated. In most of the specimens from Pennsylvania referred by Professor Lesquereux to this species, including Nos. 9190 and 9191 of the Lacoe collection, originals used in the description of the species, the axis is somewhat convex and shows

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[1] The fragment figured in the Coal Flora is from the vicinity of Clinton, Missouri; not from Cannelton, Pennsylvania, as inferred from the habitat named on p. 546 of that work.

merely the irregular transverse cracks or fissures in the carbon. The latter may be only the result of shrinkage of an axis composed largely of cellular tissue or they may bear some relation to the chambering of the pith. The specimens from Cannelton have the gemmules usually more crowded, the scales being generally a little shorter.

Very interesting, as furnishing the data for the correlation of this species, is the type described on page 534 of the Coal Flora as the stem of *Cordaites communis* Lx. In the specimen, No. 8946 of the Lacoe collection, the impression of a segment of stem or branch 14 cm. long and 2.3 cm. in diameter shows about thirty leaf scars. From the axils of every one of these, so far as can be learned without injury to the specimen, in the upper half of the segment, there radiate rather slender racemes of *Cordaianthus*. The pedicels and gemmules on the upper part of the slab are rather slender, having about the proportions of the *C. dichotomus* figured in the Coal Flora,[1] but those nearer the base of the segment are unmistakable specimens of *Cordaianthus ovatus*, and indicate the specific identity of the latter with the type stem and intermingled leaf fragments of *Cordaites communis*.

The full length of the lineate bracts is rarely shown. In one rather small specimen they are, however, seen as slender, slightly decurrent needles, 39 mm. in length, or over five times the length of the gemmules.

The fragment of a very small raceme, shown in Pl. LXXII, Fig. 1, is suggestive of the *Cordaianthus gracilis* of Grand 'Eury,[2] or to some extent the *C. Volkmanni* (Ett.) Zeill.,[3] though the resemblance to Ettingshausen's *Calamites Volkmanni*[4] is more remote.

Cordaianthus ovatus appears to differ from *C. ebracteatus* Lx., to which it seems closely related, by the absence of the bracts and the usually shorter scales in the latter.

The difference between it and *C. dichotomus* consists perhaps in the rather larger and longer scales and the possible dichotomy of the axis in the type described under the latter name, though it appears somewhat questionable whether the distinction between these two plants, found at the same locality, is of even varietal rank. The characters in common will be mentioned in the remarks on the latter species.

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[1] Pl. lxxvi, fig. 6.

[2] Fl. carb. Loire, p. 230, pl. xxvi, fig. 7.

[3] Fl. foss. bassin houill. Valenciennes, p. 637, pl. xciv, figs. 6, 6*a*.

[4] Steinkohlenfl. Stradonitz, pl. v, figs. 1–3.

Localities.—Vicinity of Clinton, Missouri, Nos. 8946, 9187, 9192, 9202, 9209, 9210, Lacoe collection, U. S. Nat. Mus; Pitcher's coal mine, U. S. Nat. Mus., 6073, 6212; Hobbs's coal mine, U. S. Nat. Mus., 6210.

CORDAIANTHUS DICHOTOMUS Lx.

1878. *Cordaianthus gemmifer* Gr. 'Ey., Lesquereux, Proc. Amer. Phil. Soc., vol. xvii, p. 326, pl. xlvii, fig. 6.
1879. *Cordaianthus gemmifer* Gr. 'Ey., Lesquereux, Coal Flora, Atlas, p. 16, pl. lxxvi, figs. 6, 6*b*; text, vol. iii (1884), p. 914.
1880. *Cordaianthus dichotomus* Lesquereux, Coal Flora, vol. ii, p. 546, pl. lxxvi, figs 6, 6*b*.

The relationship of the type[1] described under the above name to *C. ovatus* is one of the closest affinity, if the two species are not in fact identical. After an attentive examination of the original of figs. 6 and 6*b*, on pl. lxxvi of the Coal Flora, I am far from certain that the specimen there represented is to be separated from the *C. ovatus* found in the same locality. The gemmules do not differ in form from those described above. The scales are likewise ovate-lanceolate, carinate, the keel passing into the acute point conspicuously as in *ovatus*, though this character is not brought out in the detail, fig. 6*b*. So also the bracts are dilated at the base and quickly contracted to a striated, rigid, long, slender needle, being identical in their superficial characters with those in the other species.

With the exception of the dichotomies, the only external features by which *C. dichotomus* and *C. ovatus* may be separated are a possibly greater elongation of the gemmule, the scales being perhaps a little longer and larger, and the less robust axis. But we have seen fertile axes of the same character, save the forking, in the upper part of the stem of *Cordaites communis* (type No. 8946 of the Lacoe collection) which bear indubitable gemmules of *Cordianthus ovatus*, while the attitude in the matrix of the compressed radiating spikes about the stem in No. 8946 is strongly suggestive of the arrangement figured as typical of *C. dichotomus*. The inspection of the figure of the latter species given in the Coal Flora[2] convinces me that three at least of the four dichotomies there represented are the result of coincidence of position in the horizontal projection, the axes, all of which undoubtedly spring from a single branch or stem, being

[1] No. 9212 of the Lacoe collection, U. S. Nat. Mus.
[2] Pl. lxxvi, figs. 6. 6*b*, p. 546

in different planes, while the fourth lower central dichotomy in the figure leaves much to be desired as to distinctness. However, dichotomy is not unknown in other species of *Cordaianthus*.

It is quite possible that further discoveries of *Cordaianthus* in these beds will lead to the union not only of *Cordaianthus dichotomus* and *C. ovatus*,[1] but also *C. rugosus* Lx., the Illinois type of which affords very slight ground for its differentiation.

Localities.—Vicinity of Clinton, Missouri, No. 9212 of the Lacoe collection. Two fragments, perhaps representing *C. ovatus* Lx., with rather long scales, are from Hobbs's coal mine, U. S. Nat. Mus., 6200; and Deepwater, U. S. Nat. Mus., 6199.

CORDAICARPON Geinitz, 1862.

1828. *Cardiocarpon* Brongniart, Prodrome, p. 87 (pars).
1857. *Cyclocarpon* Goeppert and Fiedler, Nova Acta Acad. C. L. C. Nat. Cur., vol. xxvi, p. 292.
1862. *Cordaicarpon* Geinitz, Dyas, vol. ii, p. 150.
1881. *Cordaispermum* Brongniart, in Renault: Cours bot. foss., vol. i, p. 102 (pars).

CORDAICARPON CERASIFORME (Presl).

1838. *Carpolites cerasiformis* Presl, in Sternberg: Fl. d. Vorw., vol. ii, p. 208, pl. x, fig. 9.
1884. *Carpolithus cerasiformis* Presl, Lesquereux, Coal Flora, vol. iii, p. 824, pl. cxi, fig. 18.

The two specimens which I refer to this species represent a small suborbicular, slightly cordiform fruit, the walls of which appear to have been less resistant than those of most of the fruits referred to this genus. Like the fruits described and illustrated by Presl and Lesquereux, they are somewhat wrinkled in the compressed state. The outer envelope seems to have been rather thick. The surface is obscurely granular. The fruit from Missouri is somewhat smaller than the one from Arkansas figured in the Coal Flora, it having in fact very nearly the size of the one shown in Presl's figure. The specimens are also smaller and less apiculate than Zeiller's *Cordaicarpus Boulayi*.[2]

At first I was disposed to regard these bodies as sporangia, but the texture is quite different from any sporangia I have seen, while the presence

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[1] The reference, on p. 933 of the 3d volume of the Coal Flora, of fig. 6, pl. lxxvi, to *Cordaianthus ovatus* is probably a mechanical error.

[2] Fl. foss. bassin houill. Valenciennes, Atlas, pl. xciv, figs. 14, 14*a*.

of a narrow border zone, apparently corresponding to the compressed profile zone of one of the envelopes of a Cordaicarpon, such as *C. Gutbieri*, and the obscurely cordate base, have convinced me that we have really to do with representatives of the latter genus. The reference to Presl's *Carpolites cerasiformis* is not without doubt.

Localities.—Deepwater, U. S. Nat. Mus., 6164; Hobbs's coal mine, U. S. Nat. Mus., 6165.

CARDIOCARPON Brongniart, 1828.

Prodrome, p. 87 (pars).

CARDIOCARPON (SAMAROPSIS) BRANNERI Fairch. and D. W. MSS.

Pl. LXXII, Fig. 3; Pl. LXI, Fig. 1*e*.

1899. *Cardiocarpon Branneri* Fairch and D. W. MSS., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 534.

Fruit small, oval or ovate, and slightly prolonged at the somewhat truncate base, 10 to 12 mm. long, 7 to 9 mm. wide, consisting of an ovate nucleus within a relatively wide wing; wing oval, blunt, and incised a little, or very slightly emarginate at the apex, sometimes slightly rounded on either side of the micropyle, near which it forms a border 2 to 2.5 mm. in width, narrowing slightly downward toward the lateral angles of the nucleus to 1.5 to 2 mm. in width, then prolonged or dilated in a basal lobe 3 to 5 mm. wide, extending 3 to 5 mm. downward and truncate, or truncate rounded at the base, which is often traversed by a fine, clear line passing downward from the nucleus; nucleus ovate-triangular, usually rather obtuse just below the acuminate apex, generally uniform in size, about 7 mm. long, 5 mm. wide, broadest a little below the middle of its altitude, either very obtusely rounded or truncate at the base, very thinly lenticular in cross section, thickest near the base, or, when flattened, often marked by a small oval medial convexity above the base, above which a line or faint ridge passes upward to the micropyle.

The interesting examples of *Samaropsis*, one of which is figured in Pl. LXXII, Fig. 3, are found in the clay ironstone matrix, both with and without the marginal wing. The specimens that are less flattened are but slightly convex and have but very little adherent carbonaceous residue. The wing, which is peculiarly dilated at the base, differing thus from all the other small species with which I am acquainted, is obviously very thin, and probably membranaceous. In one compressed specimen the nucleus is bordered by an intervening narrow, minutely rugose-striate zone, about .5 mm. in width, which apparently represents an envelope. The surface of the wing is dull and moderately smooth; that of the nucleus is granular near the base and granular-striate toward the top, as viewed by the lens. The illustration of *C. Branneri* in Fig. 3, Pl. LXXII, fails to show the ordinary width of the basal dilation of the wing, or the usually more or less triangular form of the nucleus.

This species, found quite abundantly at Gilkerson's Ford, has also been discovered in the Coal Measures of Arkansas, from which it has been described by Prof. H. L. Fairchild and myself in a report submitted to the State geologist of that State. The upper part of the fruit resembles on a small scale the corresponding portion of the *Cardiocarpus orbicularis* Ett.,[1] though the basal portion is quite different. It is probably nearest to *C. zonulatus* Lx.,[2] from which it differs, however, by the much broader downward expansion of the wing. The *C. fluitans* of Dawson[3] is somewhat smaller, more distinctly granular, and lacks the pronounced dilation of the wing at the base, while the marginal expansion at the top is proportionally wider.

Locality.—Gilkerson's Ford, U. S. Nat. Mus., 6150, 6157, 6255, 6262.

RHABDOCARPOS Goeppert and Berger, 1848.

De fructibus et Seminibus ex Form. Lithanthr., p. 20.

RHABDOCARPOS (PACHYTESTA) MANSFIELDI Lx.

1879. *Rhabdocarpus Mansfieldi* Lesquereux, Coal Flora, Atlas, p. 18, pl. lxxxv, fig. 21.
1883. *Rhabdocarpus Mansfieldi* Lesquereux, 13th Rept. Geol. Surv. Indiana, pt. 2, pl. xxii, fig. 7.
1889. *Rhabdocarpus Mansfieldi* Lx., Lesley, Dict. Foss. Pennsylvania, vol. ii, p. 868, text fig.
1880. *Cordaicarpus Mansfieldi* Lesquereux, Coal Flora, vol. ii, p. 539, pl. lxxxv, fig. 21; vol. iii (1884), p. 916.
1880. *Cordaites Mansfieldi* Lesquereux, Coal Flora, vol. ii, p. 537 (pars), pl. lxxxvii, fig. 8.

Several specimens from Missouri agree well with examples in the collections of the United States National Museum derived from the type locality, Cannelton, in Pennsylvania, and labeled with the above name by Professor Lesquereux. On one slab three specimens, slightly smaller than

[1] Steinkohlenfl. V. Stradonitz, pl. vi, fig. 4.
[2] Coal Flora, vol. iii, p. 813, pl. cx, figs. 14–17.
[3] Cond. Dep. of Coal, pl. xii, fig. 74.

the average, lie nearly in a row, their axes parallel, close by the side of a striated branching stem over 2 cm. in diameter. No direct attachment of the fruits to the stem is clear, though the arrangement is strongly suggestive of a former organic union.

Although *Rhabdocarpos Mansfieldi* is described by Lesquereux as the fruit of *Cordaites Mansfieldi*, it having been found by him on a branch referred to that species and occurring in the same beds, no leaves have yet been found in Missouri that can, I believe, safely be identified with the Cannelton *Cordaites.*

Rhabdocarpos Mansfieldi resembles in size *Pachytesta incrassata* Brongn., to which it is so obviously closely related that there is little room for doubt that its structure is in general the same as that of the latter species, so thoroughly and beautifully illustrated by Brongniart in his Recherches sur les Graines Fossiles Silifiées[1] and by Renault in the Flora of Autun and Épinac.[2] Our American fruit, which is shorter, proportionally wider, more distinctly obovate, with wider ribs than the species last named, is much smaller than the *P. gigantea* Brongn. *P. intermedia* of Grand 'Eury,[3] another related species, is longer, much more slender, and more pointed at the extremities. *Rhabdocarpos Schultzianus*, which has also been included in *Pachytesta* by Grand 'Eury,[4] is much smaller than *R. Mansfieldi*, oval, and rounded at the ends.

Localities.—Owen's coal mine, U.S. Nat. Mus., 6178. The precise locality of the slab from the vicinity of Clinton is not known; U. S. Nat. Mus., 6170.

RHABDOCARPOS MULTISTRIATUS (Presl) Lx.

1838. *Carpolites multistriatus* Presl, in Sternberg: Versuch, vol. ii, p. 208, pl. xxxix, figs. 1, 2.
1880. *Rhabdocarpus multistriatus* (Presl) Lesquereux, Coal Flora, vol. ii, p. 578 (pars).
1899. *Rhabdocarpus multistriatus* (Presl) Lx., D. White, 19th Ann. Rept. U. S. Geol. Surv., pt. 3, p. 534.

It is with great doubt that I refer several specimens to this species, the interpretation of which seems to have led to much confusion both in the literature and in the collections pertaining to American Paleozoic plants. Much of this material, including that now under consideration, would appear to be referable to the original type of *Trigonocarpum Schultzianum* of

[1] Paris, 1881, pls. xix, xx. See also pls. xvii, xviii, xxi.

[2] Bassin houiller et permien d'Autun et d'Épinac, fasc. iv; Flore fossile, 2me partie, Atlas, Paris, 1893, pl. lxxx.

[3] Géol. et pal. bassin houill. Gard, 1890, p. 308, pl. viii, fig. 3.

[4] Fl. carb. Loire, p. 203.

Goeppert and Berger[1] more properly than to *Carpolites multistriatus* Presl.[2] The former type, setting aside the question of the essential Trigonocarpal character, appears to be longer, more distinctly elliptical, pointed, with the ribs much more numerous and finer. The latter is oval, with wider, broadly convex ribs, apparently about fifteen or eighteen in number. Some of the specimens referred to the former are undoubtedly close to *Rhabdocarpos apiculatus* and *R. carinatus* of Newberry, as Kidston[3] has pointed out. Others, chiefly from the Pottsville series, have nutlets resembling the last-named form, but the envelopes appear to have been long, extending some distance above the apex of the nut, with broad truncate-rounded apex and striated, not ribbed, surface. On the other hand, a portion of the material labeled as well as that figured[4] by Professor Lesquereux as *Trigonocarpus Schultzianus*, appears to me to stand closer to some of the forms illustrated by Fiedler[5] than to the original example described by Goeppert and Berger, or the specimens figured by Zeiller.[6] It is more than possible that the incompatibilities in the identification of these two species in our native collections are very largely due to the varied conceptions of those species portrayed by the European authors. The examination, as I have suggested above, of the collections to which I have had access, seems to show that most of our specimens determined as *Rhabdocarpos multistriatus* are really much nearer the *Trigonocarpum Schultzianum*, although in the flattened specimens the main tricostate feature is often obliterated. On the other hand, some of the examples labeled as *Trigonocarpum Schultzianum* often lack all traces of the tricostate character and are probably nearer the *Rhabdocarpos multistriatus*, while still others approach the *Rhabdocarpos Jacksonensis* of Lesquereux.[7] The material from Missouri, although lacking a distinct Trigonocarpoid aspect, belongs among the large number of specimens which, as it seems to me, would better be placed under *Trigonocarpum Schultzianum*. However, for the present I follow the identification by Professor Lesquereux, leaving the final reference of this fruit to a revision of this entire group of species.

Locality.—Owen's coal mine, U. S. Nat. Mus., 6202.

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[1] Berger, De fruct. et semin. ex form. lithanthr., 1848, p. 20, pl. ii, figs. 22, 23.
[2] In Sternberg: Versuch, vol. ii, appendix, 1838, p. 208, pl. xxxix, fig. 12.
[3] Cat. Pal. Pl. Brit. Mus., 1886, p. 213.
[4] Coal Flora, vol. iii, p. 819, pl. cx, figs. 63–65.
[5] Die foss. Früchte d. Steink.-Form., 1857, p. 283, pl. xxiv, figs. 18–20; pl. xxvi, figs. 25–26.
[6] Fl. foss. bassin houill. Valenciennes, p. 651, plate xciv, figs. 15–16.
[7] Rept. Geol. Surv. Illinois, vol. ii, 1860, p. 461, pl. xlvi, fig. 4.

TITANOPHYLLUM Renault, 1890.

Fl. foss. bassin houill. Commentry, pt. 2, p. 622.

Among the material sent by Dr. Britts from North and Wood's coal shaft, one-half mile east of North's Station, on the Kansas City, Clinton and Springfield Railroad, there was found what appears to be the base of a very large and very thick leaf, like *Cordaites* in several respects. In a memorandum accompanying it was the statement that some of the leaves of this plant were over 1 foot wide and 4 to 6 feet in length. This specimen, though imperfectly preserved, seemed so strongly to resemble the large leaf bases figured by Renault[1] that further inquiries were made as to the occurrence and form of these specimens. In reply Dr. Britts writes: "They are certainly immense leaves, and were attached without foot-stalks to large stems or trees, like a corn blade. * * * I found several bases of these leaves, but no points. * * * The bases were somewhat contracted laterally and thickened where they appear to have been attached to round stems, some of them at least 6 inches or more in diameter."

The evidence so kindly furnished by Dr. Britts, as well as that afforded by the fragment in hand, leads me to regard it as probable that we have here to do with an American representative of that interesting genus of Gymnosperms, *Titanophyllum*, hitherto known only in the Commentry Basin. The generic description given by Renault[2] is as follows:

> Leaves of great size, measuring 70 to 75 cm. long by 20 to 25 cm. wide, with smooth, shining upper surface, traversed by longitudinal, hypodermal, parallel, nonbifurcating bands, inserted by a much enlarged elliptical base; outline rectangular, gradually tapering toward the upper end, which is often fissured, the opposite extremity being sometimes concave or cordate. The bands and the nerves, which are parallel for nearly the whole length of the leaf, are curved in to terminate in the surface of insertion; a cuticle very thick and smooth covers the epidermis.

From a study of the internal structure of the Commentry species, *Titanophyllum Grand'Euryi*, Renault was enabled to demonstrate a Cycadean organization analogous to that of the *Colpoxylon* Brongn. described from silicified material obtained at Autun.

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[1] Fl. foss. bassin houill. Commentry, pt. ii, p. 622, pl. lxix.
[2] Loc. cit., p. 622.

?TITANOPHYLLUM BRITTSII n. sp.

The specimen in hand, from what seems to be the thick base of the leaf, though flattened, seems to represent a system of bands similar to that illustrated by Renault.[1] They are somewhat finer than those in the French type. The surface is distinctly and zonally striated. The incurving of the bands and nerves accompanying the contraction of the base of the leaf is very clearly seen. As flattened, the fragment seems to have a thickness of about 2 mm. While our flattened specimens are, possibly as the result of pressure, thinner at the base than are the French specimens, they appear to be somewhat larger.

The generic identity of the American material with the French seems probable from the description communicated by Dr. Britts, though it can not be absolutely assured until more and better material shall have been examined. The slightly narrower bands in leaves apparently less thick and much larger, the leaves measuring 6 to 12 inches in width and 4 to 6 feet in length, distinguish our plant, supposing it to belong to *Titanophyllum*, from the *Titanophyllum Grand 'Euryi*, though in view of the resemblance of the impression to certain compressed stems or large branches, the formal diagnosis of our species should not be given until more satisfactory material, susceptible of good illustration, is at hand. The specimens from Missouri are entirely carbonized and strongly compressed.

Localities.—North and Wood coal shaft, one-half mile east of North's Station on the Kansas City, Clinton and Springfield Railroad, the vein worked being an extension of Jordan's coal, U. S. Nat. Mus., 6168. A smaller fragment, possibly of the same nature, comes from Gilkerson's Ford, U. S. Nat. Mus., 6169.

CONIFERÆ.

TAXACEÆ?

DICRANOPHYLLUM Grand 'Eury, 1873.

Comptes Rendus Acad. Sci., vol. lxx, p. 1021.

The genus *Dicranophyllum*, as founded by Grand 'Eury, contains certain arborescent conifers with spirally arranged, long, narrow, dichotomous, coriaceous, rigid, acute, parallel-veined leaves with decurrent contiguous cushion-

[1] Loc. cit., pl. lxix, fig. 4 or fig. 13.

like enlarged subrhomboidal, slightly oblique fleshy leaf bases. The aspect of the branches is somewhat like *Trichopitys*. The male element is generated in small cones in the axils of the leaves, while the female organs are, according to Renault,[1] ovules or seeds arranged in considerable numbers along the very oblique linear basal portion of the leaf. The leaves bearing the seeds fork but once. Generally the leaves, which vary greatly in length, adhere to the branches until the latter are quite large. The leaf bases are suggestive of *Lepidodendron*, but lack the lateral traces in the leaf scar and the appendages, though they are carinate. The scars are described[2] as a little above the middle of the cushions, oval, and marked in the center by a small depression corresponding to the single vascular bundle.

Dicranophyllum should, perhaps, together with *Trichopitys*, *Ginkgophyllum*, *Saportæa*, and *Whittleseya* be associated with the *Salisburieæ* in the *Ginkgoales*, to which, among living plants, it appears to be most closely related.

DICRANOPHYLLUM? sp.

Pl. LXXIII, Fig. 1; Pl. XLI, Fig. 10.

Among the specimens collected by Dr. Britts from Hobbs's coal mine is a fragment of shale, on one side of which is a forked branch, each of the slightly unequal divisions being at an angle of about 45°, between 10 and 14 cm. long, very thick in proportion to the length, and clothed rather densely with narrow dichotomous leaves. The back side of the thin fragment of shale contains a robust twig of the same character, about 15 cm long and, like the others, thickly clothed with leaves. This twig lies in the same direction as that on the other side, and at the edge of the shale where the branches on both sides pass downward off the rock fragment the broken ends are inclined toward each other and are less than 5 mm. distant. It is probable, therefore, that both belong to a common parent branch. Unfortunately this example is not adapted to photography, while the macerated aspect of the whole specimen and the commingled ramose leaves, passing on all sides into the matrix, render its delineation without idealization most difficult. The leaves are very oblique and appear to overlap at the decurrent bases. They are generally, as seen in the detail, Pl. XLI, Fig. 10, slightly rigid, though often forked but a short distance

[1] Fl. foss. bassin houill. Commentry, pt. 2, p. 628.

[2] Renault, Fl. foss. bassin houill. et perm. d'Autun et d'Épinac, pt. 2, 1896, p. 373.

from the base. The dichotomies are repeated three or four times at a rather narrow angle, and the ultimate divisions are often strongly outward curved. As remarked above, the branches appear to have been macerated; so that while it is obvious that the axis was robust and of considerable substance, no satisfactory evidence as to the leaf bases is at hand, while the leaves themselves are so destitute of any considerable residue of carbonaceous matter and so lax, particularly toward the apex, as to suggest that the fossil should be rather associated nearer the Algæ. Usually there is left not even any other trace of the vascular axis of the leaves than a rugose furrow or canal. Often this, too, is lacking. Numerous spore-like bodies of various dimensions, some of which equal large macrospores in size, are mingled with the leaves and seem to have been lodged there. In the form and aspect of the branches, the general attitude of the decurrent leaves and the bifurcation and apparent basal rigidity of the latter—in fact, in their habit and such superficial characters as are visible, these plant fragments seem to represent badly macerated twigs of Dicranophyllum. It is possible that specimens better preserved will show characters of the axes, leaf bases, or even the leaves, that will make it necessary to refer them to some other genus or even to a different class, such as the Thallophyta.

The specimen in hand is not the first representative of this genus to be reported from this country, *D. dichotomum* and *D. dimorphum* having been described by Professor Lesquereux from Cannelton, Pennsylvania.[1]

Of the few species of *Dicranophyllum* yet described, *D. gallicum* Gr. 'Ey. and *D. tripartitum* Gr. 'Ey. are nearest to the form in hand. Our specimens should be compared with the illustrations of the former species given by Grand 'Eury,[2] Wenceslau de Lima,[3] and Renault,[4] or of the latter species given by its author.[5]

The resemblance to several of the figures given by de Lima[6] and Renault[7] is certainly very interesting and appears to indicate a closely related species in the flora of Missouri. The leaves of the American plant fork more frequently and nearer the base, are less rigid, while the lower

[1] Coal Flora, vol. ii, p. 553, pl. lxxxvii (bound in text), figs. 9, 9*a*, p. 554: pl. lxxxii, figs. 1–3.
[2] Fl. Carb. Loire, 1877, p. 275, pl. xiv, figs. 8–10.
[3] Monogr. d. gen. Dicranophyllum, 1888, p. 13, pl. i, figs. 2, 3; pl. iii.
[4] Fl. foss. bassin houill. Commentry, pt. 2, pp. 6, 26, pls. lxx, lxxi.
[5] Grand 'Eury: Géol. et pal. bassin houill. Gard., p. 335, pl. vi, figs. 12, 13.
[6] Op. cit., pl. iii.
[7] Op. cit., pl. lxx, fig. 7; pl. lxxi, fig. 5.

portions of the leaf are wider. While the fragments from Missouri appear to represent a species different from any yet described, a specific designation or description of them is postponed pending the discovery of additional better-preserved material.

Locality.—Hobbs's coal mine, U. S. Nat. Mus., No. 6076.

ANIMALIA?

PALÆOXYRIS Brongniart, 1828.

1828. *Palæoxyris* Brongniart, Ann. Sci. Nat., vol. xv, p. 456; Prodrome, p. 137.
1840. *Carpolithes* Morris, Trans. Geol. Soc. London, (2) vol. v, p. 489 (pars).
1852. *Palæobromelia* Ettingshausen, Abh. d. k.-k. geol. Reichsanst., vol. i, no. 3, p. 1.
1860. *Sporlederia* Stiehler, Bromeliaceen d. Vorwelt, p. 5.
1872. *Spirangium* Schimper, Traité, vol. ii, p. 514.

PALÆOXYRIS APPENDICULATA Lx.

1870. *Palæoxyris appendiculata* Lesquereux, Rept. Geol. Surv. Illinois, vol. iv, p. 465, pl. xxvii, fig. 11.
1888. *Palæoxyris appendiculata* Lx., Renault and Zeiller, Fl. foss. bassin houill. Commentry, pt. 1, p. 18, pl. xlii, figs. 6, 6*a*, 6*b*.
1879. *Spirangium appendiculatum* Lesquereux, Coal Flora, Atlas, p. 16, pl. lxxv, fig. 12; text, vol. ii (1880), p. 520.
1889. *Spirangium appendiculatum* Lx., Saporta, Paléont. franç., Vég. Jurass., vol. iv, p. 46, pl. ccxxxi, fig. 3; pl. ccxxx, fig. 3.

Of this, the most common American species of *Palæoxyris*, I have seen but a single fragment from Missouri. This specimen shows the narrow, sharp-keeled, equivalvate form characteristic of the species. The valves, which are probably eight in number, cross the flattened capsule at a very wide angle to the axis.

Mr. Kidston, in his review of the British species of the genus, unites this species with the Old World *Palæoxyris carbonaria* Schimp. The two forms are undoubtedly very closely related, but from an examination of material representing the latter species from the vicinity of Dudley, England, I am convinced that the American type is distinguished by the narrower valves, and consequently smaller areolation in the compressed specimens; and while in *P. appendiculata* the whole organ is, in general, smaller, the dilated portion is proportionately larger. No other equivalvate American species has yet been described which is liable to be mistaken for the one in hand.

Palæoxyris is now regarded by many paleobotanists as representing the egg capsules of certain Paleozoic Selachians. The writer has at present under examination a series of specimens, including several new species, that will, it is hoped, throw some additional light on the nature and organization of these very interesting remains.

The name *Spirangium*, proposed by Schimper on the ground of propriety, should be abandoned. While it has long been known that these fossil remains have no relation to the living *Xyris*, the generic appellation *Palæoxyris* is clearly understood to have been applied exclusively to this type. It therefore has priority, and in its proper function as a generic designation, not as a description, it should prevail.

Locality.—Gilkerson's Ford, Grand River, U. S. Nat. Mus., 6203.

DISCUSSION OF THE FLORA.

SPECIES REPORTED FROM THE LOWER COAL MEASURES OF MISSOURI, BUT NOT INCLUDED IN THE FOREGOING ARRANGEMENT.

As was remarked in the introduction to this report, the descriptions and discussions given herein relate only to species of which I have been able to examine specimens from the Lower Coal Measures of Missouri. Fortunately, nearly all the Paleozoic plant material from Missouri ever published by Professor Lesquereux was collected by Dr. J. H. Britts, of Clinton, Missouri, to whose enthusiastic and continued researches paleobotany owes a great debt, and this material is now either in the private collection of the latter or in the national collections. The latter include not only the extensive consignments forwarded from time to time by Dr. Britts to the United States Geological Survey and the United States National Museum, but also the private collection of Professor Lesquereux, which passed into the great collection of Mr. R. D. Lacoe, of Pittston, Pennsylvania, through whose generous patriotism and disinterested love of science they were transmitted as a part of the Lacoe collection to the United States National Museum.

Two lists of the fossil plants from the Coal Measures of Missouri have been published. The first of these, by Professor Lesquereux, which appears in the summaries at the end of the Coal Flora[1] comprised an enumeration of the species described or identified from Henry and Vernon counties up to the date (1884) of the termination of the manuscript for the third volume. I repeat in the following list the enumeration there given, the species discussed or quoted as synonyms, etc., in the preceding pages being marked with an asterisk (*):

**Alethopteris ambigua*	**A. Serlii*
**A. lonchitica*[2]	**Annularia longifolia*[3]

[1] Second Geological Survey of Pennsylvania, Report of Progress P, vol. iii, 1884, pp. 879, 880.

[2] Specimens referred to *A. Serlii* Brongn.

[3] *A. stellata* (Schloth.) Wood.

A. longifolia var. *angustifolia*
**A. sphenophylloides*
**Asterophyllites fasciculatus*
**A. rigidus*[1]
**Calamites Suckowii*
**C. Cistii*
**Callipteridium membranaceum*
C. Owenii
**C. Sullivantii*
**Cordaites communis*
**C. diversifolius*
**Cordaianthus dichotomus*
**C. gemmifer*[2]
**Dictyopteris obliqua*[3]
**Eremopteris Missouriensis*
**Lepidodendron Brittsii*
**L. cyclostigma*[4]
**L. lanceolatum*
**L. marginatum*[5]
**L. scutatum*
L. Sternbergii
**Lepidophloios dilatatus*[6]
**L. sigillarioides*[7]
Lepodophyllum minus
Lepidostrobus Goldenbergii[8]
**Lepidoxylon anomalum*
**Megaphytum Goldenbergii*
**Neuropteris angustifolia*[9]
N. cordata
**N. dilatata*
N. flexuosa
**N. hirsuta*[10]
N. Loschii
**N. Missouriensis*
**N. rarinervis*
Odontopteris subcrenulata
O. heterophylla
**O. sphenopteroides*[11]
**Pecopteris arborescens*
**P. Clintoni*
**P. cristata*[12]
**P. dentata*
**P. erosa*
**P. pennæformis*[13]
**P. vestita*
**Pinnularia capillacea*[14]
**Pseudopecopteris acuta*[15]
**P. irregularis*[16]
P. macilenta
**Pseudopecopteris nummularia*[17]
**P. obtusiloba*
P. Sillimanni

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[1] Specimens referred to *A. longifolius* (Stb.) Brongn.

[2] The specimens figured from Missouri under this name were used as types of *C. ovatus* Lx. and *C. dichotomus* Lx.

[3] The specimens from Clinton thus recorded represent the *Linopteris gilkersonensis.*

[4] Type of the genus *Omphalophloios.*

[5] Specimens from Missouri referred to *L. lanceolatum* Lx.

[6] Missouri specimens changed to *L. Van Ingeni* n. sp.

[7] Transferred to *Sigillaria.*

[8] Probably the species treated as *L. princeps* in this report.

[9] *Neuropteris Scheuchzeri* var. *angustifolia* (Brongn.) Lx.

[10] *Neuropteris Scheuchzeri* Hoffm.

[11] *Mariopteris sphenopteroides* (Lx.) Zeill.

[12] *Aloiopteris Winslovii* n. sp., from the Missouri specimens.

[13] A species concerning which there is much uncertainty in the American material. All the specimens from the region of Missouri found by the writer under this name represent the *Pecopteris dentata* of Brongniart.

[14] *Radicites capillacea* (L. and H.) Pot.

[15] Specimens from Missouri identified with this species are referable to *Mariopteris sphenopteroides* (Lx.) Zeill.

[16] The Missouri form is indistinguishable from that described as *Pseudopecopteris obtusiloba* (Stb.) Lx.

[17] The secondary types of *Sphenopteris mixta* Schimp. were labeled by Lesquereux with this name. I have been unable to discover the species of Gutbier in any of the collections.

**Rhacophyllum adnascens*[1]
**R. arborescens*[2]
**R. filiciforme*[3]
R. fimbriatum
**R. hamulosum*
**R. hirsutum*
**R. lactuca*[4]
**R. membranaceum*
**R. spinosum*
**Sigillaria fissa*[5]
S. Menardi
S. reniformis
S. sculpta
S. spinulosa
**Sphenophyllum erosum*[6]
**S. filiculme*[7]
**S. longifolium*[8]
**S. oblongifolium*[9]
**S. Schlotheimii*[10]
**Soroclades ophioglossoides*[11]
**Sphenopteris Brittsii*
**S. chærophylloides*
**S. Dubuissonis*[12]
**S. furcata*[13]
**S. Gravenhorstii*
**S. mixta*
**S. spinosa*[13]
S. splendens[13]
S. tridactylites[14]

Certain of the above species may with a high degree of probability be referred to other forms described in the preceding pages, though the names have generally been omitted from the discussion for the reason that I have not seen the specimens on which the determinations were based. Such are (1) the *Lepidodendron Sternbergii*, which, as seen in the collections identified by Professor Lesquereux, was sometimes interpreted so broadly as to include branches hardly distinguishable from *L. lanceolatum*, to which I am inclined to believe the fragments from Missouri may have belonged; (2) the *Lepidostrobus Goldenbergii*, which is no doubt the cone correlated in the foregoing pages with *Lepidostrobus princeps* Lx.; (3) *Neuropteris cordata*, which is here, as in most other cases in our American literature, used for certain

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[1] Mentioned in connection with *Pecopteris dentata* Brongn.

[2] Material from Missouri referred to *Aphlebia* cf. *filiciformis* and *A. crispa*.

[3] The earlier generic name *Aphlebia* Presl has priority, and is employed for this and other species included by Lesquereux and Schimper in *Rhacophyllum*.

[4] Cf. *A. Germari* Zeill.

[5] The specimens determined as *Sigillaria fissa* belong to *S. sigillarioides* (*Lepidophloios sigillarioides* Lx.).

[6] *S. cuneifolium* (Stb.) Zeill.

[7] The examples found under labels bearing "*S. filiculme* Lx." are referable to *S. emarginatum* Brongn., or *S. cuneifolium* (Stb.) Zeill.

[8] The specimens from Missouri appear to represent the *S. majus* of Bronn.

[9] The specimens labeled "*S. oblongifolium* Germ." are included in a new species, *S. Lescurianum*.

[10] The Missouri specimens and most other American material recorded as this species belong to *Sphenophyllum emarginatum* Brongn.

[11] *Sphenopteris ophioglossoides* (Lx.).

[12] The plant listed under this name is hereinbefore described as *S. Van Ingenii* n. sp.

[13] All specimens in the collections from Missouri found labeled with this name are here referred to *Eremopteris missouriensis* Lx.

[14] The examination of the figured specimens from Missouri shows them to belong to the species earlier described by Lesquereux as *Sphenopteris pinnatifida*.

more lanceolate pinnules of *N. Scheuchzeri* Hoffm.; (4) *Odontopteris heterophylla*, which represents probably but heteromorphous pinnules of the same type of *Neuropteris*, and (5) *Rhacophyllum fimbriatum*, a wholly obscure and equivocal species. Nowhere in the writings of Professor Lesquereux have I found any other mention than that cited above of a *Lepidophyllum* [or *Lepidostrobus*] *minus*. In Hambach's list, referred to below, it is credited to Lesquereux. It is not likely to be Schenk's *L. minus*,[1] for I can find no evidence that the publication of the latter was known to Professor Lesquereux at the time of the completion of the Coal Flora. The *Sigillaria reniformis* of the list is of too little value or importance as a species to merit any further consideration.

If we accordingly exclude the somewhat doubtful records just passed in review we shall have left, unaccounted for, species as follows:

Callipteridium Owenii Lx.	*Ps. Sillimanni* (Brongn.) Lx.
Neuropteris flexuosa Stb.	*Sigillaria Menardii* Brongn.
N. Loschii Brongn.	*S. sculpta* Lx.
Odontopteris subcrenulata Lx.	*S. spinulosa* Germ.
Pseudopecopteris macilenta (L. and H.) Lx.	

It is appropriate in this place to consider briefly a few points relating to both the affinities and the geologic occurrence of these species.

Callipteridium Owenii is a species in general characteristic of the upper part, or Sewanee group, of the Pottsville series; and I have not yet seen it from the Lower Coal Measures.

As generally differentiated in our American collections, *Neuropteris flexuosa* and *N. Loschii* extend throughout the Coal Measures, but the plant most commonly found under the latter name is indistinguishable from Hoffmann's *N. ovata*, and should be so designated. *Pseudopecopteris macilenta*, as at present exemplified in our collections, includes two very distinct types, one of which, from the higher coals, is similar to the species of Lindley and Hutton, while the other, from the upper beds of the Pottsville series, passes by transition into the form described as *Pseudopecopteris decipiens* Lx. It is uncertain which of these two types is meant in the above list. *Odontopteris subcrenulata* and *Pseudopecopteris Sillimanni* are both rare species, and are closely identified with the Mammoth vein in the Southern Anthracite field. *Sigillaria Menardi*, *S. sculpta*, and *S. spinulosa*, the remaining

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[1] In Richthofen's "China:" vol. iv, 1883, p. 219, pl. xlii, fig. 13.

species, are, in general, to be found only in the higher coals of the anthracite series. Thus, from a cursory glance at the stratigraphic range of the species given on the high authority of Professor Lesquereux in the above list, it appears that most of the plants of limited range are more or less distinctly peculiar to the coals below the Freeport in the bituminous fields of Pennsylvania or the Mammoth vein in the region of the Southern Anthracite field in the same State.

The second list of the fossil plants of the Carboniferous of Missouri is that embodied in Mr. G. Hambach's Preliminary Catalogue of the Fossils Occurring in Missouri.[1] In this enumeration we find, besides the species listed by Lesquereux, a number of others, as follows:

Neuropteris tenuifolia Brongn.,
Sphenopteris cristata Stb.,
Lepidophyllum majus Brongn., and
Taonurus Colletti Lx. from Henry County.
Neuropteris fimbriata Lx. and
Desmiopyhllum gracile Lx. from Jasper County.
Lepidodendron aculeatum Stb. from Vernon County.
Trigonocarpus Dawesii L. and H. and
T. olivæformis L. and H. from Cedar County.

Since there is no statement to the contrary, we may infer that these additional species are recorded on the basis of identifications made by Dr. Hambach.

If we consider these species from the standpoint of their affinities and stratigraphic occurrence, we may note that *Neuropteris tenuifolia* as a name is somewhat ambiguous in this country, some of the material, even contiguous fragments, included thereunder being identical with other material known as *N. Loschii*. The species, in any case, is unknown to me from below the Lower Coal Measures, though it ascends probably as high as the Lower Barren series (XIV) of the Pennsylvanian sections. *Neuropteris fimbriata* Lx. is not found until we reach some distance above the base of the Coal Measures, and it passes up into the higher coals of the Northern Anthracite field. *Desmiophyllum gracile* is very close to *Tæniophyllum latifolium*. *Lepidodendron aculeatum* Stb. should have a wide range in the upper part of the Lower Coal Measures, while *Trigonocarpus Dawesii*, if

[1] Bull. Geol. Surv. Missouri, No. 1, 1890. See pp. 83-85.

correctly identified, may possibly have been derived from a terrane of upper Pottsville age. In any case, it can avail little to attempt to utilize for correlation the species listed by Hambach, since not only are we left in ignorance, except as we may gain some idea from a general geologic map, as to which of the three divisions of the Coal Measures any of the specimens outside of Henry County came from, but we are also furnished no other geographic localization than the bare name of the county in which the various species are said to have been found.

For the reasons given above, little if any weight will be attached to or use made of the few additional species said to have been found in the Coal Measures of Missouri, but which have not been seen in any of the collections to which I have had access.

EVIDENCE OF THE FOSSIL PLANTS AS TO AGE AND EQUIVALENCE OF THE TERRANES.

Preliminary to an attempt to ascertain the stratigraphic significance of the floras of the Lower Coal Measures of Missouri, it will be necessary first to take into consideration the general character or facies of the combined flora; to review the vertical distribution of the species and differentiate those possessing, so far as is known, special correlative value, and to consider some of the relationships, and the consequent implied chronologic data, of some of the forms made known in this report. This accomplished, we may proceed to the comparison, with special reference to the contemporaneities indicated by the vegetable remains, of the Lower Coal Measures of Missouri (1) with sections of the Carboniferous in other portions of the eastern United States and (2) with several of the sections of the Carboniferous group in the Old World.

SYNOPSIS OF THE FLORA.

In the consideration of the relationships of the plants from the Lower Coal Measures of Missouri and their occurrence in other regions I shall exclude the few reported[1] species of which I have not seen specimens, limiting my discussion to the species examined by myself, and recording only such distribution of these species as is based on personal observations.

To obtain a comprehensive view of the plants treated in the foregoing

[1] Enumerated in the preceding sections.

pages, we may summarize them, somewhat unsystematically, as follows, the figures given representing the number of species described:

Algæ, 2.	Cycloeladia and Macrostachya, 2.
Fungi, 2.	Radicites, 2.
Eremopteris, 2.	Sphenophyllum, 5.
Pseudopecopteris, 3.	Lepidodendron, 5.
Mariopteris, 4.	Lepidophloios, 1.
Sphenopteris, 19.	Lepidostrobus, 3.
Oligocarpia, 3.	Lepidophyllum and Lepidocystis, 2.
Pecopteris, 10.	Omphalophloios, 1.
Spiropteris and Brittsia, 2.	Sigillaria, 4.
Aphlebia and Fern trunks, 12.	Stigmaria, 2.
Alethopteris and Tæniopteris. 3.	Tæniophyllum and Lepidoxylon, 2.
Callipteridium, 5.	Cordaites, 2.
Neuropteris, 5.	Cordaianthus, 2.
Linopteris and Odontopteris, 2.	Cordaicarpon, 1.
Calamites, 3.	Cardiocarpon, 1.
Asterophyllites, 2.	Rhabdocarpos, 2.
Annularia, 3.	Titanophyllum? 1.
Calamostachys and Volkmannia, 2.	Dicranophyllum? 1.

GENERAL RANGE OF THE MISSOURI FLORA IN THE COAL MEASURES OF THE UNITED STATES.

From the summary given above, it will be seen that nearly all the common genera of the Mesocarboniferous of the world are represented in the flora of Missouri. Among the more important exceptions are the genera *Trigonocarpum*,[1] *Bothrodendron*, *Lonchopteris*, and the newer divisions of the old genus *Cordaites*. The second genus, *Bothrodendron*, is very rare in this country and has been supposed by many to be entirely wanting. There are, however, numerous specimens of it in the recent collections made by the Survey from the Kanawha series (Lower Coal Measures in the European sense) of West Virginia. There is, moreover, little room for doubt that the fossil described by Professor Lesquereux[2] from "near the base of the Middle Carboniferous Measures" near Alta, Illinois, as *Cyclostigma Kiltorkense* Haught., is a representative of the same genus, though the identity of the fossil with the species found in the Old Red Sandstone of Ireland is most improbable. The genus *Lonchopteris* has not yet, so far as I am aware, been found in North America.

[1] It is possible that the crushed fruits identified as *Rhabdocarpos multistriatus* may, when found better preserved, show the characters of *Trigonocarpum*.

[2] Coal Flora, vol. ii, 1880, p. 429.

Several biologic features will at once appear from a casual review of the species discussed in the preceding portion of this report. One of these is the great preponderance and considerable diversity of the ferns. These are especially characterized by the presence of a large number of species of *Sphenopteris* and *Pecopteris*, many of them representing types generally found at no little distance above the base of the Lower Productive Coal Measures, or No. XIII of the system of denomination employed in the later State geologic reports of Pennsylvania. In fact, the aggregate of species is distinctly such as is only to be found in the Coal Measures proper. With the exceptions of a very obscure fragment, doubtfully referable to *Sphenopteris Hoeninghausii* Brongn., and a solitary specimen[1] representing a new species of small *Mariopteris* usually confined to the Sewanee group (Upper Pottsville), there does not appear to be a species in the collections before me that is not at least varietally different from any I have yet seen in the rich floras gathered from the Pottsville series in the Appalachian province. Even the exceptions just noted are represented by not more than three fragments in all.

A large proportion of the species in our flora appear to range through a considerable thickness of the Mesocarboniferous in America, and offer us, accordingly, but little correlative aid, except, in some cases, by reference to their first ascertained appearance. Others, like *Spiropteris*, *Hysterites Cordaitis*, *Conostichus*, *Caulopteris? acantophora*, and *Excipulites Callipteridis* are presumably little adapted for stratigraphic use on account of their nature and mode of occurrence, though the last named has not, I believe, been found on any other host than *Pseudopecopteris squamosa* (*Sphenopteris neuropteroides*). As representing the former category, or as species insufficiently defined in general, or species whose distribution has not yet been properly studied in the American collections, we may exclude from further consideration *Sphenopteris pinnatifida*, *Pecopteris dentata*, the *Aphlebiæ*, *Callipteridium Sullivantii*, *Neuropteris rarinervis*, *N. Scheuchzeri*, the *Calamites*, *Asterophyllites equisetiformis*, the *Annulariæ*, *Sphenophyllum cuneifolium*, *S. majus*, *Sigillaria tessellata*, *Stigmaria verrucosa*, *Cordaites diversifolius*, and *Rhabdocarpos multistriatus*.

Before dismissing these, however, I should add that a close inspection of many of the species of wide vertical range shows some very interesting chronologic modifications or phases, which, though they may be local, appear

[1] *Callipteridium Owenii* enumerated by Lesquereux in the list of species from Henry County, Missouri, should perhaps also be included, although I have not seen the specimens or specimen on which the record is based.

to be vertically limited and to promise in many cases as great aid, within certain conditions, as distinct species. Thus, among the plants just mentioned, the *Pecopteris dentata* from Henry County, Missouri, represents the robust type, larger than the typical *P. plumosa* of the lowest of the Coal Measures, yet not so flat and broad as the one found above the Waynesburg coal in the Upper Barren or "Dunkard Creek series" (XVI) of Pennsylvania and West Virginia. The form in hand is like that seen in the higher coals of the Lower Productive Coal Measures. On the other hand, the small, narrow form of *Neuropteris Scheuchzeri* and the more delicate *Asterophyllites equisetiformis* found in the Missouri material are as yet unknown in any of the coals above the Kittanning group of the bituminous series of Pennsylvania or the E coal of the anthracite region.

So, too, the species which have not hitherto been found outside of the Missouri terranes under consideration have but a subordinate correlative value, based chiefly on analogies and inferences drawn from their relations to other species. The species which, so far as I am aware, are, with reference to their American distribution, peculiar to the flora under discussion, are given in the following list:

Hysterites Cordaitis.
Eremopteris bilobata.
Sphenopteris Broadheadi.
S. missouriensis.
S. Van Ingeni.
S. suspecta.
S. capitata.
S. ophioglossoides.
S. bilobata.
Oligocarpia missouriensis.
Pecopteris Jenneyi.
P. Clintoni.
P. mertensides.
P. pseudovestita.
Brittsia problematica.
Aphlebia membranacea.
A. subgoldenbergii.
Callipteridium membranaceum.
C. Jenneyi.
Neuropteris missouriensis.
Dictyopteris gilkersonensis.
Tæniopteris missouriensis.
Sphenophyllum fasciculatum.
Cyclocladia Brittsii.
Macrostachya longifolia.
Sphenophyllum Lescurianum.
Lepidodendron Brittsii.
L. lanceolatum.
L. scutatum.
Lepidophloios Van Ingeni.
Lepidophyllum missouriense (*Lepidostrobus* and *Lepidocystis missouriensis*).
L. Jenneyi (*Lepidostrobus Jenneyi*).
Omphalophloios cyclostigma.
Lepidoxylon anomalum.
Sigillaria ovata.
Cordaites communis.
Cordaicarpus cerasiformis.
Cardiocarpus Branneri.[1]
Titanophyllum? Brittsii.

[1] This species is also found in the Coal Measures of Arkansas, though the report in which it is described by Prof. H. L. Fairchild and myself for the State geological survey is not yet published.

STRATIGRAPHIC RANGE OF SPECIES HAVING A RESTRICTED VERTICAL DISTRIBUTION.

The remaining species of our flora may, on account of either their specific solidarity or their somewhat limited vertical range, be regarded as compositely possessing a more direct and accurate chronologic significance. In the following table is shown the summarized distribution of these species in the bituminous fields of Ohio, Indiana, Illinois, and Pennsylvania, and in the Northern Anthracite field, based on a personal examination of the collections that have formed the subjects of the principal printed reports. Several of the species here tabulated are recorded in some of the American literature relating to these collections as having a vertical range greater than that shown in the table; but an examination of the specimens serving as bases for the greater number of those extended records shows that materials from vertically widely separated horizons have often been assigned to the same species, although when closely inspected it is seen that they represent entirely distinct species, and frequently also no transitional or intermediate forms, varieties, or species have been found. Numerous examples are seen among the specimens from the Pottsville series ("subconglomerate" and "conglomerate"), which have been recorded under the names of distinctly Coal Measures species. Those who may wish to consult the extended distribution as recorded in the literature will find a nearly complete compilation in the publications of the Second Geological Survey of Pennsylvania.[1]

In the following table no account is taken of the variations or modifications which some of the species have undergone within the time of their ascertained duration.

The distribution of the species in Rhode Island is omitted on account of lack of information relating to both the geographic and the stratigraphic sources of much of the material. It would seem, however, from the large number of species in the Rhode Island collections that are identical with those in Missouri and the affinities of others, that a considerable portion of the specimens from the former State may have come from a fossiliferous horizon of perhaps not much later date than the fossils from Missouri.

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[1] See Reports of Progress, P, vol. iii, 1884; PP, 1880; and P 4, vols. i–iii, 1889–90.

Occurrence of Missouri species observed in other basins of the United States.

Species in Lower Coal Measures of Missouri having restricted distribution in the United States.	Illinois; Morris coal, or Mazon Creek.	Kittanning coals, Indiana or Ohio.	Darlington coal, Cannelton, Pa.	Anthracite coals, Northern field.	Higher coals.
Eremopteris missouriensis Lx	×				
Pseudopecopteris obtusiloba (Stb.) Lx	×				
Ps. squamosa (Lx.)	×	×		E & D	Kans
Mariopteris sphenopteroides (Lx.) Zeill	×				
Sphenopteris pinnatifida (Lx.)	×			E ?	Kans
Sphenopteris mixta Schimp	×	?		E ?	
S. Lacoei White			×		
S. charophylloides Brongn	×		×	D & E	
S. cristata Brongn	×		×		
S. Brittsii Lx		?			
S. illinoisensis n. sp	×				
S. canneltonensis n. sp			×		
S. subcrenulata Lx	×		×		
Oligocarpia cf. *Gutbieri* Goepp	×				
Aloiopteris Winslorii n. sp	×	×	×		
A. erosa Gutb	×		×	D & E	Kans
Pecopteris arborescens Brongn. ?		?		E	G
P. hemitelioides Brongn					G +
P. squamosa Lx	×	×	×		Kans
P. Candolliana Brongn	?			E & F	
P. clintoni Lx	?				
P. vestita Lx	×	×	×	D?	
Caulopteris ovalis Lx. Mss			×		
Aphlebia hamulosa (Lx)	×				
A. spinosa (Lx)	×				
Alethopteris ambigua Lx	×			D	
A. Serlii Brongn	×	×	×	C, D, E, F?	
Callipteridium Mansfieldi Lx			×		
C. inæquale Lx			×		
C. Sullivantii (Lx.) Weiss	×		×	D E?	G Kans
Neuropteris fasciculata Lx	×				
N. dilatata (L. & H.) Schimp				D & E	
Megaphyton Goldenbergii Weiss				D	
Asterophyllites longifolius (Stb.) Brongn	×		?	D	
Calamostachys ovalis Lx. ?			×		
Sphenophyllum emarginatum Brongn	×	×	×	D & E	
S. majus Bronn			×	E	
Volkmannia prælonga Lx			×	D	
Lepidodendron rimosum Stb	×			E	
L. clypeatum Lx			?	B, C, D?	
Lepidostrobus princeps Lx	×				
Sigillaria camptotænia Wood	×		×	E	Kans
Stigmaria Evenii Lx	×				
Tæniophyllum latifolium White			×	E	
Cordaianthus ovatus Lx			×		
C. dichotomus Lx			×		
Rhabdocarpos Mansfieldi Lx			×	E?	
Palæoxyris appendiculata Lx	×				
Total (48)	28–30	6–10	22–24	19–23	7–10

PROBABLE STAGE OF THE LOWER COALS OF MISSOURI IN EASTERN SECTIONS.

A review of the preceding table shows (1) that nearly all the species from Missouri which have a relatively restricted vertical range have also been collected from near the horizon of coal B near Morris or Mazon Creek, Illinois, or in the Kittanning coals of Ohio and Pennsylvania, and that the plants from the Lower Coal Measures of Missouri, especially in Henry County, appear to be most nearly related to those floras; (2) that the greater portion, or nearly two-thirds, of these species are present in the floras of Mazon Creek and Morris; (3) that over one-half of them have been gathered from the Kittanning (chiefly the Darlington and Middle Kittanning) of Ohio and Pennsylvania, and (4) that nearly one-half are also present in the collections from coals D and E (the "Marcy" and "Pittston" coals) in the Northern Anthracite field.

If we take into account the stratigraphic occurrence of the species most nearly related to those that are peculiar to the Missouri flora the proportions will not be materially changed. Thus *Oligocarpia alabamensis* Lx., the nearest American ally of *O. Missouriensis*, is found in the upper beds of the Pottsville series. The fern figured by Lesquereux[1] as *Pecopteris abbreviata?* Brongn., the *Lepidodendron Wortheni* Lx., and *Lepidophyllum ovatifolium*, which are correspondingly related to *Sphenopteris ophioglossoides*, *Lepidodendron Brittsii*, and *Lepidophyllum Jenneyi*, respectively, are found at Mazon Creek; *Tæniophyllum deflexum* Lx., *Lepidophyllum Mansfieldi*, and *Lepidophloios dilutatus* Lx., the relatives of *T. latifolium*, *Lepidophyllum Missouriense*, and *Lepidophloios Van Ingeni*, are typically from the Darlington coal at Cannelton, while *Pecopteris oreopteridia*, *P. pennæformis* (as seen in some American collections), related to *P. Jenneyi* and *P. pseudovestita* in the Missouri flora, are abundant in the E and D coals, respectively, of the Lackawanna anthracite field. On the other hand, little information of immediate use in correlation is to be derived from the distribution of the species excluded from the table, on account of their great stratigraphic range, except the very important fact that most of them have not yet been discovered below coal B of the northern bituminous fields.

If we assume, then, that the table furnishes a fair representation of the average or mean vertical distribution of our flora, it becomes quite apparent

[1] Coal Flora, Atlas, p. 8, pl. xlvi, figs. 4–6.

that the flora from Missouri is not, as a whole, older than the Morris coal, while a large proportion, more than one-half, of the species are to be found in the Middle or Upper Kittanning coal of western Pennsylvania. For, with the exception of the obscure fragment which may possibly belong to *Sphenopteris Hoeninghausii*, the two specimens of a new species of *Pseudopecopteris*, and the solitary fragmental impression somewhat doubtfully referred to *Lepidodendron clypeatum*, there is not, I believe, in all the material before me a specimen in any degree characteristic of or usually limited to the Pottsville series. Extensive collections of the plants from the latter series in western Pennsylvania, Ohio, the Virginias, Kentucky, and Tennessee, are now under examination. The flora of the uppermost beds of this series in the anthracite regions in eastern Pennsylvania, is, however, largely unknown. It is certain that the exceedingly slight Pottsville element, which is astonishingly small when we consider the local stratigraphic position of the coals, is no greater than that found in the coal at Morris, Illinois, although the stratigraphic interval between the latter and the Millstone grit or Pottsville is much greater and more uniform. The coals with the fine clays and shales in Henry County, Missouri, are seldom over 100 feet above the Lower Carboniferous terranes, while in some instances the lower coal appears to rest on the eroded surface of the latter.

On the other hand, a great part of the flora under consideration lies on the other side of the Morris coal, in the direction of the Kittanning horizons of Ohio and Pennsylvania. Thus, in evidence of a later age for our flora we find a number of types of a generally higher range than the flora of Morris and Mazon Creek, apparently higher than the plants from the Brookville and Clarion coals in the western Pennsylvania region, and far higher than the A and B coals of the Northern Anthracite field. The presence of some of the younger types, especially the representatives of some of the later species of *Pecopteris*, in our flora is of far greater importance than mere numerical ratios. And, if we take the testimony of these elements into consideration, we can only conclude that, while the preponderant identity of the vegetation under examination is found near the horizon of the Morris coal in Illinois, it can not, as a whole, be of quite so early a date. The intimate relations of the Missouri plants, especially of the later types unknown in the stage of the Morris coal, with those of the Darlington coal point strongly to a stratigraphic position for the synchronous beds in the interval between the Morris, or supposed Clarion coal, and the Upper Kittanning. In other words, if we take Henry County, from which most of our evidence, both stratigraphic and paleontologic, is drawn, as the stratigraphic type of the base of the Coal Measures of the State, and assume that the conditions are constant along the margin of the coal field in other counties, the evidence of the fossil plants, so far as they are now obtainable, appears to indicate the deposition of the lowest coals in the State at a time subsequent to the formation of the lower coals of the Lower Coal Measures of the eastern regions, including the Morris coal of Illinois, the Brookville and probably the Clarion coal of Ohio and Pennsylvania, yet perhaps earlier than the formation of the Darlington or Upper Kittanning coals of the two States last named.

The difficulties attending correlation by fossil plants in the bituminous fields will presently be pointed out. In the Northern Anthracite field, however, in which, thanks to the systematic and scientific methods of collection pursued by Mr. R. D. Lacoe, of Pittston, Pennsylvania, plants have been assembled from nearly every fossiliferous horizon, the paleobotanic section is, as compared with all other areas in this country, relatively complete. The study of the distribution of the Henry County flora in this field shows its closest relations in coals D and E, locally known as the "Marcy" and the "Big," or Pittston, coals. But in view of the fact that the E coal of the Pittston and Wilkesbarre regions seems to carry many types of a more modern cast, it is not likely that the Missouri stage is so high in the series as that coal. In the plants of the D coal, not only are a large part of the species identical with those from Missouri, but the flora as a whole is of a similar type. Compared, however, with the somewhat equivocal combined flora reported from the C coal,[1] the material from the Mississippi Valley appears on the whole fully as recent, while lacking many of the older types found at several of the mines correlated by stratigraphy with that coal. Hence I am inclined to regard the plants from Henry County, Missouri, as more nearly contemporaneous with those in the roof of the D or "Marcy" coal in the Northern Anthracite field, though they are possibly as old as the C coal. Even in the latter case it is clear that several hundred feet of the sandstones, conglomerates, shales, and coals, comprising the lower part of the Coal Measures and the Pottsville, which lie between the

[1] See Coal Flora, vol. iii, p. 859.

contemporaneous beds and the top of the Lower Carboniferous in the Wyoming Valley, are represented by an uncorformability in portions of Missouri.

But very little is known of the plants of the Lower Coal Measures south of the Kentucky-West Virginia boundary. But extensive material, showing a rich and highly varied flora, has been collected from the Kanawha series, about 1,200 feet in thickness, along the Great Kanawha River, in the latter State. Although these collections will properly form the subject of a special report, it may be remarked in this place that few of the species tabulated above are met with below the middle of the Kanawha series, while many common species, such as *Annularia sphenophylloides* or *Neuropteris Scheuchzeri*, are found only in the upper third of that series. In fact, the paleontologic features of the Kanawha series are more nearly like those of the Lower Coal Measures of Europe, as will in due time be shown.

TEMPORARY OBSTACLES TO ACCURACY IN CORRELATION.

Far more serious than all the natural limitations of fossil plants as a means for geologic correlation in our American Carboniferous terranes is the difficulty resulting from the lack of standard paleobotanic sections for comparison. By paleobotanic section is here meant a knowledge of the plants that may be found in all the various phytiferous beds that comprise or may with assured accuracy be referred to a single section. Such sections would become, according to their completeness, with reference to the number or nearness of the fossiliferous beds and the degree of exploitation of the floras, their extent, or their geographic and geologic positions, standards not only for the comparison and reference of isolated beds or plant-bearing horizons in the same vicinity or region, but for the determination of time equivalents in different fields or basins.

The surprising and painful inadequacy of the materials relating to stratigraphic paleobotany, which has been referred to in the above discussion of the distribution of the Missouri plants, and which constituted so serious an obstacle in the attempt to ascertain the age of the outlying small basins in southwestern Missouri, has already been set forth in another place.[1]

[1] Bull. U. S. Geol. Survey, No. 98, 1893, pp. 118-120. The conclusion that in these basins coals were probably formed near the close of the time of No. XIII, or during the deposition of the Lower Barren Measures, No. XIV, reached in the report on these basins, has, so far, been supported by subsequent studies of the plants in other fields. Several of the peculiar forms then described have since been met in the McAlester coal field of Indian Territory.

Since the report on these basins was written, comprehensive collections have been made from the lowest coals (including the Brookville and Clarion) of the Bernice semi-anthracite basin, the bituminous fields of northwestern Pennsylvania, and the lowest coals above the Pottsville series in the anthracite regions. But our knowledge of the floras of the different stages above these or the Morris coal of Illinois, and below the Upper Barren Measures (XVI) in the bituminous fields north of the Ohio and Potomac rivers is, with the exception of several small floras in Illinois, practically still limited to the rich collections from the Darlington coal at Cannelton, Pennsylvania; small collections from three or four points in the "Kittanning" in Ohio, and a small number of species from near the Pittsburg coal at Wheeling, West Virginia, and a few points in Ohio. But from all the bituminous fields of Pennsylvania no systematic collecting of fossil plants has, so far as I am aware, been done from any horizon between the Clarion coal in the lower part of the Lower Productive Coal Measures and the Waynesburg coal, except at Cannelton, near the Upper Kittanning. Not only are we ignorant of the floras of the various coals in the upper part of the Lower Productive Coal Measures (XIII), or Alleghany series, in that State, but also of the plants of the entire Lower Barren Measures (XIV) and of the Upper Productive Measures, or Monongahela series (XV). With these facts in mind, not only will it be easy to understand the great difficulty in correlating the various stages in the bituminous fields with either definiteness or confidence by means of the fossil plants, but it will also be clear why, in studying the range or correlative affinities of the species in these fields, the smaller or isolated floras are drawn as by magnets toward the stages of Cannelton or Morris. It is paradoxical that these two stages at Mazon Creek and Cannelton should have been paleobotanically exploited nearly to exhaustion, while east of Illinois the plant fossils of the succeeding measures have remained essentially untouched. So long as paleontologists and museum curators remain content with filling their collections from the two famous localities, Cannelton and Mazon Creek, without an effort to ascertain the floral characters of any other stages, we shall continue without knowledge of the paleobotanic characterizations necessary for the definite or satisfactory recognition in the northern bituminous fields of any stage between the Kittanning and Waynesburg coals.

COMPARATIVE POSITION OF THE COALS.

Notwithstanding the difficulties which attend any attempt to ascertain the contemporaneity of terranes in the upper half of the Mesocarboniferous in the United States, the study of the elements in the floras in hand and their distribution in the lower two-thirds of the Lower Productive Coal Measures, which are better known paleobotanically, shows that the Lower Coal Measures of Missouri, as represented by the coals of Henry County, were laid down soon after the Morris coal[1] in Illinois, though probably earlier than the Upper Kittanning of western Pennsylvania, or very likely about the time of the formation of the D coal in the Northern Anthracite field.[2] Thus the chronology of the plants shows that the process of the deposition of the Mesocarboniferous terranes was well advanced, so that in the bituminous fields of Ohio, Pennsylvania, and Illinois not only the Pottsville series (XII), ranging from 60 to 1,200 feet or more in thickness north of the Potomac River, but also the lower portion of the Lower Productive Coal Measures, or "Alleghany series" (XIII), extending as far upward at least as the Clarion coal, had been laid down on the Lower Carboniferous (Eocarboniferous) group by the time the lower coals of Henry County were sedimented in fringing ponds or marshes along the coast of eroded Eocarboniferous rocks in Missouri.

It will be remembered that in some places the lower of the two coals (the interval between them being reported as 40 to 60 feet) rests directly on the uneven Eocarboniferous surface, while at other points a variable arenaceous formation intervenes. The latter, which is very irregular, sometimes conglomeratic, and nowhere of great thickness, appears to represent a wash derived from the decomposed underlying rock, whose hollows it tends to fill, and is generally regarded by the local geologists as belonging to the "Millstone grit" (Pottsville). So far as the writer is aware, however, no primary fossils have been procured from it to show its true age, and it would seem that it may represent simply the subaerial surface material of decomposition accumulated subsequent to the Eocarboniferous uplift and but imperfectly distributed and sorted when the subsidence of the coast brought about the

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[1] Supposed by many, for stratigraphic reasons, to be the equivalent of the Clarion coal of the eastern bituminous field, and therefore commonly designated by the same letter (B).

[2] The letters in use to designate the coals in the anthracite fields are not to be construed as indicating their equivalency with the coals similarly designated in the bituminous regions.

coal-forming conditions at or below water level. This superficial wash may be developed, supplemented, or replaced by other formations in other counties of the State, but in portions of Henry County, at least, it seems to have been eroded and sometimes entirely cut through to the subjacent rock before the fire clays or lower coal were deposited on the uneven surface.

The transgression of the water level during the early Mesocarboniferous time has already been discussed by Broadhead,[1] Winslow,[2] and Keyes,[3] the State geologists. The evidence of the fossil plants not only corroborates their views in general, but it also fixes the time of the encroachment of the sea on the old coast in the region of Clinton. The paleobotanic criteria indicate that the minimum time represented by the unconformity between the Jordan or Owen coal and the subjacent Eocarboniferous terrane is measured by the period required for the deposition of the Pottsville and the Clarion group of the Lower Productive Coal Measures, a series of rocks reaching a thickness of over 1,200 feet in portions of the anthracite regions, and exceeding 2,400 feet in southern West Virginia.

RELATION OF THE MISSOURI FLORA TO THOSE OF EUROPEAN BASINS.

ZONE OF THE FLORA IN THE COAL MEASURES OF GREAT BRITAIN.

In the preceding pages it has been shown that the coals, resting in places directly on the Lower Carboniferous terranes in Henry County, Missouri, are probably of a rather later date than the plants of Mazon Creek and the Morris coal in Illinois, and that they are very likely older than the Upper Kittanning coal of Pennsylvania.

It is customary to consider the flora of Mazon Creek, the plants from which are preponderantly identical with those from Missouri, as typically representative of the flora existing immediately at the beginning of Lower Coal Measures time, there being but little difference between the plants from Illinois and those of the bituminous Brookville and Clarion coals in northwestern Pennsylvania, which are probably fully as old as those of the Buck Mountain coal, long since made the boundary between the Pottsville series and the Productive Coal Measures of the typical section in the South-

[1] Amer. Geol., vol. xiv, 1894, pp. 380-388.

[2] Bull. Geol. Soc. Amer., vol. iii, 1892, pp. 109-121; Amer. Geol., vol. xv, pp. 81-89; Prelim. Rept. on Coal, Geol. Surv. Missouri, 1891, p. 19.

[3] Amer. Geol., vol. xii, 1893, p. 100.

ern Anthracite field. It will be interesting, therefore, in a brief comparison of the Missouri flora with the floras of the European basins, to note the positions of our species in several of the paleobotanically better known Old World Carboniferous sections.

This task, so far as it relates to Great Britain, is made easy through reference to a late publication in which Mr. Robert Kidston, the highest British authority on the Paleozoic floras, has combined and tabulated the results of his most valuable and interesting studies of the fossil floras of the British Carboniferous rocks.[1]

In the following table is given (1) the vertical distribution by groups of the species found both in our Missouri flora and in Great Britain, and (2) the distribution of a number of Old World species (parenthesized) whose relations to our species are sufficiently intimate to lend an inferential significance to their stratigraphic occurrence. But in drawing conclusions of a chronologic nature, relatively little weight should be given to the distribution of the related species, whose evidence is subject to other and perhaps more important elements of uncertainty than those of mere personal opinion and interpretation of figures and descriptions.

Table showing distribution in the Coal Measures of Great Britain of the plants of the Lower Coal Measures of Missouri or of certain closely related species.[2]

Species.	Millstone grit.	Lower Coal Measures.	Middle Coal Measures.	Transition series.	Upper Coal Measures.
Excipulites Callipteridis (Schimp.) Kidst	....	....	....	....	×
Pseudopecopteris obtusiloba (Brongn.) Lx	....	×	×	....	....
Ps. squamosa (Lx.)	....	....	....	×	×
Mariopteris cf. *nervosa* (*M. nervosa* (Brongn.) Zeill.)	×	×	×	....	....
M. sphenopteroides (Lx.) Zeill. (*M. acuta* (Brongn.) Zeill.)	....	×	×	....	....
Mariopteris n. sp. (*Sphenopteris Jacquoti* (Zeill.) Kidst.)	....	....	×	....	....
Sphenopteris mixta Schimp	....	....	×	....	....
S. Lacoei D. W. (*S. rotundifolia* Andrä)	....	....	×	....	....
S. Broadheadi D. W. (*Hymenotheca Dathei* Pot.)	....	....	×	....	....
S. missouriensis D. W. (*S. Woodwardii* Kidst.)	....	....	....	....	×
S. pinnatifida (Lx.) (*S. quadridactylites* Gutb.)	....	....	×	....	....
S. cristata (Brongn.) Presl	....	....	×	....	....
S. subcrenulata (Lx.) (*Pecopteris crenulata* Brongn.)	....	....	....	....	×
Oligocarpia missouriensis D. W. (*O. Brongniartii* Stur)	....	....	×	....	....

[1] On the Various Divisions of British Carboniferous Rocks as determined by their Fossil Flora. Address of the retiring vice-president. Proc. Roy. Phys. Soc. Edinb., vol. xii, 1894, pp. 183–257.

[2] Names of foreign related species, whose distribution is given, are in parentheses immediately following the names of the American species to which they bear relation.

Table showing distribution in the Coal Measures of Great Britain of the plants of the Lower Coal Measures of Missouri or of certain closely related species—Continued.

Species.	Millstone grit.	Lower Coal Measures.	Middle Coal Measures.	Transition series.	Upper Coal Measures.
Aloiopteris Winslovii D. W. (*A. Sternbergii* (Ett.) Pot.)	....	×	×	....	....
A. erosa Gutb	....	....	....	....	×
Pecopteris dentata Brongn	....	....	×	....	×
P. cf. *arborescens* (*P. arborescens* (Schloth.) Brongn.)	....	....	....	....	×
P. hemitelioides Brongn. ? (*P. arborescens* var. *cyathea* (Brongn.) Kidst.)	....	....	....	....	×
P. Jenneyi D. W. (*P. oreopteridia* (Schloth.) Brongn.)	....	....	....	....	×
P. Candolliana Brongn	....	....	....	....	×
P. squamosa Lx. (*P. lamuriana* Heer)	....	....	....	....	×
P. restita Lx. (*P. villosa* Brongn.)	....	....	....	....	× ?
Aphlebia spinosa (Lx.)	....	....	....	....	×
A. crispa (Gutb.) Presl	....	....	....	....	×
A. filiciformis (Gutb.) Sterz	....	....	....	....	×
A. subgoldenbergii D. W. (*A. Goldenbergii* Weiss)	....	....	....	....	×
Alethopteris ambigua Lx. (*A. aquilina* (Schloth.) Goepp.)	....	....	×	....	×
A. Serlii (Brongn.) Goepp	....	....	×	×	×
Callipteridium Mansfieldi Lx. (*Alethopteris Grandini* (Brongn.) Goepp.)	....	....	....	....	×
C. inæquale Lx. (*A. Davrenxii* (Brongn.) Goepp. ?)	....	....	×	....	×
Odontopteris Bradleyi Lx. (*Od. Lindleyana* Stb.)	....	....	....	×	×
Neuropteris rarinervis Bunb	....	....	×	×	×
N. missouriensis Lx. (*N. flexuosa* Stb.)	....	....	....	×	×
N. fasciculata Lx. (*N. macrophylla* Brongn. ?)	....	....	....	×	×
N. Scheuchzeri Hoffm	....	....	×	×	×
N. dilatata (L. & H.) Lx	....	....	×	....	....
Linopteris gilkersonensis D. W. (*L. Münsteri* (Eichw.) Brongn.)	....	....	×	....	×
Calamites ramosus Artis	....	×	×	....	×
C. Suckowii Brongn	×	×	×	....	×
C. Cistii Brongn	....	×	×	×	×
Asterophyllites equisetiformis (Schloth.) Brongn	....	×	×	×	×
A. longifolius (Stb.) Brongn	....	×	×	....	....
Calamostachys ovalis Lx. ? (*Palæostachya pedunculata* Will.)	....	×	×	....	....
Annularia stellata (Schloth.) Wood	....	....	....	×	×
A. sphenophylloides (Zenk.) Gutb	....	....	×	×	×
A. ramosa Weiss (*A. radiata* (Brongn.) Stb.)	....	×	×	....	....
Cyclocladia Brittsii D. W. (*Macrostachya infundibuliformis* (Bronn) Schimp.)	....	....	....	....	×
Radicites capillacea (L. & H.) Pot	....	×	×	....	×
Sphenophyllum cuneifolium (Stb.) Zeill	....	×	×	×	....
S. emarginatum Brongn	....	....	....	×	×
S. majus Bronn	....	×	×	....	×

Table showing distribution in the Coal Measures of Great Britain of the plants of the Lower Coal Measures of Missouri or of certain closely related species—Continued.

Species.	Millstone grit.	Lower Coal Measures.	Middle Coal Measures.	Transition series.	Upper Coal Measures.
S. Lescurianum D. W. (*S. oblongifolium* (Germ.) Ung.)			× ?		
Lepidodendron Brittsii Lx. (*L. Wortheni* Lx.)			×	×	×
L. lanceolatum Lx.					×
L. rimosum Stb			×		
L. scutatum Lx. (*L. ophiurus* Brongn.)		×	×		
Lepidostrobus princeps Lx. (*L. Geinitzii* Schimp.)		×	×		
Lepidophyllum Jenneyi D. W. (*L. triangulare* Zeill.)			×		
L. Missouriense D. W. (*L. majus* Brongn.)		×	×		×
Sigillaria camptotænia Wood		×	×	×	×
S. tessellata (Steinh.) Brongn	×	×	×	×	×
S. ovata Sauv			×		
Stigmaria verrucosa (Mart.) S. A. Mill	×	×	×	×	×
S. Evenii Lx				×	
Cordaites communis Lx. (*C. borassifolius* (Stb.) Ung.?)		×	×		×
Cordaianthus ovatus Lx. (*C. Volkmanni* (Ett.) Zeill.)			×		
Rhabdocarpos multistriatus (Presl.) Lx					×
Palæoxyris appendiculata Lx. (*P. carbonaria* Schimp.)			×		
SUMMARY.					
Identical species 34	3	12	22	14	25
Related species 35	1	9	22	4	19

A glance at the accompanying table shows that the greater portion of our species are found in the Upper Coal Measures and the Middle Coal Measures of Great Britain. Whether in this table of distribution the related species are excluded or taken into consideration, we find nearly equal proportions of the floras occurring in either of these two groups. The number of species found in the Lower Coal Measures is but about one-half that in either of the above-mentioned groups, and is, moreover, composed largely of plants of wide vertical range, found in one or all of the above groups. It is important to note that the percentage of species in the Millstone grit of Great Britain, as well as in the Pottsville series of the United States, is very small, being practically insignificant.

On the face of the numerical proportions it would seem that the Henry County flora is so evenly divided between the floras of both the Upper and the Middle Coal Measures as to deserve consideration as intermediate between them. The Sphenopteroid species, both identical and related, appear to bind our flora to the Middle Coal Measures. But the characteristic floras of these British groups are more conspicuously marked by the important additions which enrich the variety of plant life as we pass upward than by the disappearance of the older forms, though the latter feature is clearly indicated and of great service. The development of the Pecopteroid flora appears to be confined in Great Britain almost exclusively to the Upper Coal Measures. And it is largely to the proportion of identical or related species of *Pecopteris* and the intimately connected *Aphlebiæ* that the approximate equality of the percentages in this table is due. It must, however, be borne in mind that the Middle Coal Measures of England contain a number of more recent species, such as *Pecopteris polymorpha* Brongn., *P. Miltoni* Artis, and *P. pteroides* Brongn., which are of generally younger rank than the flora from Missouri. Among the extensive material from the Radstock coal field in the Lacoe collection the higher forms are in abundance, notwithstanding the presence of very many species in common with those from the trans-Mississippian region. On the other hand, the younger types, such as *Pecopteris Jenneyi*, *P. Candolliana*, *P. hemitelioides*?, and *P.* cf. *arborescens*, are very rare in our flora.

In view of the foregoing considerations it appears very evident that the flora of Henry County is not older than that of the Middle Coal Measures of Great Britain. The presence in our flora, not only of an equal number of species, but also of a considerable number of younger types identical with or closely related to those of the Upper Coal Measures justifies the belief that our flora is not much younger than the Upper Coal Measures, and that, considering its almost equally close relation to that of the Middle Coal Measures, it may safely be considered as intermediate between the two, or as occupying approximately the position of the "transition beds,"[1] with a very intimate connection with the flora of the Upper Coal Measures. The plants of these beds are very imperfectly known, but from the common facies of their flora as yet revealed I am at present disposed to regard these terranes as not younger than the lower coals of Henry County. The flora of the latter may even correspond in part to that of the basal portion of the Upper Coal Measures in the British coal fields.

[1] The "New Rock" and the "Vobster Series" of the Bristol and Somerset coal field and the "Lower Pennant" of the South Wales coal field.

ZONE OF THE MISSOURI FLORA IN THE CARBONIFEROUS BASINS OF CONTINENTAL EUROPE.

A comparison of the fossil plants from Henry County, Mazon Creek, or Cannelton with the floras of the different stages of the Carboniferous in the Old World coal fields reveals a series of paleontologic and chronologic relations that are full of significance and interest to American students.

One need but glance at the monographs of the floras of the various stratigraphic groups in the Carboniferous basins of western Europe to recognize the strong similarity between the forms familiar in our American Lower Coal Measures of the Northern States and those from the Valenciennes or Franco-Belgian Basin, the Westphalian coal field in Germany, or the Schatzlar group in Bohemia.

The broadest, most general, and most valuable results of a comparative study of these forms would be reached by a view of the identities, affinities, and distribution, as well as the vertical range and sequence, of the plants of those European basins in which the Middle Carboniferous is present combined with those of the American Lower Coal Measures. But since such a study would be laborious on account of its extent, and would encounter numerous difficulties in local stratigraphic correlations and nomenclature, it would be much simpler to consider each basin separately, regarding the succession of floras from the various levels as constituting a single paleobotanic section of that basin.

Since, however, the series in the Valenciennes Basin is more limited in vertical extent, and since its flora, exhaustively elaborated with special reference to the stratigraphic problems, is more readily adapted to an epitomized comparison, it may be chosen as typically illustrating the general continental position of the flora under consideration.

In his admirable monograph of the fossil flora of the Valenciennes Basin,[1] M. Zeiller divides the terranes on the basis of the floral characters into three well-marked zones, viz: 1. The lower zone, or zone of Vicoigne, represented at numerous points in the horizons of Annœulin and Vicoigne, Departments of Nord and Pas-de-Calais, and populated with *Sphenopteris*

[1] Études des gîtes minéraux de la France. Publiées sons les auspices de M. le Ministre des travaux publics par le Service de topographies souterraines. Bassin houiller de Vallenciennes. Description de la flore fossile, par R. Zeiller, Ingénieur en chef des mines. Text, Paris, 1888, pp. 1–731, 4°. Atlas, 1886, pp. i–vi, pl. i–xciv, 4°.

Hoeninghausii, *Mariopteris muricata*, *Pecopteris aspera*, *P. dentata*, *Alethopteris lonchitica*, *Neuropteris Schlehani*, *Lepidodendron Veltheimii*, *Bothrodendron punctatum*, and *Sigillaria elegans*.[1] This zone is presumably next above the Millstone grit. 2. The middle zone, or zone of Anzin-Meurchin, is divisible on paleobotanic lines into three horizons, of which the lower is characterized by the great abundance of *Sphenopteris* (*Pseudopecopteris*) *trifoliolata*, *Diplothmema* (*Sphenopteris*) *furcatum*, *Alethopteris Davreuxii*, *Sphenophyllum myriophyllum*, and *Sigillaria rugosa*, as well as rarer specimens of *Sphenopteris* (*Pseudopecopteris*) *obtusiloba*, *Pecopteris abbreviata*, *Asterophyllites equisetiformis*, *Sigillaria lævigata*, and *Cordaites borassifolius*; the middle horizon by the continuation of *Sphenopteris Hoeninghausii*, *Alethopteris lonchitica*, *Bothrodendron punctatum*, and the rare appearance of *Alethopteris valida*, *A. Serlii*, and *Sigillaria camptotænia*, while the third horizon is marked by the excessive rarity of the species typical of the lower zone, the absence of the Stephanian species found in the upper zone, and the abundance of *Pecopteris abbreviata*. 3. The third or upper zone, that of Bully-Grenay, in the Franco-Belgian Basin, includes among its typical species the *Sphenopteris* (*Pseudopecopteris*) *obtusiloba*, *S. neuropteroides*, *Pecopteris abbreviata*, *Alethopteris Serlii*, *Neuropteris rarinervis*, *N. tenuifolia*, *Linopteris Sub-Brongniartii* (near to *L. obliqua* Bunb.), *Asterophyllites equisetiformis*, *Sphenophyllum emarginatum*, *Sigillaria tessellata*, *S. camptotænia*, and *Cordaites borassifolius* in abundance, and the first examples of the Stephanian types, *Alethopteris Grandini*, *Annularia sphenophylloides*, *A. stellata*, *Pecopteris crenulata*, and *Linopteris Münsteri*, while the characteristic species of the lower zone are entirely wanting.

The reader will already have recognized the names of the common American species in this upper zone, which belongs to the upper portion of the "Westphalian" group.[2] The Westphalian (*Houiller Moyen*) is succeeded in the stratigraphic column of Europe by the Stephanian, on which rest the Autunian and other Permian subdivisions.

The relation of our flora to the European series is, however, somewhat concisely represented by the accompanying condensed tabulation of the

[1] In this discussion no attention will be paid to the horizons or minor geologic subdivisions of which the various species are characteristic or at which their distribution begins or ends. These features, which have been worked out with brilliant results by M. Zeiller, are too detailed to warrant consideration in an intercontinental comparison.

[2] It seems possible that the Valenciennes series may hardly extend to the top of the Westphalian.

abridged distribution of (1) the identical and (2) the apparently closely related (parenthesized) species in the Westphalian as represented in the Valenciennes Basin:

Table showing distribution in the Valenciennes Basin (Westphalian) of species identical with or probably closely related (parenthesized) to those from Missouri.

[× = present; C = common; R = rare.]

Species.	Lower zone.	Middle zone.	Upper zone.
Eremopteris missouriensis Lx. (*Diplothmema furcatum* (Brongn.) Stur)		R	R
Pseudopecopteris obtusiloba (Brongn.) Lx	R	×	C
Ps. squamosa (Lx.)		×	C
Mariopteris cf. *nervosa* (Brongn.) Zeill. (*M. muricata* (Schloth.) Zeill.)	R	R	R
M. sphenopteroides (Lx.) Zeill			×
Mariopteris n. sp. (*Diplothmema Jacquoti* Zeill.)			R
Sphenopteris mixta Schimp			×
S. pinnatifida (Lx.) (*S. quadridactylites* Gutb.)		R	R
S. chærophylloides (Brongn.) Presl			×
S. cristata (Brongn.) Presl (*S. Douvillei* Zeill.)			R
S. canneltonensis D. W. (*Diplothmema Zeilleri* Stur)			R
S. capitata D. W. (*S. Poticri* Zeill.)			R
S. ophioglossoides (Lx.) (*S. Crepini* Zeill.)			R
S. subcrenulata (Lx.) (*Pecopteris crenulata* Brongn.)			R
Oligocarpia missouriensis D. W. (*O. Brongniartii* Stur)		R	R
Aloiopteris Winslovii D. W. (*A. Sternbergi* (Ett.) Pot.)		R	R
Pecopteris dentata Brongn	×	×	×
P. pseudovestita D. W. (*P. abbreviata* Brongn. ?)		R	R
P. vestita Lx. (*P. Volkmanni* Sauv.)	R	R	
P. clintoni Lx. (*P. integra* (Andrä) Schimp.)			R
Aphlebia crispa (Gutb.) Presl		×	×
Alethopteris Serlii (Brongn.) Goepp		×	C
Callipteridium cf. *Mansfieldi* Lx. (*Alethopteris Grandini* (Brongn.) Goepp.)			R
Neuropteris rarinervis Bunb		×	C
N. missouriensis Lx. (*N. flexuosa* Stb.)	R	R	R
N. Scheuchzeri Hoffm		×	×
Linopteris gilkersonensis D. W. (*L. Münsteri* (Eichw.) Brongn.)			R
Calamites ramosus Artis	×	×	×
C. Suckowii Brongn	×	×	C
C. Cistii Brongn	×	×	×
Asterophyllites equisetiformis (Schloth.) Brongn		×	C
A. longifolius (Stb.) Brongn		×	?
Calamostachys ovalis Lx. ? (*Palæostachya pedunculata* Will.)		R	
Annularia sphenophylloides (Zenk.) Gutb			C
A. stellata (Schloth.) Wood			×
Radicites capillacea (L. & H.) Pot. (*Pinnularia columnaris* (Artis) Zeill)			R

Table showing distribution in the Valenciennes Basin (Westphalian), etc.—Continued.

Species.	Lower zone.	Middle zone.	Upper zone.
Sphenophyllum cuneifolium (Stb.) Zeill	×	×	×
S. emarginatum Brongn	....	×	C
S. majus Bronn	....	....	×
Lepidodendron Brittsii Lx. (*L. Wortheni* Lx.)	....	R	....
L. rimosum Stb	....	×	....
L. lanceolatum Lx. (*L. lycopodioides* Stb.?)	....	R	R
L. scutatum Lx. (*L. ophiurus* Brongn.)	....	R	....
Lepidostrobus princeps Lx. (*L. Geinitzii* Schimp.)	....	R	....
Lepidophyllum Jenneyi D. W. (*L. triangulare* Zeill.)	....	R	R
Sigillaria camptotænia Wood	....	×	C
S. tessellata (Steinh.) Brongn	....	×	C
S. ovata Sauv	....	×	×
Stigmaria verrucosa (Martin) S. A. Mill	×	×	×
S. Evenii Lx	....	....	×
Cordaites communis Lx. (*C. borassifolius* (Stb.) Ung.)	....	R	R
Cordaianthus ovatus Lx. (*C. Volkmanni* (Ett.) Zeill.)	....	....	R
SUMMARY.			
Identical species 26	7	19	25
Supposed related species 26	3	15	21

The comparative distribution of identical or closely related species exhibited in the foregoing table is at once striking and instructive. A glance at the columns shows that many among both identical and related species are found in the middle zone. But the conspicuous and significant fact is the occurrence of 24 or 25 of the 26 of the identical Missouri species in the upper zone of the Franco-Belgian basin. If we take account of the distribution of the related species, we find 21 of the 27 in the same zone. Thus our flora has a very marked and preponderant affinity with the flora of the zone of Bully-Grenay.

The evidence afforded by the distribution of the species needs only to be supplemented by a review of the profuse and admirably executed figures of the species from the upper zone given in Professor Zeiller's great memoir to insure a conviction that in that upper zone of the Valenciennes coal field we find terranes of the age of the lower coals in Henry County, Missouri. In fact, assuming a uniform distribution for the plants, there can be little doubt that the floras are nearly synchronous.

But although the identical species coincide so nearly exactly in their occurrence in the upper zone, we may profitably inquire as to the relations of the Missouri flora to that of higher beds not represented in this field, and therefore not tabulated, or whether, while the main body of our flora is most closely allied to the zone of Bully-Grenay, the flora as a whole is not more closely bound to the succeeding floras or those of the lower zone.

The testimony of the related species recorded in the table, so far as it concerns this inquiry, would seem to indicate less strongly the similarity of our flora to that of the upper zone, although nearly the same ratio prevails in the distribution in the middle zone. As tending, however, to explain this, it should be stated that in a few cases the species from the Valenciennes Basin, tabulated for the comparison, are not really so intimately bound in their specific details to the corresponding Missouri plants as are other Stephanian species not occurring in the Valenciennes series. Thus *Sphenopteris Van Ingeni* is probably most closely related to *Sphenopteris Matheti* from the Commentry Basin (Stephanian), *Pecopteris Jenneyi* to *P. densifolia* or *P. oreopteridia* of the same group, while *Lepidostrobus princeps* is much nearer *L. Goldenbergii* than to *L. Geinitzii*, used for comparison with the Valenciennes flora.

But besides the evidence of related species, which is after all of very subordinate weight, we have in the material from Henry County a number of species of Stephanian identity or affinity. Among the former are *Sphenopteris cristata*, *S. subcrenulata*, *Pecopteris hemitelioides?*, and *P. Candolliana* and *P.* cf. *arborescens*, while *Sphenopteris chærophylloides* is regarded as essentially a Stephanian species. Still other types are more modern in their characters or generic occurrence. Examples of these are possibly present in *Brittsia*, which is perhaps related to the Stephanian genus *Zygopteris*, and in the plants provisionally referred to *Titanophyllum* and *Dicranophyllum*, both genera of the Stephanian, or in *Callipteridium Sullivantii*, perhaps most nearly related to *Odontopteris obtusa*, *Sphenophyllum Lescurianum*, which seems to belong to the later group represented by *S. angustifolium*, etc.; the *Rhabdocarpus Mansfieldi*, which is undoubtedly very closely allied to *Pachytesta insignis* of the higher Measures, and perhaps the *Tæniopteris missouriensis*.

The presence of these later types in the flora of Henry County,[1] as

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[1] Of the 26 species represented in both the Missouri and Valenciennes floras, only 1, *Lepidodendron rimosum*, is lacking in the upper (Bully-Grenay) zone. This species was found only in the lower horizon of the middle zone of the Franco-Belgian Basin.

well as the comparative absence of species characteristic of the middle zone of the Valenciennes Basin, indicates for our flora a greater and more significant affinity with that of the beds succeeding the zone of Bully-Grenay than with those below it; and, if the Old World deposits which are contemporaneous with the Henry County Coal Measures transgress either boundary of the upper zone of the Valenciennes series, the transgression or overlap is undoubtedly on the side of the beds succeeding the Valenciennes series and perhaps infringing on the Stephanian. For my own part, I am inclined to consider our flora as perhaps in a measure transitional; and that, while it is probably contemporaneous with a portion at least of the upper zone of the Valenciennes Basin, its marked affinities with many of the types of the Stephanian, as presented in the basins of Commentry or the Saar, make it far from impossible that it may represent a slight paleontologic transgression on the Stephanian ("Houiller supérieur").

The above conclusions as to the contemporaneity of the Henry County flora with the plants of the upper zone of the Westphalian ("Houiller moyen") in the Franco-Belgian Basin are in striking harmony with the conclusions drawn from our comparisons with the British Coal Measures. For the study of the respective floras by Kidston[1] and Zeiller[2] has shown that the variations of the flora in the different stages of the British series are very nearly parallel with those in the Valenciennes Basin, so that the Lower Coal Measures of Great Britain are regarded as essentially contemporaneous with the lower (Vicoigne) zone of the Valenciennes Basin. The Middle Coal Measures are correlated with the middle zone,[3] while the transition beds of the British series, the plants of which are less completely known, are referred with little doubt to the zone of Bully-Grenay. Thus we find that those portions of the Old World terranes in (1) the British Coal Measures and (2) the Franco-Belgian Basin, which as the result of entirely independent and distinct paleontologic comparisons I have been led to regard as contemporaneous with our Missouri flora, have, in the course of the paleobotanic studies of the Old World series, been correlated by the

[1] Foss. Fl. Radstock Ser., 1887, p. 408.

[2] Bull. Soc. géol. Fr., (3) vol. xxii, 1895, p. 494.

[3] In the case of the Potteries coal field in North Staffordshire, the uppermost beds are regarded by Zeiller, from their paleophytologic characters, as extending a little above the middle zone.

European paleobotanists. In the uniformity, consistency, and definition of the correlative evidence the fossil plants here offer an example seldom equaled in any other class of paleontologic evidence.

If we compare the Missouri plants with the floras of the other European basins, we shall find the synchronologic evidence essentially the same. Thus, in brief, just as our flora, while it is largely identical and probably contemporaneous, in part at least, with the "Transition series" of Great Britain and the zone of Bully-Grenay, in the Valenciennes Basin, seems to transgress slightly on the Upper Coal Measures and the Stephanian, so we find it in the basin of Saarbrück near the top of the Westphalian (*Saarbrücker Schichten*), where in the Geislautern beds, which probably extend higher than the top of the Valenciennes series, being in partial correspondence with the British Upper Coal Measures, a number of Stephanian (*Ottweiler Schichten*) types make their appearance.

In the basin of Zwickau, in Saxony, the treatise on the plants of which by Geinitz is among the classics in paleobotanic literature, the closely related and probably synchronous beds are toward the base of a continuous series marked in passing upward by a mingling of Westphalian and Stephanian forms,[1] which give way to the predominance of the ordinary species of the latter division.

In the basins of lower Silesia and Bohemia we shall find large representations of our species in the Schatzlar and Radnitz groups. With the flora of the "*Schazlarer Schichten*," the monographic elaboration of which was unhappily interrupted by the death of Director Stur, there is a close relation, especially between plants from the upper beds of that group and those which form the subject of this report. Of the groups in central Bohemia, the "*Radnitzer Schichten*," whose plants have received treatment by Sternberg, Corda, Ettingshausen, and O. Feistmantel, are of the greatest present interest to us. The presence in this series, especially in the Swina and Mostitz beds, of a large number of species either identical or closely related to those from Missouri is at once apparent from an inspection of Ettingshausen's plates or the memoirs of O. Feistmantel,[2] though the nomenclature in the former is largely different.

[1] See Sterzel: Paläont. Char. d. Oberen Steink. u. Rothl., p. 70.

[2] Verst. d. böhm. Kohlen-Ablag., i–iii, 1874.

GENERAL CONSIDERATIONS.

General comparisons, such as those summarized in the preceding pages, of the flora in hand from Missouri with the floras of the Mesocarboniferous series in the principal basins of Europe show (1) so large a number of identical species, (2) so great a proportion of related species, (3) so important a predominance of the same floral elements, and (4) so close a general parallelism in the appearance and disappearance of the types as shown in their vertical distribution and occurrence in the upper beds of the Westphalian (*Houiller Moyen, Saarbrücker Schichten*), that the conclusion that the lower coals of Henry County, Missouri, were deposited near the close of that period is not on any demonstrable grounds avoidable. The evidence of uniformity in the climate prevailing over Europe, within the Arctic Circle,[1] in North America, Asia, and, to some extent at least, in the southern hemisphere, during early Carboniferous time, is too generally recognized to require discussion as to the fact. The astonishingly large proportion, not only of genera, but of species as well, found to be identical in the Culm and Mesocarboniferous in all the basins of Europe, North America, and China, and the comparative regularity in the sequence of the floras in these basins, are so strongly marked as to leave little room for doubt as to the extremely intimate connection of the floras living about the respective basins, or the existence of continental conditions necessary to their rapid, almost simultaneous and uniform, distribution. The extremely close relationship, so well known to paleobotanists, between the respective floras of the Culm, Millstone grit (Pottsville series), and basal portions of the Lower Coal Measures in the fields of Europe and America necessitates the assumption of wonderful facilities for plant distribution during Culm and early Mesocarboniferous time, facilities which, with the aid of an even climate and presumably relatively low topography, made possible the comparatively regular distribution and sequential order of probably nineteen-twentieths of the genera and an unknown proportion (perhaps over one-half between North America and Europe) of the identical species. The degree of identity in the types is not less remarkable than the geographic range of

[1] The plants of Bear Island and Spitzbergen are shown by Nathorst not only to have included the common genera, but largely identical species, while the individuals are as fully developed and robust as those found in the contemporaneous beds of southern Europe or the United States. (See Zur Paläozoischen Flora d. Arkt. Zone, Stockholm, 1893.)

individual species, and this in turn is much less impressive than the uniformity of the sequence and the parallelism of their appearance and extinction during this epoch, or the similarity of the elements which composed each flora. The writer is disposed to believe that the conditions favorable for plant distribution and the consequent comparatively homogeneous dispersion of the successive floras of the northern hemisphere during the period extending from the later Culm to near the middle of the Mesocarboniferous have never been equaled since. That there was plant migration can not for a moment be questioned. Yet the evidence of distribution, of vertical range, of characteristic associations, and of the succession of the floras bespeaks for the terrestrial plant species of that period such geographic uniformity of climate and such facility of intermigration, probably over a minimum distance, as to justify us in regarding the astonishingly similar associations of identical or closely related genera and species which characterize each stage, zone, or group of the Culm and Mesocarboniferous as essentially contemporaneous in all the basins of the northern hemisphere.

Whether the Carboniferous flora was developed within the arctic zone or some other region of the earth is hardly more than a subject for speculation. Personally I am inclined to believe that many of the species or genera of the Mesocarboniferous were, under similar local conditions, evolved in different portions of the land surface, whence they spread, with a rapidity difficult to conceive in the present day, over the greater part of the northern continents. Such a mode of generation, at different points, of the various elements comprising a given flora might be described as polychthanous.

The suggestion offered at different times by several European paleobotanists[1] that the flora of Mazon Creek, which is generally cited in America as the familiar illustration of the plant life of the lower part of our Lower Productive Coal Measures, really represents a stage much higher than the lowest series above the Millstone grit of Europe seems to be fully corroborated by a comparative examination of the floras. Such an examination will show, if we accept the synchronology of the respective floras, that the plants of the Middle Kittanning, or of the E coal, fall within and are apparently nearly contemporaneous with the Geistlautern beds or the upper-

[1] See Zeiller: Fl. foss. bassin houill. Valenciennes, p. 195.

most beds of the Westphalian, while the Pittsburg coal of the bituminous basins[1] and the G coal of the Northern Anthracite field are clearly referable to the Stephanian (*Ottweiler Schichten*).

There is a strongly marked contrast between the known flora of the lowest coals of Missouri, Illinois, Indiana, Ohio, and western Pennsylvania and that of the Pottsville series, or Millstone grit, which lies in most cases close beneath them, there being in fact relatively few species in common. The latter flora agrees in its later phases with the flora of the Millstone grit of Europe.

The Lower Coal Measures of Great Britain and the zone of Vicoigne in the Franco-Belgian Basin, with their intermingling of Millstone grit or Culm species with the earliest of the Coal Measures types, appear, so far as we know at present, to be unrepresented by any interval in the Lower Productive Coal Measures in the bituminous regions mentioned above. It is not improbable, however, that this interval is concentrated in some cases in the deposition of the highly variable upper benches of the Pottsville series in the Northern States, rather than that it is represented by a time break or that there is homotaxis without contemporaneity in the floras. For in the greatly expanded sections of the Lower Coal Measures in the Kanawha region in West Virginia, which is in the same Appalachian trough and was throughout Mesocarboniferous time united with the northern areas by continuous shore lines, the characteristic forms of the lowest coals of the Lower Productive Coal Measures of the States north of the Ohio and Potomac rivers are not met until we arrive at a point several hundred feet above the Pottsville series as hitherto limited. The floras of the Kanawha series, extensive collections from which are now in my hands for examination, will be found to show a lower zone of mingled types, corresponding very closely to the Lower Coal Measures of Great Britain or the lower zone of the Franco-Belgian Basin.

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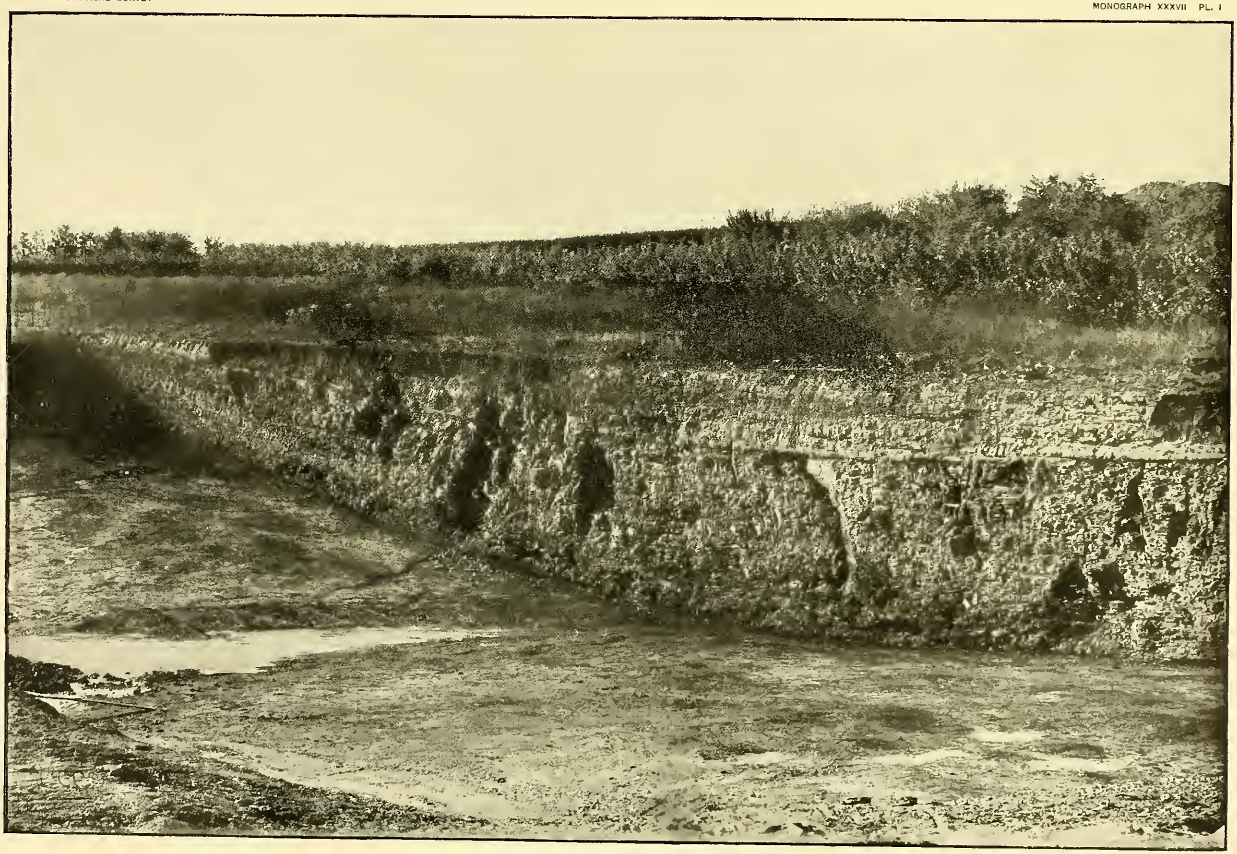
[1] The flora of the Freeport coals is so nearly unknown that its relations to the floras of any other stage outside of the anthracite series is still quite uncertain.

PLATES.

PLATE I

PLATE I.

Strip coal pit at Hobbs's bank, 8 miles south of Clinton, Missouri, showing basin-shaped bedding of coal and overlying plant-bearing shales. (From a photograph by Dr. W. P. Jenney.)



COAL STRIPPING AT HOBBS'S BANK, HENRY COUNTY, MISSOURI.

PLATE II.

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PLATE II.

Conostichus Broadheadi Lx.

(Pages 12 and 13.)

Fig. 1. Basal (?) view of the type of the species, Coal Flora, Plate B, figures 1 and 2. The triradiate character is not very distinctly shown in the photograph. No. 250, Lacoe collection, U. S. Nat. Mus.

2. Lateral view of the same type. The side exposed is not that illustrated in the original figure.

3. Lateral view of No. 251, Lacoe collection, U. S. Nat. Mus. Identified by Professor Lesquereux

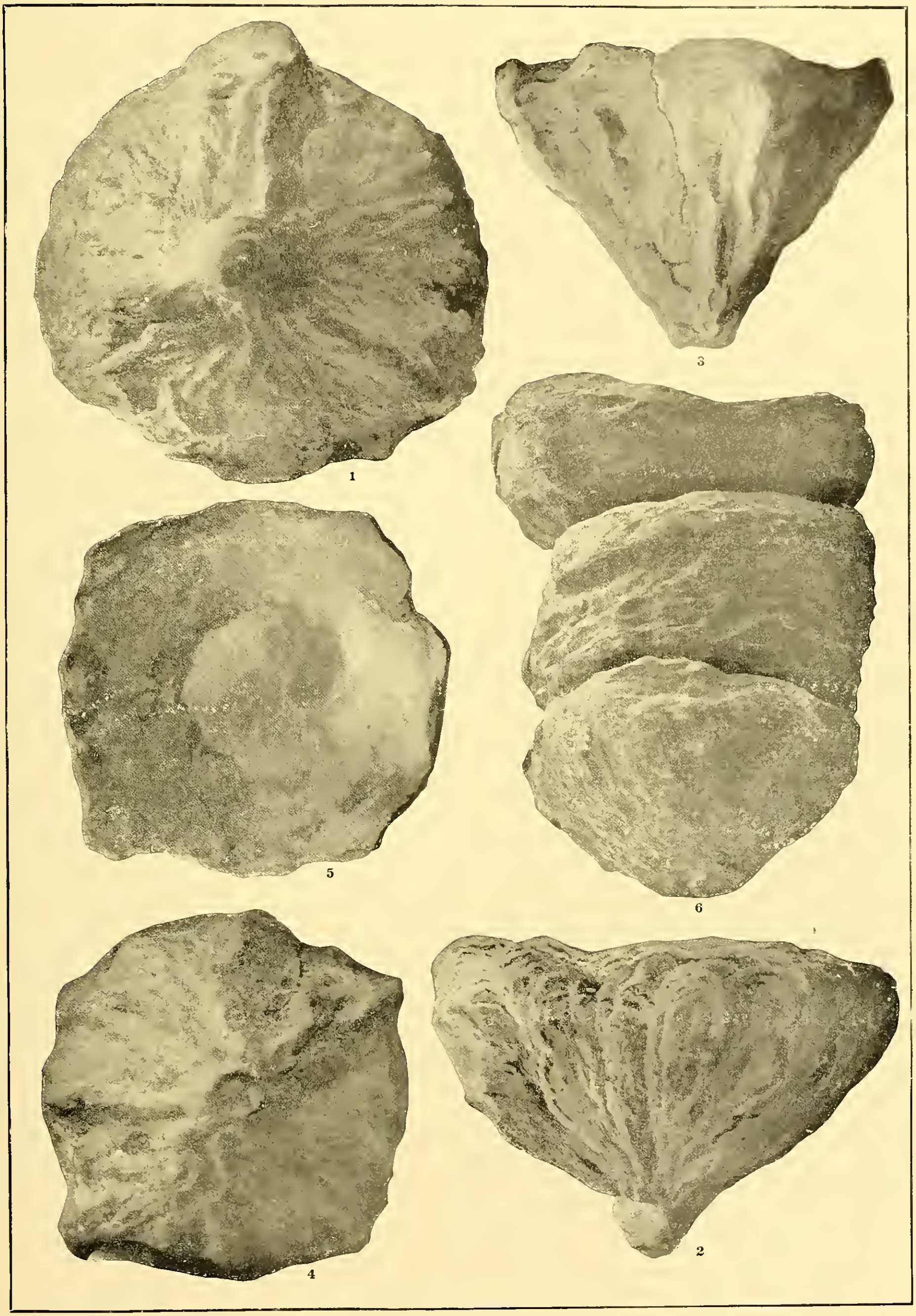
4. Basal (?) view of the same example, showing profile of top and small concave point of supposed separation from its anchorage.

5. Apical (?) view of the same specimen, showing concave surface.

Conostichus prolifer Lx.

(Page 13.)

Fig. 6. Side view of characteristic discoid extensions, concave above, convex below. U. S. Nat. Mus., p. 6035.



CONOSTICHUS, A SUPPOSED FOSSIL ALGA

PLATE III.

PLATE III.

HYSTERITES CORDAITIS Grand 'Eury

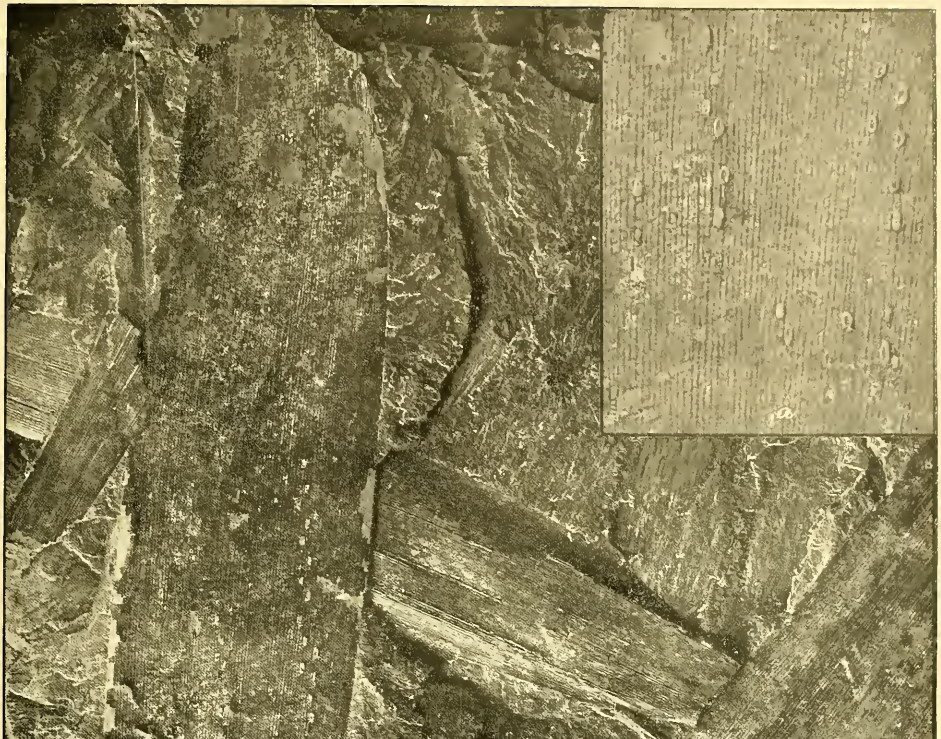
with

CORDAITES COMMUNIS Lx.

(Pages 14 and 260.)

FIG. 1. Portion of a rock slab bearing fragments of several leaves of *Cordaites communis* Lx., between the nerves of which are seen the small oblong pits, with raised borders, produced by the fungus, *Hysterites Cordaitis* Gr. 'Ey.

1*a*. Photographic enlargement of portion of *Cordaites* leaf, showing pits produced by the fungus. U. S. Nat. Mus., 5418. ×2.



FUNGI: HYSTERITES ON LEAVES OF CORDAITES.

PLATE IV.

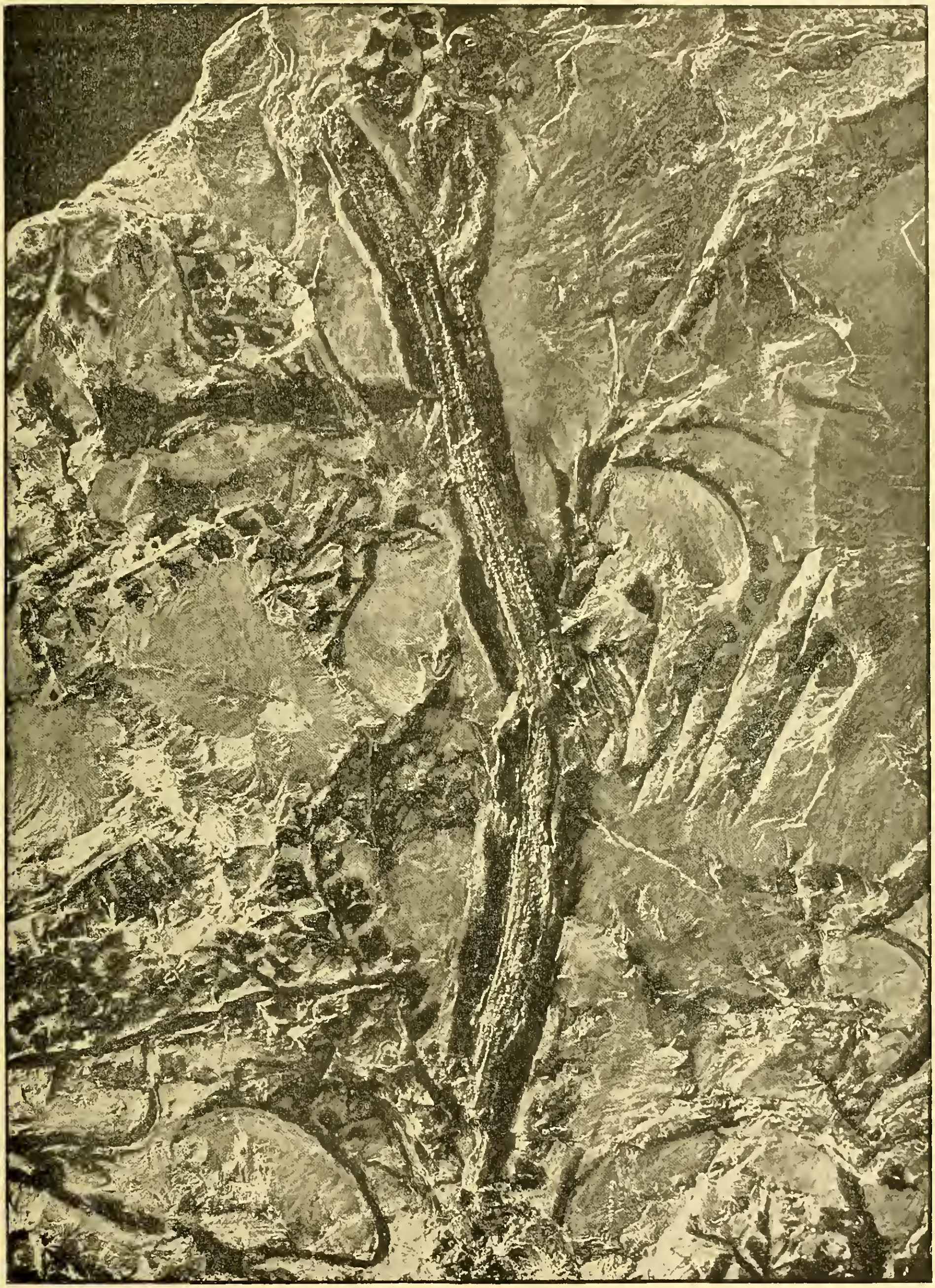
PLATE IV.

EREMOPTERIS BILOBATA D. W.

(Page 19.)

The large flexuose axis of the fern frond, with faintly ribbed central zone and broad border zones, traverses vertically the center of the slab. Two pinnæ are given off on the left and three on the right of the axis or rhachis.

U. S. Nat. Mus., 5699.



FERNS: EREMOPTERIS.

PLATE V.

PLATE V.

EREMOPTERIS MISSOURIENSIS Lx.

(Page 16.)

FIG. 1. Fragment with distant slender pinnules. U. S. Nat. Mus., 5670.
2. Segment showing small pinnæ and pinnules. U. S. Nat. Mus., 5681.
2*a*. Pinna of the same specimen enlarged ×2.
3. Fragment of segment with very large pinnules. U. S. Nat. Mus., 5659.
3*a*. Enlarged pinnule of the same to show characteristic surface and dentition. ×2.

EREMOPTERIS BILOBATA D. W.

(Page 19.)

FIG 4. Small pinna and pinnules. U. S. Nat. Mus., 5700.
5. Fragment of compound pinna. U. S. Nat. Mus., 6036.
5*a*. Enlarged pinnæ of the same, showing epidermal striato-rugosity. ×2.
6. Fragment with large pinnules. U. S. Nat. Mus., 5701.
6*a*. Enlarged detail of two pinnules from the same specimen. ×2.

FERNS; EREMOPTERIS.

PLATE VI.

PLATE VI.

EREMOPTERIS MISSOURIENSIS Lx.

(Page 16.)

FIG. 1. Sections of parallel pinnæ, showing the form and proportions of the ultimate pinnæ and pinnules. U. S. Nat. Mus., 5657.

1*a*. Enlarged detail of pinnules from same slab. ×2.

FERNS: EREMOPTERIS.

PLATE VII.

PLATE VII.

Pseudopecopteris obtusiloba (Brongn.) Lx.

(Page 24.)

Fig. 1. Fragment with very small, deeply lobed pinnules. U. S. Nat. Mus., 5635.
2. Segment showing the polymorphous character of the inferior pinnæ and pinnules in the lower portion of the frond. U. S. Nat. Mus., 5717.
3. Apical portions of the primary pinnæ, showing flexuous rachis and rather lax pinnæ. U. S. Nat. Mus., 5718.

Pseudopecopteris sp. nov.?

(Page 29.)

Fig. 4. Fragment showing compactly placed, thick, leathery pinnules, or pinnæ, terminating in spinous prolongation of the rachis. U. S. Nat. Mus., 5667.
4a. Enlarged detail. ×2.
5. Apical portion of a compound pinna showing long, naked extension of the rachis. U. S. Nat. Mus., 5618.

Mariopteris sp.

(Page 34.)

Fig. 6. Fragment showing short triangular pinnæ with broad pinnules or lobes, the lamina convex between the nerves. U. S. Nat. Mus., 5666.
6a. Enlarged detail of pinnule. ×2.

FERNS: PSEUDOPECOPTERIS AND MARIOPTERIS.

PLATE VIII.

PLATE VIII.

PSEUDOPECOPTERIS OBTUSILOBA (Brongn.) Lx.

(Page 24.)

Contiguous apical portions of two bi- or quadripartite pinnæ. U. S. Nat. Mus. 5627.

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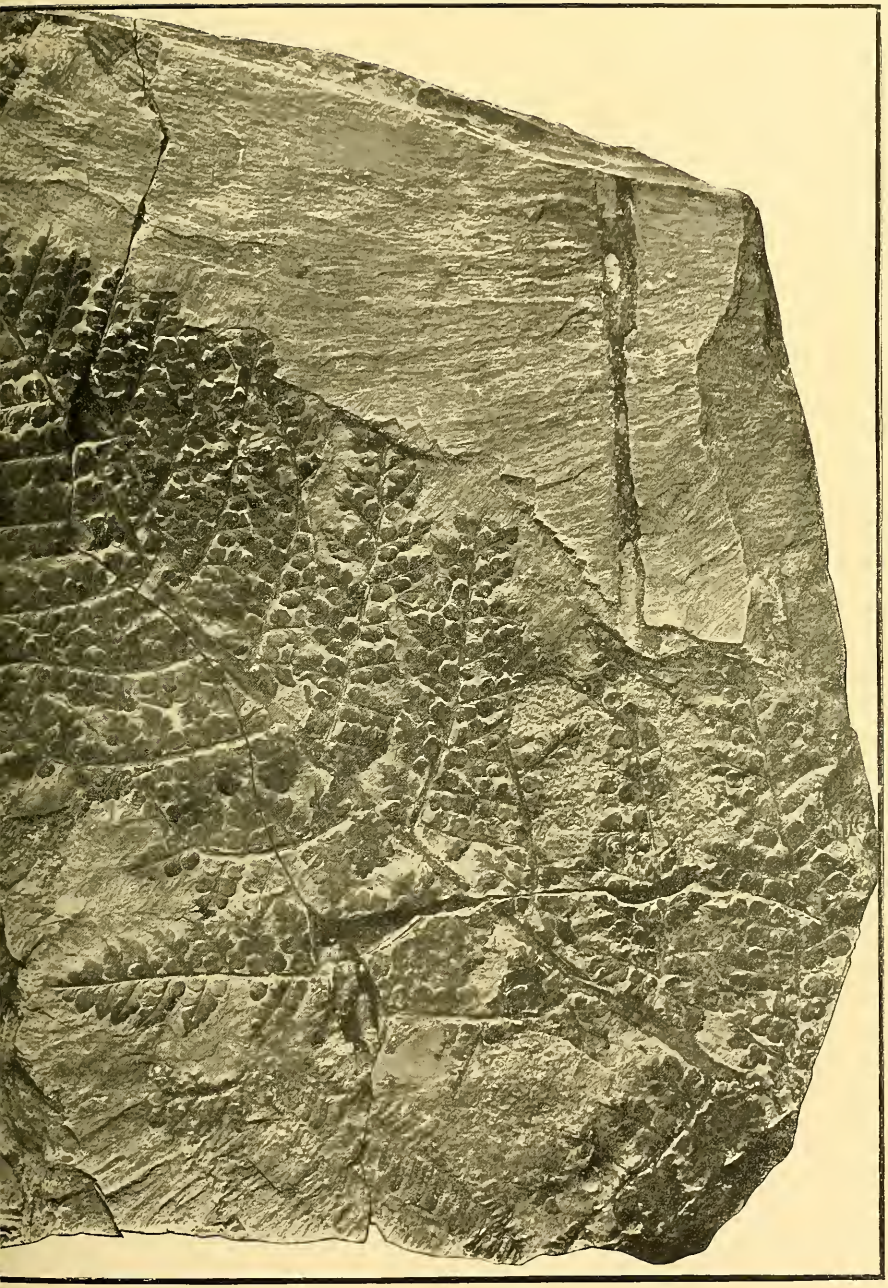


TERIS.

PLATE IX.

PLATE IX.

MARIOPTERIS SPHENOPTEROIDES (Lx.) Zeill.

(Page 31.)

FIG. 1. Portions of two sections of a primary pinna. The lower specimen illustrates the heteromorphy of the inferior pinnæ and pinnules. U. S. Nat. Mus., 5709.

1*a*. Enlarged detail of pinna showing heteromorphy and dentition. The teeth are generally longer than is shown in the figure, and the lamina of the pinnule is strongly convex between the nerves. ×2.

2. Fragment from near the apex of one of the quadri-sections of the primary pinna. U. S. Nat. Mus., 5710.

MARIOPTERIS (sp. nov.).

(Page 33.)

FIG. 3. Fragment very closely related to *M. inflata*, an unpublished MSS. species of Dr. Newberry, from Ohio. Lacoe collection, U. S. Nat. Mus., 4438.

3*a*. Enlarged detail of pinna from the same specimen. ×2.

PSEUDOPECOPTERIS SQUAMOSA Lx. sp.

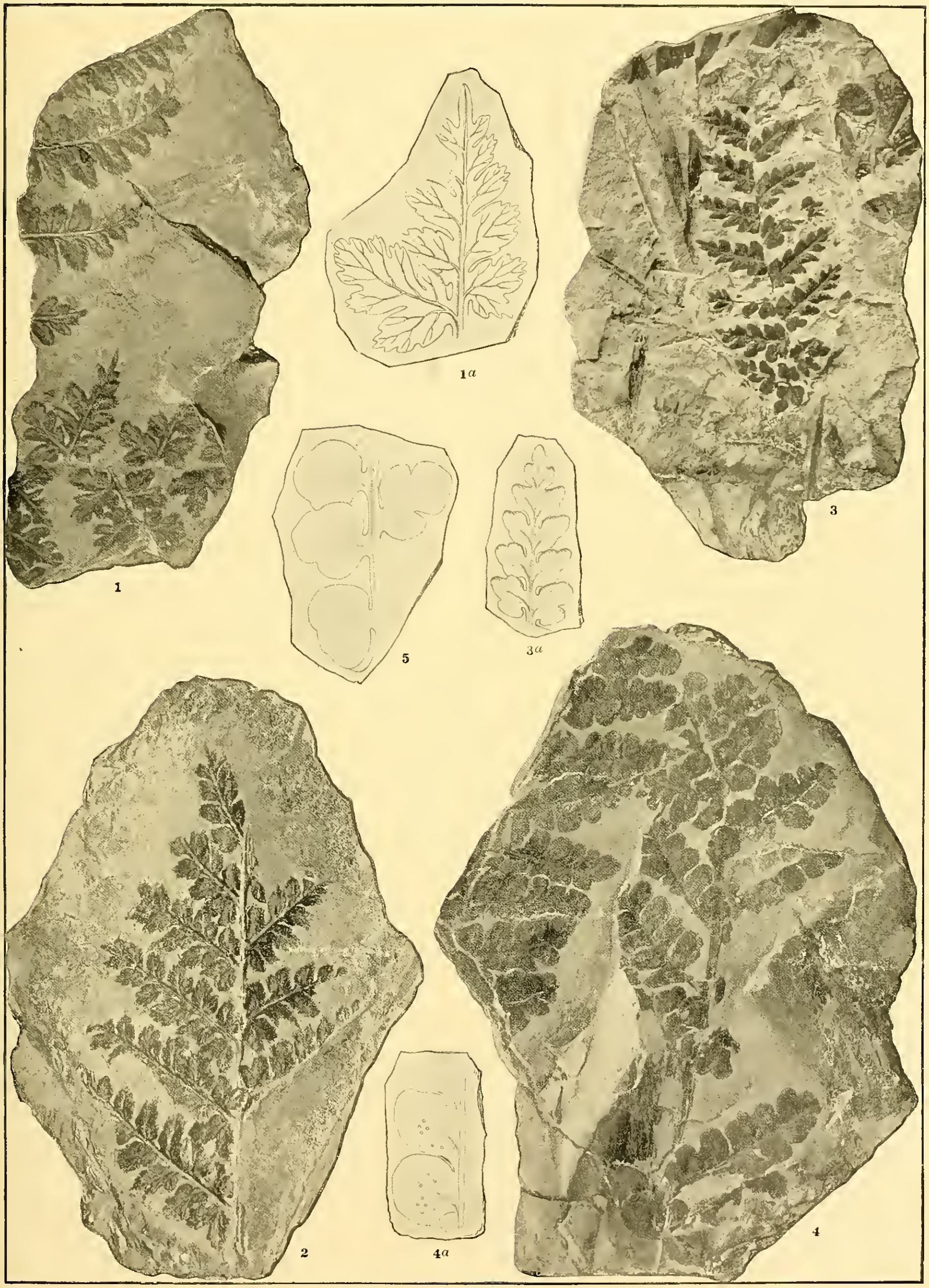
with

EXCIPULITES CALLIPTERIDIS (Schimp.) Kidst.

(Pages 15 and 27.)

FIG. 4. Fragments of the *Pseudopecopteris squamosa*, the pinnules of which are dotted by the fungus, *Excipulites Callipteridis*. No. 325 of the collection of Dr. J. H. Britts, Clinton, Missouri.

4*a*. Enlarged detail of pinnules of the same fern showing the fungus between the nerves. ×2.



FERNS: MARIOPTERIS AND PSEUDOPECOPTERIS.

PLATE X.

PLATE X.

Mariopteris sphenopteroides (Lx.) Zeill.

(Page 31.)

Fig. 1. Portions of quadrisections of primary pinnæ, showing characteristic apices. U. S. Nat. Mus. 5708.

1*a*. Enlarged detail of pinna of same specimen. ×2.

2. Terminal portions of primary pinnæ. The convex lamina between the nerves is partially abraded so as to reveal the more deeply impressed nervation in the photograph. U. S., Nat. Mus., 5707.

FERNS: MARIOPTERIS.

PLATE XI.

PLATE XI.

SPHENOPTERIS WARDIANA D. W.

(Page 39.)

FIG. 1. Small compact pinnæ. U. S. Nat. Mus., 5617.
1*a*. Enlarged detail of portion of the same. ×2.
2. Segment from one side of middle portion of a secondary (?) pinna. U. S. Nat. Mus., 5615.
2*a*. Enlarged detail from the same showing three ultimate pinnæ with form of pinnules and nervation. ×2.

SPHENOPTERIS MIXTA Schimp.

(Page 35.)

Fig. 3. Upper part of a primary pinna, showing compact pinnules near the top, and pinnatifid pinnules, developing as tertiary pinnæ, in the lower portion. U. S. Nat. Mus., 5712.

FERNS: SPHENOPTERIS.

PLATE XII.

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PLATE XII.

SPHENOPTERIS MIXTA Schimp.

(Page 35.)

FIG. 1. Fragment of secondary pinna showing form with compact pinnules and slender rachis. The apex of one of the tertiary pinnæ of this species is seen on the far right, a small fragment of *Callipteridium Sullivantii* (Lx.) Weiss lying between. U. S. Nat. Mus., 5714.

1*a*. Detail of pinnule of the same specimen, showing characteristic slightly crenulate margin. ×2.

2. Portion of a primary (?) pinna of the species. The specimen, though somewhat dim, is interesting as showing the delicacy of the slender graceful pinnæ and the smaller ordinary pinnules. U. S. Nat. Mus., 5687.

SPHENOPTERIS LACOEI D. W.

(Page 38.)

FIG. 3. Pinnæ showing small ultimate pinnæ or lobes. Original described in Bull. U. S. Geol. Survey, No. 98, p. 56. U. S. Nat. Mus., 5802.

3*a*. Enlarged detail showing broadly rounded pinnules or lobes. ×2.

FERNS; SPHENOPTERIS.

PLATE XIII.

PLATE XIII.

SPHENOPTERIS BROADHEADI D. W.

(Page 41.)

FIG. 1. Fragment from near the apex of a fertile pinna. U. S. Nat. Mus., 5620.

1*a*. Enlarged detail of portion of the same to show the fruit dots (sori) on the ends of the lobes; the sori, which are not well represented, appear to be referable to *Hymenotheca*. ×2.

2. Larger segment lower in the frond of the same species; also fertile. U. S. Nat. Mus., 5619.

2*a*. One of the lateral pinnæ enlarged to show the lobation and the position of the fruit. ×2.

SPHENOPTERIS VAN INGENI D. W.

(Page 47.)

FIG. 3. Penultimate and ultimate pinnæ. The very delicate, membranaceous quality of the lamina is imperfectly indicated. Fragments of *Aloiopteris Winslovii* D. W. are seen at the top. U. S. Nat. Mus., 5616.

3*a*. Enlarged detail from the former. ×2.

SPHENOPTERIS MIXTA Schimp.

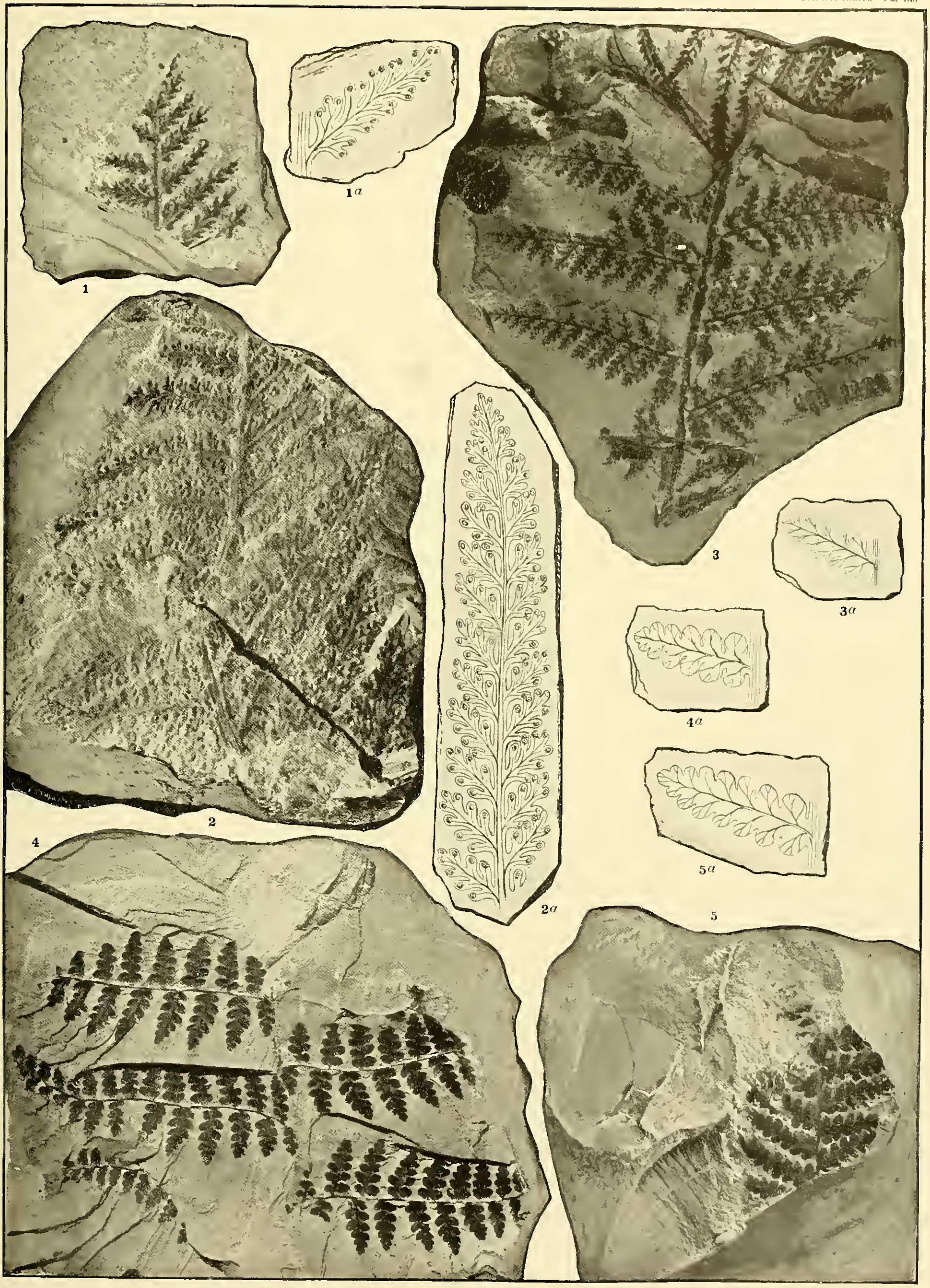
(Page 35.)

FIG. 4. Portions of several graceful, curving, secondary (?) pinnæ. U. S. Nat. Mus., 5713.

4*a*. Enlarged detail from same showing slightly crenulate lobes or pinnules. ×2.

5. Fragment of lateral pinnæ with pinnules or lobes connate to an unusual degree. U. S. Nat. Mus., 5692.

5*a*. Enlarged detail from the same specimens. ×2.



FERNS: SPHENOPTERIS.

PLATE XIV.

PLATE XIV.

SPHENOPTERIS MISSOURIENSIS D. W.

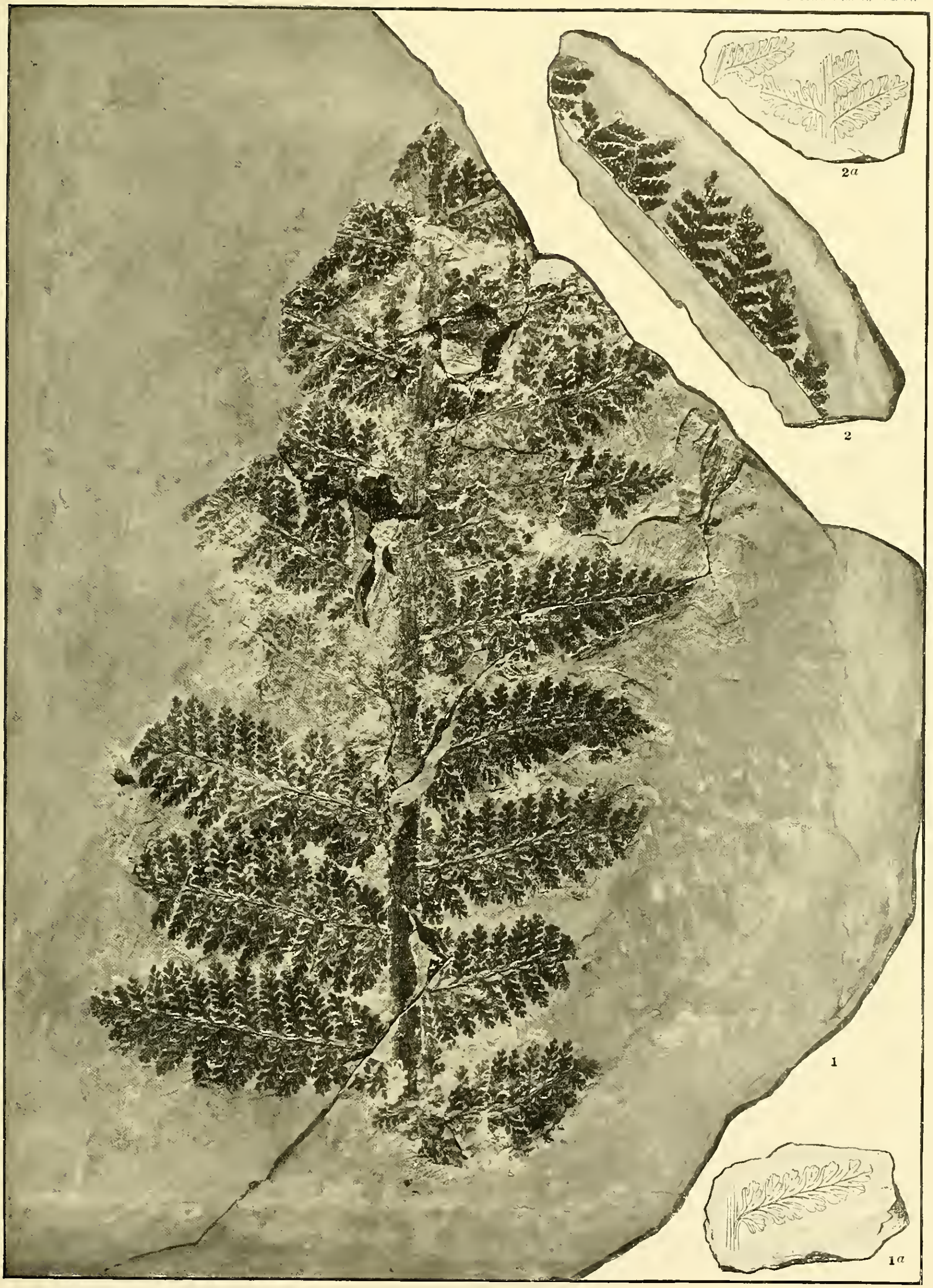
(Page 43.)

FIG. 1. Segment showing lateral pinnæ in lower part of a primary (?) pinna. The broad rachis indicates a large pinna of considerable length. U. S. Nat. Mus., 5663.

1*a*. Enlarged detail of ultimate pinna of the same, to illustrate obtuse and imperfect lobation. ×2.

2. Apical portions of lateral pinnæ of the same species. U. S. Nat. Mus., 5664.

2*a*. Enlarged detail of pinnules from the same. ×2.



FERNS: SPHENOPTERIS.

PLATE XV.

PLATE XV.

SPHENOPTERIS BRITTSII Lx.

(Page 53.)

FIG. 1. Fragment showing the long, slender, secondary (?) pinnæ, in which the teeth of the pinnules are less buried in the matrix than usual. U. S. Nat. Mus., 5626.

1*a*. Enlarged pinnule from upper part of the same segment, showing punctations caused by minute glands or the bases of hairs. ×2.

1*b*. Similar detail from the lower pinna in the same specimen. ×2.

SPHENOPTERIS CANNELTONENSIS D. W.

(Page 55.)

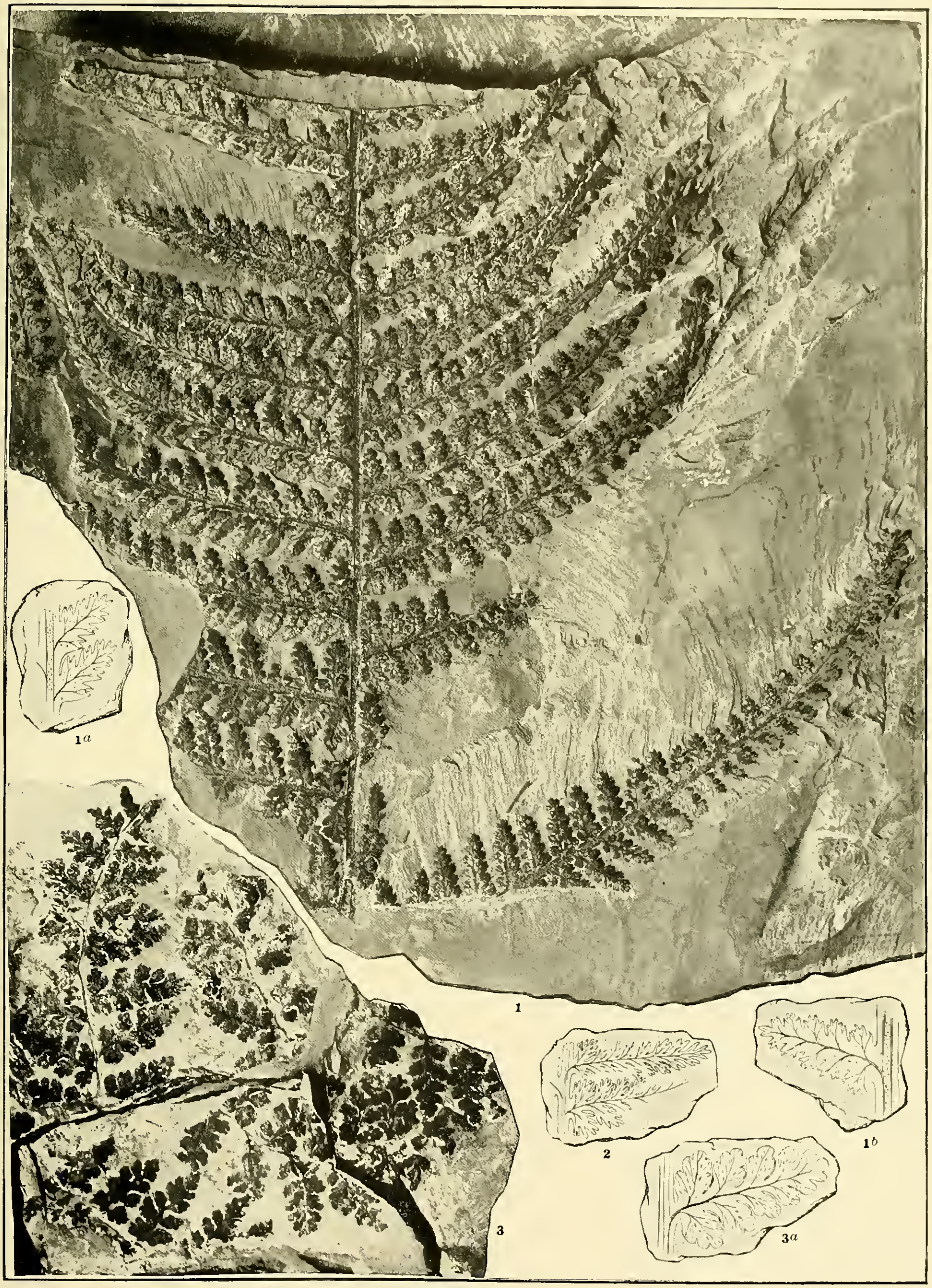
FIG. 2. Fragment showing the form of the pinnules and lobes, drawn natural size. U. S. Nat. Mus., 5567.

SPHENOPTERIS CAPITATA D. W.

(Page 57.)

FIG. 3. Section showing the rather lax aspect of the pinnæ and pinnules. U. S. Nat. Mus., 5662.

3*a*. Enlarged detail of ultimate pinna showing very obtuse erect lobation of broad pinnules marked by appressed short hairs, which are really much more numerous than the drawing indicates. ×2.



FERNS: SPHENOPTERIS.

PLATE XVI.

PLATE XVI.

CORDAITES COMMUNIS Lx.

with

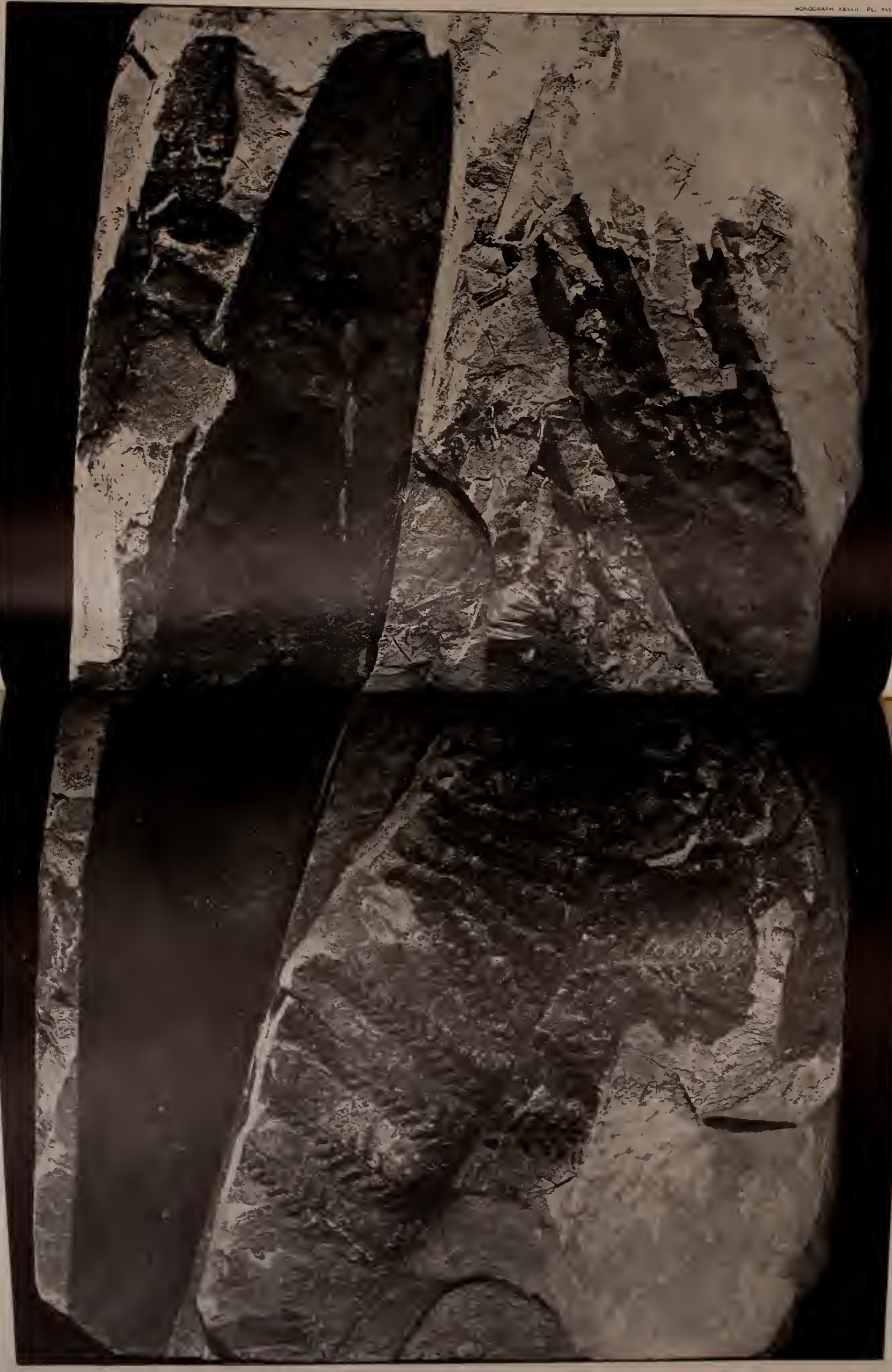
SPHENOPTERIS BRITTSII Lx.

(Pages 53 and 260.)

The large leaf of the *Cordaites*, on the left, is slightly above the average in size; the base is wanting. A basal fragment is shown in Pl. XLVI, while another small medial portion is seen in Pl. XXVII. U. S. Nat. Mus., 5702.

The specimen of *Sphenopteris Brittsii*, on the right, represents the ordinary aspect of the fragments of that fern, though the photograph is obscure. U. S. Nat. Mus., 5706.

FERN: SPHENOPTERIS.
GYMNOSPERM: CORDAITES.



FERN SPHENOPTERIS
GYMNOSPERM CORDAITES

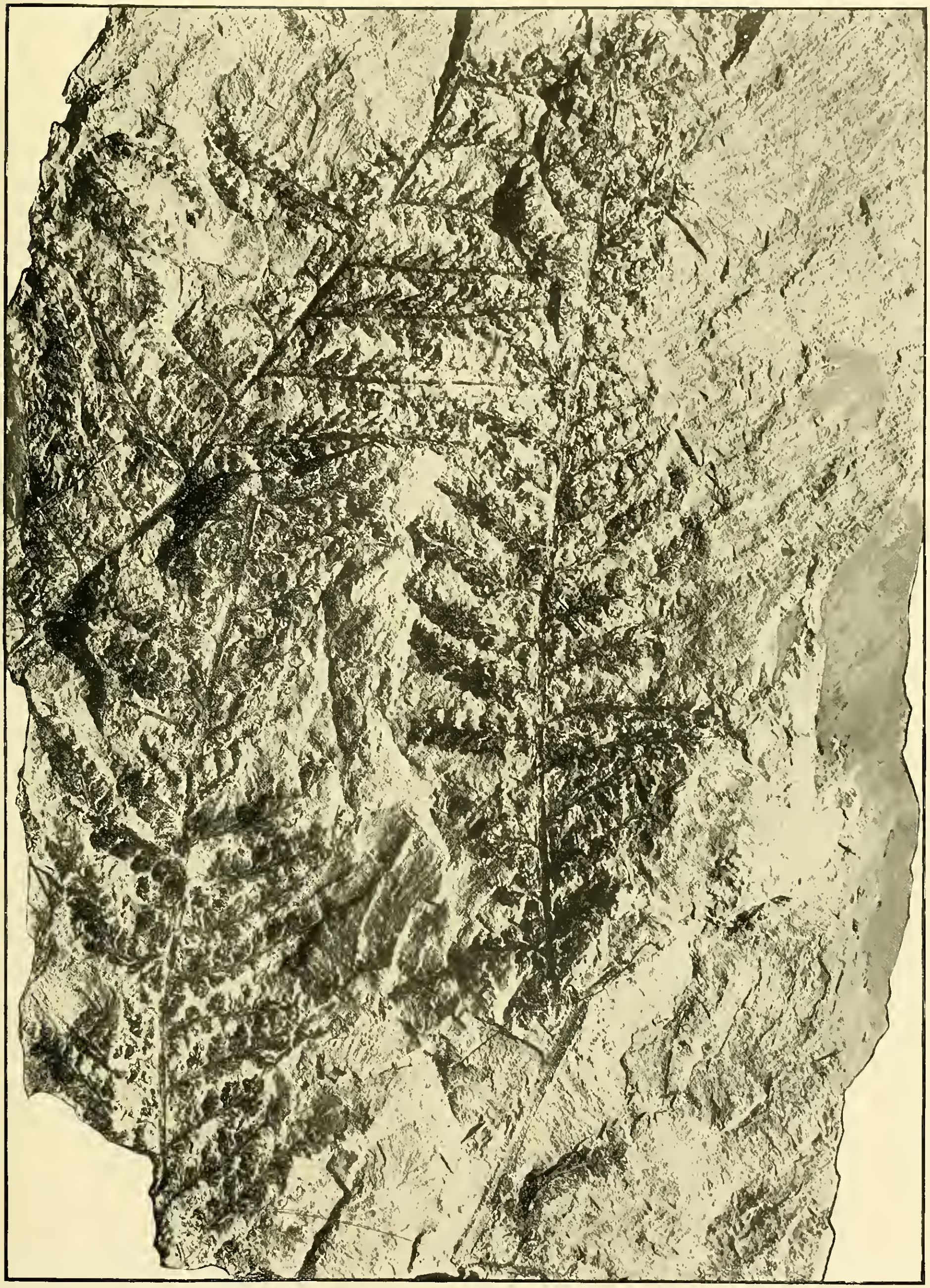
PLATE XVII.

PLATE XVII.

SPHENOPTERIS BRITTSII LX.

(Page 53.)

The photograph shows the ordinary aspect of portions of the fronds of this species, in which the margins are usually curved backward, burying the teeth more or less completely in the matrix. U. S. Nat. Mus., 5668.



FERNS: SPHENOPTERIS.

PLATE XVIII.

PLATE XVIII.

Sphenopteris Brittsii Lx.

(Page 53.)

Fig. 1. Fragment with spread pinnules. U. S. Nat. Mus., 5705.

2. Upper portion of young pinna on which the pinnules are the smallest found. This form is perhaps identical with that listed from the same beds by Professor Lesquereux as *Sphenopteris Gravenhorstii* Brongn. U. S. Nat. Mus., 6669.

2*a*. Enlarged detail of small pinna of same. ×2.

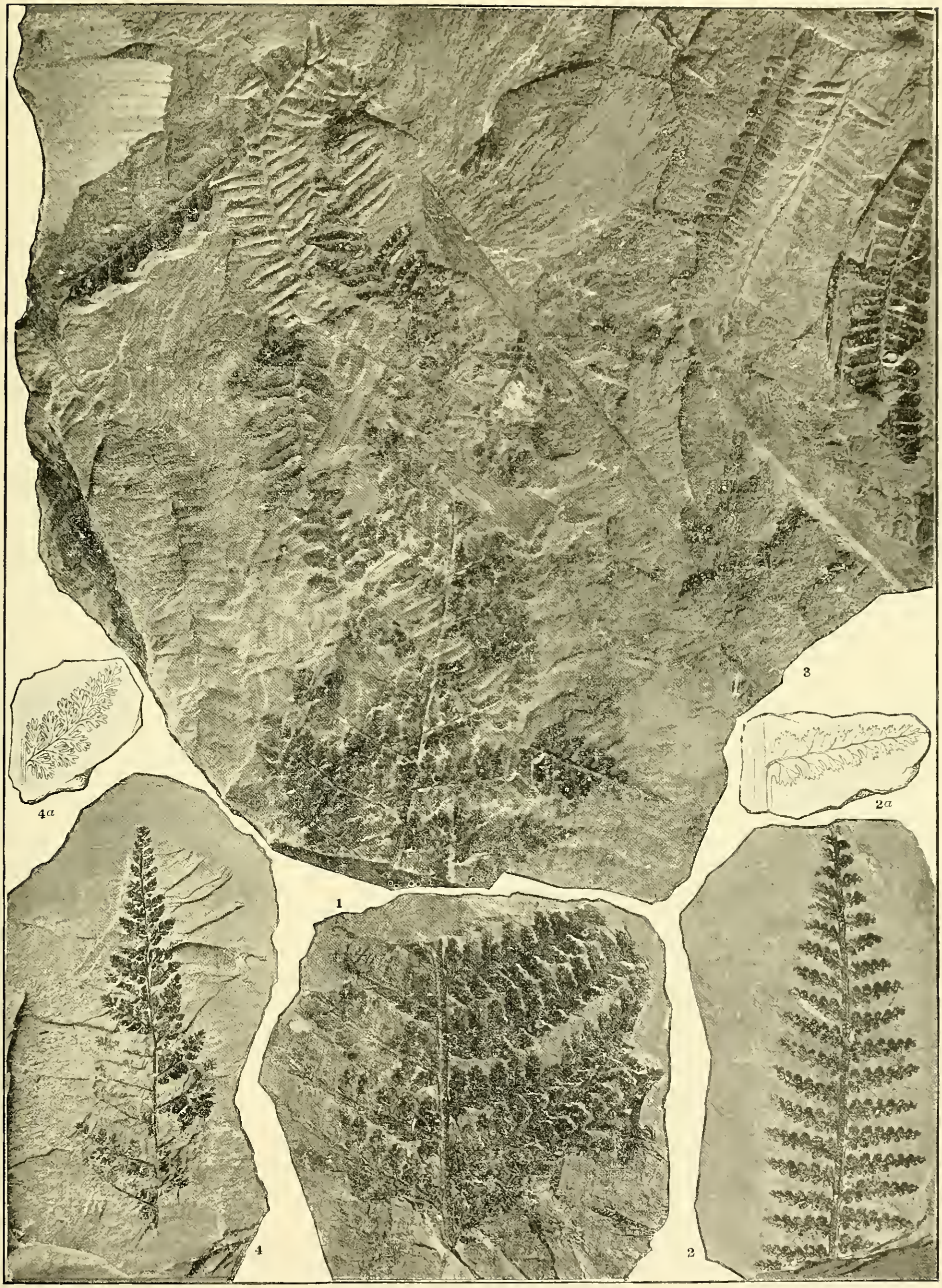
Sphenopteris pinnatifida Lx. sp.

(Page 45.)

Fig. 3. A fragment with large pinnules of this species occupies the central and lower portions of the rock. Small fragments of *Callipteridium membranaceum* Lx. occur on the left center, while pinnæ of *Pecopteris vestita* Lx. lie near the lateral borders. U. S. Nat. Mus., 5807.

4. Apical portion of pinna of *Sphenopteris pinnatifida* with smaller pinnules. U. S. Nat. Mus., 5803.

4*a*. Enlarged detail from the same, showing lobation of the pinnules. ×2.



FERNS: SPHENOPTERIS.

PLATE XIX.

PLATE XIX.

SPHENOPTERIS PINNATIFIDA Lx. sp

(Page 45.)

FIG. 1. Photograph of the original specimen, a portion of which was illustrated in fig. 9, pl. lv, of the Coal Flora as *Sphenopteris tridactylites*. The greater portion of the rock, to the left, is covered by a fertile segment; a sterile fragment is on the right. Lacoe collection, U. S. Nat. Mus., 4304.

1a. Enlarged detail from the sterile pinnæ on the right in the same specimen. ×4.

1b. Similar enlargement of reduced fertile pinnule to show sporangia. ×4.

SPHENOPTERIS cf. GRAVENHORSTII Brongn.

(Page 50.)

FIG. 2. Fragment of doubtful specific identity. U. S. Nat. Mus., 5720.

2a. Enlarged detail of pinna to show margins and nervation of pinuules. ×2.

SPHENOPTERIS BRITTSII Lx.

(Page 53.)

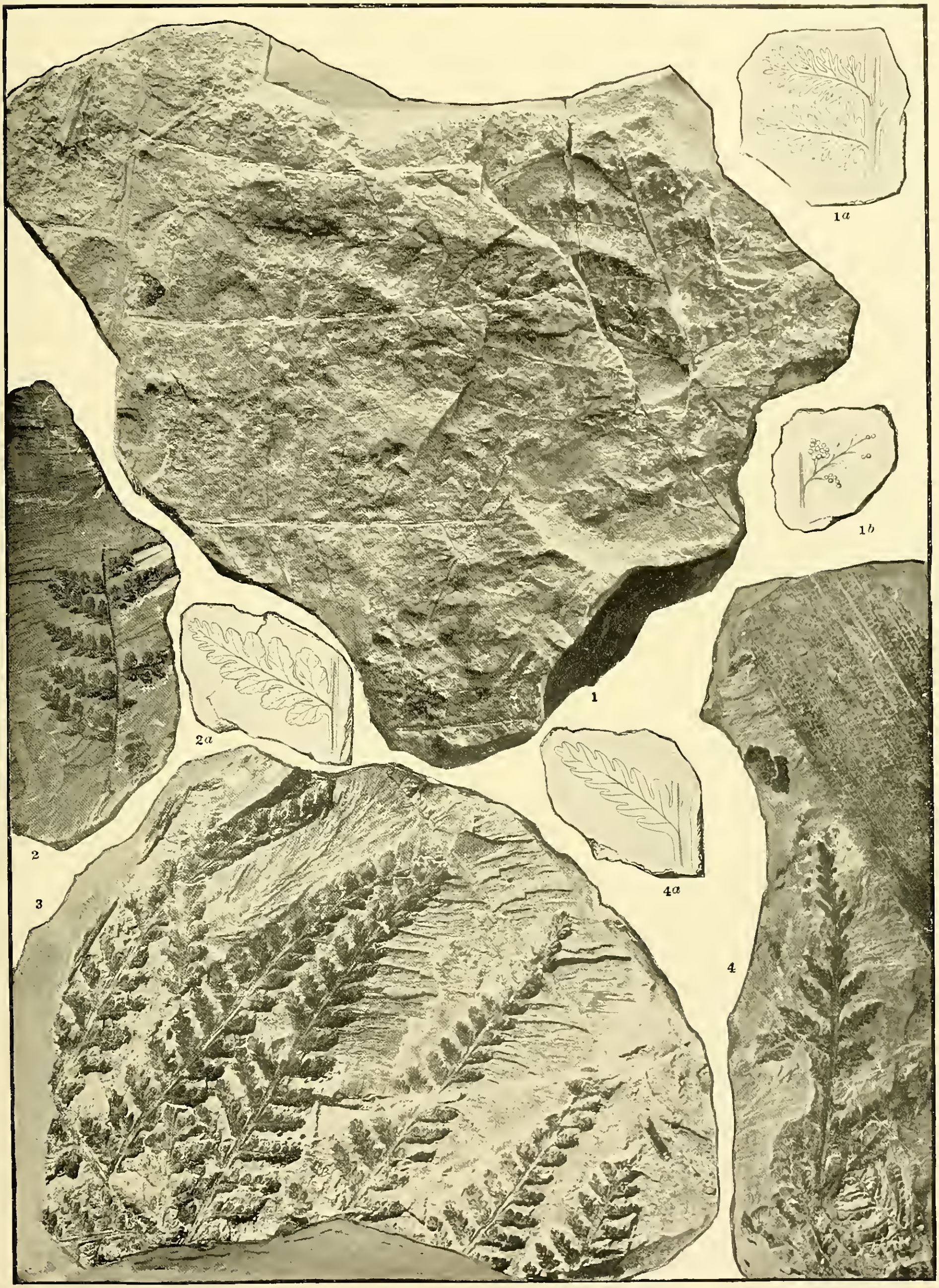
FIG. 3. Pinnæ showing rather strong, rugose, ventrally depressed rachises. U. S. Nat. Mus., 5703.

SPHENOPTERIS ILLINOISENSIS D. W.

(Page 58.)

FIG. 4. Terminal portion of piuna. U. S. Nat. Mus., 5697.

4a. Enlarged detail of pinnule of the same showing simple, very oblique lobation. ×2.



FERNS: SPHENOPTERIS.

PLATE XX.

PLATE XX.

OLIGOCARPIA MISSOURIENSIS D. W.

(Page 66.)

FIG. 1. Portion of primary pinna showing slender flexuose rachis and graceful lateral pinnæ. The pinnæ in the upper portion are fertile, the sori being expressed as small rounded elevations on the ventral surface of the pinnules. U. S. Nat. Mus., 5694.

1*a*. Enlarged detail showing sterile pinnules on same slab. ×2.

2. Small sterile pinnæ. U. S. Nat. Mus., 5619.

SPHENOPTERIS (CROSSOTHECA) OPHIOGLOSSOIDES LX. sp.

(Page 60.)

FIG. 3. Portions of secondary sterile pinnæ. U. S. Nat. Mus., 5698.

3*a*. Enlarged detail to show outline and nervation of pinnules. ×2.

3*b*. Pinnule of No. 5698 still further enlarged to show the nervation. The convex margin and slightly depressed nervation are imperfectly indicated in Fig. 3. ×6.

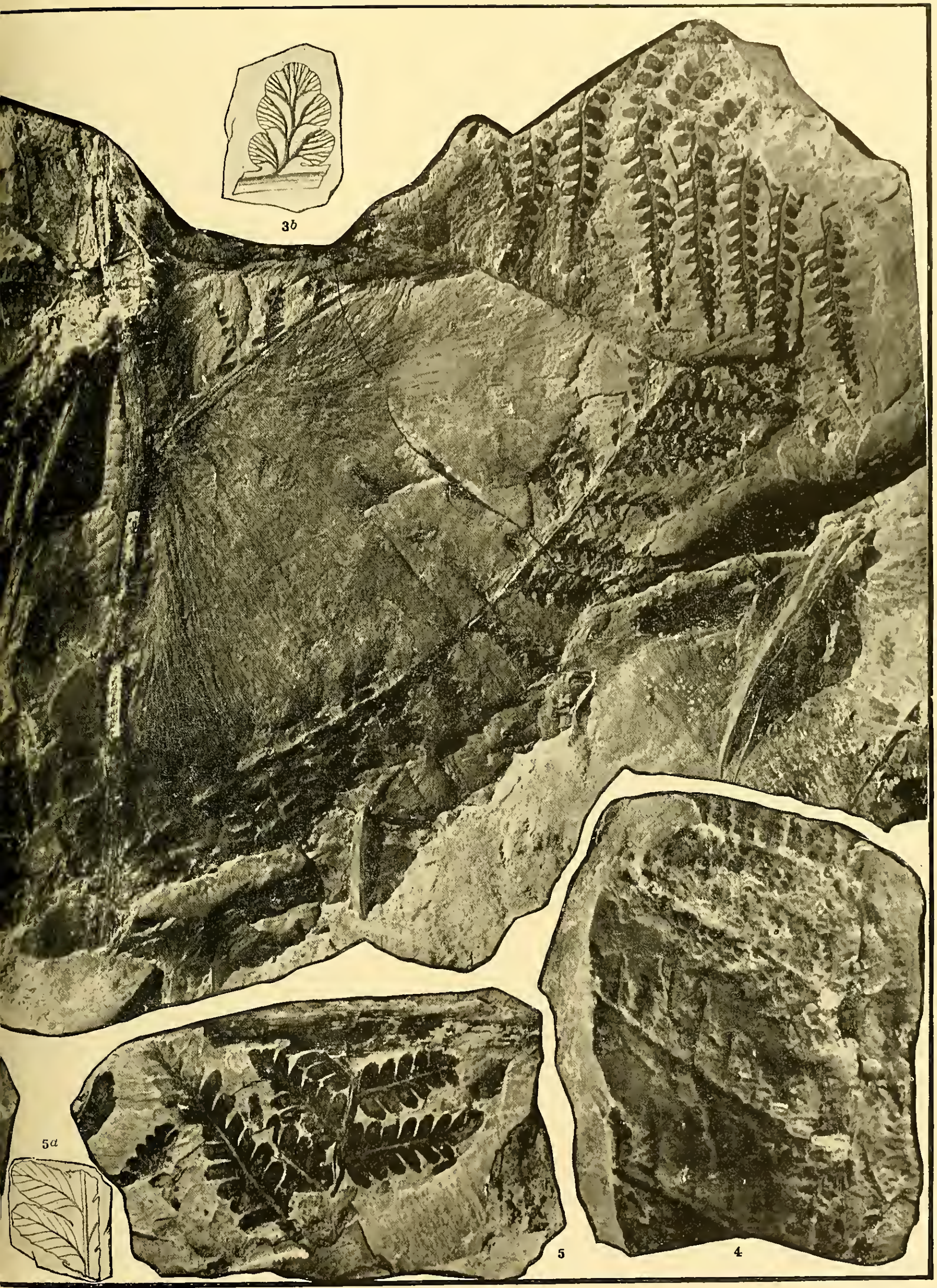
4. Portion of the same frond as that seen in the left of Fig. 3. U. S. Nat. Mus., 5698.

SPHENOPTERIS SUBCRENULATA LX. sp.

(Page 64.)

FIG. 5. Pinnæ showing pinnules of ordinary type. Collection of Dr. J. H. Britts, Clinton, Missouri.

FERNS: OLI



HENOPTERIS.

FERNS O[illegible] [illegible]HENOPTERIS.

PLATE XXI.

PLATE XXI.

OLIGOCARPIA MISSOURIENSIS D. W.

(Page 66.)

FIG. 1. Fragment with slender fertile lateral pinnæ supposed to be referable to this species. The sori are impressed in the lamina and show on the upper surface of the pinnules as minute, dome-shaped elevations. Lacoe collection, U. S. Nat. Mus., 4467.

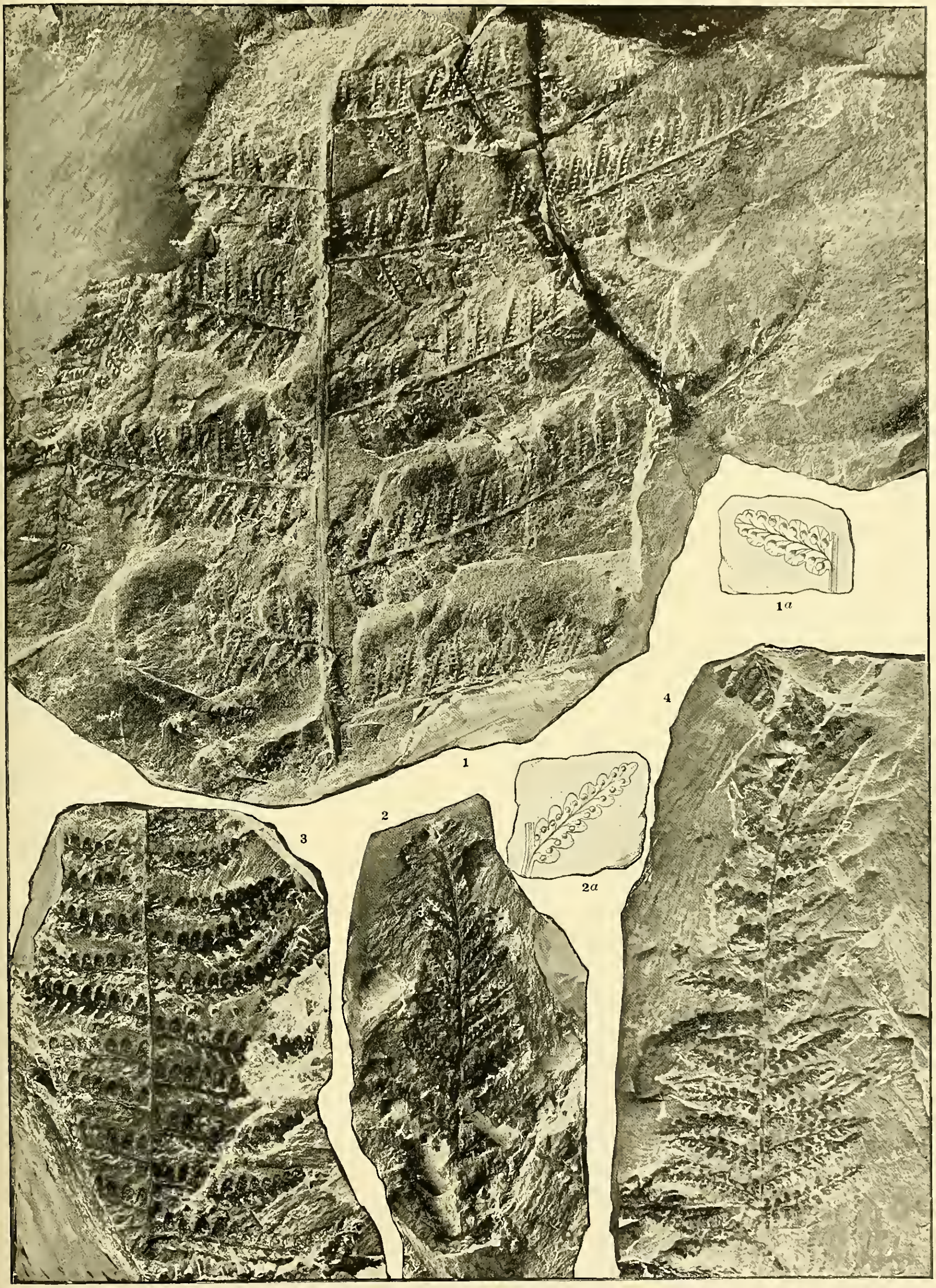
1*a*. Enlarged detail of pinnule of the same. ×2.

2. Terminal portion of pinna of same character as that shown in Fig. 1. Lacoe collection, U. S. Nat. Mus., 4468.

2*a*. Enlarged small pinna from the same specimen. ×2.

3. Fragment of secondary pinna of *O. missouriensis*, representing the form shown in Pl. XX, Figs. 1, 2. U. S. Nat. Mus., 5695.

4. Another specimen similar to that in Fig. 3, but smaller, the sori showing as dark spots on the pinnules. U. S. Nat. Mus., 5696.



FERNS: OLIGOCARPIA.

PLATE XXII.

PLATE XXII.

ALOIOPTERIS WINSLOVII D. W.

(Page 72.)

FIG. 1. Portions of three of the very long secondary pinnæ bearing ultimate pinnæ of the normal form and size. U. S. Nat. Mus., 5609.

2. Sterile pinnæ of same species on right. Fragments of several fertile pinnæ on the left. U. S. Nat. Mus., 5610.

3. Fragments showing very largè pinnules of the same species. U. S. Nat. Mus., 5613.

FERNS: ALOIOPTERIS.

PLATE XXIII.

PLATE XXIII.

ALOIOPTERIS WINSLOVII D. W.

(Page 72.)

FIG. 1. Small ultimate pinnæ, in which the pinnules are but partially separated, the nerves forking once at a wide angle, more than halfway from the rachis to the margin. U. S. Nat. Mus., 5721.

1*a*. Enlarged detail of the same, showing dentition and nervation. ×2.

2. Macerated pinnæ, revealing skeletonized nervation of the same species. It will be noted that the nerves fork only above the middle. U. S. Nat. Mus., 5611.

3. Enlarged detail, showing pinnules and nervation of another specimen of the same species U. S. Nat. Mus., 5612. ×2.

4. Fragments of fertile pinnæ of *A. Winslovii*. U. S. Nat. Mus., 5690.

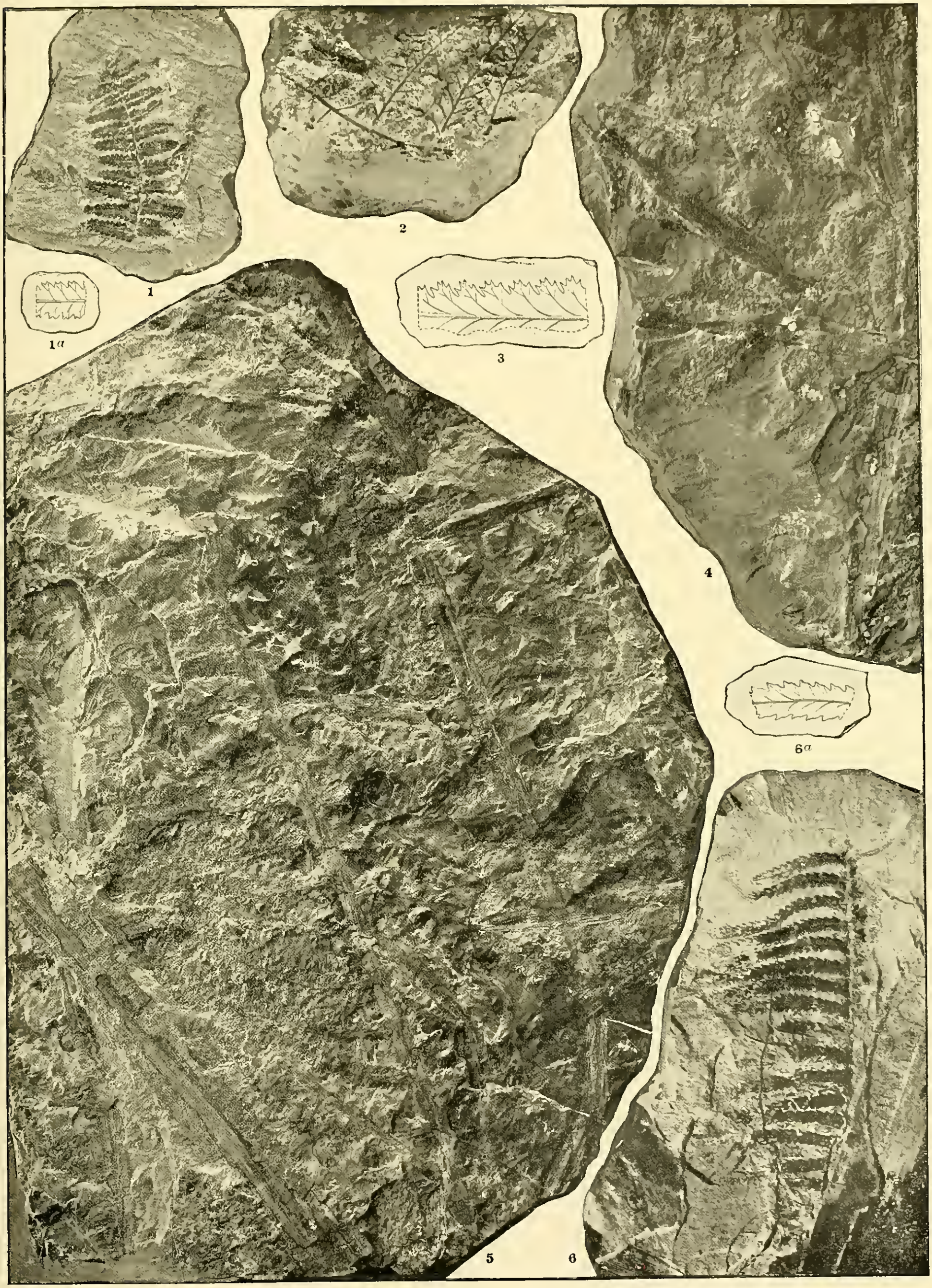
5. Portions of fertile secondary (?) pinnæ of the same species. The reduced fertile pinnules are obscure, the margin obliterated by the projecting elongated sporangia. A fragment of sterile pinna, with large pinnatifid pinnules is seen in the upper part. U. S. Nat. Mus., 5689.

ALOIOPTERIS EROSA Gutb. sp.?

(Page 70.)

FIG. 6. Ordinary pinnæ, below the average in size. U. S. Nat. Mus., 5614.

6*a*. Enlarged detail from same, showing character of margin, and nerves forking below the middle at a not very wide angle. ×2.



FERNS; ALOIOPTERIS.

PLATE XXIV.

PLATE XXIV.

PECOPTERIS DENTATA Brongn.

(Page 75.)

FIG. 1. Pinnæ with pinnules of ordinary form and size. U. S. Nat. Mus., 5643.
1*a*. Photographic enlargement of portion of the same. ×2.
1*b*. Similar enlargement of same, showing lamina convex between the nerves. The photograph is inverted in the plate. ×2.
2. Fertile pinnæ of the species, seen from the upper surface. U. S. Nat. Mus., 5739.

ALOIOPTERIS EROSA Gutb. sp.?

(Page 70.)

FIG. 3A. Portion of secondary pinna with large pinnules. The specimen was identified as *Pecopteris erosa* Gutb. by Professor Lesquereux. Lacoe collection, U. S. Nat. Mus., 2386.
3A*a*. Enlarged detail from the same fragment, showing dentition and nerves forking below the middle. ×2.

ANNULARIA STELLATA (Schloth.) Wood.

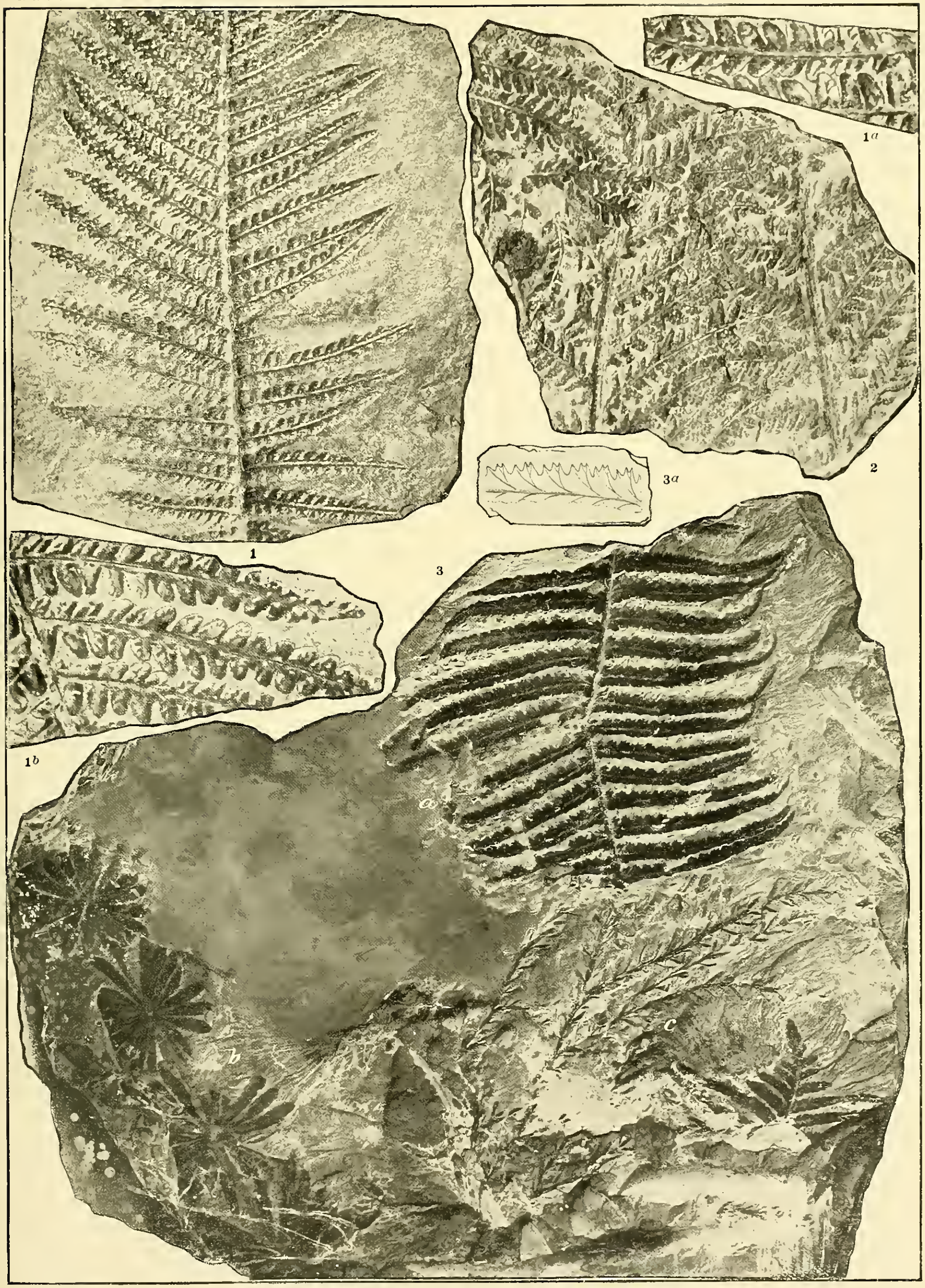
(Page 159.)

FIG. 3B. Verticils with rather short leaves, on the left of Fig. 3. Lacoe collection, U. S. Nat. Mus., 2386.

SPHENOPHYLLUM LESCURIANUM D. W.

(Page 182.)

FIG. 3C. Obscure specimen; shows frequent branching. Lacoe collection, U. S. Nat. Mus., 2386.



FERNS: PECOPTERIS AND ALOIOPTERIS.
EQUISETALES; ANNULARIA.
SPHENOPHYLLALES; SPHENOPHYLLUM.

PLATE XXV.

PLATE XXV.

PECOPTERIS DENTATA Brongn.

(Page 75.)

Parallel secondary (?) pinnæ, the upper portions of which are sterile. U. S. Nat. Mus., 5655.

FERN: PECOPTERIS.

PLATE XXVI.

PLATE XXVI.

PECOPTERIS VESTITA Lx.

(Page 91.)

FIG. 1. Pinna showing strong punctate rachis. U. S. Nat. Mus., 5808.

1a. Detail of portion of same enlarged to show villosity and nervation. ×2.

PECOPTERIS DENTATA Brongn.

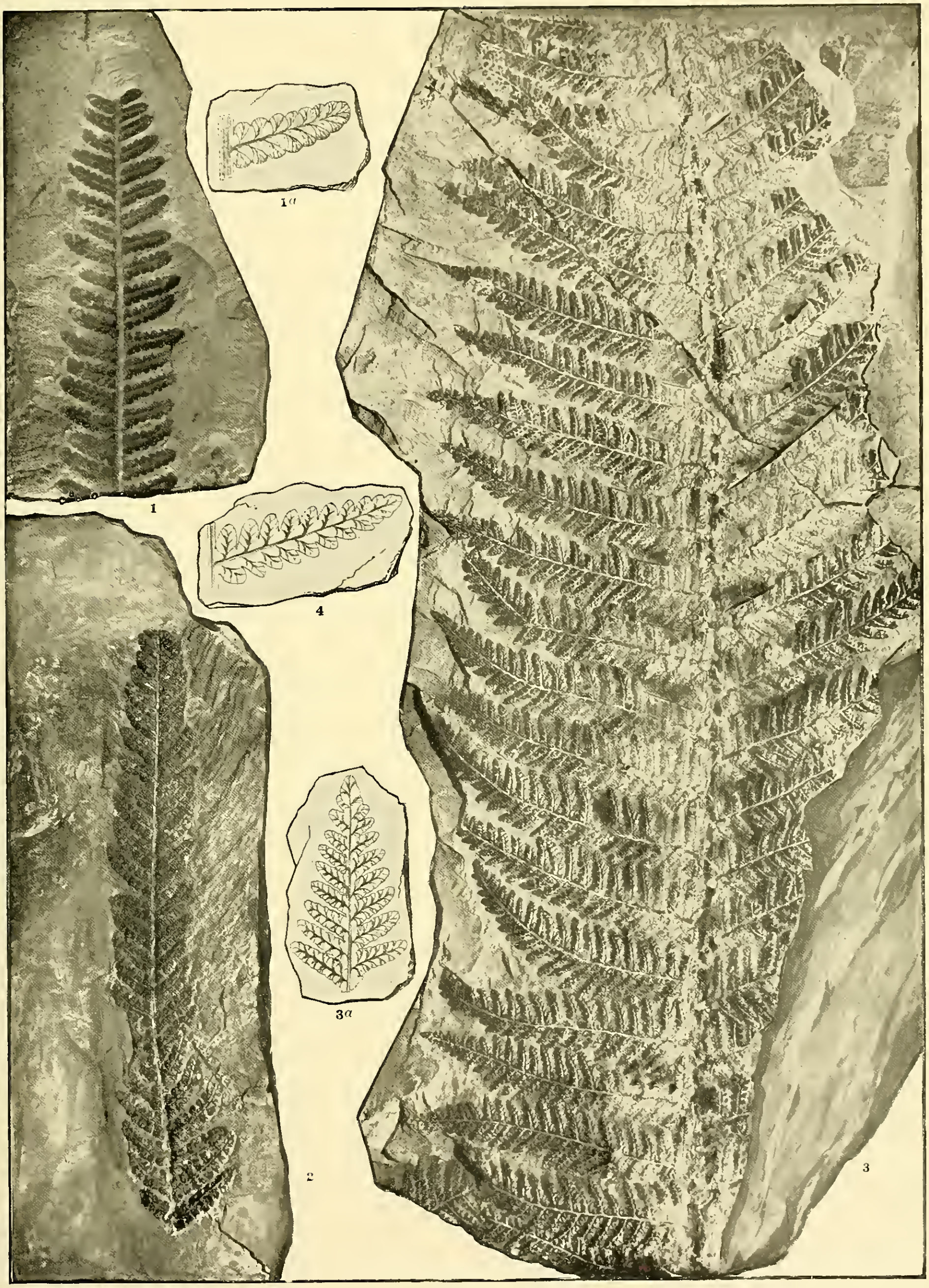
(Page 75.)

FIG. 2. Small pinnæ in which the lobes and young pinnules are unusually connate and obtuse. U. S. Nat. Mus., 5641.

3. Characteristic aspect of large pinnæ with young pinnæ and pinnatifid pinnules of this species. U. S. Nat. Mus., 5642.

3a. Enlarged detail of apex of one of the lateral pinnæ of the same specimen. The aspect of tho lamina and border are not well shown. ×2.

4. Enlarged detail of small pinna of U. S. Nat. Mus., 5621, shown in Pl. XXVII. ×2.



FERNS: PECOPTERIS.

PLATE XXVII.

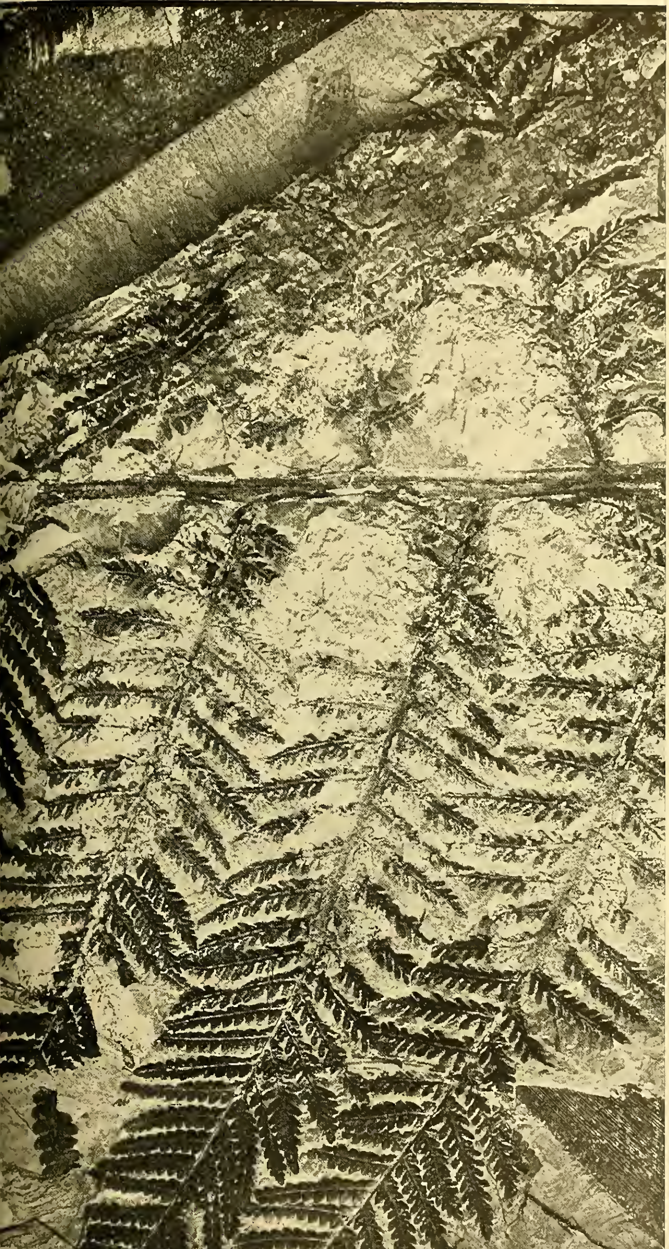
PLATE XXVII.

PECOPTERIS DENTATA Brongn.

(Page 75.)

Upper portion of a primary pinna, showing very large pinnules in the uppermost secondary pinnæ, and ordinary and typical pinnules in tertiary pinnæ a little above the middle of the specimen. The lower portion of the segment is fertile, the margins of the pinnules being rolled backward a little and buried in the matrix. U. S. Nat. Mus., 5621.

An enlarged detail of sterile pinnules of this specimen is given in Pl. XXVI, Fig. 4.



FERN PECOPTERIS.

PLATE XXVIII.

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PLATE XXVIII.

PECOPTERIS PSEUDOVESTITA D. W.

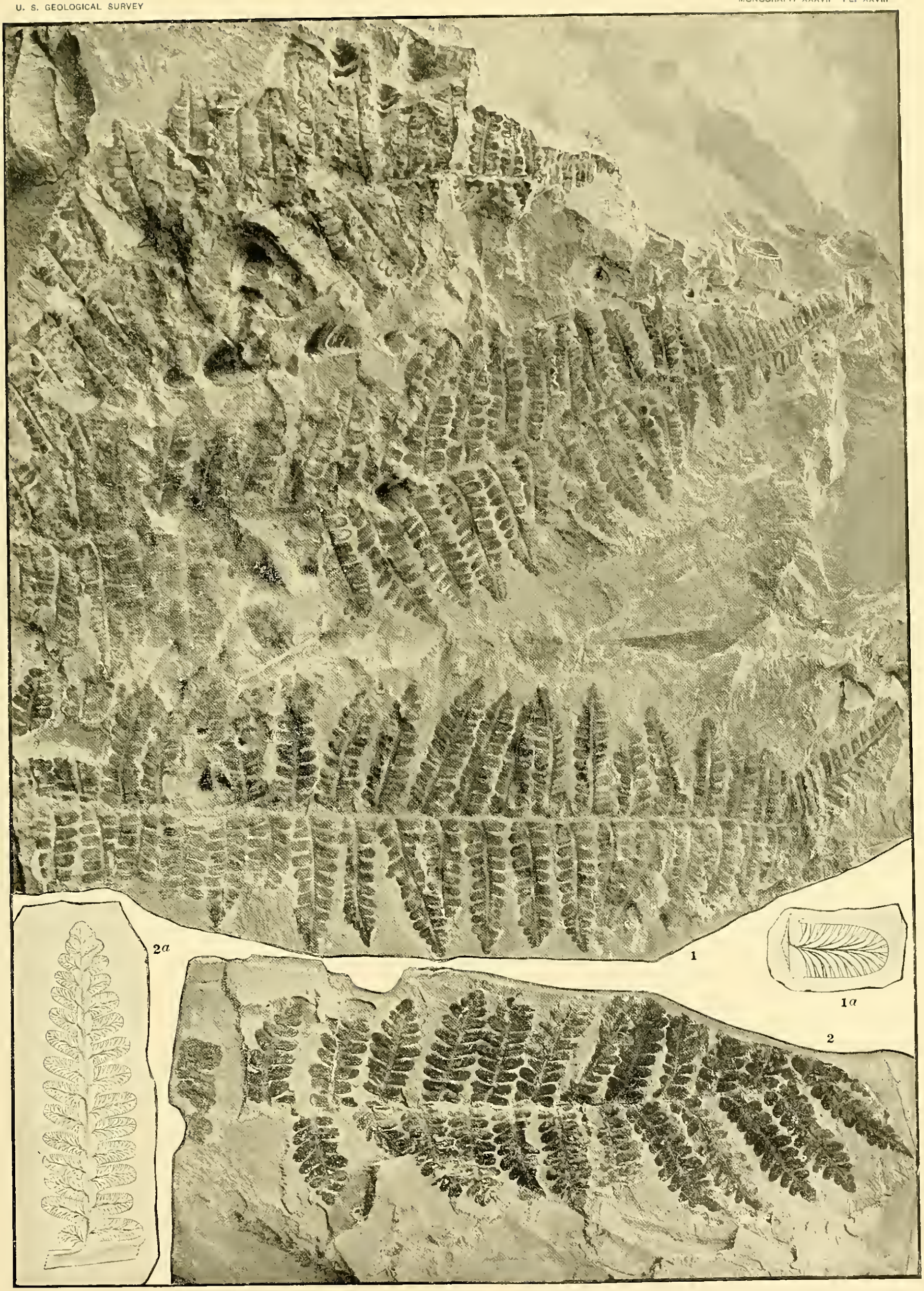
(Page 85.)

FIG. 1. Typical lateral, secondary (?) pinnæ, with characteristic slightly obtuse ultimate pinnæ of this species. This specimen, formerly a part of Professor Lesquereux's private collection, was named by him as *Pecopteris Clintoni* Lx. Lacoe collection, U. S. Nat. Mus., 3174.

1*a*. Enlarged detail of pinnule of the same. ×4.

2. Fragment with pinnæ similar to those in Fig. 1. This also was determined by Professor Lesquereux as *P. Clintoni*. Lacoe collection, U. S. Nat. Mus., 3179.

3. Enlarged detail of pinnæ of No. 5648, partly shown in Pl. XXIX. ×2.



FERNS: PECOPTERIS.

PLATE XXIX.

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PLATE XXIX.

PECOPTERIS PSEUDOVESTITA D. W.

(Page 85.)

Portion of a slab 36 cm. in height covered by parallel sections from the interior of large pinnæ. The large size of the rachises of the two segments shown in this plate indicate a great length, perhaps more than 5 meters for the large pinnæ, which evidently belonged to the same individual tree fern. It is not, however, certain whether these large fragments of rachis proceeded directly from the trunk or axis of the fern or whether, as their close parallelism suggests, they belong only to lateral pinnæ of giant fronds of the fern. A detailed enlargement of one of the ultimate pinnæ of this specimen is shown iu Pl. XXVIII, Fig. 3. U. S. Nat. Mus., 5648.

In the lower right-hand corner of the plate are seen several rather dim fragments of *Pecopteris clintoni* Lx.

FE

IS.

FERN PECOPTERIS

PLATE XXX.

PLATE XXX.

PECOPTERIS PSEUDOVESTITA D. W.

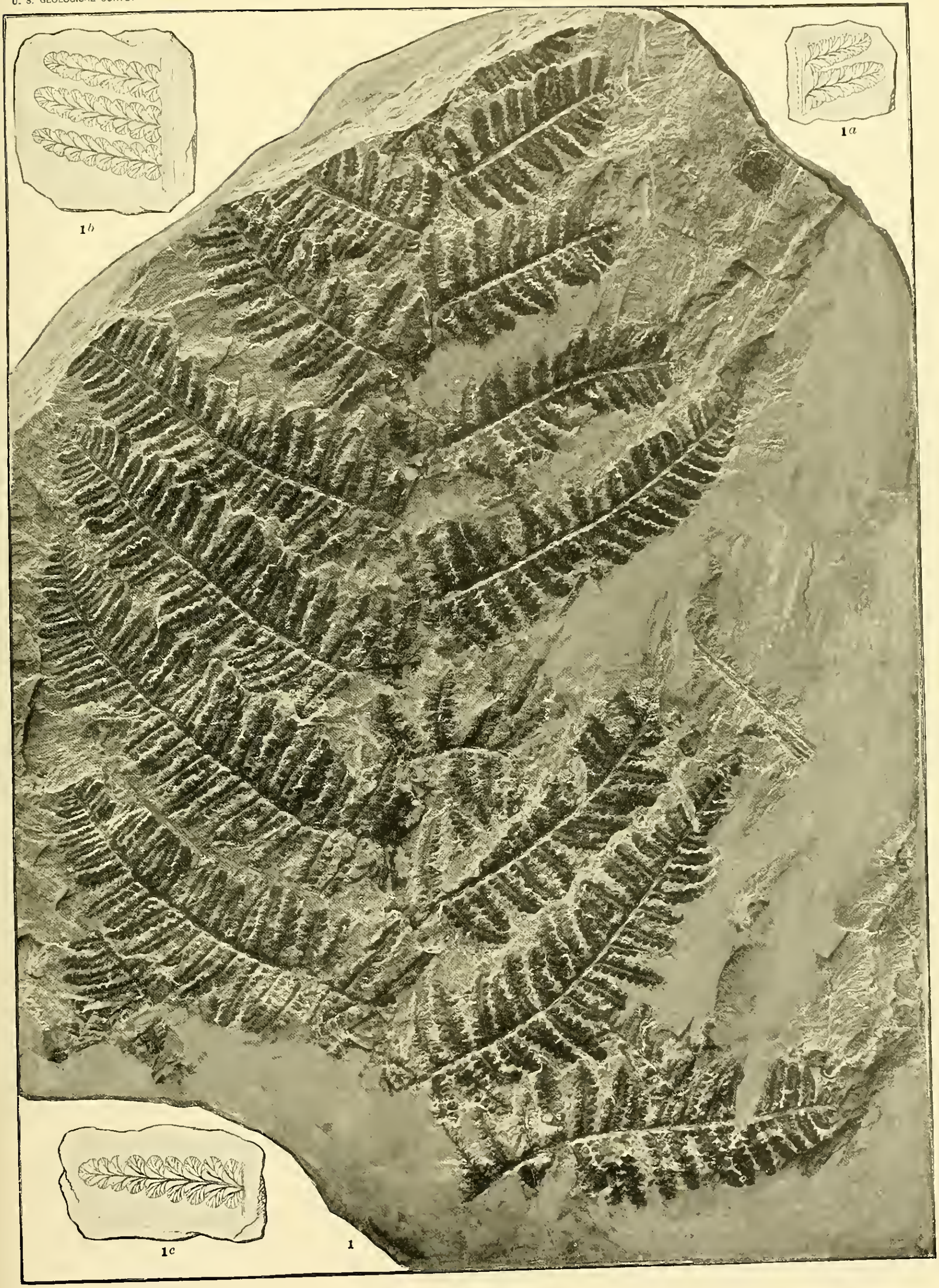
(Page 85.)

FIG. 1. Segment showing pinnatifid pinnules and young pinnæ of this species. Small *Aphlebiæ* are present at the bases of the second lateral pinna from below on the left, and of the fourth on the right. U. S. Nat. Mus., 5725.

1*a*. Enlarged detail of pinnatifid pinnules in upper portion of same. ×2.

1*b*. Detail of young pinna from left middle of Fig. 1. ×2.

1*c*. Enlarged detail of young pinna in lower right of the slab. The nervation is too close and too much divided in the upper lobes. ×2.



FERNS: PECOPTERIS.

PLATE XXXI.

PLATE XXXI.

PECOPTERIS PSEUDOVESTITA D. W.

(Page 85.)

FIG. 1. Portion of lateral pinna similar to those in Pl. XXIX. This specimen is one of the originals illustrated in pl. xxxi, fig. 2, of the Coal Flora as *Alethopteris ambigua* Lx. Lacoe collection, U. S. Nat. Mus., 3093.

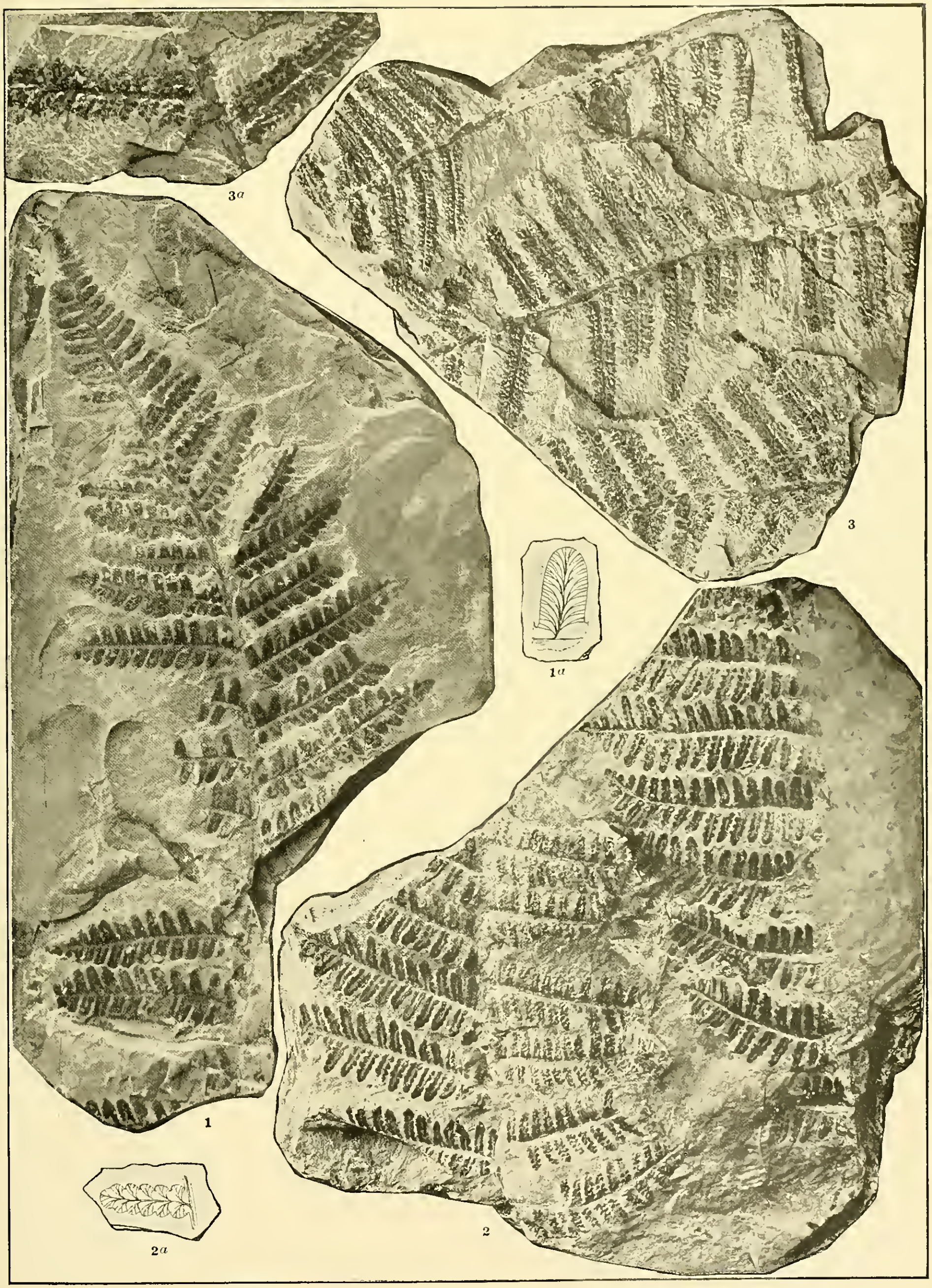
1*a*. Pinnule from same specimen enlarged. ×2.

2. Pinnæ of the same species, in which the sori are in the process of development on the under surface of the pinnules and the lamina is slightly reduced. This example also was labeled as *Alethopteris ambigua* by Professor Lesquereux. Lacoe collection, U. S. Nat. Mus., 3097.

2*a*. Enlarged detail of pinnules of the same. ×2.

3. Fertile pinnæ supposed to be referable to the same species. U. S. Nat. Mus., 5809.

3*a*. Photographic enlargement of a portion of the same species. The oblong sporangia of *Asterotheca* are dimly indicated. ×2.



FERNS: PECOPTERIS.

PLATE XXXII.

PLATE XXXII.

PECOPTERIS PSEUDOVESTITA D. W.

(Page 85.)

FIG. 1. Portion of secondary (?) pinna, showing robust yonng pinnæ of this species. U. S. Nat. Mus., 5644.

2. Fragment showing form of lateral pinnæ, and portion o' large rachis similar to those in Pl. XXIX. U. S. Nat. Mus., 5645.

FERNS: PECOPTERIS.

PLATE XXXIII.

PLATE XXXIII.

PECOPTERIS VESTITA Lx.

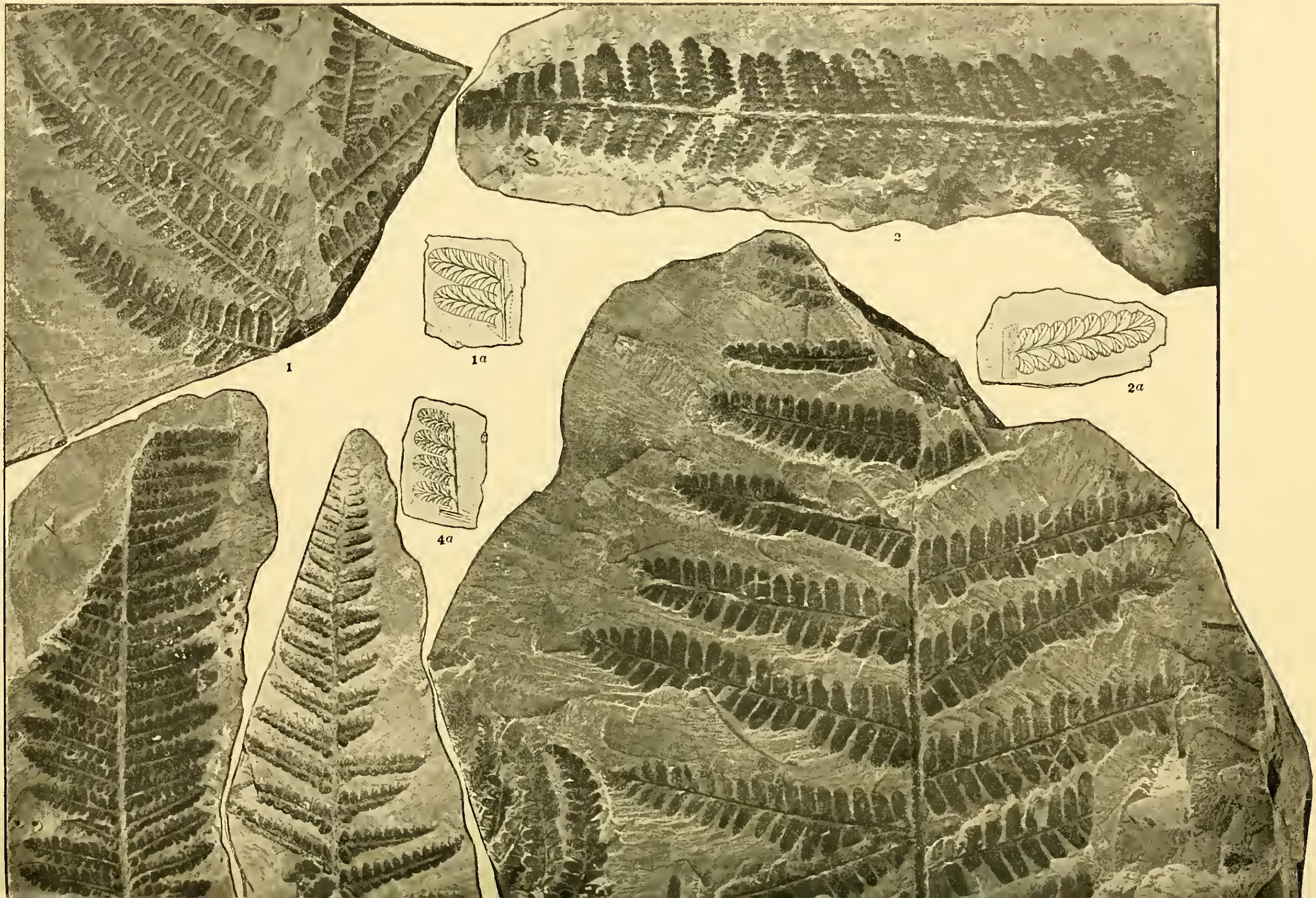
(Page 91.)

FIG. 1. Pinna of ordinary form, tapering gradually toward the apex. U. S. Nat. Mus., 5685.
1*a*. Pinnules of same enlarged. The villosity of the surface is not shown in this or Figs. 2*a* and 5*a*. ×2.
2. Common form of pinnatifid pinna of this species. U. S. Nat. Mus., 5647.
2*a*. Enlarged detail from the same to show nervation. The villosity of the pinnules is not represented. ×2.
3. Young pinnæ. U. S. Nat. Mus., 5683.
4. Apical portion of secondary (?) pinna. Characteristic slender tapering apex. U. S. Nat Mus., 5646.
4*a*. Pinnules of the same enlarged to show the villosity. ×2.
5. Portion of secondary (?) pinna, showing lateral pinnæ with pinnules a little larger than those figured in pl. xxxi of the Coal Flora. U. S. Nat. Mus., 5684.
5*a*. Detail of pinnules of 5684. The marginal crenulation is exaggerated. ×2.
6. Pinna of same species, showing tapering form. U. S. Nat. Mus., 5688.

PECOPTERIS cf. ARBORESCENS Brongn.?

(Page 78.)

FIG. 7. Specimen with mostly simple nerves, doubtfully referred to the above species. U. S. Nat. Mus., 5686.


1
1a
2
2a
4a

FERNS: PECOPTERIS.

FERNS: PECOPTERIS.

PLATE XXXIV.

PLATE XXXIV.

PECOPTERIS CLINTONI LX.

(Page 94.)

FIG. 1. Pinnæ of lax habit, showing irregularity in their large pinnules. U. S. Nat. Mus., 5606.
1a. Details of pinnules in upper left of the large segment. ×2.
1b. Detail of pinnule in middle right of same specimen. ×2.

FERNS: PECOPTERIS.

PLATE XXXV.

PLATE XXXV.

SPHENOPTERIS SUSPECTA D. W.

(Page 51.)

FIG. 1. Fragment with large, rather lax, pinnules. U. S. Nat. Mus., 5650.
2. Portions of secondary (?) pinnæ with more compact pinnules. U. S. Nat. Mus., 5652.
2*a*. Enlarged detail of pinnules in the lower part of the same specimen. ×2.
2*b*. Similar detail of pinnule higher in position. ×2.
3. Enlarged detail of small pinnules of another specimen, No. 5649, U. S. Nat. Mus., doubtfully referred to the same species. ×2.

PECOPTERIS CLINTONI Lx.

(Page 94.)

FIG. 4. Part of secondary (?) pinna showing lax habit of pinnules. U. S. Nat. Mus., 5605.
4*a*. Pinnule of the same enlarged, showing distant, thin nerves. ×2.

PECOPTERIS HEMITELIOIDES Brongn.?

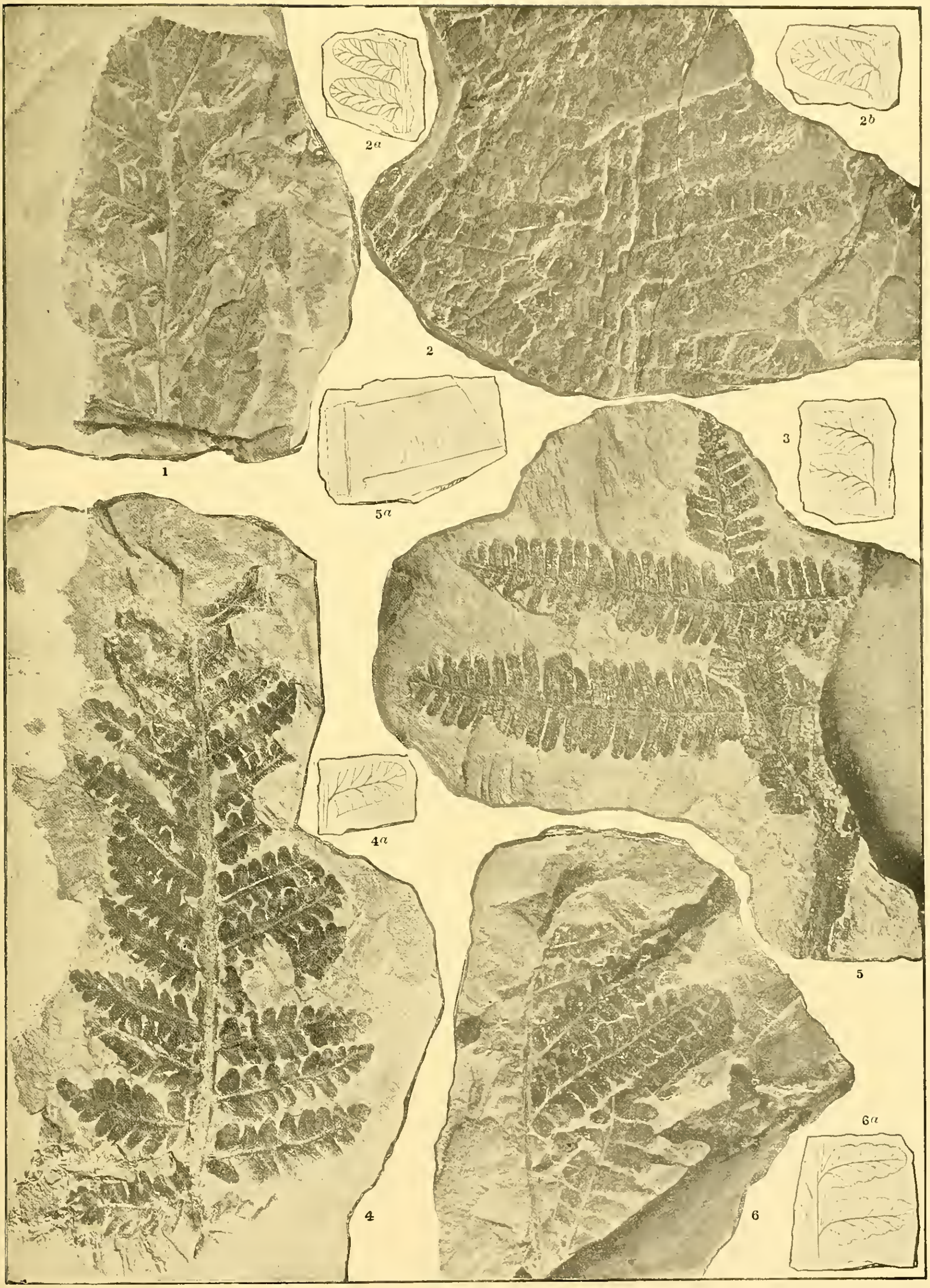
(Page 79.)

FIG. 5. Fertile pinnæ provisionally referred to this species. U. S. Nat. Mus., 5594.
5*a*. Enlarged detail of portion of one pinnule to show the two rows of sori of the type of *Asterotheca*, each consisting of four or five slender acute sporangia, inclined, in the compressed specimen, toward the midrib of the pinnule. ×4.

SPHENOPTERIS sp.

(Page 66.)

FIG. 6. Fragment showing lax pinnules, slightly stalked, with undulate margins. U. S. Nat. Mus., 5654.
6*a*. Enlarged detail of two pinnules in lower part of the same specimen. ×2.



FERNS: PECOPTERIS AND SPHENOPTERIS.

PLATE XXXVI.

381

PLATE XXXVI.

PECOPTERIS JENNEYI D. W.

(Page 80.)

FIG. 1. Portions of two lateral pinnæ from a part of which the organic residue has been removed. U. S. Nat. Mus., 5598.

1*a*. Single pinnule of the same (slightly enlarged).

1*b*. Photographic enlargement of pinna of same specimen, showing very coarse nervation. ×2.

2. Another example of the same species, in which the pinnules are proportionally longer. U. S. Nat. Mus., 5599.

PECOPTERIS cf. ARBORESCENS Brongn.?

(Page 78.)

FIG. 3. Pinnæ on the lower portion of which the sporangia are in the process of development. U. S. Nat. Mus., 5596.

FERNS: PECOPTERIS.

PLATE XXXVII.

PLATE XXXVII.

ALETHOPTERIS SERLII (Brongn.) Goepp. var. MISSOURIENSIS D. W.

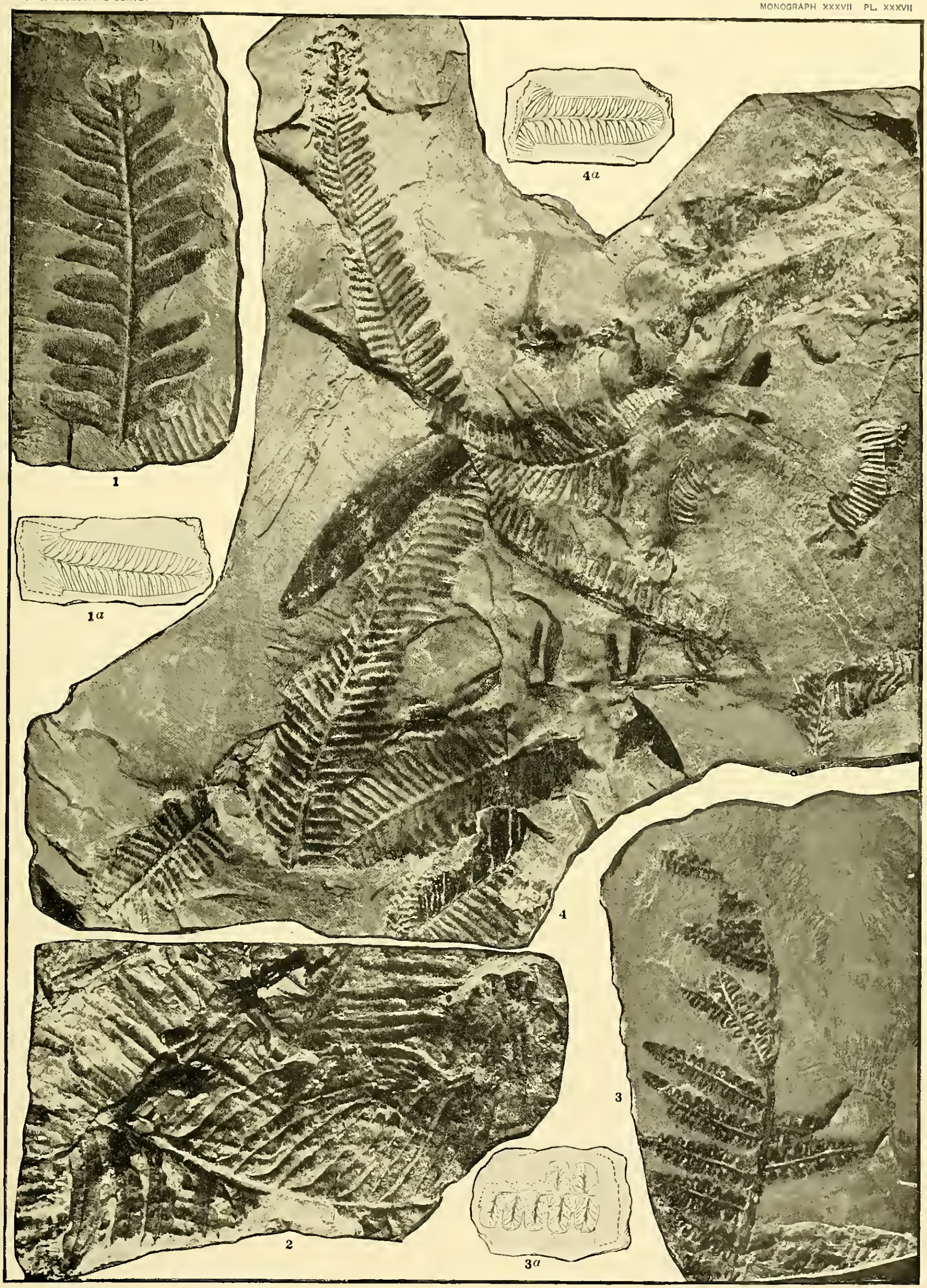
(Page 117.)

Fig. 1. Young pinna with small pinnules. U. S. Nat. Mus., 3594.
1*a*. Enlarged detail of pinnules of the same. ×2.
2. Pinna with fully developed pinnules. U. S. Nat. Mus., 3594*a*.

ALETHOPTERIS AMBIGUA Lx.

(Page 113.)

FIG. 3. Young pinnæ of this species. U. S. Nat. Mus., 5634.
3*a*. Detail showing young pinnules. ×2.
4. Pinnæ and pinnules showing the normal form and size. U. S. Nat. Mus., 3590. A pinnule of the *angustifolia* form of the *Neuropteris Scheuchzeri* Hoffm. is seen on the left.
4*a*. Enlarged detail of pinnule of *Alethopteris ambigua*. ×2.



FERNS: ALETHOPTERIS AND NEUROPTERIS.

PLATE XXXVIII.

PLATE XXXVIII.

CALLIPTERIDIUM MEMBRANACEUM Lx.

(Page 120.)

FIG. 1. Fragment from which the carbonaceous matter is largely removed. Its reference to this species is tentative. U. S. Nat. Mus., 5810.

1a. Enlarged detail of pinnule of same. ×2.

2. Slender pinna showing slightly variable pinnules. U. S. Nat. Mus., 5625.

3. Fragment with large pinnules separate to the rachis. U. S. Nat. Mus., 5691.

3a. Enlarged detail of pinnules of the same. ×2.

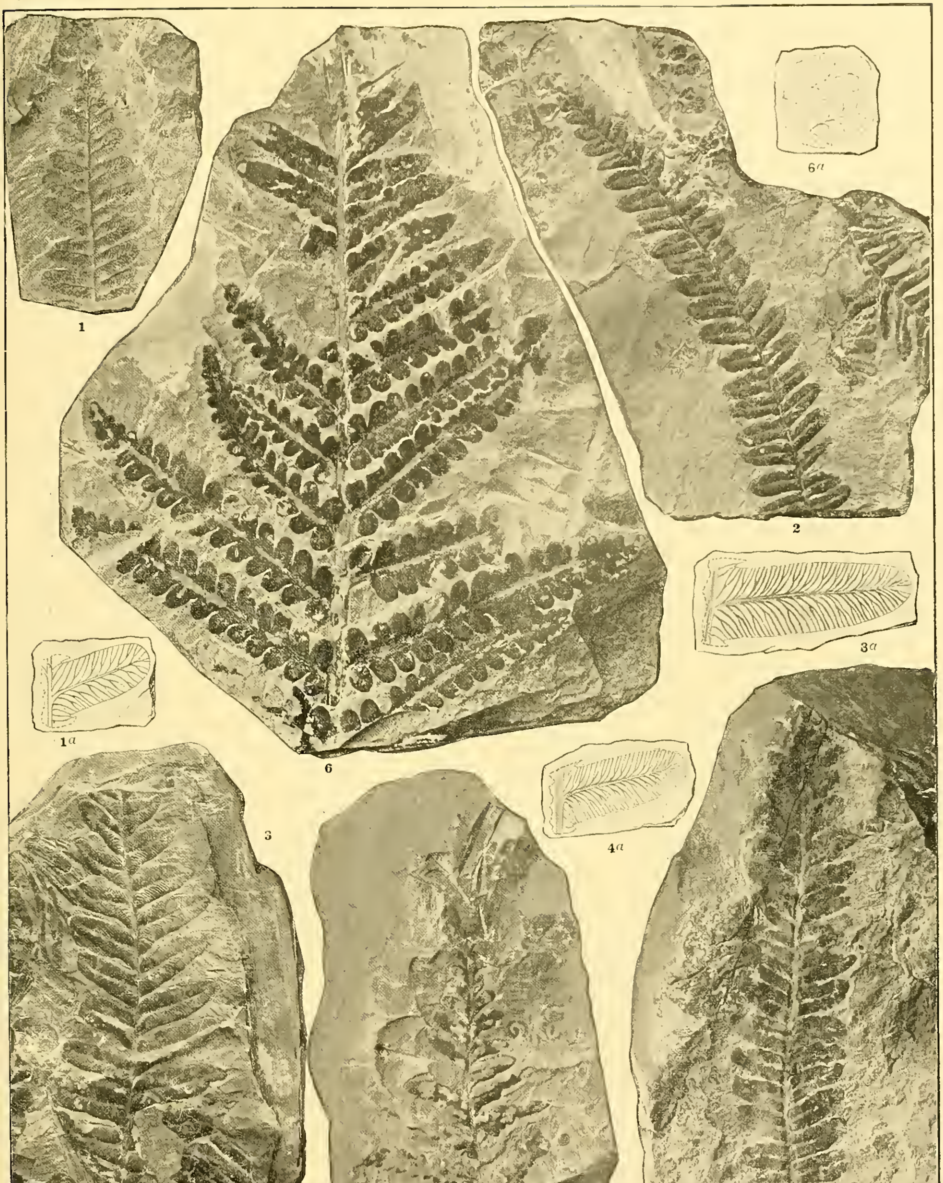
4. One of the types of the species. Original of fig. 5, pl. xxvii, p. 177, of the Coal Flora. Lacoe collection. U. S. Nat. Mus., 3182.

4a. Pinnule from the upper portion of the same enlarged to show the nervation. The marginal gutter, slightly exaggerated in the drawing, is also present in the other specimens. ×2.

5. Apical segment determined as this species by Professor Lesquereux. Lacoe collection. U. S. Nat. Mus., 3187.

6. Apical fragment with young pinnæ doubtfully referable to this species. It appears to represent a peculiar form with very broad rachises and thin midribs. The example photographed is the only one yet found. Collection of Dr. J. H. Britts, Clinton, Missouri.

6a. Enlarged pinnules from the same. ×2.



FERNS: CALLIPTERIDIUM.

PLATE XXXIX.

PLATE XXXIX.

CALLIPTERIDIUM SULLIVANTII (LX.) Weiss.

(Page 123.)

FIG. 1. Portion of secondary (?) pinna with robust lateral pinnæ, the lower pinnules of which are constricted in Neuropteroid form at the base. U. S. Nat. Mus., 5660.

1*a*. Detail showing one of the basally constricted lower pinnules. ×2.

2. Ordinary aspect of a pinna of the species. U. S. Nat. Mus., 3589.

2*a*. Enlarged detail of an average pinnule, from the same. ×2.

3. Apex of secondary (?) pinna. U. S. Nat. Mus., 5674.

CALLIPTERIDIUM INÆQUALE LX.

(Page 123.)

4. Fragment of pinna. U. S. Nat. Mus., 5603.

FERNS: CALLIPTERIDIUM.

PLATE XL.

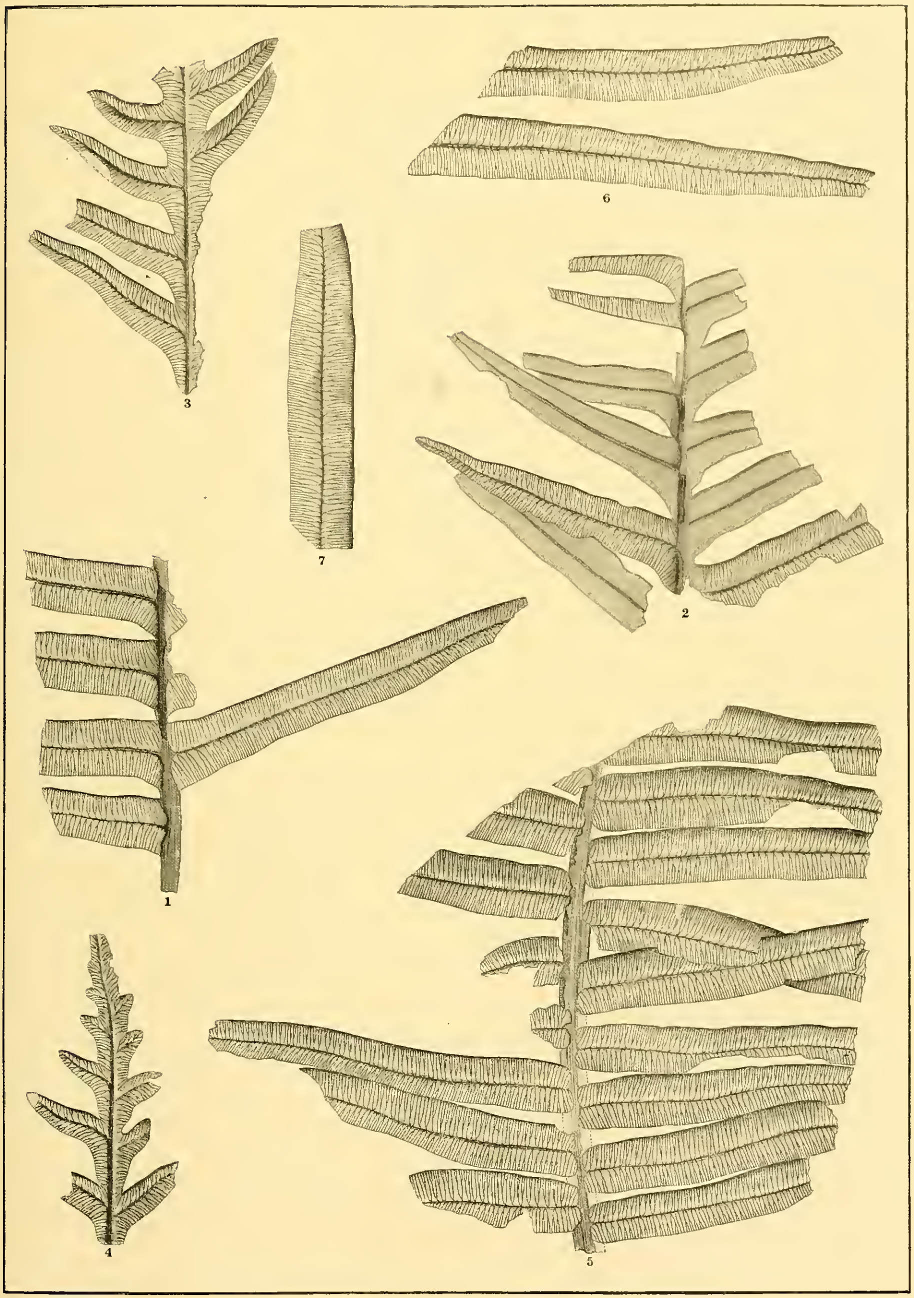
PLATE XL.

TÆNIOPTERIS? MISSOURIENSIS D. W.

(Page 140.)

FIG. 1. Fragment in which the pinnules are attached by the entire width of the base. U. S. Nat. Mus., 5557.

2. Upper portion of pinna with connate Alethopteroid pinnules. U. S. Nat. Mus., 5556.
3. Alethopteroid phase from still higher in the pinna. U. S. Nat. Mus., 5560.
4. Apex of the pinna, Alethopteroid, with strongly decurrent pinnules. U. S. Nat. Mus., 5558.
5. Fragment low in pinna, showing basally constricted pinnules attached to central zone of a broadly bordered rachis. U. S. Nat. Mus., 5557*a*.
6. Fragments of pinnules. U. S. Nat. Mus., 5556*a*.
7. Portion of a very large pinnule. Specimen in the collection of Dr. J. H. Britts, Clinton, Missouri.



FERNS: TÆNIOPTERIS?.

PLATE XLI.

PLATE XLI.

Callipteridium Sullivantii (Lx.) Weiss.

(Page 123.)

Fig. 1. Young pinnæ developing in Odontopteroid form, constricted at base. U. S. Nat. Mus., 5479.

2. Apex of compound pinna, showing Neuropteroid constriction of large pinnules, before passing into the pinnatifid stage. U. S. Nat. Mus., 5481.

3. Incomplete fragment, becoming sublobate. U. S. Nat. Mus., 5482.

Neuropteris missouriensis Lx.

(Page 130.)

Fig. 4. Pinnæ showing characteristic forms of lateral and terminal pinnules. U. S. Nat. Mus., 5631.

5. Example with smaller pinnules of the same species. U. S. Nat. Mus., 5472.

Neuropteris dilatata (L. and H.) Lx.

(Page 137.)

Fig. 6. Portion of No. 5672 (shown in Pl. XLII, Fig. 1), showing the nervation; natural size.

6a. Enlarged detail of small area to show vascular strands in the lamina between the larger nerve bundles. The number and distribution of the strands is greater than is represented. They are somewhat irregular. ×2.

Linopteris gilkersonensis D. W.

(Page 139.)

Fig. 7. Slightly undersized pinnule, showing nervation. U. S. Nat. Mus., 5485.

8. Large pinnule showing linear form and peculiar meshing of the nerves. U. S. Nat. Mus., 5485.

Alethopteris ambigua Lx.

(Page 113.)

Fig. 9. Fragment showing young pinna, with irregular pinnules. The specimen was identified by Professor Lesquereux. Lacoe collection. U. S. Nat. Mus., 3590.

Dicranophyllum? sp.

(Page 272.)

Fig. 10. Fragment from the macerated specimen photographed in Pl. LXXIII, Fig. 1. It should perhaps be regarded as an Alga. U. S. Nat. Mus., 6076.

FERNS: CALLIPTERIDIUM, NEUROPTERIS, ALETHOPTERIS, AND LINOPTERIS.

PLATE XLII.

PLATE XLII.

NEUROPTERIS DILATATA (L. and H.) Lx.

(Page 137.)

FIG. 1. Portion of relatively small pinnule. U. S. Nat. Mus., 5672.
1*a*. Detail of portion of surface showing vascular bundles. Another detail of an area nearer the base is shown as Pl. XLI, Fig. 6*a*. ×2.

ODONTOPTERIS? BRADLEYI Lx.

(Page 125.)

FIG. 2. Apical portion of pinna, on right of which are seen pinnules representing *O. Bradleyi*, while on the left the lamina is for some distance entire as in *O. Wortheni* Lx. The specimen is perhaps only a heteromorphous pinna of the *Neuropteris Scheuchzeri* Hoffm. U. S. Nat. Mus., 5623.
2*a*. Enlarged detail of portion of the same showing nervation and short fine hairs appressed on the surface of the pinnules. U. S. Nat. Mus., 5623. ×2.

NEUROPTERIS SCHEUCHZERI Hoffm.

(Page 132.)

FIG. 3. Single pinnule, representing a small narrow form of the species, with relatively slender apex, known as *N. angustifolia*. U. S. Nat. Mus., 5633.
3*a*. Portion of the same enlarged to show the asymmetrical auriculate and pedicellate base, the nervation, and the short slender hairs appressed on the surface. ×2.

NEUROPTERIS MISSOURIENSIS Lx.

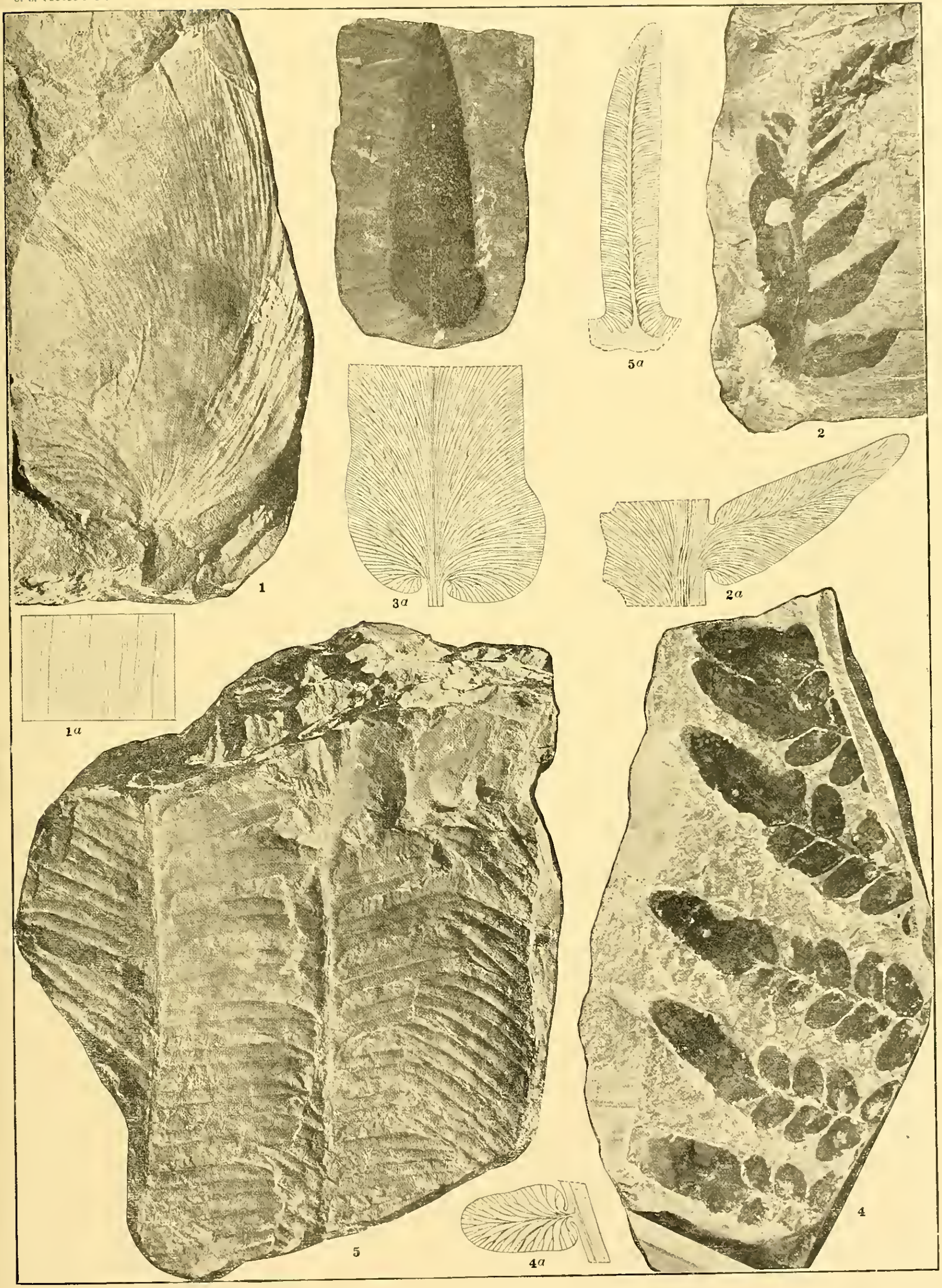
(Page 130.)

FIG. 4. Typical small pinnæ. U. S. Nat. Mus., 5632.
4*a*. Enlarged detail of a pinnule of the same. ×2.

ALETHOPTERIS SERLII (Brongn.) Goepp. var. MISSOURIENSIS D. W.

(Page 118.)

FIG. 5. Characteristic aspect of pinna with large pinnules. U. S. Nat. Mus., 3591 B.
5*a*. Enlarged detail of pinnule. ×2.



FERNS: NEUROPTERIS, ODONTOPTERIS, AND ALETHOPTERIS.

PLATE XLIII.

PLATE XLIII.

NEUROPTERIS DILATATA (L. and H.) LX.

(Page 137.)

Incomplete, large, Cyclopterid pinnule. Original of the description by Professor Lesquereux under the above name in Coal Flora, vol. i, p. 78. U. S. Nat. Mus., 6038.

FERN: NEUROPTERIS.

PLATE XLIV.

PLATE XLIV.

SPHENOPTERIS ILLINOISENIS D. W.

(Page 158.)

FIG. 1. Apex of compound pinna. U. S. Nat. Mus., 5661.
1*a*. Detail of pinnule showing simple dentition. ×2.

NEUROPTERIS DILATATA (L. and H.) LX.

(Page 137.)

FIG. 2. Portion of a pinnule of more elongated form. The margin is seen on the left only. U. S. Nat. Mus., 5658.

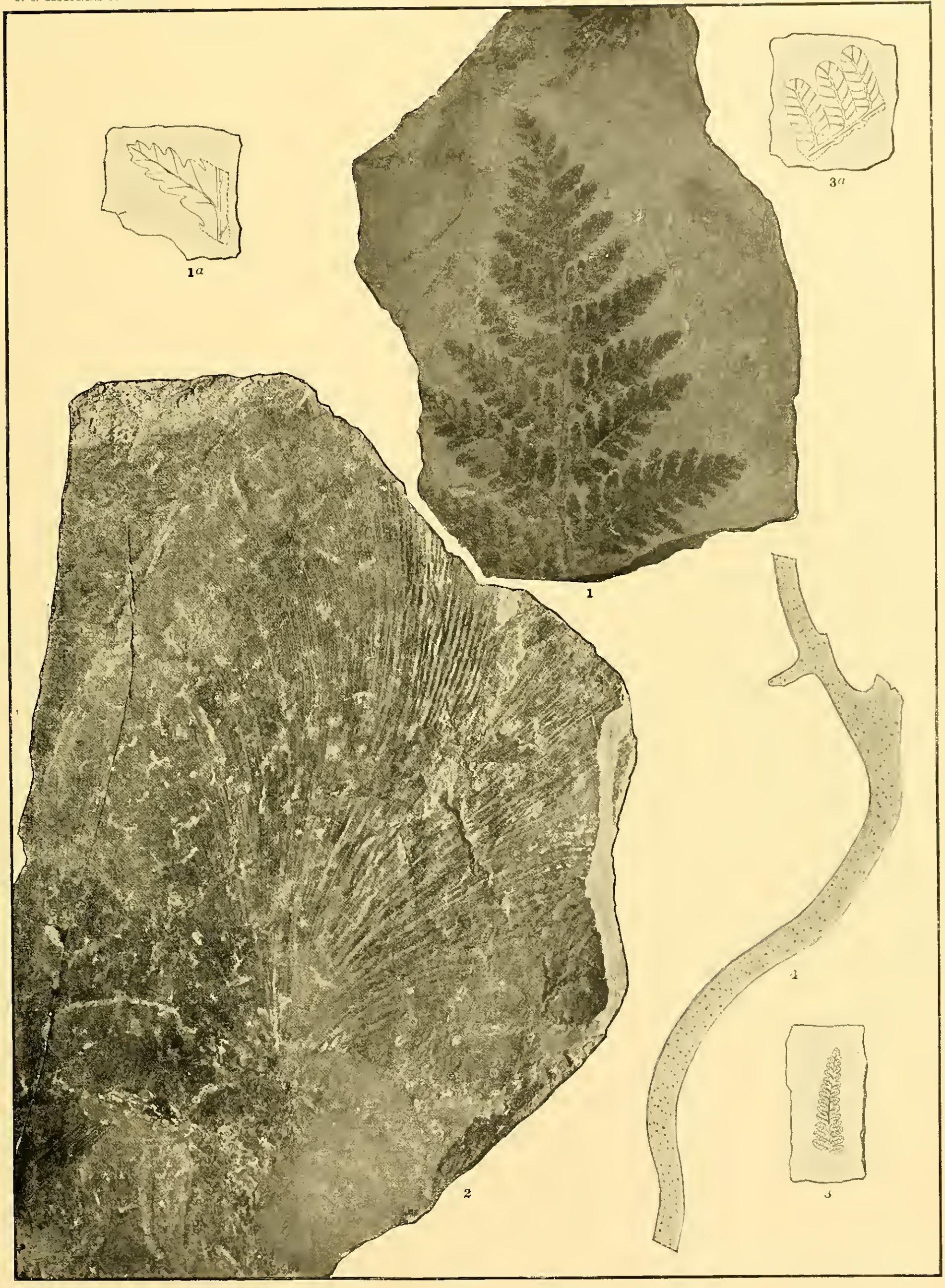
PECOPTERIS ARBORESCENS Brongn.?

(Page 78.)

FIG. 3. Fragment, natural size, Lacoe collection. U. S. Nat. Mus., 4873.
3*a*. Enlarged detail of pinnules of the same. ×4.

ALGOID AXIS?

FIG. 4. The figure shows the finely punctate surface of the impression on which no clear traces of vascular bundles are seen. U. S. Nat. Mus., 5726.



FERNS: NEUROPTERIS, SPHENOPTERIS, AND PECOPTERIS. ALGOID AXIS

PLATE XLV.

PLATE XLV.

APHLEBIA sp.

(Page 112.)

FIG. 1. Large axis, 2.5 cm. in diameter, clothed by large, oblong, chaffy or foliar scales. On the right is seen an expanded *Aphlebia* comparable to *A. Lactuca*. U. S. Nat. Mus., 5727.

SPHENOPTERIS sp.

FIG. 2. Fragment showing lax habit of decurrent pinnæ and lobes. U. S. Nat. Mus., 5815.
2*a*. Enlarged detail showing nervation of the same. ×2.

NEUROPTERIS MISSOURIENSIS Lx.

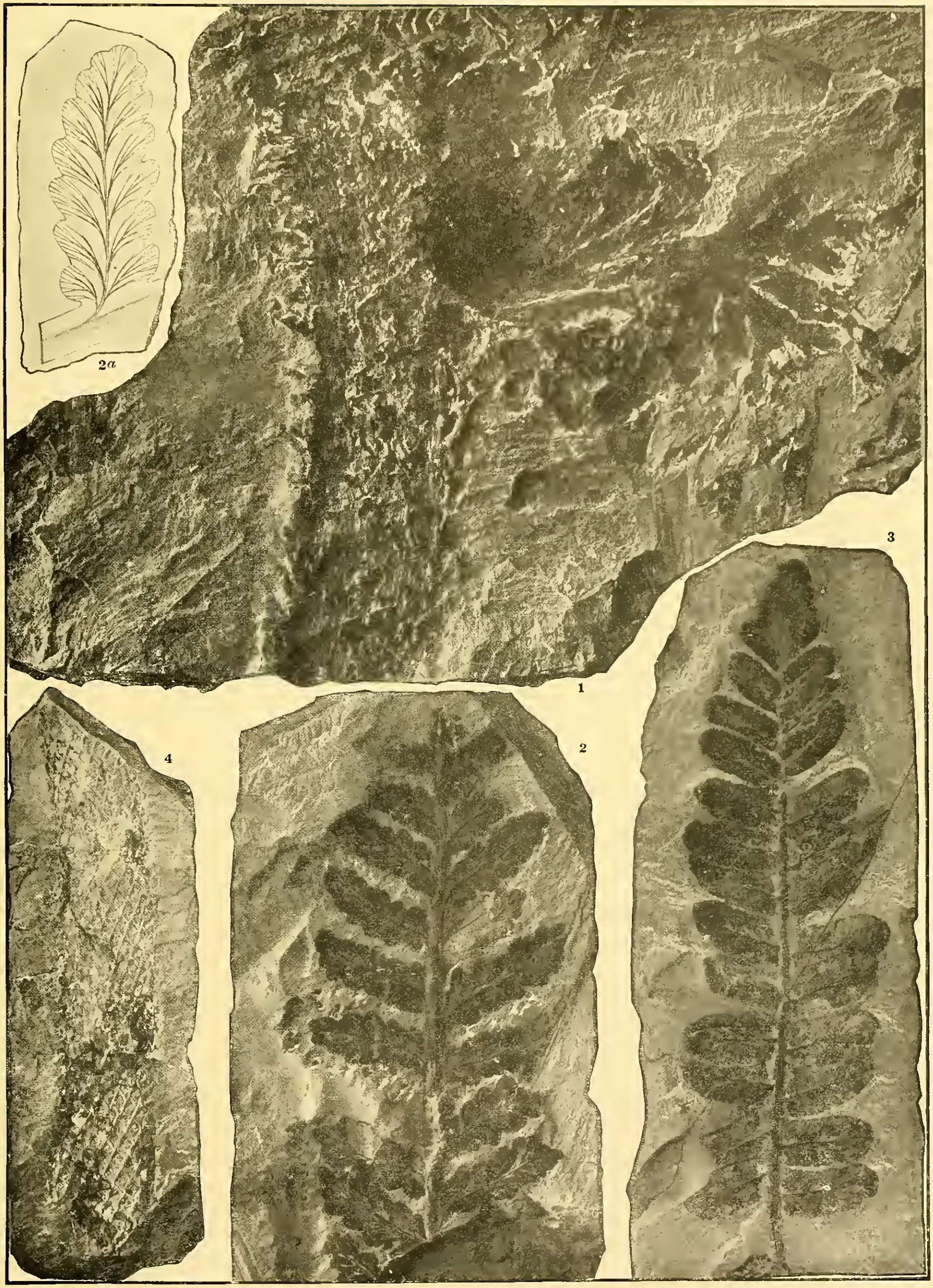
(Page 130.)

FIG. 3. Pinna showing very large pinnules of the species. U. S. Nat. Mus., 5630.

LEPIDODENDRON SCUTATUM Lx.

(Page 198.)

FIG. 4. Cortex of compressed branch showing leaf cushions and leaf scars. U. S. Nat. Mus., 6044. Other examples of this species are illustrated in Pl. LIV, Fig. 5, and Pl. LV, Figs. 1, 2.



FERNS: SPHENOPTERIS, NEUROPTERIS, AND APHLEBIA.
LYCOPODIALES: LEPIDODENDRON.

PLATE XLVI.

PLATE XLVI.

APHLEBIA GERMARI Zeill.

CORDAITES COMMUNIS Lx.

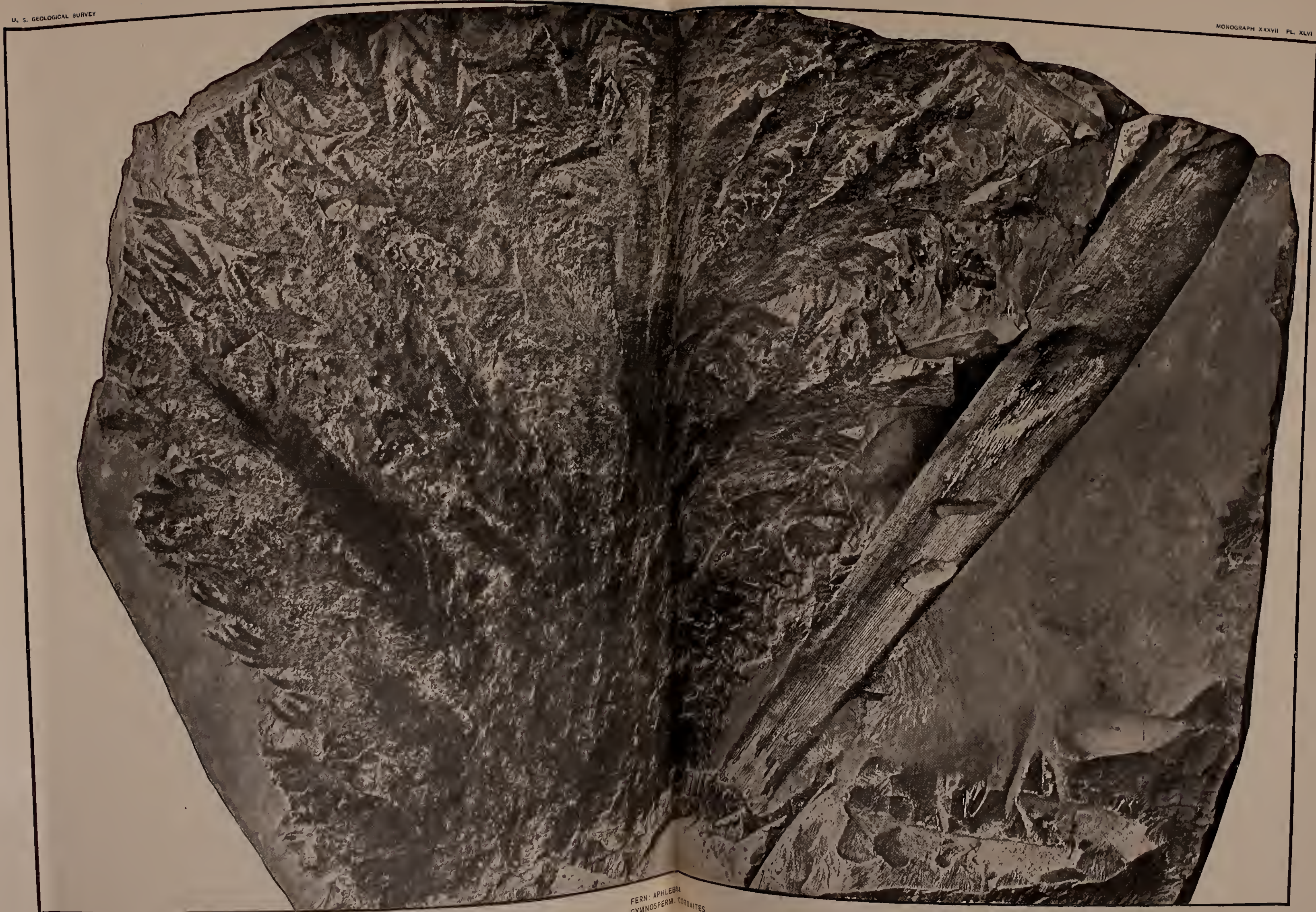
(Pages 106 and 260.)

The photograph shows the greater portion of a large frond of *Aphlebia Germari* Zeill. spread out on the slab. The spinous, villose aspect of the surface, especially near the base, is imperfectly indicated. U. S. Nat. Mus., 5546.

On the right lies a small leaf of *Cordaites communis* Lx. For further illustration of the latter see Pl. I.

FERN: AR
GYMNOSI

DAITES.



FERN: APHLEBIA
GYMNOSPERM: CORDAITES

PLATE XLVII.

403

PLATE XLVII.

Brittsia problematica D. W.

(Page 98.)

Fig. 1. View of frond in which the pinnæ are rolled back on all sides, showing the broad central rachis. Portions of the thalloid expansions are seen on the upper right. The photograph is inverted. U. S. Nat. Mus., 5683.

2. Opposite side of the same specimen, with inrolled pinnæ.
3. Expanded frond, from which the pinnules have been removed, showing the broad lobular expansions of the fleshy or thalloid wing of the rachis. The light spots in the sinuses of the lobes correspond to the attachment of the imbricated pinnules. The margins of the lobes, though thinning, are hardly so uneven as the retouching indicates. U. S. Nat. Mus., 5724.
4. Enlarged detail of one of the lobes or fleshy expansions of the rachis of a lateral pinna. The vascular bundles are seen to diverge from the axis and pass to the sinus at the upper angle of the lobe, where a distinct carbonaceous residue of the base of the pinnule usually remains. The character of the surface of the lobe, which is destitute of vascular trace, is also shown in the enlargement. ×5.
5. Portions of two of the "pinnules" which are attached at the sinuses of the lobes. The detail enlargement shows the nervation and a very small portion of the margin, including one of the teeth. U. S. Nat. Mus., 5723. ×5.

Pecopteris cf. arborescens Brongn.?

(Page 78.)

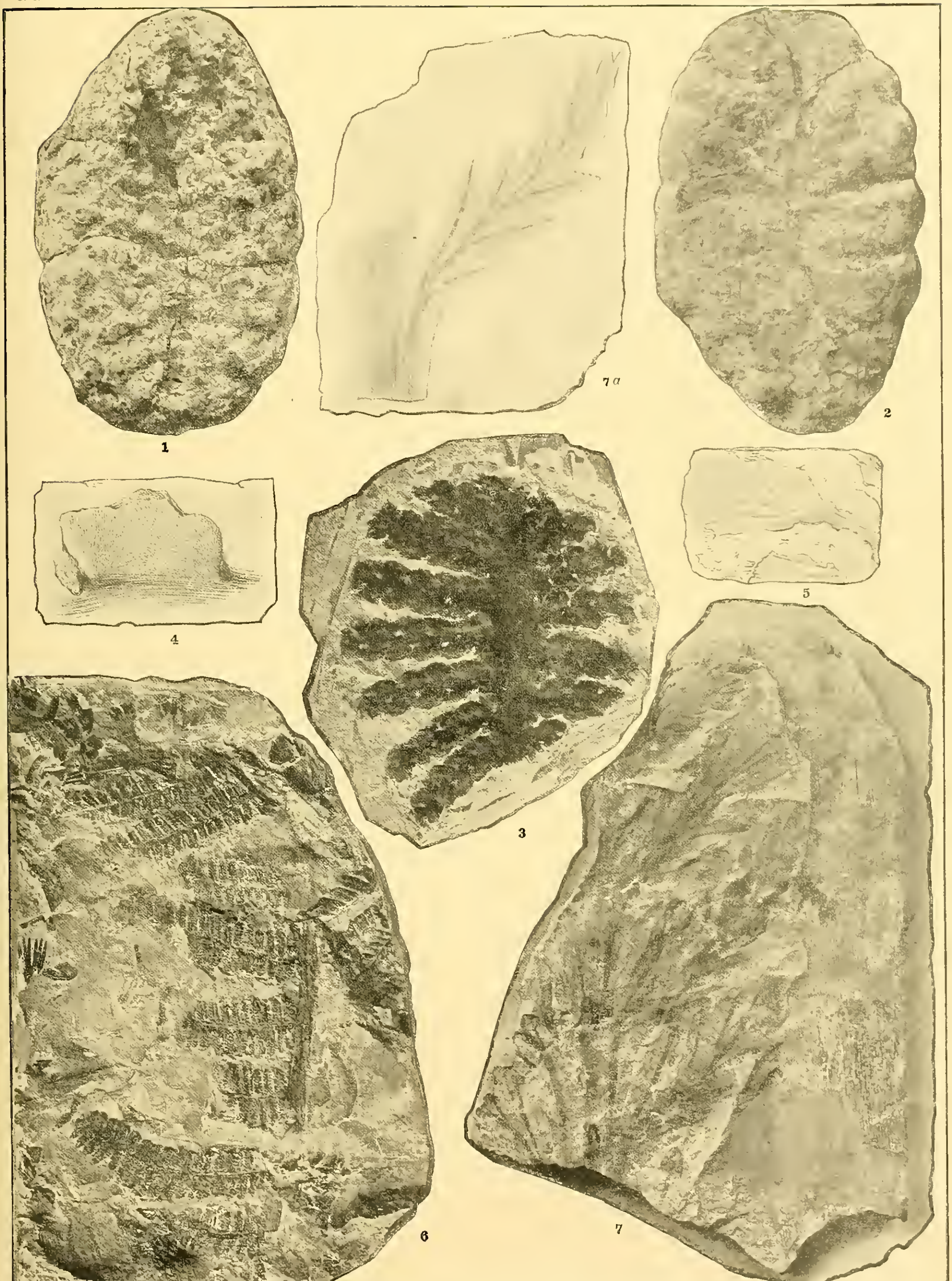
Fig. 6. Fertile pinnæ. U. S. Nat. Mus., 5595.

Aphlebia subgoldenbergii D. W.

(Page 110.)

Fig. 7. Fragment showing lateral divisions or pinnæ, with thin lobes or pinnules traversed by broad, flat vascular bands. Lacoe collection, U. S. Nat. Mus., 9599.

7a. Portion of the same enlarged to show the form of the lobes. ×2.



FERNS: PECOPTERIS, APHLEBIA, AND BRITTSIA.

PLATE XLVIII.

PLATE XLVIII.

BRITTSIA PROBLEMATICA D. W.

(Page 98.)

FIG. 1. Frond showing fleshy expansions of the central axis (rachis) and pinnæ. The thick, apparently veinless, thalloid lobes of the latter are seen on the left. In the lower left fragments of the pinnules overlying the fleshy bordered rachises are seen. U. S. Nat. Mus., 5723.

1*a*. Enlarged detail of the lower left of the same specimen, showing portion of main axis and four pinnæ with their fleshy expansions or thalloid lobes. The vascular system is also indicated. Toward the margin portions of several of the pinnules expanding in a plane above the rachis are seen, with their dentate margins. The individuality of the pinnules is not clear in the figure. ×2.

2. Photograph of portion of frond from which the rachial plane has been broken away, leaving the imbricated pinnules in the matrix. (See 2*a*.) U. S. Nat. Mus., 5811.

2*a*. Enlarged photograph of the same. The remains of the double (parallel) rows of pinnules of three pinnæ are seen, especially the two rows of one pinna on the right. ×2.

2*b*. Detail of the same showing the broken remains of the two imbricated rows of pinnules or scales of the pinna on the right of Fig. 2*a*. The basal portions of the pinnules which narrow to the sinuses between the lobes of the rachis are broken away. The pinnules are not so striated as the drawings 1*a* and 2*b* indicate. ×2.

2*c*. Detail showing pinnules in left of Fig. 2. The thick nerves and several of the teeth of the pinnules are seen, while the trend of the nerves toward the sinuses, and the vascular bands of the rachis are indicated. The impressions on the underlying fleshy rachis indicate a considerable length for the basal portions of the pinnules. ×2.

3. Small frond showing axis, pinnæ which are somewhat radiately disposed, and fleshy lobes of the rachis, the borders of the lobes being overlain in places by fragments of the overlying compressed pinnules. U. S. Nat. Mus., 5722.

FERNS: BRITTSIA

PLATE XLIX.

PLATE XLIX.

CYCLOCLADIA BRITTSII D. W.

(Page 169.)

FIG. 1. Fragment of stem showing large excentric branch cicatrices, and transversely elongated leaf scars. Collection of Dr. J. H. Britts, Clinton, Missouri.

ASTEROPHYLLITES LONGIFOLIUS (Stb.) Brongn.

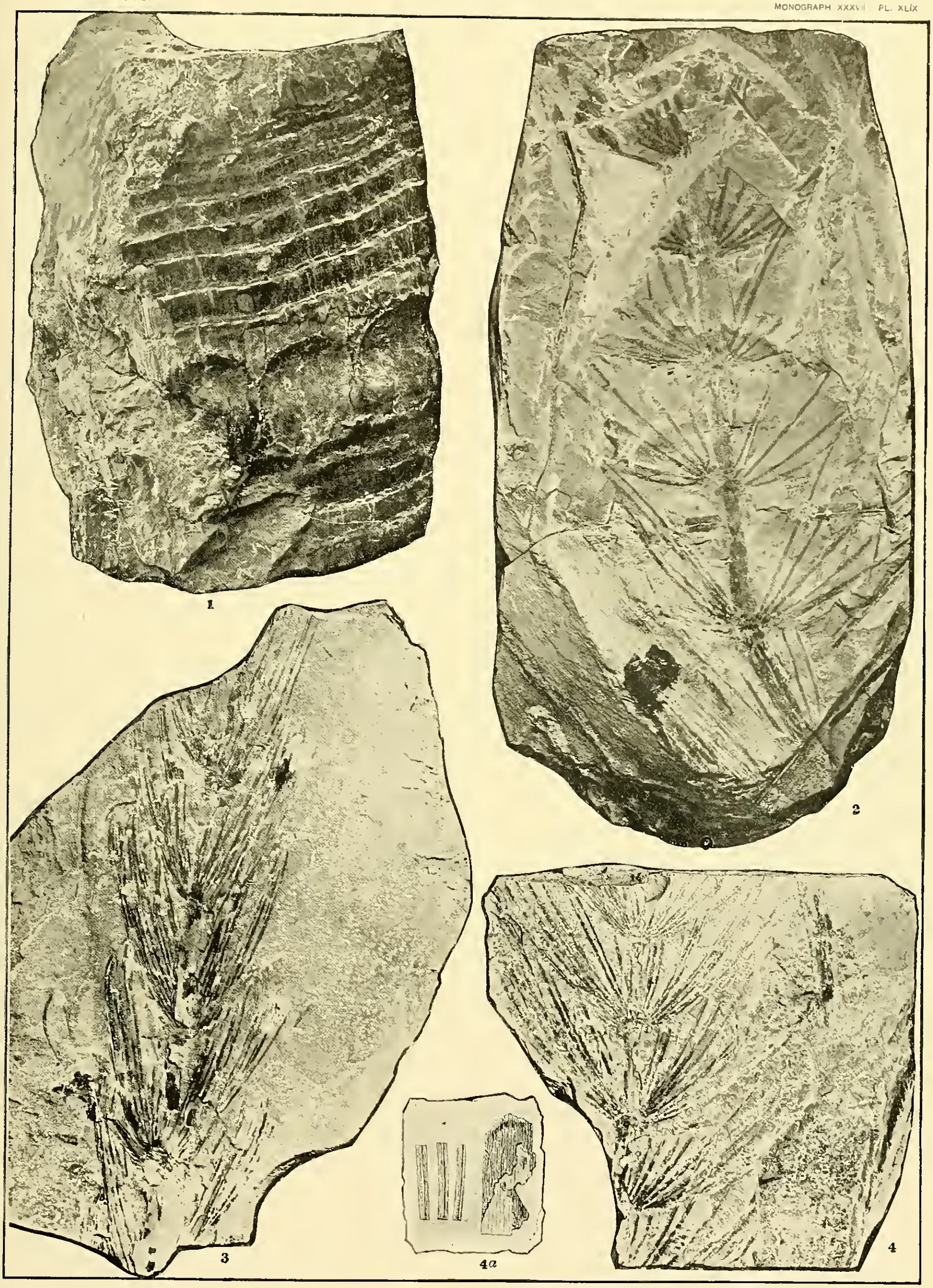
(Page 153.)

FIG. 2. Stem with spreading verticils. U. S. Nat. Mus., 5677.

3. Fragment with more nearly erect leaves. U. S. Nat. Mus., 5676.

4. Distinctly carinate leaves. U. S. Nat. Mus., 5673.

4a. Enlarged details showing cortex of stem and lineate, minutely carinate leaves from same specimen. ×2.



EQUISETALES: CYCLOCLADIA AND ASTEROPHYLLITES.

PLATE L.

PLATE L.

Sphenophyllum (Asterophyllites?) fasciculatum Lx. sp.

(Page 183.)

Fig. 1. One of the specimens determined by Professor Lesquereux as *Asterophyllites fasciculatus* Lx. Lacoe collection, U. S. Nat. Mus., 8296.

1*a*. Photographic enlargement of the upper portion of the same, showing bifurcate leaves. ×2.

1c. Detail of a portion of the same to show the nervation. ×2.

2. Another specimen labeled as *Asterophyllites fasciculatus* by Professor Lesquereux. The bifurcate form of the leaves appears in the upper part, though it does not show well in the photograph. Lacoe collection, U. S. Nat. Mus., 8295.

3. Branches of the same species. Most of the leaves are seen in profile, but several in the front of the verticils in the upper part of the specimen show the forked form. U. S. Nat. Mus., 5639.

4. Examples of small branchlets. U. S. Nat. Mus., 5637.

Sphenophyllum majus Bronn?

(Page 180.)

Fig. 5. Two verticils, showing form of leaves. U. S. Nat. Mus., 5679.

6A. Leaves on the upper part of the rock, showing margin. Lacoe collection, U. S. Nat. Mus., 8711.

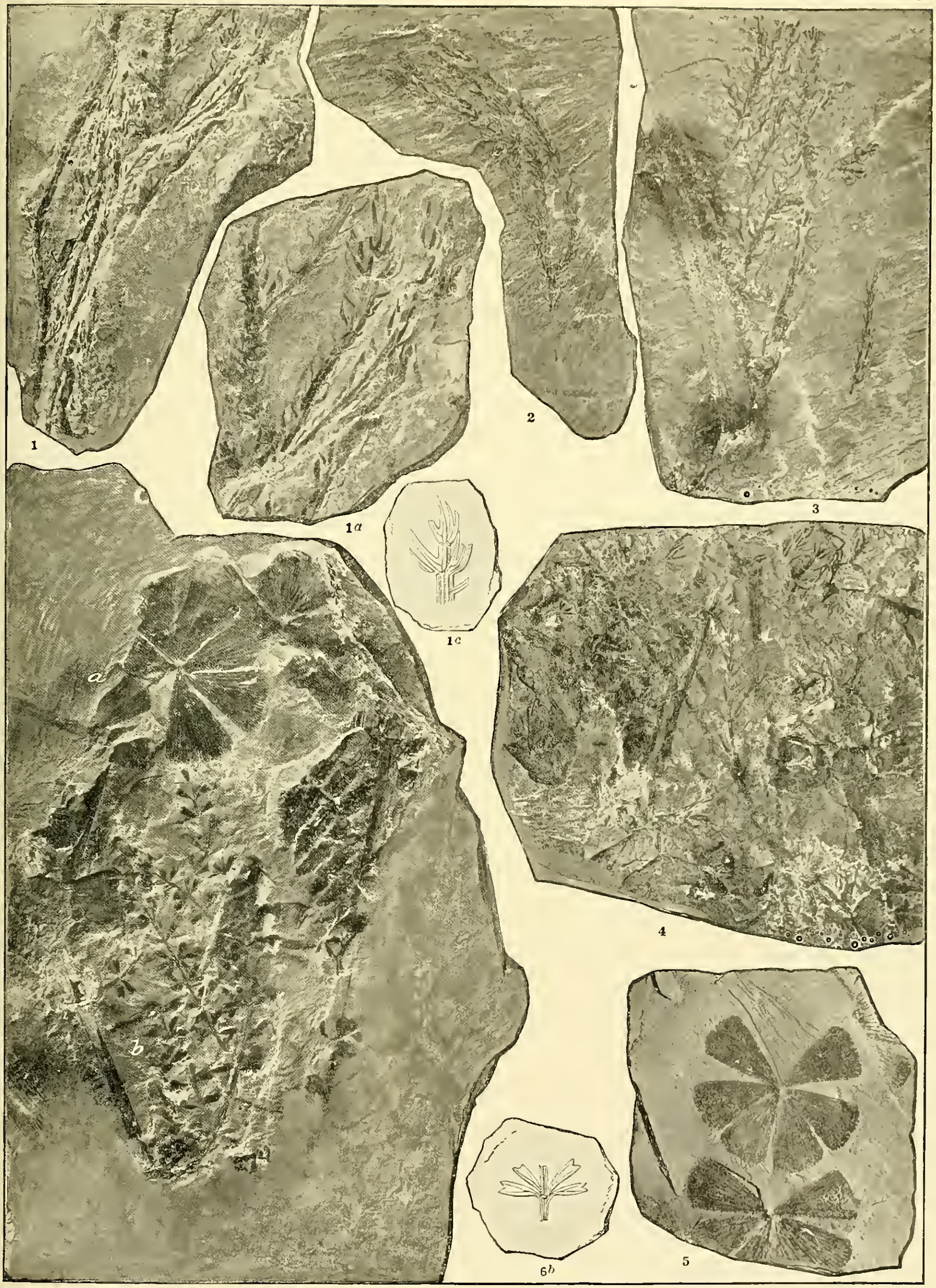
Sphenophyllum Lescurianum D. W.

(Page 182.)

Fig. 6B. Branches, showing verticils of peculiarly bidentate leaves. This example was labeled and recorded by Professor Lesquereux as *Sphenophyllum oblongifolium* Germ. Lacoe collection, U. S. Nat. Mus., 8711.

6*b*. Enlarged detail of leaves. ×2.

The entire rock is photographically enlarged in Pl. LI.



SPHENOPHYLLALES: SPHENOPHYLLUM.

PLATE LI.

PLATE LI.

SPHENOPHYLLUM MAJUS Bronn?

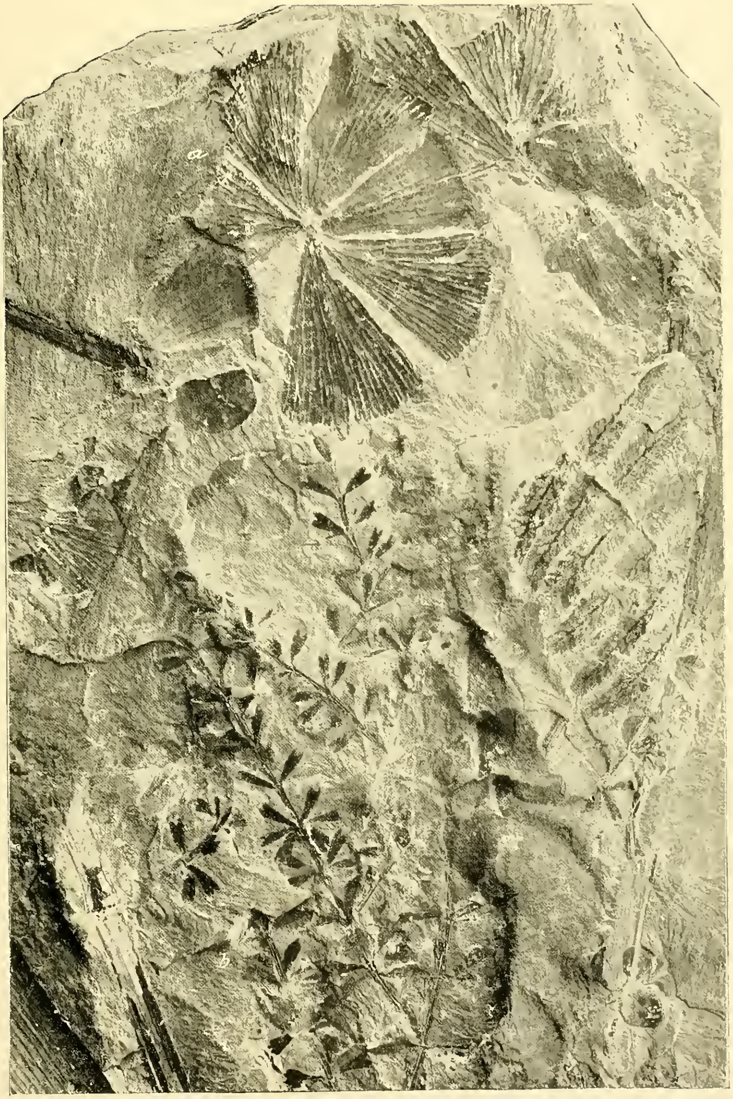
(Page 180.)

FIG. *a*. Enlarged photograph of Fig. 6A, Pl. L. ×2.

SPHENOPHYLLUM LESCURIANUM D. W.

(Page 182.)

FIG. *b*. Photographic enlargement of No. 8711, Lacoe collection, U. S. Nat. Mus., shown natural size in Fig. 6, Pl. L. The enlargement shows well the form and dentition of the leaves. ×2.



SPHENOPHYLLALES: SPHENOPHYLLUM.

(Twice the natural size.)

PLATE LII.

PLATE LII.

Lepidodendron Brittsii Lx.

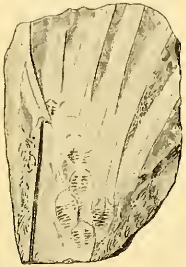
(Page 188.)

Fig. 1. Slab covered with branchlets and leafy twigs. The bifurcation of the branches is seen at several points. U. S. Nat Mus., 5640.

2. Enlarged detail from lower right of the same slab, showing lower portions of leaves attached to the bolsters. ×4.

3. Portions of the cortex of old trunks, showing the form of the bolsters or leaf cushions; the crescentic leaf scars, convex upward, and the corrugation above and below the leaf scar. U. S. Nat. Mus., 6039.

3a. Enlarged detail of bolster of the same. The limits of the leaf scar are hardly so clearly defined in the specimen, nor are the appendages so distinct, though they appear to be faintly visible. ×2.



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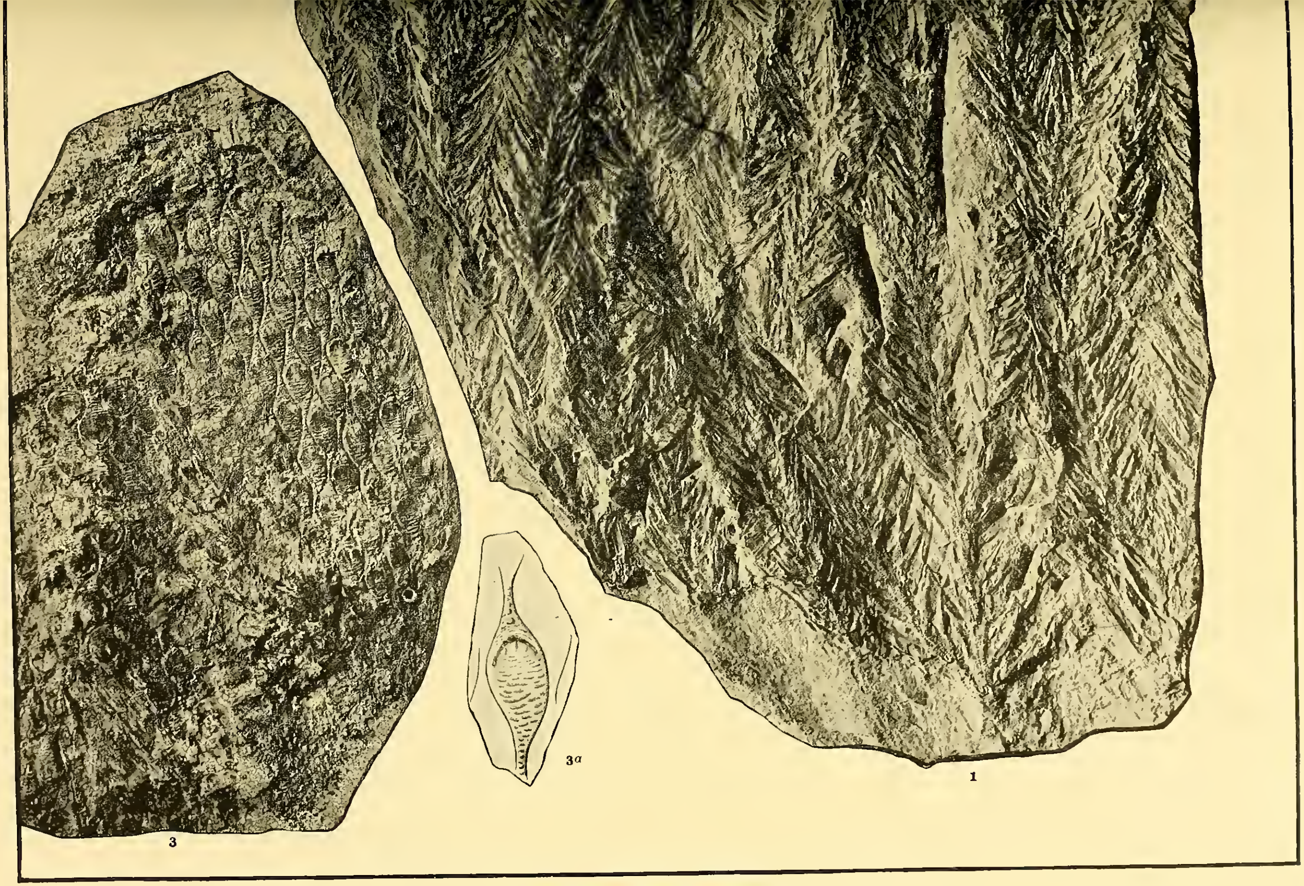


LYCOPODIALES: LEPIDODENDRON.

LYCOPODIALES LEPIDODENDRON

PLATE LIII.

PLATE LIII.

LEPIDODENDRON BRITTSII Lx.

(Page 188.)

FIG. 1. Branch with many narrow, tapering leaves. The latter are slightly reflexed. The outlines of the slender, fusiform bolsters are faintly seen, the corrugation being visible. U. S. Nat. Mus., 6040.

1*a*. Enlarged detail, showing form and ornamentation of a bolster of the same. The appendages are delineated too distinctly. ×2.

LEPIDODENDRON LANCEOLATUM Lx.

(Page 192.)

FIG. 2. Forking branch, showing diamond-shaped bolsters. The latter are a little distant. Collection of Dr. J. H. Britts, Clinton, Missouri.

2*a*. Enlarged detail of two bolsters of the same, showing the very slight altitude of the leaf scars, which are distinctly directed upward, and the ligular trace just above the leaf scar. ×2.

LYCOPODIALES; LEPIDODENDRON.

PLATE LIV.

PLATE LIV.

Lepidodendron Brittsii Lx.

(Page 188.)

Fig. 1. Branchlet showing leaves attached. U. S. Nat. Mus., 6042.
1a. Enlarged detail of same to show the bolsters and leaf attachments. ×2.
2. Fragment from larger branch at the point of bifurcation. The leaf scars are faintly shown. The specimen was determined by Professor Lesquereux. Lacoe collection, U. S. Nat. Mus., 5488.

Lepidodendron rimosum Stb. var. retocorticatum D. W.

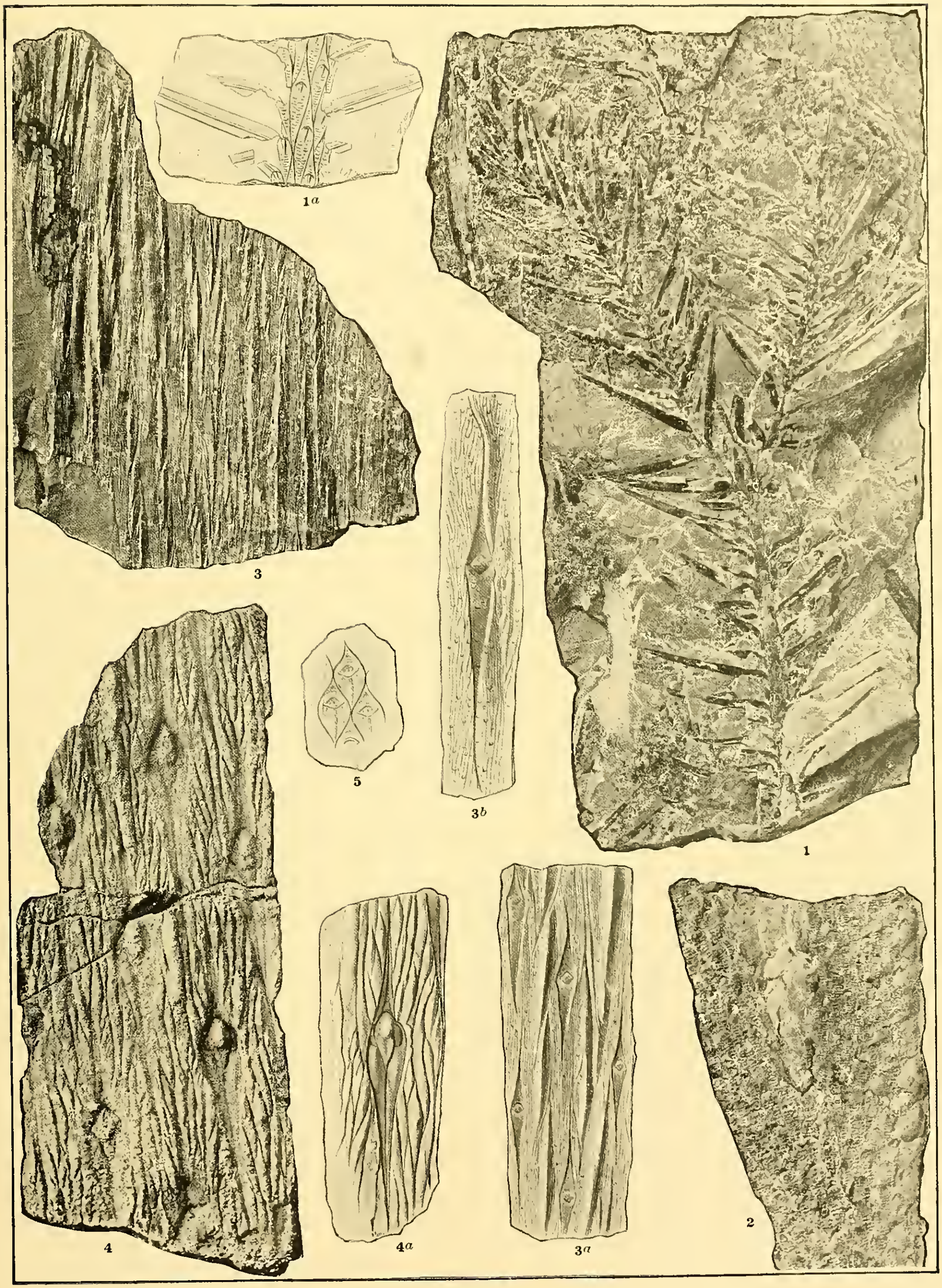
(Page 196.)

Fig. 3. Fragment of cortical impression in which the outer cortex appears to have been longitudinally ruptured in elongated diamond-shaped breaks by the expanding inner cortex, separating still further the already distant, linear, fusiform bolsters. U. S. Nat. Mus., 6043.
3a. Enlarged detail showing linear, elongated bolsters and the transversely rhomboidal leaf scars. ×2.
3b. Single bolster of the same still further enlarged to show the cortical ornamentation and the cicatricules of the leaf scar. ×6.
4. Fragmentary impression of cortex of old trunk in sandstone. The specimen, which was labeled as this species by Professor Lesquereux, shows the distant, greatly elongated bolsters and the complex wrinkling of the bark between the bolsters. Lacoe collection, U. S. Nat. Mus., 5280.
4a. Detail, natural size, from the same, to show the features of the leaf scars. It is hardly probable that the features of the actual outer surface of the scar are here presented.

Lepidodendron scutatum Lx.

(Page 198.)

Fig. 5. Enlarged detail of No. 6044 photographed in Pl. XLV, Fig. 4. It shows the character of the leaf scars and the appendages. ×2.



LYCOPODIALES: LEPIDODENDRON.

PLATE LV.

PLATE LV.

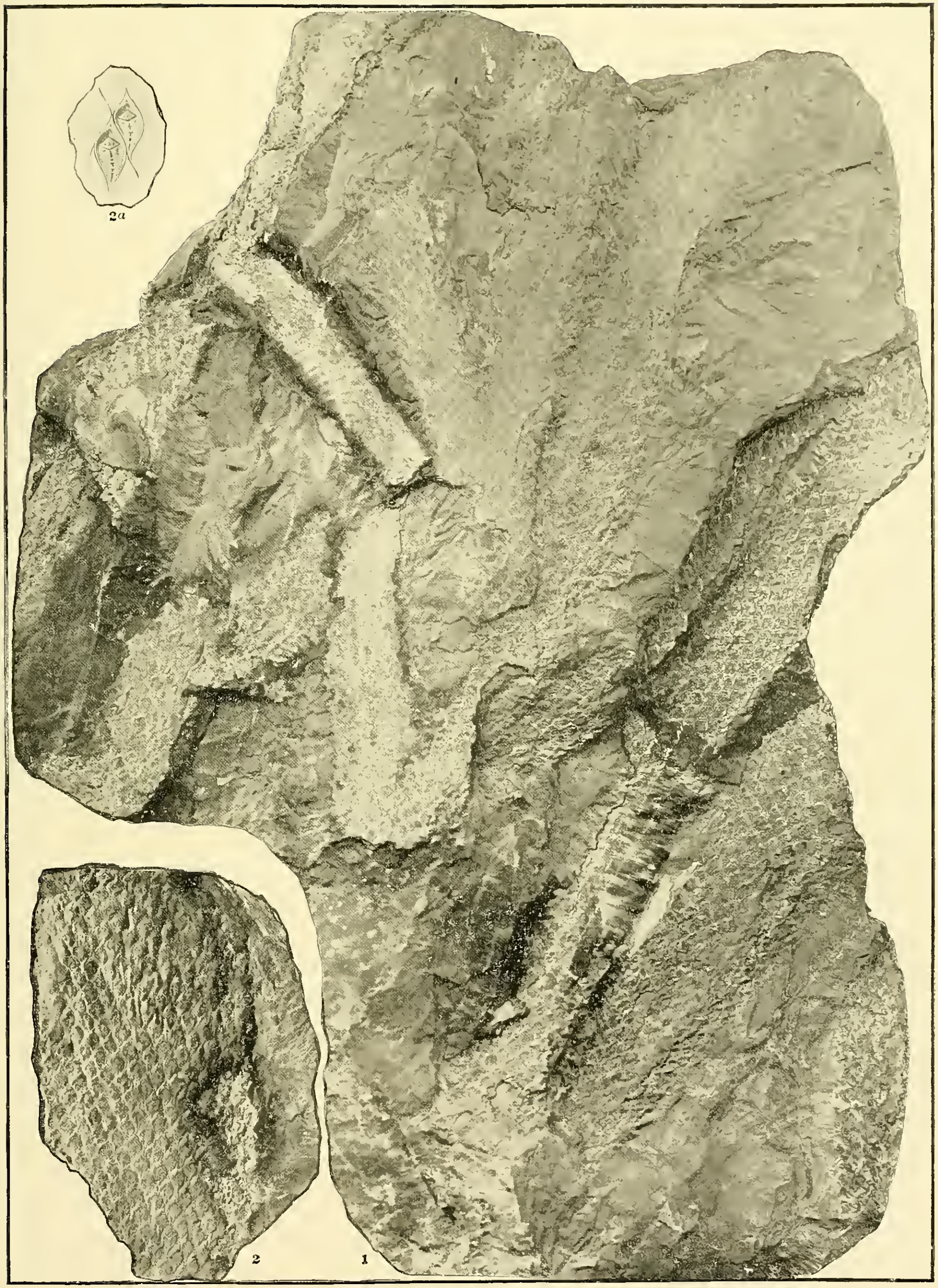
LEPIDODENDRON SCUTATUM Lx.

(Page 198.)

FIG. 1. Slab strewn with dichotomous branches of this species. The form of the bolster is obscurely shown on the right. U. S. Nat. Mus., 6045.

2. Fragment from larger stem. U. S. Nat. Mus., 6046.

2*a*. Detail of bolsters and leaf scars of same. ×2.



LYCOPODIALES: LEPIDODENDRON.

PLATE LVI.

PLATE LVI.

Lepidophloios Van Ingeni D. W.

(Page 205.)

Fig. 1. Portion of stem from which the epidermis has been removed. U. S. Nat. Mus., 6047.

2. One of the specimens described and figured by Professor Lesquereux (Coal Flora, vol. iii, p. 781, pl. cv, fig. 4) as *Lepidophloios dilatatus* Lx. Lacoe collection, U. S. Nat. Mus., 5944.

2*a*. Photographic enlargement of the same, in different light, to show the aspect of the leaf scars. ×2.

2*b*. Enlarged detail of exposed portion of bolster of No. 5944. ×2.

3. Isolated and partially decorticated bolster showing portion of leaf scar and the pit above it on the bolster. U. S. Nat. Mus., 6050.

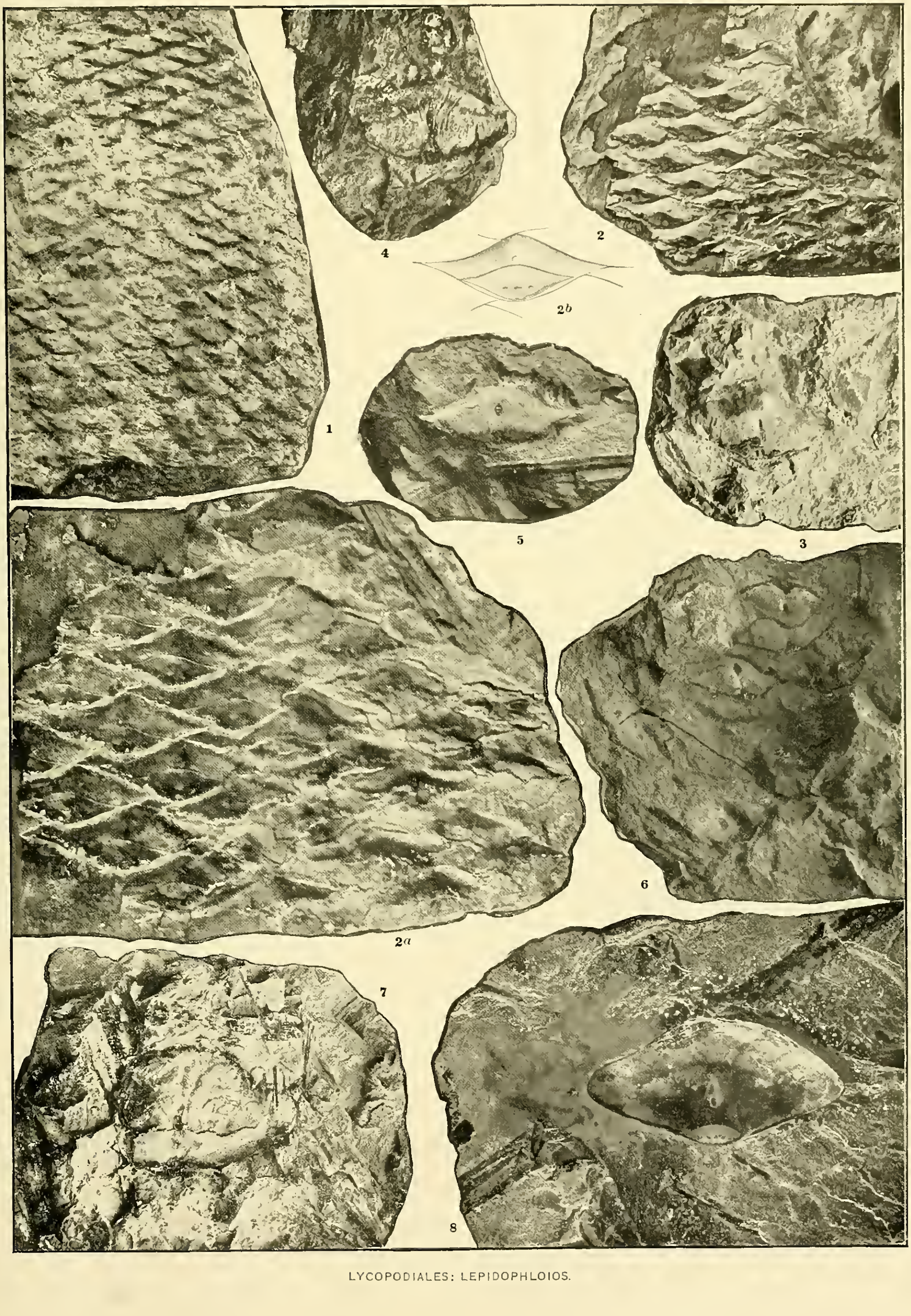
4. Similar isolated bolster showing vertical wrinkles, due perhaps to flattening of the bolster. U. S. Nat. Mus., 6048.

5. Bolster from which nearly all carbonaceous residue has been removed, showing the approximate profile of leaf scar and distinct "ligular pit." U. S. Nat. Mus., 6049.

6. Detached bolsters grouped on rock. U. S. Nat. Mus., 6051.

7. Very large bolster, partially decorticated. U. S. Nat. Mus., 6052.

8. Very large and strongly convex bolster in shale. It shows rounded lateral angles and base. U. S. Nat. Mus., 6053.



LYCOPODIALES: LEPIDOPHLOIOS.

PLATE LVII.

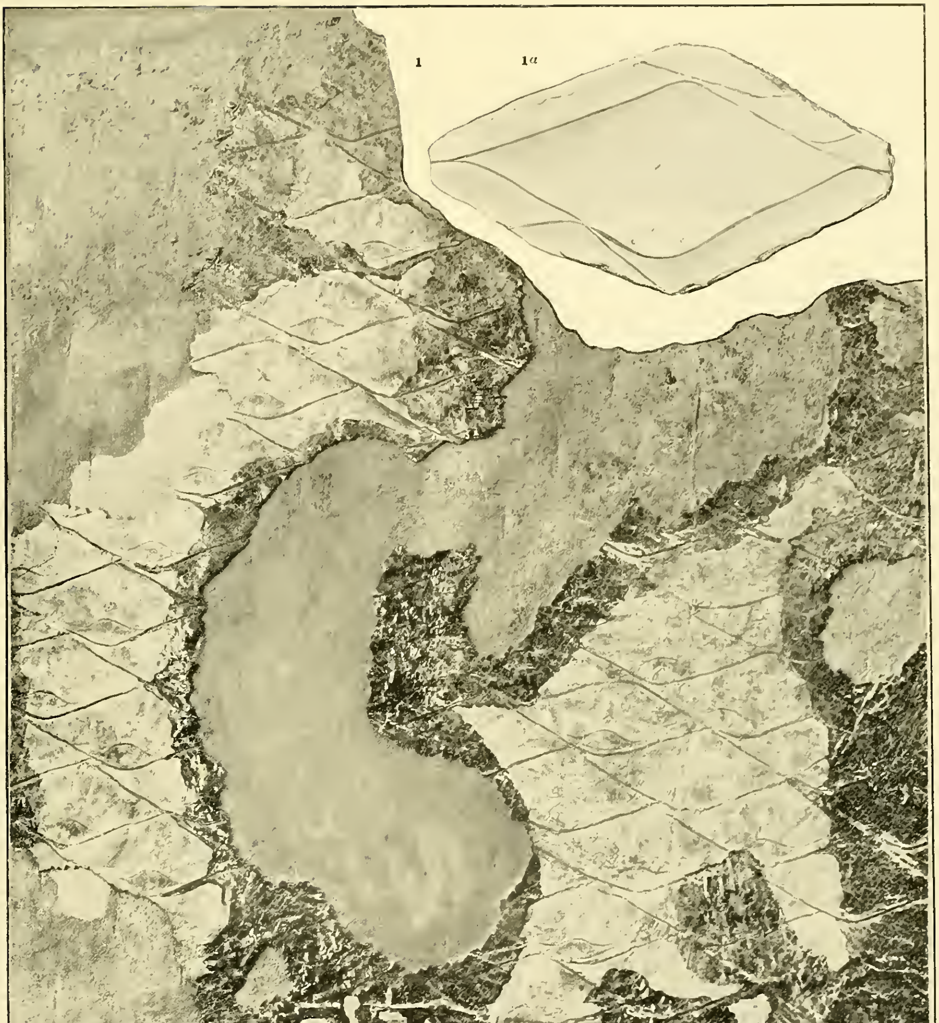
PLATE LVII.

LEPIDOPHLOIOS VAN INGENI D. W.

(Page 205.)

FIG. 1. Portion of large slab described and partially figured by Professor Lesquereux in Coal Flora, vol. iii, pl. cv., fig. 2, as *Lepidophloios dilatatus* Lx. The rhomboidal profiles of the completely flattened bolsters are visible over the corticated portion, while in most cases the leaf scar is seen. The *Knorria* stage of the trunk is indicated in the lower left. Lacoe collection, U. S. Nat. Mus., 5947.

1*a*. Enlarged detail of bolster of same. ×2.



LYCOPODIALES: LEPIDOPHLOIOS.

PLATE LVIII.

PLATE LVIII.

Lepidophloios Van Ingeni D. W. ?

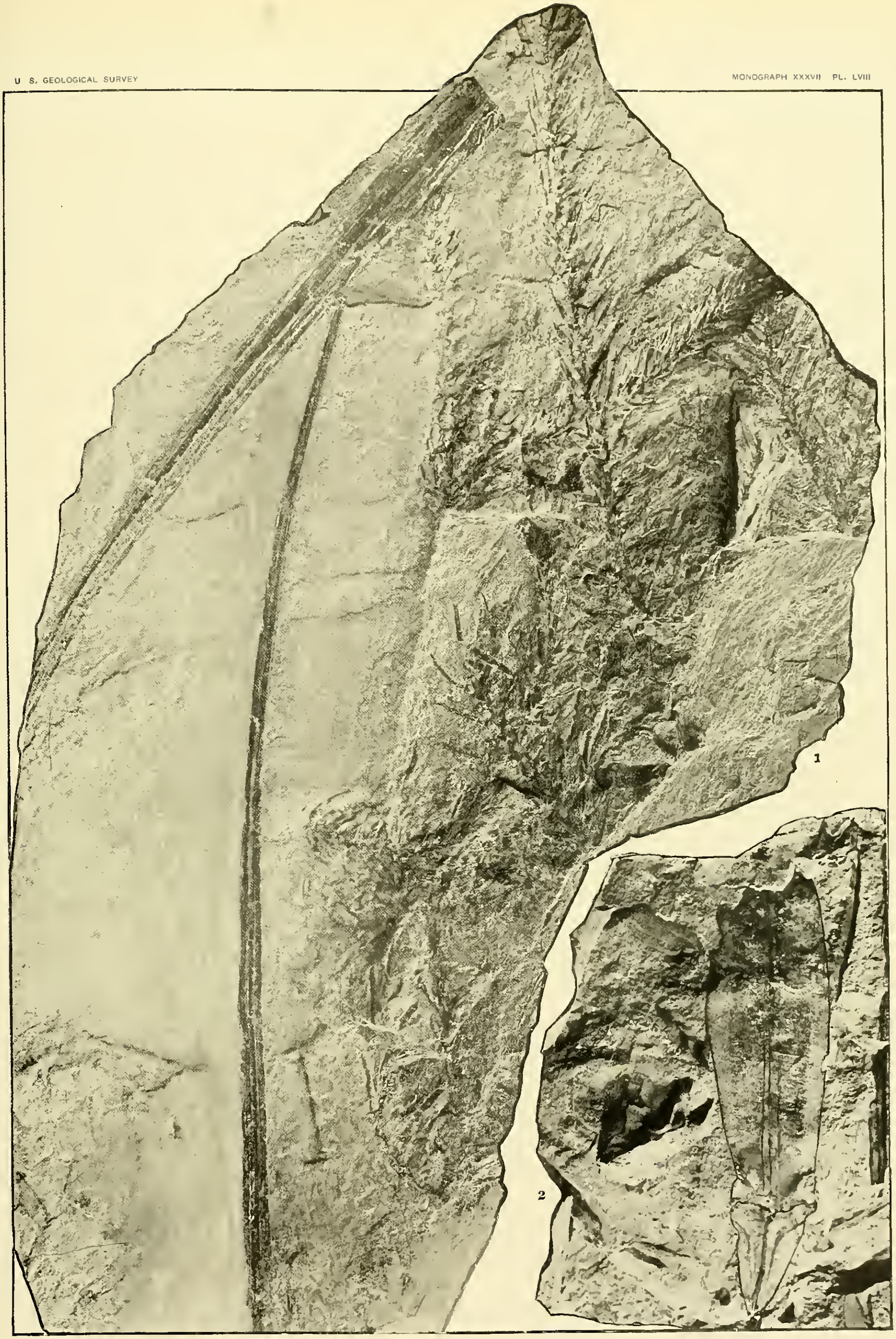
(Page 205.)

Fig. 1. The large leaf fragments on the left half of the slab are probably referable to this species. Small branchlets of *Lepidodendron Brittsii* Lx. appear on the right. U. S. Nat. Mus., 6061.

Lepidophyllum missouriense D. W.

(Page 216.)

Fig. 2. Lower part of bract, dilated at the point of union with the large sporangiophore. U. S. Nat. Mus., 6062. A portion of an isolated bolster of *Lepidophloios Van Ingeni* lies to the left.



LYCOPODIALES: LEPIDOPHLOIOS AND LEPIDOPHYLLUM.

PLATE LIX.

PLATE LIX.

Lepidostrobus Jenneyi D. W.

Lepidophyllum Jenneyi.

(Page 215.)

Fig. 1*a*. Upper part of cone, showing bracts along the profile, the interior mass being composed of the long sporangiophores crushed with the spore cases (*Sporocystis*). U. S. Nat. Mus., 6054.

1*b*. Detached fully grown bract of the same species, illustrating the relatively long sporangiophore.

2. Another bract (*Lepidophyllum Jenneyi*) showing dilation at base of blade. The membraneous expansion of the sporangiophore is wanting. U. S. Nat. Mus., 6056.

Lepidocystis Jenneyi D. W.

(Page 215.)

Fig. 3. Isolated and partially compressed spore case of *Lepidostrobus Jenneyi*. U. S. Nat. Mus., 6055.

Asterophyllites equisetiformis (Schloth.) Brongn.

(Page 151.)

Fig. 1*c*. Branch with unusually slender leaves, to the left of the Lepidostrobus on the slab.

Sphenophyllum emarginatum Brongn.

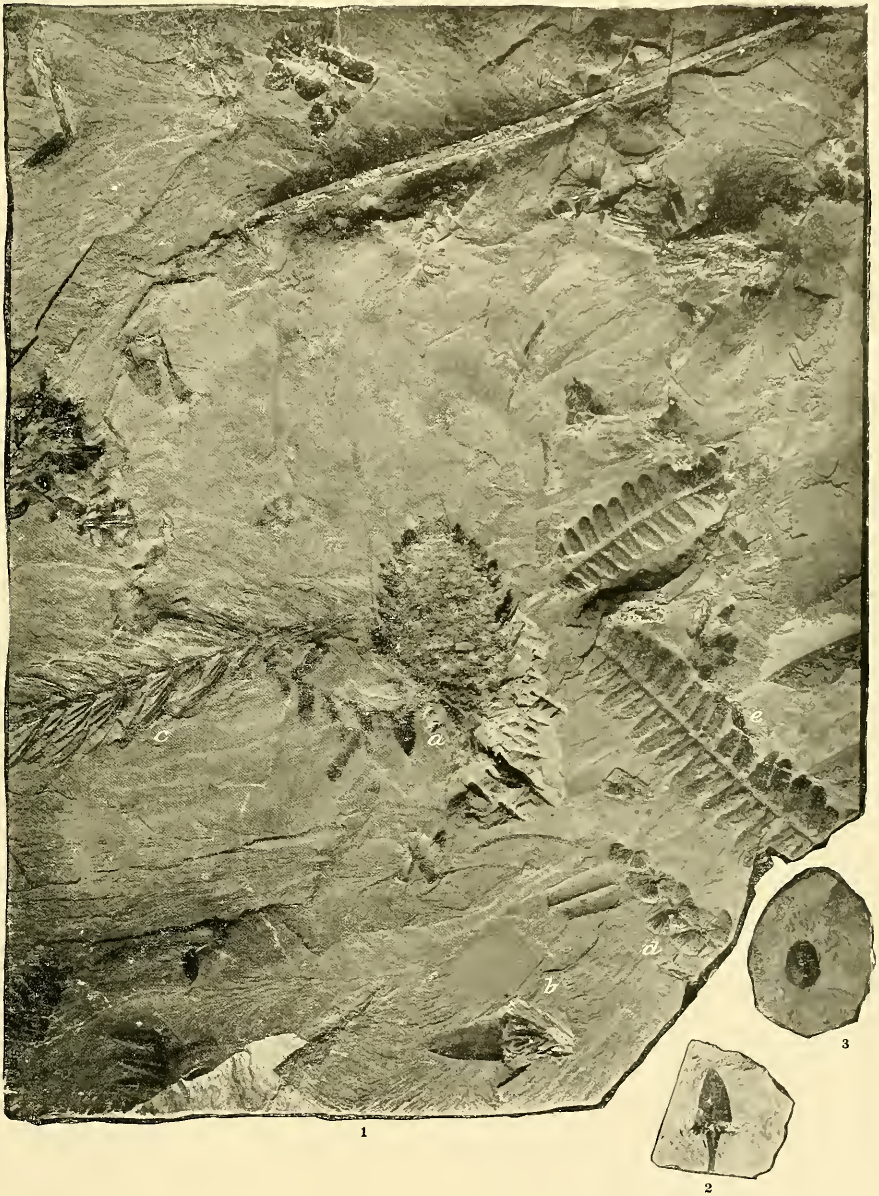
(Page 177.)

Fig. 1*d*. Fragments, with very small leaves, near the top and in the lower right of slab.

Pecopteris vestita Lx.

(Page 91.)

Fig. 1*e*. Fragment of pinna on the right.



FERNS PECOPTERIS.
EQUISETALES ASTEROPHYLLITES.
SPHENOPHYLLALES. SPHENOPHYLLUM.
LYCOPODIALES LEPIDOSTROBUS, LEPIDOPHYLLUM, AND LEPIDOCYSTIS.

PLATE LX.

PLATE LX.

LEPIDOSTROBUS MISSOURIENSIS D. W.

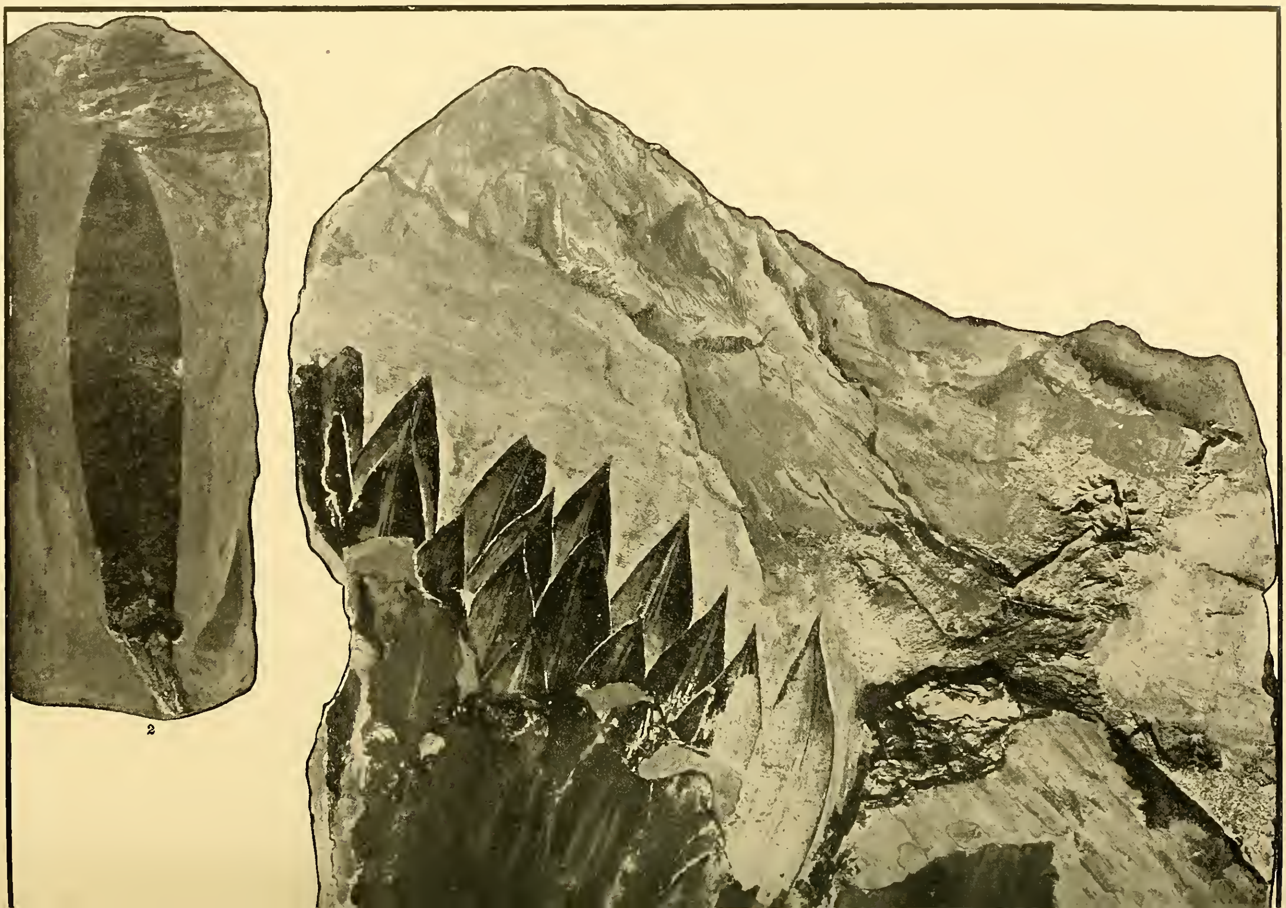
LEPIDOPHYLLUM MISSOURIENSE.

(Pages 216 and 217.)

FIG. 1. Slab, on the left of which is a fragment of a large cone of this species, while scattered bracts lie on the right. Collection of Dr. J. H. Britts, Clinton, Missouri.

2. Bract (*Lepidophyllum missouriense*) of the same species, showing dilation of blade at junction with sporangiophore, which is incomplete. U. S. Nat. Mus., 6066.

3. Bract of same species showing acuminate apex and large sporangiophore. U. S. Nat. Mus., 6059.



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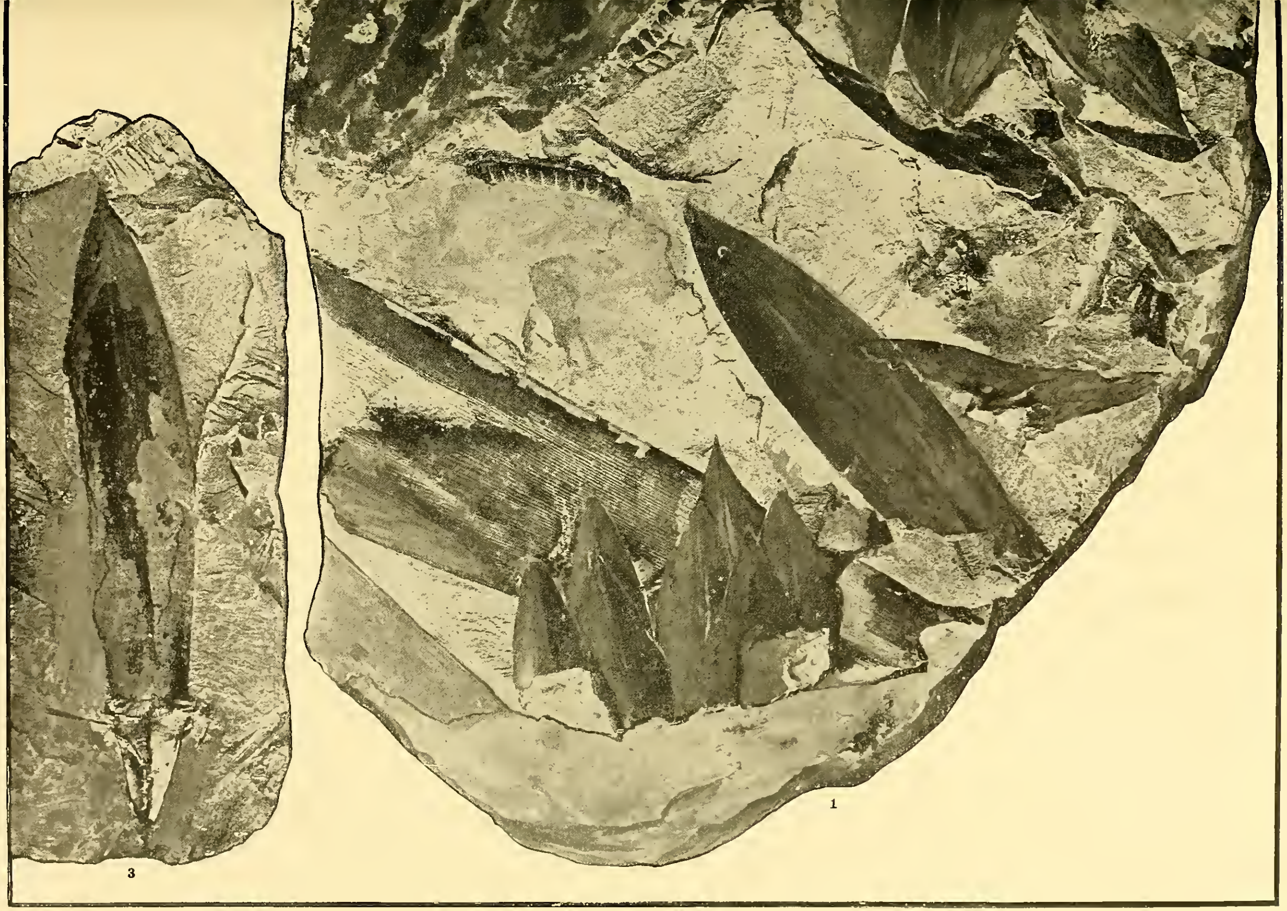
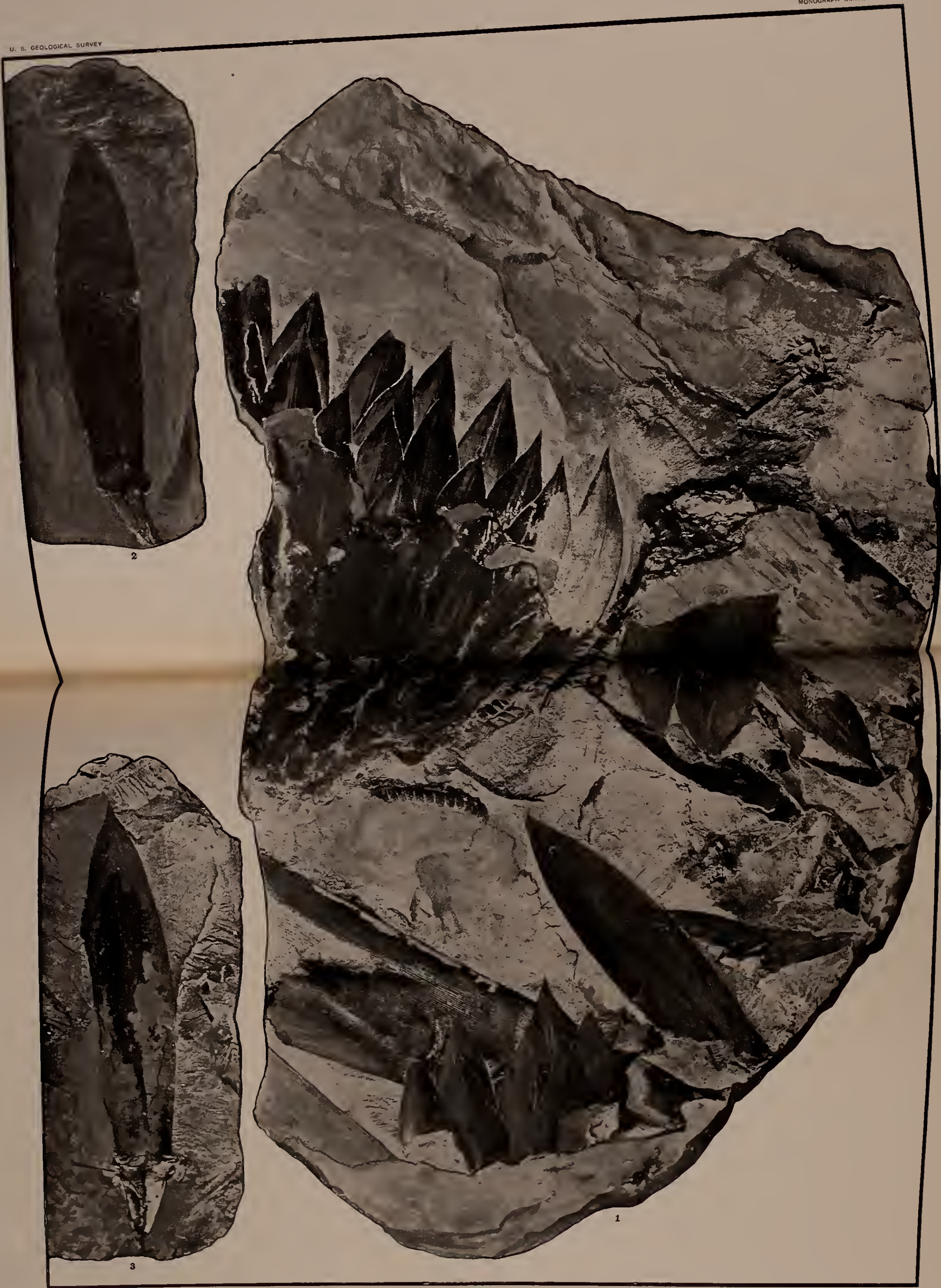


3

1

LYCOPODIALES: LEPIDOSTROBUS AND LEPIDOPHYLLUM.



LYCOPODIALES LEPIDOSTROBUS AND LEPIDOPHYLLUM.

PLATE LXI.

431

PLATE LXI.

Ferruginous sandstone from Gilkerson's Ford, Grand River, Missouri. U. S. Nat. Mus., 5065.

LEPIDOPHYLLUM MISSOURIENSE D. W.

(Page 216.)

FIG. 1*a*. Fragments scattered over slab. The sporangiophore and midrib are well shown in a specimen in the upper middle of the plate.

LEPIDOCYSTIS MISSOURIENSIS D. W.

(Page 218.)

FIG. 1*b*. Spore cases of *Lepidophyllum* (*Lepidostrobus*) *missouriense*. Most of them are longitudinally ruptured and are spread out, the spores having been discharged.

2. Isolated empty spore case.

LEPIDOPHLOIOS VAN INGENI D. W.

(Page 205.)

FIG. 1*c*. Detached and isolated bolsters.

CALLIPTERIDIUM INÆQUALE LX.

(Page 123.)

FIG. 1*d*. Fragments of pinnæ.

CARDIOCARPON BRANNERI Fairch & D. W.

(Page 266.)

FIG. 1*e*. The normal form of the seed with its wing is shown in the example on the right.

LINOPTERIS GILKERSONENSIS D. W.

(Page 139.)

FIG. 1*f*. Pinnule of ordinary size and form. It lies just below the specimen to which reference was last made.

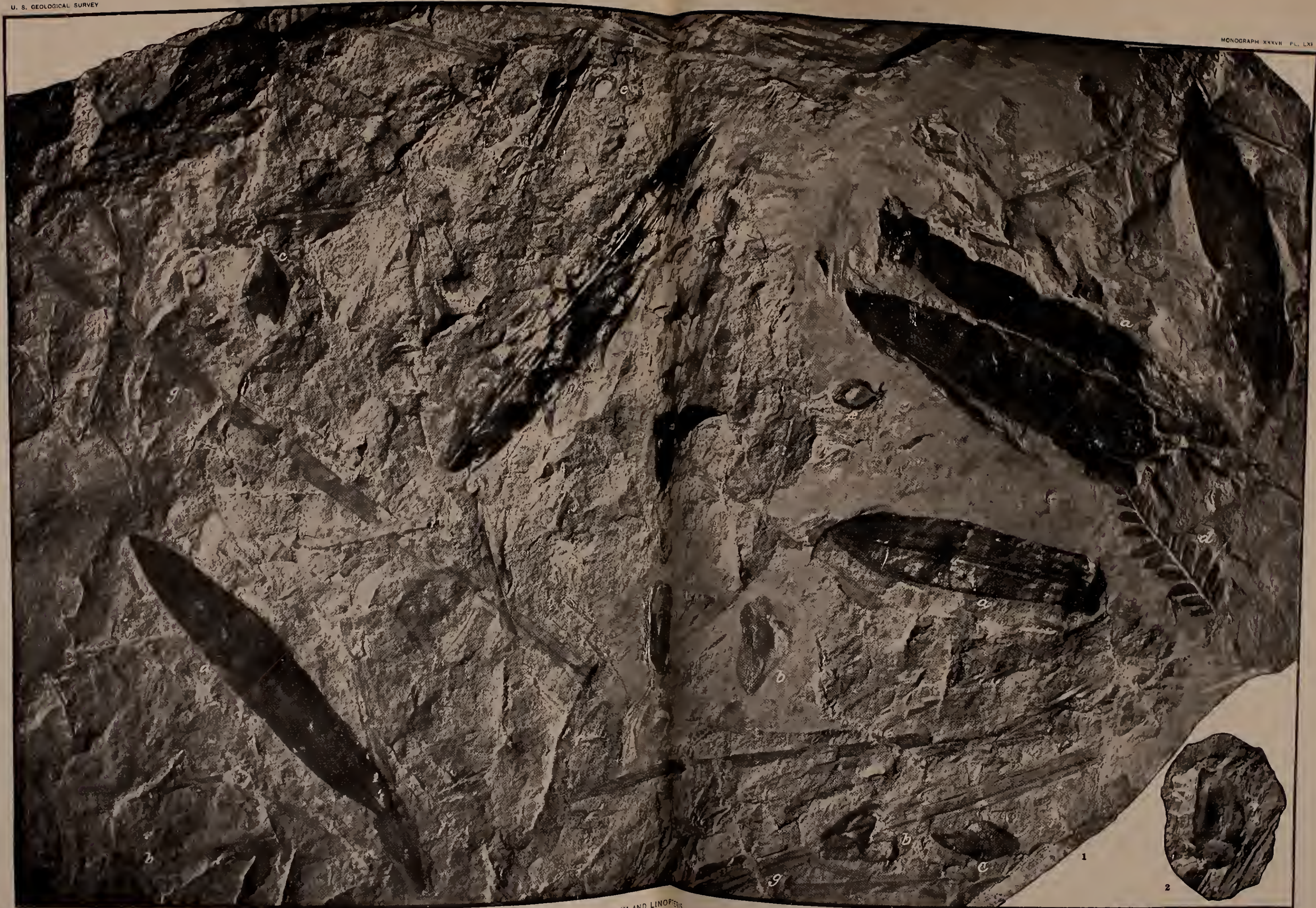
SIGILLARIA CAMPTOTÆNIA Wood?

(Page 230.)

FIG. 1*g*. Sigillarioid leaves, probably preferable to *S. camptotænia* Wood, which is found associated in the same stratum.

FERNS: CALLIPTERIDIUM AND
LYCOPODIALES: LEPIDOPHLOIC
CORDAITALES: CARDIOCARPON.

IS.
OPHYLLUM, AND LEPIDOCYSTIS.



FERNS: CALLIPTERIDIUM AND LINOPTERIS
LYCOPODIALES: LEPIDOPHLOIOS, LEPIDOPHYLLUM, AND LEPIDOCYSTIS.
CORDAITALES: CARDIOCARPON.

PLATE LXII.

PLATE LXII.

Ferruginous sandstone from Gilkerson's Ford, Grand River, Missouri. U. S. Nat. Mus., 5065. (The back side of this slab is photographed in Pl. LXI.)

Lepidophyllum missouriense D. W.

(Page 217.)

Fig. *a*. Several bracts scattered over slab. The upper one on the right is the most slender example yet seen. U. S. Nat. Mus., 6065.

Lepidocystis missouriensis D. W.

(Page 217.)

Fig. *b*. Collapsed spore cases. The specimen to the right of the center of the slab, and especially that in the upper extreme left, are typical of the size and form of the ruptured and spread spore cases of *Lepidostrobus missouriensis*.

c. Spore cases compressed, but not ruptured.

Triletes of Lepidostrobus missouriensis.

(Page 217.)

Fig. *d*. Macrospores of the above species. On the left are seen the agglomerated spores as contained in two of the spore cases. The masses retain the size and form of the flattened spore cases, though the latter have been removed.

e. Scattered and isolated macrospores of the same. The triradiate surface sculpture of these is shown in the enlarged details from this specimen given in Pl. LXIII, Figs. 3, 3*a*.

Lepidophloios Van Ingeni D. W.

(Page 205.)

Fig. *f*. Isolated bolsters.

Callipteridium inæquale Lx.

(Page 123.)

Fig. *g*. Fragments of pinnæ.

Lepidostrobus princeps Lx.

(Page 212.)

Fig. *h*. Portion of rather small cone showing long sporangiophores at the base and fragments of bracts. The sporangiophores are very oblique in this example.

Sigillaria camptotænia Wood?

(Page 230.)

Fig. *i*. Fragments of Sigillarioid leaves, presumably referable to the associated species, *Sigillaria camptotænia*. They may, however, represent a *Lepidodendron*.

FERNS: CALLIPTERIDIUM.
LYCOPODIALES: LEPIDOSTROBUS, LEPIDOPHYLLUM, LE

YSTIS, TRILETES, LEPIDOPHLOIOS, AND SIGILLARIOID LEAVES.

FERNS: CALLIPTERIDIUM.
LYCOPODIALES: LEPIDOSTROBUS, LEPIDOPHYLLUM, LEPIDOCYSTIS TRILETES, LEPIDOPHLOIOS, AND SIGILLARIOID LEAVES

PLATE LXIII.

PLATE LXIII.

LEPIDOSTROBUS PRINCEPS Lx.

(Page 212.)

FIG. 1. Fragment of broken cone showing the very broad axis and the crowded sporangiophores on either side. The blades of the bracts are broken away. U. S. Nat. Mus., 6066.
2. Portion of cone showing long bracts. U. S. Nat. Mus., 6071.

TRILETES OF LEPIDOSTROBUS MISSOURIENSIS D. W.

(Page 217.)

FIG. 3. Enlarged detail from Fig. *d*, Pl. LXII. ×2.
3a. Enlarged detail of isolated macrospores, Pl. LXII, Fig. *e*. ×4.

TÆNIOPHYLLUM LATIFOLIUM D. W.

(Page 247.)

FIG. 4. Small axis, showing leaves on the right. U. S. Nat. Mus., 6070.

LEPIDOPHLOIOS VAN INGENI D. W.

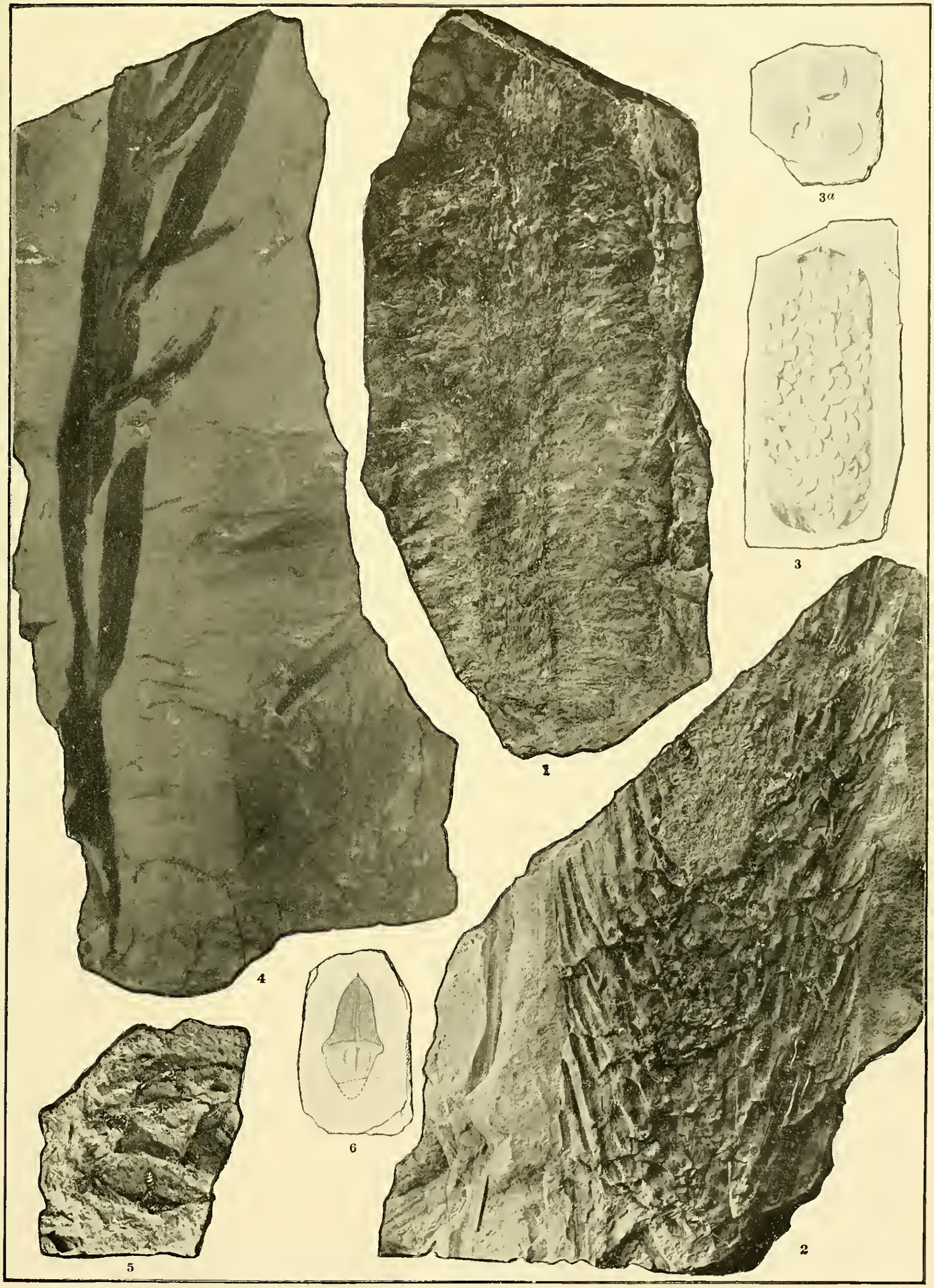
(Page 205.)

FIG. 5. Detached bolsters, slightly deformed. U. S. Nat. Mus., 6075.

LEPIDOPHYLLUM JENNEYI D. W.

(Page 214.)

FIG. 6. Specimen showing acuminate apex. U. S. Nat. Mus., 6070.



LYCOPODIALES: LEPIDOPHLOIOS, LEPIDOSTROBUS, TRILETES, AND TÆNIOPHYLLUM

PLATE LXIV.

PLATE LXIV.

LEPIDOSTROBUS PRINCEPS Lx.

(Page 212.)

FIG. *a*. Segment of cone from which a large portion of the blades have been broken away. U. S. Nat. Mus., 6057.

LEPIDOCYSTIS MISSOURIENSIS D. W.?

(Page 216.)

FIG. *b*. Specimen very small for this species.

LINOPTERIS GILKERSONENSIS D. W.

(Page 139.)

FIG. *c*. Pinnule, showing straight form of the species.

NEUROPTERIS SCHEUCHZERI Hoffm.

(Page 132.)

FIG. *d*. Incomplete pinnule of the *angustifolia* form.

SIGILLARIOID LEAVES.

(Page 230.)

FIG. *e*. Very long Sigillarioid or Lepidodendroid leaves, probably referable to *Sigillaria camptotænia* Wood.

FERNS: NEUROPTERIS AND LINOPTERIS.
LYCOPODIALES: LEPIDOSTROBUS, LEPIDOCYSTIS, AND SIGILLARIOID LEAVES

PLATE LXV.

PLATE LXV.

OMPHALOPHLOIOS CYCLOSTIGMA Lx. sp.

(Page 218.)

Fragment of impression of compressed trunk showing rhomboidal bolsters within which are crushed or folded, rounded, prominences or bosses. U. S. Nat. Mus., 6024.

LYCOPODIALES: OMPHALOPHLOIOS.

PLATE LXVI.

PLATE LXVI.

OMPHALOPHLOIOS CYCLOSTIGMA Lx. sp.

(Page 218.)

FIG. 1. Impression of old stem in which the bosses are crushed, with infolded cortex upon the bolster surface. This is one of the originals described by Professor Lesquereux as *Lepidodendron cyclostigma*. Lacoe collection, U. S. Nat. Mus., 5502.

1*a*. Enlarged detail of bolster of the same. $\times 2$.

2. Cortex from which the epidermis has partly been removed. The bosses, resembling Lepidodendroid leaf scars, are not so compressed as in the other cases. U. S. Nat. Mus., 6025.

2*a*. Detail of bolsters from No. 6025. $\times 2$.

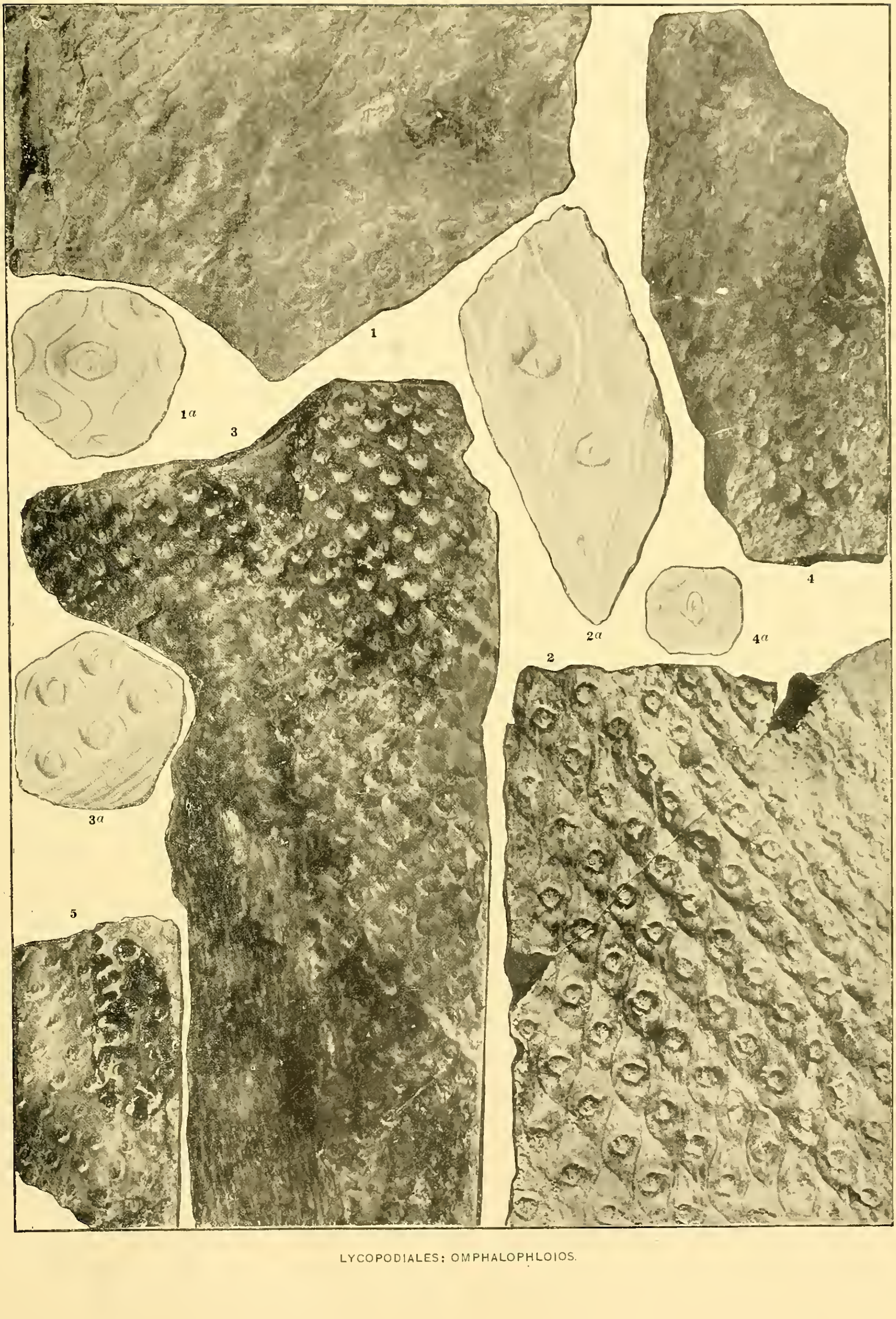
3. Impression of young trunk, to which the epidermis has adhered. The form of the bolsters is obscured by the prominent large bosses, in which may be seen the small raised oval bosses. Collection of Dr. J. H. Britts, Clinton, Missouri.

3*a*. Detail of bolsters of the same. $\times 2$.

4. Young stem, or branch, with rounded cortical depressions in the lower portion. The aspect of the partially decorticated stem is also seen. The photograph is inverted on the plate. U. S. Nat. Mus., 6027.

4*a*. Detail from the same.

5. Fragment of young branch from which the epidermis has been removed. U. S. Nat. Mus., 6028.



LYCOPODIALES: OMPHALOPHLOIOS.

PLATE LXVII.

443

PLATE LXVII.

OMPHALOPHLOIOS CYCLOSTIGMA Lx. sp.

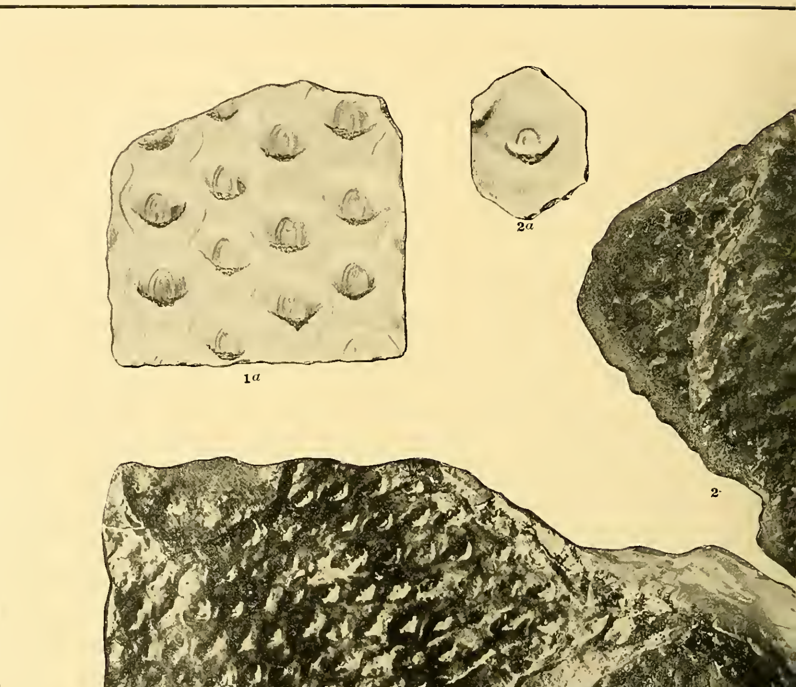
(Page 218.)

FIG. 1. Portion of flattened and apparently forked trunk. The mold of the compressed branch has been removed from the upper left, leaving the impression of the back side of the branch. The back side of the cast, or branch itself, is shown in Fig. 2. On the right and in the lower part of Fig. 1 the outlines of the bolsters are discerned, while the more or less flattened and deformed bosses are seen throughout. In the left center the inner small oval bosses, including the shallow oval pits, are visible. The prominent, transverse, broken surface, tangent or slightly connivent with the lower end of the oval boss, is construed as representative of the leaf cicatrix. U. S. Nat. Mus., 5636.

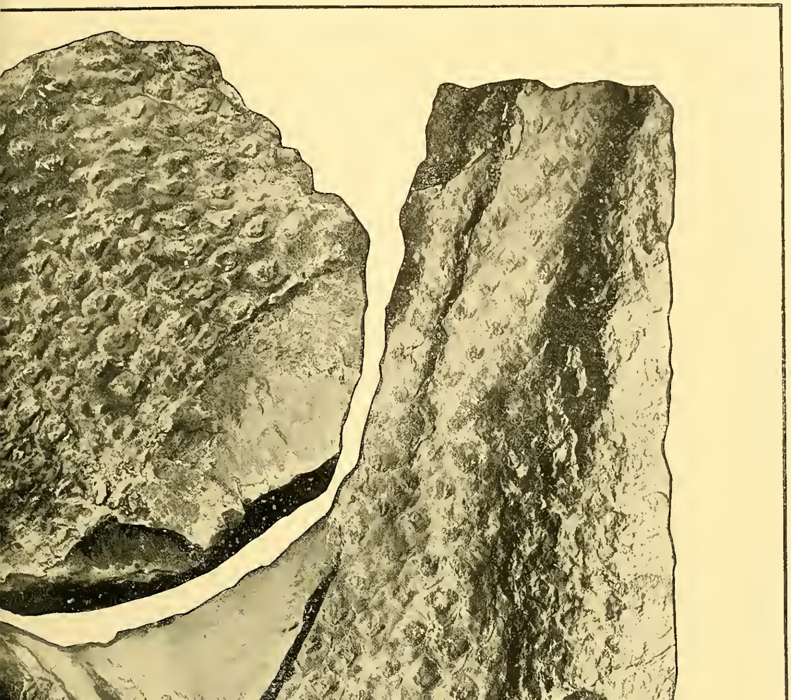
1a. Enlarged details of bolsters on the left of the same specimen, showing the oval boss with central oval depression containing small mammilla. The transverse line of fracture, supposed to represent the leaf scar, is not so well shown. ×2.

2. Back side of portion of branch removed from the left of the trunk shown in Fig. 1. The opposite side of this fragment is shown in Pl. LXVIII, Fig. 1. U. S. Nat. Mus., 6029.

2a. Detail from the same, showing supposed leaf scar. ×2.



LYCOPODIALES



ALOPHLOIOS.

LYCOPODIALES OMPHALOPHLOIOS.

PLATE LXVIII.

PLATE LXVIII.

OMPHALOPHLOIOS CYCLOSTIGMA Lx. sp.

(Page 218.)

FIG. 1. Photographic enlargement of face of the portion of flattened branch removed from the upper left of the large trunk shown in Fig. 1, Pl. LXVII. The bolster outlines are more or less distinctly seen, as well as the oval bosses and central depressions. As usual the prominent, shallowly transversely triangular area, just beneath the oval boss, supposed to represent the leaf scar, is more or less abraded. U. S. Nat. Mus., 6029. ×2.

1*a*. Enlarged details of bolsters in same specimen. ×2.

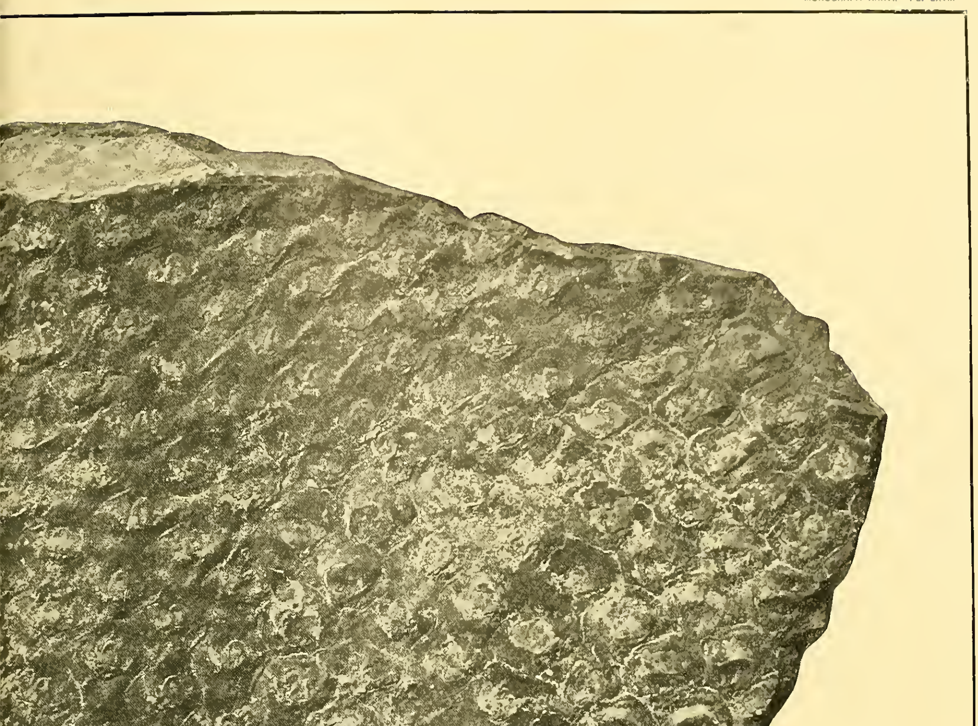
2. Fragment from impression of crushed stem. U. S. Nat. Mus., 6030.

1a

2

LYCOPODIAI

(Fig. 1 i

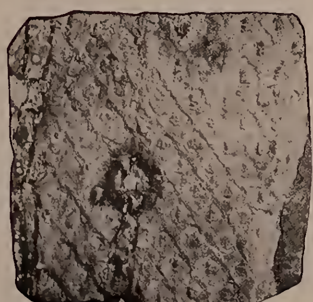


1

PHALOPHLOIOS.

natural size.)

1a



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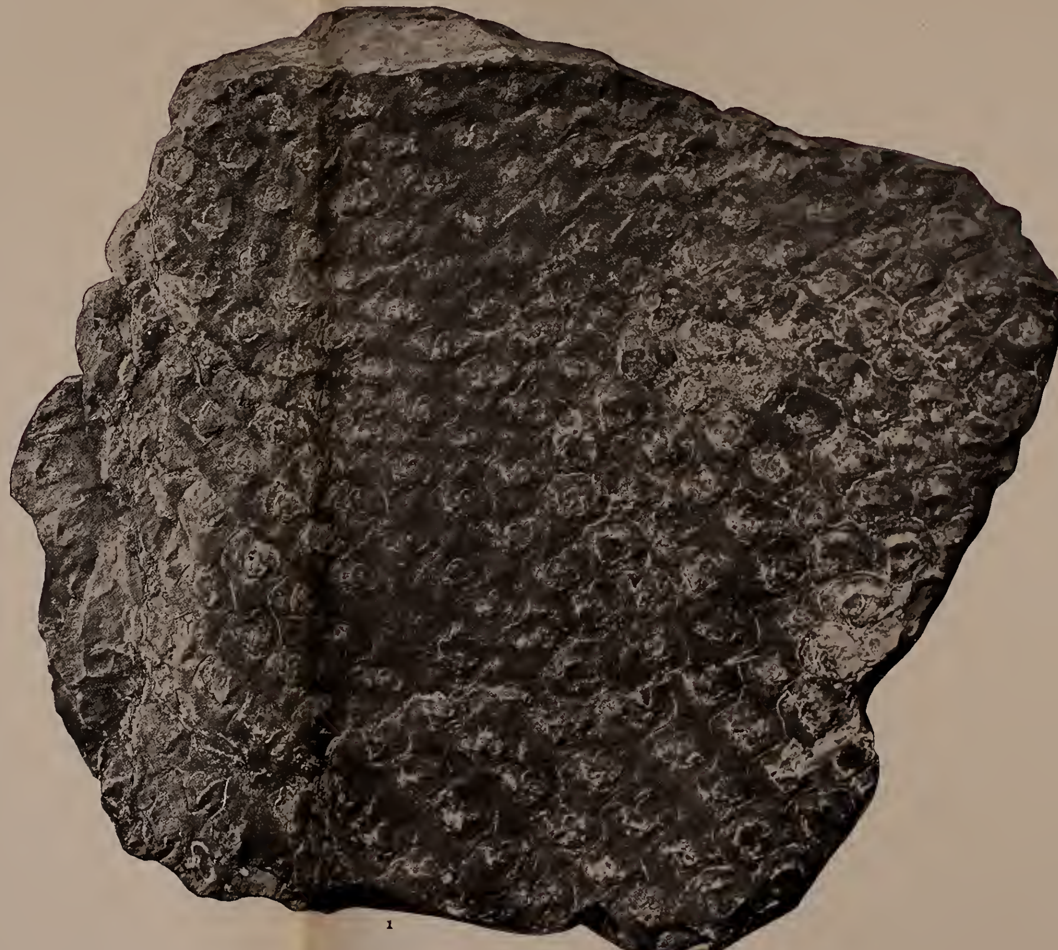


1

LYCOPODIALES: OMPHALOPHLOIOS.

(Fig. 1 is twice the natural size.)

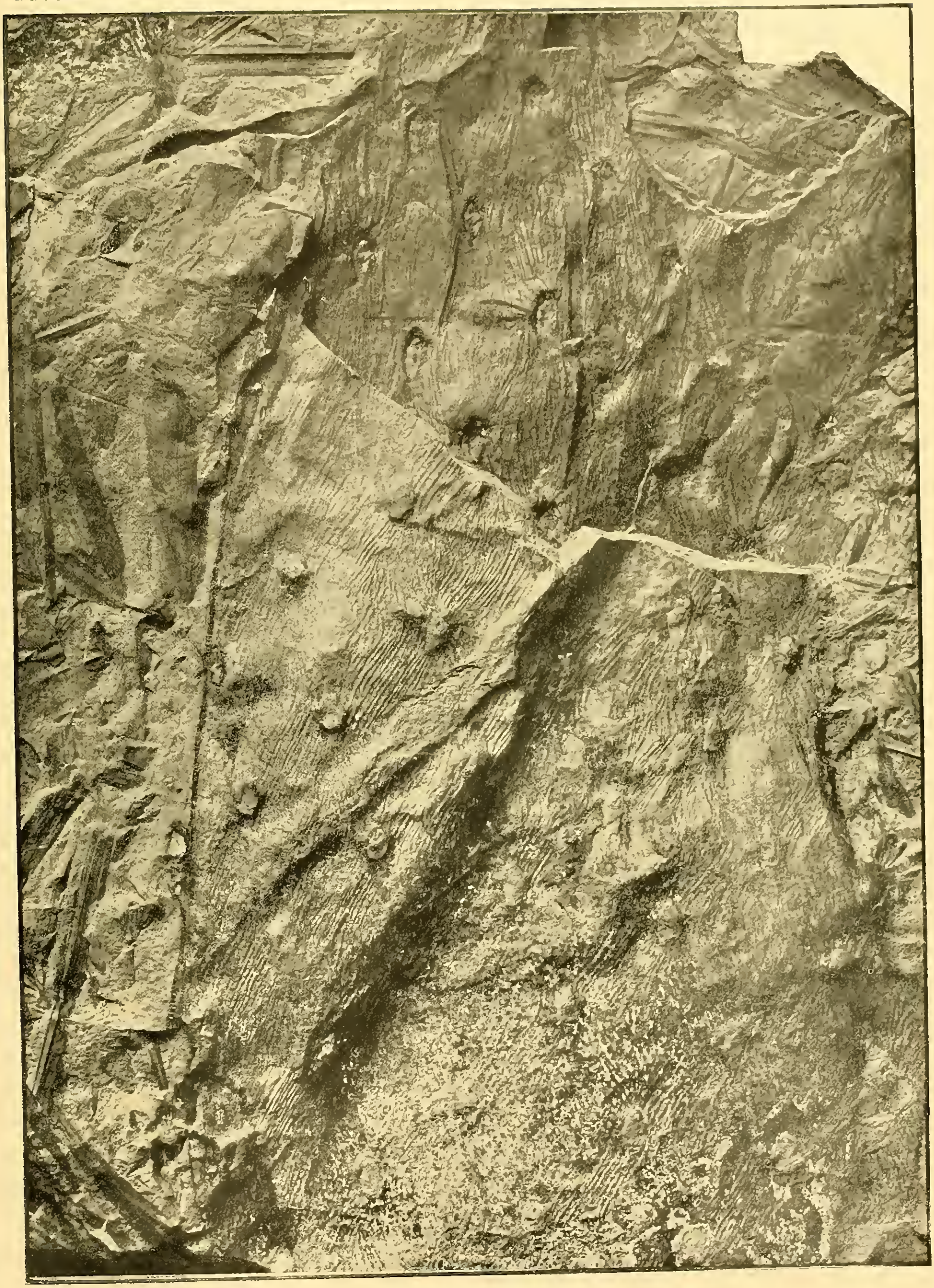
PLATE LXIX.

PLATE LXIX.

SIGILLARIA CAMPTOTÆNIA Wood.

(Page 230.)

Part of a slab, in the lower part of which is a portion of a flattened trunk. The impression of the back side of the trunk is continued to the top of the slab. Between the subepidermal casts of the leaf scars are seen the diagonal systems of cross-striation of the cortex characteristic of the *Subsigillariæ*. U. S. Nat. Mus., 6057.



LYCOPODIALES: SIGILLARIA.

PLATE LXX.

PLATE LXX.

SIGILLARIA CAMPTOTÆNIA Wood.

(Page 230.)

FIG. 1. Fragment from young stem, partially deprived of the epidermis. U. S. Nat. Mus., 6063.

3. Another stem in which both the leaf scars and the diagonal cross-striation, usually less clearly seen when the epidermis is preserved, are shown. U. S. Nat. Mus., 6064.

3a. Enlarged detail showing leaf scars, supra- and subjacent shields, and cortical aspect; from the same specimen. ×2.

3b. Enlarged detail of leaf scar and environment; from same. ×4.

4. Surface of fragment of old trunk, from which the epidermis is partly removed. It shows the casts of the narrow, short bolsters. U. S. Nat. Mus., 6052.

4a. Partially decorticated bolster of the same. ×2.

4b. Bolster of same, without epidermis and leaf cicatrix. ×2.

STIGMARIOID IMPRESSION.

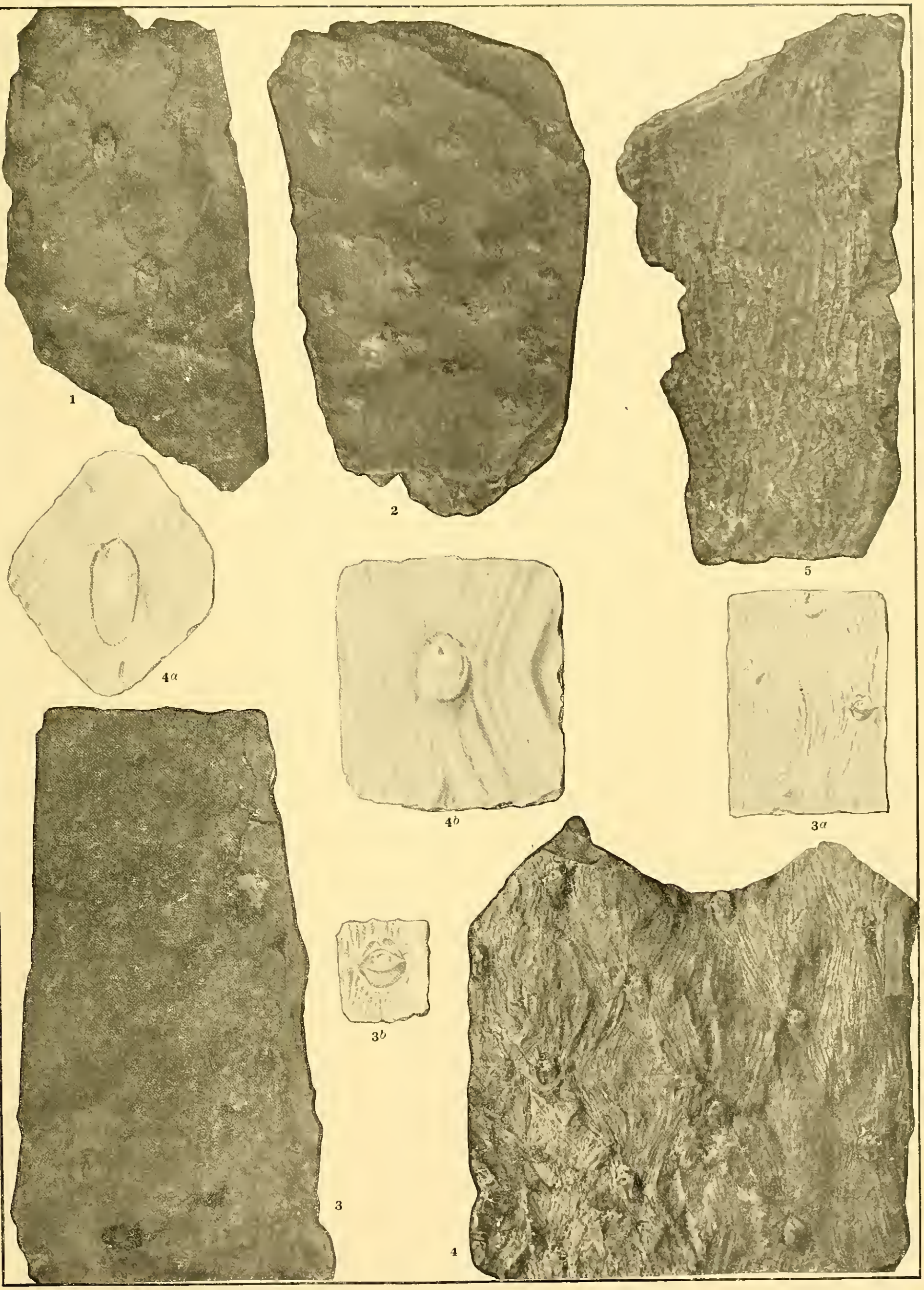
(Page 246.)

FIG. 5. Impression, apparently Stigmarian in nature, with deep diagonal cross wrinkling, perhaps referable to *Sigillaria camptotænia* Wood. U. S. Nat. Mus., 6067.

SIGILLARIA SIGILLARIOIDES Lx. sp.

(Page 230.)

FIG. 2. Portion of flattened stem. The fragment photographed is the "reverse" of the original type, described and illustrated (Coal Flora, p. 425, pl. lxviii, figs. 8, 8*a*) as *Lepidophloios sigillarioides* Lx. Lacoe collection, U. S. Nat. Mus., 6659.



LYCOPODIALES: SIGILLARIA

PLATE LXXI.

PLATE LXXI.

TÆNIOPHYLLUM LATIFOLIUM D. W.

(Page 247.)

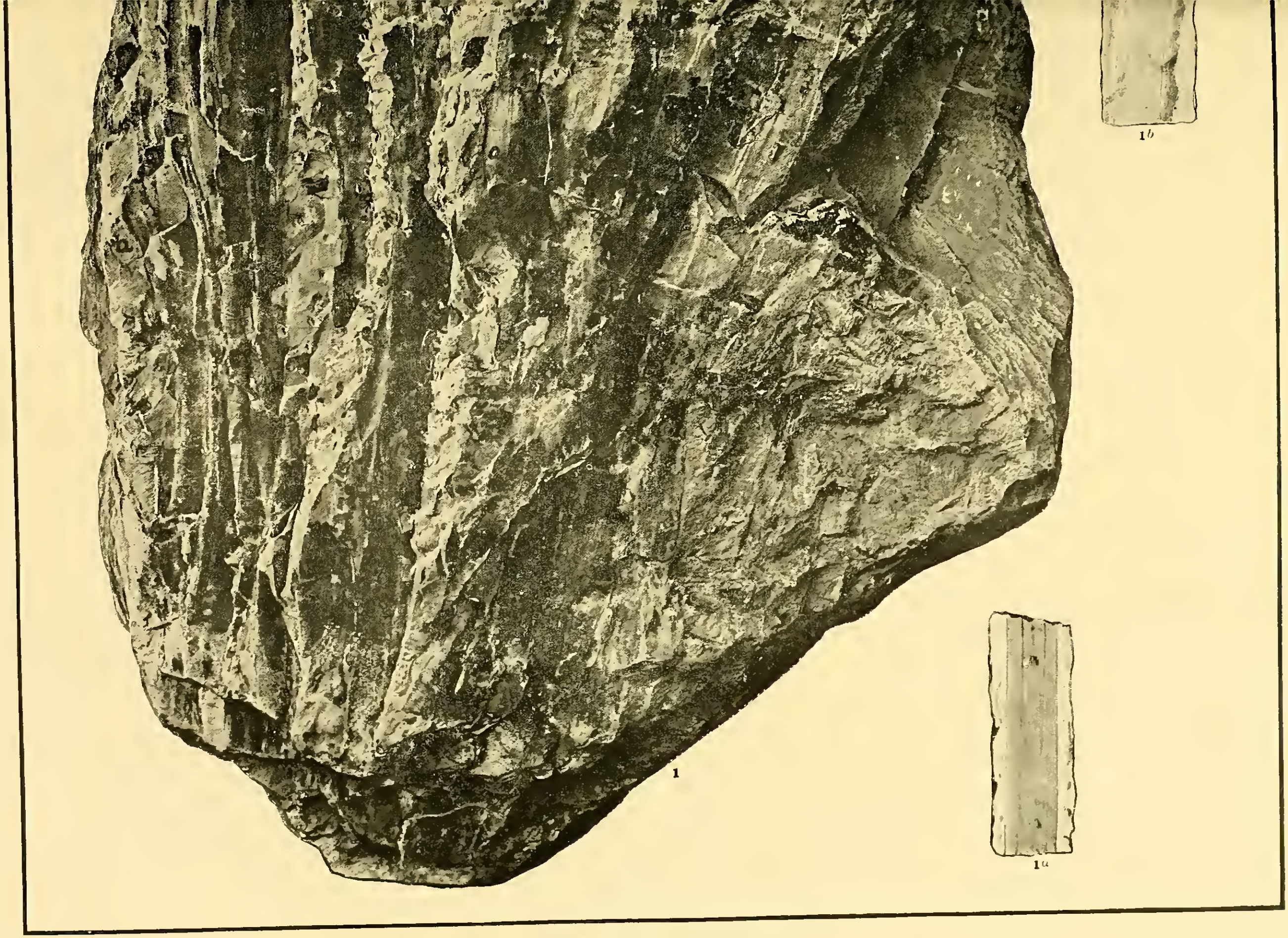
FIG. 1. Slab covered by broad parallel leaves. The thin carbonaceous scale is removed from portions of the surface, showing faintly the position of the loose flexuose vascular band traversing each leaf. Small leaves are emitted, distantly, from the large ones, the point of union giving a somewhat Stigmarioid impression. Such an impression is seen about 2.5 cm. below the upper end of the broad leaf in the upper center of the rock. U. S. Nat. Mus., 6068.

1*a*. Detail of same showing faint lineation of the leaf.

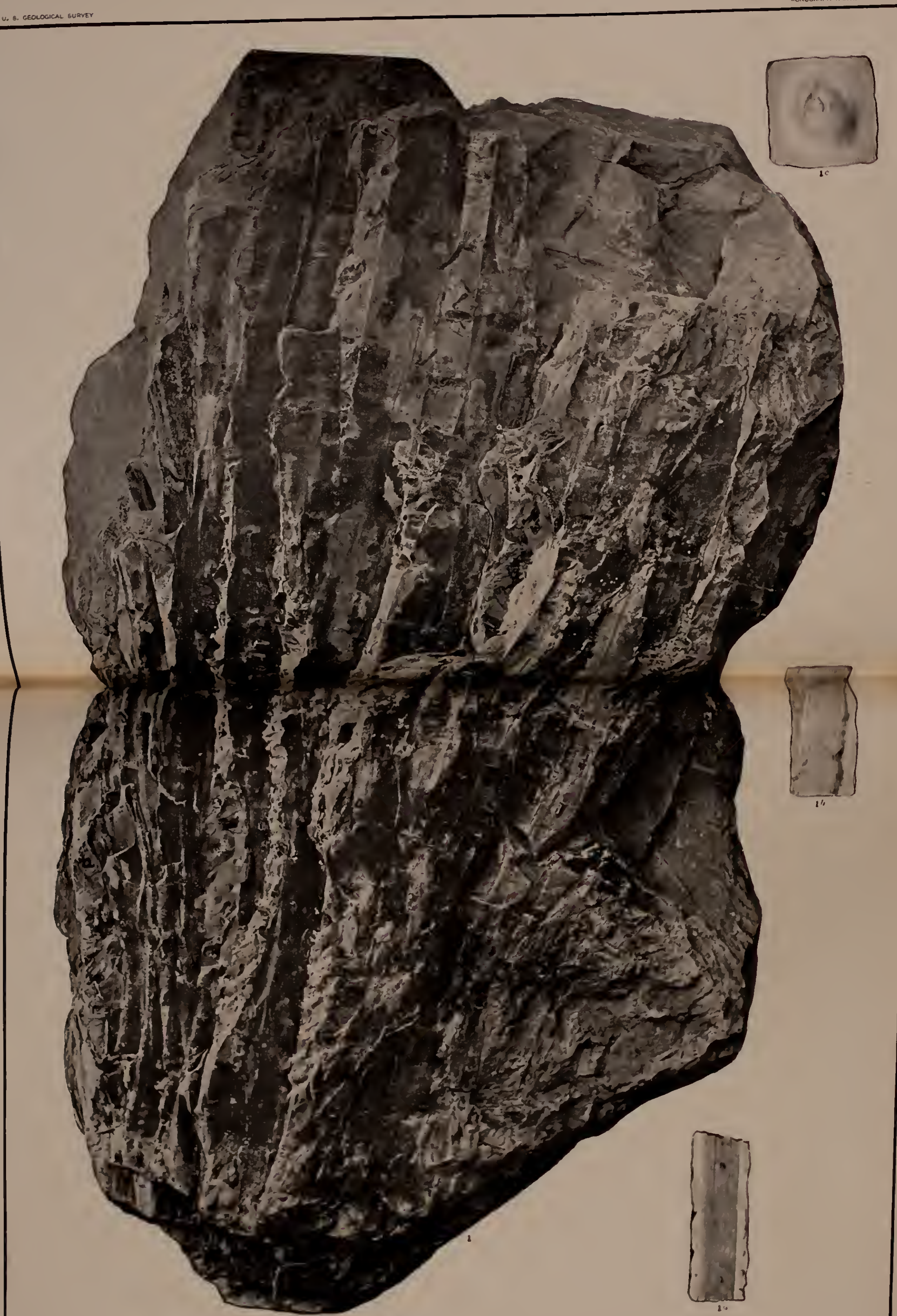
1*b*. Fragment of leaf showing position of two branches.

1*c*. Detail of the attachment of a small leaf near the top of and on the back side of the large leaf in the upper center as expressed through the leaf. It also shows the lineation of the leaf. ×4.

1c



LYCOPODIALES?: TÆNIOPHYLLUM.



LYCOPODIALES? TÆNIOPHYLLUM

PLATE LXXII.

PLATE LXXII.

CORDAIANTHUS OVATUS Lx.

(Page 262.)

FIG. 1. Fragment with very small gemmules. U. S. Nat. Mus., 6073.

1*a*. Detail of gemmules and spine from same. ×2.

2. Portion of spike with large gemmules. This specimen was identified under the above name by Professor Lesquereux. With it are fragments of a *Cordaites*, probably *C. communis* Lx., and of a macerated *Pecopteris pseudovestita*. Lacoe collection, U. S. Nat. Mus., 9202.

2*a*. Enlarged detail of gemmule on upper left of the fragment of *Cordaianthus ovatus*. ×2.

CARDIOCARPON BRANNERI Fairch. & D. W.

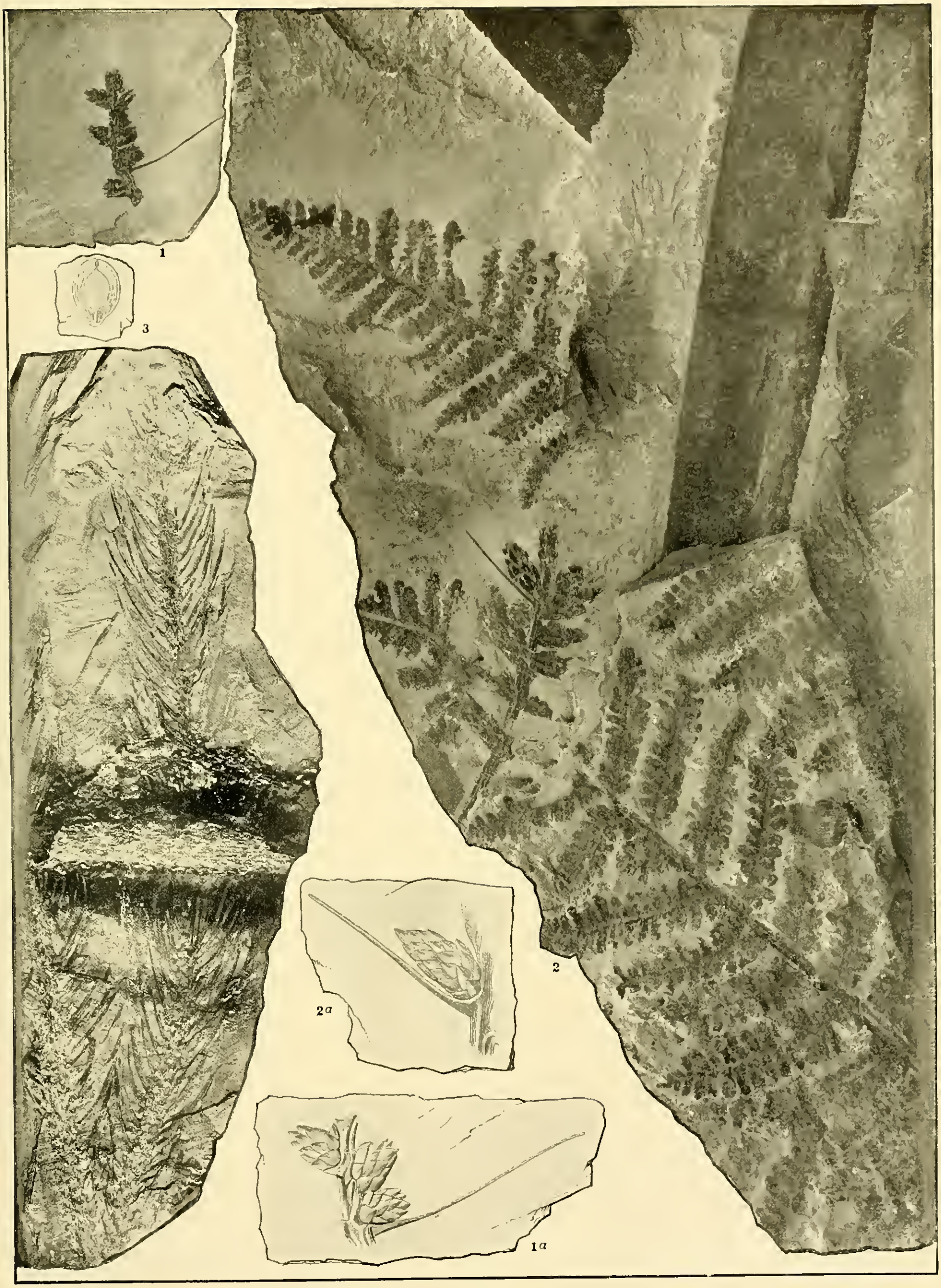
(Page 266.)

FIG. 3. Specimen showing nucleus and wing. The basal dilation is exceptionally narrow in this example. U. S. Nat. Mus., 6065.

LEPIDODENDRON SCUTATUM Lx.

(Page 198.)

FIG. 4. Branchlets showing characteristic attitude of the leaves. U. S. Nat. Mus., 6074.



FERNS: PECOPTERIS.
LYCOPODIALES: LEPIDODENDRON.
CORDAITALES: CORDAITES, CORDAIANTHUS, AND CARDIOCARPON.

PLATE LXXIII.

PLATE LXXIII.

DICRANOPHYLLUM? sp.

(Page 272.)

FIG. 1. Photograph showing aspect of a specimen doubtfully referred to the above genus, but which may be Algoid in its nature. The fossil is somewhat macerated. A detail from the same is given in Pl. XLI, Fig. 10. U. S. Nat. Mus., 6076.

LEPIDOCYSTIS MISSOURIENSIS D. W.

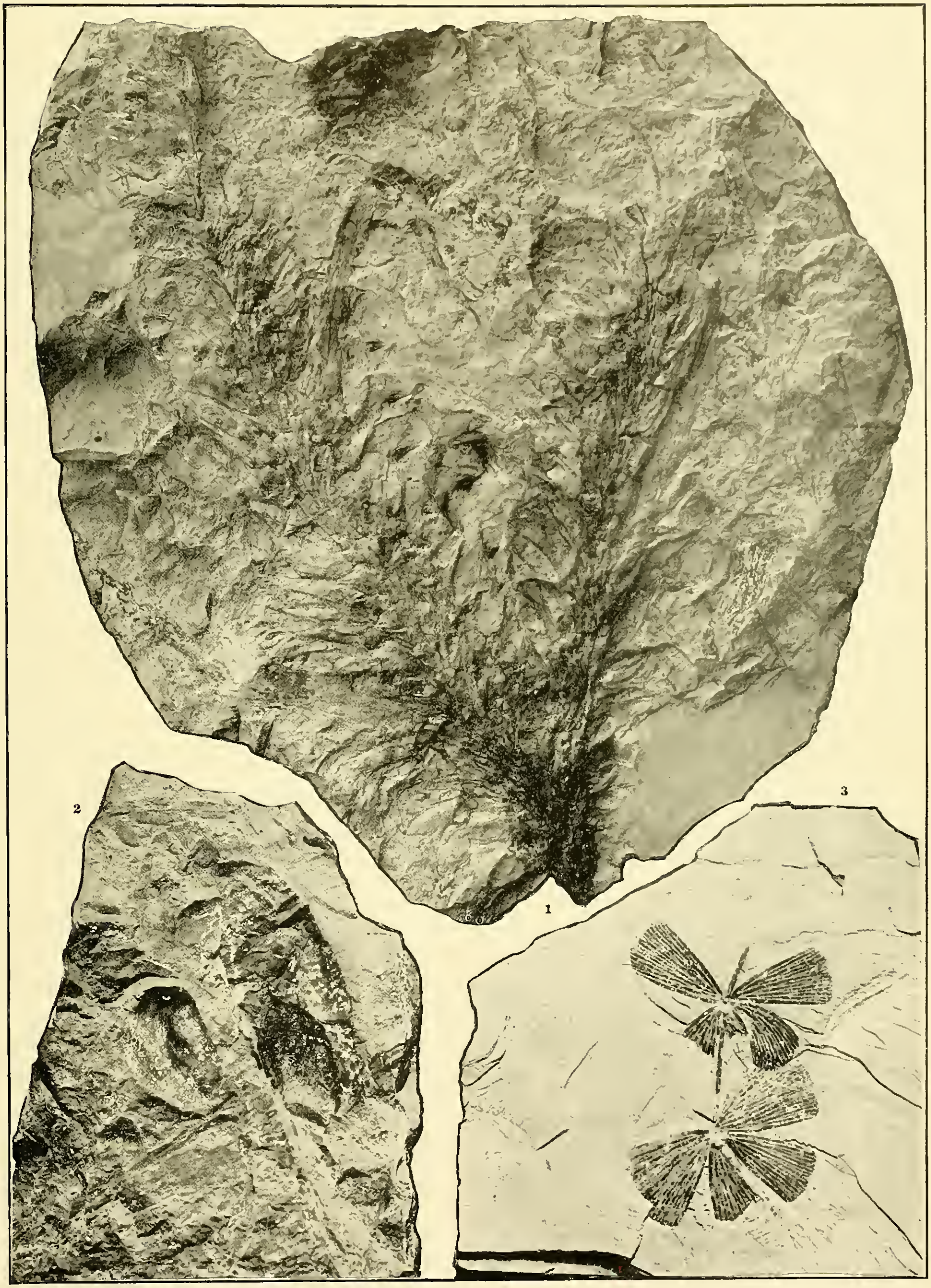
(Page 216.)

FIG. 2. Partially compressed spore case in sandstone.

SPHENOPHYLLUM MAJUS Bronn.

(Page 180.)

FIG. 3. Verticils showing nervation of the leaves. U. S. Nat. Mus., 5680.



LYCOPODIALES: LEPIDOCYSTIS.
SPHENOPHYLLALES: SPHENOPHYLLUM.
GYMNOSPERM: DICRANOPHYLLUM?

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29	Nevada City: Nevada City Grass Valley Banner Hill	California	121° 00′ 25″-121° 03′ 45″ 121° 01′ 35″-121° 05′ 04″ 120° 57′ 05″-121° 00′ 25″	39° 13′ 50″-39° 17′ 16″ 39° 10′ 22″-39° 13′ 50″ 39° 13′ 50″-39° 17′ 16″	11.65 12.09 11.65	50
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31	Pyramid Peak	California	120°-120° 30′	38° 30′-39°	932	25
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Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

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Mineral Resources of the United States, 1894, David T. Day, Chief of Division. 1895. 8°. xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl. Being Parts III and IV of the Sixteenth Annual Report.

Mineral Resources of the United States, 1895, David T. Day, Chief of Division. 1896. 8°. xxiii, 542 pp., 8 pl. and maps; iii, 543-1058 pp., 9-13 pl. Being Part III (in 2 vols.) of the Seventeenth Annual Report.

Mineral Resources of the United States, 1896, David T. Day, Chief of Division. 1897. 8°. xii, 642 pp., 1 pl.; 643-1400 pp. Being Part V (in 2 vols.) of the Nineteenth Annual Report.

Mineral Resources of the United States, 1897, David T. Day, Chief of Division. 1898. 8°. viii, 651 pp., 11 pl.; viii, 706 pp. Being Part VI (in 2 vols.) of the Nineteenth Annual Report.

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