ART. VI.—*Cordaitean Wood from the Indiana Black Shale;* by MARION G. ELKINS and G. R. WIELAND. With Plates I and II.

I. ILLUSTRATION AND DESCRIPTION (by Miss Elkins).

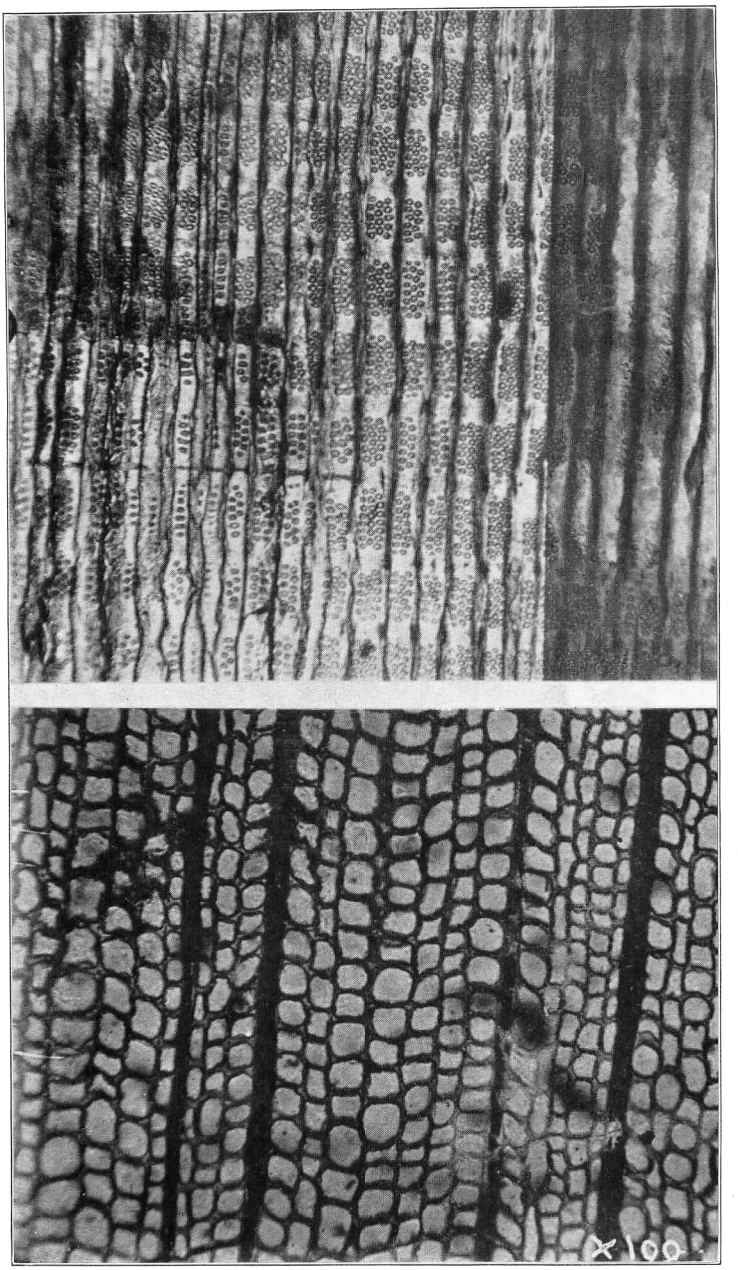
Early in the year 1911, Dr. G. R. Wieland handed me for description three sections of Cordaitean wood, which he had prepared from Yale Museum material, and in addition, certain of his notes concerning these sections and four photomicrographs, which accompany this paper. In regard to this material, Dr. Wieland says:

"I noticed among some unstudied examples of silicified wood in the Yale collections a medium sized hand specimen from Lexington, Scott County, Indiana, which had evidently been acquired many years ago from Mr. J. H. Thompson of Hanover. Later, on inquiry, Dr. Edward M. Kindle, who is thoroughly familiar with the Indiana localities and stratigraphy, assured me that the specimen must certainly be from the Black Shales of the Upper Indiana Devonian, which are approximately of the same age as the Genesee Shales of New York. He also stated that sections of trunks, a foot or more in diameter, had at various times been noted in the Black Shales."

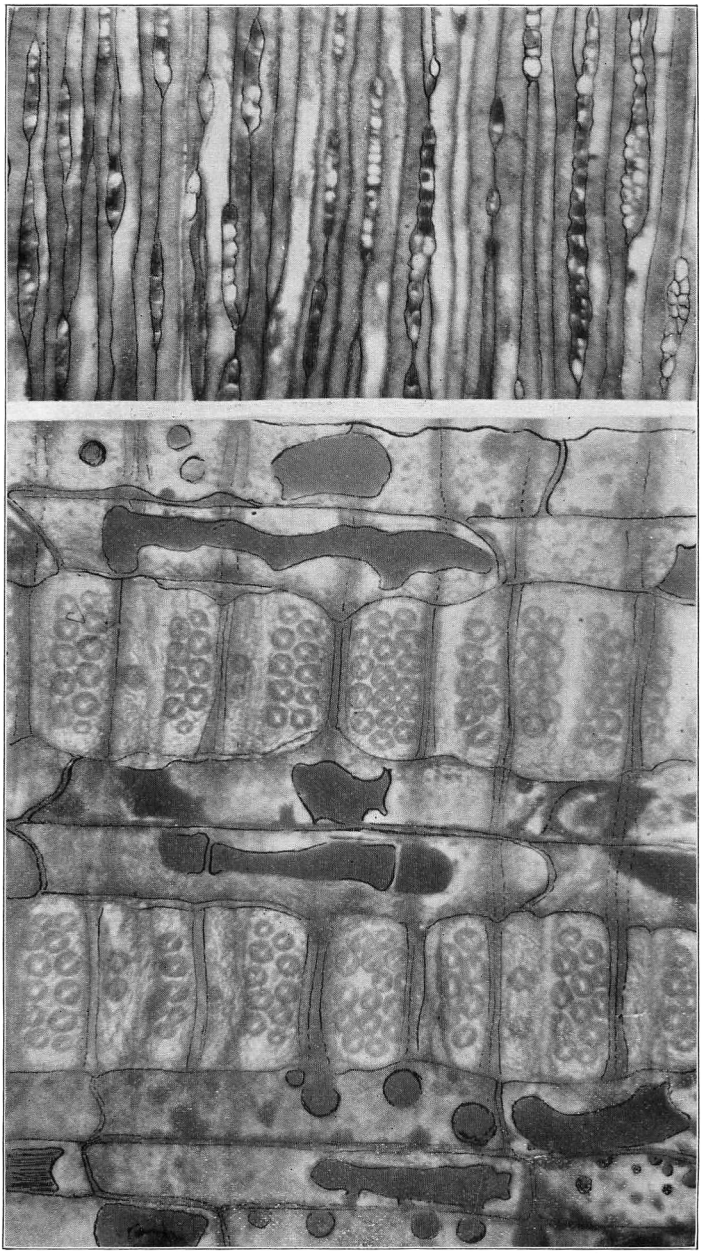
A further description of this locality is found in the Sixth Annual Report of the Geological Survey of Indiana, 1874:

"Resting on the black shale are found large fossil trees. Some of these specimens are of great size; all are silicified. The fossil tree exhumed from the black shale by J. Richardson and myself (W. W. Borden) on the land of E. B. Gurnsey near Henryville, Clarke County, and exhibited at the Indianapolis Exposition of 1873, measured over sixteen feet in length and two feet in diameter, and had a jointed structure which is a characteristic feature of all these fossil trees. Another large specimen of tree, measuring nineteen feet in length and three feet in the broadest part, being somewhat flattened, was taken from the black shale a short distance north of Vienna by James Powers of Lexington and exhibited at the Indianapolis Exposition of 1874. This fossil wood is very closely associated with the black shale, and large specimens are found in almost every outcrop on the headwaters of Silver Creek in Clarke County. I have never yet met with a specimen above the summit of the black shale. A stump of one of these fossil trees is to be seen in Finley Township."

The material sectioned by Dr. Wieland without doubt came from this locality, but it is not known whether the Yale hand specimen is a section of one of the trunks mentioned in the Indiana Report or not.



Callixylon (*Cordaites*) *Oweni*, sp. nov.



Callixylon (*Cordaites*) *Oweni*, sp. nov.

Preparation of Material.—Concerning the preparation of this material, Dr. Wieland says:

"The initial trial section was a transverse one cut from the entire specimen, 6 × 4 centimeters in area, and showed that the tissues had not been subjected to decay, although with the exception of a central area of about 2 × 1·2 centimeters, the cell walls had been crushed together into a nearly dense mass. Carefully oriented sections were next cut from the well-preserved central portions of the specimen, as thus indicated. As completed these are of exquisite beauty, and yield all the essential structural details."

The dimensions of the sections from the area of perfect conservation described here are: transverse, 25 × 15^{mm}; radial, 20 × 13^{mm}; tangential, 12 × 11^{mm}. These sections must have been cut with the very finest skill since they easily permit study under a 1/12 oil immersion focussed through the entire thickness, structure details being sharp over the entire section and from surface to surface.

Description of Material.—Before describing the material in hand, it may be of convenience to the reader to briefly recall the generic characters of Cordaitean wood.* The wood is made up entirely of tracheids. In the protoxylem they are spiral and scalariform; transition stages occur leading to the characteristic pitted tracheids of the secondary wood. The tracheids are conspicuously rectangular in cross section and occur in regular, radial rows. Hexagonal bordered pits appear only on the radial walls of the tracheid in from one to five vertical rows. This primitive multiseriate arrangement of pits is however likewise an Araucarineous feature. Penhallow in *North American Gymnosperms* speaks of the hexagonal form and compact arrangement of pits as being two constant Cordaitean characteristics. Growth rings, when present, are for the greater part obscure. Medullary rays are rather numerous, usually uniseriate, though often partly biseriate. The ray cells are mostly of one kind, long and thin walled; the terminal walls are oblique or curved; the lateral walls are alone provided with bordered pits. Specialized resin canals are wanting in the wood, though in one species, *Cordaites materiarum*, resinous plates occur in the tracheids near the rays. Wood parenchyma is unknown.† The secondary wood‡ of

*Penhallow, D. P.; Notes on the North American Species of Dadoxylon. Trans. Roy. Soc. Canada, vol. vi, sec. iv, p. 61, 1900–1901.

†Penhallow, D. P., North American Gymnosperms, p. 57, 1907.

‡Coulter, J. M., and Chamberlain, C. J., Morphology of Gymnosperms, p. 165, 1910. [Seward and Scott.]

Thomson, R. B., On the Comparative Anatomy and Affinities of the Araucarineæ. Phil. Trans. Roy. Soc. of London, ser. B, vol. cciv, pp. 1–50, pl's 1–7. May, 1913.

Cordaites so closely resembles that of *Araucaria* that it is "really indistinguishable."*

Penhallow, in his classification of North American species of *Dadoxylon*, places the species in two groups: in one group the growth rings are distinct, in the other group the growth rings are obscure or obsolete. In the first group the demarcation between the fall and spring wood is quite abrupt and well defined; in the second group, the annular appearance is mainly due to a line of tracheids with radially shortened diameters, the transition into the elements of the surrounding tissue taking place similarly and gradually on either side of the ring, so that it would be impossible to determine either the inner or the outer face if it were not for careful orientation. These two groups strongly suggest Araucarian affinities and ancient parallels to the *Dammara* and *Araucaria* types of modern Araucariæ.

FIG. 1.

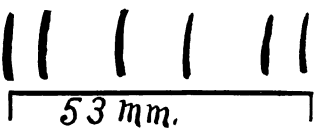


FIG. 1. Showing the proportional distance of six growth rings from each other. × 3.

The species under consideration, which, for convenience, will be referred to as the Indiana species, falls into the group with somewhat obscure growth rings and is, therefore, an Araucarioid type.

In a transverse section of the Indiana species, the growth rings, though not conspicuous, are quite apparent when viewed either macroscopically or microscopically. To the unaided eye they appear as fine parallel lines traversing a homogeneous field. In the section studied, the dimensions of which have already been given, there occur six growth rings; these vary in distance from each other in the proportion indicated in fig. 1. With the microscope the rings can be identified only

* Wood now referred to Cordaites was formerly called *Araucarioxylon*. and *Dadoxylon*. According to some authors, *Dadoxylon* is a general name for Paleozoic wood of Cordaitean type. Penhallow properly considers it a noncommittal term harboring forms of doubtful affinity. *Araucarioxylon* is of necessity often applied somewhat generally to post-carboniferous wood resembling *Araucaria*, but which may actually include woods of diverse families. *Cordaites* was first applied to woods known to accompany Cordaitean leaves and fruits. Now it is a group name including *Dadoxylon* and *Araucarioxylon*. Other terms applied to Cordaitean wood of infrequent use have here been avoided. Penhallow uses *Dadoxylon* as synonymous with *Cordaites*. For further discussion of Cordaitean nomenclature see the introduction to Penhallow's *Notes on the North American Species of Dadoxylon*; also see Coulter and Chamberlain's *Morphology of Gymnosperms*, Chapter IV, and especially Knowlton in Proc. U. S. National Mus., Vol. XII, 1889.

FIGS. 2–5.

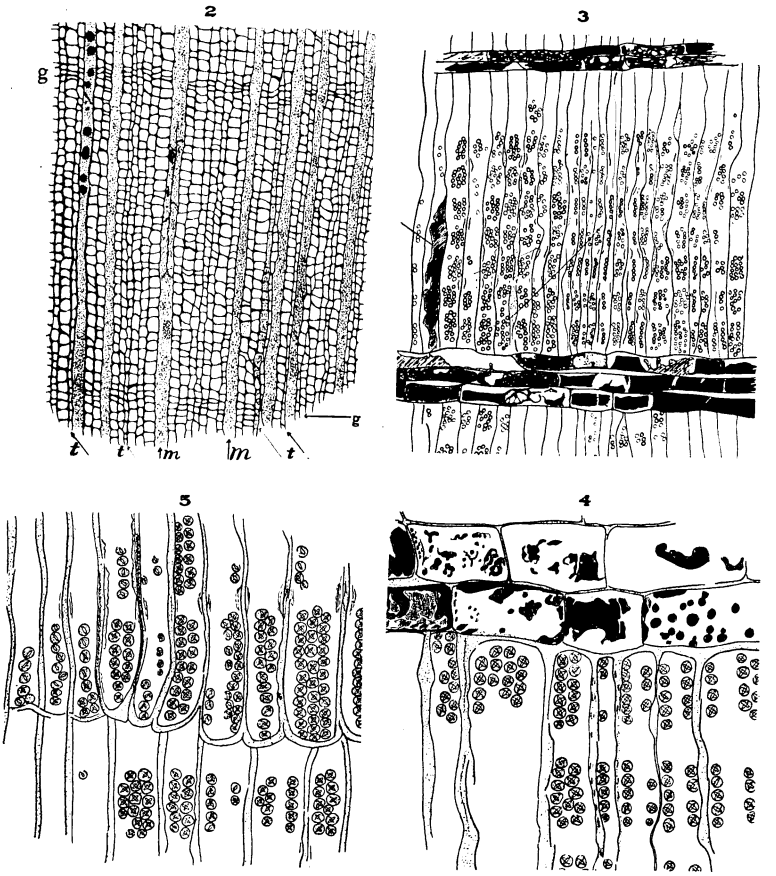


FIG. 2. Transverse section of wood showing two growth rings, *g*. *m*, medullary rays. The cellular structure of the medullary rays is not shown, as the cell walls are seen only with difficulty. Resinous tracheids occasional. The rows of tracheids marked *t* are probably near their terminations, hence of smaller diameter than the neighboring cells. (See similar cells in photomicrograph 1.) Note the isolated cells with shortened radial diameters. × 30.

FIG. 3. Radial section of wood showing rays and tracheids. Note the contents of the tracheid to the left. The pitless appearance of parts of tracheids is due to extreme thinness of section, both radial walls being cut away. A growth ring five cells broad traverses the middle of the figure. × 50±.

FIG. 4. Radial section of wood more highly magnified than fig. 3. The presence of a growth ring tracheid is indicated by single rows of pits in tracheid in midfield. The pits in the lower part of tracheids were cut away. The medullary ray is six cells in height, but only two rows of ray cells are shown. × 140.

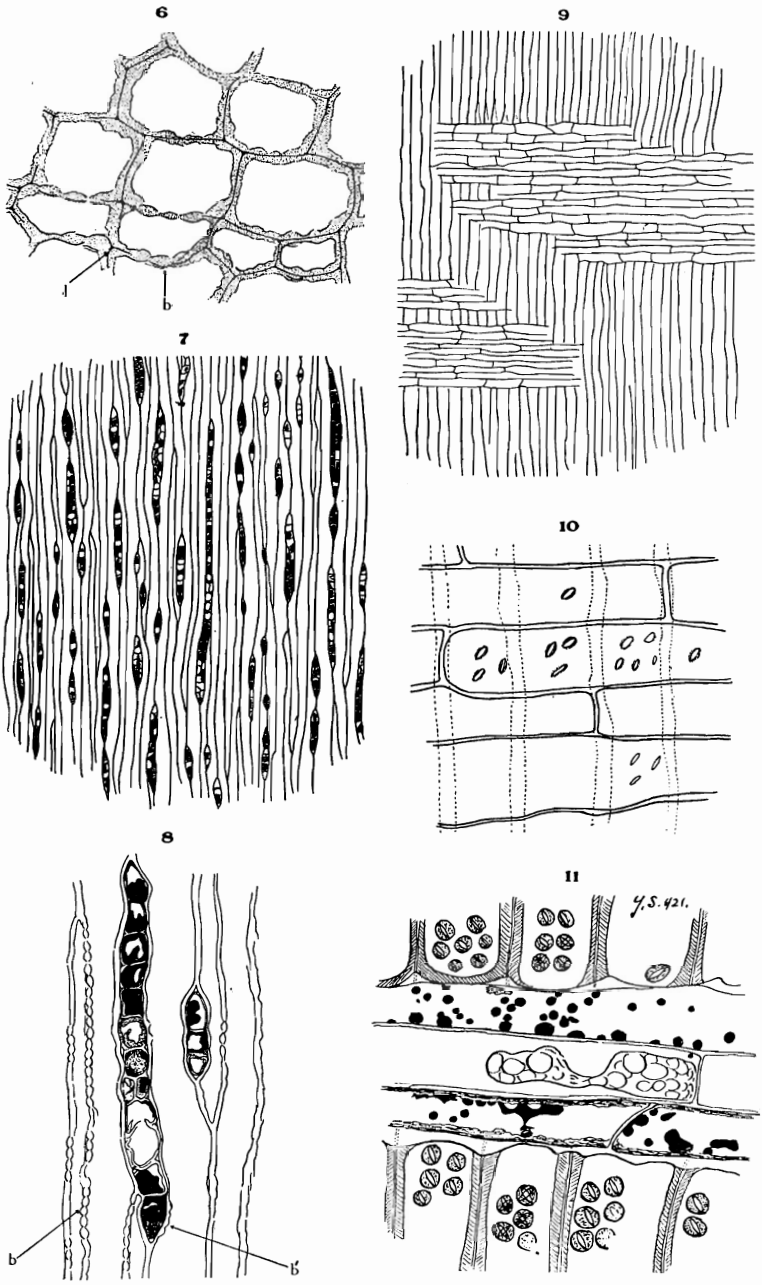
FIG. 5. The same as fig. 4. Showing series of tracheids cut near termination and including a growth ring to the left. × 140.

as narrow bands, one to three tracheids in thickness; these tracheids are distinguished by their radially shortened diameters, fig. 2, photomicrograph 1. On either side of the ring the tracheids quickly though not abruptly attain the normal tracheid dimensions. The slight curvature of the rings affords the only means of judging which may be the outer ones, and indicates a trunk of large size. This type of ring is practically identical with that of modern Araucariæ. The significance of this structure in *Cordaites* is not fully known, though in the judgment of both the present writers it obviously indicates some kind of seasonal or other climatic variation, such rings not so far being known to have any relation to fructification. Whatever the cause, it often failed to affect cells in the growth ring area; for bridges of full sized tracheids are frequently observed crossing the growth rings. Scattered cells with strikingly short radial diameters also occur between the rings.

The *tracheids* in cross section are usually rectangular; some, however, are circular, evidently at the points of constriction, which as one may plainly see in longitudinal sections both radial and tangential occur quite regularly near the tracheid ends. There is, however, so much variation in size that it scarcely seems feasible to use tracheid dimensions as a specific character, except as the upper and lower limits of size variation may corroborate the diagnosis of a species already determined from more fixed characters. This size variation does not include rows of seemingly small tracheids extending radially, which are in reality normal tracheids appearing in this section near their termination, where the diameters, particularly the tangential diameters, are shortened (figs. 2 (*t*), 5 and 7). The thickness of the walls, also, can hardly be determined accurately since they either vary or may, as silicified, appear somewhat irregular and ragged; although Penhallow in his description of *Dadoxylon* species gives the thickness of cell walls and cell diameters as specific characters.

By far the most interesting and finely preserved structure is the bordered pit. These pits are strikingly arranged in radial bands not varying markedly either in width or distance apart (fig. 3, photomicrograph 1). The number of vertical rows of pits varies generally with the size of the tracheid from one to four. The position of the growth ring can readily be discerned in a radial section by the occurrence of one or more tracheids of comparatively short radial diameter, containing a single vertical row of pits sometimes slightly smaller than the others, figs. 3 and 4. But the single row usually conforms to the radial band arrangement of pit grouping in each of these lesser tracheids. The number of pits to a group may be as few as three in the growth ring tracheid up to as many as forty on

FIGS. 6–11.



the normal wood tracheid where, presumably owing to termination of a ray cell, two of the largest single groups coalesce; they may be crowded or lie well apart. Several examples like the following have been noted: two distinct radial bands gradually approach each other, coalesce for the distance of several tracheids, then part, resuming their separate identities. Along the line of coalescence occur the large or double groups of pits. In the main, however, the radial grouping of the pits is the most striking feature of the wood, appearing with great regularity over large areas of the radial section. The pit groups are normally separated by about the width of a ray cell, and the radial surface of the tracheids between the groups is finely but characteristically rugose. Furthermore, the dominance of the group system of pits is conditioned by induration and thickening of the appressed tracheid walls between the groups, with presence of intercellular spaces. This feature is quite apparent under even low powers, and so definite that it may be studied to advantage with a 1/12 oil immersion and ocular 5. In the tangential section a spindle-shaped interspace may mark the point of tracheid wall thickening between the pit groups.

The *bordered pits* are circular or elliptical in outline, occasionally irregularly flattened. The hexagonal form, which is reputed to be a constant feature of Cordaitean bordered pits, appears to be wanting here. Even when the pits are very close together they maintain their circular outline (figure 4 and 5, photomicrograph 4). Occasionally pits occur which might be considered hexagonal, though such are not a striking feature (photomicrograph 4). The oblique slit-like opening extends nearly the full diameter of the pit and lies at right angles to the corresponding orifice in the wall of the adjacent tracheid, thus presenting a cross-like arrangement to the eye. And in the sections where the slits cross there is formed a rhombic perforation of the paired pits across which one looks through

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FIG. 6. Detail of transverse section. Note the bordered pits, *b*, and the middle lamella, *l*. × 240.

FIG. 7. Tangential section of wood. × 30 ±. [Another area is shown × 105 by Wieland as fig. 43 of his American Fossil Cycads.]

FIG. 8. Detail of tangential section showing two medullary rays and portions of tracheids with the actual distribution of the bordered and semi-bordered pits. *b*, bordered pits; *b'*, semi-bordered pits connecting tracheid and ray cell. The middle lamella is not distinct in this section. × 120.

FIG. 9. Outlines of ray cells and tracheids showing their arrangement. × 30.

FIG. 10. Radial section of wood. Detail of ray cells showing the semi-bordered pits, also indicated in fig. 8. The vertical dotted lines indicate tracheid walls. × 240.

FIG. 11. Radial section detail showing ray three cells in height crossing pitted tracheids. Lower ray cells thicker walled with considerable intercellular space next the tracheids; middle ray cells squarish, and containing tyloses. Other ray cells with much vacuolated resin attached to cell walls. Resin vacuoles of upper ray cell all on cell wall, not in interior.

nearly clear silica, the pit walls being distinctly dense. Similarly arranged cross-like orifices are present in *Pityoxylon Chasense* as described by Thomson and Allin,* who claim that this latter species is of Cordaitean affinity and not related to the Abietineæ. The *X*-like aspect of the apertures in the pits also characterizes *Araucaria brasiliana*, as long since figured by Winkler†; while Goeppert noted this feature in fossil forms.‡

The presence of pits in the walls of the tracheids may be seen, though with less distinctness, in transverse or tangential sections. The walls, when viewed with a high power of the microscope, exhibit series of broken, bulging outlines, which plainly indicate the presence of the pits (figures 6 and 8). The position of the middle lamella is also absolutely distinct with oil immersion $\frac{1}{12}$ oc. 2 in all the sections (figure 6). Whether or not a torus is present I cannot now say.

The *medullary ray*, because of the large amount of dark colored material in many of the cells, is a conspicuous feature. The rays, viewed in a transverse section, are very similar, being usually one cell in breadth, though sometimes two cells wide. The biseriate ray of this species is, however, always partly uniseriate (figure 7, photomicrograph 3). A radial section shows that the rays, though narrow, are of considerable depth as appears in figure 9. In a tangential section the ray is seen to vary from a single cell in depth and breadth to a ray forty cells in depth and from one to two cells in breadth. Between the two extremes all gradations may be found (cf. figure 7). *Dadoxylon Pedroi*, of Zeiller, however, exceeds the Indiana species in the remarkable height of its rays, which sometimes consist of even fifty superposed cells.§

The ray cells are parenchymatous, long and thin walled. Using the tracheid width as a unit of measurement the ray cells range from two to eight tracheids in length; the terminal wall is vertical, curved or oblique. A tangential view of the wood shows the ray cells to be rectangular, oval or circular in cross-section and of exceedingly variable size. The horizontal walls of the outermost cells are irregular, seeming to extend in pointed projections between the tracheids (cf. photomicrograph 3); this often gives the appearance of an abrupt narrowing at the ends of the ray cells, which is really a return to the normal diameter. Through the lateral walls, the ray cells communicate with the tracheids by means of pits, which are simple in the ray cell wall and bordered in the tracheid wall;

* Thomson, R. B., and Allin, A. E., Do the Abietineæ Extend to the Carboniferous? Botanical Gazette, vol. liii, No. 4, April, 1912.

† Winkler, C. Zur Anatomie von *Araucaria braziliensis*, Botanische Zeitung 1872, p. 583, (Tafel VII).

‡ Goeppert, H. R., Monographie der Fossilen Coniferen, Leiden, 1850.

§ Zeiller, M. R., Note sur la Flore Fossile des Gisements Houillers de Rio Grande do Sul., Bull. Soc. Géol. de France, Série 3, Tome 24, p. 624, 1896.

this is inferred from the appearance of a single oblique slit in each pit of the ray cell. In examining the pits on the walls of the ray cells it is occasionally possible to detect the border of the pit in the adjoining tracheid wall; or depending on the plane of the section the border is indistinct and only a slit or broader aperture is visible. However the relation of the slit—semi-bordered pits to ray cell and tracheid can always be clearly discerned, the slit appearing first when seen from the interior of the ray cell, the semi-border when the view is from the tracheid side. The shallowness of these pits and narrowness of slit combined with greater distance apart renders them virtually invisible in the transverse and tangential section, even when highly magnified; though some evidence of them may be observed as illustrated in figure 8.

I, of course, have some hesitation in describing the ray pit features, as so thorough and careful a student of gymnosperm structure as Thomson (loc. cit.) says:

"The medullary ray cells are characteristically thin walled in the Araucarians, and are comparable to those in the Cordaitean forms. They are also unpitted in the Araucarineæ as in the latter. Often these cells have been wrongly spoken of as having pits on the lateral walls where they come into contact with the tracheids, some anatomists even going so far as to distinguish the pitting as of the bordered type. Gothan has noted this especially in the case of Penhallow when discussing the latter's statement that there are ray tracheids in *Cordaites Clarkii*. He says that all Penhallow's ray cells are tracheids on account of their pitting. With this as a basis and the fact that the ray tracheids have not been figured he goes so far as to question this unique example of their occurrence in the Cordaitean forms. I have carefully examined the type set of sections and have found no evidence to contradict Gothan's conclusion."

However this may be, and the point is indeed of far-reaching import in determining the relationships amongst ancient gymnosperms and the modern lines of descent, I can only figure the structures as shown in fig. 8, which appears correct. That the ray parenchyma cells vary greatly in length and development is of course true, as fig. 9 well shows.

The contents of the ray cells occur as dark opaque masses (tyloses) almost entirely filling the cell or scattered like little droplets. These masses have been described as resinous or starchy matter, and their appearance does strongly suggest a resinous vacuolation. Penhallow states that the ray cells of *C. Newberryi* are of one kind only, resinous and starch bearing.* E. C. Jeffrey, in describing an Araucarian genus, says that the rays are not clear in transverse section; certain dark spots occur, which are not resiniferous parenchyma, but car-

* North American Species of Dadoxylon, p. 64.

bonized aggregations not infrequent in petrified wood.* Of course the exigencies of silicification must be fully taken into account, but doubtless the resinous character of the bodies here described can be definitely established after various well conserved fossil species have been fully and thoroughly studied.

Certain of the tracheids also contain dark silicified bodies, which appear to be of resinous origin (cf. *r* in figures 2 and 3).

In 1900 Professor Penhallow of McGill University published an interesting and suggestive account of the *Dadoxylon* species of North America. In this paper he describes a species,—*Cordaites Newberryi*—which was discovered in the Middle Devonian of Ohio by Dr. Newberry and in the Carboniferous of Ohio by Claypole. The species from the Indiana Black Shale, as described above, bears a striking resemblance to *Cordaites Newberryi.* However there are several clear variations. Before quoting from Penhallow's account, which is the most complete, I may refer to several brief earlier accounts of this species.

Dawson merely describes *Dadoxylon Newberryi* as having areoles (pits) in two or three rows with large oblique pores and numerous rays made up of eighteen rows of narrow cells in two series.† Later he describes carbonized or silicified trunks from the Hamilton of New York having hexagonal areoles with oval pores.‡ Newberry gives a much more definite description; he states that the wood cells are quadrangular; the largest diameter noted, ·04–·05^{mm}; the thickness of the wall, ·01^{mm}; the length of the ray cell, 4–5 times the diameter; the terminal walls are oblique; the areoles are in groups of one to three rows; the pores are elliptical and obliquely inclined; the areole diameter is ·01^{mm}. The rays are single or double in width and consist of from one to twenty superposed cells. Nearly all the ray cells contain globules of resinous matter.§ Penhallow's description agrees in general with that of Newberry, but Penhallow emphasizes a character which is the important and distinguishing feature of this species, namely the arrangement of the pits in radial bands and hence in definite groups of pits, 6 to 13 in number, in each tracheid. Newberry mentions the pit groups without emphasis and fails to note the radial band. Penhallow in reference to the growth rings says: "In a radial extent of 17 millimeters, this species shows no evidence of growth rings."

*Jeffrey, E. C., A New Araucarian Genus from the Triassic "Woodworthia Arizonica." Proc. Boston Soc. Nat. Hist., vol. 34, No. 9, July, 1910.

† Dawson, J. W., Fossil Land Plants of the Devonian and Upper Silurian. Geol. Surv. of Canada, 1871.

‡ Dawson, J. W., Fossil Plants of Erian (Devonian) and Upper Silurian Formations of Canada. Geol. Surv. of Canada, Pt. II, 1882.

§ Newberry, J. S., Devonian Plants from Ohio. Jour. Cincinnati Soc. Nat. Hist., vol. xii, pp. 48-56, 1889.

II. Specific Characters (by Dr. Wieland).

Of the generic identity of *Cordaites Newberryi* and the Indiana form before us we rest assured since the larger characters are the same, and in the specialized feature of tracheidal pit groups both closely agree. Both then are clearly of the same genus, but must represent distinct species, since in the material studied by Penhallow growth rings are not present in a radial extent of 17^{mm}, while in the Indiana specimen there occur in the same distance six growth rings which could not be overlooked even in a cursory examination. Taking the growth rings as a basis of classification and relying upon the accuracy of Penhallow's description, the main features of these species may therefore be tabulated thus:

Comparison of Cordaites Newberryi and the Indiana Species.

Callixylon (Cordaites) Newberryi	*Callixylon Oweni*
Transverse	
Tracheids 44 × 55 mic.	Tracheids 45–60 × 45–60 mic.
Walls about 12·5 mic. thick.	Walls about 5 ± mic. thick.
In a radial extent of 17^{mm} no evidence of growth rings (obscure or obsolete).	In a radial extent of 15^{mm} 6 growth rings.
Tracheids conspicuously squarish, sometimes unequal in the two diameters.	Tracheids squarish, sometimes round.
	Ray cells distinct because of contents.
Radial	
Ray cells resinous and starch-bearing, long and narrow, about equal to 3–7 tracheids, ends conspicuously narrower, the pits on the lateral walls 3–6, chiefly 4 per tracheid, the slit-like orifice nearly the full diameter of the pit.	Ray cells often with opaque material, long and narrow, about equal to 2–8 tracheids, ends not conspicuously narrower, the pits on the lateral walls usually 6–8 per tracheid, the slit-like orifice nearly the full diameter of the pit, pits simple in the ray cell wall, bordered in the tracheid wall.
Bordered pits numerous, round, about 9·3 mic. broad, distributed in radially disposed groups of about 6–13, the orifice diagonal, nearly extending the diameter of pit.	Bordered pits numerous, round or elliptical, distributed in radially disposed groups of 3–40, groups of 40 probably double groups, in 1–4 vertical rows per tracheid, orifice diagonal, which with the corresponding orifice of adjacent tracheid gives the appearance of a cross.
	Tracheids resinous (?)
Tangential	
Rays of medium height, 1–2 rarely 3–seriate in part, 24–55 mic. broad the oval or round cells all thin walled.	Rays from 1–40 cells in height, 1–2 seriate, never 3-seriate, 30-45 mic. broad, all cells thin walled, oval or round in section, vary in size, most of them contain more or less resinous (?) material with frequent tyloses.

In defining new species it is sometimes desirable to state certain facts of negation as succinctly as may be. Accordingly in the present case it is well to repeat that the exact nature of the growth ring especially in forms so ancient as those in question is not fully understood. And since the growth rings described above occur at irregular intervals it is possible that a longer period of growth may have ensued at times between two successive appearances of the stimulus necessary to cause the formation of growth rings. It is also possible that the specimen studied by Penhallow may have been taken from an area between two such successive rings of unusual width. This is merely a conjecture. The far greater chance is that both specimens are average trunk wood, and do differ by presence and absence of the growth rings.

Furthermore Penhallow describes the ends of the ray cells as being conspicuously narrowed. It is true that the ends of the ray cells in the Indiana specimen are often narrower than the rest of the cell, but it is not a constant feature and is never conspicuously true. The reader may recall that in the description of the ray cells it was stated that the horizontal walls of the outer rows of cells were frequently irregular and appeared to narrow at the ends when only returning to the normal cell diameter, a condition which might be misleading. There are other minor differences between *C. Newberryi* and the Indiana form in regard to the number of pits in a group, the height of a ray, etc., which could be accounted for in a species with very wide limits of variation, as seen from the preceding table. But one may only conclude that in the absence of evidence that the differences apparently present are simply variations within the species, the logical course is to erect a new species based on good material.

In dealing with the present fine fossil tree from Indiana it has been preferable so far to use the old names applied to wood of Cordaitean affinity; but in naming the new species quite clearly indicated to be present it appears necessary to include it together with the *Cordaites Newberryi* in the new genus, *Callixylon*, recently established by Zalessky* with apparent correctness for Cordaitalean woods with grouped bordered pits. A new Russian form he describes, *Callixylon Trifilievi*, from the Upper Devonian of Bolchaia-Karakouba, district of Marioupol in the province of Ekaterinoslaw, has this character. Only the preliminary description of this Russian species with three photomicrographs has so far come to hand. But Zalessky shows that while the Araucarian type of pitting is present, and the grouping is distinct as in our two American forms, the

* Etude sur l'Anatomie du *Dadoxylon Tchihatcheffi* Goeppert sp., par M. D. Zalessky. Mémoires du Comité Géologique de Russie, Nouvelle Série, Liv. 68, St. Petersbourg, 1911, pp. 29 with 4 plates.

species, *Callixylon Trifilievi*, plainly differs, having smaller medullary rays with less biseriation and, so far as the figures show, fewer bordered pits in the groups.* As to whether or not the American species have, like *C. Trifilievi*, a fine development of primary xylem is of course more or less conjectural, so that in accepting classification under *Callixylon* a sharp doubt remains. However, no other course appears consistent, and our species is therefore named in honor of the early Indiana geologist, David Dale Owen, and the illustrious family to which he belonged,—

Callixylon Oweni sp. nov.

Inasmuch as the characters of this new form have been clearly brought out in the preceding descriptions, while *Callixylon (Cordaites) Newberryi* is not very well known (efforts to locate the types having so far failed), and *C. Trifilievi* awaits further description, it is not necessary to here append a searching recapitulation of the specific characters separating the three members of *Callixylon*, *C. Newberryi*, *C. Oweni* and *C. Trifilievi.* It is sufficient to state in résumé that all three plainly differ in various minor features and that while the small medullary rays and low number of bordered pits to the group clearly separate *Callixylon (Cordaites) Newberryi* Dawson from *C. Trifilievi* Zalessky, both are further isolated from *Callixylon Oweni* by obscurity or absence of the growth rings, which, while not a strongly fixed character, are in the latter species distinct. Moreover it could at most only produce confusion to assign this perfectly conserved material to so imperfectly known a species as *C. Newberryi* in reality is.

I have in other connections urged the necessity for basing types on the best known material.

In conclusion it may be added that the main value of this contribution must consist in Miss Elkins' excellently drawn

* The lateral tracheidal bordered pits of the *Callixylon* species are small of diameter, not large as in many modern conifers and cycads, the actual dimensions having some interest as follows:—In *Callixylon Newberryi* the pits have a diameter of 9 microns, in *C. Oweni* 10 to 11 microns, in *C. Trifilievi* 12 to 13 microns; in *Araucaria Bidwilli* 11, in *Agathis bornensis* 10 to 12, and in *Araucaria Cookei* roots only 3 microns; while these measurements rise in *Pityoxylon* (sp.) to 15, in *Larix americana* to 16, in *Dion spinulosum* to 19, and in *Pinus strobus* to from 25 to 35 microns. Lest any doubt as to the bordered pit features of *C. Oweni* should remain, I may emphasize the fact that the cellulose bands or "bars of Sanio" often so characteristic in various recent Abietineæ, are not present in even a rudimentary condition. The testimony of the sections is conclusive on this point. Indeed the pits can be studied to even better advantage than in some artificially stained woods. Nor are the bars absent because there is crowding. Normally the pits barely touch and no more, although the outer border does appear very distinct and it is easy to see how cellulose thickening on a contact line could arise.

figures and the attention they invite to one of the best conserved Devonian woods ever sectioned. Doubtless some details of structure have been imperfectly observed or understood by us, but the results show an advanced structural type which can stand in an ancestral relationship to other gymnosperms, or even be regarded as standing near to cycadaceous types, and slightly in advance of the actual line leading into the modern Araucarians. Moreover this wood suggests that it may well be that both Jeffrey and Thomson are virtually correct when the one assigns a high antiquity to Araucarian, and the other equal great age to Abietineous structures. The fact that the latter have undergone much variation in Cretaceous time, playing the great rôle in the Cretaceous coniferous forests, merely makes the ancestral Abietineous features harder to discern; whereas in the Araucarians primitive structures stand out in bold relief. At least it is evident that great variety of structure exists in Devonian woods, and considering the further diversity of the ancient seed types it begins to appear that if there is any past period which can be fairly singled out as the true age of gymnosperms it must be Devonian time.

Randolph-Macon Woman's College.
Yale University Museum.

EXPLANATION OF PLATES.

Plate I.

Photomicrograph 1 (above). Radial section of wood showing the radially grouped pits and the highly characteristic appearance produced by these together with the thickening of tracheidal walls and constriction between the pit groups. × 100. Yale Museum Section No. 421.

Photomicrograph 2 (below). Transverse section of wood interior to growth ring, showing marked variation from large rounded to pentagonal rhomboidal and other outlines. See fig. 2. Yale Museum Section No, 420.

Plate II.

Photomicrograph 3 (above). Tangential section of wood. × 100. Yale Museum Section No. 427.

Photomicrograph 4 (below). Radial section of wood. × 280. Focussed to bring out the x-figure formed by the crossed slits of paired pits of appressed tracheids. [Neither slit is in full focus in such a photograph.] Yale Museum Section No. 421.