VIII.

DESCRIPTIONS OF NEW SPECIES OF FOSSIL PLANTS FROM ALLEGHANY CO., VIRGINIA; WITH SOME REMARKS ON THE ROCK SEEN ALONG THE CHESAPEAKE AND OHIO RAILROAD, NEAR THE WHITE SULPHUR SPRINGS OF GREENBRIER COUNTY, WEST VIRGINIA.

BY F. B. MEEK.

(Read June 15, 1872.)

While on a visit last summer at the White Sulphur Springs of Greenbrier County, West Virginia, I saw, in the possession of a gentleman near that place, a beautiful specimen of a fossil fern, that had been found at Lewis's tunnel, on the Chesapeake and Ohio Railroad, some six miles southeast of the springs. Being much impressed with its elegant form, and fine state of preservation, I concluded to stop at the locality on my return home, with the view of examining the rocks, and collecting such specimens as could be found; and, while there, I succeeded in procuring the species described in this paper.*

The masterly preliminary reports and papers of Prof. William B. Rogers, on the territory now composing Virginia and West Virginia, have rendered the grand general features of the geology of those States so familiar to most scientific readers, that any extended remarks on that subject are unnecessary here.† For the information, however, of those who may never have visited this interesting mountain region, as well as to convey a more clear idea of the geological horizon of the fossils under consideration, it may be proper, before proceeding to describe these plants, to state a few of the details of the geology and topography of the country immediately surrounding the springs, as well as for a few miles west of the same, and eastward along the railroad to the locality of Lewis's tunnel, where these fossils were discovered.

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* I am under obligations to Gen. W. C. Wickham, Vice-President of C. and O. Railroad, for a letter to the conductors of passenger trains, instructing them to stop and allow me to get off at any points I might wish to examine along the road; also to H. D. Whitcomb, Esq., Chief Engineer of the road, and to Maj. Peyton Randolph, Chief Assistant Engineer, for accurate maps of portions of the country along the same, and for other information. I am also indebted to Mr. J. J. Gordon, one of the contractors of Lewis's tunnel, and to Mr. Terrence McGlone, for fine specimens of the fossil plants found at that place.

† It is much to be regretted that Prof. Rogers's final reports on the Geology of Virginia, which I understand were prepared in much detail, were never published.

In the first place it may be stated that these springs are situated in a narrow valley, two thousand feet above tide, near the eastern margin of Greenbrier County, West Virginia, and also within a few miles of the dividing line between Virginia and West Virginia. A little to the northwestward of the inclosed grounds at the springs, which are not situated quite in the lowest part of the valley, flows Howard's creek, a beautiful, perfectly clear mountain stream, that runs westward into Greenbrier River, a tributary of the Great Kanawha. Almost immediately on the southeast side of the grounds, and at a little greater distance across the valley to the northwestward, mountains, clothed with pines and various deciduous trees, rise from twelve to fifteen hundred feet above the valley; that to the northwestward being composed, at least near its base, of shales and flags of the age of the Hamilton Group (including the Marcellus shale) of the New York series; while that on the southeastward, for five or six hundred feet above its base, is composed of the same formation, with heavy beds of Chemung strata above, the whole dipping at a high angle to the southeast, and containing many characteristic fossils. To the southward Kate's Mountain is in sight, at a distance of two miles; while Greenbrier Mountain bounds the view on the west, within a mile or so of the springs. Four to five miles to the eastward, the Alleghany Mountains proper occur, the springs being west of the principal crest of this range, in the midst of a district abounding in mineral springs of various kinds and temperatures.

The grandeur of the scenery of this region, its pure mountain air, always comparatively cool and pleasant during the hottest part of the season at this altitude, together with the well-known medicinal properties of its waters, and the elegant and ample preparations for the accommodation of large numbers of visitors, render this a delightful place for invalids and seekers of pleasure and comfort to while away the sultry months of summer.

As stated by Prof. Rogers, these springs issue directly from a local uplift of rock of the age of the Oriskany sandstone of the New York series; but so near the junction of this with the overly lower black shales at the base of the Hamilton group, as to render it probable that the water derives its sulphurous properties, and possibly some of its salts, from the latter.*

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* According to Prof. Rogers's analysis, the solid matter left by the evaporation of 100 cubic inches of this water, at a temperature of 212° Fah., was 65.54 grains, composed as follows:—

Sulphate of lime	31.680	grains.
Sulphate of magnesia	8.241	"
Sulphate of soda	4.050	"
Carbonate of lime	1.530	"
Carbonate of magnesia	0.506	"
Chloride of magnesium	0.071	"
Chloride of calcium	0.010	"

The exposed portions of the Oriskany beds here are not, as is often the case further north, composed of sandstones, but consist, at least mainly, of a rough, yellowish-gray mass of highly cherty strata, in some parts passing almost into a quartz rock. Although little exposed at this place, this rock evidently forms almost the entire bulk of a low hill, or ridge of oval form, and a few hundred yards in length, included as a part of the north side of the ornamented grounds about the springs. This hill is depressed on top and covered by a natural growth of shade trees, and has been tastefully laid out into walks and winding paths, provided with occasional rustic seats for the accommodation of visitors. Its summit is perhaps not more than ninety to one hundred feet above the lowest part of the valley on the north, around which side it is more or less precipitous; while to the southward it slopes down more gradually to the lower parts of the grounds, laid out into winding walks and drives, with intervening spaces of grassy sward, shaded at intervals by clumps of spreading oaks, elms, and other trees. Along the entire length of its southern slope a

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Chloride of sodium	0.226 grains.
Protosulphate of iron	0.069 "
Sulphate of alumina	0.012 "
Earthy phosphates	a trace
Azotized organic matter, blended with a larger proportion of sulphur, about	0.005 "

Iodine, combined with sodium or magnesium, a trace.

The volume of each of the gases in a free state in 100 cubic inches of the water, he found to be as follows:—

Sulphuretted hydrogen	0.66
Nitrogen	1.88
Oxygen	0.19
Carbonic acid	3.67

The water is perfectly clear, and flows copiously; and, although appearing cool to the taste when drank during the warmer part of a summer's day, it is, as first shown by Prof. Rogers, properly speaking, a thermal water, its temperature, though somewhat variable, never being less than about nine, and sometimes as much as nearly thirteen degrees Fah., above the mean annual temperature of the air at the locality and altitude. That is, its temperature varies from 61° to 65° Fah.; while the mean temperature of the air, as determined by seven years' observations under the direction of the Smithsonian Institution, at Lewisburg, a few miles west of the springs and at a little lower elevation, is, I am informed by Prof. Henry, 52.2° Fah. Most of the mineral springs of this region, especially those that issue from anticlinal axes of the strata, are, as observed by Prof. Rogers, thermal waters, from which fact we may infer that they most probably arise from considerable depths, and owe their temperature to the internal heat of the earth.

The White Sulphur is, I believe, the only proper thermal water in the State, that is at the same time rather strongly impregnated with sulphur. When freely drank, it acts as a mild cathartic and diuretic; but its most valuable properties are its alterative powers in chronic diseases of various kinds, for the relief of which it has long been celebrated.

continuous excavation has been made to form a terrace, for the reception of a long row of neat one- and two-story cottages, which are, at places, almost hidden from view by shade trees.

At the eastern end of this terrace, just behind the cottages, as well as along the broad walk winding around that end of the hill, the dark Devonian shales belonging at the base of the Hamilton group of the New York series, are seen dipping off at a high angle to the southeastward. But on following the terrace westward behind the cottages, we soon come to a low nearly continuous outcrop of the Oriskany beds, dipping at the same high angle as the shale mentioned, to the southeastward. This rock can be traced to the west end of the hill on this side, and also forms high precipitous exposures around its northern side, one of which has been fancifully called the "lover's leap." At the western base of the hill, it is likewise again seen in the walk leading down to the bath-houses, where it presents almost a flinty appearance. Again it appears just below the principal spring, some ten or fifteen feet higher than at the bath-houses, forming the bed of the little stream running from the spring—being here, in places, whitened by the deposit of hydrated sulphur left by the water trickling over its surface. The bottom of this spring is also formed of this rock, and it is a little exposed along the side of a road, at a somewhat higher elevation, about forty or fifty yards south of the same.

This last seems to be about the end of the exposed part of this little uplift of the Oriskany formation here, in a southwestward direction, the overlying shales being met with in a hill on this side behind another row of cottages situated along its northeastern slope.

A low naked knob, only about twelve feet in height, of the lower black shales, is also seen on the immediate margin of Howard's creek, some sixty or seventy yards west of the springs, which, as already intimated, are situated at the western and lowest part of the grounds. This exposure is hardened, contorted, and crumpled as if it had been kneaded together by some powerful agency while in a yielding or semiplastic condition.

Another elevation at the northeast side of the grounds, called "Prospect hill," rises gradually to about the height of that already mentioned on the north, and is also covered by shade trees and laid out into walks; its southwestern slope being likewise occupied by a row of elegant two-story cottages; which, with those already mentioned, and others on the south side, surround the central part of the ornamented grounds in which the large hotel is situated. So far as I could see, this last-mentioned hill seems to be composed entirely of the shales and flags of the Hamilton group, of different shades of color.

The exposures here show that the strike of this little uplift of Oriskany and the overlying shales, is northeastward, and south-

westward, or parallel to the general trend of the ranges of the whole Appalachian region, as is most generally the case (local flexures excepted) with the anticlinal axes throughout this district.

As there are no corresponding Oriskany beds seen just on the northwest of this uplift, dipping in the opposite direction, and it is evident that such material could not have been worn away by Howard's Creek, the immediate valley of which directly intervenes between this hill and the mountain, composed mainly, if not entirely, of Hamilton and perhaps Chemung group beds on that side, it would seem that there may be a slight local inequality in the elevation of the strata here, along the opposite sides of a fracture. Whether this axis brings to view the Oriskany beds further northeastward, along the opposite side of the valley on the line of strike, I did not ascertain by personal observation, as I did not examine the mountains in that direction. I infer, however, from Prof. Rogers's remarks that it does, and this would indicate an oblique fracture of these beds, because the valley of Howard's Creek, which crosses the strike obliquely, could hardly have been cut through such a rock by that stream.

For some time I was unable to find any recognizable fossils in the Oriskany beds here, though I had seen some obscure casts and moulds of brachopods in the cherty beds along the little stream running from the springs. After diligent search, however, I succeeded in finding, near the bath-house, behind the cottages, at the west end of the hill above mentioned, imperfect casts of the well-known Oriskany shells *Spirfer arenosus*, *Meristella lata*, and moulds of *Rensselaeria ovoides?*

The deep cuts of the Chesapeake and Ohio Railroad through the spurs and ridges of the mountains along the south side of the valley here, afford a very fine opportunity to study the Hamilton group shales and more or less slaty beds, which seem to be of considerable thickness, and from near the springs dip at various angles to the southeastward, excepting where they are locally flexed and contorted. As the railroad runs close along the south side of the grounds, some of these deep cuts are within a few hundred yards of the hotel. One of these, in a direction nearly south from the springs, and almost on a line with the strike of the Oriskany uplift, but at a higher elevation than the nearest exposures of this rock immediately at the springs, shows the black Hamilton shale at the bottom, much contorted, with many polished surfaces caused by the slipping of one part upon another at the time of the upheaval, or during other disturbances of the beds. As freshly laid open by the excavations in progress when I was there, these dark shales emitted, under a noon-day sun, a sulphurous odor, suggesting the probable origin of the sulphuretted hydrogen of the springs, that have their source, as already stated, near the connection of these shales with Oriskany formation.

I saw no traces of any kind of organic remains in these lower dark shales, excepting a few trails, apparently of annelids, but they doubtless owe their dark color mainly to minutely comminuted particles of organic matter, perhaps chiefly of marine plants. From their position, however, and general appearance, there is little or no reason to doubt that they represent the Marcellus shale of the New York series; which, although sometimes viewed as a distinct formation, may perhaps be properly considered a subdivision of the Hamilton group. Here these dark beds are seen to shade upward into various lighter colored shales, and flags, presenting different shades of drab, olive, and dull gray, and bluish-gray. In some parts there are intercalated layers of various thickness and harder texture, composed of variable proportions of arenaceous and argillaceous matter. These latter harder layers are usually of dull gray color, or often on fresh fractures, bluish-gray, and, as may be seen in other cuts further eastward and westward, increase in proportion to the more shaly portions as we ascend in the series. At some places, however, higher in the series there are seen beds of dark shale. The lighter colored shaly beds above the lower dark shales are often quite soft, and are dug out along the railroad in small rhomboid blocks that soon crumble under exposure to atmospheric agencies.

Fossils seem also to be rather rare here in the lighter colored beds of the Hamilton group, near the bases of the mountains, in the immediate vicinity of the springs, but I succeeded in finding, in some of the harder layers at several places along the cuts of the railroad, and up the side of the mountain to the southeastward, casts and moulds of the well-known Hamilton species, *Spirifer mucronatus*, and *Orthis Vanuxemii*, along with *Martinia umbonata*, *Atrypa reticularis*, *A. aspera*, a flattened *Strophomena* and a smooth *Avicula* or *Pterinea*.

From what has already been said, it seems that there are here no representatives of the Upper Helderberg limestones or grits of the New York series; the black shales at the base of the Hamilton group being found resting directly against and upon the Oriskany.

West of the Springs, the lower dark shales are seen along the base of the mountains for a mile or more, on the right or northwest side of the valley, dipping at high angles to the northwestward, or at places locally tilted vertically, or variously flexed and distorted as if by lateral pressure, as well as from upheaval. The direction of the valley here is southwestward, but within a short distance its direction becomes nearly east and west, and five miles below, it curves around more nearly to the north. The railroad sweeps around the south side of this curve, cutting through several spurs and ridges of the mountains on that side of the valley, at an elevation of some fifty feet above its bottom. Its direction for several miles below the springs being very obliquely

across the axis of elevation, the cuts continue in the lighter colored shales and harder layers, which are at places seen contorted and dipping locally in different directions. As the road curves around to the northwestward, however, it crosses the strike of the strata less and less obliquely, so that, although a descending grade, it rapidly passes from (geologically) lower to higher strata, as it turns more nearly in the direction of the dip.

I found Hamilton types of fossils for a mile or more below the springs, but beyond this my examinations in that direction were not sufficient to determine exactly where the Hamilton ends, in going down the valley. To the westward, the harder less shaly beds were noticed to increase, but no very abrupt or strongly marked lithological changes were observed near the bases of the mountains, until about four to four and a half miles below the springs, by the curve of the road, near which point some whitish, rather coarse sandstone, at places containing pebbles of white quartz, was seen along the sides of the mountains, in rather massive beds, dipping at a high angle to the northwestward. Some half mile or less further on, in a nearly northwestward direction, the dip brings this sandstone down to the bottom of the valley. A deep cut at this place, at the entrance of a tunnel some forty to fifty feet above the sandstone, penetrates hard bluish-gray, more or less gritty beds, alternating with softer crumbling reddish, and, in places, greenish strata, in which argillaceous matter seems to predominate.* I saw no fossils here, excepting fragments of black vegetable matter, but I was impressed with the resemblance of these beds, and the red clays some of them form by disintegration, to some of those seen in the Catskill Mountains of New York, formerly referred to the Old Red Sandstone, but which, since Col. Jewett's discovery of Chemung fossils high in those mountains, have been mainly included in the Chemung group of the New York Devonian. I have the impression, however, that the beds penetrated by this excavation are at least as high in the series as the Old Red, or possibly somewhat higher, as there must be, owing to the dip here, a very considerable thickness of strata between them and the Hamilton group seen further up the valley. Being at the time in rather feeble health, I did not attempt to make the necessary examinations to ascertain the exact limits of the groups here, and only allude to the rocks seen in this cut, on account of their close similarity in lithological characters, to those containing the plants described in this paper from Lewis's tunnel, about six miles to the southeast of the springs; especially as the reverse of dip, to the southeastward from the springs to the last-mentioned locality, would also indi-

* It is probable that these beds and the whitish sandstone seen below them, owing to the general inclination of all the rocks here, rise to the summits of the mountains, some miles further eastward, on the west side of the valley, and nearer the springs, than where I saw them.

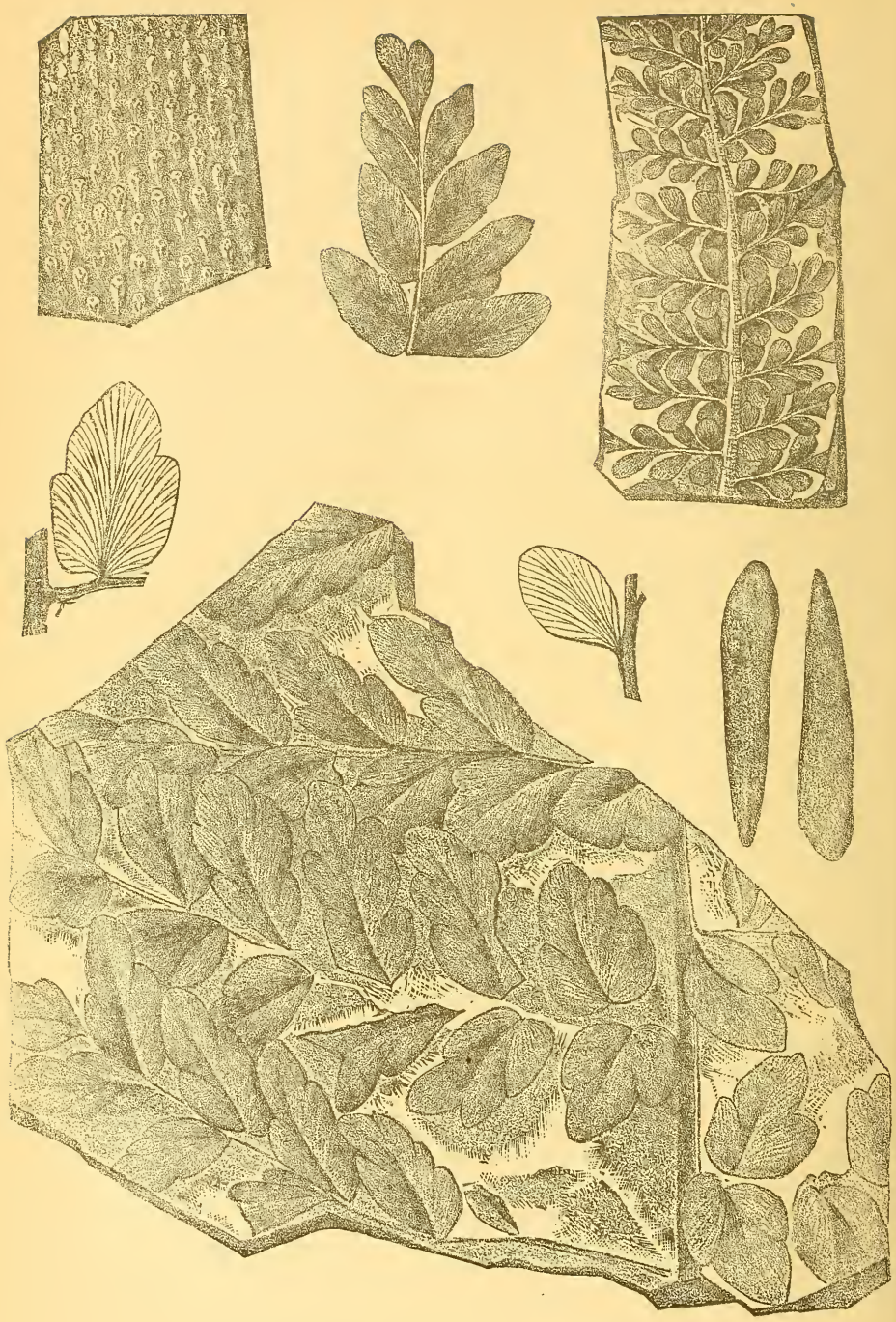


PLATE I.

Fig. 1. LEPIDODENDRON SCOBINIFORMIS.
A part of one of the smaller branches, showing the character of the surface scars of the same.

Fig. 2. CYCLOPTERIS (ARCHÆOPTERIS) ALLEGHANENSIS.
2*a*. A part of a frond, natural size.
2*b*. One of the pinnules magnified, to show the nervation.

Fig. 3. CYCLOPTERIS VIRGINIANA.
3*a*. Part of a frond, natural size.
3*b*. Outer extremity of one of the pinnæ.
3c. One of the pinnules magnified, to show the nervation.

Fig. 4. CARPOLITHES.

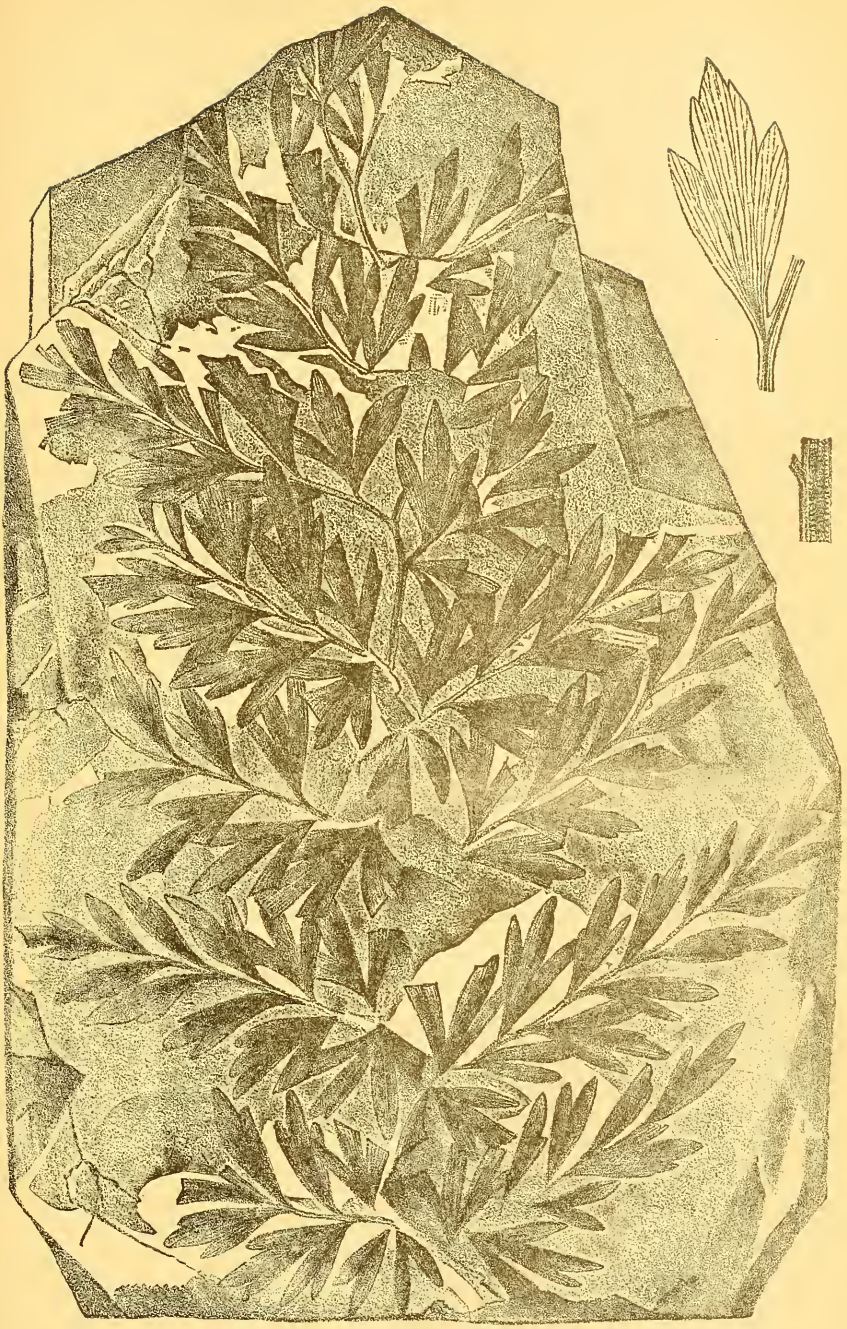
PLATE II.

Fig. 1. CYCLOPTERIS (ARCHÆOPTERIS) LESCURIANA.

1*a*. A part of a frond, upper side, reduced somewhat more than one-eighth diameter in size.

1*b*. One of the pinnules magnified, to show the nervation.

1c. A small part of the rachis magnified, to show its rugose character.



cate that the beds at these two excavations occupy about the same position in the series.

Returning to the springs, which are situated in the axis of elevation, we find that several deep cuts and tunnels along the railroad, just east of the same, present fine sections of the Hamilton group shaly beds, with more or less of harder and more compact gray layers intercalated. The more shaly softer beds here present the usual light-drab and grayish tints, but at one place I noticed some very dark shale. Generally fossils seem to be rare here also, along the cuts of the road, though in some of the harder more arenaceous beds, within about one mile of the springs, I found casts of a few Hamilton types.

Between this and Alleghany tunnel, three and a half miles southeast of the springs by a right line, I only saw the rocks in passing along on the cars. As already stated, the dip of the strata east of the springs is to the southeastward, with the exception of local distortions, apparently all the way to Lewis's tunnel and beyond; and as the direction of the road between these two places is nearly, though not exactly, the same as the dip, in coming eastward, we ascend again rather rapidly in the series, the inclination of the strata being at a pretty high angle. With local exceptions, the beds become less shaly, with a larger proportion of hard layers in coming eastward. At the west end of Alleghany tunnel, which is seven-eighths of a mile in length, and at nearly the same actual elevation as the springs, I saw gray and olive shales, with some more compact arenaceous layers, tilted and much confused, some parts standing nearly in a vertical posture, as if crowded together by lateral pressure. Similar shaly beds seem also to occur at some points in the tunnel, as it has been found necessary to wall up and arch it over with masonry at places.

At the east end of this tunnel there is a long open cut, with vertical walls on each side, in which the strata are seen to be more compact, and show little of the shaly structure. They generally present a bluish-gray tint on fresh fractured surfaces, and dip to the southwestward at an angle of from 45° to 50° below the horizon. Where long exposed to atmospheric agencies, however, above the cut, on the slope of the mountains, they weather to a light yellowish-gray color, but sometimes show rusty surfaces, when broken. At one place, a little above the east end, and on the south side of this cut, I found a mould of the ventral valve of a *Spirifer* agreeing exactly with that of the more extended forms of *S. mucronatus*. Associated with this, however, were numerous casts of the interior, and moulds of the exterior, of the Chemung species *S. mesacostalis*, agreeing in all respects with the transversely extended variety of that shell, as found in New York, not only in form, surface markings, and the characteristic mesial rib, but also in having a deep slit in casts of the

rostral cavity, left by a prominent, narrow, internal ridge or septum, similar to that seen in *Spiriferina*. In the same beds with these, I also found several casts agreeing well with the Chemung species *Leiorhynchus mesacostalis*, and *Orthis impressa*, together with the Chemung and Hamilton forms *Atrypa reticularis* and *Martinia umbonata:* likewise a small hemispherical *Productus*, a small plicated *Rhynchonella*, and an *Avicula* or *Pterinea*, like *A. spinigera*.

From such an assemblage of fossils, it can scarcely be doubted that these beds belong to the horizon of the Chemung group of the New York Devonian series. It is true, *Spirifer mucronatus*, is, I believe, not there known above the horizon of the Hamilton group, but Prof. Henry D. Rogers states that it occurs in the Chemung in Pennsylvania, while the associated species form together a group of fossils nowhere, so far as I am informed, ever found below the horizon of the Chemung.

About half a mile east of the locality where the above-mentioned fossils were found, I collected from loose pieces of fine-grained, gray, somewhat gritty rock, along the bed of a little mountain stream, a *Schizodus* apparently identical with a New York Chemung species; and from a cut a few hundred yards further eastward, from a similar rock in place, several bivalves like Chemung forms, along with casts of the well-known Chemung species *Spirifer disjunctus*.

The beds all along here continue to dip at the same high angle to the southeastward, and become rather more gritty in that direction; while immediately east of the last-mentioned locality, small masses of whitish, more or less pebbly sandstone had slidden from the slope above the road. This material seems, however, scarcely to form a continuous bed here, but apparently passes into fine-grained, hard gray rock, nearly or entirely without pebbles. This, more or less pebbly and at places whitish grit, is very probably the same seen dipping to the northwestward, five miles below the springs on Howard's Creek, though here it seems to be much less developed as a distinct mass from the other beds.

At a point some three-fourths of a mile east of the Alleghany tunnel, exposures were seen along the road, of rather massive beds of hard, bluish-gray, more or less gritty rock, alternating with softer crumbling material of brownish color, the whole being much like the beds seen in the cut five miles below the springs. At one place, thin local seams of dark shale, and some little coal were seen intercalated among these rocks. A little east of this the road curves around to the left, in a northeast direction, and enters a long open cut, leading to the southwestern end of Lewis's tunnel; and it was at the bottom of this excavation that the plants under consideration were found.

The base of this excavation is here perhaps some twenty odd feet lower than the exposures containing the thin seams of dark

shale and coaly matter already mentioned; but I am inclined to think it very nearly, if not exactly at the same geological horizon, as the dip of the strata would apparently bring those seams down to this level. The direction of the cut being more nearly parallel with the strike of the strata than the general course of the road west of this curve, the beds dip more obliquely across the excavation, and at the point where the laborers were at work when I was there, a thin seam of black, more or less shaly matter, containing at places a few inches of coal, was seen passing across the bottom of the cut. This seam of bituminous shaly matter is very irregular in thickness, being in some places a foot or more thick, but soon thinning out to a few inches. The included coal is also even more irregular, being sometimes several inches in thickness, and again thinning to a mere streak of black bituminous shaly matter, or sometimes entirely disappearing. Where pure and not crushed,* it often presents a somewhat lustrous appearance like anthracite, but it burns with a bright flame that shows it to be bituminous or semi-bituminous. Of course it does not exist in sufficient quantities to be made available for any practical purposes, but its occurrence here among these older strata, so far beneath the horizon of the true Coal measures, and in connection with so many beautiful fossil plants, is, to the geologist, an interesting fact, as it shows that similar physical conditions to those that gave origin to our great widely extended coal-beds of the later Carboniferous period, prevailed locally here, at least for a comparatively brief period of time, long before the true coal-producing epoch.

The plants found associated with this coal occur both in the more or less dark-colored shaly matter, and in the fine-grained argillaceous and slightly gritty harder rock just below it, as well as above. The wonderfully perfect condition of the most delicate fronds of the ferns found here, shows that these plants could not have been drifted any great distance, by streams or ocean currents, before being buried beneath the fine sediment now forming the rocks in which they are imbedded, but that they must have grown at least near the locality where they are now found. Hence it is evident that while the vast accumulations of sedimentary matter composing these mountain masses, were being deposited upon a gradually sinking ocean bottom, there were shores, and perhaps islands near, that supported a growth of terrestrial vegetation. Indeed it is probable that even at some of the very spots where the coal is found, the bed upon which it rests was raised slightly above the surface of the sea, and that most of the plants of which the coal is formed, as well as those with which it is associated, may have grown very nearly, or pos-

* Being a much softer material than the hard rocks above and below, this seam of coal and shaly matter has, at some places, been crushed by the movements of the beds under tremendous pressure.

sibly in some cases exactly where they are now found. Of course there were many subsequent oscillations of level, by which much of our continent was sunk deep enough beneath the ocean level, to receive thousands of feet in thickness, of later deposits, and again raised to its present elevation.

The walls of the excavation at the bottom of which these plants were found, are composed of the same fine-textured, more or less hard, gray and bluish-gray, argillaceous, slightly gritty beds, as some of those containing the plants, for ten or twelve feet above the bottom of the cut; and farther up, apparently much the same kind of rocks continue for thirty or forty feet, alternating with beds of softer, crumbling, brownish-red material, disposed to form red clays by disintegration. The nature of the rocks composing the mountains here, above this last-mentioned horizon, was not determined by examination; and no organic remains, excepting those of the plants collected here, were seen at this locality.

About two hundred yards to the northeastward from the point where the plants already mentioned were taken out at the bottom of the cut, excavations were in progress in the tunnel, by means of a vertical shaft sunk on an elevation more than one hundred feet above the actual horizon of the point where the plants alluded to above were found. The rock thrown out of this shaft is a very hard, compact, rather coarse-grained, massive grit, of a light bluish-gray color, differing from any of the beds exposed in, or directly over, the cut at the plant locality. It is brought up from the shaft generally in large, irregular massive blocks, as blasted from the beds. In these I saw many fragments of stems and branches of trees, most of which are small, but I obtained several specimens of moderate size, one of which consists of a fragment broken at both ends, measuring twenty-two inches in length, and three to four inches in diameter. Some crushed examples seen in the rock appear to have belonged to individuals of considerably larger size. All of these specimens are coated, as it were, by a bark-like covering of shining coaly matter, while inside of this nothing but the same hard, gritty material composing the surrounding matrix occurs. Generally no well-defined markings are seen either on the surface of this coaly matter, or on the rock within. On one of the specimens, however, obtained here, there are pits closely resembling, in size, form, and arrangements, those of the genus *Stigmaria*.

The absence of surface markings on most of these specimens is perhaps due, in part, to the fact that they were drifted and consequently abraded before being deposited here, and in part to the tremendous pressure to which they have been subjected during the consolidation of the rock, or its subsequent movements. The evidences of pressure are seen on nearly all the specimens, which are usually found crushed and broken, with the surface of the

shining coaly covering polished and striated by the slipping of contiguous portions of the matrix under great pressure.

Owing to the fact that nearly or quite all of the plants I obtained here in a condition to show their specific characters, seem to be new species, while no other organic remains of any kind were observed in these beds during my rather limited examination, we scarcely have the means of determining their exact horizon in the series. The affinities of the several species of ferns found in the bed at the bottom of the cut, at this place, would, however, favor the conclusion that they belong near the junction of the Old Red Sandstone and the lower Carboniferous, but probably in the latter.

That the remains of Chemung types of shells occur at lower stratigraphical positions at several places between here and Alleghany tunnel, has already been stated. There must, however, be a considerable thickness of strata intervening between these two points, the dip being all along here, I should think, scarcely less than 30° to 40° below the horizon, and perhaps at some points more, to the southeastward. I made no measurements of distances, angles of dip, or of the thickness of strata (having no instruments), but the distance between the two tunnels, by the curve of the road, is, I was informed, about one and a half miles. A straight line between these two points, however, would not be in the direction of the dip, but obliquely across the strike, and something less.

The distance, by a right line, between the locality where I found the last Chemung fossils, coming eastward, and the point where the remains of the plants were found in the cut at Lewis' tunnel, I should think little more than half a mile; and, making allowance for the direction of this line with relation to the dip, there would seem to be scarcely less than 1500 feet of strata, and possibly more, between the horizons of these two points. How much if any of this space may be occupied by Chemung rocks remains to be determined. That the Chemung extends from the furthest eastward point at which I found its characteristic fossils, back to Alleghany tunnel, however, where the same types occur, there can be no doubt, and there appears to be good reason to believe that there are from 1200 to 1500 feet of these rocks between these two points. Whether or not the Chemung extends back into Alleghany tunnel, I did not ascertain. I think it probable, however, that at least a part of the strata penetrated by this tunnel belongs to the horizon of the Portage group, because among the material brought out of its eastern end, I saw many thin slabs, of bluish and greenish tinge, showing, on their slightly glazed surfaces, fucoidal markings very similar to *Fucoides graphica*, so characteristic of the Portage group in New York. There is ample space between this point and the White Sulphur

Springs, for great developments of the Portage and Hamilton groups, if both exist here.

The thickness of the Chemung group was formerly estimated at about 1500 feet in New York; but from Col. Jewett's discovery, that a considerable thickness of the strata forming the Catskill Mountains, that had for a long time been referred to the Old Red Sandstone, really belongs to the Chemung, we may perhaps infer that 1500 feet is considerably below the maximum thickness of the latter formation in New York. Prof. Henry D. Rogers estimated its greatest thickness in Pennsylvania at more than 3000 feet.

From all the facts observed, I had at one time supposed that the plant bed at Lewis's tunnel holds a position in the upper part of the Devonian; but as Prof. Rogers informs me that the Old Red, if it exists there, is probably but little developed, the position of these plants may be more properly within the inferior part of the lower or subcarboniferous series.

Fossil Botany not coming within the range of my own especial department of investigation, my object in studying these plants was, at first, merely to identify the species, which it was supposed had probably been described. After making extensive comparisons, however, with the figures and descriptions in a large number of publications, without finding any species agreeing with them, I arrived at the conclusion that they are new, and decided to name and describe them. The specimens, however, have been submitted to Prof. Lesquereux, and afterwards to Dr. Newberry, as well as in part (with tracings of others), to Prof. J. W. Dawson, of Montreal, all of whom are well known to be high authorities on fossil botany; and these gentlemen concurred in the opinion that the species are new; though they differed somewhat in opinion respecting the generic affinities of the ferns, which happen to be types standing, as it were, intermediate between several of the established genera. This peculiarity of these forms, and the fact that the most important generic character (the nature of the fructification) can very rarely be seen in specimens of these older types of fossil ferns, render their classification difficult, and give origin to conflicting opinions, among the most careful and conscientious observers, respecting the generic names under which the species should be ranged.

I take pleasure in acknowledging my obligations to Prof. Dawson, Prof. Lesquereux, and Dr. Newberry, for the suggestions alluded to above, respecting these plants.

Lepidodendron scobiniforme, M.

Pl. I, fig. 1.

Cicatrices of smaller branches moderately distinct, small, or about 0.14 inch in length, and 0.09 inch in breadth, subovate in form, or rounded above and tapering to a mucronate point below,

placed in the usual obliquely ascending rows so as to present a quincuncial arrangement, smooth below. Interspaces smooth, somewhat less than the breadth of the cicatrices, measuring transversely, and half their breadth measuring in the direction of the oblique rows. Leaf scars small, placed at the upper end (and usually a little excentric to the right) of the cicatrices, subrhombic, about as wide as long, with upper side convex in outline, the lateral angles rounded, and the base abruptly pointed; sometimes with the entire outline subcircular, smooth, or without any visible vascular pits within.

The above description is taken from a portion of a flattened branch about an inch and a half wide, showing the cicatrices quite distinctly. But these markings present a great diversity of appearances on different portions of the different sized branches and trunks; and, consequently, the description would not apply to all of its parts. In some of the impressions of still smaller branches, or individuals, the cicatrices are more crowded laterally, more elongated, proportionally narrower, and, as seen in a cross light, present a decided elongate-rhombic outline, the interspaces being proportionally narrow, so as to make the cicatrices appear as if acutely pointed, both above and below. In this aspect, the leaf scars are scarcely seen, and the whole surface presents much the appearance of the figure of *Sigillaria Chemungensis*, given on page 275 of the Report on the fourth Geological District of New York. Even in these specimens, however, when viewed in a different light, the cicatrices can be seen to be really more or less rounded above, and the leaf scars obscurely defined. On still larger branches, the cicatrices become more and more faintly defined, and the leaf scars proportionally more distinct and more scattering, so that the surface looks very much like that of a *Stigmaria*. In following the markings to larger and larger branches, or individuals, the cicatrices are seen gradually to become obsolete, and longitudinal ridges begin to be developed. On fragments, apparently of the trunk of the same tree, these ridges are found to be from 0.25 to 0.46 inch in breadth, nearly flat (with sometimes very obscure traces of irregular longitudinal striæ), and separated by narrow irregularly interrupted furrows; while a single row of the small scars occurs along the middle of each, separated by intervals of about 0.50 inch. Again other specimens, apparently of portions of the trunk, show the ridges to have become obsolete or nearly so; but the leaf scars are still seen, more widely separated, and more obscurely defined. These longitudinally ridged specimens, therefore, present very nearly the characters of *Sigillaria*. Hence, it becomes a matter of some doubt to which one of the three genera, *Lepidodendron*, *Stigmaria*, or *Sigillaria*, the species should be referred.

It is true that the specimens seen are not in such a condition as positively to demonstrate that they all belong to the same

species—that is, no one individual tree has been seen entire, and showing all of the characters mentioned—but the specimens were found flattened together in the same matrix, and present such an uninterrupted series of gradations as to render it impossible to separate them; and to leave the impression on the mind that they really belong to the different parts of the same species.

Prof. Lesquereux has also informed me, that after figuring and describing his *Stigmaria minuta*, of the Pennsylvania Report, from the Lower Carboniferous of the State, he found other specimens clearly showing very similar gradations in the surface markings, and yet under circumstances rendering it positively certain that they all belong to one tree.

So far as I have been able to see, the markings on decorticated surfaces all become nearly obsolete.

In the same matrix numerous very slender grass-like leaves occur that probably belong to this species. The widest of these are not more than 0.13 inch in breadth, while some of them can be traced to a length of more than seven inches, and yet they are broken at both ends, and appear to be simple and almost of the same breadth throughout the entire length. They are always flattened by pressure, and generally show no very well-defined median vein, but in some cases they appear to exhibit traces of about four longitudinal lines, or veins.

STIGMARIA ? (sp. undetermined).

The specimens of this fossil in the collection are more or less compressed laterally by accidental pressure, and surrounded by a thin bark-like covering of shining coal. Generally they show scarcely any traces of surface scars; but one of them about 19 inches in length, with both ends broken away, and measuring at the larger end (which rather suddenly enlarges), 3, by a little more than $5\frac{1}{2}$ inches in diameter, and at the smaller 2.40 by 4.30 inches in diameter, retains the scars or pits on the decorticated surfaces, with some degree of distinctness. These are alternately arranged in obliquely ascending rows, and are simple, vertically elongated depressions, deepest in the middle, and becoming rapidly shallower and narrowed to nothing above and below. In the direction of the spiral rows, as well as transversely, they measure about 0.40 inch from the middle of one to that of the next; while the interspaces are sometimes obscurely and irregularly a little wrinkled longitudinally.

The whole interior, within the surrounding bark-like coating of coal, is merely composed of the hard, rather fine gritty material composing the surrounding matrix, and shows no traces of an eccentric pith. This latter fact and the rather elongated form of the surface pits, without any ring or elevated point within, render it doubtful whether or not this form can be properly referred to the genus *Stigmaria*.

The specimens of this species do not occur directly associated with the other plants described in this paper, but at a somewhat higher geological horizon, about one or two hundred yards further eastward.

Carpolithes?

Pl. I, fig. 4.

These bodies may or may not be fruits, as they are too imperfectly preserved and defined to be satisfactorily determined. They seem to have been vesicular, or, at any rate, to have possessed little solid substance, as they are almost entirely flattened by pressure. As thus seen flattened in the matrix, they most generally present a spatulate outline, and vary in length from 1 inch to 1.60 inches, and from 0.20 to 0.30 inch in breadth, the widest part being generally near one end; while the opposite end is sometimes abruptly pointed, and the other usually more obtuse, or more or less rounded. They show no surface markings of any kind.

Cyclopteris? (Archæopteris) Lescuriana, M.

Pl. II, fig. 1, *a*, *b*, *c*.

Frond tripinnate,* attaining a large size, primary pinnæ lanceovate or lanceolate in general outline, with a moderately stout, straight, somewhat rugose rachis. Secondary pinnæ regularly alternating, rather approximate, lanceolate, nearly straight or a little arched upward, with a slender, very slightly flexuous rachis, that diverges from the secondary one at distinctly less than a right angle. Tertiary divisions or pinnules regularly alternating, narrowed below to the short oblique petiole, the lower or inner ones being deeply divided into from three to five (rarely six) alternating, moderately divergent, narrow sublanceolate, simple, or rarely dentate leaflets; upper ones gradually becoming less and less divided, until they pass into merely slightly dentate, or simple lanceolate forms that are more oblique to, and slightly decurrent upon, the rachis. Nervation rather obscure; nerves not very numerous, moderately diverging, and apparently several times bifurcating.†

* The descriptions of this and the following species, are drawn up under the supposition that the largest specimens found are not fronds, but mere divisions of the same. If they should be found to be entire fronds, however, of course the description would have to be modified to correspond, as in that case the species should be described as bi-pinnate, and the division termed secondary pinna, would be primary, etc.

† In some of the specimens the upper side of the pinnules can be seen under a strong magnifier in a cross light, to be covered by numerous extremely minute, crowded longitudinal striæ, apparently independent of the nervation. These striæ can be traced down the narrowed base, or petiole, upon and along the rachis.

The specimens apparently belonging to this species before me, present considerable variations of form and other characters, some being decidedly narrower, with their pinnæ shorter, more distant, and more oblique, and their pinnules less divided. These, however, probably belong to different parts of the frond from that described here as the typical form of the species. Others have the pinnæ and pinnules, as well as the subdivisions of the latter, smaller and proportionally more slender, and presenting a more delicate appearance throughout. These latter may possibly belong to a distinct species, but they agree so nearly in all other respects with the form described as to leave the impression that the whole series belongs to one somewhat variable species.

This species has much the aspect of a *Sphenopteris*, to which Dr. Newberry thought it might be referred without impropriety. In this opinion Prof. Dawson was inclined to concur on examining a photograph of it. On a critical examination of its nervation, as seen in some specimens sent to him, he writes that he thinks it belongs more properly to the same group as *Archæopteris Halliana* (= *Sphenopteris laxa*, Hall), to which I had from the first supposed it to be related. Prof. Lesquereux, to whom I showed the specimens, also supposed the species to belong to *Palæopteris* of Schimper, which is the same as *Archæopteris*, Dawson, the name *Palæopteris* being preoccupied. Some other high authorities on fossil botany, however, have arranged similar forms under the names *Asplenites* and *Adiantites*.

From these remarks the student will readily understand that in the present unsettled state of opinion in regard to the limits between several of these older groups of fossil ferns, and the consequent confusion existing in their nomenclature, it is impossible to determine beyond doubt under what genus this species may ultimately have to be ranged, when all of these questions can be settled. It may therefore have to take the name *Sphenopteris Lescuriana*, or *Adiantites* (*Asplenites*) *Lescurianus*. Or, possibly, in case the name *Palæopteris* of Genitz should be found not to have been based upon a tenable genus, so that Schimper's name *Palæopteris* would have to replace *Archæopteris*, our species may have to be called *Palæopteris Lescuriana*.

Specifically this form will be readily distinguished from *Cycl.* (*Archæopteris*) *Halliana*, by wanting the row of broad separate pinnules along its rachis between the pinnæ as seen in that species, as well as by its more divided inner pinnules and more rigid pinnæ. Prof. Dawson thinks it more nearly related to his *C.* (*Palæopteris*) *Rogersi*, though, on comparison, he says he finds that the *Rogersi* has larger pinnæ, and more obtuse as well as larger pinnules, and a somewhat different venation.

Cyclopteris Virginiana, M.

Pl. I, fig. 3, *a*, *b*, *c*.

Frond apparently attaining a large size, and probably tripinnate. Primary pinnæ with a rather stout, rigid, smooth, or slightly striated rachis. Secondary pinnæ long lanceolate, regularly alternating, nearly straight, rather closely arranged, and standing nearly or quite at right angles to the rachis. Pinnules more oblique, rather approximate and regularly alternating; lower or inner ones shorter and broader than the others, abruptly narrowed, or apparently sometimes subcordate at the base, and attached to the rachis by an extremely short petiole, more or less distinctly trilobate, the lobes being obtuse, and broad-ovate in form; succeeding pinnules gradually becoming five-lobed, more elongated, or obtusely sublanceolate, more oblique, and less abruptly tapering at the base; beyond these, the others are less and less strongly lobed, or merely undulated on the margins, while a few near the extremities of the pinnæ are quite simple, still more oblique, and very gradually tapering to, and more or less decurrent upon, the rachis. Nervation distinct, nerves slender, palmately spreading, and bifurcating several times.

If specimens of this species, like the one figured, are imperfect primary pinnæ, and not fronds, it must have been a very large beautiful fern. It seems to have been much more rare than the last, as only the two specimens figured occur in a collection, containing fifteen or sixteen more or less imperfect examples of the last.

Although very distinct specifically from the foregoing, this seems, like that form, to stand as it were intermediate between several of the established genera. In some respects it is related to both *Sphenopteris* and *Cyclopteris*, while Prof. Schimper has included some similar forms in his genus *Triphyllopteris*. Still other high authorities have placed apparently congeneric forms under the names *Adiantites* and *Asplenites*. It is therefore possible that when the affinities of the ancient types of ferns can be better understood, and the confusion that now exists in their nomenclature is corrected, the name of this species may have to be changed to *Sphenopteris* or *Triphyllopteris Virginiana*. I am not sure, however, that it should not be called *Archæopteris (Palæopteris) Virginiana*.

Cyclopteris (Archæopteris) Alleghanensis, M.

Pl. I, fig. 2, *a*, *b*.

Frond tri- or bipinnate. Primary pinnæ (or possibly the frond) narrow, or apparently lanceolate, with a comparatively strong, transversely wrinkled, rigid rachis, that is provided

with short, sublanceolate, regularly alternating, rather crowded pinnæ, directed nearly at right angles to its sides. Pinnules simple, alternate, very obtuse, and varying from subcircular to obovate, those nearest the rachis being sometimes nearly circular, and connected with the rachis by an extremely short petiole, or almost sessile; those further out narrower, more oblique, and tapering to a narrow base that is more or less decurrent on the rachis; terminal one sometimes a little larger than the smaller of the others, and partly confluent with the nearest of the latter. Nervation moderately distinct; nerves spreading from the base, and bifurcating two or three times.

This is probably a smaller species than either of the other two already described, and is very distinct from them both in the form and simplicity of its pinnules. But the single imperfect specimen of it figured was found, and it occurred directly associated with the others. In the form of its pinnules and their nervation it resembles *Archæopteris* (*Nœggerathia*) *minor*, of Lesquereux, but its pinnæ and pinnules are much more crowded and shorter.

For the reasons already explained, future corrections of nomenclature may require the name of this species ts be written *Adiantites* (*Asplenites*) *Alleghanensis*, or *Palæopteris Alleghanensis*.