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DESCRIPTIONS OF FOSSIL PLANTS.

BY

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DESCRIPTIONS OF FOSSIL PLANTS

FROM

THE COAL MEASURES OF OHIO.

Comparatively few of the fossil plants obtained from the Coal measures of Ohio are described on the following pages. Several hundred species have been collected, many of which are new to science, and of these descriptions and drawings of quite a number have been prepared; but of most of these it has been thought best to defer the publication for the present. This volume of the Report is mainly devoted to the strata and fossils of the Silurian and Devonian systems and to fossil fishes.

Our fossil fishes are derived from both the Devonian and Carboniferous systems, but the largest and most interesting forms are from the Devonian. As it seemed to me desirable that this group of vertebrates should be considered as a whole, a general review of the fishes found in our rocks is given on the preceding pages.

Our fossil plants are for the most part found in the Carboniferous strata, yet some very interesting ones are furnished by both the Silurian and the Devonian systems. I have thought that the fossil plants should somewhere be discussed together, and, so far as practicable, the history of plant life in the different geological ages should be traced out, and the relations of our fossils plants to each other and to other fossil floras should be made the subjects of investigation. A memoir which should have this character and be similar in its scope to that now published on our fossil fishes, would, as it seems to me, have considerable interest and value; and I have intended to prepare something of the kind for our Reports. This work has been deferred, however, for the present, and precedence has been given to the discussion of our fossil fishes. This arrangement has seemed to be the natural one, inasmuch as our study of the geology and palæontology of the State has been progressive, from the older to the newer formations.

In our next volume on palæontology the invertebrate fossils of the Carboniferous will be described and figured, and that will also contain a memoir by Prof. Cope on the fossil salamanders of the Coal Measures. In that volume the general discussion of our fossil flora will naturally find place. The descriptions of *all* our fossil plants would have been deferred until they could be presented together, but this would have thrown the larger amount of material into our second volume. To divide this material more evenly, therefore, as well as to give variety to the contents of this volume, a few of our fossil plants are now figured and described. Most of the space alloted to these is taken up by the descriptions of such fruits and seeds as have been obtained from the Coal Measures. These form a group of genera and species of which the relations to the other portions of the coal flora are somewhat obscure, and they can therefore with some propriety be made the subjects of a special memoir. To these are added a few ferns of special interest, of which those who are students or collectors of fossil plants will be glad to have descriptions as early as possible.

GENUS POLYSPORIA, Newb.

The above name has been chosen to designate certain cones which are sometimes found in the roof-shales of Coal No. 1, in Summit and Mahoning Counties. When well preserved—which is rarely the case—they are seen to be composed of a central woody axis, from which radiate, spirally, a large number of cylindrical or clavate sporangia, filled with minute, discoidal—once spherical—spores. Oftener than otherwise the cones are much crushed and broken; the sporangia being detached from the axis, and forming a matted and irregular mass. Not unfrequently, too, the spores have burst their capsular sporangia, and are scattered thickly through the adjacent shale.

The individual sporangia are club-shaped, rounded at their distal extremities, where crucial or transverse marks are frequently to be seen. These marks I have supposed to indicate the position of sutures where the sporangia opened at maturity to permit the escape of the spores.

No connection has ever been observed between these singular groups of seed-vessels and the plants to which they were originally attached; we are, therefore, driven to an examination of their minute structure for a clue to their botanical relations. Here the conclusions attained are only general, and are not such as will permit us at present to refer them to even the genus of plants of which they formed the fruit. Composed, as they are, of sporangia and spores, and attaining so considerable dimen-

sions, we are safe in considering them the fruit of an acrogenous tree, but whether of Lycopod or fern, it is scarcely possible to decide.

The fruit of the *Lycopodiaceæ* forms a cone of some sort, having a central woody axis, from which radiate, spirally, bracts or scales, of which the shield-like extremities form an imbricated, external surface, concealing and protecting the seeds within. These seeds consist of spores, contained in capsular sporangia, borne by the pedicel which supports the scale. The fruit before us, however, while it had a cone-like form and a woody axis, shows no imbricated scales; but, instead, naked, club-shaped sporangia, inserted directly upon the axis. This is not *very* unlike the style of fructification of some ferns; such, for example, as have a distinct fertile frond consisting of capsules or sporangia of various forms and variously grouped, and containing numberless minute spores. Among our common ferns, *Onoclea* and *Botrychium* may be cited as examples of the group whose fructification forms clusters of spore-bearing capsules. There is no fern known to me, however, of which the fructification forms a massive cone at all like that before us. The cones of the living Lycopods are also far removed from this, both in size and structure, but the fruit-cones of some of the fossil *Lycopodiaceæ* approach considerably nearer to it. Most of the cones of the gigantic extinct Lycopods—*Lepidodendron, Lepidophloios, Sagenaria*, etc.—are several inches in length, and, like the cones of *Lycopodium* and *Selaginella*, consist of a woody axis, supporting horizontally-radiating bracts, each of which bears upon its upper surface one or more sporangia filled with spores (microspores or macrospores, sometimes one, sometimes both). In *Polysporia*, we have the same woody axis, but no bracts; the sporangia having thick and strong walls, and being so closely set that they occupy all the circumference of the axis, and form a solid, cylindrical fruit-cone. This structure is evidently such as would require the plant which bore this fruit to be separated generically from the cone-bearing Lycopods which I have enumerated above. In all of these, so far as known, the cones are largely composed of bracts, and the sporangia are as closely covered and well protected as are the seeds of the pine or fir. Doubtless at maturity the cones opened, so that the spores might escape, but at an earlier period the sporangia must have been entirely concealed.

In the cones called *Lepidostrobus* the sporangia are large, oblong or cylindrical in form, each occupying the entire length of the horizontal portion of the bract that sustains it, and only microspores are contained in those of all parts of the cone.

In *Flemingites*, each bract of the cone sustains a number of relatively small sporangia, which, as in *Lepidostrobus*, contain only microspores.

In *Triplosporites*, the sporangia are large and simple, as in *Lepidostrobus*, but they contain microspores above and macrospores below.

When, now, we compare the cone of *Polysporia* with these, we see that it agrees with *Lepidostrobus* in the character of its sporangia and spores, but differs from it widely in the absence of bracts. In a cone which has been called *Lepidostrobus Dabadianus* by Schimper*—but which, containing microspores and macrospores, should rather be considered as a species of *Triplosporites*—the form and general aspect are much more like those of *Polysporia* than any of the other fossil cones heretofore described. In this, too, the bracts are shorter and more slender, the sporangia forming a relatively greater portion of the mass of the cone. If in this cone we could imagine the bracts still further dwarfed, until finally the ends of the sporangia should be exposed, and form a tesselated surface, we should have *Polysporia*, in all respects save this, that it has only, so far as observed, microspores in the sporangia.

It will be seen from the above description that, as has been stated, in general structure *Polysporia* most resembles the fructification of the great Carboniferous Lycopods; and while the peculiarities it exhibits are plainly sufficient to exclude it from any genus yet described, the characters it has in common with *Lepidostrobus, Triplosporites* and *Flemingites* seem to require that it should be included in the same family with them.

POLYSPORIA MIRABILIS (n. sp.).

Plate 41, Figs. 5, 5*a*, 6.

Cone, 3 inches in length by l½ inches wide, consisting of a series of club-shaped sporangia, thickly set upon a central axis and filled with minute spores; each sporangium, of which there are, perhaps, a hundred in each cone, three-fourths of an inch in length, rounded at its remote extremity, narrowed, and sometimes necked or wedged at its proximal end. The sporangia are filled with microspores, many hundreds being contained in each. They are flattened and discoid as fossilized, but were originally spherical. They are often marked with three salient, radiating lines.

Formation and locality: Roof of Coal No. 1; Tallmadge, Summit County, Ohio.

* Paleontologie Vegetale, Tom. II., p. 69, Pl. LXII., Figs. 1-12.

ANTHOLITHES PRISCUS, Newb.

Plate 41, Fig. 3.

Antholithes priscus, N.; Annals of Science, Vol. II., p. 2 (1854).

Flower-stem smooth, somewhat flexuous; bearing six or more flowers? placed alternately—the lower ones nearly opposite—in the axils of bracts; flowers? pendulous, bases and peduncles covered with scales.

No detailed description of this interesting fossil is required, since all its more important characters are given in the figure now published. It is plainly the florescence of some plant; and although the component parts of flowers cannot be distinctly made out, and it is by no means certain that the organs which still remain ever formed or surrounded a conspicuous corolla, still the specimen possesses a certain grace and beauty which almost warrants us in believing that it was once a spray of flowers, such as form the greatest charm of the vegetation of the present day. The stem which supports these floral organs is perfectly smooth, and is now so much flattened that it is evident it could never have been composed of solid woody tissue. It would only be necessary for anyone to see the specimen to be satisfied that it was never a branch of a tree with scaled buds or catkins; but it was a tender and perhaps succulent stem which had for its sole function the support of the florescence of the plant which bore it. In two instances I have found the flowers? which are here attached separated from the stem and expanded in a disk upon the shale. Under such circumstances they present very much the appearance of some composite flower with its scaled involucre compressed vertically.

In the remarks which will be made on the genus *Cardiocarpon*, I shall refer to this specimen and the circumstances under which it was found. On Plate 41, figures 1, 2 and 4 represent some fruit and flower stems found with that which I have described. These were accompanied by great numbers of the leaves and stems of *Cordaites*—most of the former being flabellate, and different from the most common species—and I have been led to conjecture that all these belonged to the same plant; and that in *Antholithes* we had the florescence of *Cardiocarpon*, and that *Cardiocarpon* was the fruit of *Cordaites*. Future discoveries will doubtless prove or disprove this conclusion, and it is manifestly wiser to leave the solution of the question to time, than to attempt to enforce it by arguments drawn from the imperfect material at our command.

Formation and locality: Shale over Coal No. 1; Youngstown, Ohio.

GENUS TRIGONOCARPON, Brongt.

Fossil nuts, of an ovoid form, marked with three salient longitudinal lines, have been found in the Coal Measures, in greater or less abundance, in every country where rocks of this age occur. These nuts were grouped in the genus *Trigonocarpon*, many years ago, by Brongniart. Since that time they have been collected in great numbers, but in no case have they been found attached to the tree or plant on which they grew; so that their affinities with other members of the coal flora remain a matter of doubt, and have been the subject of much discussion among fossil botanists. As generally preserved, all details of anatomical structure have disappeared. Most frequently, indeed, the fossil consists of a cast in sandstone of the nut, stripped of its integuments and more or less worn and broken. In a few instances they have been found better preserved, and such have been described by Dr. Hooker and Prof. Dawson. By both these gentlemen a general resemblance in structure between these nuts and the fruit of some of the Conifers and Cycads has been noticed, and the "Gingko" (*Salisburia*) has been cited as bearing a fruit containing a nut not unlike them. As will be seen further on, my own observations throw some additional light upon the fruit of which *Trigonocarpon* is the nut.

I have said that up to the present time the nuts under consideration have never been found connected with the plant which bore them. This is the more surprising as they occur in such profusion. In the roof-shales of Coal No. 1, in Summit County, I have seen literally hundreds within the area of a few square yards, and they are not unfrequently so well preserved there as to show the entire form of the drupaceous fruit with its rind or epicarp unbroken. This proves that they had not been transported, but had accumulated with twigs and leaves under the trees on which they grew. With these nuts are the *debris* of various coal plants, viz.: the trunks and branches of *Lepidodendron,* the trunks and leaves of *Sigillaria,* the leaves of *Cordaites,* countless fern fronds, *Calamites, Asterophyllites, Sphenophyllum, Annularia,* etc. Among all these are none which have been regarded as Conifers. The *Coniferæ* were well represented in the Carboniferous flora, as we know, and the highlands of the Carboniferous continent were undoubtedly clothed with forests of pine-like *Araucariæ*. But these did not grow in the coal marshes, and contributed little or nothing to the formation of coal itself. We seem, therefore, to be compelled, in tracing the parentage of *Trigonocarpon*, to make choice among the well known elements of the coal flora. The fruit

of *Lepidodendron* is a cone, like that of *Lycopodium*, and has often been found attached to the tree. The fructification of the Calamites and of their allies *Asterophyllites, Sphenophyllum*, etc., as well as that of the ferns, is also well known. There remain, therefore, only two common coal plants of which we can consider *Trigonocarpon* the possible fruit, *Sigillaria* and *Cordaites*. Fossil botanists have discussed the relations of *Sigillaria* at considerable length, without, however, reaching any universally accepted conclusion. Prof. Dawson considers them Gymnosperms, while Mr. Carruthers regards them as distinctly cryptogamous, and more nearly allied to the Lycopods than to the Conifers. My own observations confirm those of Prof. Dawson in regard to the structure of the trunk of *Sigillaria*. The outside was evidently composed of a thick cortical integument, to which the leaves were attached. Within this was a mass of cellular tissue, surrounding a slender woody axis, with a relatively large medullary cavity. This is very unlike the structure of the trunk in most of our Conifers, but is not very dissimilar to that of the trunk of Cycads. The probabilities are that the *Sigillariæ* formed a group of plants considerably unlike any now living, and such as served to connect the Gymnosperms with the Acrogens. If this was their botanical position, it would not be at all surprising if we found that they possessed a trunk sharing the peculiarities of the Sago-palms and tree-ferns, bearing drupaceous fruits not unlike those of the Cycads and some of the infinitely varied *Coniferæ*. If we compare the fruits of *Pinus, Taxus, Salisburia* and *Ephedra*, among the *Coniferæ*, we shall discover such a latitude of structure as will prepare us to accept the association of the fruit *Trigonocarpon* with the trunk *Sigillaria* without much hesitation.

In regard to *Cordaites*, I think we have good proof that it is not, what it has sometimes been considered, a fern, but was more nearly allied to the Cycads than to any other living plants. In another place, I shall give my reasons for associating *Cordaites* with the Cycads, and for considering *Cardiocarpon* as its fruit. I should have no difficulty in considering *Trigonocarpon* as the fruit of *Cordaites*, were it not that I have found *Cardiocarpon* more directly connected with it, and that in some localities where *Trigonocarpon* is abundant, the remains of *Cordaites* are rare or absent, and *vice versa*.

We know that *Sigillariæ* were the most common trees in the forests of the Coal period, and that the tissues of their trunks and leaves contributed largely to the formation of coal. Hence their fruit or seed-vessels must be abundant in the coal or roof shales of our coal seams. As all the other fruits and seeds, except *Trigonocarpon*, that are frequently met with in the Coal strata are satisfactorily connected with the plants

that bore them, and *Sigillaria*, equally abundant, is without known fruit, until something more than circumstantial evidence is obtained, I shall be disposed to regard *Trigonocarpon* as the fruit of one or the other of the very different and, perhaps, generically distinct groups of trees now included in the genus *Sigillaria*. Goldenberg has described and figured a very different form of fruit as that of *Sigillaria*. He represents it as consisting of small sporangia, borne on the bases of modified leaves; but I am compelled to say that in many years spent in collecting fossil plants from strata where *Sigillariæ* abound and are well preserved, I have never seen such a form of fructification as that described by Goldenberg.

Whatever plants bore these nuts as fruit, it is evident that they grew in clusters on deciduous fruit-stalks; probably much as the palm-nuts grow at the present day. If they had been borne on the twigs of a branching plant, we should be quite sure to find them still connected with some fallen branches, broken off by wind or lightning-stroke; the immature fruit adhering firmly, under such circumstances. We may conclude, therefore, that they sprang from the trunk, borne by delicate sprays, to which no leaves were attached; almost never falling except at maturity, and generally each by itself, though sometimes dropping in clusters, but with no appendages that could give a clue to their former connections. One of these days, a tree, fallen in full leaf and fruit, will be discovered in the roof of some coal mine, displayed in all its length, from root to summit. This will show the clusters of fruit still attached to the parent stem, and thus solve the long mystery.

On Plates 42 and 43 will be found several figures which exhibit the entire fruit of which *Trigonocarpon* is the nut. These show that it was ovoid or elliptical in outline, with a smooth, leathery rind. In some specimens the contained nut is entirely concealed (pl. 42, Fig. 10, Pl. 43, Fig. 12); in others its outlines are brought out by pressure in the shales (Pl. 42, Fig. 9, and Pl. 43, Fig. 15). Most of the specimens obtained from the sandstones are more or less beach-worn and marred. Occasionally, however, one is found—like that represented on Plate 42, Fig. 1—which has suffered little injury beyond the loss of the fleshy envelope. In this and some others I have seen, the three conspicuous salient ridges which traverse the surface longitudinally, are shown to be the remains of broad and delicate wings; so delicate that they are generally all torn away, with the exception of their thickened bases. In the argillaceous shales overlying the beds of coal, we find not only the entire fruits which I have described, but detached portions of the external skin or coating bearing the impression of the stem at the base, of the flower above. The latter is sometimes a six rayed star, such as we might suppose would be left by the fall of a six-parted flower (Pl. 42, Figs. 5 and 6).

Those who have collected the fossil nuts so abundant in our coal shales will have noticed that portions or fragments of the shells of *Trigonocarpon* are much more abundant than the complete nuts; and they will have noticed, too, that the shell has often separated in thirds, each third presenting an elliptical or lenticular arched surface, bordered by the projecting wings, which, more or less perfectly preserved, form a more or less complete margin to the arched side of the nut. Such specimens as these have been described as distinct species of either *Rhabdocarpus* or *Carpolithus*. Abundant examples prove to me, however, that they are but portions of the shells of *Trigonocarpon*, which seem to have divided naturally through the salient angles or wings, very much as the external envelope of the hickory nut divides. This is well shown in Plate 43, Fig. 14, where a portion of a slab, covered with the remains of a cluster of nuts, is represented. In this group, with innumerable irregular fragments of the shell and external rind, many segments of the shell, such as I have described, are visible; also several nuclei or kernels which they once enclosed (*a*, *b*, segments of shell; c, *d*, nuclei).

TRIGONOCARPON TRILOCULARE, Hildreth.

Plate 42, Figs. 1, 13, 13*a;* Plate 43, Fig. 13.

Carpolithus trilocularis, Hild.; Amer. Jour. Science, 1st. Ser., Vol. XXXI., p. 29, Fig. 4.
Trigonocarpon Hildrethi, Lesqx.; Geol. of Pennsylvania, Vol. II., p. 877.

Nut ovoid, sometimes nearly spherical, marked with three salient ridges which pass from base to summit. These ridges are the remains of prominent wings, which, in a few rare instances, are preserved. When present they unite above and form a long, triangular point, as in Plate 42, Fig. 1. The surface of the nut between the wings is smooth. Within the shell is contained an ovoid nucleus, of which the surface is reticulately marked (Fig. 13*a*).

This is the most common species of *Trigonocarpon* found in the Conglomerate of Northern Ohio. I have, also, obtained it from the heavy-bedded sandstone over Coal No. 1. As will be seen in the figures now given, this species sometimes attains large size—2 inches in length by 1½ in diameter—almost reaching the dimensions of *T. magnum*. But it differs from that species in having but three salient ridges. From *T. Bertholletiforme*, another large species which occurs higher up in the Coal Measures, it may be distinguished by its broad, ovoid, or spherical form.

This is undoubtedly the nut described by Dr. Hildreth in his "Miscellaneous Observations during a Tour to the Falls of the Cuyahoga," 1835, (Amer. Jour. Sci., Vol. XXXI).

Formation and locality: Conglomerate and Lower Coal Measures; Summit and Mahoning Counties, Ohio.

TRIGONOCARPON TRICUSPIDATUM (n. sp.).

Plate 42, Figs. 2 to 6.

Nut elliptical in outline, rounded below, narrowed above into a neck-like prolongation, which is expanded into a three-pointed area. From these points three salient ridges are prolonged downward nearly to the base of the nut, where they become obsolete. As was probably the case with all other species of *Trigonocarpon*, this nut was surrounded by a drupaceous envelope, covered with a leathery rind.

The nucleus or kernel contained within the shell was elliptical in form, having the surface marked with reticulating lines.

On Plate 42, Fig. 2, is given a representation of the complete nut without its envelope; Figs. 3 and 4 represent the kernel; Figs. 5 and 6 portions of the leathery integument.

Formation and locality: Roof Shales of Coal No. 1; Tallmadge, Ohio.

TRIGONOCARPON ORNATUM (n. sp.).

Plate 42, Figs. 7, 7*a*.

Nut elliptical in outline; 1 inch in length by 3/8 of an inch wide; constricted above into a neck, which is expanded into a stellate, six-rayed, cupped area at the summit. From the points of this area six sharp, keel-like ridges are prolonged to near the base of the nut, where they become obsolete. Of these ridges three are the more prominent, three lower ones alternating with these. The elliptical or fusiform outline of this elegant little nut, its stellate summit and six sharp and prominent keels, will enable anyone to distinguish it at a glance from any other described species.

The figures given represent side and end views, of the natural size.

Formation and locality: Carboniferous Conglomerate; Cuyahoga Falls, Ohio.

TRIGONOCARPON MULTICARINATUM (n. sp.).

Plate 42, Figs. 8, 8*a*.

Nut of small size, 9 lines long, 6 lines wide; rounded below, truncated and cupped above; the surface marked by about 21 longitudinal ridges, of which three are more prominent than the others. These ridges give a crenulated margin to the cup at the top. The three most prominent ridges are prolonged from the margin to the raised centre of the cupped summit, dividing it into three nearly equal divisions.

Formation and locality: Carboniferous Conglomerate; Cuyahoga Falls, Ohio.

TRIGONOCARPON MAGNUM (n. sp.).

Plate 42, Figs. 11, 11*a*.

Nut ovoid or elliptical in form, large, 2½ inches in length by l¾ in width; surface marked by six salient ridges running from base to summit; spaces between the ridges smooth, and, at the base of the nut, rising into prominent arches between the depressed bases of the salient ridges.

This is the largest species of *Trigonocarpon* of which I have any knowledge. The only specimen I have of it I owe to the courtesy of L. V. Bierce, Esq., of Akron, Ohio, who obtained it from the Coal-measure sandstone near Coshocton, Ohio.

TRIGONOCARPON BERTHOLLETIFORME, Foster.

Plate 42, Figs. 12, 12*a*.

Trigonocarpon Bertholletiforme, Foster; Annals of Science, Vol. I., p. 128 (1853).

Nut long-ovoid in outline, rounded and obtuse at base, acute at summit; section trigonal; the angles marked by ragged salient ridges. In general appearance it resembles the Brazil nut, the fruit of *Bertholletia excelsa*.

Of this nut I have seen no specimen, and the only one known to Col. Foster was that from which his drawings, now copied, were made. These seem, however, to indicate differences from any other known species, which will be readily appreciated by those who may discover other specimens. The most striking features in this nut are its large size, elongated form, trigonal section and strong ridges running from base to summit.

Formation and locality: Upper part of Lower Coal Measures; Guernsey County, Ohio.

CARPOLITHUS FRAGARIOIDES (n. sp.).

Plate 43, Figs. 2, 2*a*.

Nucleus spherical or transversely elliptical in outline, about half an inch in diameter; in the fossil state very much flattened, though doubtless originally nearly spherical; surface marked with a kind of net-work of smooth bands, with areoles which form a double spiral. These areoles were apparently more prominent than the separating bands, so that the nut must have had somewhat the aspect of the strawberry with its prominent achenia. External envelope apparently drupaceous, contained in a leathery rind.

This peculiar fruit is found in the shales over Coal No. 1, but is quite rare. The figure given of the nucleus (2*a*) conveys a very imperfect idea of the marking of the surface. The figure of the external envelope (2) shows the appearance it usually presents—torn open, and the nucleus having escaped. I am, perhaps, in error in supposing that these two fossils are portions of the same fruit; but they are so associated in one locality as to render it almost certain that they belong together. Further observation will doubtless clear this question of any doubt now hanging over it, and will perhaps reveal something in regard to the botanical relations of a fruit which is so unlike anything hitherto found in the Coal Measures.

Formation and locality: Shales over Coal No. 1; Mill Creek, near Youngstown, Ohio.

GENUS CARDIOCARPON, Brongt.

This is the name given by Brongniart to certain flattened, more or less heart-shaped seed vessels, found in the Coal Measures of all countries. The fruit consists of a central nucleus, often beautifully heart-shaped, surrounded by a margin which forms, sometimes a larger copy of the nucleus, sometimes an annular band enclosing the nucleus, but is oftener more or less deeply notched at the summit; while in a remarkable species, *C. samaræforme,* from the roof of the lowest coal in Summit County, the margin forms two broad lobes or wings, which give the fruit much the aspect of the winged seeds of the maple. Nearly all species of *Cardiocarpon* show a distinct point of attachment at the broad end of the nucleus, and, unlike *Trigonocarpon,* they are never found enclosed in an endocarp. Usually the entire fruit, nucleus and margin of *Cardiocarpon,*

forms a smooth, thin carbonaceous wafer, and it is quite evident that it was originally thin and flat.

Though very abundant in the roof shales of some of the coal strata, especially of the lowest, *Cardiocarpa* have never been found united to the plants which bore them. Hence their relation to the other coal-plants with which they are associated is a matter of conjecture, but I have been led to suspect that they may be the fruits of *Cordaites*. From their abundance in the coal shales, it is evident that they must have belonged to some plant which grew abundantly in the coal marshes, and could not have been connected, as has been suggested, with some unknown plant inhabiting the distant uplands. In one instance, only, I have found *Cardiocarpa* attached to stems. These stems had been detached from the plant on which they grew, but were so mingled with the leaves and stems of *Cordaites* as to afford strong presumptive evidence that they belonged together. In the same association were numerous specimens of *Antholithes,* so that I have been led to suspect that these are the flowers or immature fruit of *Cardiocarpon.* On Plate 41, I have given figures of *Antholithes* and *Cardiocarpa,* all from the same locality and found in juxtaposition, and it is possible that they may represent but different phases of the fructification of *Cordaites*.

In another place I shall have something to say about the botanical relations of *Cordaites,* and I will only remark here, in passing, that in an interesting suite of specimens which I obtained in the locality that furnished a large number of *Antholithes* and *Cardiocarpa* (specimens 1 to 4 on Plate 41, and a great number beside), were stems of *Cordaites* which showed both their external surface and internal structure. These lead me to class this plant with or near the Cycads, and it requires no great stretch of imagination to suppose that such a plant had flowers and fruit similar to *Antholithes* and *Cardiocarpon.* The resemblance between the seed vessels we call *Cardiocarpon* and the fruit of *Cycas revoluta,* e. g., is very striking, as may be seen by a comparison of Figs. 1 and 8, Plate 43. Here in Fig. 1 we have the entire fruit of the recent *Cycas,* the nucleus it contains being represented beside it; while in Fig. 8 we see a common form of *Cardiocarpon.* If the fruit of our *Cycas* were strongly compressed, the outline of the nucleus it contains would become visible, and we should have almost an exact copy of Fig. 8. It is apparent, however, that *Cardiocarpon* was always flatter than the drupe of *Cycas revoluta;* but this is a "mere matter of detail." In general structure, so far as we know, the fruits I have compared are very much alike; enough so, at least, to encourage further consideration of the question now proposed. It may be objected that if we accept the fruit or flower spikes

called *Antholithes* as the flowers of *Cardiocarpon* and *Cordaites*, we must imagine the florescence of *Cordaites* to have been different from that of *Cycas*—different not merely in form, but in structure and function. In the modern *Cycadæ* the flowers are diœcious, but the grouping suggested would require that the florescence of *Cordaites* should be monœcious or hermaphrodite. This objection, however, has little weight, as we see great variation in this respect in the same family—the Palms, for example—and there may very well have once been hermaphrodite Cycads, though in the living forms the sexes are separated. Hermaphroditism would seem to be a simpler and earlier mode of florescence. Diœcious and monœcious flowers are generally regarded as examples of differentiation, though as results of natural selection, quite incomprehensible to me. To my mind the chances of fertilization would seem to be diminished in the ratio of the square of the distance to which the male and female organs were separated.

The theory has been advanced by some botanists that *Cardiocarpon* is the fruit of *Lepidophloios*, but unless we are grossly mistaken, this latter plant was a Lycopod, and I can hardly imagine any modification of *sporangia* which would resemble *Cardiocarpon*.

CARDIOCARPON LATUM, Newb.

Plate 43, Fig. 3.

Cardiocarpon latum, N.; Annals of Science, Vol. I., p. 153 (1853).

Nucleus broad, heart-shaped, flat, smooth, sharply acuminate, marked with a cicatrix at base, and surrounded, except at the basal cicatrix, with a narrow margin, terminating, like the nucleus, in a sharp point at the summit. A fine line runs from the apex of the nucleus to the summit of the margin.

Formation and locality: Roof of Coal No. 1; Cuyahoga Falls, Summit County.

CARDIOCARPON MINUS, Newb.

Plate 43, Fig. 4.

Cardiocarpon minus, N.; Annals of Science, *loc. cit.*

Nucleus ovate, acuminate, smooth, from 4 to 6 lines in length, marked by a small cicatrix at base, and by a short, elevated line which passes through the apex, extending about 1 line toward the base; margin entirely surrounding the nucleus, conforming to its outline, broadest at the summit.

Formation and locality: In bituminous shale, immediately below Coal No. 1; Cuyahoga Falls, Summit County.

CARDIOCARPON ELONGATUM, Newb.

Plate 43, Fig. 5.

Cardiocarpon elongatum, N.; Annals of Science, *loc. cit.*

Nut small; length 6 lines, width 3 lines; nucleus ovoid, acuminate, 3 lines long, flat, smooth, with cicatrix at base, entirely surrounded by a margin which is very narrow at the base, is much prolonged beyond the apex of the nucleus, and terminates in a rounded summit, which is sometimes emarginate. A line passes from the summit of the margin into the apex of the nucleus.

Formation and locality: In shale over Coal No. 1; Youngstown, Ohio.

CARDIOCARPON BICUSPIDATUM, Sternb.

Plate 43, Figs. 9, 9*a*.

Carpolithus bicuspidatus, Sternb.; *Flora der Vorwelt,* I., t. 7, f. 8.

Nucleus transversely elliptical or reniform, flat, smooth, abruptly acuminate, without cicatrix at base, surrounded by a very narrow margin, which is broadest at the summit. This is probably the species figured by Sternberg, although I have never seen a specimen from this vicinity which was bicuspidate. As he has given no description with his figure, it is impossible to determine whether his species is the same with ours. Both evidently belong to the genus *Cardiocarpon*.

Formation and locality: Roof shale of Coal No. 1; Tallmadge, Ohio.

CARDIOCARPON MARGINATUM, Foster.

Plate 43, Fig. 7.

Cardiocarpon marginatum, Foster; Annals of Science, Vol. I., p. 129 (1853).

Outline of fruit ovoid-oblong, rounded above, apiculate at base, 8 lines long, 6 lines wide; nucleus ovoid, 4 lines long, 3 lines wide, marked by a salient line running from the acute apex to the base of the fruit; margin entirely surrounding nucleus, broadest above.

Of this species of *Cardiocarpon* I have never seen a specimen, but the figure and description given by Col. Foster prove it to be quite distinct from any of those found by myself in Northern Ohio. The figure now given is a copy of the drawing made by Col. Foster.

Formation and locality: Lower Coal Measures; Zanesville, Ohio.

CARDIOCARPON ANNULATUM, Newb.

Plate 43, Figs. 8, 8*a*.

Cardiocarpon annulatum, N.; Annals of Science, *loc. cit.*

Nucleus heart-shaped, or short-ovoid, acuminate, 6 lines in diameter, flattened, faintly striate; marked at base by the cicatrix of the pedicel; surrounded by an annular margin of nearly equal breadth, which is sometimes slightly emarginate at the summit. This species resembles *C. emarginatum,* Goepp. and Berger, but differs from it in the absence of the emargination of the border at the base, and in the slight, often obsolete, emargination of the apex.

Formation and locality: In shale over Coal No. 1; Youngstown, Ohio.

CARDIOCARPON ORBICULARE, Newb.

Plate 43, Fig. 10.

Cardiocarpon orbiculare, N.; Annals of Science, *loc. cit.*

Nucleus orbicular, 3 lines in diameter, flat, or a little round, smooth, with a minute cicatrix at base, entirely surrounded by a very narrow border, which is narrowest at the base.

Formation and locality: In shale over Coal No. 1; Cuyahoga Falls, Ohio.

CARDIOCARPON RETUSUM, Sternb.

Plate 43; Fig. 6.

Carpolithus retusus, Sternb.; *Flora der Vorwelt,* I., t. 7, f. 10.

Nucleus heart-shaped, with cicatrix at base, strongly rugose or tubercular, bordered by a very narrow striated margin. Sternberg's figure is more rounded at the apex than our fossil generally is, and is destitute of the striated margin. I have specimens, however, which agree precisely with his figure.

Formation and Locality: In shale over Coal No. 1; Tallmadge, Youngstown and Massillon.

CARDIOCARPON SAMARÆFORME, Newb.

Plate 43, Figs. 11, 11a.

Cardiocarpon samaræforme, N.; Annals of Science, *loc. cit.*

Nucleus round-cordate, flat, 9 lines in diameter, faintly concentrically-striate and reticulate, a fine elevated line running from base to apex; base strongly marked with the cicatrix formed by the detachment of the organs of support and nutrition. Attached to the nucleus are broad, apparently membranous wings, which spring from the cicatrix at the base, encircle the nucleus, becoming broader as they approach the apex where they meet; from this point they rise, diverging from each other, with a rounded outline, to a height nearly equal to the diameter of the nucleus. Wings distinctly veined, and having a thickening border.

Formation and locality: In shale over Coal No. 1; Tallmadge, Summit County, Ohio.

GENUS RHABDOCARPUS, Goepp. et Berg.

This name was given by Goeppert and Berger to certain nuts found in the Coal Measures, and which, with some resemblances to *Trigonocarpa,* differ from them in this—that they are not triangular or tripartite, are more or less flattened, have a lenticular section, are often elongated and pointed above and below, and generally have the surface marked with numerous longitudinal ribs or rods, whence the name. It will be seen, however, by reference to Plate 44, on which several species of this genus are figured, that not all the species which have the general form of *Rhabdocarpus,* agree with Goeppert's generic description, as some of the ovoid, flattened nuts associated with *Trigonocarpa,* and yet clearly distinct from them, are not elongated or pointed, and are without the longitudinal ribs. Very likely these differences represent generic differences in the trees which bore them, but it seems hardly worth while, at present, to attempt any refined classification of these *disjecta membra.* I shall, therefore, include in *Rhabdocarpus* all the ovoid, flattened nuts which do not exhibit the tripartite character of *Trigonocarpon.*

Up to the present time we know too little of the details of structure of these fossil nuts to make it worth while to spend much time in speculations as to their botanical affinities. The trees which bore them were undoubtedly closely allied to those of which *Trigonocarpon* was the fruit, and the general structure of the two groups of fruits was undoubtedly

the same, *i. e.*, the nuts were enclosed in more or less fleshy envelopes, covered with a leathery rind, and containing a kernel, consisting of a mass, in one or two cotyledons of elaborated nutriment stored up for the use of the germinating embryo; all of which is quite different from any known form of fructification among cryptogamic plants. We are compelled, therefore, to look among the Phænogams for the congeners of *Rhabdocarpus* and *Trigonocarpon*. But it is not necessary to look far up the scale of flowering plants before we reach resembling forms. Among the palms are fruits not very unlike these, and among the Gymnosperms, such as *Salisburia*, those that come still nearer. Dr. Hooker compares *Trigonocarpon* with the fruit of the "Gingko," and is inclined to consider the tree which bore the fossil nut a Conifer. For reasons given elsewhere, I am disposed to regard *Trigonocarpon* as the fruit of *Sigillaria*, and, from their similarity of structure, *Rhabdocarpus* must follow *Trigonocarpon* wherever it goes.

RHABDOCARPUS CARINATUS (n. sp.).

Plate 44, Fig. 3.

Nut ovoid in outline, rounded below, somewhat acute above; surface marked by numerous longitudinal, rounded ridges, which become obsolete near each extremity. In some specimens portions of an external envelope, which covered and concealed the ridged shell, are visible.

Formation and locality: Shales over Coal No. 1; Summit and Mahoning Counties, Ohio.

RHABDOCARPUS DANAI, Foster.

Plate 44, Fig. 4.

Rhabdocarpus Danai, F.; Annals of Science, Vol. I., p. 129 (1853).

Nut oblong, compressed and finely striated; the base obtuse, the apex sharp, terminating in a point; the remains of an elevated line visible at the apex, and of a depressed line extending from the base nearly one-half the length of the nut in the direction of the axis; nucleus surrounded by a broad corrugated margin, in which are visible four or five folds parallel with the margin of the nucleus.

I have seen but a single specimen of this nut, and this is that from which Col. Foster's description was drawn. It is badly fractured and

gives but an imperfect idea of the entire fruit. It is quite certain, however, that it is distinct from any nut before described, and it will be readily recognized, when found, from the figure now published.

Formation and locality: From shales over Coal No. 3; Zanesville, Ohio.

RHABDOCARPUS LÆVIS (n. sp.).

Plate 44, Figs. 5 and 5*a*.

Nut 2 inches in length by 1¼ wide, ovoid in outline, rounded below, with the central point of the base slightly prominent; constricted but obtuse above; sides equally arched, smooth and polished; section lenticular, with acute edges.

This fine nut, when its broader side is seen, exhibits the ovoid outline and general proportions of the largest specimens of *Trigonocarpon Hildrethi*, but is strikingly different from that, in wanting its three salient ridges, and in its flattened form and lenticular section; its shortest transverse diameter being less than one-half the distance from edge to edge.

Formation and locality: Carboniferous Conglomerate; Cuyahoga Falls, Ohio.

RHABDOCARPUS APICULATUS (n. sp.).

Plate 44, Fig. 6.

Nut elliptical in outline, rounded below, acute or apiculate at the summit; surface marked by about twelve nearly equal, rounded, longitudinal ridges, which are strongest in the central portion of the nut, and become obsolete near either extremity; length 1¼ inches; width ¾ of an inch.

Possibly this will prove to be not distinct from *R. costatus*, as we have not yet learned the limit of variability in these groups of nuts; and it is even possible that both these may be but varieties of *R. carinatus*. In the specimens before me, however, marked differences are discernible, and such as, if permanent, would constitute fair ground for considering them specifically distinct. In *R. carinatus*, the form is more elongated, the summit more produced, the longitudinal ridges more slender and numerous, and somewhat grouped in fascicles of three. In *R. costatus*, the form is more nearly circular, the carinæ are much stronger, are acute angled, and alternate stronger with fainter ones; while in the

species under consideration, they are rounded, equally spaced and nearly uniform in strength.

Formation and locality: Over Coal No. 1; Tallmadge, Ohio.

RHABDOCARPUS ACUMINATUS (n. sp.).

Plate 44, Fig. 7.

Nut large, 2¼ inches in length by 1½ in breadth; broadly ovate in outline; rounded below, acute and long-pointed above; surface nearly smooth, but showing faint traces of longitudinal ridges.

I have thought it possible that this form is but a phase or condition of *R. costatus*; perhaps that nut with the external envelope more or less perfectly preserved. Up to the present time, however, proof of identity is wanting, and the marked differences which are perceptible in the specimens before me seem to require that they be designated by distinct names.

Formation and locality: Roof shales of Coal-seam No. 1; Youngstown, Ohio.

RHABDOCARPUS COSTATUS (n. sp.).

Plate 44, Fig. 8.

Nut large, 1 $^{5}/_{8}$ inches long by 1¼ wide; outline round-ovate or elliptical, rounded below, abruptly acuminate at summit; surface marked by numerous longitudinal carinæ, of which alternate ones are strong and acute; intermediate ones lower and rounded. These carinæ rise at the summit and become obsolete some distance above the base.

Formation and locality: Shale over Coal No. 1; Youngstown, Ohio.

GENUS NERIOPTERIS (n. gen.).

Frond pinnate or bi-pinnate; rachis strong, punctate; pinnules lanceolate, simple, entire; medial nerve strong, extending from base to summit; secondary nerves given off at an acute angle, numerous, simple or forked at base, parallel, equal; fructification marginal (?)

The plant to which the above name is given is, perhaps, not generically distinct from that upon which Brongniart founded his genus *Cannophyllites*, though departing widely from his description. The typical species of *Cannophyllites* is nowhere fully described, being simply enumer-

ated in the *Prodromus* of Brongniart and Unger's *Genera et Species*. From the generic description and a notice in the *Tableau des Genres*, p. 92, it seems that the type species (*C. Virlettii*, Br.) is a simple leaf, supposed, when the description was written, to belong to the *Zingiberaceæ*, and named *Cannophyllites*, from its supposed botanical affinities. Since that time other specimens have shown to Brongniart that his plant was a fern, and, without suggesting a substitute, he seems to have abandoned the name formerly given it (*Cannophyllites*), as liable to induce error.

Unger, in his *Genera et Species*, applies the name of *Cannophyllites* to a probably very different plant, from the Cretaceous formation.

Since our plant is distinctly a fern, with a compound frond and forked nervation, thereby excluded from Brongniart's genus *Cannophyllites*, as defined by him, it becomes necessary to give it a new generic title. I have, therefore, called it *Neriopteris*, in allusion to the strong resemblance borne by its pinnules to the leaves of *Nerium* (Gr. *Nerion*). This resemblance is due, not simply to their regular, lanceolate outline, but also to the strong, straight, rigid midrib which traverses them from base to summit.

By this latter character *Neriopteris* is widely separated from *Neuropteris*, some species of which have pinnules of not very dissimilar form.

The nervation of *Neriopteris* is most like that of *Tæniopteris*, among fossil ferns, but the species which should properly be included in that genus have mostly simple fronds, and always a rectangular nervation. The species from the Italian Tertiaries (*T. Bertrandi*, etc.), with pinnate fronds, and acute angled nervation have almost nothing in common with these, and should plainly be separated from them.

In its general aspect our plant is also considerably like the larger species of *Alethopteris*, such as *A. macrophylla*, Newb., of which the upper pinnules are nearly as large, are entire, acute, and unequally cordate at the base. The texture of the leaf is, however, quite different, as is the nervation, and the lower pinnules of *Aleth. macrophylla* have scalloped edges. The margins of the pinnules in the specimens before me are all sensibly thickened and are apparently fructiferous. If this appearance is not fallacious, the fructification would be that of *Pteris*.

In form the pinnules of *Neriopteris* resemble those of the plant described and figured by Prof. Dawson (Acadian Geology, pp. 446, 484), under the name of *Phyllopteris antiqua;* but the nervation is entirely different.

In the enlarged figure of a portion of a pinnule, Plate 45, Fig. 3*a*, the nervation of *Neriopteris* is not quite accurately represented, as most of the nerves fork at the base, while, as there shown, they are all simple.

The marginal band shown in the figures, and noted in the description

of the pinnules of *Neriopteris,* is not visible in all my specimens, and I have had considerable doubt of its significance. It is possible that it is due simply to a thickened or revolute margin.

The nervation of the only species which I have of the genus is very fine and uniform, and must have been inconspicuous, and was apparently for the most part buried in the parenchyma of the pinnule when the plant was living. It often happens, therefore, that it is not clearly defined in the fossil state. When distinctly visible, however, it will be seen that, though fine and parallel, as in those of *Tæniopteris,* the secondary nerves are more or less forked; and generally, as in *Tæniopteris,* at or near the base.

Since the above description was written, Prof. Schimper has published his magnificent work, *Traite de Paleontologie Vegetale,* in which he proposes some important changes in the order *Tæniopteridæ,* restricting the genus *Tæniopteris* to the Coal Measures and the Permian formation, and taking as a type species *T. multinervis,* Weiss. (Pl. XXXVIII., Fig. 8). Prof. Schimper establishes a new genus, *Angiopteridium,* for the species of *Tæniopteris* which are found in the Triassic and more recent strata, and in which the fructification is bi-valvular and forms a sub-marginal band on the fronds or pinnules. In this genus he includes the old species of *Tæniopteris, T. Munsteri* and *T. Bertrandi. Tæniopteris vittata,* Brongt., forms the type of his new genus *Oleandridium,* which he supposes to have the fructification of *Asplenium.* It is evident, however, that our plant with lanceolate, cordate pinnules three inches in length, and with apparently a marginal fructification, has little in common with the simple, linear fronds, an inch and a half in width and a foot and a half in length of *Tæniopteris multinervis.* Prof. Goeppert has described two species of *Tæniopteris* from the Permian of Bohemia and Silesia, *T. coriacea* and *T. fallax* (*Foss. Flor. d. Perm. Form.*, p. 130, Tabs. VIII., IX), both of which he thinks may have pinnate fronds; but of this no proof is given, and the fronds or pinnæ described are very much larger than the pinnules of the plant before us. In his description of the genus *Tæniopteris,* Prof. Schimper describes the fronds as simple, and it is quite evident that all the well-known species he has grouped in this genus are so. Hence, as now constituted, the genus *Tæniopteris* cannot receive our plant, and we have, up to the present time, no facts which warrant us in so modifying *Tæniopteris* as to admit it. It is possible that future researches will bring to light species which will connect *Tæniopteris* and *Neriopteris;* but for the present, since the geological range of the genera is different—ours being limited to the base of the Coal Measures—and the frond, large and simple in one case, is pinnately divided in the other, we are compelled to regard them as generically distinct.

NERIOPTERIS LANCEOLATA (n. sp.).

Plate 45, Figs. 1 to 3*a*.

Frond pinnate or bi-pinnate; rachis strong, punctate; pinnules diverging from the rachis at an acute angle, lanceolate, acute, entire, narrowed and cordate or rounded at the base; medial nerve strong, straight, reaching to summit of pinnule; secondary nerves leaving the midrib at an acute angle, slightly curved at base, crowded, simple or forked near the base, parallel, equal.

As this is the only species yet known of this beautiful fern, and it has served as a basis for the generic description, but little more need be said to give a clear idea of it. I first obtained detached pinnules many years ago from the under-clay of Coal No. 1, at my father's mine, near Cuyahoga Falls, Summit County, and subsequently found a single one in the roof of the same seam at the mine of Dr. Amos Wright, in Tallmadge. Much the best specimens of the plant, however, I collected from the shale over the same coal at Youngstown, Ohio. Two of the specimens obtained from the latter locality are represented in Figs. 1 and 2, Plate 45. These show that the frond was pinnate, with a very strong rachis, which is punctate or scabrous, and was perhaps in life somewhat chaffy. In these specimens the pinnules are less distinctly cordate at base than in those from Tallmadge. In all the specimens except that obtained from Wright's mine, the margins of the pinnules are thickened as though by a band of fructification; but none of the specimens which I have seen are sufficiently perfect to justify me in asserting that this is a true explanation of this otherwise somewhat incomprehensible character.

I repeat here a remark made in the generic description that the figure given of the nervation of *Neriopteris*, Plate 45, Fig. 3*a*, is faulty inasmuch as it represents the secondary nerves of the pinnules as all simple, whereas the larger number of them are forked at the base, and they are generally somewhat curved at their junction with the midrib.

Formation and locality: So far as yet known, this fern has been found only at the base of the Coal Measures, and at the localities I have mentioned.

ODONTOPTERIS NEUROPTEROIDES (n. sp.).

Plate 47, Figs. 1 to 3.

Frond bi-pinnate; pinnæ of lower part of frond linear in outline, composed of 20 or more pinnules, of which the terminal one is large and

irregular, as in *Neuropteris;* the upper pinnæ shorter and broader, with the terminal pinnule relatively smaller; pinnules of various forms; those near base of lower pinnæ ovoid and cordate, precisely like those of *Neuropteris;* upper ones more or less cuneate, strongly decurrent; the upper side of the base free as in *Otopteris;* pinnules of the upper pinnæ linear, often acute, connate and decurrent at base.

The terminal pinnæ of the frond are nearly entire, forming large, simple pinnules; nerves very numerous and fine, radiating from the center and decurrent portion of the bases of the pinnules.

This polymorphous species seems to unite *Odontopteris* and *Neuropteris*. The lower pinnules of the lower pinnæ being attached only by the center of the base, the nerves radiating from that, are not distinguishable from those of *Neuropteris;* while the upper portions of pinnæ and frond are clearly *Odontopteris*.

In the figures given on Plate 47, figure 1 represents a subdivision of a large frond of which several pinnæ are shown. On these the pinnules vary considerably in form, those at the base of each pinna having the form and nervation of the pinnules of *Neuropteris,* while the upper pinnules are those of *Odontopteris*. Fig. 2 shows the latter form still better. Fig. 3 exhibits one of the many aberrant forms which this protean species presents. The terminal pinnæ of the frond have been drawn, and will be engraved for another volume. They are very broad and simple, and would never be suspected of belonging to this plant if not found in connection with such pinnæ as are now figured.

Formation and locality: Fragments of the fronds of this plant have been found in the roof shale of several mines opened in Coal No. 1, in Mahoning and Summit Counties. All the good specimens, however, have come from the locality on Mill Creek, near Youngstown, which has furnished so many additions to the flora of the lowest coal-seam in our Coal Measures.

ODONTOPTERIS GRACILLIMA (n. sp.).

Plate 46, Figs. 1 to 3*a*.

Sterile frond bi-pinnate, pinnæ very numerous, extremely elongated and narrow, parallel among themselves, slightly arched upward; pinnules very short, rhomboidal, acute, those on the upper pinnæ and near the extremities of the lower pinnæ united by their margins, their summits forming a coarse serration of the margin of the pinnæ; venation relatively strong, the secondary veins of each pinnule usually consisting of two branches springing from the rachis of the pinna, of which the

lower is strongest and gives off three branchlets on the lower side; the upper vein is simple or once forked; both veins are sigmoidally curved. Sometimes both veins seem to spring from a common root, and the pinnule is then nourished by a single irregularly-pinnate vein. Fertile frond of the same general form as the sterile, except that the pinnæ are relatively narrower, and the inferior surface is completely covered with sori.

I have placed this peculiar form provisionally in the genus *Odontopteris,* though fully aware that it is very unlike any species hitherto described. It should perhaps form a new genus, but the difficulties in the way of giving good generic definitions of fossil ferns are so great, that the genera created should be as few as possible, and only established on a large amount of material. We may safely affirm that the plant before us exhibits a closer resemblance to some species of *Odontopteris* than to any other fossil ferns now known, but its nervation departs widely from that of all described species of that genus. In those it is very fine, and a large number of veins spring from the adherent base of the pinnule. In the plant before us, on the contrary, there are but two branches to each pinnule, sometimes indeed but one, and these are coarse and strong. Where a single branching vein supplies the pinnule, the nervation is not very unlike that of *Diplazium,* except that the tertiary veins are not so regularly pinnate and arched.

The fructification is apparently somewhat different from that of *Odont. Schlotheimi,* the entire under surface of the fertile frond being covered with sori. The details of the fructification are, however, not well shown in the only fertile frond which I possess.

Formation and locality: Over Coal No. 1; Youngstown, Ohio.

ALETHOPTERIS MACROPHYLLA (n. sp.).

Plate 48, Figs. 3, 3*a.*

Frond pinnate or bi-pinnate; pinnules? simple, leaf-like, lanceolate; margins sometimes undulated or scalloped, revolute; apex acute; base obliquely cordate; medial nerve straight and strong; lateral nerves given off at a right angle from the midrib, very numerous, fine, simple or once forked.

This species presents marked differences from any other hitherto described, being readily distinguished by its very large, simple or sinuate-margined, acute, oblique-based pinnules, of which the midrib is strongly depressed. The secondary nerves are set at right angles with this, or

rather they spring from the midrib at an acute angle, but are immediately and abruptly curved downward till they reach a position perpendicular to the midrib, whence their course is remarkably straight to the margin. The secondary nerves are usually forked at the base, and each branch divides somewhere near the middle of the interval between the middle nerve and the margin, though often one or both branches may be simple. The secondary nerves are very fine and numerous, and being straight, parallel, and at right angles to midrib and margin, they give their pinnules the aspect of a *Tæniopteris,* but closer examination will show them to be distinctly forked even when detached; also the oblique bases of the pinnules show them to be parts of a pinnate frond.

It is clearly an *Alethopteris,* and nearly related to *A. lonchitica,* Br., and perhaps still more closely to *A. Sternbergii,* Goepp., in which the margin is not always entire. The pinnules are, however, two or three times as large as in either of these species, and the nerves are differently forked. The crenulation of the margin of the lower pinnules, and the lower side of the medial pinnule, is very different from that of *A. Sternbergii,* and such as to recall the leaves of *Comptonia.*

But for its rectangular nervation I should be inclined to include it in *Neriopteris,* but the nervation of the type species of that genus (*N. lanceolata,* N.) is not only oblique, but in its fineness and regularity rivals that of *Tæniopteris magnifolia.*

Formation and locality: Sandstone over Coal No. l; Youngstown, Ohio.

ALETHOPTERIS GRANDIFOLIA (n. sp.).

Plate 48, Figs. 1, 1*a*, 2.

Frond tri-pinnate, very large, 6 to 8 feet long, 3 to 4 broad; stipe 2 to 2½ inches broad, marked with fine longitudinal striæ; pinnæ alternate, nearly opposite, the lower ones linear-lanceolate in outline, with rounded terminations, those near the extremity of the frond narrower, with waved margins terminating in long acutish points. The summit of the frond is formed by pinnæ reduced to pinnules, at first with waved margins, at the very summit with entire borders; pinnules closely set, decurrent and connate, at base of lower pinnæ deeply pinnatifid; toward the middle of the pinnæ, and higher in the frond, lanceolate-elliptical and with waved margins; still higher, lanceolate-elliptical with entire borders, 3 to 4 times as long as broad. Toward the summit of the frond, the pinnules become much smaller and relatively shorter, presenting an

appearance so different as to be readily mistaken for another species; medial nerve strongly marked, secondary nerves distinct, twice or thrice-forked, numerous.

This splendid species resembles in some respects *A. Massillonis*, Lesqx., but is a much stronger plant, and the frond is much more *leafy*, the pinnules broader and more closely set, more narrowed at base, and less broadly connate; secondary nerves less strongly marked, and more compound than in that species. A strong pinna from the middle of the frond resembles *A. Serlii*, but fragments of any other portion of the frond are not likely to be confounded with it. The pinnules in *A. Serlii* are never crenulate or pinnatifid as in this species. *A. Serlii* also belongs at a much higher level—above Coal No. 4. This species is limited to Coal No. l.

Alethopteris grandifolia is the most common species in the coal mines of Tallmadge, where during my boyhood I collected thousands of specimens representing all parts of its great frond, and the many varieties into which it runs. I have also found this species at Massillon, in the Mahoning Valley, and, indeed, wherever Coal No. 1 is worked.

On Plate 48, two phases of *A. grandifolia* are given—that with narrow pinnules, often with waved margins (Fig. 1), and that with broad and entire pinnules (Fig. 2). These might very well be taken for distinct species; but they blend in such a way that it is impossible to separate them. A common feature in this species, but one that will serve to distinguish it from others, is this: the basal pinnule on the lower side of the pinna is frequently larger than its fellows, and pinnately lobed.

Formation and locality: Over Coal No. 1; Tallmadge, Ohio.

1.

PLATE XLI.

PAGE.

Fig. 1. ANTHOLITHES PITCAIRNIÆ? L. and H.....

Fig. 2. ANTHOLITHES?.....

With last, and probably more mature state.
Youngstown, Ohio.

Fig. 3. ANTHOLITHES PRISCUS. Newb 363

From over Coal No. 1, Youngstown, Ohio.

Fig. 4. CARDIOCARPON. Brongt..... 370

Stems bearing Cardiocarpa, associated with Cordaites.
From over Coal No. 1, Youngstown, Ohio.

Fig. 5. POLYSPORIA MIRABILIS. Newb..... 362

Cone, showing arrangement of sporangia.
5 *a*. Detached sporangium, containing microspores.

Fig. 6. POLYSPORIA MIRABILIS. Newb..... 362

Summit of cone surrounded by a mass of spores, escaped from the sporangia.

Roof of Coal No. 1, Tallmadge, Summit county, Ohio.

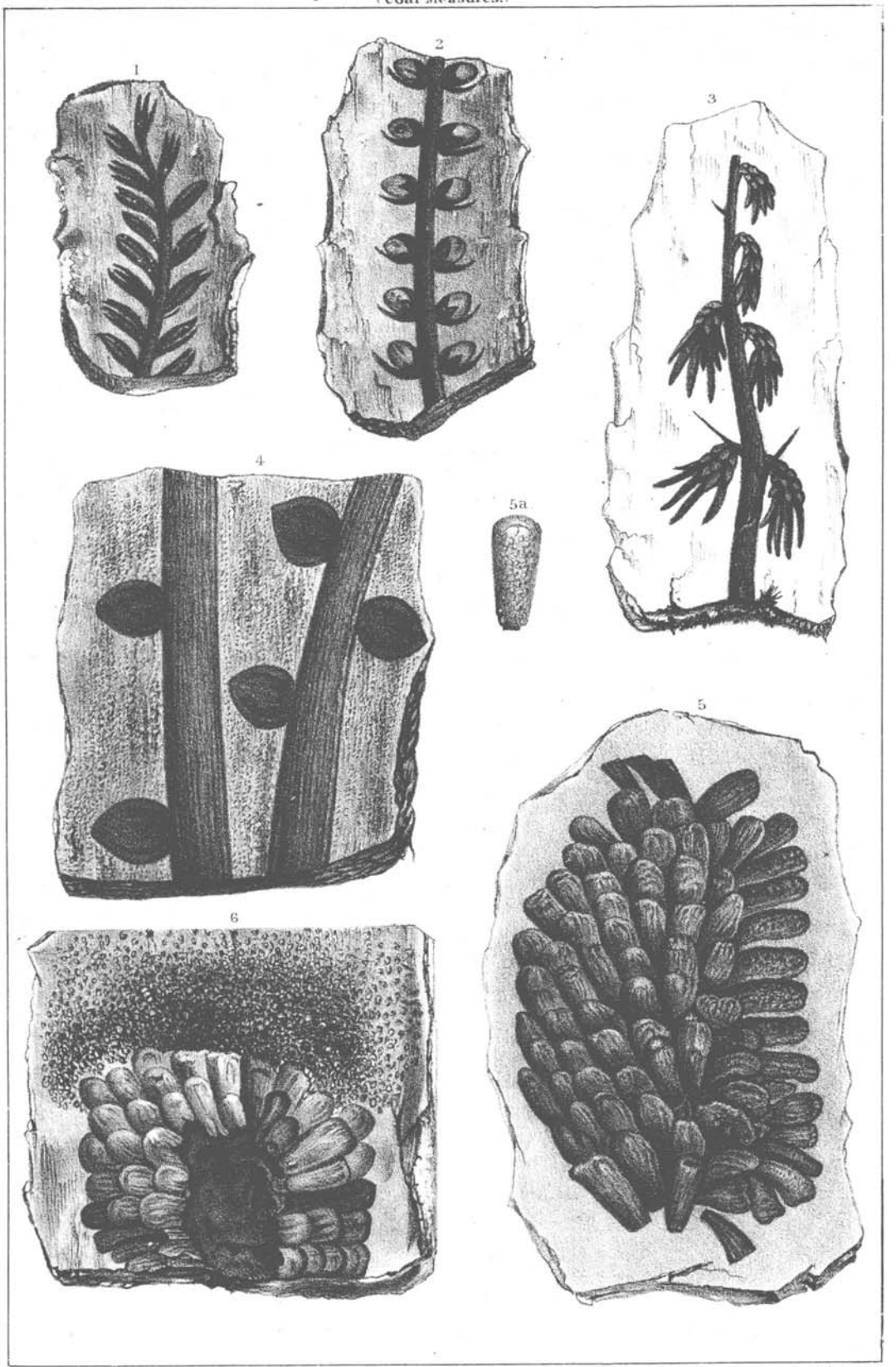

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PLATE XLII.

PAGE.

Fig. 1. TRIGONOCARPON TRILOCULARE. Hildreth 367
Showing the wings.

Fig. 2. TRIGONOCARPON TRICUSPIDATUM. Newb 368
Complete nut.

Fig. 3. TRIGONOCARPON TRICUSPIDATUM. Newb 368
Nucleus of nut.

Fig. 4. TRIGONOCARPON TRICUSPIDATUM. Newb 368
Another specimen. Nucleus of nut.

Fig. 5. TRIGONOCARPON 366
Portion of rind of drupaceous fruit which inclosed *Trigonocarpon*. Flower end.

Fig. 6. TRIGONOCARPON 366
Same, showing impression of stem.

Fig. 7. TRIGONOCARPON ORNATUM. Newb 368
7 *a*. Basal end of Fig. 7.

Fig. 8. TRIGONOCARPON MULTICARINATUM. Newb 369
8 *a*. Upper end of Fig. 8.

Fig. 9. TRIGONOCARPON 366
Nut inclosed in drupaceous fruit.

Fig. 10. TRIGONOCARPON 366
Inclosed in drupaceous fruit.

Fig. 11. TRIGONOCARPON MAGNUM. Newb 369
11 *a*. Basal end of same.
Sandstone over Coal No. 6, Coshocton, Ohio.

Fig. 12. TRIGONOCARPON BERTHOLLETIFORME. Foster 369
12 *a*. Another view of same.
Coal Measures, Zanesville, Ohio.

Fig. 13. TRIGONOCARPON TRILOCULARE. Hildreth 367
13 *a*. Basal view of same.
All figures on this plate natural size.

Figs. 1, 7, 8 and 13 from Conglomerate, Cuyahoga Falls, Ohio. Figs. 2, 3, 4, 5, 6, 9 and 10 from over Coal No. 1, Tallmadge, Ohio.

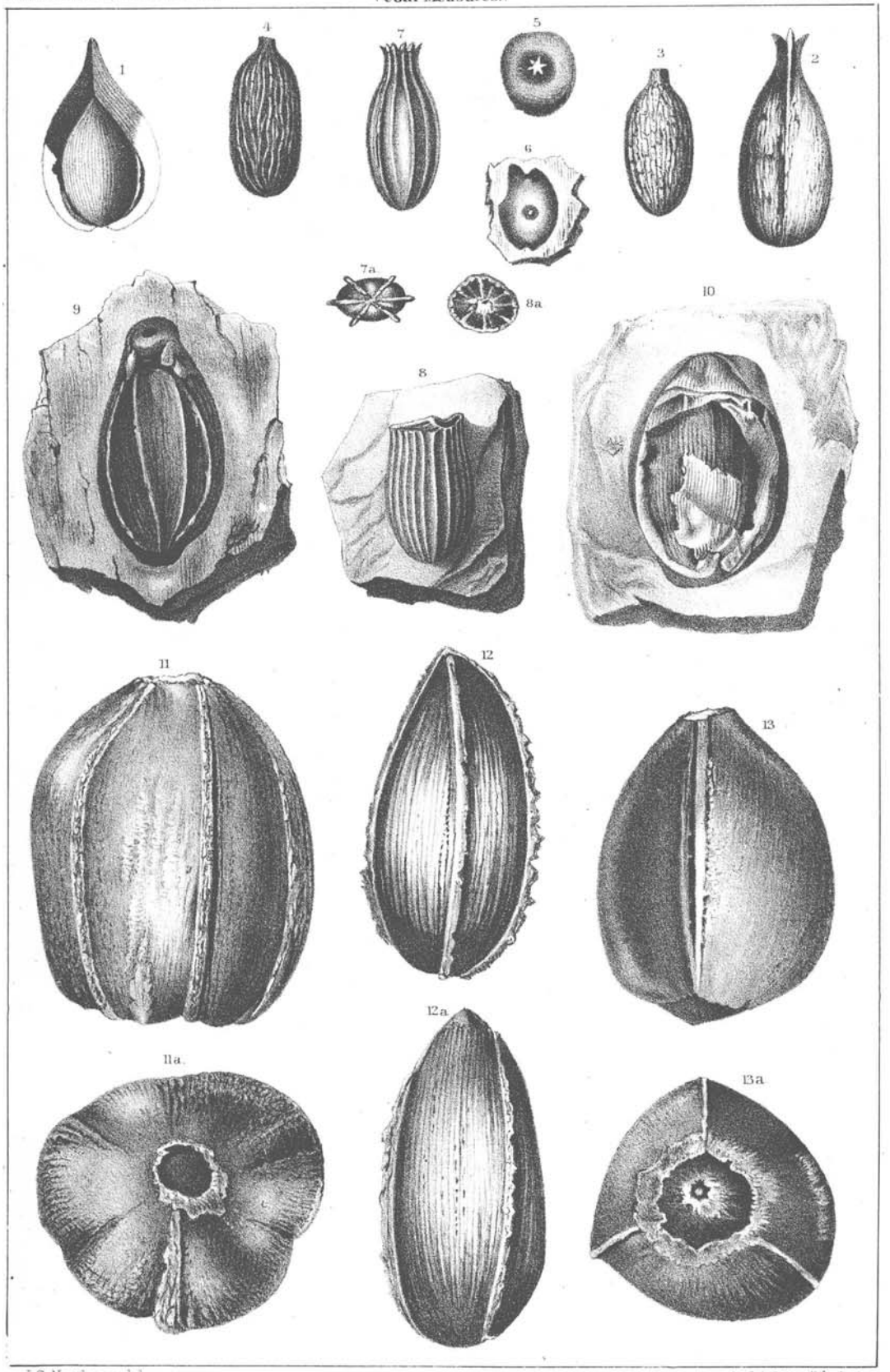

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PLATE XLIII.

PAGE.

Fig. 1. CYCAS REVOLUTA (living) 371

Entire fruit. Compare with Figs. 8, 8 *a*.

1 *a*. Nut contained in same.

Fig. 2. CARPOLITHUS FRAGARIOIDES. Newb 370

External envelope, the nucleus having escaped.

2 *a*. Nucleus of same.

Fig. 3. CARDIOCARPON LATUM. Newb 372

Fig. 4. CARDIOCARPON MINUS. Newb 372

Fig. 5. CARDIOCARPON ELONGATUM. Newb 373

Fig. 6. CARDIOCARPON RETUSUM. Sternbg 374

Fig. 7. CARDIOCARPON MARGINATUM. Foster 373

Fig. 8. CARDIOCARPON ANNULATUM. Newb 374

8 *a*. Another specimen of the same.

Fig. 9. CARDIOCARPON BICUSPIDATUM. Sternbg 373

9 *a* Smaller specimen of same.

Fig. 10. CARDIOCARPON ORBICULARE. Newb 374

Fig. 11. CARDIOCARPON SAMARÆFORME. Newb 375

11 *a* Another specimen of the same.

Fig. 12. TRIGONOCARPON .....

Drapaceous fruit inclosing *Trigonocarpon*.

Fig. 13. TRIGONOCARPON TRILOCULARE. Hildreth 367

Basal end of compressed specimen showing nucleus.
Conglomerate, Cuyahoga Falls, Ohio.

Fig. 14. TRIGONOCARPON 367

Group of fragments, showing (*a*, *b*) segments of shell (*c*, *d*) nuclei.

Fig. 15. TRIGONOCARPON 366

Outline of drupaceous fruit, showing inclosed nut.

All figures on this plate natural size.

All specimens excepting 1, 1 *a*, 7 and 13 from shale over Coal No, 1, Summit and Mahoning counties, Ohio.

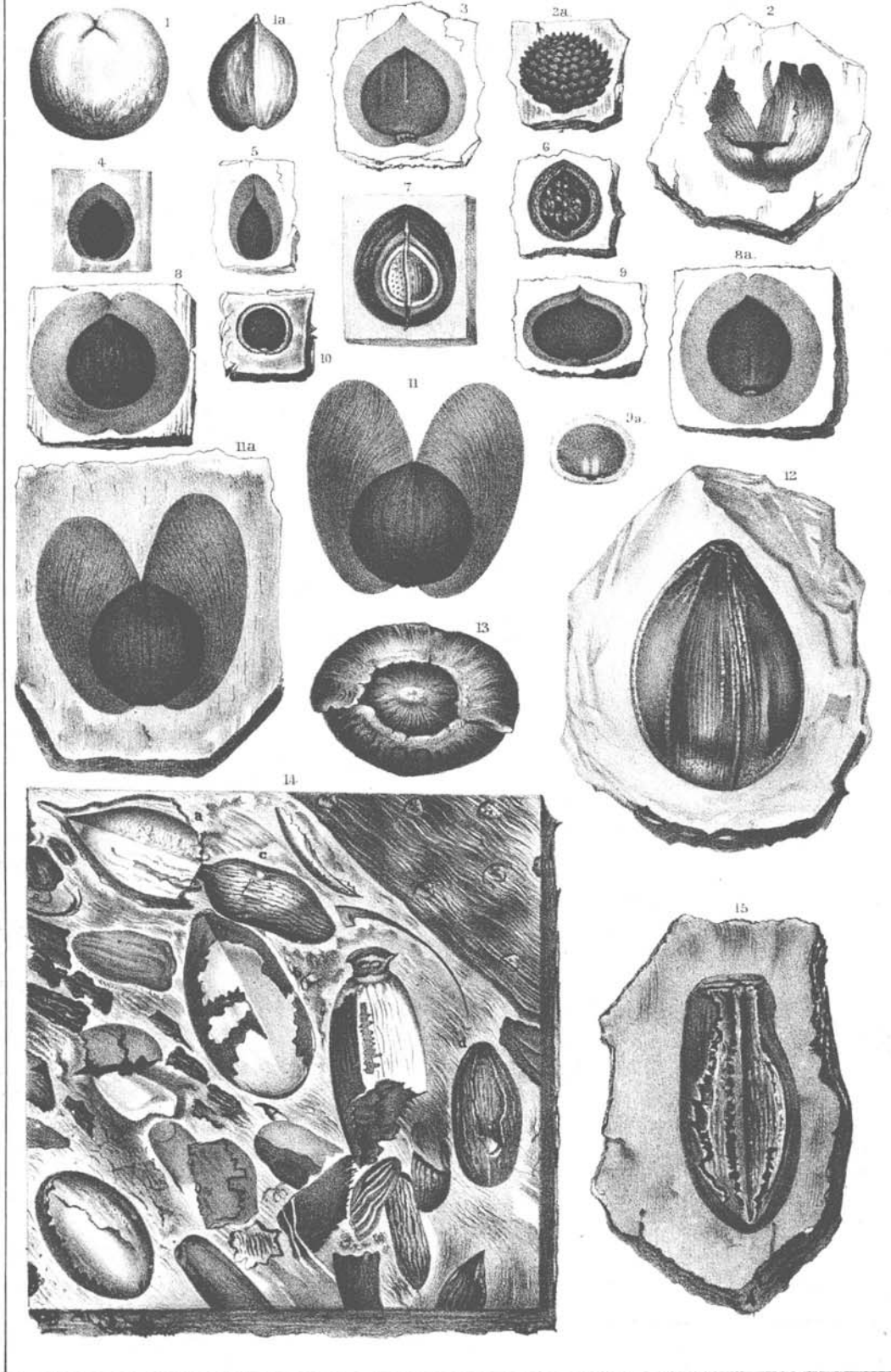
1
1a
3
2a
2
4
5
6
7
8
9
8a
10
11
9a
11a
12
13
14
15

PLATE XLIV.

PAGE.

Fig. 1. TRIGONOCARPON 366
Showing portion of fleshy envelope.

Fig. 2. TRIGONOCARPON 366
Entire fruit, inclosing nut.

Fig. 3. RHABDOCARPUS CARINATUS. Newb..... 376
Showing portion of envelope.

Fig. 4. RHABDOCARPUS DANAI. Foster 376
Zanesville, Ohio.

Fig. 5. RHABDOCARPUS LÆVIS. Newb 377
5 a Edge view of the same.
Conglomerate, Cuyahoga Falls, Ohio.

Fig. 6. RHABDOCARPUS APICULATUS. Newb..... 377
Over Coal No. 1, Cuyahoga Falls, Ohio.

Fig. 7. RHABDOCARPUS ACUMINATUS. Newb 378
Over Coal No. 1, Youngstown, Ohio.

Fig. 8. RHABDOCARPUS COSTATUS. Newb 378
Over Coal No. 1, Youngstown, Ohio.

All figures on this plate natural size.

Figs. 1, 2 and 3 from over Coal No. 1, Tallmadge, Ohio.

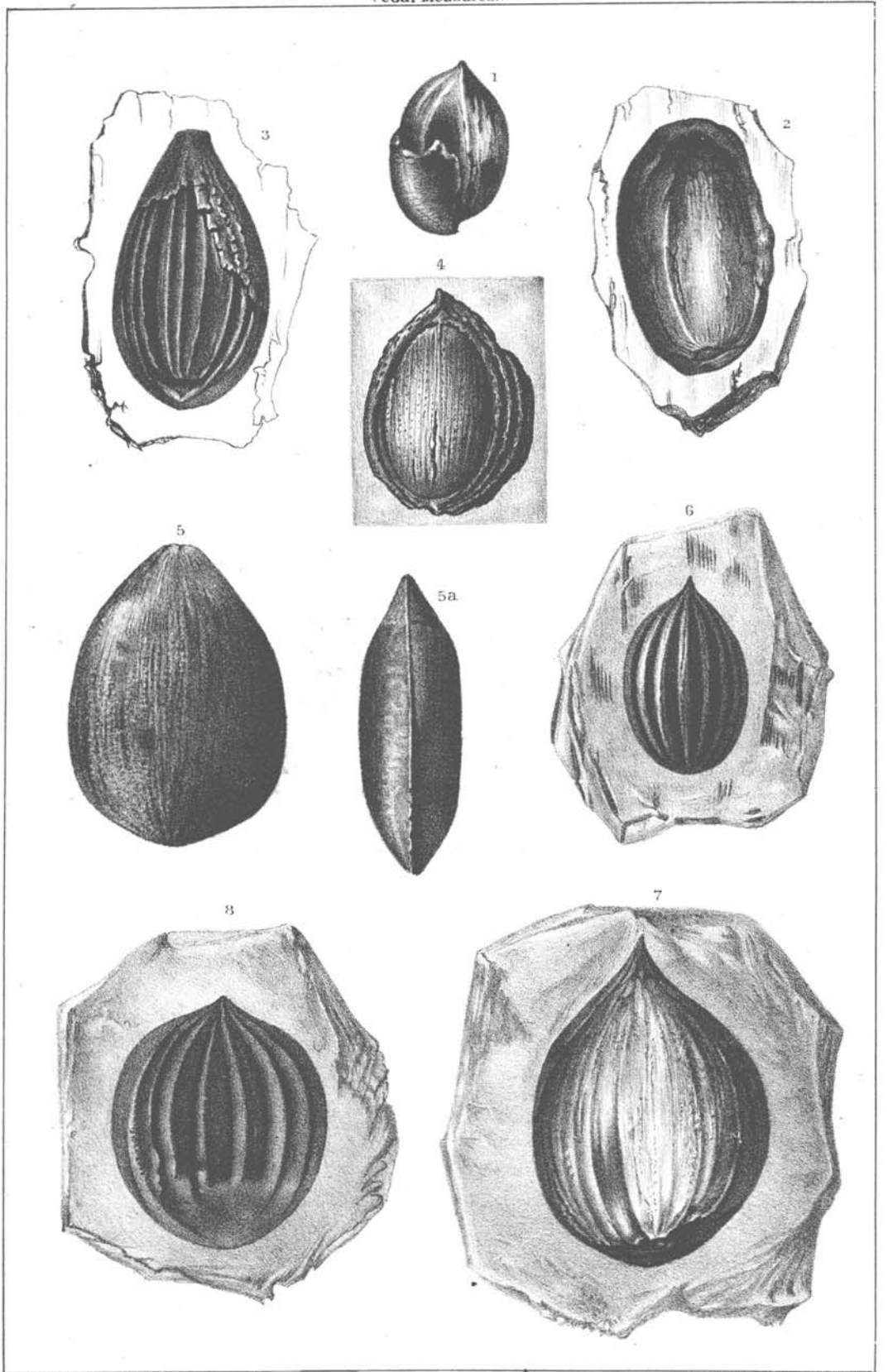

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PLATE XLV.

PAGE.

NERIOPTERIS LANCEOLATA. Newb..... 881

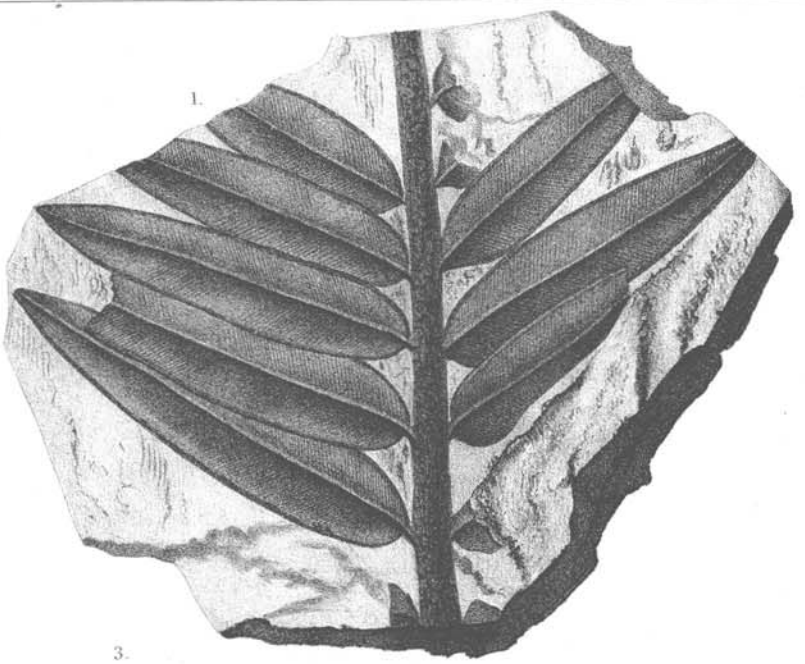
Fig 1. Portion of frond near upper extremity.

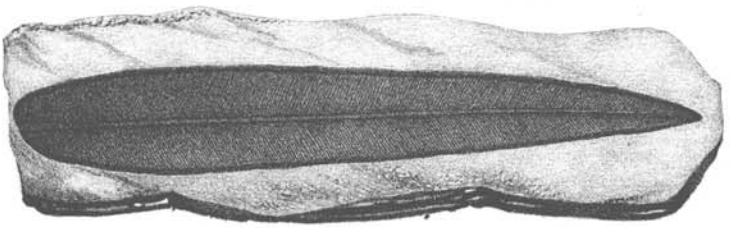
Fig. 2. Middle portion of frond.

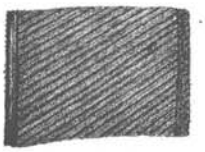
Fig. 3. Single pinnule. Natural size.

3 *a*. Portion of same enlarged to show nervation.

In Fig. 3 *a* the nerves are incorrectly represented as all simple, whereas they are frequently forked at the base. See pp. 380, 381.







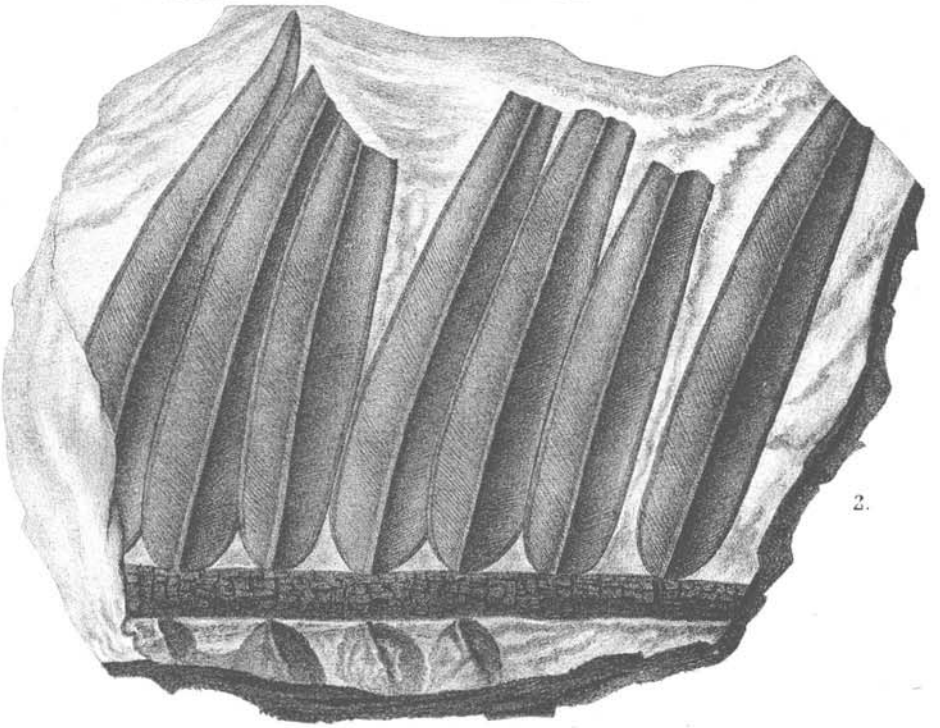


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PLATE XLVI.

PAGE.

ODONTOPTERIS GRACILLIMA. Newb..... 382

Fig 1. Portion of the summit of a frond.

Fig. 2. Middle portion of a frond.
2 *a*. Portion magnified to show nervation.

Fig. 3. A single pinna, nearly entire, from middle of a frond.
3 *a*. Portion enlarged to show nervation.

Roof shales of Coal No. 1, Youngstown, Mahoning county, Ohio.

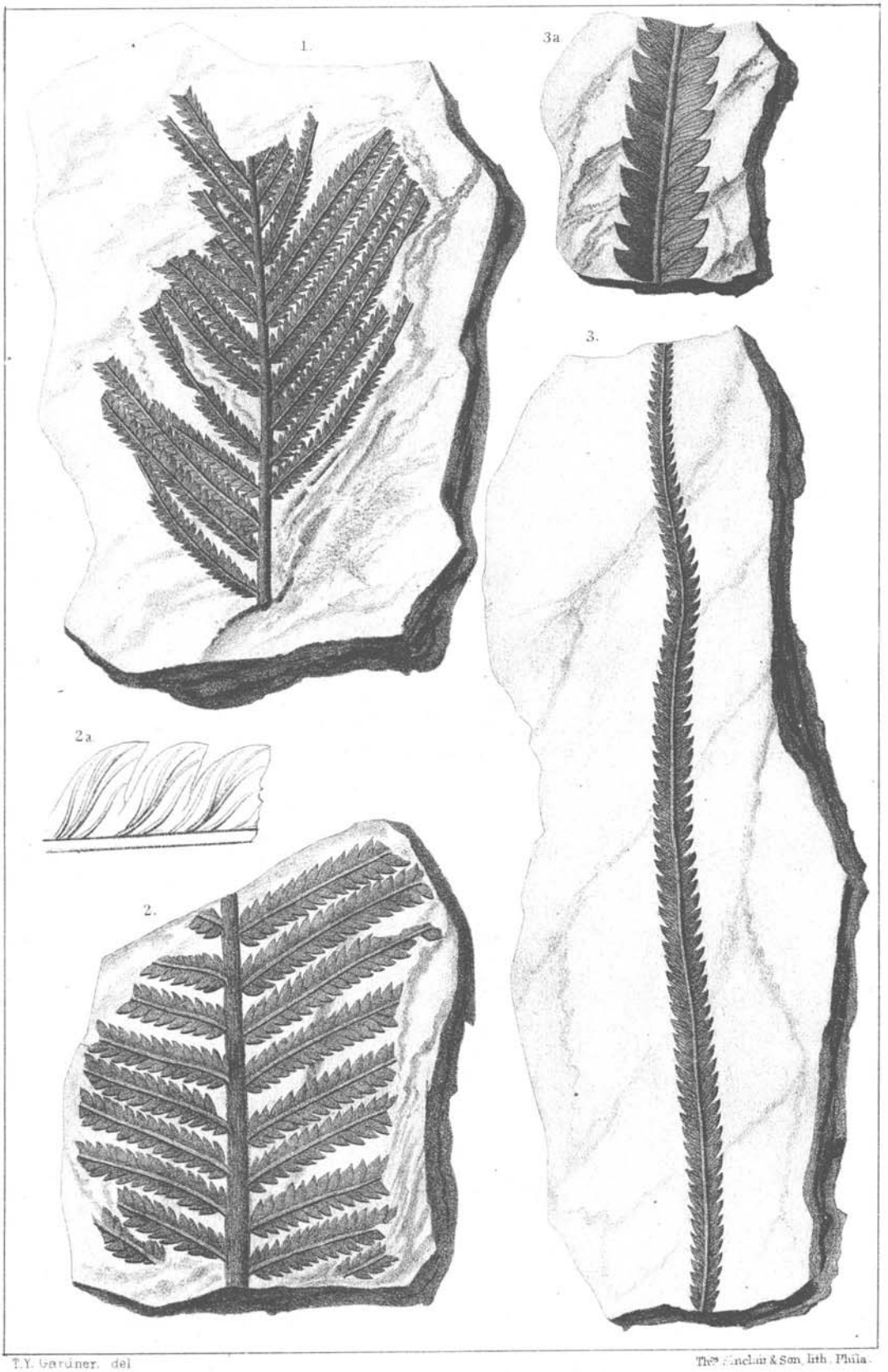

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PLATE XLVII.

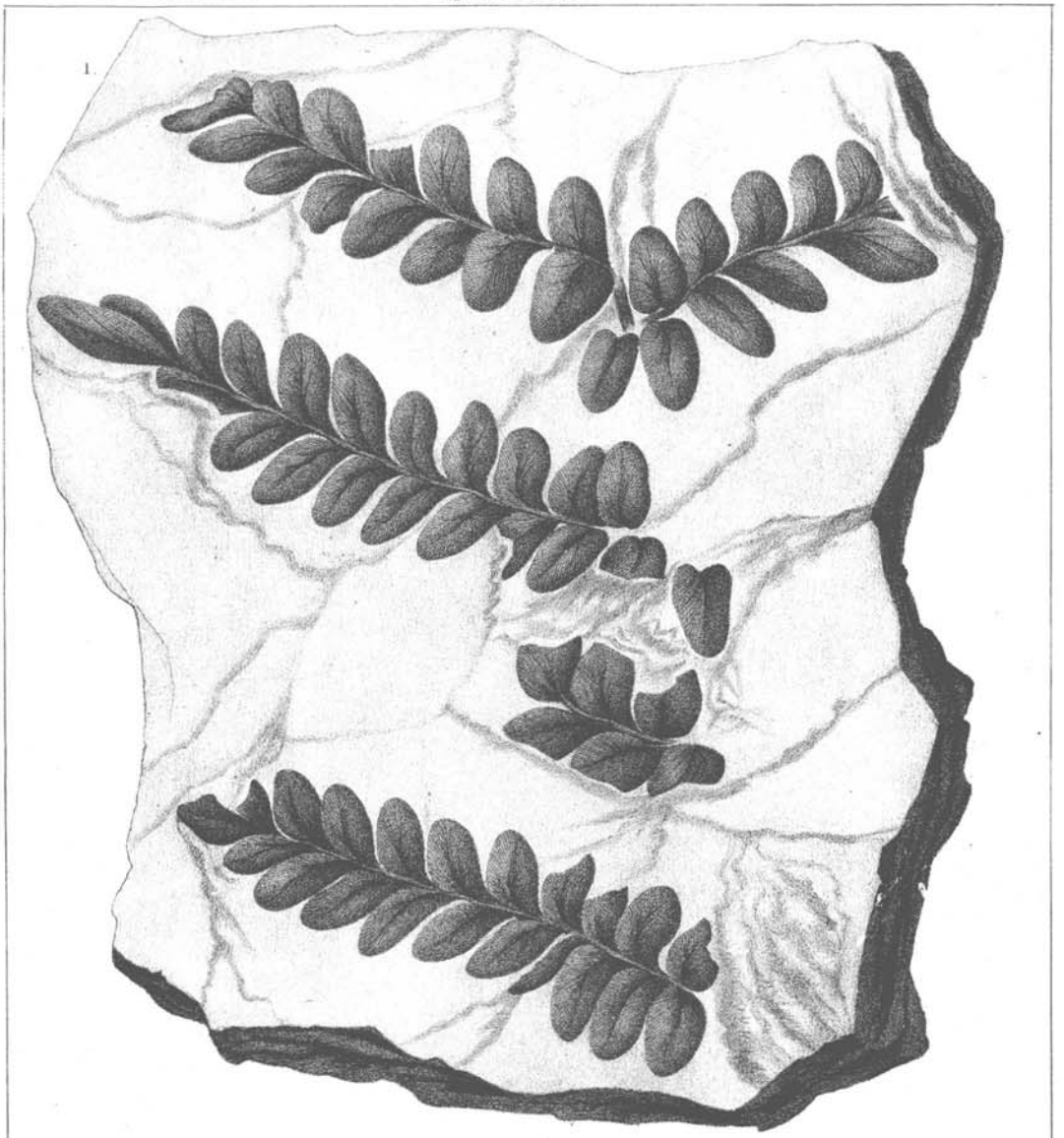
PAGE.

ODONTOPTERIS NEUROPTEROIDES. Newb 381

Fig 1. Portion of frond with basal pinnules of pinnæ like Neuropteris.

Figs. 2 and 3. Pinnæ having characters of Odontopteris.

From shale over coal No. 1, Youngstown, Ohio.



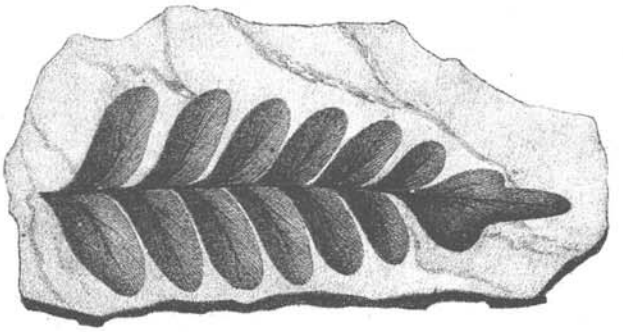


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PLATE XLVIII.

PAGE.

Fig. 1. ALETHOPTERIS GRANDIFOLIA. Newb 384

Two pinnæ from near base of one of the subdivisions of the tri-pinnate frond of variety with narrow pinnules.

1 *a*. Two pinnules enlarged to show nervation.

Fig. 2. ALETHOPTERIS GRANDIFOLIA. Newb 384

Pinna of most common form with broad elliptical pinnules.

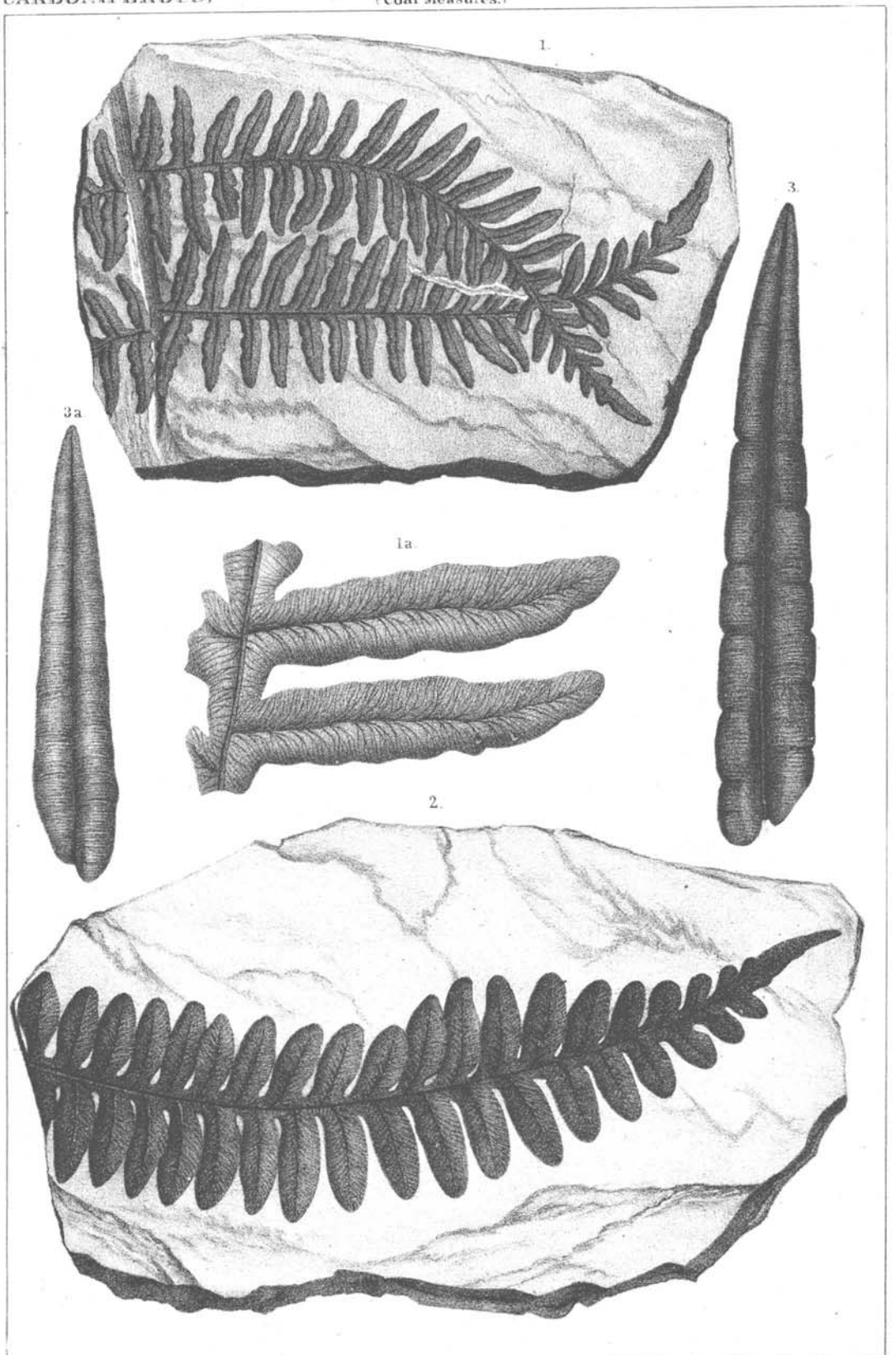
Both from Coal No. 1, Tallmadge, Summit county, Ohio.

Fig. 3. ALETHOPTERIS MACROPHYLLA. Newb 383

Single pinnule, natural size.

3 *a*. Another specimen of the same.

Over Coal No. 1, Youngstown, Ohio.



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