DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

# STATUS

OF THE

# MESOZOIC FLORAS OF THE UNITED STATES

## FIRST PAPER: THE OLDER MESOZOIC

BY

LESTER F. WARD
WITH THE COLLABORATION OF
WM. M. FONTAINE, ATREUS WANNER, AND F. H. KNOWLTON

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# STATUS OF MESOZOIC FLORAS OF UNITED STATES.

## FIRST PAPER: THE OLDER MESOZOIC.

By Lester F. Ward.

### INTRODUCTORY REMARKS.

It is proposed in this paper to give a succinct account of the progress thus far made in the direction of developing the Mesozoic floras of the United States. The treatment will be primarily in the ascending geological order, secondarily in such geographical order as seems most natural, and finally in the chronological order of discovery. The aim will be to enumerate for the several formations, geographical areas, and special localities the fossil plants that have been found, collected, and reported upon, and to give a somewhat complete bibliography of the work accomplished in strictly paleobotanical lines, with special reference to correlation, but without any attempt to treat the subject from the stratigraphical or general geological standpoint, since this latter task would be much too large, and has, moreover, to considerable extent, been done already by numerous writers. The stratigraphical results thus arrived at will be simply accepted, and the horizons will be arranged with reference to them. There will be no attempt to republish what has already appeared, and the new matter will consist altogether of additional results here published for the first time.

A special feature will be the enumeration of discoveries made and of materials collected and in hand, either now in process of elaboration or to be taken up as early as possible for future publication.

It is believed that such a paper will be useful not only as showing the work that has been done, the results of which are now scattered through a great number of volumes of the most diverse character, and are difficult to find, but also as indicating the direction and prospects of future work along the same lines.

The paper naturally falls under three general heads, based on the general geological nomenclature of the Mesozoic—Triassic, Jurassic, and Cretaceous—which, notwithstanding the difficulty in making the

American beds conform in all respects with the older classification, still proves a convenient and more or less satisfactory basis of subdivision. These general heads may be made to designate the three parts, I, II, and III, of the paper, and each of the parts may then be conveniently further subdivided into lesser heads dealing with the smaller geological groups or formations, designated for the most part by special names derived from localities where each is best exposed.

In view of the considerable magnitude which such a memoir is found to assume, and especially of the impossibility of having all the illustrations prepared in time to be embodied in the Twentieth Annual Report of the Survey, it has been necessary to make a more general subdivision of it into two papers, one on the Older Mesozoic (Parts I and II), and the other on the Younger Mesozoic, or Cretaceous, and to confine the present paper to the former of these subdivisions, the matter for which is ready, leaving the other subdivision to form the subject of a second paper to be published in a subsequent report.

# PART I.

## THE TRIASSIC FLORA.

There are certain beds which are generally admitted to belong to the great series called Triassic in all parts of the world, and the fossil plants only help to confirm the conclusions on this point which have been drawn from stratigraphical considerations and from other forms of life. It so happens, however, that the paleobotanical record is here very incomplete, and there is no adequate evidence that any plant remains have thus far been found in any but the uppermost portion of the Triassic series. It is true that Mr. Benjamin Smith Lyman, of the Pennsylvania Geological Survey, argues for a great thickness of the Triassic beds in Bucks and Montgomery counties, Pennsylvania,[1] claiming that they extend into the Permian and contain the remains of Calamites and Lepidodendron, but no one else finds the same conditions, and Mr. Henry B. Kümmel, after an exhaustive study of these beds in the adjacent State of New Jersey, with Mr. Smith's results before him, finds reasons for doubting his conclusions, and reduces the thickness from 27,000 to 12,000 or 15,000 feet by the discovery of faults.[2]

With regard to the fossil plants, Mr. Lyman admits that the supposed Calamites was never submitted to a competent specialist, and it is altogether probable that it represents the stem of a large Equisetum, as, for example, *E. Rogersii* (Bunb.) Schimp. It must be remem-

[1] Proc. Am. Philos. Soc., Vol. XXXIII, pp. 5-10; 192-215; Pennsylvania State Geological Survey Summary, Final Report, Vol III, Pt. II, pp. 2589-2638.

[2] Annual Report of the State Geologist of New Jersey for 1897, p. 138.

bered that Bunbury[1] in 1851, when he named that species, and all before that date, back to Brongniart in 1828, who first figured it,[2] regarded it as a Calamites. For the existence of Lepidodendron there would seem to be good authority; not, however, for its occurrence in the thick deposits of Pennsylvania, but in the New Jersey beds, in quarries of Newark and Belleville, a photograph of a specimen from which was sent to Professor Lesquereux by Professor Cook, State geologist of New Jersey. In his report Professor Lesquereux says:

The photographs are sufficient, if not for specific determination at least for positive reference of the specimens to Lepidodendron. Even I should say that the specimens represent *L. Veltheimianum* Presl, as distinctly as a specific representation can be made upon a decorticated trunk of Lepidodendron. *L. Veltheimianum* is a leading species of the Old Red Sandstone found here, as in Europe, from the Subcarboniferous Measures down to the Devonian, while until now we do not have any remains of Lepidodendron of any kind from the Upper Coal Measures (Permo-Carboniferous), or from higher up than the Pittsburg coal.

*L. Veltheimianum* is recorded only once from the true Coal Measures; this by Eichwald, from the Carboniferous sandstone of Russia. But European authors, among others Goeppert, doubt the identity of the Russian species with *L. Veltheimianum*, which is, moreover, extremely variable, and has been described already under about thirty different names.[3]

While the authority in this case is not to be questioned, there is certainly room for doubt as to whether so important a conclusion drawn from a photograph of a decorticated specimen can be regarded as final.

After reading Mr. Lyman's articles I wrote to Professor Fontaine under date of May 4, 1894, as follows:

Have you seen Mr. Lyman's articles in the Proceedings of the American Philosophical Society (Vol. XXXIII, January, 1894, No. 144, pp. 5–10)? I wish you could see the specimen of so-called Lepidodendron from the Newark brownstone, to see whether you agree with Lesquereux. It is just possible that there may be points at which the change from the brown sandstone to the underlying Carboniferous is not easily distinguished, and they may have got down into the Carboniferous. The whole matter ought surely to be looked into.

To this Professor Fontaine replied under date of May 12, 1894, as follows:

I had seen a notice of Lyman's remarks on the Newark beds, but not the articles. Since you called my attention to them I have carefully read them. I think that he makes out a case strong enough to call for a careful revision of all that is known of the flora of these strata. It is possible, but I do not think probable, that the Devonian may be reached in some of the Newark strata. I think that the supposed Lepidodendron is the plant that I have figured in Monograph VI, pl. xlviii, fig. 5, which I supposed to be the stem of a cycad (see p. 91 of monograph) like Williamson's stem of *Zamia gigas*. This may be really a coniferous stem and belong to the conifer that bore the cones depicted on pls. xlvii and xlviii. These are possibly kin to Abies and the ancestral forms of the Abietites of the Potomac. This is strikingly

[1] Quart. Jour. Geol. Soc. London, Vol. VII, 1851, p. 190.

[2] Histoire des Végétaux Fossiles, Vol. I, p. 125, Pl. XVI, fig. 1.

[3] Geological Survey of New Jersey, Annual Report of the State Geologist for the year 1879, Trenton, 1879, pp. 26–27.

like Lepidodendron, but even if it be such the absence of all other Paleozoic plants and the fact that the accompanying flora is wholly Mesozoic would simply indicate that Lepidodendron survives into the Mesozoic. It is noteworthy, with reference to what Lesquereux says, that this Richmond coal-field plant is more like *L. Veltheimianum* than any other of that genus. I do not know what Mr. Lyman's authority is for the statement that the Newark beds are 9,000 feet below the Milford strata, or for the great thickness he gives for the Pennsylvania Trias, 27,000 feet. I have not seen any publication indicating that thickness. Do you know of such? Mr. Lyman questions my rejection of Lepidodendron from the Mesozoic flora. I do not see that that, if correct, helps his contention, which is that the fossils may be Lepidodendron, and therefore the beds may be Paleozoic. If we grant that these plants are Lepidodendron, all that can be deduced is that this genus lived in the Mesozoic, for the supposed Lepidodendron of North Carolina and Virginia is accompanied by an abundance of well-marked Mesozoic plants; otherwise we must conclude that the North Carolina and Virginia beds are Paleozoic. Surely he would not maintain that.[1]

In all this the question has not been whether we have in these few doubtful remains representatives of the flora of the lowest Triassic beds corresponding to the Variegated Sandstone or Vosgian and the Muschelkalk, but whether they are Mesozoic or Paleozoic. Professor Fontaine seems to have sufficiently answered this question, and all agree to the absence thus far of the characteristic Lower Triassic forms, such as Æthophyllum, Voltzia, Albertia, and Yuccites.

With regard to the alleged Trias of Prince Edward Island,[2] it presents a question singularly similar to the one just considered, since none of the fossil plants at least are claimed to represent the Lower Trias, while two of them are decidedly Paleozoic in their affinities. I therefore fully indorse all that Dr. Knowlton has said[3] with regard to them. I had myself raised the question whether the *Cycadeoidea abequidensis* may not represent a cone of some coniferous tree. It is very small for a cycadean trunk, though this alone would not negative such a reference. Sir William Dawson's fig. 29, which is about natural size, does not bring out cycadean characters, and the supposed scars of leaves and buds represented enlarged in figs. 29*a* and 29*b* do not help support his view. He does not explain why he places the small end down and describes it as "obovate" instead of reversing it and treating it as originally conical, but if the side of the scars toward the small end are, as represented, more pronounced than that toward the large end, this would seem to justify that position. A photograph, slightly enlarged, which Sir William was so good as to send me, and which bears enlargement with a lens much better than the engraving, still fails to answer the question of orientation, but it must be admitted

[1] At the time this letter was written the negotiations described below (pp. 274-276) relative to the then recently discovered Emmons's collection were going on, and it will be observed that Professor Fontaine, after examining the specimens themselves, refers the supposed Lepidodendron to *Zamiostrobus virginiensis*, virtually confirming his previous conclusion derived from an examination of the figures alone.

[2] Report on the Geological Structure and Mineral Resources of Prince Edward Island, by J. W. Dawson, assisted by B. J. Harrington; Montreal, 1871; 51 pp., 3 plates. See pp. 13-22, 45, 46, pl. iii.

[3] In the Newark system, by I. C. Russell: Bull. U. S. Geol. Survey No. 85, 1892, p. 29.

that some of the supposed buds when thus enlarged simulate very closely the reproductive organs of certain Cretaceous cycadean trunks. This treatment further shows that the scars or scales point toward the large end, which would be singular for a cone, whatever the conditions of compression to which it might have been subjected. It would seem, therefore, that the whole question must be left for the present in abeyance, but there is at least no evidence of these beds representing the early Trias.[1]

It will therefore be necessary to treat the American Trias as a geological unit, and to confine the classification to the several geographical areas in which its flora has been developed.

There is no fact more commonly remarked by paleontologists than that of the defectiveness of the geological record in Mesozoic time, especially as regards fossil plants. Of the three divisions or systems of the Mesozoic, the defectiveness of this record is most apparent in the earliest or lowest, viz, the Trias. In Europe the lower member of the Trias, viz, the Buntersandstein, contains fossil plants at some points, notably in Alsatia, on the slopes of the Vosges, and in the vicinity of Strasburg. The second or middle member, viz, the Muschelkalk, is also represented by a few plant remains at Recoaro, in Italy, and perhaps at a few other points. The last member, viz, the Keuper, is very well represented at many different localities on the Continent. The Triassic fossil plants are most numerous of all in the extreme upper member or transition beds, viz, the Rhetic, especially in the Kingdom of Bavaria, province of Franconia, near Baireuth, and in South Sweden (Scania).

The attempt to correlate the Trias of America with any other of these three series of the European Trias has thus far been more or less unsuccessful, but it is remarkable that all the fossil plants that have ever been discovered in American strata within the proper limits of the Trias not only appear to belong to nearly the same horizon, but also have their nearest affinities with those found in the very uppermost of the four different members which have been enumerated. It is quite immaterial whether we denominate this member the upper Keuper or call it the Rhetic.

The principal plant-bearing deposits which have been assigned to the Trias in America occur in the Connecticut Valley, in the vicinity of Richmond, Virginia, and in North Carolina. In the West there are large tracts of country which have been assigned to the Trias and which probably belong to that system, and many eminent geologists, including Dr. J. S. Newberry, have been disposed to identify this Western formation with that of the eastern part of the country. These deposits are most extensive in New Mexico and Arizona, but are perhaps to be found in Indian Territory and adjacent parts of Texas. They also

[1] See Dana, Manual of Geology, 4th ed., 1895, p. 741.

extend into Utah, Nevada, and Colorado. The beds near Taylorsville, California, will receive separate treatment.

Of these several deposits the one that has attracted the largest share of attention is the so-called Richmond coal field in Virginia, which has been the subject of a valuable contribution by Prof. William M. Fontaine, published in 1883 as Monograph VI of the United States Geological Survey.

Next in importance is the region in the State of North Carolina which was early investigated by Dr. Ebenezer Emmons, who published the results primarily in his report on the Geology of North Carolina as State geologist, and finally embodied them in his American Geology, Part VI.

A few fossil plants were long ago described and figured by Dr. Edward Hitchcock in his report on the geology of Massachusetts, and in several papers in the American Journal of Science. Later, Dr. J. S. Newberry elaborated certain material in his hands at the School of Mines, Columbia College, New York, and published the same in connection with the fossil fishes of the Connecticut Valley in a monograph of the Geological Survey.[1] This work is of special value to us in the consideration of the question of correlation of the various Triassic beds, since Dr. Newberry took much interest in this question and made careful comparisons with all the other plant remains as well as the animal remains of the Trias. His conclusions, therefore, upon this question are of the highest importance and are quite freely expressed.

The material from the Western beds has consisted chiefly of fossil wood, of which vast quantities exist, strewn over the plains of Arizona and New Mexico, and which has been repeatedly reported upon and graphically described by many writers. But until recently very little else has been known from that region. The work upon which we must rely for most of our information with regard to that region, aside from the fossil wood, is that known as the report of the Macomb Exploring Expedition, in which Dr. J. S. Newberry, as naturalist of that expedition, describes and figures a considerable number of Triassic fossil plants; but most of the plants dealt with in this report come from Mexico and not from any part of the United States.

Better to understand the history of the work done on the fossil plants of the American Trias, we will now undertake a brief review of the subject.

## THE CONNECTICUT VALLEY AREA.

Beginning with the most northern of the Eastern deposits, viz, that of the Connecticut Valley, we find that the earliest mention made of fossil plants was that by Dr. Edward Hitchcock, in the American

[1] Fossil fishes and fossil plants of the Triassic rocks of New Jersey and the Connecticut Valley, by John S. Newberry: Mon. U. S. Geol. Survey, Vol. XIV, Washington, 1888.

Journal of Science for 1823, in an extended article read before the American Geological Society on September 11, 1822.[1] Neither of the two objects found is specifically determinable, the first being some sort of cane or grass, the other a coniferous branch, possibly Palissya or Voltzia. The first was found one-half mile south of Newgate Prison, and the second at Sunderland, in Massachusetts.

The first mention made of the petrified tree found in the Southbury area of the Connecticut Trias, about which so much has been said, was a paragraph devoted to it by Dr. Hitchcock in his Miscellaneous Notices of Mineral Localities, with Geological Remarks, in 1828,[2] describing a fragment from it obtained by Dr. Smith of Southbury, broken off by a man who had mistaken it for a recent stump and ruined his ax upon it.

In his first Geological Report of Massachusetts, published in 1833,[3] and accompanied by an atlas of 18 plates, Dr. Hitchcock made passing mention on pages 232–234 of vegetable remains in the Trias and figured a few obscure objects on pl. xiii of the atlas. He supposed that he had found a species of Calamites agreeing closely with *C. arenaceus* of Brongniart, and refers to the mention by De la Beche, in his Manual of Geology, of the discovery of *Lycopodites Sillimanni* at "Hadley, Connecticut," which he believes to have meant South Hadley, Massachusetts. Speaking of the coniferous plant figured in the American Journal, already referred to, he concludes that it is probably a Voltzia related to *V. brevifolia*. The fucoid there found he was disposed to regard as *Fucoides Brongniartii;* but, as we shall see later, he afterwards gave this plant another name. It was found in Deerfield and Greenfield, and was referred to Dr. Morton for determination. Dr. Hitchcock also here again calls attention to the fossil trunk of a tree discovered at Southbury, Connecticut.

The Report on the Geological Survey of Connecticut, by Charles Upham Shepard,[4] 1837, refers to the occurrence of vegetable remains in the red sandstone at Middletown and in the cupriferous sandstone-slate at Enfield Falls, in Suffield, and at Southington and Durham.

In his second Geological Report of Massachusetts[5] Hitchcock devotes nine pages (pp. 450–458) to the subject of fossil plants in the Trias or New Red Sandstone, as he calls it. Some of these are of doubtful vegetable nature; others that he figures are probably fucoids, which can scarcely be determined from his description. The one men-

[1] A sketch of the geology, mineralogy, and scenery of the regions contiguous to the River Connecticut, with a geological map and drawings of organic remains, and occasional botanical notices, Part I, by Edward Hitchcock: Am. Jour. Sci., 1st series, Vol. VI, 1823, pp. 1–86. For reference to fossil plants see p. 80, pl. ix, figs. 4, 5.

[2] Am. Jour. Sci., 1st series, Vol. XIV, 1828, p. 228.

[3] Report on the Geology, Mineralogy, Botany, and Zoology of Massachusetts, by Edward Hitchcock, Amherst, 1833.

[4] New Haven, 1837, pp. 1–188, 8°. See pp. 62, 166.

[5] Final Report on the Geology of Massachusetts, Vol. II, Northampton, 1841.

tioned in the previous report he now calls *Fucoides Shepardi*, and he distinguishes another as *F. connecticutensis*. These plant impressions are for the most part figured in the text; but in addition he gives one plate (which in the text he refers to as pl. 29, but which bears the number 28) on which occur four figures of various small objects, none of which are generically determinable, and only one can be with certainty referred to the vegetable kingdom. viz, fig. 2, which probably represents a Palissya.

The same author read a paper before the Association of Geologists and Naturalists in 1842, in which he described a number of additional plant forms from this same region.[1]

In this paper Dr. Hitchcock gives an account of the fossil tree already mentioned, which was found at Southbury, the specimens of which he had sent to Professor Bailey at West Point, whose language he quotes in this paper and whose figures he also gives on the plate. Professor Bailey had made three sections, one of which was longitudinal and sufficiently radial to show conclusively that the wood of this tree was coniferous, and he so pronounced it. Dr. Hitchcock also here figures a specimen found in the dark-gray sandstone of Mount Holyoke, Massachusetts, which he says belongs to the genus Tæniopteris, and which he compares with *T. vittata* Brongn., as figured in Bronn's Lethæa Geognostica. The figure (fig. 2) of this specimen is so very poor that no one would suspect it of being a fern, but inasmuch as he states that the specimen closely resembles *Tæniopteris vittata* we can interpret the figure with some satisfaction, and there would scarcely seem to be any doubt that this specimen actually represented a Tæniopteris or Macrotæniopteris. This is interesting in view of the fact that Dr. Newberry, in his work already quoted,[2] speaking of *Tæniopteris magnifolia* of Rogers, says that "this has not yet been found anywhere in the North, nor has any other similar fern been met with there," showing that Dr. Newberry had probably overlooked this paper by Dr. Hitchcock. The other three figures represent a conifer allied to Voltzia or perhaps belonging to Palissya, but too poorly preserved and too badly figured to be determinable.

In 1847 Dr. Benjamin Silliman gave an account[3] of two fossil trees, one of them with branches, found in place in the red sandstone in the town of Bristol, Connecticut. A clear picture of the quarry with the trees exposed is given on page 117, and his description is rather full and satisfactory. As in the case of the Southbury specimens, a report was secured from Prof. J. W. Bailey on the internal structure, with the same result: that it indicated the coniferous character of these remains.

[1] Description of several species of fossil plants from the New Red Sandstone Formation of Connecticut and Massachusetts, by Edward Hitchcock: Report of the first, second, and third meetings of the Phil. Assoc. of Am. Geologists and Naturalists, 1840-1842, Boston, 1843, pp. 294-296, pl. xiii.

[2] Mon. U. S. Geol. Survey, Vol. XIV, 1888, p. 12.

[3] Am. Jour. Sci., 2d series, Vol. IV, 1847, pp. 116-118 (fig. on p. 117).

At the close of the paper Dr. Silliman mentions the fact that "large stems of reedlike plants are found in the beds which furnish the fish, at Middlefield, in the same State."

In the same volume[1] Dr. Hitchcock noted the occurrence in bowlders of porphyritic trap at Amherst of "a vegetable stem from 1 to 3 inches in diameter, scarcely flattened."

Several years later (1855), in an article contributed to the American Journal of Science,[2] Dr. E. Hitchcock, jr., describes another fern, which he calls *Clathropteris rectiusculus*, found in the sandstone of Mount Tom, in Easthampton, Massachusetts. From the figures on page 24 Professor Fontaine, in his Older Mesozoic Flora,[3] identifies this with *Clathropteris platyphylla* (Göpp.) Brongn. There is some further mention of this plant by the elder Hitchcock in 1861.[4] In his paper Dr. Hitchcock, jr., speaks of other specimens of what he supposed to be Clathropteris in the cabinet of Amherst College, taken from the quarry of Roswell Field, in Gill, Massachusetts. These specimens are not figured, but from the description Dr. Hitchcock gives of them Professor Fontaine concludes that they can hardly represent a Clathropteris, and are probably Dictyophyllum or Camptopteris.

In a paper by Dr. James Deane on the Sandstone Fossils of Connecticut River (Turners Falls, Massachusetts), published in the Journal of the American Academy of Natural Sciences of Philadelphia for November, 1856,[5] he figured one specimen (pl. xix, fig. *a*) which was thought by Professor Gray to be the "leaf scars of some plant like a tree fern," and which Professor Dana could refer "to nothing but a plant, the prominences being the traces of leaves, probably coniferous;" but he admitted it was "not like any known coniferous plant, ancient or modern" (see p. 177). Dr. Deane, however, did not share these opinions, and says of this specimen:

> I think in the present state of science it is impossible to explain the origin of this elegant fossil. If the accumulated bodies that constitute the various lines of impressions be not due to the deciduous fronds of plants, they must be taken for the dermoid protuberances of some animal. There is not the slightest evidence of a compressed stem of a coniferous or other plant, which should certainly be the case in so perfect a specimen; and, moreover, upon the superior or superincumbent stratum the imprint is reversed; it is a cast, and this, it appears to me, is conclusive evidence against a vegetable origin.

In his Ichnology of New England[6] Dr. Edward Hitchcock speaks, on page 6, of the fern (*Clathropteris rectiusculus*) described by Dr.

[1] Loc., cit., p. 202.

[2] Description of a new species of Clathropteris, discovered in the Connecticut Valley sandstone, by Dr. E. Hitchcock, jr.: Am. Jour. Sci., 2d series, Vol. XX, 1855, pp. 22-25.

[3] Mon. U. S. Geol. Survey, Vol. VI, 1883, p. 57.

[4] Proc. Am. Assoc. Adv. Sci., Vol. XIV, pp. 158-159.

[5] 2d series, Vol. III, pp. 173-178, pl. xviii-xx.

[6] Ichnology of New England: A Report on the Sandstone of the Connecticut Valley, made to the Government of the Commonwealth of Massachusetts, by Edward Hitchcock; Boston, 1858, 4°. See pp. 6, 8, pl. v, fig. 1; pl. vii, figs. 1 and 2.

Edward Hitchcock, jr., mentioned above, and gives a figure of the whole frond (pl. v, fig. 1), showing the radiating structure, and another (pl. vii, fig. 1) of a small segment more enlarged than that previously published.

In the same work (p. 8) he mentions a cone found in the quarries of Mr. Roswell Field at Turners Falls, which he thought similar to some described in Europe from the Wealden. A sketch of this cone and of some coniferous twigs from the same locality, made by Mr. F. A. Lydston, is introduced on pl. vii (fig. 2). Professor Fontaine, in a letter dated February 7, 1891, expresses the opinion that the twigs here figured belong to *Cheirolepis Muensteri*, and that the cone may have been that of a species of Palissya of the type of *P. aptera* Schenk.

From the date of the Ichnology of New England there seem to have been nearly thirty years during which no additional paleobotanical discoveries were made in the Connecticut Valley. In 1885 Mr. H. H. Hendrick, a member of the Meriden Scientific Association, found in the Durham shales the fruit of a cycadean plant, a brief notice of which was published by the Rev. J. H. Chapin, of Meriden, president of the association, in the proceedings for that year.[1] The specimen was sent to Dr. J. S. Newberry, who described and figured it in his Fossil Fishes and Fossil Plants (p. 92, pl. xxiv, fig. 4) under the name of *Cycadinocarpus Chapini*. Mr. Chapin recorded this fact in a later volume[2] of the same series in which the original announcement was made.

On March 28, 1887, Dr. Newberry presented to the New York Academy of Sciences a very brief account of the results at which he had arrived in his study of the paleontology of the Triassic beds. An abstract of this paper appeared the same year.[3] It contains a list of the plants that had been obtained from both the New Jersey and the New England beds, all of which were fully treated in the work on which he was then engaged.

The above enumeration brings the record of paleobotanical discovery in the Trias of the Connecticut Valley and New England areas down to the date of Dr. Newberry's Monograph of the Fossil Fishes and Fossil Plants, to which reference has already been made (supra, p. 222). In this he gives a sketch of the Triassic, and includes 17 species of fossil plants. They were collected at Sunderland, Massachusetts, at Durham and Middletown, Connecticut, and at Newark and Milford, New Jersey, and are treated in a thorough and systematic way, being illustrated in six plates with very excellent figures. Through this work we are therefore at length placed in possession of a considerable body

[1] Proceedings and Transactions of the Scientific Association, Meriden, Connecticut, 1885–86, Vol. II, Meriden, 1887, p. 29.

[2] Vol. IV, Meriden, 1891, p. 62.

[3] The fauna and flora of the Trias of New Jersey and the Connecticut Valley: Trans. N. Y. Acad. Sci., Vol. VI, 1886–87, pp. 124–128.

of facts relating to the fossil flora of the northern extension of the American Trias.

My own investigations in this area began in the year 1890. During the month of August of that year Professor Fontaine and myself visited the beds in the vicinity of New Haven and most of the localities above mentioned in Connecticut and Massachusetts, especially those in the Connecticut Valley as far as Turners Falls and Gill, Massachusetts. Our object was, first, to see the collections at Yale University, at the Wesleyan University in Middletown, Connecticut, and at Amherst and Turners Falls, Massachusetts, and to examine the older material that had been collected as above stated and all the fossil plants from the Trias deposited in these collections; secondly, to examine, so far as possible, the beds themselves from which fossil plants have been taken, and to note their mode of occurrence in the rocks.

Of recent collectors in this section by far the most successful has been Mr. S. Ward Loper, of Middletown. Mr. Loper was in the field at the time of our visit, and we met him at Tariffville, Connecticut, at which place he had discovered a plant-bearing locality. There being no true coal mines in the Connecticut Valley Trias, the mode of occurrence of the fossil plants is, of course, somewhat different from that in Virginia. It is equally true here, as in Virginia, that fossil plants are not found in the red sandstone, but are confined to the dark shales, and those in the Connecticut Valley occur for the most part in close connection with the trap ridges of that region. They are usually found at the margin of the shales near their contact with the trap. The locality at Tariffville was in close contact with one of the secondary trap ridges located on the eastern side of the main ridge, which, in the general trend of these ridges, places it higher in the Trias, geologically speaking, or, as Professor Davis expresses it, "posterior." From what Mr. Loper told us, and from numerous observations upon localities from which fossil plants have been previously reported, it would seem that they usually occur in this position. A fairly good specimen of *Ctenophyllum Braunianum angustum* was found during our visit to this locality, and Mr. Loper had already sent considerable material of this character to Professor Davis, which subsequently found its way into the general collection at Washington.

Besides examining the Portland quarries and those of Turners Falls and Gill, Massachusetts, where no vegetable remains other than those presently to be named occur, we visited several places in Connecticut where Mr. Loper had obtained fossil plants, especially at Westfield and Highlands. In the Portland quarries there occur large logs clearly representing Triassic trees embedded in the red sandstone and now thoroughly silicified; but besides these and the fine specimens of Dendrophycus which occur there, nothing of a vegetable nature seems to have been found. At Turners Falls careful investigation was made in the red shales bearing the tracks so celebrated in that locality, and under the guidance of Mr. T. M. Stoughton we visited all the important places from which specimens of interest had been taken. We saw in these beds nothing that could be called vegetable, and it seems very doubtful whether any plants either grew or were ever transported by any agency into the riparian clays in which the Brontotheria and other saurians left their footprints in such profusion.

Special attention was paid on this excursion to the form called *Dendrophycus triassicus* Newb. The original of one of the specimens figured by Dr. Newberry[1] was seen at the museum of Yale University, the other[2] was examined at the museum of the Wesleyan University. Two other good specimens were afterwards secured at the Portland quarries by Mr. John H. Sage, of Portland, and generously donated by him to the National Museum. The finest specimens, however, are those at the Wesleyan University, also from the Portland quarry. Through the courtesy of Prof. W. N. Rice, of that institution, permission was obtained to have these specimens photographed, and Mr. De Lancey W. Gill, then chief of the division of illustrations of the United States Geological Survey, kindly undertook to visit Middletown in November and attend to the photographing of these specimens. Pl. XXXV, Fig. 1, represents one of these views. Although this differs considerably from the specimens figured by Dr. Newberry, coming as they do from the same quarry, it is to be supposed that they represent one species, and it may be assumed that the specimens figured by Dr. Newberry show the lower portion of the frond and did not contain those higher and finer lines so beautifully shown in the specimen at the Wesleyan University. These, therefore, will also be treated as belonging to *D. triassicus*.

I may add that at Amherst several specimens of Dendrophycus from the Portland quarry, and, perhaps, from other points, were seen by us. They were labeled, apparently in the handwriting of Dr. Edward Hitchcock, "Aroid plants." This is of special interest as showing that Dr. Hitchcock supposed them to be of vegetable origin.

At the Washington meeting of the Geological Society of America in December, 1890, Prof. W. M. Davis and Mr. S. Ward Loper read a joint paper giving the results of their work in the Connecticut Valley.[3] The first part of this paper, by Professor Davis, is devoted to the discussion of his theory of the formation of the "trap" and the general stratigraphy of the Triassic formation in the Connecticut Valley. The second part, by Mr. Loper, treats of the fossils. It gives an enumeration of the fossil fishes and fossil plants found by him and their stratigraphical position, showing those that are confined to the anterior and

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[1] Op. cit., pl. xxi, fig. 2.

[2] Loc. cit., fig. 1.

[3] Two belts of fossiliferous black shale in the Triassic formation of Connecticut, by W. M. Davis and S. Ward Loper: Bull. Geol. Soc. America, Vol. II, Rochester, 1891, pp. 415–430.

to the posterior shales, and those that are common to both. This enumeration includes 13 plant forms, 11 of which are specifically named. Six of these forms are confined to the anterior and 2 to the posterior shales, while the remaining 5 are common to both situations.

## THE HUDSON-POTOMAC AREA.

By this name may be designated the continuous belt of Triassic deposits that begins with the palisades of the Hudson and ends with the Seneca quarries on the Maryland side of the Potomac. Its position is too well known to require description. The several States may be treated in their order. No fossil plants have been reported from any locality in the Trias of New York.

### TRIASSIC PLANTS FROM NEW JERSEY.

Prof. Henry D. Rogers, in his description of the Geology of the State of New Jersey, published in 1840, devotes a chapter (Chapter III, p. 114) to "the Middle Secondary Rocks," which is the designation preferred by him for this series, and of these rocks he says (pp. 115–116):

> The organic remains hitherto discovered are extremely few, and the evidence they afford is not sufficient to establish within near limits the era to which these strata should be referred. They consist merely of a few rather imperfect relics of one or two species of fishes, some indistinct impressions of Fucoides, or other aquatic vegetation, and occasional thin bands of ligniform coal, in which the fibrous structure, apparently that of the wood, is traceable.

On May 6, 1869, Mr. T. A. Conrad presented a paper to the Conchological Section of the Philadelphia Academy of Natural Sciences[1] in which he described two species of fossil mollusks from South River, New Jersey, found in ash-colored clay near Washington, Middlesex County, which he says "contains abundant stems and leaves of *Cyclopteris.*" He further remarks that, although Rogers had referred this clay to the Cretaceous, he (Conrad) had "ascertained it to be Triassic."

No one, to my knowledge, has since seen these "Cyclopteris" leaves. Whitfield[2] refers to this and remarks:

> It will be seen by reference to Professor Lesquereux's list published in the "Report on Clays" (Geol. Rept. New Jersey, 1878, p. 28, 29) that Professor L. does not include this genus among those examined and reported upon. We may, therefore, consider that Mr. Conrad may have been mistaken.

As the list in the Report on Clays contains only species found in the Plastic Clays, which are Cretaceous, this seems curious reasoning. There are clay pits near Washington from which I have myself collected beautiful impressions of fossil plants belonging to the flora of

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[1] Am. Jour. of Conchology, Vol. IV, 1869, pp. 278-279.
[2] Mon. U. S. Geol. Survey, Vol. IX, 1885, p. 22.

the Amboy Clays, but they were chiefly dicotyledonous leaves, and this clay does not seem to be the source of the specimens mentioned by Conrad. The Triassic runs under the Cretaceous a short distance west of Washington and Middletown, and it is quite possible that the clays in question may be Triassic.

Mr. I. C. Russell, in 1878, found "a considerable abundance of obscure vegetable remains" at an abandoned copper mine on the western slope of the First Newark Mountain, near Plainfield.[1]

The discovery of fossil plants in the Newark and Belleville quarries, as recorded in the Report of the State Geologist for 1879, has already been referred to (supra, p. 219). Besides the specimen of a supposed Lepidodendron, of which a photograph was sent to Professor Lesquereux, it is added that—

Another fragment has since been obtained from the same quarries by Dr. Skinner, of Belleville, and is now in our possession. It is 7 inches long, 5½ inches wide, and 1½ inches thick, and is as plainly marked as the first. Other and smaller specimens somewhat like the above have also been found in the quarries in Newark. If these fossils are sufficient to determine the geological age of these beds, they put it in the Upper Carboniferous, at least, which is lower than has been heretofore claimed for it. A larger and more complete collection of such fossils must be made if possible.

Vegetable impressions are found in large numbers at the quarries of Mr. Smith Clark, of Milford, but most of them are fragmentary and indistinct. Those which can be seen plainly enough for identification resemble the Equisetum and some coniferous plants. They are evidently much newer than the fossils at Newark and Belleville.[2]

Reference may be made to a paper by Mr. Henry Carvill Lewis, published in the Proceedings of the Philadelphia Academy of Sciences for November 24, 1879, On a New Fucoidal Plant from the Trias. This plant was found at Milford and is figured in this paper. The generic determination was made by Professor Lesquereux, who considered it a new species of Palæophycus, and Mr. Lewis called it *P. limaciformis*.

In the Report of the State Geologist of New Jersey for 1885, page 95, it is stated that Prof. T. C. Porter had obtained specimens of a conifer and an Equisetum in some Triassic sandstone quarries in Hunterdon County, and also that the *Clathropteris rectiusculus* Hitchcock had been found at a quarry near Pluckemin, in Somerset County.

Plant remains were also seen by Mr. F. Braun in a layer from 3 to 4 inches in thickness near the base of a bed of slate under the trap rock along the western bank of the Hudson River at Weehawken, Guttenburg, and neighboring localities in New Jersey, as noted by Mr. Gratacap in 1886.[3]

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[1] On the occurrence of a solid hydrocarbon in the eruptive rocks of New Jersey, by I. C. Russell: Am. Jour. Sci., 3d series, Vol. XVI, August, 1878, pp. 112–114.

[2] Geological Survey of New Jersey, Annual Report of the State Geologist for the year 1879, Trenton, 1879, p. 27.

[3] Fish remains and tracks in the Triassic rocks at Weehawken, New Jersey, by L. P. Gratacap: Am. Naturalist, Vol. XX, March, 1886, pp. 243–246

The Annual Report of the State Geologist of New Jersey for the year 1888 is largely devoted to the Triassic or red sandstone rocks, and mentions the occurrence of vegetable remains at a number of points, especially at Belleville, Little Falls, Pleasant Dale, Martinsville, Pluckemin, Wilburtha, and Milford.

The above embraces the greater part of the record of paleobotanical discovery in the Trias of New Jersey beyond what is noted in Dr. Newberry's monograph.

### TRIASSIC PLANTS FROM PENNSYLVANIA.

In Pennsylvania there are several localities at which vegetable remains have been noted.

In 1856 Mr. Isaac Lea gave an account[1] of some observations of his made the previous year in this vicinity, where he found in dark shales, and associated with Posidonia, saurian teeth and footprints, "impressions of plants, some of which belong to the *Conifera* [sic]." He continues:

> One of the cones was nearly 6 inches long and a full inch wide. These were accompanied by other plants of very obscure character, covering large portions of the surface of some of the layers.
>
> Mr. Lea also mentioned that he had observed the same red, black, and gray shales at Gwynedd, on the North Pennsylvania Railroad, where he found the same Posidonia and some of the same obscure plants, impressions of which covered the surfaces of many of the rocks. A single specimen was obtained of a plant with long leaves somewhat resembling *Noeggerathia cuneifolia* Brongniart, which is from the Permian.[2]

More or less successful attempts must have been made to determine these plants collected by Lea, as Mr. Wheatley, in a paper read before the Connecticut Academy of Arts and Sciences on February 20, 1861,[3] identified a number of them with forms described by Rogers and Emmons from Virginia and North Carolina.

In his Older Mesozoic Flora, p. 116, Professor Fontaine says that, according to Professor Lesquereux, *Ctenophyllum robustum* (Emm.) Font. (*Pterophyllum robustum* Emm.) occurs at Phœnixville, Pennsylvania, but he does not state where Professor Lesquereux has made this statement, and I have been unable to find any reference to it from that locality.

Mr. Persifor Frazer, in his Geology of Chester County,[4] says that "plants are numerous at one or two horizons in the Mesozoic formation; referable to Equisetes (horsetails); Zamites therefore Triassic; with lignitic fragments of conifers;" but he does not state the exact locality and only leaves it to be inferred that this refers to Pennsylvania, as he has been describing fossils of other kinds from Phœnixville.

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[1] Proc. Acad. Sci. Phil., Vol. VIII, April 15, 1856, pp. 77–78.

[2] See also Am. Jour. Sci., 2d series, Vol. XXII, 1856, pp, 123, 422.

[3] Remarks on the Mezozoic red sandstone of the Atlantic slope, and notice of the discovery of a bone bed therein, at Phœnixville, Pennsylvania, by Charles M. Wheatley, M. A.: Am. Jour. Sci., 2d series, Vol. XXXII, July, 1861, pp. 41–48. (See p. 43.)

[4] Second Geological Survey of Pennsylvania, 1883, C4, p. 213.

In the Report of the State Geologist of New Jersey for 1885, page 96, the following paragraph occurs:

The recent discovery of a stratum full of impressions of the plant *Schizoneura* (*Calamites*) *planicostata* (Fontaine), in the red shales near Doylestown, Pennsylvania, by Mr. E. C. Pond, and of bivalve mollusks in those near Phœnixville, Pennsylvania, where also a deposit containing cycads is reported, taken with the finds above noted, suggests that the flora and fauna of the Triassic may be richer than hitherto supposed, and encourages further search.

In the Annual Report of the Geological Survey of Pennsylvania for 1887 Mr. A. Wanner[1] describes supposed vegetable remains from the red sandstones of York County, in the vicinity of Goldsboro, and figures three specimens on pl. xiii. He regards them as representing algæ of a very ancient type, and proposes for this form the name *Ramulus rugosus*. As we shall presently see, Mr. Wanner followed up his investigations with great success.

Mr. Benjamin Smith Lyman, in the several papers already cited (supra, p. 218), does not seem to have made any fresh contributions to the Triassic flora of Pennsylvania, and is content to enumerate the plants that had already been reported, and to use some of them as proofs of the Paleozoic age of certain beds previously regarded as Triassic.

Mr. Frederick Ehrenfeld, of Philadelphia, a student at the University of Pennsylvania, presented to the faculty, in 1898, a thesis[2] which was the result of a somewhat careful study of the Triassic beds in the vicinity of York, and virtually the same as those in which Mr. Wanner had been working, as it seems independently and without knowledge of the work of Mr. Ehrenfeld.

In this paper (pp. 10–15) Mr. Ehrenfeld enumerates half a dozen fossil plants that he had found in the Trias of that section, and had himself identified. They are: *Macrotæniopteris magnifolia* (Rogers) Schimp., *Cheirolepis Muensteri* (Schenk) Schimp., *Baiera Muensteriana* (Presl) Heer, *Loperia simplex* Newb., *Mertensides bullatus* (Bunb.) Font., and *Equisetum Rogersii* (Bunb.) Schimp.

As above remarked, Mr. Wanner continued his researches, and reached the results which are here published for the first time. Before completing his work he made two visits, in April and May, 1899, to Washington, bringing with him a part of his material, and carefully comparing it with the type specimens at the National Museum. He finally concluded to turn over his manuscript and drawings to the Director of the United States Geological Survey for publication, and they were referred to me to edit and see through the press. After correspondence with Mr. Wanner it was decided to send them, as also

[1] The discovery of fossil tracks, algæ, etc , in the Triassic of York County, Pennsylvania, by Atreus Wanner: Ann. Rept. Geol. Survey of Pennsylvania for 1887, Harrisburg, 1889, pp. 21-35:

[2] A Study of the Igneous Rocks at York Haven and Stony Brook, Pennsylvania, and their Accompanying Formations, by Frederick Ehrenfeld; Philadelphia, 1898; pp. 1-24, 1 plate.

his entire collection of fossil plants, to Professor Fontaine for thorough revision, and for a report upon them, including such notes and suggestions as he should deem of interest. This was done, and the work was completed about the middle of June. The collection proved of special interest, coming as it does from this wholly new region of the Trias, and, as might have been expected, it contained a number of new species and hitherto unknown plants, besides several not heretofore found in American deposits.

In editing the manuscripts of the two authors I have aimed to give the fullest possible expression to the views of both. Professor Fontaine's long experience and extensive researches in this group render him the recognized authority, and Mr. Wanner fully acknowledges this. His determinations are therefore accepted as final by all concerned, and will be embodied in the following systematic treatment of the plants. Mr. Wanner's notes, however, as the collector and original investigator of the material, are of the utmost value and are also embodied as nearly in his own language as accords with Professor Fontaine's determinations. His figures are used as finished up by himself, but to them Professor Fontaine has added a number, and in a few cases has redrawn the same specimens to emphasize his own interpretation of their characters. The joint result may be put into the following form:

## TRIASSIC FLORA OF YORK COUNTY, PENNSYLVANIA.

By ATREUS WANNER and WILLIAM M. FONTAINE.

### INTRODUCTORY REMARKS BY MR. WANNER.

For a number of years the writer, as opportunity permitted, has been exploring the Trias of York County. Encouraged by discoveries made elsewhere, and impelled by an inherent love of geological study and investigation, he has collected enough material to warrant its presentation. It is a report of progress.

So far as the writer knows, no one else[1] has discovered or reported

[1] Since the preparation of this report, but prior to its publication, and at the time of its presentation to Hon. Charles D. Walcott, I received a thesis on A Study of the Igneous Rocks of York Haven and Stony Brook, Pennsylvania, and their accompanying formations, by Frederick Ehrenfeld.

On pages 10 and 11 the author names the following fossils which he found near York Haven:

Macrotæniopteris magnifolia.
Cheirolepis Muensteri.
Baiera Muensteriana.
Loperia simplex = Bambusium Font.
Mertensides bullatus?
Equisetum——?

Mr. Ehrenfeld had no knowledge of the fact that I had previously found fossils at the York Haven locality and had in preparation the report now submitted, for which reason to him also must be given the credit of having discovered fossil plants at that locality, and the further credit of having first published his report.

Mr. Ehrenfeld's thesis was received by me on April 10, 1899, and my report was presented to Hon. Charles D. Walcott on April 15, 1899.

As I understand the facts, the work of each has been unknown to and independent of that of the other.

any fossils from the Trias in this region, with a single exception. That exception relates to Lecrone's copper mine. About twenty years ago fossil teeth and bones were found at the bottom of a shaft sunk for the purpose of developing a supposed vein of copper. These were sent to the late Prof. E. D. Cope, of Philadelphia.

The drawings were all carefully made by the writer and are intended to be exact illustrations of the specimens. No details have been supplied, though the possession of a number of other specimens in different instances clearly furnished the material from which to fill out missing parts.

In the description of fossil plants the publications of William M. Fontaine have been referred to almost exclusively. Such has been the case not simply because the York County fossil plants are almost wholly included in Fontaine's Mesozoic Flora, but because of the completeness and clearness of his descriptions and illustrations.

The writer is indebted to Mr. J. Heckert for valuable assistance. In this connection it is but just to acknowledge the potent influence exerted by the indefatigable energy and comprehensive and exhaustive methods of research of the Director of the United States Geological Survey, Hon. Charles D. Walcott, whom it was the author's privilege to accompany in a hurried inspection of the Cambrian rocks of this section. That association served as an inspiration and stimulated the writer to still more zealously continue his researches.

The author is further indebted to the Director of the United States Geological Survey and to Prof. Lester F. Ward and his associates in the National Museum for the opportunity of examining the collection of Mesozoic and related floras at Washington.

*Flora.*—A brief description of the geological and lithological features of the Trias in this section will be found in the reports of the Geological Survey of Pennsylvania.

In York County the bedded Triassic series is largely made up of the characteristic red shales, quartz conglomerate, and sandstones, matrices not favorable to the preservation of recognizable fossil forms. Moreover, intrusive trap, in dikes and great sheets, has contributed greatly to modify and disturb the original deposits. Because of these conditions the search after impressions that can be identified is generally disappointing and unproductive. A few localities yield illegible impressions of plants. Occasionally there is but a dark, earthy, carbonaceous band, in a sand bank, or a thin, short seam of coal, a mere trace of irregular width, unmistakably to locate a vegetable deposit. More frequently rough casts of limbs or trunks of trees, in blocks of quartz conglomerate or sandstone of varying composition, mark the final resting place of vegetation now decomposed.

A shale at the York Haven locality, yielding most of the plants described, and the Little Conewago Creek shales, encouraged the hope that like deposits might be found elsewhere and still further enrich the contributions to the flora of York County.

It was mainly due to that expectation, a vain one thus far, that the writer did not publish the results of his geological explorations years ago, when he first discovered the York Haven locality.

## DESCRIPTIONS OF THE SPECIES.

### Subkingdom PTERIDOPHYTA (Ferns and Fern Allies).

### Class FILICALES.

### Family FILICES (Ferns).

### Genus THINNFELDIA Ettingshausen.

#### THINNFELDIA ? RETICULATA Fontaine n. sp.

Pl. XXII, Figs. 1, 2.

Professor Fontaine says of this plant:

> This is a fragment of what seems to be a new species of fern. It is a portion of the terminal part of an ultimate pinna. The plant does not show enough for one to make out its true character. The nerves anastomose in an irregular manner. It has the general aspect of a Thinnfeldia, and but for the anastomosis of the nerves might without hesitation be placed in that genus.
>
> As the portion is from the upper part of the frond, the pinnules probably differ from the normal ones lower down on the plant, and hence the true character may not be disclosed. There is a midnerve at the base of the pinnules, but it splits up into branches. Lateral nerves go off on each side of it from the main rachis very obliquely. All the nerves are strong and distinct. They anastomose irregularly at long intervals and form elongate meshes.
>
> It is without doubt a new species and may be a new genus. Provisionally it may be called *Thinnfeldia reticulata*.

Mr. Wanner makes this statement:

> The lobes are decurrent and the rachis winged. Fig. 2, Pl. XXII, shows the anastomosing nervation. More specimens are needed better to define it.

*Locality.*—N. C. R. R. cut, south of York Haven.

### Genus CLADOPHLEBIS Brongniart.

#### CLADOPHLEBIS RETICULATA Fontaine n. sp.

Pl. XXI.

Professor Fontaine's description of this species is as follows:

> This is a fine specimen of a new and interesting fern. Mr. Wanner's Fig. 1 gives a good idea of the appearance of the largest specimen as seen with all accidental imperfections. I have attempted in Fig. 3 to indicate its character as seen under the lens and omitting accidental imperfections. Figs. 4, 5 give the basal and terminal

portions of a pinnule magnified three diameters, in order to show the nervation, which is uncommon. I have very carefully studied it and failed to see some of the points given in Mr. Wanner's Fig. 2. The nerves are more slender than is indicated in that figure and more closely placed. There is some indication of a toothing on the margins of the pinnules, but, as I see it, it is not so constant and regular as that indicated by Mr. Wanner. It appears to be a laceration of the margin at the termination of some of the lateral nerves, that is due to accident in the splitting of the slate on which the impressions are found. The description is as follows:

The midrib is strong and rigid. The pinnules are opposite or subopposite, and extremely long and slender. They are a little over 5 cm. long and only 4 mm. wide near their base. They are falcate, with the basal portion of the lamina on the upper side of the midnerve a good deal wider than that on the lower side, tending to form an ear. This upper basal portion overlaps the lower basal portion of the pinnules following next above, and all the pinnules are so closely placed as to overlap or touch at their margins. The pinnules narrow gradually to a subacute tip. In the lower portion of the pinnules there is a distinct midnerve, which is inserted on the rachis below the middle of the base of the pinnules. The midnerve disappears in the upper part of the pinnule, being split up into very long branches that fork at long intervals. These branches and the lateral branches sent off above the base are remarkable for their length and closeness of position, and for the fact that they diverge so slightly that they are almost parallel. The nerves at base on the upper side of the midnerve diverge more strongly to fill the ear. Some of the lateral basal nerves, especially on the upper side of the midnerve, go off from the rachis. Lateral nerves go off from the midnerve on each side so obliquely that they almost follow the course of that nerve. They fork at long intervals, and, as stated before, diverge so slightly that they and their branches are approximately parallel. The branches occasionally anastomose in a straggling, irregular manner, so as to form no regular and definite meshes.

This plant may form the type of a new genus. It reminds one in its habit of Otozamites, especially of some of the forms of *O. Bucklandii*, as given by Schenk in Foss. Flor. der Grenzschichten, more especially of figs. 2, 3, pl. xxxiii, but the nervation and other points are different. The nervation, apart from the reticulation, resembles the peculiar nervation of some of the forms of Zamiopsis of the Potomac formation. It may be compared with that of *Z. insignis*, Mon. U. S. Geol. Survey, Vol. XV, pl. lxv, fig. 4. It is, however, a plant quite different from any species hitherto described. But for the anastomosis it agrees well with the genus Cladophlebis, and may be provisionally placed in that genus, with the name *C. reticulata*.

The following is Mr. Wanner's account of it:

No other specimen found here so completely presents the original in its entirety. The exceptionally well-preserved group of leaves, Fig. 1, Pl. XXI, showing the shape of the frond, angle of departure of the pinnæ and their shape, stands alone. Even the rootstalk, showing the points where the leaves were attached, as well as numerous slender rootlets, has left its plain impress upon the shale.

A slightly mutilated basal end of a leaflet, Fig. 2, Pl. XXI, shows the auricle as well as the forking and anastomosing nerves.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus ASTEROCARPUS Göppert.

### ASTEROCARPUS FALCATUS (Emmons) Fontaine.

### Pl. XXII, Fig. 3.

1856. *Pecopteris falcatus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 327, pl. iv, fig. 9.
1856. *Pecopteris carolinensis* Emm.: Op. cit., p. 327, pl. iv, figs 1, 2.
1857. *Pecopteris falcatus* Emm.: American Geology, Pt. VI, p. 100, pl. iv, fig. 9.
1857. *Pecopteris falcatus variabilis* Emm.: Op. cit., pl. iv, fig. 5.
1857. *Pecopteris carolinensis* Emm.: Op. cit., p. 100, text fig. 68, pl. iv, figs. 1, 2.
1883. *Asterocarpus virginiensis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 41, pl. xix, figs. 2, 2a, 3–5; pl. xx; pl. xxi, figs. 1, 1a, 1b, 2; pl. xxii; pl. xxiii; pl. xxiv, figs. 1, 2, 2a.
1883. *Laccopteris Emmonsi* Font.: Op. cit., p. 102, pl. xlviii, figs. 6, 7.
1883. *Laccopteris carolinensis* (Emm.) Font.: Op. cit., p. 102, pl. xlix, figs. 11, 12, 12a.

Only one important pinna of this plant seems to have been found. Mr. Wanner figured it and says that the figure shows part of a frond not referred to any genus because of insufficient data. The nervation can not be discerned, nor were any other specimens of its kind found.

Professor Fontaine seems to have found the specimen, and remarks:

This seems to be a fragment, with small pinnules, of *Asterocarpus virginiensis*. At least such a fragment of that fossil occurs among Mr. Wanner's plants.

*Locality*.—N. C. R. R. cut, south of York Haven.

## Genus TÆNIOPTERIS Brongniart.

### TÆNIOPTERIS? YORKENSIS Fontaine n. sp.

### Pl. XXII, Figs. 4–6.

Professor Fontaine's treatment of this species is as follows:

In Fig. 4 of Pl. XXII Mr. Wanner depicts a long, narrow leaf as a form of *Macrotæniopteris magnifolia*. A careful inspection of this specimen convinces me that it is not *M. magnifolia*. It is, I think, a Tæniopteris, but as the leaf is imperfect and there is only one specimen of it, I do not positively identify it as such. If it be one, it is the first of the genus found in the Older Mesozoic of the Atlantic States. The following points indicate that it is a Tæniopteris: The length is great for a leaf of its small width, and the width changes little throughout. The midrib is strongly defined and prominent, unlike the vaguely defined, flat midrib of *M. magnifolia*. No form of *M. magnifolia* as narrow as this ever attained such a length. It reminds one strongly of some of the Tæniopterids of the Oroville Jurassic flora. It may also be compared with *T. tenuinervis* Brauns. The nerves, however, seem to be finer and closer than those of the latter plant.

Fig. 5 of Pl. XXII represents a plant that certainly is not *M. magnifolia*. It probably is the same with the plant represented by Fig. 4.

Fig. 6 of Pl. XXII may represent a smaller form of the same plant, or it may be *Pseudodanæopsis reticulata* Font. [*P. plana* (Emm.) Font.] Provisionally the plant given in Fig. 4 may be called *Tæniopteris ? yorkensis*. It comes from York Haven, N. C. R. R. cut, as do the forms depicted in Figs. 5 and 6.

As Professor Fontaine has said, Mr. Wanner regarded these specimens as small forms of *Macrotæniopteris magnifolia*, and in discussing the larger leaves he almost entirely neglected to comment on them after having drawn them. The following is his only allusion to them:

Parts of leaves from the Conewago locality are shown in Figs. 4–6, Pl. XXII. The only tip found and illustrated, Fig. 6, Pl. XXII, is somewhat obscure, whilst no basal ends have been obtained from here.

## Genus MACROTÆNIOPTERIS Schimper.

### MACROTÆNIOPTERIS MAGNIFOLIA (Rogers) Schimper.

### Pl. XXII, Figs. 7–9; Pl. XXIII; Pl. XXIV.

1843. *Tæniopteris magnifolia* Rogers: Philadelphia Association of American Geologists and Naturalists, 1843, p. 306, pl. xiv, unnumbered fig. on the right, ½ nat. size.

On this species Professor Fontaine remarks:

Mr. Wanner has in his collection several good specimens of this plant. On Pl. XXIV he gives a good representation of a portion of a leaf of the largest size. Fig. 7 of Pl. XXII gives a form that is probably *M. magnifolia*. It may, however, well be some larger Tæniopteris, like *T. superba*.

Mr. Wanner took a special interest in this species and gives the following descriptive account:

No impressions of whole leaves were found. Pl. XXIV shows part of a large leaf with a truncate termination. Figs. 2 and 3, Pl. XXIII, are ends of other leaves, in all cases truncate. Whilst impressions of different parts of leaves are very common at the York Haven locality, strange to say, no tips similar to those which one would expect to find were observed. All ends, as shown, were truncate.

Figs. 8 and 9, Pl. XXII, are illustrations of typical bases. The side of one is entire, that of the other nearly so.

Fig. 1, Pl. XXIII, shows the venation. The nerves are fine, parallel, and about one-third of a millimeter apart. In nearly all of the specimens the forking of the nerves is not evident; on the contrary, they seem to be single and parallel to the point of insertion; but in a few specimens, by closer inspection, nerves are seen that fork very close to the point of attachment, and apparently within the rachis.

Fontaine calls attention to the difference in shape of the specimens which he examined, a peculiarity which is strikingly presented in the specimens from these two localities.

*Localities.*—N. C. R. R. cut, south of York Haven; Little Conewago Creek, exploitation pit.

## Genus PSEUDODANÆOPSIS Fontaine.

### PSEUDODANÆOPSIS PLANA (Emmons) Fontaine.

### Pl. XXV, Figs. 1, 2.

1857. *Strangerites planus* Emm.: American Geology, Pt. VI, p. 122, fig. 90.

1883. *Pseudodanæopsis reticulata* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, pp. 59, 116, pl. xxx, figs. 1, 2, 2a, 3, 4, 4a; pl. liv, fig. 3.

Professor Fontaine says of this specimen:

This plant, left in doubt by Mr. Wanner, is almost certainly *Pseudodanæopsis reticulata*. It has the copious anastomosis, with the thick and smooth leaf substance of that plant.

Mr. Wanner's statement with regard to it is as follows:

The specimen Fig. 1, Pl. XXV, contains neither base nor tip, and reveals the nervation shown in Fig. 2 on but a small part of the surface. The nerves are not easily distinguished, evidently because of the thickness of the leaf substance, as indicated by the impression. The midrib is prominent and stout. This is the only specimen of its kind found, though several other impressions somewhat similar, in which no venation can be traced, may belong to the same species.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus LONCHOPTERIS Brongniart.

### LONCHOPTERIS OBLONGA (Emmons) Fontaine.

Pl. XXV, Figs. 3–5.

1856. *Acrostichites oblongus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 326, pl. iv, figs. 6, 8.

1857. *Acrostichites oblongus* Emm.: American Geology, Part VI, p. 101, pl. iv, figs. 6, 8.

1883. *Lonchopteris oblongus* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 103, pl. xlix, figs. 1, 1a.

Mr. Wanner correctly classed this in the genus Lonchopteris. Professor Fontaine says:

This is much like *Lonchopteris oblongus* of the North Carolina Mesozoic, and most probably is that plant. The pinnules are not smaller than many of those of the North Carolina fossil; the nervation is also similar. The only difference is that the York fossil has a distinct granulation, strikingly like the fructification of Acrostichites. As, however, the fructification of *L. oblongus* is not known, this feature does not preclude the identification of the York fossil with that of North Carolina.

The following are Mr. Wanner's notes:

Assuming that the specimens, Figs. 3–5, Pl. XXV, are pinnæ of a compound fern, the shape of the pinnules, together with the elliptical meshes formed by the anastomosing nerves, Fig. 5, refer this impression to Lonchopteris. The pinnules, however, are very much smaller in proportion to the length of the pinnæ than in *L. virginiensis*, nor are they so closely crowded together, moreover they show a very pronounced variation in size and shape near the base of the pinnæ.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus SAGENOPTERIS Presl.

### SAGENOPTERIS sp. Fontaine.

Pl. XXV, Fig. 6.

The very defective character of this specimen makes it doubtful whether it is best to admit it at all, but in view of the special interest attaching to the York florula it may stand as a stimulus to further discovery. As Professor Fontaine says, "It is too poorly preserved to give any distinct character, but the nervation indicates that it is a fragment of some Sagenopteris."

Mr. Wanner speaks of it as an undetermined frond, and says that the figure shows an impression sufficiently legible to be referred to a fern, but so fragmentary as to prevent any further conjecture as to genus or species. It suggests Thyrsopteris.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus ACROSTICHITES Göppert.

### ACROSTICHITES LINNÆÆFOLIUS (Bunbury) Fontaine.

Pl. XXV, Figs. 7, 8.

1847. *Neuropteris linnææfolius* Bunb.: Quart. Jour. Geol. Soc., Vol. III, Pt. I, pp. 281, 288, pl. x.

1857. *Cyclopteris linnææfolia* (Bunb.) Heer: Am. Jour. Sci., 2d Ser., Vol. XXIV, p. 428.

1883. *Acrostichites linnææfolius* (Bunb.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 25, pl. vi, figs. 3, 3a; pl. vii, figs. 1–4; pl. viii, figs. 1, 1a; pl. ix.

Mr. Wanner had doubtfully identified this plant with *Mertensides bullatus* Font. Professor Fontaine says:

This identification is probably not correct. I noted several sterile pinnules of *Acrostichites linnææfolius* and none of *Mertensides bullatus*. The specimen is probably the former plant.

Mr. Wanner had made the following very brief statement with regard to it:

A fragmentary part of the original, Pl. XXV, Figs. 7, 8, seems to belong here. However, other and better specimens are needed satisfactorily to locate it. Fig. 8 shows the venation.

*Locality.*—N. C. R. R. cut, south of York Haven.

### ACROSTICHITES MICROPHYLLUS Fontaine?

Pl. XXV, Figs. 9, 10.

1883. *Acrostichites microphyllus* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 33, pl. vii, fig. 5; pl. x, fig, 2; pl. xi, fig. 4; pl. xii, figs. 3, 3a.

Mr. Wanner doubtfully identified this plant with *Mertensides distans* Font. Professor Fontaine thinks it can not be that species, and remarks:

This small fragment, marked doubtfully as *Mertensides distans*, did not show, so far as I could see, the nervation given by Mr. Wanner. The pinnules have a granulation that suggests that the plant may be an Acrostichites. If so, it is probably *A. microphyllus*. Another specimen, not figured by Mr. Wanner, shows some rather obscure pinnules of *A. microphyllus*. At the same time the pinnules of Mr. Wanner's *Mertensides distans* look much like his Lonchopteris?

The following is Mr. Wanner's note:

Whilst the exact shape of the pinnules of the frond, Pl. XXV, Fig. 9, can not be determined easily, the opposite is true of the nervation. The lower pair of lateral nerves forks twice (Fig. 10), all the rest but once. The pinnæ are broken off at each end. Only one other specimen was found.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Class EQUISETALES.

### Family EQUISETACEÆ.

### Genus EQUISETUM Linnæus.

#### EQUISETUM ROGERSII (Bunbury) Schimper.

Pl. XXV, Figs. 11, 12.

1851. *Calamites Rogersii* Bunb.:[1] Quart. Jour. Geol. Soc. London, 1851, Proceedings, p. 190.

1869. *Equisetum Rogersii* (Bunb.) Schimp.: Traité de Paléontologie Végétale, Vol. I, p. 276.

Professor Fontaine says of this:

Mr. Wanner indicates by question his doubt regarding the species. He has, without doubt, in his collection a large fragment of a crushed stem of *E. Rogersii*, showing several nodes and the imprint of a portion of the outer surface of the plant. There are also several small imprints of Equisetum, which suggest the presence of *E. Muensteri*, but they are too vague to justify this identification.

The following is Mr. Wanner's description:

The compressed and distorted specimen, Fig. 11, unmistakably reveals the fact in its nodes and appearance that it belongs to the Equiseteæ. No other specimens were found to shed additional light on its individuality, though a still more fragmentary impression made by another member of the same family is illustrated in Fig. 12.

*Locality.*—The pumping station, N. C. R. R. cut, 600 feet above the plant-bearing shales.

[1] Specimens of this species had been several times described and figured by other authors, who confounded it with the Carboniferous species *Calamites Suckowii* Brongn. Brongniart distinguished it as var. δ (Hist. Vég. Foss., p. 125, pl. xvi, fig. 1).

## Subkingdom SPERMATOPHYTA (Phanerogams).

## Subdivision GYMNOSPERMAE.

## Class CYCADALES.

## Family CYCADACEÆ.

### Genus PTEROPHYLLUM Brongniart.

#### PTEROPHYLLUM INÆQUALE Fontaine.

Pl. XXVI, Figs. 2, 3.

1883. *Pterophyllum inæquale* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 64, pl. xxxvi.

Mr. Wanner identified this doubtfully with *Ctenophyllum Emmonsi* Font. Professor Fontaine simply says:

This is almost certainly a fragment of *Pterophyllum inæquale* Font. of the Virginia Older Mesozoic.

Mr. Wanner's description is as follows:

The leaf, evidently a Ctenophyllum, has its upper portion pushed out of place, but in such a manner as to be restored easily to its true position. The leaflets are of uniform width, with a slight expansion along the rachis. They are striated by closely placed parallel nerves, about one-third of a millimeter apart, some of which fork shortly after leaving the rachis. Fig. 3 shows the nervation. Several of the leaflets terminate in broadly rounded or truncate tips, which, taken in connection with the absence of any great length, suggests *Ctenophyllum Emmonsi*. More specimens are needed better to define its properties.

*Locality.*—Little Conewago Creek, west of Manchester, exploitation pit.

### Genus ANOMOZAMITES Schimper.

#### ANOMOZAMITES PRINCEPS (Oldham and Morris) Schimper?

Pl. XXVI, Fig. 1.

1862. *Pterophyllum princeps* Oldh. and Morr.: Mem. Geol. Surv. India, Palæontologia Indica, Ser. II, Foss. Fl. Gondw. Syst., Vol. I, Foss. Fl. Rajmahal, p. 23, pl. x; pl. xi, fig. 1; pl. xii, fig. 1; pl. xiii, figs. 1, 2.

1870. *Anomozamites princeps* (Oldh. and Morr.) Schimp.: Traité de Paléontologie Végétale, Vol. II, p. 142.

Professor Fontaine's description, which follows, explains the circumstances under which this species was brought to light. For some reason he prefers to retain the original name of Oldham and Morris and call it *Pterophyllum princeps*, although not only did Schimper place it in his genus Anomozamites, but Feistmantel accepted this change and it has been so known since 1870. The figure is Professor Fontaine's.

Among the specimens collected by Mr. Wanner is a fragment of a large leaf that has not been figured and described by him. The name given on the label is *Macro-*

*tæniopteris magnifolia*. This form, in the segmentation of the leaf, is strikingly suggestive of a large Pterophyllum, and it most resembles *P. princeps* Oldh. and Morr., of the Rajmahal flora of India, showing the same variation in the width of the segments and the same dimensions. As, however, there is only one specimen, it is possible that it is a leaf of *Macrotæniopteris magnifolia* that has by accident been segmented in this manner. I have collected many hundred specimens of *M. magnifolia* from the Older Mesozoic of Virginia and have never seen a case of a leaf lacerated by accident that was so suggestive as this. It should be stated also that Emmons mentions seeing in the flora of the Older Mesozoic of North Carolina supposed leaves of *M. magnifolia* that were so regularly segmented that they attracted his attention as being possibly not that plant. They may well have been some forms similar to this from York.

## Genus CTENOPHYLLUM Schimper.

### CTENOPHYLLUM GRANDIFOLIUM Fontaine.

### Pl. XXVII.

1883. *Ctenophyllum grandifolium* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 73, pl. xxxix, figs. 1, 1a, 2, 3, 3a; pl. xl; pl. xli; pl. xlii, fig. 1.

This specimen was accurately determined and figured by Mr. Wanner. After looking over the collection Professor Fontaine says:

Mr. Wanner has several very good specimens of this plant, and gives some good figures of it.

Mr. Wanner's notes are as follows:

The leaf, three separated parts of which are shown in Figs. 1, 2, 3, Pl. XXVII, is very fragmentary. One and two closely associated with three in the matrix, the impressions being in the same piece of shale, probably belong to the same leaf and are so considered. Only parts of the leaflets remain extending to varying distances from the rachis, in all cases without tips. After a slight expansion they are attached throughout their entire width to the rachis. Immediately beyond the midrib some of the leaflets are narrowest, from whence they gradually expand. Two of the longest segments at length attain a uniform width, for which reason the same peculiarity is assumed to be a characteristic of the leaf.

In this specimen it is difficult to determine whether only some or all of the nerves fork shortly after leaving the rachis, as shown in Fig. 5, a magnified portion of a leaflet. The nerves are close, about one-third of a millimeter apart, and parallel; in this specimen they can not be resolved into two nerve strands, a property to which Fontaine calls attention.

*Locality.*—N. C. R. R. cut, south of York Haven.

### CTENOPHYLLUM WANNERIANUM Fontaine n. sp.

### Pl. XXVIII, Fig. 1.

This was supposed by Mr. Wanner to represent *Ctenophyllum Braunianum* var. *α* of Göppert, but Professor Fontaine says:

This is a new species of Ctenophyllum, allied to *C. Braunianum*. The specimen figured by Mr. Wanner is a fine one. There is in his collection a smaller fragment of the same species, showing leaflets narrower and more delicate than those of the form he depicts. It, however, evidently belongs to the same species. The form given by Mr. Wanner may be taken as the type. It has narrower leaflets that are uniformly narrow, not more than 1 mm. wide. None of them are entire. The greatest length seen is 4 cm. They go off from the midrib at an angle of 45° and are inserted on its side after the position of *C. Braunianum.*

Mr. Wanner has made the following note:

The lower part of the leaf, its apex, and the tips of the leaflets are wanting. Enough, however, remains to present very clearly the characteristics of *Ctenophyllum Braunianum.* The long, narrow leaflets, slightly expanded at the base, are attached throughout their entire width to the rachis. The closely placed nerves, about six in number, are parallel.

The few other specimens found strikingly duplicate the one illustrated in its essential features. In one the leaflets are not more than one-half as wide.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus DIOONITES Miquel.

### DIOONITES CARNALLIANUS (Göppert) Bornemann.

### Pl. XXVIII, Fig. 2.

1843. *Pterophyllum Carnallianum* Göpp.: Uebersicht schles. Ges., 1843, p. 130, pl. i, fig. 4.

1856. *Dioonites Carnallianus* (Göpp.) Born.: Ueber organische Reste der Lettenkohlengruppe Thüringens, p. 56.

This plant was regarded by Mr. Wanner as *Ctenophyllum Braunianum* and classed with the one represented by Fig. 1 of Pl. XXIX. Professor Fontaine regards them as different. Of this one he says:

Schenk, in Foss. Flor. der Grenzchichten, pl. xxxix, fig. 4, gives a representation of a plant which he calls *Pterophyllum Carnallianum,* but which Schimper regarded as a Dioonites. This fossil seems to be identical with one of the specimens considered by Mr. Wanner as *Ctenophyllum Braunianum.* The Pennsylvania fossil has broader leaflets and stronger nerves than any form of *C. Braunianum.* The specimen is the terminal portion of a leaf, not, however, retaining the tip. The length of the fragment is 14 cm. The midrib of the leaf is stout and rigid, showing a maximum width of 3 mm. It has narrower leaflets, none of which are entire. The largest fragment has a length of 6 cm. The leaflets toward the summit are narrower and seemingly shorter. They are set on the midrib at a very large angle (75°–80°). The texture of the leaflets seems to have been thin, and they have the same width from base to end. Their width is about 3 mm. The nerves could not be made out satisfactorily. This specimen is a finer one than that figured by Schenk.

Mr. Wanner says of it:

Fig. 2 is marked by a somewhat abrupt shortening of the leaflets near the apex, after which their length remains about the same. The leaflets are terminated by rounded tips and striated by closely-placed parallel nerves, about one-third of a millimeter apart. It is difficult to trace the nerves to the point of insertion in the rachis, but they seem to be parallel throughout their extent.

Fragmentary specimens from the Little Conewago Creek, evidently belonging to the Ctenophylla, may or may not be of the species *Braunianum*, for which reason attention is called to that locality in this connection.

*Localities.*—N. C. R. R. cut, south of York Haven; Little Conewago, exploitation pit, west of Manchester(?).

## Genus ZAMITES Brongniart.

### ZAMITES PENNSYLVANICUS Fontaine n. sp.

Pl. XXVIII, Figs. 3, 4.

Mr. Wanner referred this plant very doubtfully to *Ctenophyllum truncatum* Font. Professor Fontaine regards it as a new species of Zamites and has refigured it (Fig. 4). The following is his description of it:

Schenk, in Foss. Flor. der Grenzschichten, pl. xxxv, fig. 8, gives a figure of a plant that he calls *Zamites angustifolius*. Schimper named it *Podozamites angustifolius*. The plant Mr. Wanner calls *Ctenophyllum truncatum* is very much like this. It is a true Zamites, as is shown by the insertion of one entire leaflet seen on it. This shows that the leaflets are 3 cm. long, 2 mm. wide, and that they are widest near their base, where they are abuptly rounded off. They are attached by a callosity to the upper surface of the midrib. At their tips they are narrowed to a sharp lancet-shaped termination. The nerves are several in number and fine, but were not clearly visible.

The following is Mr. Wanner's account:

Fig. 3, Pl. XXVIII, shows part, a very fragmentary part, of a leaf containing the bases of several leaflets. Two other specimens from the same locality, one of which contains leaflets only one-half as wide, exhibit certain characteristics easily recognized in this one. No entire leaflets and no tips of leaflets were found. The opposite and rather remote leaflets contract near the line of attachment to the rachis, and are neither procurrent nor decurrent. Shortly after emerging from the midrib many of the nerves fork, after which they continue close together and parallel. Were it not for the evident absence of decurrent leaflets the author would refer the specimen to *Dioonites Buchianus* with greater confidence than he feels now in associating it with the partially defined *Ctenophyllum truncatum*. More specimens are needed better to define its characteristics.

*Locality.*—Little Conewago Creek, west of Manchester, exploitation pit.

### ZAMITES YORKENSIS Fontaine n. sp.

Pl. XXIX, Figs. 1-4.

Mr. Wanner regarded this as probably representing *Ctenophyllum Braunianum* Göpp., and says:

In Fig. 1 the leaflets are very close together, overlapping and pushed over the rachis in such a manner as largely to conceal the midrib and make it difficult to determine the exact manner in which the veins depart from the line of contact. Fig. 2 represents a magnified portion of a leaflet and shows the venation.

Professor Fontaine sees in it another new species of Zamites, and has refigured the same specimen (Figs. 3, 4) to give his interpretation of it. He describes it as follows:

On the fragment of slate that shows the imprint of *Tæniopteris? yorkensis*, there is an imprint of what seems certainly to be a true Zamites of the type of *Z. Feneonis*, which type characterizes the Jurassic. This plant may be the form depicted by Mr. Wanner in Fig. 1, Pl. XXIX. If so, the figure does not correctly represent the insertion of the leaves. It should also be stated that then the identification of the plant given in that figure with *Ctenophyllum Braunianum* var. $\alpha$ is erroneous. The description of the plant now in question is as follows:

The specimen is a portion of a leaf showing a number of leaflets, some of them entire. The leaves are closely placed, about 25 mm. long, 4 mm. wide, and widest at base. They taper to a subacute tip. At base they are slightly auriculate and are inserted on the upper surface of the midrib. The nerves are fine and closely placed. They are not distinct enough to show the details. Fig. 3 represents the specimen of natural size, and 4 gives a leaflet enlarged 2 diameters, and partly restored. This and the preceding constitute the first species of Zamites found in the older Mesozoic flora of the Eastern States.

## Genus PODOZAMITES Friedrich Braun.

### PODOZAMITES DISTANS (Presl) Friedrich Braun?

### Pl. XXIX, Figs. 5–7.

1833. *Zamites distans* Presl in Sternberg: Flora der Vorwelt, Vol. II, p. 196, pl. xli, fig. 1.

1843. *Podozamites distans* (Presl) Friedrich Braun in Münster: Beiträge zur Petrefactenkunde, Vol. II, Pt. VI, p. 28.

Mr. Wanner identified this doubtfully with *Zamites tenuinervis* Font. Professor Fontaine says:

These are not *Zamites tenuinervis*, but fragments of some other Zamites or Podozamites. The fragments are too obscure to determine fully. The smaller fragment is like Schenk's *Zamites distans* (*Podozamites distans*), as given in Foss. Flor. der Grenzschichten, pl. xxxvi, figs 1–9, 9a, 9b. The larger resembles the variety given in fig. 10 of the same plate.

Mr. Wanner has the following note:

Figs. 5 and 7 of Pl. XXIX show parts of detached leaflets containing the remains of basal ends exhibiting properties which agree with those described by Fontaine. No whole leaves and no tips were found.

Fig. 6 shows the venation. The veins are parallel, very fine and close, being about one-tenth of a millimeter apart. The surface of some leaflets presents a regularly banded appearance, owing to the prominence of stronger nerves, about one in five.

*Locality*.—Little Conewago Creek, lowest horizon.

## Genus SPHENOZAMITES Brongniart.

### SPHENOZAMITES ROGERSIANUS Fontaine.

### Pl. XXIX, Figs. 8, 9.

1883. *Sphenozamites Rogersianus* Font.:[1] Older Mesozoic Flora, of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 80, pl. xliii, figs. 1, 1a; pl. xliv, figs. 1, 2, 2a, 2b; pl. xlv, figs. 1, 2.

Professor Fontaine simply remarks that this is correctly determined. Mr. Wanner's notes are very meager:

Figs 8 and 9, Pl. XXIX, present part of a turned-over leaf. The specimen is poor but shows the dichotomous forking of the nerves and the transverse bars, characteristics of Fontaine's type specimen.

But two specimens were found; the other, being equally fragmentary, while it agrees with the one illustrated, reveals nothing additional.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus CYCADEOSPERMUM Saporta.

### CYCADEOSPERMUM WANNERI Fontaine n. sp.

### Pl. XXIX, Fig. 10.

Mr. Wanner called this a "seed of Leptostrobus." Professor Fontaine says:

This is not a seed of Leptostrobus but is probably one of some cycad. It is almost circular in form and looks somewhat as if it were winged, as represented by Mr. Wanner. This appearance is probably due to the accentuation, from pressure, of the thicker central portion of the nut. It has the dimensions 8 by 11 mm. It may be called *Cycadeospermum Wanneri.*

Mr. Wanner says of it:

This seed, by reason of association with Leptostrobus, has been referred to it. Seeds of this kind were not found at York Haven. They are plentiful at the other locality, on the Little Conewago, suggestively associated with Brachyphyllum but not with Leptostrobus, the latter being unknown in this locality and represented by only one specimen at York Haven.

*Locality.*—Little Conewago Creek, $1\frac{1}{2}$ miles west of Manchester, exploitation pit, green shale.

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[1] In view of the fact that Professor Fontaine did not find at Williams College the specimen figured by Emmons in his American Geology, Part VI, pl. vi, fig. 5, and described on p. 35 under the name *Calamites punctatus*, considered to belong to this species (see Mon. U. S. Geol. Survey, Vol. VI, p. 98, and infra, p. 288) it is not thought best to enter that form in the synonymy, especially as its earlier date would involve a change of nomenclature.

## Class BENNETTITALES.

## Family BENNETTITACEÆ.

### Genus CYCADEOMYELON Saporta.

### CYCADEOMYELON YORKENSE Fontaine n. sp.

### Pl. XXX.

1888. *Palissya?* sp. Newb.: Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley, Mon. U. S. Geol. Survey, Vol. XIV, p. 94, pl xxvi, figs. 1, 2.

Mr. Wanner designated this as the "trunk of a conifer?" resting the case on the figures of Dr. Newberry. Professor Fontaine, however, regards it as a Cycadeomyelon not hitherto described, and remarks:

This is an imprint of the same kind as those Saporta has described, with the generic name Cycadeomyelon, in Paléont. française, Plantes Jurassiques, Tome II, pp. 331–332. He considers them as casts of partly decayed cycad trunks. The cigar-shaped prominences on this fossil are decidedly larger than those of Saporta's *C. hettangensis*. If it is worth while giving a name to it, it might be called *Cycadeomyelon yorkense*.

Mr. Wanner gives the following account of it:

Dr. J. S. Newberry, in Mon. U. S. Geol. Survey, Vol. XIV, p. 94, pl. xxvi, figs. 1, 2, illustrates and describes what he supposed to be the decorticated trunk of some conifer from Newark, New Jersey. A similar impression from here, Fig. 1, Pl. XXX, comes from a locality which yielded nothing else. For that reason as well as because of the decorticated and compressed condition of the specimen, no additional light is shed upon the character of the trunk which produced it. Thin seams of carbonized vegetable matter are irregularly included in the overlapping folds that mark the specimen. The section, Fig. 2, is drawn at the point of greatest width.

*Locality.*—Fox Run, one-eighth of a mile from its junction with the Little Conewago Creek.

There seems scarcely any doubt that whatever the stems from Newark may be, this one from York represents the same plant. Dr. Newberry's fig. 2 is almost exactly the same as Mr. Wanner's Fig. 1. Dr. Newberry refers to the specimen called *Voltzia coburgensis* Schaur., figured by Schenck in Palæontographica, Vol. XI, pl. xlvi, fig. 2, and there certainly is a close resemblance between this figure and those of the American specimens.

It may not be out of place to draw attention to the somewhat similar class of objects which I have described under the name Feistmantelia.[1] The specimen from the Lettenkohl, near Würzburg, forms a sort of transition between some of the forms to which I there call attention and those now under consideration.

[1] Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, pp. 693–696, pl. clxix, fig. 19.

## Class GINKGOALES.

### Family GINKGOACEÆ.

### Genus BAIERA Friedrich Braun.

#### BAIERA MUENSTERIANA (Presl) Heer?

Pl. XXXI, Figs. 1, 2.

1838. *Sphærococcites Muensterianus* Presl in Sternberg: Flora der Vorwelt, Vol. II, p. 105, pl. xxviii, fig. 3.
1841. *Baiera dichotoma* Fr. Braun: Flora, Neue Reihe, Jahrg. XXIV, p. 33.
1843. *Baiera dichotoma* Fr. Braun in Münster: Beiträge zur Petrefactenkunde, Vol. II, Pt. VI, p. 20, pl. xii, figs. 1–8.
1857. *Baiera* ? sp. Emm.: Am. Geol., Pt. VI, p. 133, fig. 102.
1863. *Jeanpaulia Schlagintweitiana* Popp: Neues Jahrb f. Mineralogie, 1863, p. 412.
1866. *Jeanpaulia Muensteriana* (Presl) Schenk: Foss. Flor. der Grenzschichten des Keuper und Lias Frankens, p. 39, pl. ix.
1878. *Baiera Muensteriana* (Presl) Heer in Saporta: Plantes Jurassiques. Paléontologie Française, 2e Sér., Vol. III, p. 272, pl. clv [xxvii], figs. 10–12; pl. clvi [xxviii], figs. 1–6; pl. clvii [xxix ], figs. 1–3.

Mr. Wanner thought this might be a Baieropsis. Professor Fontaine admits its doubtful character, and says:

This is an obscure and very fragmentary specimen. It is too imperfect to show anything definite, but may be a small form of *Baiera Münsteriana*. It is a small form, resembling that plant.

Mr. Wanner's note is equally brief:

The few specimens found are so fragmentary as to present but little more than outlines; yet in general appearance they sufficiently resemble Baieropsis to justify their being referred to some species of that genus.

*Localities.*—N. C. R. R. cut, south of York Haven; Little Conewago, lowest horizon.

## Class CONIFERÆ.

### Family PINACEÆ.

### Genus PALISSYA Endlicher.

#### PALISSYA SPHENOLEPIS (Friedrich Braun) Brongniart.

Pl. XXXII.

1843. *Cunninghamites sphenolepis* Fr. Braun: Beitr. z. Urgeschichte d. Pflanzen, Programm z. Jahresber. d. Kön. Kreis-Landw. u. Gewerbsschule z. Bayreuth, pp. 17, 18, pl. ii, figs. 16–20; also in Münster: Beiträge zur Petrefactenkunde, Vol. II, Pt. VI, p. 24, pl. xiii, figs. 16–20.
1847. *Palissya Braunii* Endl.: Synopsis Coniferarum, p. 306.
1849. *Palissya sphenolepis* (Fr. Braun) Brongn.: Tableau, p. 68.
1856. *Walchia longifolius* Emm.: Geological Report of the Midland Counties of North Carolina, p. 333.
1857. *Walchia longifolius* Emm.: American Geology, Pt. VI, p. 105, pl. iva.

Mr. Wanner determined this plant correctly, following Professor Fontaine in the use of the synonymy *P. Braunii* of Endlicher. As Endlicher founded the genus Palissya on the plants that Braun called *Cunninghamites sphenolepis* and carefully described and figured in two prominent places, he had, of course, no right whatever to change Braun's specific name.

Professor Fontaine says:

There are numerous fine specimens of *P. Braunii* in Mr. Wanner's collection. Some of them are better and larger than any previously known to me. One of these large specimens shows a feature not seen by me on any previously known fossils. The young, undeveloped branches are seen in the axils of the leaves. Fig. 2, Pl. XXXII, represents one of these forms, and Fig. 1, of the same plate, gives a good representation of one of the large fragments.

The following is Mr. Wanner's account:

Part of a large limb, Fig. 1, Pl. XXXII, containing broken branches and leaves in a fairly good state of preservation, exhibits the characteristics of the plant as presented in this and other specimens. Fig. 4 represents a leaf magnified to show the venation. The midrib is prominent. The leaves are decidedly decurrent and, when not pushed out of place or macerated, as is frequently the case, are uniformly and strongly falcate. Another specimen, Fig. 2, only part of the impression in the shale, presents a different phase and well illustrates the changed appearance caused by the presence of young shoots. Fig. 5 illustrates part of another limb containing fewer young branches of greater length than those shown in Fig. 2. Another specimen, Fig. 3, natural size, shows the leaf scars.

The descriptions of *Palissya Braunii*, to which the author has had access, are very meager and unsatisfactory, hence, notwithstanding the fact that his specimens are well defined, he is unable to assert, with any degree of certainty, that the plant belongs here. It strongly suggests *Sequoia Reichenbachi*.

*Localities.*—York Haven, N. C. R. R. cut; Little Conewago Creek, exploitation pit and lowest horizon.

### PALISSYA DIFFUSA (Emmons) Fontaine.

### Pl. XXXI, Figs. 3–5.

1856. *Walchia diffusus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 333, pl. iii, fig. 2.
1857. *Walchia* (*Lycopodites*) *diffusus* Emm.: American Geology, Pt. VI, p. 105, pl. iii, fig. 2.
1857. *Walchia gracile* Emm.: American Geology, Pt. VI, p. 108, fig. 75.
1883. *Palissya diffusa* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI., p. 107, pl. li, fig. 4.
1883. *Cheirolepis Muensteri* (Schenk) Schimp. in Fontaine: Op. cit., p. 108, pl. liii, fig. 3.

Of this Professor Fontaine says:

Mr. Wanner has correctly determined this plant, of which he has a number of very fine specimens. Some of them are much finer than any obtained by even Emmons from the North Carolina beds. There is some difference between the Pennsylvania and the North Carolina fossils. The Pennsylvania specimens do not show such a marked recurving of the leaves as those from North Carolina, and the midnerve of the leaves is not so distinct. These features may be due to the accidents of preservation, and do not call for the separation of the Pennsylvania plant as a variety. The leaves of this form are strikingly like those of *Cheirolepis gracilis* Feistm. of the Rajmahal flora.

The following is Mr. Wanner's record:

Fig. 3, Pl. XXXI, represents a very symmetrical branch in an excellent state of preservation. Both twigs and leaves are crowded closely together. Fig. 4 presents another specimen, containing near the extremity of one of its lateral branches the impression made by some kind of a fruit. Beyond the general outline and the unmistakable imprint made by the stem, by which it is attached to the twig, the fruit contains no definite markings to give it character. In another specimen not illustrated the leaves are somewhat larger. Fig. 5 shows the venation in a magnified leaf.

*Palissya diffusa* is common at the York Haven locality and may be represented at the Little Conewago Creek, but the few fragmentary specimens from the latter place cannot be positively identified.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus BRACHYPHYLLUM Brongniart.

### Brachyphyllum yorkense Fontaine n. sp.

Pl. XXXI, Figs. 6–9.

Mr. Wanner identified this with *Brachyphyllum crassicaule* Font., of the Potomac flora. Professor Fontaine does not accept this, and says:

This is not *Brachyphyllum crassicaule*, but a new and smaller species, which may appropriately bear the name *B. yorkense.*

There are in Mr. Wanner's collection several imprints of a small Brachyphyllum which resembles Saporta's *B. Papareli*, a plant of the Rhetic and Infralias of France. It is, however, I think, a new species. Mr. Wanner's figure shows the most complete specimen. The ultimate twigs on this are very slender. The full length of none of them is shown. They are only 2 mm. wide. The leaves seem to be thinner in texture than those of the Jurassic Brachyphylla. They are rotundate-rhombic in form, with the longer diameter transverse to the axis of the twig. Fig. 8 shows the shape of the best-preserved forms, the enlargement being 3 diameters. They are subspirally arranged, somewhat after the fashion of those of Palæocyparis (Echinostrobus) of the Oolite.

Mr. Wanner says of it:

Fig. 6, Pl. XXXI, presents a branch containing closely placed lateral twigs. Other specimens from the same locality vary considerably in the number of branches, usually having fewer than are contained in the illustration. No terminal branches were identified to a certainty, though several blunt ends may represent extremities, and if such is the case the width of the branch remains the same throughout its extent. The leaves are thick and closely appressed, with beaks and a scarcely perceptible keel, as illustrated in Fig. 7, a magnified leaf.

*Locality.*—Little Conewago Creek, exploitation pit.

With regard to the small specimen, Fig. 9, Professor Fontaine remarks:

I did not see this small fragment. It is probably a portion of a twig of *Brachyphyllum yorkense*, above described.

Mr. Wanner's note upon it was as follows:

This specimen, Fig. 9, Pl. XXXI, is suggestive of Frenelopsis, and that is about all that can be said of it. It is a fragment of a stem of some sort, the only one of that kind found. No traces of leaves and no marks of any sort are visible.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus CHEIROLEPIS Schimper.

### Cheirolepis Muensteri (Schenk) Schimper.

### Pl. XXXIII, Figs. 1, 2.

1867. *Brachyphyllum Muensteri* Schenk: Fl. der Grenzschichten des Keupers und Lias Frankens, p. 187, pl. xliii, figs. 1–3, 3a, 3b, 4–12, 12a.
1870. *Cheirolepis Muensteri* (Schenk) Schimp : Traité de Paléontologie Végétale, Vol. II, p. 248.

This fine plant was correctly determined and well figured by Mr. Wanner. Professor Fontaine remarks:

Mr. Wanner's collection has a number of specimens of this plant which he has correctly determined and figured well. Some of them are splendid fragments, much finer even than those figured by Schenk. It should be stated that the specimens of this plant hitherto found in the United States are small and imperfect. The finding of such fine imprints of this and a number of other older Mesozoic plants makes these Pennsylvania localities very important.

The following is Mr. Wanner's note:

A limb, Fig. 1, Pl. XXXIII, bearing branches and twigs, with short decurrent leaves, falcate in arrangement, admirably illustrates the characterictics of the species. The other illustration, Fig. 2, presents a remarkably well preserved and symmetrical branch, a property, however, not peculiar to a few specimens, but belonging to most of those found.

*Localities.*—N. C. R. R. cut, south of York Haven; Little Conewago Creek, exploitation pit and lowest horizon.

## Genus SCHIZOLEPIS Friedrich Braun.

### Schizolepis liaso-keuperina Friedrich Braun.

### Pl. XXXIII, Figs. 3–5.

1847. *Lepidodendron liaso-keuperinum* Fr. Braun: Flora, Neue Reihe, Jahrg. V [XXX], p. 84.
1847. *Lepidodendron laricifolium* Fr. Braun: Loc. cit.
1847. *Isoetites pumilus* Fr. Braun: Loc. cit.
1847. *Schizolepis liaso-keuperinus* Fr. Braun: Ibid., p. 86.
1852. *Halochloris baruthina* Ett.: Abh. d. k. k. Geol. Reichsanst., Vol. I, Pt. III, No. 3, p. 6, pl. ii, fig. 4.
1867. *Schizolepis Braunii* Schenk: Foss. Fl. der Grenzschichten des Keupers und Lias, p. 179, pl. xliv, figs. 1–4, 4a, 5.

Mr. Wanner believed that the specimen, Fig. 5, represented a different plant from that of Figs. 3 and 4. The latter he regarded as

*Sequoia Reichenbachi longifolia* of the Potomac formation, while the other he identified with *Leptostrobus foliosus*, also of the Potomac.

Professor Fontaine finds them the same, and refers this form to the *Schizolepis Braunii* of Schenk. Schenk worked over all of Braun's material, from the Rhetic of Veitlahm, near Culmbach, in the vicinity of Baireuth, in Bavaria, and found that he had given several names to this form. As it is a Schizolepis, Braun's name, *S. liaso-keuperina* must be retained, and can not be changed to *S. Braunii*, as Schenk proposed to do.

The following is Professor Fontaine's comment on this plant:

This is what appears to be a specimen of *Schizolepis Braunii*, differing from the type only in the somewhat narrower leaves. This is given in Pl. XXXIII, Fig. 3. Fig. 5 of this same plate gives a plant which Mr. Wanner calls *Leptostrobus foliosus*. It is the same Schizolepis. This latter specimen is a fragment of a large twig, with several ultimate branches carrying leaves.

Mr. Wanner's notes follow. Relative to the first of these specimens he says:

Two specimens were found, only the better of which, Fig. 3, Pl. XXXIII, is illustrated. They probably belong to a new species. The author is unable to locate the specimen, and names it as he does simply because the leaves in width and falcate arrangement, particularly in the specimen not drawn, suggest *Sequoia Reichenbachi longifolia* Font. Fig 4 shows a leaf magnified two diameters.

On the other specimen he remarks:

In the only specimen collected, Fig. 5, Pl. XXXIII, the parallel nerves are faintly visible in several leaves, but the number is not definitely revealed. Three nerves are recognized beyond question, but doubt exists as to whether or not there is another. As yet no entire leaf has been found. Closely crowded pit marks on the macerated stems indicate a dense foliage, without betraying the order in which the leaves were attached.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Genus ARAUCARITES Presl.

### ARAUCARITES ? PENNSYLVANICUS Fontaine n. sp.

Pl. XXXIV, Figs. 1, 2.

Mr. Wanner made scarcely any attempt to identify this specimen, and contents himself with saying:

The author is unable to locate Fig. 1, Pl. XXXIV. The venation is shown in Fig. 2. Another specimen, not drawn, has leaves of about the same length, but of greater width. In it the nerves still more plainly converge at the tip.

Professor Fontaine is in doubt with regard to the generic affinities, and describes it as a new species, probably of Araucarites. He says:

The specimen figured by Mr. Wanner is a portion of a twig with a number of small leaves. These in size resemble somewhat Saporta's *Araucaria microphylla*. On the label accompanying this plant Mr. Wanner has given the name *Nageiopsis heterophylla* ?

I have carefully examined this specimen. The nerves are too obscure to be made out with positiveness, and I am not sure that they are not single in each leaf. If so the plant is a Palissya. Mr. Wanner speaks of a second specimen which I have not seen. If the nerves be really numerous, as he gives them, the plant is probably an Araucarites, and possibly the same with the cone in his collection.

*Locality.*—N. C. R. R. cut, south of York Haven.

### ARAUCARITES YORKENSIS Fontaine n. sp.

Pl. XXXIV, Fig. 3.

Mr. Wanner merely says of this that it shows the impression made by part of a large cone. The specimen is too fragmentary to be identified or described. Professor Fontaine makes it a new species of Araucarites, which he describes as follows:

This is an imprint of a portion of what must have been a fine, large cone. It is not complete enough to show certainly the original shape, but a globular form is indicated, with a diameter of about 6 cm. The impressions of the terminations of a number of scales are quite distinct, and they have the character of Araucarites. It might be called *Araucarites yorkensis.* This may be the cone of *Araucarites ? pennsylvanicus*, determined from a leafy branch.

*Locality.*—N. C. R. R. cut, south of York Haven.

## Subdivision ANGIOSPERMAE.

## Class MONOCOTYLEDONEÆ.

### Family GRAMINEÆ.

### Genus YORKIA Wanner nov. gen.

### YORKIA GRAMINEOIDES Ward n. sp.

Pl. XXXIV, Figs. 4–6.

Mr. Wanner has here drawn some very clear figures of this form. Professor Fontaine says of it:

Mr. Wanner regards this plant as a new species of grass. The specimen he uses as a type shows no distinct features. The supposed leaves appear to me to be long succulent stems of some kind. I am not prepared to say that the plant is not some form of grass.

Mr. Wanner's description is as follows:

GRAMINEÆ. *Yorkia* nov. gen.; leaves long, narrow, smooth, thick, and deeply channeled, with no perceptible variation in width. In the specimen illustrated, Fig. 4, Pl. XIV, there are no whole leaves, nor were any found, but the impressions indicate that none were less than 15 cm. in length, ranging from 1 to 2 mm. in width. An indistinct impression at the base can be traced clearly, but can not be resolved into more than a faint vegetable imprint. Markings made by slender roots extend a short distance below the base. No tips of leaves were observed, but Fig. 6 represents the nearest approach to an entire end. Fig. 5 shows the base of another cluster of leaves, about which is a delicate obscure mantle produced by some organic substance.

*Locality.*—N. C. R. R. cut, south of York Haven.

The Marquis Saporta described and figured,[1] under the name of Poacites, a considerable number of grass-like forms from the Mesozoic of Portugal, some of them from the Infralias, others from the uppermost Jura, and still others from the Lower Cretaceous. They were all supposed to represent portions of leaves and not culms. The plant discovered by Mr. Wanner closely resembles some of these, but the leaves are much longer than any obtained by M. Choffat from the Portuguese beds. If these leaves grew directly from a cæspitose base, as Mr. Wanner's figures would imply, it is difficult to refer them to the grass family, but if Fig. 5 represents a short collection of culms giving off leaves from their upper nodes, this would not wholly negative the idea of their belonging to the Gramineæ, as Mr. Wanner supposes. At any rate, the form is quite definite and extremely interesting. I therefore retain the generic name suggested by Mr. Wanner, which carries with it no systematic implications, and express the likeness of the plant to a grass by the specific name chosen. The systematic position given to the plant is, of course, merely conjectural.

The following general remark by Professor Fontaine on Mr. Wanner's collection and work may fittingly conclude this part of our subject:

> Mr. Wanner has succeeded in making a surprisingly good and varied collection of fossils. A number of them had not yet been found in the Trias of America. Some of them are apparently new. A number of splendid impressions of fossils previously described are found in his material. These are better specimens than those by which these fossils have been hitherto known. Mr. Wanner deserves great credit for his intelligent use of the opportunity afforded him for collecting from a region heretofore not known as yielding good plants.
>
> The plants in this collection seem to indicate a somewhat higher Mesozoic horizon than that of the Virginia, and even of the North Carolina beds, being more decidedly Rhetic in character.

## TRIASSIC PLANTS FROM MARYLAND.

In 1883[2] Mr. P. Frazer, in treating the New Red Sandstone Region, makes passing mention "of a plant bed in Frederick County, Md." At the meeting of the Geological Society of America on December 30, 1890, in the course of the discussion of Dr. Williams's paper on the Petrography and Structure of the Piedmont Plateau in Maryland, Mr. Charles S. Prosser called attention to the remark quoted above and asked Dr. Williams for further information.[3]

In reply, Dr. Williams said:

> Fossils have recently been found in two localities in the Triassic of Frederick County, Maryland: first, by Professor Philip R. Uhler, about 2 miles west of Fred-

[1] Flore Fossile du Portugal, Direction des Travaux Géologiques du Portugal, Lisbonne, 1894.
[2] Second Geological Survey of Pennsylvania, $C^4$, 1883, p. 29.
[3] Bull. Geol. Soc. America, Vol. II, March, 1891, p. 318.

erick; and, secondly, by Mr. S. L. Powell, not far from Utica Mills. Those collected by Mr. Powell are from the red shales, and are very abundant. Some of the forms resemble nuts; others may be interlacing roots.[1]

I am not aware that anything has been published relative to the discoveries of either Professor Uhler or Mr. Powell here recorded.

In the spring of 1890 there were discovered in the red sandstone quarries at Seneca, on the Potomac, at the mouth of Seneca Creek, Maryland, some very fine specimens of Dendrophycus. The first of these, and the finest that has been found, was brought to the National Museum on May 7 by Mr. D. L. Shoemaker, proprietor of the quarry. I recognized it at once and took so deep an interest in it that I visited the place a few days later, in company with Mr. Charles S. Prosser, and we collected a number of additional specimens. They are well marked and typical of this form; but, like all others thus far known, are destitute of organic matter or coaly pellicle. They closely resemble *D. Desorii* Lx., of the Devonian of Iowa, a fine specimen of which is in the collection of the National Museum, but they have the red color of the building stone in which they occur. They differ perhaps more from the form found in the Trias at Portland, Connecticut, and named by Dr. Newberry *D. triassicus*, of which mention has already been made. It is, however, interesting to know that this genus occurs at two widely separated localities of this formation.

Important differences exist between these and the Maryland specimens, differences sufficient to constitute the latter a distinct species. I shall therefore call this species *Dendrophycus Shoemakeri*, thereby acknowledging Mr. Shoemaker's kindness in bringing the above-mentioned specimen to the Museum, without which act the existence of this form in the Maryland deposit might never have been discovered.

The fine specimen brought by Mr. Shoemaker was carefully photographed, under the immediate supervision of Mr. De Lancey W. Gill, and the accompanying half-tone illustration shows with great minuteness all the details of structure; and I also had photographs taken of the best specimen collected by Mr. Prosser and myself. This last is represented on Pl. XXXV, Fig. 2, and by the side of it, Fig. 1, is the view of *D. triassicus* Newb., of Portland, Connecticut, already mentioned (supra, p. 228). Pl. XXXVI is the view of the original specimen brought by Mr. Shoemaker, the most complete thus far found.

The description of the species is as follows:

### DENDROPHYCUS SHOEMAKERI Ward n. sp.

Pl. XXXV, Fig. 2; Pl. XXXVI.

Upper portions of the so-called rhizomes alone present, forming the rachis of the frond. Fronds very numerous, covering large areas, 8 to

[1] Loc. cit.

10 cm. long, 5 cm. broad at the summit, consisting of 3 to 5 secondary divisions proceeding alternately from each side of the rachis at a uniform angle of about 30°, these again throwing off tertiary branches chiefly from the other side, some of which still further fork or ramify, forming a spreading fan-shaped mat of overlapping fibers covering the rock. The surface of the rock is very uneven, the fronds forming reliefs, and each branch, strand, or subdivision constituting a smooth raised ridge or line. The counterparts of the fronds of course present the opposite features, the reliefs becoming intaglios.

This is not the place to enter into a discussion of the question whether Dendrophycus really represents a plant. I will only say that Professor Fontaine, who has not only seen all the Seneca and Portland specimens but has visited the locality and examined their mode of occurrence, does not, any more than did Dr. Newberry, hesitate to pronounce them as of vegetable nature. I reserve my own opinion, if I can be said to have one, until more and stronger evidence shall be produced.

## THE VIRGINIA AREA.

Fossil plants were early discovered in the rich beds of the Richmond coal field, and mention of them was from time to time made by geologists and other writers near the beginning of the century.

Among the earliest of these mentions was that of Mr. William Maclure, in 1817.[1] After having discussed the primitive formations of the more northern sections, he proceeds to speak of—

"A range of secondary, extending with some intervals, from the Connecticut to the Rappahannock rivers, in width generally from 15 to 25 miles; bounded on the northeast, at New Haven, by the sea, where it ends to recommence on the south side of Hudson River. * * * This secondary formation is interrupted after it passes Frederickstown, but begins again between Monocacy and Seneca creeks, the northeastern boundaries crossing the Potomac by the west of Cartersville, touches the primitive near the Rappahannock, where it finishes. * * * About 10 or 12 miles west of Richmond, Virginia, there is an independent coal formation, 20 to 25 miles long, and about 10 miles wide; it would not be far distant from the range of the red sandstone formation had it continued so far south; it is situated in an oblong basin, having the whitish freestone, slaty clay, etc., with vegetable impressions, as well as most of the other attendants of that formation."

This last hint is of special interest in view of the fact that all the more northern deposits are of the red or brown sandstone, while that of the Virginia basin, in the vicinity of Richmond, is a true coal formation, and Mr. Maclure must therefore have derived this information largely from paleontological data.

In 1821 we find Mr. Thomas Nuttall[2] discoursing learnedly with

[1] Observations on the Geology of the United States of America, by William Maclure, Philadelphia, 1817. (See pp. 39–49.)

[2] Jour. Acad. Nat. Sci., Phila., Vol. II, Pt. I, pp. 35–38.

regard to this same formation. Speaking of what he calls "the second calcareous formation," he says:

In its geographical limits it occupies a position universally to the east of the primitive and transition formations. * * * It appears, however, to be destitute of the concomitant minerals, excepting, indeed, it were possible to conceive it in connection with the coal basins of Richmond, which I have found on examination to be actually underlaid with a calcareous rock of peculiar appearance. Mr. Heath's coal mines, and in fact nearly all of them, except those which were in a state of combustion, are overlaid by a massive micaceous conglomerate, or grit rock, containing crystals of feldspar like porphyry, in which, besides gigantic *culmarii*, occur veins of the argentine calcareous spar of Kirwan. * * * In the bituminous slate clay, which, as usual, accompanies this coal, besides impressions of ferns and the supposed Equiseta, there are vestiges of some enormous flaccid-leaved gramineous plant, leaves of one of the Scitamineæ similar to those of the ginger, and fine casts of a palm resembling the pennate fronds of some species of Zamia or cycad. * * * Although there can remain but little doubt of the continuity of the Floetz limestone we are endeavoring to trace toward the south, still, in consequence of the more recent alluvial deposits, it is not again discernible until we arrive in North Carolina.

Relative to his "gigantic Culmarii," he appends a footnote explaining that it "is an assumed generic name for an assemblage of extinct Zoophytes, one species of which is the *Phytolithus striaticulmis* of Martin's Petrificata Derbiensia." This *Phytolithus striaticulmis* is a Calamites, and the Culmarii described by Nuttall are undoubtedly the *Equisetum Rogersii* (Bunb.) Schimp.

Mr. Richard C. Taylor, in 1834,[1] was somewhat unfortunate in combating the views of Nuttall and Maclure relative to the secondary age of the Richmond coal field, and in claiming for it a Carboniferous age. But he was supported by the opinion of Adolphe Brongniart upon a specimen which had been sent to him, which he had identified as *Calamites Suckowii* Brongn., but of which species he made it a new variety, and in describing it he remarked:

La var. δ, dont la surface externe est assez mal conservée, se rapporte cependant à cette espèce par sa forme générale et par la ténuité de l'écorce. Les côtes sont seulement plus convexes, ce qui peut tenir à une moindre compression; car ces tiges, qui étaient probablement verticales, paraissent avoir été comprimées dans le sens de leur longueur, et presentent des replis nombreux qui semblent indiquer combien leurs parois étaient minces et flexibles. Cet échantillon est même fort remarquable sous ce rapport, et prouve que ces tiges étaient fistuleuses comme celles des Equisetum vivans.[2]

In an article by Mr. A. W. Wooldridge,[3] president of the Midlothian Mining Company, mention is made of the occurrence of "vegetable remains, such as ferns, bark, and knobs of wood found in the slate overlying the coal" in the basin which is now more generally understood by the name of the Richmond coal field.

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[1] Memoir of a section passing through the bituminous coal field near Richmond, in Virginia, by Richard C. Taylor: Trans. Geol. Soc. Pennsylvania, Vol. I, p. 275.

[2] Histoire des Végétaux Fossiles, Vol. I, 1828, p. 126.

[3] Geological and statistical notice of the coal mines in the vicinity of Richmond: Am. Jour. Sci., Vol. XLIII, 1842, pp. 1–14 (see pp. 9 and 11).

At the Third Annual Meeting of the American Association of Geologists and Naturalists, held at Boston in 1842, Prof. W. B. Rogers read a very important paper On the Age of the Coal Rocks of Eastern Virginia. The second and much larger part of this paper is devoted to the description of the vegetable remains known to him at that date, and of which he enumerates some dozen species. This paper was published in the Transactions of the Association for that year (pp. 298–316), and is accompanied by a plate (pl. xiv), on which three of these species are figured. It is reproduced in the Geology of the Virginias, New York, 1884, pp. 645–658, with the plate.

When Sir Charles Lyell was making his journey through the United States, so fruitful in geological results, he visited this coal field in the vicinity of Richmond and made a careful study of the strata and of the remains of animal and vegetable life. He took back with him to England a quantity of the material which he had collected and handed the vegetable remains over to Sir Charles J. F. Bunbury for determination. Bunbury's report upon this collection was contributed to the Geological Society of London, and published in 1847.[1] Bunbury describes in this paper about fifteen different forms, a few of which were not the same as those described by Rogers, with whose paper he was acquainted. He shared with Lyell and Rogers the belief that Calamites occurred in this formation, and several of the coniferous forms were provisionally referred by him to Sigillaria, Lepidodendron, and Knorria.

On June 18, 1849, Mr. Jules Marcou made a communication to the Geological Society of France on the coal of Chesterfield County, Virginia, near Richmond.[2] Mr. Marcou had recently visited the Chesterfield bed and had observed the abundant plant remains. He collected many of them and discusses their affinities, relying apparently upon Bunbury's determinations. Nevertheless, he refers these beds to the Keuper, which was at least a shrewd guess.

The paper which Professor Rogers read before the Boston Society of Natural History on January 4, 1854,[3] makes mention of the fossil plants of the Richmond coal field, but adds nothing to what he had previously said on this subject. His statement, however, that "in the belt in Virginia, toward the Potomac River * * * he had met, in the more sandy rocks, vegetable impressions which, although obscure, are strongly suggestive of the leaves of Zamites," furnishes a datum point for future investigations. It is to be regretted that he did not definitely locate these discoveries. One additional line describing the exact spot at which these remains were observed might have saved weeks of patient search to the student of the present generation.

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[1] Description of fossil plants from the coal field near Richmond, Virginia, by C. J. F. Bunbury: Quart. Jour. Geol. Soc. London, Vol. III, Pt. I, pp. 281–288, pls. x, xi.

[2] Note sur la houille du comté de Chesterfield, près de Richmond (État de Virginie), par J. Marcou: Bull. Soc. géol. de France, 2d series, Vol. VI, 1848–1849, pp. 572–575.

[3] Proceedings, Vol. V, July, 1854, pp. 14–18.

Mr. Jules Marcou, as we have seen, had visited this region and made a small collection of fossil plants. Some of these he took with him on a visit to Europe and showed them to the eminent paleobotanist, Prof. Oswald Heer, of Zurich. In his Geology of North America[1] he introduces a translation of Professor Heer's report upon this collection. It contains nothing additional to the forms described by Rogers and Bunbury.

At the Philadelphia meeting of the American Institute of Mining Engineers, in February, 1878, Mr. Oswald J. Heinrich read an elaborate paper on the Mesozoic Formation in Virginia, which was published in the Transactions.[2] He gives numerous sections in the principal mines of the Richmond coal field, mentioning the occurrence of plants, and on page 264 he attempts an enumeration of the species, basing it on determinations made for him by Prof. C. E. Hall, of the University of Pennsylvania, to whom the material collected was referred. The list is short, and the names the old erroneous ones of Brongniart, Bunbury, and Rogers.

Prof. William M. Fontaine commenced his important researches in this field early in the seventies and contributed a preliminary paper[3] in 1879. This paper is chiefly geological and covers a wide field, discussing the relations of the older to the younger Mesozoic, but it is based largely on the evidence furnished by the flora, and that of the Richmond coal field receives special treatment (pp. 37–39).

This paper was the natural forerunner of his Older Mesozoic Flora of Virginia,[4] with which we have already had much to do, and which is unquestionably the most important contribution that has yet been made to the flora of the American Trias. It forms one of the smaller monographs of the United States Geological Survey, containing 144 pages of text and 54 plates. As stated by the author, "it is based upon the study of a number of plants obtained after several years of diligent search in the older Mesozoic strata of Virginia." The number of species, or rather of distinct plants, that are here described and figured amounts to 45, which will be seen to be a large increase over those hitherto known. Eight of these species were already known from other localities under established names; 4 more of this class are referred to different genera or species, making 12 not confined to Virginia. Of the remaining 33, which are so confined, 9 have close affinities with species already described. It thus appears that considerably over half of the entire number are peculiar to the locality and have no weight in determining its horizon.

[1] Geology of North America, with Two Reports on the Prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California, originally made for the United States Government: by Jules Marcou; Zurich, 1858; p. 16.

[2] Vol. VI, pp. 227–274.

[3] Notes on the Mesozoic of Virginia: Am. Jour. Sci., 3d series, Vol. XVII, January, 1879, pp. 25–55.

[4] Mon. U. S. Geol. Survey, Vol. VI, Washington, 1883, 4°.

One of the most important purposes subserved by this work is that of correcting the determination of the forms that had previously been described. Professor Fontaine undertook, in the preparation of this work, to make careful comparisons of all the forms in his collection with the figures that had already been published, and he went to great pains to indicate those species occurring in beds of similar age in Europe and other parts of the world which were capable of being compared with those of Virginia. This was possible in a considerable number of cases, and we are, therefore, placed in a position to consider the age of this formation from the point of view of vegetable paleontology in its relation to older and better-established deposits. In view of its importance, Professor Fontaine's work must, therefore, serve as the basis, or general starting point, from which not only this discussion but the general discussion of the Triassic plants of North America will proceed.

Professor Fontaine did not restrict his investigations and comparisons to the Oolite of Yorkshire, as Rogers and Bunbury had done, but availed himself of all the extant literature upon the subject relating to the fossil plants of all the formations of Europe and other parts of the world whose geological position is not far removed from that to which the American beds had already been referred. The important researches of August Schenk upon the fossil flora of the Mesozoic of Bavaria, especially of Franconia, in the vicinity of Baireuth, previously known to him only imperfectly through Count von Münster's Beiträge and two papers by D. Brauns, had opened up a new and important field and furnished a very much broader basis for the study of the analogous floras the world over. Nathorst had also contributed in an important way to the study of the Rhetic flora of southern Sweden. Heer had investigated the Oolitic floras of the Arctic regions and Siberia, and Feistmantel had published his exhaustive works on the Gondwana system of India. All these, and other important works, were consulted by Professor Fontaine, so that he was in position to revise and correct the works of Rogers, Bunbury, Emmons, and Hitchcock upon the fossil flora of the American Mesozoic.

It was thus found that the Virginia Mesozoic flora did not correspond with anything like the same completeness as had been supposed to the Oolite of Yorkshire. Many of the most important species which had been depended upon to establish its Oolitic age were discovered to have been wrongly named and to belong to different genera from those to which they had been assigned.

This revision operated in two directions, viz: primarily, in showing that those who had regarded the Richmond coal field as Carboniferous or Permian, or had supported their views upon the supposed discoveries in these fields of such Carboniferous plants as Calamites, Sigillaria, and Lepidodendron, were mistaken in these determinations, and that no such ancient forms exist in the Mesozoic formation; and, secondly, in showing that many of the species referred to the Yorkshire flora are not identical with those forms and are either new species belonging to the same orders or genera or are species nearly or quite identical with those of the Rhetic beds of Europe. So that while upon the whole the revised flora indicates that these deposits are more ancient than the Oolite of England, at the same time it does not indicate an age having anything like the antiquity of the true coal floras of this country and of Europe.

Forms supposed to belong to Calamites were shown to belong to Equisetum, having the broad trunks and great size of those Equisetums which occur in the Trias. The supposed Sigillarias and Lepidodendra were shown to belong to the Cycadaceæ or Coniferæ, probably to the genus Palissya, which is strictly Mesozoic. On the other hand, the important *Pecopteris whitbiensis* and *Neuropteris linnææfolia*, supposed to be common to the Oolitic flora and that of Virginia, are both shown to belong to the genus Acrostichites, which is Rhetic, and the equally important *Pecopteris bullatus*, from which so much had been argued, is referred by Professor Fontaine to an entirely new genus of his own, viz, Mertensides, by which it loses altogether its diagnostic value. These are merely examples of the searching character of Professor Fontaine's investigations and of the important alterations in the data for forming a conclusion with regard to the age of these deposits.

After describing the species of the Virginia flora, Professor Fontaine sets forth in a table of distribution the general elements of this flora as compared with those of other countries. Forty-two species had been enumerated, of which 21, or just half, prove to be new to science, or at least peculiar to Virginia. In the table appended to this paper it will be shown that several of these have affinities with other plants whose geological age is known, therefore are not without diagnostic value from a geological standpoint. Professor Fontaine could find no forms identical with any that had hitherto been described from any part of the Trias, but 4 of his species were allied to species of the Trias. Only 2 of them were shown to be identical with any plants of the Jurassic, and neither of these belong to the Oolite of Yorkshire, but there are 5 species related to Jurassic forms. With the Rhetic flora the affinities seem closer, 4 species having been identified with Rhetic plants of Europe, and 8 others are shown to be closely related to such. Professor Fontaine's table is carefully discussed by him, each species being taken up and its geological bearings considered. Without following him through this discussion, we will content ourselves by quoting a few of his concluding remarks:

It is clear then from these facts that we must consider this flora as not older than the Rhætic. The only question is whether or not its strong Jurassic features ought to cause us to regard it as at least Lower Liassic in age. I think that it is fully as much entitled to be regarded as of Liassic age as is the flora of the Rajamahal group of India. Feistmantel and Zigno think that the age of this group is that of the Lias. Taking everything into consideration, the flora of the older Mesozoic of Virginia is, of the European floras, nearest to that of Theta, near Baireuth, in Franconia (p. 96).

Some authors hold that the Rhætic beds form the uppermost of the Triassic strata. Others think that they are transition beds, having more affinity with the Lower Lias. The latter view will, I think, be justified by a study of the flora, and I have, in this memoir, assumed its correctness (p. 128).

This important work of Professor Fontaine's especially attracted the attention of the late distinguished director of the Austrian Geological Survey, D. Stur, who had found at a place called Lunz, in Austria, a deposit yielding fossil plants having a very remarkable resemblance to those of the Virginia flora. Unable to satisfy himself with sufficient certainty by the study of the figures and descriptions of Professor Fontaine, Director Stur made application to Professor Fontaine and received, through the intervention of the United States Geological Survey, a good series of specimens of the Virginia fossils. In the Proceedings of the Geological Survey of Austria, published in 1888, Director Stur gave a brief account[1] of the results of his comparisons of the Virginia plants with those of Lunz. The general conclusion is that they are identical in age, many of the species being the same. But Stur regards the Lunz flora as Keuper and not Rhetic, and as nearly equivalent to that of Raibl and Stuttgart. He had arrived at this conclusion by a preliminary study already given to the flora of Lunz.[2]

This paper, as he admits, was only a Prodromus, and contains simply a list of the genera and species in systematic order, but no descriptions or figures. It bears date 1885, or two years later than Professor Fontaine's monograph. Therefore it is obvious that all Stur could do under the recognized laws of nomenclature would be to accept Professor Fontaine's species and genera in so far as they were new and identical with those of Lunz; although, of course, he would be authorized to point out any error in determination tending to show that Professor Fontaine had erroneously identified any of his plants with those of other deposits in Europe or elsewhere, or to show that any of his new species were not such, but were identical with species already described. We are therefore surprised to find that in a number of cases, as for example Speirocarpus, Heeria, etc., Stur created new genera of his own, and undertook at a later date to substitute them for the genera of Professor Fontaine. This, it is clear, can not be allowed by the laws of nomenclature. Pseudodanæopsis and Mertensides must stand and the Lunz plants be placed in them.

[1] Die Lunzer- (Lettenkohlen-) Flora in den "Older Mesozoic Beds of the Coal Field of Eastern Virginia," von D. Stur: Verhandl. k.- k. geol. Reichsanstalt, Wien, Jahrg. 1888, pp. 203–217.

[2] Die obertriadische Flora der Lunzer-Schichten und des bituminösen Schiefers von Raibl, von D. Stur: Sitzungsber. K. Akad. Wiss. Wien, math.-nat. Cl., Vol. CXI, 1885, pp. 93–103.

As confirming, so far as it goes, the views of Stur regarding the somewhat lower position of the Richmond coal field and that of North Carolina, may be fitly noted the discovery in the Lower Trias of the Vosges ("Grès bigarré de Saint-Germain près Luxeuil"), by M. Despierres, of a specimen identified by Zeiller[1] with Professor Fontaine's *Acrostichites rhombifolius rarinervis.* From this and other indications Zeiller is inclined to regard the American deposits as Triassic rather than Rhetic. This opinion, after noting the views of Professor Heer contained in the letter to Mr. Marcou, already mentioned, he expresses in the following words:

Je serais, en résumé, très disposé à accepter l'assimilation de Heer de préférence à celle de M. Fontaine, c'est à dire que je placerais les couches en question dans le trias supérieur plutôt que dans le rhétien.

This whole subject was discussed quite at length by Mr. Jules Marcou in 1890,[2] and he takes occasion to go over the history of his own investigations along with those of others. Very little is added to our knowledge of the subject, but a letter from Zeiller, which he inserts on page 172, contains his determinations of Mr. Marcou's collection, sent in 1849 to the Jardin des Plantes, and which had lain there during this long period without attention. It contained eight or ten species, none of which were new.

Some specimens of fossil wood were collected by Mr. W J McGee, near Taylorsville on the South Anna River in Hanover County, who supposed them to belong to the Potomac formation, and they were included in Dr. Knowlton's paper on the Fossil Wood and Lignite of the Potomac Formation.[3]

As all the other specimens from that formation had proved to be of Sequoian type and been referred to the genus Cupressinoxylon, there was a suspicion that these might represent an older formation. I therefore decided to visit the locality at the first opportunity, which presented itself on the occasion of the return of our expedition, presently to be recounted, over the Triassic beds of Virginia in 1890. On June 18 of that year, accompanied by Professor Fontaine and Mr. Charles S. Prosser, I examined the bed on the South Anna River and made further collections of the wood. The Trias appeared at several points in that vicinity, sometimes in the form of red shales, and the wood in question occurred in a superficial deposit, probably Lafayette, immediately overlying the Trias. It could not have come from the Potomac farther to the east, and had undoubtedly weathered out of the Trias.

During the month of June, 1890, an excursion was made by Pro-

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[1] Sur la présence dans le grès bigarré des Vosges de l'*Acrostichides rhombifolius* Fontaine, par R. Zeiller: Bull. Soc. géol. de France, 3d series, Vol. XVI, 1888, pp. 693-699.

[2] The Triassic flora of Richmond, Virginia: Am. Geologist, Vol. V, March, 1890, pp. 160-174.

[3] Bull. U. S. Geol. Survey No. 56, 1889, p. 50, pl. vii, figs. 2-5.

fessor Fontaine, Mr. Charles S. Prosser, and myself over the Triassic formation in Virginia. After visiting the Seneca sandstones, and tracing the approach of the Trias along the Monocacy River to the Potomac, we crossed the river at Point of Rocks and proceeded to Leesburg, skirting the western margin of the belt which consists entirely of conglomerates early called "Potomac marble," but known locally only as "calico rock." At Leesburg the trap appears not in the form of ridges as in New England and on the Hudson, but rather as a bowlder formation covering the surface; nevertheless, along Goose Creek it is heavily bedded and extensively quarried, there called "granite." Near points of contact of the trap with the red shales these latter become lighter colored and in a few places somewhat dark and carbonaceous. The nature of our expedition did not allow us time to search in these darker shales for fossil plants, but it is possible that such may occur and that future researches may reveal them. Several such localities were noted for this purpose. At Brentsville heavy beds of sandstone of excellent quality for building purposes occur and promising quarries have been opened. Several of these were visited by us in company with Mr. J. L. Sprogle, the general manager, who offered us special facilities for examining them. In some respects this stone seems to excel that of the quarries in Maryland, but in all the Potomac beds the color is a more lively red than in the Connecticut Valley. A short distance east of Brentsville we found in lighter shale a fossil plant, *Cheirolepis Muensteri* (Schenk) Schimp. We also found near Weaversville specimens of an Estheria and scales of fishes. Near the Rappahannock and Rapidan rivers and southward as far as Orange, notably at Culpeper, a marked difference occurs in the conglomerate from what we find at Point of Rocks and Leesburg, the material cemented in the sandstone consisting of bowlders of considerable size. We named this the Culpeper conglomerate. It is very similar to what may be seen in the Connecticut Valley and also in the vicinity of New Haven, being the same noted by Professor Dana on the east side of Pond Ridge. Professor Fontaine and myself found this conglomerate at a number of points in the Connecticut Valley.

On this excursion we traced the Trias to Barboursville, where Professor Rogers supposed it to end, and where, in fact, it does disappear; but proceeding thence to Charlottesville we were surprised to find it in the valley of the Rivanna, only a short distance from that place, and a few miles north of Monticello. From Charlottesville we proceeded to the coal field, striking it at Manakin or Dover Mines. We visited Carbon Hill and all the mines on the left bank of the James; crossed at Boscabell's ferry and proceeded to Midlothian and Clover Hill, examining with minuteness the material thrown out at all the shafts in this region. The most promising places for fossil plants in that part of the field were the Gowrie shaft and the new Stonehenge shaft, near Midlothian, and the Bright Hope and Raccoon shafts at Clover Hill. Nevertheless, many other interesting places were noted, and in the following September these were all visited by Professor Fontaine and collections made.

In the course of the more recent extended investigations that have been made in the Richmond coal field by Prof. N. S. Shaler and his field parties,[1] Mr. J. B. Woodworth, in 1896, made a small collection of fossil wood in Chesterfield County, at three localities given as near Skinquarter Station, near Otterdale, and south of Moseley Junction, at somewhat different horizons. This material was submitted to Dr. F. H. Knowlton for determination, and his results were published as an appendix to Professor Shaler's paper.[2] Dr. Knowlton distinguished two species of Araucarioxylon, *A. virginianum* and a new species which he names *A. Woodworthi*, both of which are fully described and illustrated. It will be noted that the first of these species is the same as that from Taylorsville in Hanover County (see supra, p. 264). The other species is closely allied to *A. arizonicum* of the West (see infra, pp. 273, 319).

## THE NORTH CAROLINA AREA.

Our knowledge of the existence of a coal basin in North Carolina dates back to a very remote period, and the occurrence of vegetable remains in this region was known almost as early as in any of the others considered.

Dr. Ebenezer Emmons, in his first report upon the geology of North Carolina,[3] in speaking of the coal fields of that State, mentioned (page 142) the occurrence of vegetable remains. He says:

> The vegetables are few in number, and differ from those of the coal rocks of Pennsylvania or the flora of the Carboniferous system. An Equisetites differing from *E. communis* is the only one of this genus I have seen. A Lycopodites, and other allied forms, are all I have yet found, except a naked and rather spinous vegetable, which is unknown in the Carboniferous rocks. It is a cellular cryptogamous plant. This is very common and abundant at Madison, and one or two layers of slate are covered with it at Evans Mills. The roots of vegetables, in the fire clay, are thin, narrow, ribbon-like tissues, and have lost their vegetable structure. Their thinness and compressibility show, however, that the roots were spongy, of a loose texture, and were "quatic."

Later on in the same report, speaking of the Dan River coal measures (p. 147), he says:

> Immediately above this bed of brecciated conglomerate there is one of the finest exhibitions of an ancient forest in this country. It consists partly of roots of trees

[1] Geology of the Richmond Basin, Virginia, by N. S. Shaler and J. B. Woodworth: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, pp. 385–519.

[2] Report on some fossil wood from the Richmond Basin, Virginia, by F. H. Knowlton: Op. cit., pp. 516–519, pl. lii.

[3] Executive Document No. 13, Report of Professor Emmons on his Geological Survey of North Carolina, Raleigh, 1852.

changed into lignite, and partly of perfectly silicified trunks of trees, exceeding two feet in diameter. The soil in which the majority of these trees grew is still concealed. Segments of their trunks stand out of the soft rock, inclining at an angle to the horizon, but lean in a direction contrary to the dip of the rock. A road cuts through the strata in which the forest grew. All that remains of it are the trunks; it was impossible to find a leaf or stem of herbage or fruit. The softer and more perishable parts and organs are destroyed by unknown agencies. Perhaps some fortunate blow of the hammer may bring to light the leaves and fruit. The structure of these trunks prove them to belong to the natural family of Coniferæ, or the family to which the pines, spruces, and hemlocks belong.

The trees extend for half a mile or more, and no one, on seeing the number, can doubt that here grew a forest when the rocks were forming. Similar trunks have been found at Madison, and pieces of trunks occur upon Deep River, near Evans's bridge, and another forest of the same character upon Drowning Creek, in Richmond County. They occupy the same position in the series.

We next find a casual mention by Professor Rogers in the Proceedings of the Boston Society of Natural History for January 4, 1854,[1] that he had found in the summer of 1850 in the coal rocks of Deep River, North Carolina, several of the same plants which he was describing from Virginia. Among the plants mentioned as having been seen there by him were *Equisetum columnare*, a Zamites, and a plumose plant referred to Lycopodites, strongly resembling *L. Williamsonis* of the Yorkshire coast.

At the Albany meeting of the American Association for the Advancement of Science in 1856, Dr. Ebenezer Emmons read a paper entitled: Permian and Triassic Systems of North Carolina. This paper was published only by title in the Proceedings of the Association, but a brief abstract of it occurs in the Edinburgh New Philosophical Journal for 1857,[2] in which, in addition to animal remains, he mentions the occurrence in the North Carolina deposits, regarded by him as Keuper, of a variety of plants, among which he enumerates some belonging to the Cycadaceæ, a Voltzia, and also a supposed Walchia.

The same year (1856) appeared Dr. Emmons's Geological Report of the Midland Counties of North Carolina, which contains the first important mention of the fossil plants of the North Carolina basin. In this report Dr. Emmons, besides giving the most exhaustive geological account of the North Carolina deposits that had thus far been made, paid special attention to both the vegetable and animal remains. The former he supposed to occur in two somewhat distinct formations, viz, the so-called Permian and the Trias. His Permian deposits holding vegetable remains occur along the Deep River at Haywood in Chatham County, near Wadesboro in Anson, and also some 15 miles southwest of Troy in Montgomery. He mentions the remains of petrified and silicified wood, and seems to regard these as the "most important vegetable remains" that are found at all the above-mentioned localities; also at Jones Falls, and in the Miocene of Wayne County, where they

[1] Vol. V, p. 15. [2] Vol. V, p. 370.

appear to have been washed out of the so-called Permian and stranded on the surface. This silicified wood may be the same as that which had several times previously been referred to,[1] but these previously mentioned fragments occurred along the Neuse River, and the lignites described in the second paper mentioned agree quite well with those found in the Potomac formation of Virginia. The vegetable impressions occur chiefly in the deep coal shaft at Egypt, on Deep River; also at Evans Bridge, and on the Dan River at Madison, Stokes County. Among them he enumerates several fucoids, referred to Chondrites, besides vascular cryptogams, such as Equisetum, ferns, and some forms referred to the Lycopodiaceæ. The treatment of these plants occurs in Chapter XXXIX, pp. 283–293, pl. i–iii.

A much larger number of plant forms are described by Dr. Emmons from the overlying Trias, which he identifies with the Keuper of Europe, and regards as equivalent to the coal shale of the Thüringerwald. These also occur, for the most part, on Deep River, principally at Jones Falls, which is also called Lockville; also in the blue slate at Ellingtons, and in the soft reddish marls near Haywood. These plants include a number of ferns, Cycadaceæ, Lycopodiaceæ, Coniferæ, and Equisetaceæ.

It is proper to remark that recent determinations of these various forms have changed the views expressed by Dr. Emmons in regard to their nature and systematic position, and also that Professor Fontaine does not see any reason for considering the so-called Permian forms as indicating a distinct age from those of the Trias.

To these vegetable remains are devoted four double plates of very well-drawn and well-printed figures.

A notice of Professor Emmons's North Carolina Report, relating to the Trias, which appeared in the American Journal of Science for November, 1857,[2] signed by the initials C. D., which are understood to have been those of Professor C. Dewey, is chiefly important in containing what purports to be a translation of a letter from Prof. Oswald Heer, who had made a somewhat careful study of Dr. Emmons's figures, and, as it would seem, of specimens which had been shown him by Mr. Jules Marcou, and the latter gentleman states[3] that the letter itself was originally addressed to him and was subsequently submitted to Dr. Emmons, who placed it in the hands of Professor Dewey. It is the same letter to which reference has already been made, a translation of which appeared in Mr. Marcou's Geology of North America, at page 16; but the two translations differ in some rather important respects.

In Part VI of his American Geology, Chapters VII and XV, Dr. Emmons has reproduced, almost without change, this discussion of

[1] See mention by Olmsted in Am. Jour. Sci., Vol. V, 1822, p. 261, and Vol. XIV, 1828, p. 250.
[2] 2d series, Vol. XXIV, pp. 427–429.
[3] Am. Geologist, Vol. V, March, 1890, p. 165.

the fossil flora of the Carolina Trias, making, however, a few additions and corrections. The illustrations are somewhat superior to those of the former work, and a considerable number were added. This volume bears date 1857.

Nothing further was done with this North Carolina flora until Professor Fontaine undertook, in his Older Mesozoic Flora, 1883, a careful revision of Dr. Emmons's work as published in his American Geology. This forms Part III of that important monograph, and is, as may well be judged, a very welcome contribution to this general subject, bringing the determinations down carefully to date and eliminating the greater part of Dr. Emmons's mistakes. It proved conclusively that the North Carolina basin is very closely related to that of Virginia, since of the 40 species enumerated in the North Carolina flora, 9 only are peculiar to that State, while 16 occur in Virginia. Six of his plates are devoted to reproductions of Dr. Emmons's figures, without, it must be confessed, any artistic improvement in them; but this seemed necessary in order to place the discussion in a compact form and in a clear light.

As indicative of the probable age of the coal plants, he says, at the outset:

Most of Emmons's plants come from above the horizon of the Mesozoic coal beds of North Carolina; hence, if this coal be on the same horizon as the Virginia Mesozoic coal, as it probably is, most of the North Carolina plants must come somewhat higher up in the series of older Mesozoic strata than those from Virginia. Nearly all of the latter come from the beds immediately associated with the Mesozoic coal of Virginia (p. 97).

Referring to the bituminous shale groups, which Dr. Emmons regarded as Permian, he says:

This bituminous shale group comes some distance above the base of the North Carolina Mesozoic series of strata, and, as stated, most probably stands on the horizon of the strata yielding most of the Virginia plants (p. 98).

On page 121 he further remarks:

It is not necessary to dwell upon the character of the strata of the two North Carolina areas. It is evident that they have a close resemblance to each other and to the Mesozoic beds of Virginia. The physical and stratigraphical resemblances are sufficient, without the evidence of the plants, to indicate that the North Carolina and the Virginia Mesozoic strata are of the same age, and that they were formed under similar conditions.

On pages 122 and 123 he gives a table of distribution similar to that given for the Virginia flora. This table certainly shows a remarkable similarity between the two floras. For example, only 9 species of the North Carolina plants are peculiar to that State, while 15 occur also in the Virginia flora, and one other, *Lonchopteris oblonga*, is closely allied to *L. virginiensis*. None of these forms occur in the Trias of any other country, nor are any allied to any Triassic plants. Two species occur in the Jurassic of other parts of the world, and 6 are allied to Jurassic species, but when we come to the Rhetic we find 7 identical with, and 8 others closely related to, typical Rhetic forms. The evidence of Rhetic age is therefore very strong. The results of this table are then analyzed and thoroughly discussed, and from the data here presented and from other sources he arrives at the following general conclusion :

European authors, and especially Schimper, often call attention to the strong resemblance between the Rhætic and Lower Jurassic floras, the likeness to the flora of the Lower Oolite of England being especially striking. In accordance with this fact, the presence of a marked Jurassic element in the flora of these Mesozoic beds, both in North Carolina and Virginia, is of itself an evidence that they can not be older than Rhætic. We are, then, I think, entitled to consider that the older Mesozoic flora of North Carolina and Virginia is most probably Rhætic in age, and certainly not older (p. 128).

The letter of M. R. Zeiller to Mr. Jules Marcou, published in the paper to which reference was made (supra, p. 264), contains a remark which it is appropriate to quote here in connection with Dr. Emmons's determinations and Professor Fontaine's conclusions drawn from the original figures. M. Zeiller says:

In studying the excellent figures of Emmons, very roughly reproduced by Fontaine, I have been led to contest several of the attributions and determinations of the latter, more especially about the Albertia, which Fontaine wants to make an Otozamites. The *Albertia latifolia* of Emmons is certainly an Albertia related to both *Alb. latifolia* and *Alb. Brauni;* and until now all the Albertiæ have been found in Europe in the Buntersandstein or Lower Trias. [1]

It is interesting to know that the original specimen was found in the collection at Williamstown, redescribed and refigured by Professor Fontaine, who adheres to his formerly expressed opinion that the plant "is certainly not an Albertia," comparing it with *Otozamites Beanii* (L. and H.) Brongn. (see infra, pp. 298, 299, Pl. XLII, Figs. 5, 6).

Professor Fontaine stated in the beginning of this revision[2] that on inquiry he had learned "that Dr. Emmons's collections of plants were destroyed during the late war," and it was supposed that none of his specimens were in existence, but in the spring of 1890 a collection, long ago received by the Smithsonian Institution from Mr. Isaac Lea, of Philadelphia, consisting chiefly of shells, was examined by Prof. William H. Dall and found to contain a few fossil plants, which were turned over by him to the department of fossil plants of the National Museum, and thus came into my hands. Among these plants, most of which were from the Newcastle coal fields of England, were several specimens that Dr. Emmons had sent to Mr. Lea from North Carolina, and with them was a letter from the former to the latter, dated July 12, 1856, mentioning these plants, and setting forth some of the conclusions to which a study of the coal fields of the State had led him. The plants bore provisional names, but it was thought best that they be

[1] Am. Geologist, Vol. V, 1890, p. 172.
[2] Mon. U. S. Geol. Survey, Vol. VI, 1883, p. 97.

sent to Professor Fontaine for his inspection. This was done, and I introduce here his report upon them, as some of the results are important, and no better opportunity may present itself for their publication:

NOEL, VIRGINIA, *July 8, 1890.*

Prof. LESTER F. WARD.

SIR: I have examined the fossil plants of the Older Mesozoic (Trias) of North Carolina, which were formerly sent by Dr. Emmons to Dr. Isaac Lea, and which are now in possession of the United States National Museum.

I find among them the following forms:

Nos. 1 and 2. Asterocarpus virginiensis obtusiloba (in fruit).

No. 3. Fucoid, not capable of identification.

Nos. 4 and 5. Ctenophyllum Braunianum var. β Göpp.

No. 6. Apparently a root.

No. 7. Specimen not capable of identification.

No. 8. Equisetum, too vague to identify.

Nos. 9, 10, and 11. Specimens not capable of specific identification.

No. 12. Cheirolepis diffusa.

Nos. 1 and 2 are fruiting forms of *Asterocarpus virginiensis obtusilobus*. This species, before the discovery of this specimen, had been known only from the locality Clover Hill in the Richmond coal field. Emmons does not appear to have either figured or described it among the forms given in his American Geology. Possibly he may have identified it with his *Pecopteris falcatus*=*Laccopteris Emmonsi.*

No. 3. This is a cast of a fucoid which is too imperfect to be determined. There are in the collection several other specimens showing vague imprints of fucoids. They are too imperfect to call for further notice.

Nos. 4 and 5. These specimens are *Ctenophyllum Braunianum* var. β Göpp., or the form with shorter leaflets. This plant is figured and described in Emmons's American Geology as *Pterozamites obtusifolius*. From an inspection of the figures, I came some time ago to the conclusion that no good reason existed for separating this plant from Göppert's variety β of *Ctenophyllum Braunianum*. An examination of the plant itself confirms the conclusion. Emmons seems at first to have identified this species with Rogers's *Zamites obtusifolius*, and the labels accompanying these specimens bear this name. Later he regarded it as Pterozamites.

No. 6. This is marked by Emmons as coming from the coal shale, in which the fossil plants do not seem to be so abundant and in such variety as in the shales much higher up. The label with this specimen gives the name *Gymnocaulus alternatus*, but the impression does not show any significant character. It looks more like a root than anything else.

No. 7. As indicated by the label accompanying this specimen, Emmons regarded it as a Lepacyclotes, but it is too imperfect to show anything definite.

No. 8. This is an Equisetum, an imprint of the outer portion, but it is too indefinite to permit identification. It is most probably *E. Rogersii.*

Nos. 9, 10, and 11. These specimens are all too imperfect to permit their identification with certainty.

No. 12. This is a fine specimen, called by Emmons *Walchia diffusus*. With this name he gives a figure of the plant in his American Geology, pl. iii, fig. 2. From an examination of this figure, no specimens of the plant being accessible to me, I came with doubt to the conclusion (see Older Mesozoic Flora of Virginia, p. 106) that the plant is a Palissya. An examination, however, of a specimen of this form shows that it is not a Palissya, and also that it is not a Walchia. It requires a study of more than one specimen of the plant satisfactorily to make out its character, for although a fine specimen, it does not show distinctly some features. All that can now be said of it is that it is probably a new genus, in foliage at east, intermediate between Cheirolepis and Pachyphyllum, standing nearer the former. As this single specimen does not suffice to establish a new genus, it is perhaps best provisionally to regard the plant as a Cheirolepis. In that case it might be called *Cheirolepis diffusa.*

In this connection it is proper to state that although Emmons says that he made a rich collection of the North Carolina Older Mesozoic fossil plants, I know of the existence of no collection of these plants available for study.

Accompanying these plants of Dr. Lea there are several fine specimens of ganoid fishes obtained by Emmons from the shales associated with the coal of North Carolina. They are worthy of careful study.

Respectfully, WM. M. FONTAINE.

Dr. F. H. Knowlton received from Prof. I. C. Russell some pieces of fossil wood from the Trias of North Carolina, from which he made six slides. These have not thus far been figured, but after an examination of the slides Dr. Knowlton was able to make to Professor Russell the following statement, which the latter published in his Correlation Paper on the Newark System.[1] At my request Dr. Knowlton has kindly drawn the figures and furnished the following descriptive notes:

## DESCRIPTION OF A SMALL COLLECTION OF FOSSIL WOOD FROM THE TRIASSIC AREA OF NORTH CAROLINA.

By F. H. KNOWLTON.

In 1885 Prof. I. C. Russell, then of the United States Geological Survey, submitted to me a small collection of fossil wood made by himself in the Triassic area of North Carolina. He requested a brief report on this material, which I made, and which he published in his Newark System[1] in 1892. Recently Professor Ward, who is engaged on a systematic review of the fossil plants of the Triassic of this country, has asked for a more detailed description of this wood for use in his report. The following notes are the result of this study.

This collection consists of about a dozen specimens, representing the following localities: Triassic strata between Walnut Cove and Germantown; 1 mile west of Polkton; and Lockville, all in North Carolina. None of the material is well preserved, the structure having suffered greatly in the process of fossilization. Six of the best-preserved pieces were selected and thin sections cut from them. Of these, three proved to have been so poorly preserved as to be worthless for purposes of study, and the results obtained are therefore based on the three remaining pieces.

I stated in my brief report to Professor Russell[1] that, with the possible exception of one piece, I was able to identify them with *Araucarioxylon arizonicum* Knowlton,[2] a species described from the Shinarump group of Arizona and New Mexico, and since detected, or at most

[1] Correlation papers—The Newark system: Bull. U. S. Geol. Survey No. 85, 1892, p. 29.
[2] Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 3, pl. i, figs. 1-5.

only a slightly divergent variety of it, from the copper mines near Abiquiu, New Mexico.[1] Since preparing this report for Professor Russell I again looked over the slides in connection with the study of a number of pieces of wood from the Richmond Basin, Virginia, a report of which is given in the Nineteenth Annual.[2] Among the Richmond Basin specimens I found one having the same structure as those from North Carolina, which had previously been referred to *Araucarioxylon virginianum*. Although very close to the species from New Mexico and Arizona, there seem to be slight, but thus far constant, differences, and I gave the name *Araucarioxylon Woodworthi* to the specimen from the Richmond Basin. A more complete study of the material from North Carolina confirms this view, and it is so referred here.

In 1889 I described, under the name of *Araucarioxylon virginianum*,[3] a piece of fossil wood that was supposed to have come from the Potomac formation at Taylorsville, Virginia. Subsequent investigation has shown that this specimen came from Triassic strata, the locality where it was found being almost the only known place where the Potomac formation rests on the Triassic. The specimen from North Carolina mentioned in my report to Professor Russell as doubtful appears to belong to this species, although not agreeing in every particular. The following is a brief discussion of the two species based on the North Carolina material:

### ARAUCARIOXYLON WOODWORTHI Knowlton.

Pl. XXXVII, Figs. 7–9.

1899. *Araucarioxylon Woodworthi* Knowlton: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 517, pl. lii, figs. 1–6.

As may be seen in comparing the figures here given with those accompanying the original description of *A. arizonicum*,[4] the agreement between the woods from North Carolina and those from New Mexico and Arizona is very close indeed. The annual ring is very faint and is detected with difficulty. It consists of only two or three rows of smaller, thicker-walled cells. The wood cells are seen to be equally thick-walled from both localities. The wood cells in the Richmond Basin specimen are also identical.

The medullary rays in *A. arizonicum* are composed of 1 to 22 superimposed cells, whereas in this species, both from the Richmond Basin and from North Carolina, the number ranges from 1 to 12, the usual number being perhaps 4 to 6. The rays are short-celled in all.

The bordered pits as seen on the radial walls of the wood cells are

[1] Proc. U. S. Nat. Mus., Vol. XIII, 1890, p. 285.
[2] Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, 1899, pp. 516–519, pl. lii.
[3] Bull. U. S. Geol. Survey No. 56, p. 50, pl. vii, figs. 2–5.
[4] Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 3, pl. i, figs. 1–5.

in a single series, or rarely in two series. In the Richmond Basin specimen there is one, rarely two, and very rarely three series. When in a single row they are approximately circular; when in two or three rows they are very slightly compressed and hexagonal.

In tangential section the ends of the medullary rays are of course shown. They are seen to be composed of from 1 to about 12 superimposed cells. The wood cells as seen in this section are without the bordered pits that form so important a character in *A. arizonicum*.

As I took occasion to say in my report on the Richmond Basin material, this species is very closely allied to, if not indeed identical with, *Araucarioxylon arizonicum*, differing in having a less number of cells in each medullary ray, and particularly in the absence of bordered pits in the tangential walls of the wood cells. These are, however, not important differences, and a larger series of specimens might show the breaking down of this character, but for the present, at least, it may be regarded as distinct.

*Locality.*—Road between Walnut Cove and Germantown, North Carolina; collected by I. C. Russell, August 21, 1885. Near Lockville, North Carolina, collected by I. C. Russell, July 25, 1885.

### ARAUCARIOXYLON VIRGINIANUM Knowlton.

Pl. XXXVII, Figs. 1–6.

1889. *Araucarioxylon virginianum* Kn.: Bull U. S. Geol. Survey, No. 56, p. 50, pl. vii, figs. 2–5.

1899. *Araucarioxylon virginianum* Kn.: Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 516, pl. lii, figs. 7–10.

As stated above, this species was described from what was thought at the time to be Potomac strata, but which later investigation has shown to be undoubted Triassic. It was also detected in the Richmond Basin, as mentioned in my report on that material. Its presence is now demonstrated in the Triassic area of North Carolina.

On comparing the drawings here given with the original figures, it will be seen that the agreement is very close indeed. The medullary rays have about the same number of cells and the same characters. The pits on the radial walls of the wood cells are identical. When the pits are in a single row they are less evidently hexagonal, but when in two rows they are distinctly so. I therefore do not hesitate to refer the specimen to this species.

*Locality.*—Lockville, North Carolina; collected by I. C. Russell, July 25, 1885.

## THE EMMONS COLLECTION.

On the evening of March 28, 1894, at the close of a meeting of the Geological Society of Washington, before which I had read a paper on

The Potomac Formation, Dr. T. Nelson Dale, of Williams College, Williamstown, Massachusetts, approached me and asked if I was also interested in the flora of the Trias. When I informed him that I had been studying it for the last five years and had prepared an extended paper on it which I hoped sometime to publish, he volunteered the startling information that all of Dr. Ebenezer Emmons's types from the North Carolina coal fields were deposited at Williams College and were under his charge.

As it had been so frequently and confidently stated that these types were lost or destroyed during the war, this piece of news came as a revelation. I asked him if it would be possible to obtain access to them in order to have them reexamined by Professor Fontaine and a final report published upon them, and he said that so far as his authority went he would be glad to cooperate in securing this result. He said he had compared a number of them with the published figures and was certain that a portion at least of the type specimens were in the collection, and he presumed all. Indeed, he thought there was considerable material that had not been published.

I immediately wrote to Professor Fontaine and asked him if he would like to undertake to overhaul the collection and prepare a report. His interest was of course great and he consented to do so. He corresponded directly with Dr. Dale, and after some delay the desired result was brought about. In a letter to Professor Fontaine, dated May 10, 1894, Dr. Dale says:

DEAR SIR: I have at last found time to look over Emmons's fossil plants. The specimens from which the figures reproduced by you in your monograph on the Older Mesozoic were drawn are mostly here. I have identified the following:

Your pl. 48, figs. 6 and 8 (the latter slightly damaged, the former, 2 specimens).
Pl. 49, fig. 6.
Pl. 51, fig 1 (marked *Voltzia acutifolia*) and figs. 2, 3.
Pl. 52, fig. 6.
Pl. 53, figs. 4, 5 (of the latter a better specimen).
Pl. 54, figs. 4, 7.

There is one marked "impression of trunk of cycad" somewhat like your pl. 52, fig. 5.

Also the following: *Cycadites longifolius*, Calamites, Lepacyclotes with *Walchia diffusus*, *Walchia variabilis*. A *Sphenopteris egyptiaca* better than pl. 48, fig. 8.

Besides these there is a drawer 30 by 16 by 2½ inches, full of smaller specimens, many of them with his labels still attached.

Should you chance to be in New England sometime I would be pleased to give you every facility for studying the specimens, but I ought to be advised beforehand lest I should chance to be out of town.

Yours, respectfully, T. NELSON DALE.

The pressure of other work, however, delayed attention to this important matter for a period of over three years. I had become specially interested in the subject of cycads, and as several supposed cycads had been reported from the North Carolina coal fields by Dr. Emmons, I decided to visit Williams College and endeavor to find the types of his figures of these. I accordingly arranged with Dr. Dale to meet him there on July 17, 1897, and look at the collection and try to hunt up certain specimens. Every facility for this was placed at my disposal. I found two of the supposed cycadean trunks and took detailed notes upon them. One of those figured could not be found. Another proved to be merely an impression, but evidently that of a cycadean trunk. It is tolerably clear and is described and figured below with the specific name given to it by Professor Fontaine. Dr. Emmons practically recognized it as a Cycadeoidea (see infra, p. 302, Pl. XLIII, Fig. 3). Another specimen was found which was never figured. It is a disk of a small trunk, faintly showing scars around the edge. As Professor Fontaine has not in the report to follow dealt with this specimen, the following note written with the specimen before me may as well be recorded:

This is a thin segment of a small trunk. It consists of a gray coarse sandstone and is mainly a mere cast, but around the edge is a thin layer of a finer material on which there are faint indications of scars. The cross section is elliptical, 9 by 11 cm. The thickness (length of the trunk) is from 2 to 3 cm. On one side is a label with the words "Zamites, Stem of Cycad," probably in Dr. Emmons's handwriting.

Some time afterwards, at my request, Dr. Dale brought this specimen to Washington, and, through the kindness of Professor Diller, the most promising portions were ground slightly in the hope that something of the internal structure might be revealed, but it proved to be only a sandstone cast, all within being wholly structureless. Professor Fontaine, while engaged in working up this collection, as presently to be mentioned, examined this specimen, and in a letter to me dated August 5, 1898, he says:

> The disk of sandstone which you examined to see if it might be a cycad trunk, seems to be a cross section of a cylindrical cast of an Equisetum.

I am quite prepared to accept this conclusion.

A year later arrangements were made for working up the collection, and on August 3, 1898, Professor Fontaine went to Williams College and made an exhaustive study of the material, occupying over two weeks. He described all the species, but did not then figure them, making an arrangement with Dr. Dale to have the types that he selected to be figured sent to the University of Virginia and to the United States Geological Survey, Division of Illustrations, where the drawings could be made with all necessary care. Professor Fontaine elaborated his notes and completed his report in January, 1899, and the types not figured by him were drawn in the Division of Illustrations during the winter and spring. They were returned to Williams College in June.

This careful recension by Professor Fontaine of the classic collection of Dr. Emmons, so happily preserved to science, proves to be of course a most important consummation and sheds a flood of new light on the whole subject of the Older Mesozoic flora of America. Among other results, it has the effect of rescuing from an oblivious synonymy and uncertainty a number of Dr. Emmons's names, some of them dating back to his North Carolina report of 1856. In the synonymy of the species in Professor Fontaine's descriptive paper that follows, and for which I am alone responsible, I have endeavored to do full justice to Dr. Emmons's names by preserving them as having priority over all others. In a few cases these old species of Dr. Emmons also occur in the York deposits as made known by Mr. Wanner and embodied in an earlier part of this paper. In such cases, to avoid unnecessary repetition, the synonymy is given there and only a reference to it made here.

Prof. J. A. Holmes, State geologist of North Carolina, has recently found a few more of Dr. Emmons's Triassic plants, which he sent to Professor Fontaine. The latter informs me that there is nothing new among them, and has offered to send them to Washington.

The following is Professor Fontaine's report on the Emmons collection:

NOTES ON FOSSIL PLANTS COLLECTED BY DR. EBENEZER EMMONS FROM THE OLDER MESOZOIC ROCKS OF NORTH CAROLINA.

By WM. M. FONTAINE.

Dr. Ebenezer Emmons, when State geologist of North Carolina, collected a number of fossil plants in the Older Mesozoic beds of that State. In Pt. VI of his American Geology, published in 1857, he gave descriptions and figures of them. At a subsequent time the writer made collections of fossil plants from beds of apparently the same age in Virginia. Descriptions and figures of these were published as a Monograph of the United States Geological Survey, Vol. VI.

As it was apparent from a comparison of the Virginia fossils with the figures and descriptions given by Emmons of his plants that there was much resemblance in a number of cases, it was necessary for a satisfactory determination to examine Emmons's specimens. Emmons identified some of his forms with Virginia plants. It was quite possible that the number of plants known to him from the Virginia beds was much smaller than that collected by the writer. Had he been able to compare this larger collection with his own he would possibly have made additional identifications. Besides, the more complete series of specimens collected from the Virginia beds might throw light on plants that he, from more imperfect specimens, had erroneously determined. A careful inspection of his material would be required to settle these points. Accordingly efforts were made to locate the type specimens of the forms described in Pt. VI of the American Geology, but without success. Neither the types nor any of the fossil-plant material collected by Emmons could be found. That being the case, the figures given by Emmons were the sole dependence for comparison, and under the circumstances they could not be very satisfactory. It was thought best, then, to reproduce these figures in Monograph United States Geological Survey, Vol. VI, giving Emmons's descriptions, and to accompany them with such criticisms as would be suggested by the Virginia specimens. Even from the figures it could be seen that there was a larger number of plants common to the two States than Emmons had noticed. This review was embodied in the Monograph.

Recently, Prof. T. Nelson Dale, in examining the unsorted and unclassified fossils in the collections of Williams College, Massachusetts, found fossil plants which he recognized as having been collected by Emmons. This led him to think that probably the long-lost collection might be found to have been placed in Williams College, and he so stated to Professor Ward. Professor Ward, knowing its importance, visited Williams College, and after an examination of the specimens was convinced that they formed all that remained of Emmons's collection.

Dr. Dale only recently took charge of the collections of fossils in Williams College. He found a large mass of heterogeneous and unsorted material, and going over this for the purpose of labeling the specimens and placing them in cases for preservation, he found the fossils above alluded to. They were scattered among animal fossils and other specimens. No attempt had been made to keep them together and credit them to Dr. Emmons. A considerable number of the specimens were evidently as Emmons had packed them in collecting, and they were accompanied by his field labels, bearing the names of the plants and the localities yielding them. There is no record as to how these fossils came into the possession of Williams College, and no one prior to Dr. Dale's discovery knew of their existence. It is probable that they were presented to the college by Dr. Emmons after the publication of the descriptions, or by Mrs. Emmons after his death.

The collection made by Dr. Emmons will in all probability stand as the most complete one of the plant fossils of the Older Mesozoic of North Carolina. He made it under exceptionally favorable circumstances, which will most probably never be met with again. The rocks closely associated with the coal of North Carolina are the only ones that in future will probably be opened up and afford opportunity for the collection of plant fossils. If we may judge from Emmons's experience, they, unlike those similarly placed in Virginia, are very poor in plant fossils. Emmons found nearly all his specimens, and all his best-preserved and most interesting plants, in measures that have been proved to be without workable coal, and which occur, according to him, many hundred feet above the workable coal. It is not probable that in future these strata will be extensively explored. The case, however, was quite different when Emmons was State geologist. There was at one time great activity in the search for coal. The upper portion of the Older Mesozoic had not then been shown to be without workable coal. In a number of places these beds contain thin seams of coal, enough to have caused trial pits to be sunk. A great many of these pits were opened, and in a number of cases they afforded well-preserved plants. Emmons's position as State geologist gave him unusual opportunities both for hearing of the plants and for collecting them. Fortunately he appreciated the importance of taking advantage of them.

With the passing away of the inducement to search for coal in the upper measures all opportunity for collecting in them ceased. The shallow pits soon filled up and all trace of them disappeared, so that in time no one even remembered them. I had occasion to note these pits. When it proved impossible to find in North Carolina any trace of Emmons's collection it was thought advisable to visit the localities mentioned by him as giving him his most abundant and best fossils. This was done, and the outcome was complete failure to find Emmons's localities or any others. No one remembered them. The exposures of rocks are few and poor and showed no recognizable plants. It was evident that Emmons owed his success in collecting plants to the exceptional conditions mentioned above, under which he operated.

The Emmons plants found in the Williams College collections being the best representatives of the Older Mesozoic flora of North Carolina, Professor Ward requested me to study them. I visited Williams College in the summer of 1898 and made a careful examination of the North Carolina material. It is the object of this paper to give the results obtained.

In this material most of the plants figured and described by Dr. Emmons were found. There are, besides the type specimens, many duplicates of some of the forms and some that were not given in the published figures and descriptions.

# DESCRIPTIONS OF THE SPECIES.

## Subkingdom PTERIDOPHYTA (Ferns and Fern Allies).

## Class FILICALES.

### Family FILICES (Ferns).

### Genus SPHENOPTERIS Brongniart.

#### SPHENOPTERIS EGYPTIACA Emmons.

Pl. XXXVIII, Fig. 1.

1857. *Sphenopteris egyptiaca* Emm.: American Geology, Pt. VI, p. 36, figs. 8 and 9 on p. 37.

1885. *Acrostichites egyptiacus* (Emm.) Font.: Older Mes. Fl. Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 99, pl. xlviii, figs. 8, 8a.

Emmons, in American Geology, Pt. VI, pp. 36–37, figs. 8 and 9, gives a description of a fine fern, which he names *Sphenopteris egyptiaca.* He says it is found only in the coal-bearing portions of the North Carolina Mesozoic. It is the finest of the few plants that this portion of the measures has yielded. Emmons's fig. 8, so far as it goes, gives the character of the plant very well, but it gives only a portion of the imprint visible on the specimen in the collection, which is evidently the original of the figure. Fig. 8 of Emmons gives only parts of two ultimate pinnæ attached to a primary rachis on the right-hand side. The specimen shows much more of the plant. The facies of the ultimate pinnæ and of the pinnules is given very well in this figure, and fig. 9, which represents an enlarged pinnule, shows quite faithfully the details, so far as they can be made out. The impression of the plant on the stone is not very distinct.

The original specimen shows a considerable portion of two primary pinnæ, both of which contain more of the plant than Emmons depicts. The primary pinna, a portion of which he figures, had its rachis originally much larger than represented. There is shown on the right-hand side another ultimate pinna similar to those figured, going off as if it had been attached to the rachis prolonged above. Below the pinnules figured, and on the same side, there are portions of three other ultimate pinnæ, which evidently were originally attached to the rachis prolonged below. Emmons's figure shows, on the left-hand side, only the basal portions of two ultimate pinnæ that are without pinnules. But the specimen shows here two ultimate pinnæ with pinnules nearly as numerous and well preserved as those on the right-hand side. In addition there is found on the slab of stone, to the right of the primary pinna above described, a second pinna of the same character, but with a considerably smaller rachis. This has its lower termination, about 14 cm., distinct from the lower termination of the first-mentioned primary pinna, and it is so placed that if the two were prolonged downward they would meet under an angle of 45°. This smaller pinna looks as if it were sent off lower down from the larger rachis, or probably from near the summit of a common trunk.

This smaller rachis on the right is, like the first named, only a fragment. It has attached to it, on both sides, a number of ultimate pinnæ, carrying pinnules similar to those figured by Emmons, but somewhat smaller. There are also several ultimate pinnæ so placed as to indicate that they were attached to it lower down. It will be seen from this description that the fern must have had a wide spread and that it was much larger than is indicated by Emmons's figure. Emmons's figure of the principal rachis makes it too straight and rigid. It is really rather flexuous and shows ridges. The epidermis of the plant seems to be very durable, for it is now retained on the stone as a black, shining film. The pinnules are more obtuse than Emmons's figure indicates. I have represented one of these enlarged in Pl. XXXVIII, Fig. 1. This plant is much like *Acrostichites princeps* (Presl) Schenk,[1] but as it shows no fructification it can not be stated that it is an Acrostichites. The habit of the pinnules is much like that of the pinnules of *A. princeps*, which fact is not well shown in Emmons's figure. This makes the plant too rigid in aspect. The pinnules, however, are on an average larger than those of Schenk's plant, and if it is an Acrostichites it is almost a modified form or representative of *A. princeps*. But most probably it is a new species. The attitude of the two principal pinnæ indicates that they radiate from a common trunk, as Schenk represents in *A. princeps*.

## Genus LACCOPTERIS Presl.

### LACCOPTERIS LANCEOLATA (Göpp.) Presl n. comb. ?[2]

### Pl. XXXVIII, Figs. 2–4.

1836. *Asterocarpus lanceolatus* Göpp.: Syst. Fil. Foss., p. 382.
1838. *Laccopteris elegans* Presl in Sternberg: Flora der Vorwelt, Vol. II, p. 115, pl. xxxii, figs. 8a (1, 2, 3), 8b, 8c.
1857. *Pecopteris* sp. ? Emm.. American Geology, Pt. VI, p. 104, pl. vi, fig. 2.
1883. Undetermined fern (cf. *Laccopteris elegans* Presl) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, p. 105, pl. li, fig. 6.

Emmons[3] notes a small fern which he leaves undescribed, but he says of it that it is probably a Pecopteris. Judging from the aspect of the

[1] Foss. Fl. der Grenzschichten des Keupers und Lias Frankens, pp. 46–49, pl. vii, figs. 3, 3a, 4, 4a, 5; pl. viii, figs. 1, 1a.

[2] Göppert's name *Asterocarpus lanceolatus* has priority over Presl's by two years. He bases his description on the same plate and figures, which Sternberg seems to have sent him, so that there is no question of identity. The specific name given by Göppert must therefore stand. Although he credits it to Sternberg, there is no proof that Sternberg suggested it. It was probably a mere compliment, and it must be credited to Göppert, who first published it. L. F. W.

[3] American Geology, Pt. VI, p. 104, pl. vi, fig. 2.

plant as shown in this figure, and especially from the apparent digitate arrangement of the foliage, I was led to think it a Laccopteris, probably identical with *L. elegans* of Presl, and so stated in Mon. U. S. Geol. Survey, Vol. VI, p. 105. The original of the figure is in the Williams College collection of Emmons. This is the only specimen of the plant that I saw.

Emmons's figure does not give an exact representation of the plant. This figure indicates only two pinnules going off, diverging from a common point, whereas, in the specimen, there are three if not more. Two of them are as Emmons has indicated, and the third, standing on the left of the other two, is denoted by a very short portion of its base, where it was attached to the others. Hence it may be easily overlooked. The character of the plant is given in Fig. 2, Pl. XXXVIII. The basal pinnules differ from those higher up on the rachis. They are wider than long, with a rotundate-subquadrate shape. The nervation of these is like that of Odontopteris, while that of the higher ones is like that of Pecopteris. The form of the higher pinnules is not so Pecopteris-like as Emmons's figure makes them. Their bases are much the widest portions and they are decurrent. They are obliquely placed on the rachis. Fig. 3 gives an enlargement of the lower pinnules, and Fig. 4 of the upper ones.

The features seen make it still more probable that the plant is a Laccopteris like *L. elegans*, but as no fructification is shown, and the amount of material insufficient, it will be best to leave the determination doubtful.

## Genus ASTEROCARPUS Göppert.

### ASTEROCARPUS FALCATUS (Emmons) Fontaine.[1]

Pl. XXXVIII, Figs. 5, 6.

Many specimens of a large fern are in Emmons's collection which prove to be identical with *Asterocarpus virginiensis*, a common form in the Virginia Older Mesozoic. It is the most abundant plant collected by Emmons, *Lonchopteris oblonga*, standing next to it. The large number of specimens collected most probably indicates that the plant is in fact common in the Older Mesozoic of North Carolina. This agrees well with its occurrence in the Virginia beds, where it is one of the most widely distributed ferns, affording many good specimens.

In the North Carolina strata, as indicated by Emmons's specimens, both sterile and fertile forms occur, the former being much the more common. Most of the sterile forms contain long, narrow pinnules, the proportion of slender pinnules being greater than is shown in the Virginia specimens. On one specimen of shale from Ellingtons, three

[1] For synonymy, see supra, p. 237.

ultimate pinnæ are shown, one of them 10 cm long. They are numerous, long, slender pinnæ, and are so placed as to indicate that they were all attached to a principal rachis. This denotes a plant of large size, comparable with the large Virginia forms. While the long, slender pinnules are most common on Emmons's specimens, some of them show the short, very obtuse pinnules that are more common in the Virginia forms. Fig. 5 represents the more common form of Emmons's fossils. Fig. 4 gives a fragment of a penultimate rachis and a portion of an ultimate pinna that was probably attached to it. The ultimate pinna carries some pinnules of the shorter and proportionally broader form, which are less common.

Emmons, in Pt. VI of his American Geology, p. 100, pl. iv, fig. 9, describes a fern that he calls *Pecopteris falcatus*, and in fig. 5 of the same plate he gives an allied fern, which he says may be called *P. falcatus variabilis*. On pages 100–101, fig. 68, pl. iv, figs. 1, 2, he describes sterile and fruiting forms of what he regards as a different fern, and names it *P. carolinensis*. All of these are forms of the polymorphous *Asterocarpus virginiensis*. The different appearance of the sori in the forms regarded by Emmons as different species is due to the fact that the sori of the supposed *P. falcatus* are seen with the upper surface of the frond presented uppermost, while in the forms given as *P. carolinensis* they are presented with the lower surface of the frond uppermost and show their true character, which is that of *Asterocarpus virginiensis*. Emmons's figures of these plants are not good.

In reviewing these plants in Mon. U. S. Geol. Survey, Vol. VI, p. 102, I had to depend on Emmons's figures. I supposed that they represented plants that were constant in the different forms depicted, with no specimens forming a passage from one form to the other. Hence I accepted the conclusion of Emmons that two species are involved, and, from the fructification, I supposed them to be Laccopteris. I suggested that *Pecopteris falcatus* be called *Laccopteris Emmonsi* and *Pecopteris carolinensis* be named *L. carolinensis*.

## Genus MACROTÆNIOPTERIS Schimper.

### MACROTÆNIOPTERIS MAGNIFOLIA Schimper.[1]

Emmons makes mention of this fern, which is so common in the Virginia Older Mesozoic, in American Geology, Pt. VI, p. 102, but does not say where it occurs. He gives a figure (fig. 70, on p. 103) of a fern of this general character, with the lamina in segments, saying that this form occurs often, if not always, in this shape. Possibly this may really be an Anomozamites or Nilsonia.

I saw a fragment of a leaf 13 cm. long that is certainly *M. magni-*

[1] For synonymy, see supra, p. 238.

*folia.* The lamina on one side of the midrib is all missing and on the other side there is at most only a width of half an inch. This leaf does not seem to have been large, as the midrib is only 2 mm. wide.

### Genus DANÆOPSIS Heer.

#### DANÆOPSIS ? sp. Fontaine.

Pl. XXXVIII, Fig. 7.

Emmons's collection contains a small fragment of shale, with the locality not given, similar to that from Ellington's, that yields the best-preserved fossil plants, and on this there is shown a fragment of what must have been a very large pinnule, clearly of the Danæopsis type. In his published descriptions he makes no allusion to it. A label, however, evidently attached by him, is marked "Strangerites, in fruit."

The fragment is quite imperfect. It shows a portion of a stout rachis, which retains on both sides a small portion of the lamina, more on the left side than on the right. On each side there are parallel rows of small sori, which appear to have stood, originally, one on each side of the lateral nerves, as in *Danæopsis marantacea* (Presl) Heer. Of course, only the basal portions of the rows next to the rachis are preserved. The rows are arranged as they would be to follow the course of the nerves. They make at the rachis an acute angle with it, but farther off curve away, so as to make a right angle with it. Fig. 7 shows what is now to be seen on the specimen. The fragment is too imperfect to disclose fully the nature of the plant. It may be a fructified form of *Pseudodanæopsis nervosa*, or of *P. reticulata* Font. [*P. plana* (Emm.) Font.], both of which, in sterile form, appear to occur in the North Carolina Older Mesozoic. If we take the course of the sori as indicating the nature of the lateral nerves, they not being preserved, the plant is nearer to *Danæopsis marantacea* than either of these. The lateral nerves are in that case closer than in either of the species of Pseudodanæopsis and much resemble those of *D. marantacea.*

### Genus PSEUDODANÆOPSIS Fontaine.

#### PSEUDODANÆOPSIS PLANA (Emmons) Fontaine.[1]

Emmons gives, on p. 122, fig. 90, of the same work, a description of a plant nearly allied to the above, and this he calls *Strangerites planus*, thinking that both forms are cycads. This plant I identified, in Mon. U. S. Geol. Survey, Vol. VI, p. 116, from Emmons's figure, with *Pseudodanæopsis reticulata* of the Virginia Older Mesozoic. In Emmons's collection I saw a well-preserved fragment of a pinnule of this plant

[1]For synonymy, see supra, p. 238.

that shows about 6 cm. of its length, with margins well preserved, but not possessing the basal and terminal portions. This is probably Emmons's type specimen. It is without doubt *Pseudodanæopsis reticulata*. It shows all the characteristic features of the Virginia plant,[1] both in nervation and in the general character of the pinnules. These features are strongly marked and not common.

PSEUDODANÆOPSIS OBLIQUA (Emmons) Fontaine.

1856. *Strangerites obliquus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 325.

1857. *Strangerites obliquus* Emm.: American Geology, Pt. VI, p. 121, fig. 89 on p. 122.

1883. *Pseudodanæopsis nervosa* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, pp. 61, 116, pl. xxxi, figs. 1, 2; pl. liv, fig. 3.

Emmons, in American Geology, Pt. VI, pp. 121, 122, fig 89, gives a description of the pinnule of a large fern which, from its resemblance to *Pseudodanæopsis nervosa*, I was led to regard as identical with it, and so stated in Mon. U. S. Geol. Survey, Vol. VI, p. 116. The original of Emmons's figure was not seen in his collection, but a fragment of a large pinnule of a similar plant was found. This shows a portion of its margin with the characteristic marginal anastomosis of the nerves seen in the Virginia form. This, with the character of the pinnule and its strong, rarely branching, remote nerves, shows that without doubt the plant does occur in the North Carolina beds, and that probably the form described by Emmons is identical with it. It seems to have been rare, as only the fragment mentioned was seen. The nerves in Emmons's figured specimen owe their straggling character to distortion from maceration and pressure.

## Genus LONCHOPTERIS Brongniart.

### LONCHOPTERIS OBLONGA (Emmons) Fontaine.[2]

Pl. XXXVIII, Figs. 8–10.

Emmons gives[3] a representation of a fern with reticulate nervation, which he names *Acrostichites oblongus*. Fig. 8 is a good representation of one of the specimens in the collection, which, however, is now at least more fragmentary than the figure represents it to be. It is one of the smaller forms of this plant. In preparing Mon. U. S. Geol. Survey, Vol. VI, I was led, from an inspection of this figure, to think that this species is not an Acrostichites, but a Lonchopteris, as it resembles *L. virginiensis* of the Older Mesozoic of Virginia. I was confirmed in this view after examining the considerable number of specimens of this plant that occur in the collection of Williams College.

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[1] Mon. U. S. Geol. Survey, Vol. VI, pp. 59, 60, pl. xxx, figs. 1-4.

[2] For synonymy, see supra, p. 239.

[3] American Geology, Pt. VI, pl. iv, figs. 6, 8.

To judge from the number of specimens that Emmons obtained, which is quite large, this fern must have been one of the most common plants in the North Carolina beds. None of the pinnules seen equal in size those of the largest size in *L. virginiensis*. The plant, however, must have attained considerable size, for one of the penultimate rachises seen is 1 cm. wide. This specimen, which is represented in Fig. 8, Pl. XXXVIII, shows pretty well the general character of the larger forms of the fossil. The ultimate rachises are always strong in the forms with largest pinnules, as is shown in Fig. 9, which represents an ultimate rachis that carries pinnules of the largest size seen. The pinnules are never large, as is shown by the figure. Like the Virginia Lonchopteris, the leaf substance is thick and leathery, so that it masks the details of the nervation. This is the type of the genus, and it appears to be rather more closely reticulate than Emmons has represented it to be. The pinnules are generally oblong in shape and very obtuse at their tips. The smaller pinnules, however, such as are represented in Fig. 10, tend to be more acute. They are closely crowded together, but not imbricated as Emmons has represented them in his fig. 8. In the lower portion of the frond they are separate, but higher up become more and more united.

### Genus SAGENOPTERIS Presl.

#### SAGENOPTERIS EMMONSI Fontaine n. sp.[1]

Pl. XXXIX, Figs. 1–3.

Emmons, in his American Geology, Pt. VI, p. 104, pl. iv, fig. 10, describes a plant which he names *Cyclopteris obscurus*. In Mon. U. S. Geol. Survey, Vol. VI, p. 104, I identified this with *Sagenopteris rhoifolia*. An inspection of specimens of the plant makes it most probable that it is a different species. I did not see in the collection any specimen that appears to be the original of Emmons's figure, but there are several that plainly belong to the same plant. All the specimens are very imperfectly preserved. The most complete one is that represented in Pl. XXXIX, Fig. 1. The others are fragments of single leaves. One of the largest and the most perfect of them is represented in Fig. 3. The leaves are too poorly preserved to indicate with certainty what their size and exact shape were. They seem to have been of very thin texture and to have been grouped, after the fashion of Sagenopteris, at the summit of a common stem. Basal portions of two are shown in Fig. 7, which seem to be thus arranged. In shape they seem to have been oblong, widening toward their summits and narrowing to their

[1] In view of the doubts that Professor Fontaine expresses as to whether this is really the same as Emmons's *Cyclopteris obscurus*, and especially of the fact that the type specimen was not found at Williams College, I shall not treat it as the same plant by retaining Emmons's name for it, but as a new species, leaving the question of identity as it stood before. L. F. W.

bases. They appear to have been quite small—much smaller than the normal leaves of *S. rhoifolia.* The texture appears to have been much more delicate than that of the latter plant, but the most important difference is in the nervation. There is no trace of midrib or even of a parent nerve at the base of the leaves. Schimper makes the existence of a midnerve a feature in the character of Sagenopteris. If it is an essential one, then this plant is not a Sagenopteris. In the ultimate nervation the anastomosis occurs at long intervals, the nerves forking, and occasionally a branch uniting with an adjoining nerve. The method of anastomosing resembles that of Nathorst's genus Arthrophyopsis. Nathorst[1] describes, from the Rhetic flora of Bjuf, a plant with the name *Sagenopteris dentata* that is much like the one now in question. It has the same thin texture, absence of midrib, and sparse anastomosis, but the North Carolina plant, perhaps owing to its imperfect preservation, does not show any dentation.

## Genus ACROSTICHITES Göppert.

### ACROSTICHITES LINNÆÆFOLIUS (Bunbury) Fontaine.[2]

*Acrostichites linnææfolius*, a fern that is very characteristic of the Older Mesozoic of Virginia, is not given by Emmons as occurring in North Carolina. His mention of it on page 104 of Pt. VI indicates that he had not seen it in the North Carolina beds.[3] In his collection at Williams College I saw an imprint of a fragment of an ultimate pinna, containing a number of pinnules, which show the form of the sterile pinnules of this plant, and also the characteristic sori. The specimen had no label giving the locality, hence it is possible, but not probable, that it comes from the Virginia beds.

### ACROSTICHITES TENUIFOLIUS (Emmons) Fontaine.

Pl. XXXIX, Fig. 4.

1856. Undetermined plant. Emm.. Geological Report of the Midland Counties of North Carolina, p. 349, pl. iii, fig. 5.
1857. *Odontopteris tenuifolius*[4] Emm.: American Geology, Pt. VI, p. 105, pl. iii, fig. 5.
1883. *Acrostichides rhombifolius* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI., pp. 29, 105, pl. viii, figs. 2, 2a, 3, 3a, 3b; pl. xi, figs. 1, 1a, 2, 3; pl. xii, figs. 1, 1a, 2; pl. xiii, figs. 1, 1a, 2; pl. xiv; pl. xlix, fig. 7.

One of the type specimens of the plant described by Emmons[5] as *Odontopteris tenifolius*, was seen by me in his collection. It is the

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[1] Floran vid Bjuf, Vol. I, p. 27, pl. ii, figs. 5–7.
[2] For synonymy, see supra, p. 240.
[3] His figure (North Carolina Report, pl. i', fig. 6; American Geology, Pt. VI, pl. vi, fig. 6) is a copy of the upper part of Bunbury's, in Quart. Jour. Geol. Soc. London, Vol. III, 1847, pl. x. L. F. W.
[4] Misprinted "Odontopteris tenifolius."
[5] American Geology, Pt. VI, p. 105.

original of Emmons's fig. 5 on pl. iii. In my review of Emmons's plants, published in Mon. U. S. Geol. Survey, Vol. VI, pp. 105–106, I was led, judging from Emmons's fig. 5, to regard this plant as identical with *Acrostichites rhombifolius*, a fern that is characteristic of the Older Mesozoic of Virginia. An inspection of the specimen confirms me in that belief. Emmons's fig. 5, pl. iii, gives pretty well the general aspect of this, the only specimen seen. It does not, however, represent the pinnules of the lower pinnæ quite as wide and as much separated as they are in the original. The nerves of this latter are not very distinct, but they show the character of those of *A. rhombifolius*. I give in Pl. XXXIX, Fig. 4, a representation of a few of the lower pinnules on a pinna, to indicate their character on the specimen. I did not see the original of pl. vi, fig. 1. Possibly that is a different species.

## Class EQUISETALES.

### Family EQUISETACEÆ.

#### Genus EQUISETUM Linnæus.

EQUISETUM ROGERSII (Bunbury) Schimper.[1]

In the collection there are several fossils which are much flattened casts of the stems of an Equisetum and several imprints, which were made by the exterior surface of apparently the same species of plant. Both are exactly like the markings left by similar parts of *Equisetum Rogersii*, as found in the Older Mesozoic of Virginia. Hence there can be little doubt that this plant is found in North Carolina. Emmons, in American Geology, Pt. VI, p. 35, describes a form which he calls *Calamites punctatus* and refers to pl. ii, fig. 5, for a figure of it. Plate ii is absent, but pl. vi, fig. 5, gives a plant that agrees with his description.[2] In my review published in Mon. U. S. Geol. Survey, Vol. VI, p. 98, I concluded that this is not an Equisetum, but a fragment of a leaf of *Sphenozamites Rogersianus*. I saw nothing like it in the collection and have no reason to change my opinion. The original, also, of Emmons's *Equisetum columnaroides*, described in American Geology, Pt. VI, p. 35, and figured in pl. vi, fig. 3 (given by Emmons as pl. ii, fig. 3), was not seen. The casts above mentioned are quite different from each of these fossils as described by Emmons, and they show the finely striate surface so characteristic of the casts of the Virginia plant, which has been called *Calamites arenaceus*.

Emmons gives in pl. vi, fig. 9 (p. 109), the figure of a form which

[1] For synonymy, see supra, p. 241.

[2] It is pl. ii, fig. 5, of the earlier Geological Report of the Midland Counties of North Carolina, which Professor Fontaine did not use. The plates are the same in the two volumes, but pl. ii of the earlier is plate vi of the later one. On p. 349 (description of the plates) of the former, Dr. Emmons says of this figure: "Leaflet of an undescribed plant." He does not mention it in the text. L. F. W.

he named *Equisetum columnare*. This in its markings is more like the imprints made by the exterior of the stems of *E. Rogersii* above mentioned, but these last do not show the teeth on the sheath as Emmons's figure does in its upper part. The original of Emmons's figure was not seen. His *Calamites disjunctus* is an imprint of the same nature as *Calamites arenaceus*.

### Genus SCHIZONEURA Schimper.

#### SCHIZONEURA PLANICOSTATA (Rogers) Fountaine?

1843. *Calamites planicostatus* Rogers: Trans. Assoc. Am. Geol. and Nat., Philadelphia, 1843, p. 305.

1883. *Schizoneura planicostata* (Rogers) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 14, pl. i, fig. 1.

One imprint of the interior of a stem was seen that has features presented by fossils found in the Older Mesozoic of Virginia, which I regarded as probably a new species of Schizoneura, and named it *S. planicostata*. The Williams College specimen has the same kind of raised lines or ribs on the imprint. They are decidedly wider and stronger than the lines formed by the interior of the stems of *Equisetum Rogersii* and appear to belong to a quite different plant. I do not positively identify it with *S. planicostata*, on account of the small amount of material. Emmons makes no mention of such a plant.

## Subkingdom SPERMATOPHYTA.

## Subdivision GYMNOSPERMAE.

### Class CYCADALES.

### Family CYCADACEÆ.

The cycads of Emmons's collection are the most important type of plants both in number of species and in abundance of individuals. It is important to note that they are, as Emmons states, found only in his upper series, 1,500 to 2,000 feet above the beds that contain coal.

## Genus PTEROPHYLLUM Brongniart.

### PTEROPHYLLUM DALEANUM Ward nom. nov.[1]

1857. *Pterozamites pectinatus* Emm.: American Geology, Pt. VI, p. 117, fig. 84.
1883. *Pterophyllum pectinatum* Font.. Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 112, pl. liii, fig. 4.

In American Geology, Pt. VI, p. 117, fig. 84, Emmons gives a description of a cycad which he calls *Pterozamites pectinatus*. The type specimen is in his collection, and fig. 84 gives a very accurate delineation of it. In Mon. U. S. Geol. Survey, Vol. VI, p. 112, I expressed the opinion that it is a new Pterophyllum, near to *P. Lyellianum* of Dunker. An examination of the fossil shows that it is a true Pterophyllum, and a new species. It is a beautiful specimen, and remarkably well preserved for so delicate a plant. As Emmons says, the leaflets are narrow, many nerved, and stand at right angles to the strong midrib. It may be added that they are obtuse at their tips, and are thin in texture. They are a little over 1 mm. wide and 2 cm. long, and stand close together.

## Genus ANOMOZAMITES Schimper.

### ANOMOZAMITES ? EGYPTIACUS Fontaine n. sp.

Pl. XXXIX, Fig. 5.

One of the few plants that Emmons obtained from the coal-bearing portion of the Older Mesozoic of North Carolina is the fine specimen of what he calls *Sphenopteris egyptiaca*. On the slab which bears this specimen is a rather obscure imprint of a fragment of what seems to have been a large leaf. It shows only a portion of the lamina or leaflets on one side of the midrib. None of the latter are certainly preserved, for the leaflets, in part, seem to have been torn off close to it. In one or two of the supposed leaflets there is an indication that a thin strip of the midrib is still preserved. The segments look in some respects much like *Pterophyllum affine* Nath., which occurs in the Virginia beds.[2] It resembles this plant in its fine, parallel, single nerves, which go off at right angles with the midrib, but is unlike it in the great inequality of its leaflets. These stand at right angles with the midrib, and have their margins parallel. They do not show

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[1] Both the earlier names are anticipated. Brongniart (Tableau, 1849, p. 62) says that his *Zamites pectinatus* (*Zamia pectinata*, Prodrome, 1828, p. 94) is a Pterozamites, and a number of authors have referred this same plant from the Oolite of Stonesfield, in England, to the genus Pterophyllum. The earliest such reference that I have been able to find is in the Précis élémentaire de Géologie, par J. J. d'Omalius d'Halloy, Paris, 1843, p. 481. It is true that these are all synonymys of Sternberg's *Polypodiolites pectiniformis* (Flora der Vorwelt, Vol. I, fasc. iii, 1823 p. 39, pl. xxxiii, fig. 1), but for that reason as well as for others the specific name must be dropped.

In naming this elegant species for Dr. T. Nelson Dale, I wish to express a small part of the gratitude that all who are interested in the subject feel toward him for bringing to light, in the manner described, this long-lost scientific treasure—the Emmons collection. L. F. W.

[2] Mon. U. S. Geol. Survey, Vol. VI, p. 66, pl. xxxii, figs. 2–4.

their tips, as they are torn off. The width of the leaflets varies from 11 mm. to 25 mm. or more, for the widest one, as shown in Fig. 5, is not wholly preserved. Possibly the plant is a Nilsonia, as the mode of attachment of the leaflets is not certainly shown. They seem, however, to have been attached to the side of the midrib. The general facies and nervation are unlike those of *Macrotæniopteris magnifolia*, even if we admit the segmentation to be identical. This plant resembles slightly the form mentioned above as figured by Emmons for *Tæniopteris magnifolia* of Rogers. Emmons says, as quoted before, that it is often, if not always, divided into segments down to the midrib.

It is, of course, not possible to determine from this amount of fragmentary material the true position of this plant. It should be noted that the expression quoted from Emmons implies that the plant is rather common, but he says nothing explicit regarding its occurrence, and does not mention the locality yielding it. It is significant that the constancy of its segmentation attracted Emmons's attention, and suggested the idea that it might not be accidental. In the hundreds of specimens from the Virginia Older Mesozoic that I saw many were variously lacerated, but it was always evident that the segmentation was accidental.

## Genus CTENOPHYLLUM Schimper.

### CTENOPHYLLUM BRAUNIANUM ANGUSTUM (Friedrich Braun) Schimper.

### Pl. XXXIX, Figs. 6, 7.

1843. *Pterozamites angustus* Fr. Braun in Münster' Beiträge zur Petrefactenkunde, Vol. II, Pt. VI, p. 30.
1856. *Pterozamites decussatus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 330, pl. iii, fig. 1.
1856. *Zamites graminioides* Emm.: Op. cit., p. 330 (*Dionites graminoides*, p. 349), pl. iv, fig. 11.
1856. *Pterozamites* sp. Emm.: Op. cit., p. 349, pl. iii, fig. 8.
1857. *Pterozamites spatulatus* Emm.: American Geology, Pt. VI, p. 120, fig. 88.
1857. *Dionites linearis* (*Zamites graminoides*) Emm.: Op. cit., p. 121, pl. iv, fig. 11.
1867. *Pterophyllum Braunianum* var. *α* Schenk: Foss. Fl. der Grenzschichten des Keupers und Lias Frankens, p. 164, pl. xxxviii, fig. 6.[1]
1870. *Ctenophyllum Braunianum* var. *α* (Schenk) Schimp.. Traité de Paléontologie Végétale, Vol. II, p. 144.
1883. *Pterophyllum decussatum* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 111, pl. li, fig. 2.
1883. *Pterophyllum spatulatum* (Emm.) Font.: Op. cit., p. 114, pl. liii, fig. 6.

There are in Emmons's collection several fine impressions of *Ctenophyllum Braunianum* var. *α*. They differ in no respect from the typ-

[1] Schenk leaves no doubt that his var. *α* here is the *Pterozamites angustus* of Braun in Münster's Beiträge. It is therefore much better to restore Braun's name with varietal rank than to perpetuate the awkward designation by a Greek letter. L. F. W.

ical form of this plant that is so common in the Older Mesozoic of Virginia. None of them, however, are as large specimens as some obtained from the Virginia beds. The number of specimens in the collection is proportionally large, and this fact seems to indicate that in the strata of North Carolina, as in those of Virginia, the fossil is a common one. Fig. 6 of Pl. XXXIX gives a portion of the midrib and parts of several leaflets taken from a specimen 9 cm. long, with numerous leaflets on each side of the midrib.

Emmons gives, in American Geology, Pt. VI, p. 121, pl. iv, fig. 11, a description of a form that he calls *Dionites linearis*. The original of this was found in his collection. The specimen shows leaflets slightly wider than those drawn by Emmons. He represents the bases of some of the leaflets as inserted on the upper face of the midrib. This appearance is caused by distortion due to pressure. The bases have slipped over slightly, owing to the creeping of the shale. The plant is, no doubt, a form of *Ctenophyllum Braunianum* var. $\alpha$ that is somewhat narrower in its leaflets than the average. Perhaps this narrowing is also due to pressure. The type specimen of *Pterophyllum decussatum* was also seen.

Emmons's fig. 1 on pl. iii gives an exact representation of this fossil. It is clearly *Ctenophyllum Braunianum* var. $\alpha$. The specimen belongs to a lower portion of the leaf, but the leaflets probably did not originally stand so exactly at right angles with the midrib. They probably were brought into this position by pressure. The shale on which these fossils are preserved seems sometimes to have crept, under the action of pressure, producing more or less displacement of the parts of the fossils.

Emmons gives, on p. 120 of his work, a description of a form which he calls *Pterozamites spatulatus*, representing it by fig. 88. The original of this was found in his collection, and it is given in Fig. 7 of this paper. Emmons's figure is erroneous and would completely mislead one. He represents all the leaflets on the right side of the midrib as showing their original terminations. None of them do this, and they were originally longer than the parts they now show. The narrowing of the leaflets toward their bases, as represented by Emmons, is much more decided than that shown in the specimen. What is present appears to be due mainly to pressure, which has in the basal parts pushed the margins down in the shale to a slight extent. The basal portions are not so far apart as Emmons represents them to be. The specimen now in question is the only one seen that has any tendency to a spatulate shape. There can hardly be a doubt that this is a distorted specimen of *Ctenophyllum Braunianum* var. $\alpha$.

### Ctenophyllum Braunianum abbreviatum (Friedrich Braun) Schimper.

Pl. XXXIX, Figs. 8, 9.

1843. *Pterozamites abbreviatus* Fr. Braun in Münster: Beiträge zur Petrefactenkunde, Vol. II, Pt. VI, p. 30.
1843. *Zamites obtusifolius* Rogers: Trans. Assoc. Am. Geol. and Nat., Philadelphia, p. 312, pl. xiv, lower left-hand figure.
1857. *Pterozamites obtusifolius* (Rogers) Emm.: American Geology, Pt. VI, p. 118, fig. 85.
1857. *Pterozamites gracilis* Emm.. Op. cit., p. 118, fig. 86 on p. 119.
1867. *Pterophyllum Braunianum* var. $\beta$ Schenk: Foss. Fl. der Grenzschichten des Keupers und Lias Frankens, p. 164, pl. xxxviii, fig. 2.[1]
1870. *Ctenophyllum Braunianum* var. $\beta$ (Schenk) Schimp.: Traité de Paléontologie Végétale, Vol. II, p. 144.

Emmons, in American Geology, Pt. VI, gives on pp. 118–119 a description, with figs. 85, 86, of two cycadaceous forms, which are the var. $\beta$, with shorter leaflets, of Göppert's *Ctenophyllum Braunianum*. Numerous specimens were seen in his collection of cycad leaves that range in character from the smaller leaf, which he calls *Pterozamites gracilis*, to the larger form, which he names *P. obtusifolius*. Leaves with still larger leaflets, belonging, however, to this species, occur in the collection. Figs. 8 and 9 of Pl. XXXIX show common forms of the leaves seen. To judge from the number of specimens collected by Emmons, this plant must have been one of the most common ones in the Older Mesozoic of North Carolina. It was not seen in the Virginia strata. The leaflets are not quite so obtuse as Emmons has represented them in both his *P. obtusifolius* and *P. gracilis*.

### Ctenophyllum lineare (Emmons) Fontaine.

1857. *Pterozamites linearis* Emm.: American Geology, Pt. VI, p. 120, fig. 87.
1883. *Ctenophyllum lineare* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 114, pl. liv, fig. 2.

Emmons gives a description of a small cycad which he calls *Pterozamites linearis*. His fig. 87 is a very good representation of the plant, as is shown by the type specimen, which occurs in his collection. It is the only specimen seen of this cycad. It seems to be a Ctenophyllum of the same type as *C. Braunianum* var. $\beta$, and possibly may be a narrow abnormal form of it. It is, however, probably a distinct species, as the leaflets are much narrower and more crowded than those of *C. Braunianum* var. $\beta$.

[1] Schenk here leaves no doubt that his var. $\beta$ is the *Pterozamites abbreviatus* of Braun in Münster's Beiträge. It is therefore much better to restore Braun's name with varietal rank than to perpetuate the awkward designation by a Greek letter.
L. F. W.

### Ctenophyllum robustum (Emmons) Fontaine.

Pl. XXXIX, Fig. 10.

1857. *Pterophyllum robustum* Emm.. American Geology, Pt. VI, p. 122, fig. 91 on p. 123.
1857. *Pterophyllum robustum* var.? Emm.: Op. cit., p. 123, fig. 92.
1857. *Pterozamites obtusus* Emm.: Op. cit., p. 119, fig. 86a.
1883. *Ctenophyllum robustum* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 116, pl. liv, figs. 6, 7.
1883. *Ctenophyllum Emmonsi* Font.: Op. cit., p. 113, pl. liv, fig. 1.

Emmons gives, in American Geology, Pt. VI, pp. 122, 123, figs. 91, 92, a description of a cycad which he calls *Pterophyllum robustum*. I did not find in his collection any form corresponding to his fig. 92, which represents the terminal portion of a leaf. Only one imprint with its reverse was seen. This is evidently the original of Emmons's fig. 91. This figure represents the ends of the leaflets as entire, whereas the specimen shows, on careful inspection, that the original tips are wanting. The plant may be a Pterophyllum, but the oblique position of the leaflets seems to be the natural one. It is more likely to be a Ctenophyllum.

I did not see the original of Emmons's fig. 86a, given to represent what he calls *Pterozamites obtusus*. The plant represented by it does not seem to be different from *Ctenophyllum robustum*. Pl. XXXIX, Fig. 10, gives a representation of some of the leaflets of *C. robustum*, to show how the ends of the fragments of leaflets were left in such shape that casual inspection might determine them to be true tips. Emmons's fig. 91 gives correctly the dimensions of the leaflets, their closely crowded, oblique position, and the number (8 or 9) of the strong nerves. But the leaflets narrow slightly toward their tips and are somewhat decurrent.

## Genus PODOZAMITES Friedrich Braun.

### Podozamites longifolius Emmons.

Pl. XL; Pl. XLI.

1856. *Cycadites longifolius* Emm.: Geological Report of the Midland Counties of North Carolina, p. 330.
1856. *Podozamites longifolius* Emm.: Op. cit., p. 331.
1857. *Cycadites longifolius* Emm.: American Geology, Pt. VI, p. 115, fig. 82.
1857. *Podozamites longifolius* Emm.. Op. cit., p. 116, fig. 83.
1883. *Dioonites longifolius* (Emm.) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, pp. 111, 122, pl. liii, fig. 5.
1883. *Podozamites Emmonsi* Font. non Newb.: Op. cit., p. 77, pl. xxxiii, fig. 2.

Emmons gives, in American Geology, Pt. VI, p. 116, fig. 83, a representation of a fine cycad which he calls *Podozamites longifolius*. The figure unfortunately represents a distorted specimen, and hence the true facies of the plant is not given. I found among Emmons's specimens a number of well-preserved impressions of a fine plant that had not been described in his account of the North Carolina fossils. A careful examination of them, and of the cycads described by him, convinced me that these apparently new plants are the undistorted forms of the plant given in his fig. 83. Notwithstanding the fact that Emmons's description and figure give an incorrect impression, I shall retain his name for the plant, as there is no convincing evidence that it is not a Podozamites, while the specific name *longifolius* is justified by the length of the fragments of leaves. These indicate that the entire leaves must have had great length. In the same work (p. 115, fig. 82) Emmons gives a description of a form which he calls *Cycadites longifolius*. His figure does not indicate the presence of a midrib, a fact mentioned by Emmons. He states that the midrib is indicated only by a longitudinal channel, because "the frond adheres to the rock by the back." From this he does not seem to have distinctly seen a midrib. I have seen in the collection no cycad with a midrib like this figure, but some of the forms of *Podozamites longifolius* strongly resemble it. Moreover, in *P. longifolius*, which has thick leaflets, there is often a deceptive appearance, which at first sight gives the impression of a midrib. Careful inspection, however, shows that it is due either to a wrinkle in the middle of the leaflets or to a film of carbonaceous matter that remains there. In both these species of Emmons the leaflets are represented as not narrowing much at their insertion on the midrib. That is due to the fact that both of the specimens figured present their lower surface uppermost, and the actual insertions are covered by the broad midrib. Specimens of *Podozamites longifolius* that present their lower face uppermost have the insertions of their leaflets disguised in this way.

The following may be given as the description of *Podozamites longifolius:*

The texture was thick and apparently leather-like. The leaves probably attained the length of half a meter or more. The general facies of the leaf is much like that of *Dioonites Buchianus*, having the leaflets of the lower part of the [illegible]ib so set on the midrib as to make an angle with it of 45° or more. Toward the summit of the leaf the leaflets are inserted under more and more acute angles, while at the summit there is a terminal leaflet that is found in the direction of the prolongation of the midrib. Pl. XL gives a form that belongs to perhaps the middle of the leaf. It shows the true attitude of the leaflets only in the lower ones on the right-hand side, the others going off under too large an angle, owing to distortion from pressure. The midrib is strong and ridged. Portions were seen 6 to 7 mm. wide, but these were not the largest parts, as the petioles and basal portions are represented in none of the fossils. The texture of the leaflets was thick and leathery, so as to hide the nerves. These could not be seen distinctly, but they appear to have the character of those of Podozamites. The leaflets are widest not far above their bases, and grow narrower very slowly toward their tips. They end in a lancet-shaped tip. At their bases they are abruptly narrowed and rounded into a very short petiole, by which they are inserted on the midrib. They are then in general shape linear. Pl. XL gives the specimen with the largest ones seen, and these have probably the maximum size attained. In this specimen the tips of none of the leaflets are preserved, but enough is shown to indicate that they were a little more than 7 cm. long. Their maximum width is 6 mm. The insertion of the leaflets on the midrib is mostly on the side. In some the insertion seems to be on the upper face of the midrib and slightly within its margins. Possibly this appearance may be due to pressure, which has caused the bases to slip over on the upper face of the midrib. The insertion is made by what does not seem to be a true petiole, but rather a much narrowed and thickened portion of the base. Pl. XLI shows a form that is the terminal portion of a leaf, and it is apparently the terminal part of the leaf the lower portion of which is represented on Pl. XL. Here the leaflets grow smaller and shorter and are set on more and more obliquely. This part of the leaf seems to end with a leaflet lying in the direction of the prolongation of the midrib.

As shown by the specimens collected by Emmons, there are in the Older Mesozoic strata of North Carolina at least two species of this type of plant. Emmons detected this fact. He described the form with larger leaflets in American Geology, Pt. VI, p. 116, pl. iii, fig. 7, calling it *Podozamites lanceolatus*. As it is not the *P. lanceolatus* of the Jurassic, Dr. Newberry suggested that it be named *P. Emmonsii*. Emmons's figure of it is not very good. It is clearly a different species from *P. longifolius*. I found a plant in the Older Mesozoic of Virginia of the same type with Emmons's species, and with some hesitation identified it with the latter,[1] from oversight, not crediting Dr. Newberry with suggesting the specific name *Emmonsii*. Since I have had the opportunity to examine Emmons's specimens I am satisfied that the Virginia fossil is not the same as the larger form, which must retain the name *Emmonsii*, but is *P. longifolius*. There is a marked resemblance between this type of plant and the genus Nageiopsis of the Younger Mesozoic of the Potomac formation. I am inclined to the opinion that such plants as *Podozamites Emmonsii*, *P. longifolius*, and *P. tenuistriatus* are not cycads, but conifers allied to the Nageia section of Podocarpus, and perhaps ancestral forms of Nageiopsis. Of course, until they show branching forms, or some other feature not belonging to the cycads, they must be left in the old group of Podozamites.

[1] Mon. U. S. Geol. Survey, Vol. VI, pp. 77, 78, pl. xxxiii, fig. 2.

PODOZAMITES EMMONSII Newberry.

Pl. XLII, Figs. 1, 2.

1856. *Podozamites lanceolatus* Emm. non (L. and H.) Fr. Braun: Geological Report of the Midland Counties of North Carolina, p. 331, pl. iii, fig. 7.
1857. *Podozamites lanceolatus* Emm.: American Geology, Pt. VI, p. 116, pl. iii, fig. 7.
1866. *Podozamites Emmonsii* Newb. in Pumpelly: Geological Researches in China, Mongolia, and Japan; Smithsonian Contributions to Knowledge, No. 202, p. 121, pl. ix, fig. 2.

The figure given by Emmons of this plant, as before stated, is, I think, misleading. I did not find the specimen that he illustrated, but saw others that appear to belong to this species. They are not *P. longifolius*, and agree pretty well with Emmons's figure. If we may judge from these, the figure mentioned makes the leaflets too rigid in aspect, with a petiole too long and strong. The basal portions, also, are made to appear too thick. Emmons makes all the insertions of the leaflets well within the margins and on the upper face of the midrib. They appear to be arranged in a long spiral, like those of *P. longifolius*. Some of the insertions are on the upper face and some on the side. The leaflets contrast strongly with those of *P. longifolius*. They are thin in texture and show the nerves very distinctly. The latter are as given by Emmons. The leaves are wider, in proportion to their length, than those of *P. longifolius*, but the width, in proportion to length, is not quite so great as is given by Emmons. Fig. 1 of Pl. XLII gives the most complete specimen seen by me. It is much more fragmentary than the specimen figured by Emmons. The leaflets appear to be more deciduous than those of *P. longifolius*. Emmons mentioned that some of the detached leaflets are half an inch wide. I saw none so large. Fig. 2 shows the largest seen. Possibly this is a different species from both of those described.

PODOZAMITES TENUISTRIATUS (Rogers) Fontaine.

Pl. XLII, Fig. 3.

1843. *Zamites tenuistriatus* Rogers: Trans. Assoc. Am. Nat. and Geol., Philadelphia, p. 314.
1883. *Podozamites tenuistriatus* (Rogers) Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 78, pl. xlii, figs. 2, 3, 3a, 3b, 4, 5; pl. xliv, fig. 3.

Emmons does not seem to have seen in the North Carolina beds *Podozamites tenuistriatus*, which, perhaps, is the most common cycad of the Older Mesozoic of Virginia. His collection at Williams College, however, shows several well-characterized specimens of this species. They agree best with the larger forms as shown in the Virginia beds, but some of the leaflets are rather larger than any seen in the Virginia strata. Pl. XLII, Fig. 3, represents one of the specimens with small leaflets.

### PODOZAMITES ? CAROLINENSIS Fontaine n. sp.

Pl. XLII, Fig. 4.

One of the specimens in Emmons's collection seems to be a Podozamites of a species different from any hitherto described. It is nearest to *P. tenuistriatus*, but has leaflets that are decidedly larger than any shown by that plant, besides differing in other respects. I hesitate to regard it as a new species, on account of the small amount of material, only one specimen being seen. This specimen is the terminal portion of a leaf. It is well preserved. The lowest leaflets seen go off at an angle of about 40°. Higher up they are more obliquely placed. The terminal ones lie in the prolongation of the midrib. The leaflets are long in proportion to their width. None of them are entire. The longest fragment seen is 5 cm. long, indicating an original length of about 7 cm. At their bases they narrow gradually, so that the basal part is elliptical in shape. They are attached to the side of the midrib by a very short, thickened, much narrowed portion of the leaflet. In the leaflets lower down on the midrib this thickened portion may appear as a petiole, and the leaflets may be in part attached to the upper face of the midrib and be alternate. In this terminal portion of the leaf they are opposite. They are linear in form, varying little in width from the average, which is 3 cm. The nerves are distinct, as the texture of the leaflets was thin. They resemble those of *P. tenuistriatus*, being fine and closely placed. Possibly this is a large variety of *P. tenuistriatus*, but the dimensions of the leaflets at the end of the leaf, as seen here, indicate a much larger plant. The general aspect of the specimen, and especially of the terminal leaflets, reminds one strongly of *Dioonites Buchianus* of the Lower Cretaceous, but the basal portions and mode of attachment of the leaflets are different.

## Genus OTOZAMITES Friedrich Braun.

### OTOZAMITES CAROLINENSIS Fontaine.

Pl. XLII, Figs. 5, 6.

1857. *Albertia latifolia* Emm. non Schimp.:[1] American Geology, Pt. VI, p. 126, fig. 95.
1883. *Otozamites carolinenesis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, pp. 117, 118, pl. lii, fig. 6.

Emmons has given, in Pt. VI, pp. 126, 127, fig. 95, a description of a fossil which he names *Albertia latifolia*. The original of this is in his collection at Williams College, and besides that, some detached leaflets and a second imprint showing several attached leaflets. The original of Emmons's fig. 95 is preserved on an argillaceous sandstone, which is not fitted to retain the finer details, and, in addition, the

[1] See letter of M. René Zeiller to Jules Marcou, cited above (p. 270).

specimen is much distorted by pressure, so that it does not appear so distinct as Emmons has represented. The stem to which the leaflets were attached is not so continuous or well defined as it is given in the figure. It is broken up, and, in places, pressed down into the sandy material. None of the leaflets are so distinctly outlined and entire as he makes some of them to be. The striation that he gives on them is not shown in the original, for the rock is too coarse in texture to show any such feature. The leaflets are, in fact, so distorted from the doubling down of their margins into the rock that the true character of the plant could hardly be made out from this specimen. Fortunately the imprint given in Pl. XLII, Fig. 5, has one leaflet, the lower right-hand one, that possesses still enough of its original character to give a good idea of it. All the others on this specimen are imperfect. Even this best-preserved leaflet has the lower portion of its base doubled under and hidden in the rock, and the outer or lower margin is also slightly bent down into the rock. Still, from this and other leaflets seen, a good deal of the true nature of the fossil can be made out. The character seems to be as follows:

The stem is rather stout. The leaflets had a rather thick, leathery texture, as they leave a black, shining film. On this specimen they are nearly opposite in position. The exact mode of attachment, owing to distortion, can not certainly be made out, but they appear to be inserted on the upper face of the stem, slightly within its margin. The attachment is made by the lower portion of the base of the leaflet, which is prolonged down the stem, making the leaflet decurrent. The upper portion of the base is larger and in the form of a rounded ear, which is free and curves more or less freely to the stem. The leaflets are subrhombic and slightly falcate in form, with obtuse tips. They were about 2 cm. long from the attachment to their tips, and 1 cm., or a little more, wide. The nerves are rather strong. They radiate from the point of attachment and fork repeatedly. The branches curve strongly away from the central line of the leaflets, so that they meet its margins under a large angle. There is no true midrib, but the central nerve is stronger than the others and splits up into branches, which, in turn, fork several times.

This plant may be a fern. It is certainly not Albertia. It is much like *Otozamites Beanii* (*Cyclopteris Beanii* of Lindley and Hutton), being near the smaller form given in Foss. Flor. of Great Britain, Vol. I, pl. xliv.

Pl. XLII, Fig. 5, gives the form with attached leaflets, one of which is better preserved than any in Emmons's figure, and Fig. 6 is a partial restoration of this, enlarged two diameters to show the nervation and probable original character of the leaflets.

## Genus CYCADITES Sternberg.

### Cycadites acutus Emmons.

1856. *Cycadites acutus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 330.

1857. *Cycadites acutus* Emm.: American Geology, Pt. VI, p. 114, fig. 81.

In American Geology, Pt. VI, p. 114, fig. 81, Emmons describes a plant which he calls *Cycadites acutus.* There is in the collection a specimen which is clearly the original of fig. 81. The figure gives the general aspect of the plant fairly well, but it is erroneous in some points. The leaflets are not quite so stiff looking and thick as the figure shows them. None of them have their tips preserved, whereas the figure represents several retaining their entire original length. The leaflets were probably wider originally than they appear to be now, as their margins are slightly doubled under in the shale by pressure. The specimen shows that the general form, mode of insertion, and falcate curvature of the leaflets are well represented in Emmons's figure. The point in which the figure is most misleading is the midnerve of the leaflets. It is wider than is given in the figure. The midrib might, as now seen, be exaggerated by pressure. It seems to separate the leaflets from base to tip into two narrow parts, which look like two very narrow leaflets, so that they appear to be placed in closely approximate pairs.

### Cycadites tenuinervis Fontaine.

Pl. XLIII, Fig. 1.

1883. *Cycadites tenuinervis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 84, pl. xliv, figs. 4–6.

Three specimens of a cycad were found in Emmons's collections that are exactly like *Cycadites tenuinervis*, a plant found in the Older Mesozoic of Virginia, and not hitherto noted in the North Carolina beds. They show the falcate curvature of the leaflets and the slender, rather vaguely defined midrib that are characteristic features of the Virginia fossil.

The specimens are portions of leaves, showing a number of closely placed leaflets, that, in the different imprints, show considerable variation in size. The smallest are about 1 cm long; the longest are 2 cm. in length. They are widest near their bases and taper gradually to their ends, which are lancet-shaped and rather obtuse. Emmons does not give their locality. The general aspect of the leaflets is much like that of *Ctenophyllum Braunianum* var. $\beta$, and, but for the midrib, they might be taken as belonging to this plant. They have a thick texture and are about 2 mm. wide in their widest part.

## Genus ZAMIOSTROBUS Endlicher.

### ZAMIOSTROBUS VIRGINIENSIS Fontaine.

### Pl. XLIII, Fig. 2.

1857. *Lepidodendron* sp. Emm.: American Geology, Pt. VI, p. 124, figs. 93, 94 on p. 125.
1883. *Zamiostrobus virginiensis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 85, pl. xlvii, figs. 4, 4a, 5, 5a.
1883. *Zamiostrobus* sp. Font.: Op. cit., p. 117, pl. liv, fig. 10.

In the collection of Emmons there is an imprint of a cycadaceous form that seems to be identical with fossils found in the Older Mesozoic of Virginia and named by me *Zamiostrobus virginiensis*. The specimen has Emmons's field label, marked Lepidodendron. From this he probably regarded this plant as of the same general nature as those fossils which he mentions on pages 124 and 125 of his work, as having the external marks similar to those of Lepidodendron. He gives figures of two of these (figs. 93, 94) and speaks of them as branching. If they branch they are probably some conifer. The fragment seen by me is a portion of an imprint of a stem or cone. Not enough is shown to enable one certainly to make out the size and shape of the original. It seems to have been of small size. Its original shape seems to have been oblong with at least one end truncately rounded off. To the unaided eye the scars, which are of small size, appear as crescent-shaped depressions, transverse to the axis of the cone. Examined closely with the help of a lens, they are seen to be leaf scars of the same character as those shown by *Cycadeoidea Emmonsi*, but decidedly smaller. They have their present form from having been distorted by pressure, which has caused a creeping of the rock matter in the direction of the axis of the fossil, so as nearly to close up the scars in that direction. It is quite possible that this is an imprint of a cycad trunk of the same kind as *Cycadeoidea Emmonsi*. If so, this specimen must have been a still smaller trunk. It is noteworthy that both this fossil and the Cycadeoidea are simply impressions, apparently made by the surface of the organism. Most cycad trunks are petrifactions.

# Class BENNETTITALES.

## FAMILY BENNETTITACEÆ.

### Genus CYCADEOIDEA Buckland.

### CYCADEOIDEA EMMONSI (Fontaine) Ward.

Pl. XLIII, Fig. 3.

1857. Impression or cast of a part of a trunk of a cycad Emmons: American Geology, Pt. VI, p. 123, fig. 92a on p. 124.
1883. *Zamiostrobus Emmonsi* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 117, pl. lii, fig. 5.
1894. *Cycadeoidea Emmonsi* (Font.) Ward: Proc. Biol. Soc. Washington, Vol. IX, p. 86.[1]

Emmons, in Pt. VI, pp. 123, 124, fig. 92a, gives a description of an imprint of a trunk of a small cycad which he does not name and for which he gives no locality. The original of this is probably the form given in Fig. 3 of Pl. XLIII. If so, Emmons's figure does not give a good representation of it, either for the shape of the trunk or for the character of the leaf scars. Nearly the whole of the trunk is

[1] On the occasion of my visit to Williams College, mentioned above (p. 276), I found the original of Emmons's fig. 92a, and after a somewhat careful examination of it, I took the following notes:

"This is nothing but a thin slab of light-colored shale bearing on its reverse side an impression of a very broad cycadean leaf. The slab is only 15 mm. thick. It is fissile and other plant impressions occur at other planes of cleavage within it, as seen by their projecting ends. On the side of the cycad a label is glued, on which are written, probably in Dr. Emmons's hand, these words: 'Impression of a trunk of a cycad.'

The right half of the impression is dark or nearly black, due to a thin deposit of carbon. This is partly worn off by handling, but remains at the bottom of the depressions. On the left it gradually fades out and probably never existed near the left margin. It is probable that the rounded conical form at the top and on the right side correctly represents that of the trunk, but on the left below the slab is so broken as to carry away a part of the impression. The general concavity is slight, and if it indicated the curvature of the surface the trunk would have been rather large, but from the small size of the scars and their spiral arrangement it seems to have been small, or not more than twice the diameter of the impression.

With the exception of the abrupt break on the left the cleavage all round is in the nature of a diagonal cross fracture from one natural plane to the next below it, and although not shining seems to be a slickenside. This condition gives the impression a sort of relief. It is evident that the top of the impression does not reach the top of the trunk, and the whole represents a small area of the side of a trunk near the top. It is difficult to determine the exact position of the axis, but the impression is probably nearly vertical. The impression is 7 cm. high and 6 cm. wide, maximum measurements.

The leaf scars are arranged in two spiral rows, those arising from left to right being nearly horizontal, but curving so as to have an angle near the summit of about 45°. The other set of rows are vertical at the lower end, but curve slightly to the left, reaching the summit at an angle of 10° or 15°. The scars are very small and almost exactly rhombic, with a large difference between the long and short sides. The long diagonal, which is usually nearly vertical, is about 7 mm. and the short, nearly horizontal one 4 mm. The long side is nearly 5 mm. and the short side scarcely more than 3 mm.

The ramentum walls are over 1 mm. thick, with a distinct central raised ridge, which probably represents a commissure. As the scars are depressions surrounded by these walls, it is evident that the bases of the petioles were present and rose above the ramentum walls, also that their outer ends were convex, so as to produce these concave depressions.

There is nothing on the impression from which the existence of fruiting axes or buds can be preserved so as to show its original dimensions and form. It was evidently unusually small, the height being only 6 cm. and the maximum width probably 8 cm. A portion of the right-hand side is missing, so that the entire original width is not shown. The shape was approximately broadly elliptical or bulbous. At the top is what seems to have been the growing bud. This appears to have been pressed down upon the sandy shale, which has preserved the imprint. It is merely an imprint, and not, as is commonly the case, the petrifaction of the trunk itself. The leaf scars are remarkably distinct, and they are rather small, as might be expected from the size of the trunk. They are approximately rhombic in form, about 6 mm. long and 4 mm. in height, the longer dimension being transverse to the axis of the trunk. They have a raised margin surrounding a depressed rhombic space. The upper and lower angles of the scar are more or less rounded and the lateral ones drawn out. The form clearly belongs to a new species of the group Cycadeoidea.

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inferred. The irregularity in the lower right-hand corner seems to be the result of defective preservation."

The specimen was sent to the University of Virginia, along with the other types requiring to be drawn, and came back to Washington with the rest. It was very carefully drawn by Mr. F. von Dachenhausen of the Division of Illustrations of the United States Geological Survey, under my immediate supervision and with the aid of all the descriptions and figures that had been made of it, including Professor Fontaine's fresh notes and my own, as quoted above. We fully discussed the question of orientation, especially in view of the fact that Professor Fontaine, in copying Dr. Emmons's figures, had reversed it, believing that Dr. Emmons had misinterpreted its nature. I have recently had occasion to examine and minutely describe several hundred specimens of cycadean trunks from the Mesozoic deposits of the United States, especially from the Potomac formation of Maryland, the Lower Cretaceous of the Black Hills, and the Jurassic of Wyoming (see infra., pp. 382–417). I also visited in 1894 the principal museums of Europe where collections of such trunks exist, notably the British Museum at South Kensington and the Geological Museum at Bologna, and I have thus made myself somewhat familiar with the nature of these objects. I was satisfied at a glance at Emmons's figure that he was right in regarding the impression as that of a trunk, and so stated early in 1894 (Proc. Biol. Soc. Washington, April 9, 1894, Vol. IX, p. 86).

It is true, as Professor Fontaine remarks, that such trunks are usually petrifications, having somewhat their original form and three dimensions, whereas this is only a flat impression similar to that which most other kinds of fossil vegetable remains present. Still, there is nothing in this fact that precludes the possibility of this representing a trunk. It is possible that the Triassic cycads may have been more succulent and less decidedly woody than those of the later ages. Again, the well-known petrified trunks have all been preserved under entirely different conditions. None of them occur in coal beds, but all in a more or less sandy matrix. Such is the case in the Black Hills, and the fine collection of fossil plants made by Professor Jenney in the Hay Creek coal field, at the same horizon as that of the cycads, yielded no fossilized trunks (see Nineteenth Annual Report, Part II, pp. 521–946). Any such trunks that may be found in coal beds will, in all probability, have the general character of the one now under consideration.

Special attention was paid to the true direction of the axis. The scars represent the leaf bases, and in all cases these have something like a keel on the lower side. One of the angles of the scar is therefore certain to be on the lower side, and this is one of the safest guides in finding the axis of the trunk. The position in which Dr. Emmons placed the specimen is an almost impossible one. It makes one series of rows of scars vertical and the other horizontal, or nearly so, and none of the angles are downward. By turning the bottom of his figure about 30° to the left the conditions of normal growth are fairly well satisfied. This is done in the new figure (Pl. XLIII, Fig. 3). The true apex was also found, and the spiral rows of scars encircle the trunk in a normal way and cross one another as in most other well-preserved forms.

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## Class GINKGOALES.

## Family GINKGOACEÆ.

### Genus BAIERA Friedrich Braun.

#### BAIERA MULTIFIDA Fontaine?[1]

Pl. XLIII, Fig. 4.

(?) 1857. *Noeggerathia striata* Emm.. American Geology, Pt. VI, p. 127, fig. 96.
1883. *Baiera multifida* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, pp. 87, 118, pl. xlv, fig. 3; pl. xlvi; pl. xlvii, figs. 1, 2; pl. liii, fig. 1.

Emmons gives a description in American Geology, Pt. VI, p. 127, fig. 96, of a fragment, which he calls *Noeggerathia striata.* In Mon. U. S. Geol. Survey, Vol. VI, p. 118, I expressed the opinion that this is a portion of *Baiera multifida*, a plant found in the Older Mesozoic of Virginia. I did not find in the collection the original of Emmons's figure, but did see a fragment with Emmons's field label marked Baiera. This specimen, given in Fig. 4, is too poorly preserved to permit a positive determination of it. It is a carbonaceous film that shows no nerves, but only striation. It may be a Baiera, but it is most likely a stem of some kind.

## Class CONIFERÆ.

## Family TAXACEÆ.

### Genus CEPHALOTAXOPSIS Fontaine.

#### CEPHALOTAXOPSIS CAROLINENSIS Fontaine n. sp.

Pl. XLIII, Fig. 5.

There is in Emmons's collection a fragment of slate carrying an impression of a conifer. It is without label, and there is nothing to show the locality yielding it. It is, however, apparently from Lockville, to judge from the character of the rock. This plant impression does not seem to have been described by Emmons, as it is distinctly different from any of those given in American Geology, Pt. VI. It is nearest to Emmons's Pachypteris, but is not this plant. The fossil in question is apparently a new species of Cephalotaxopsis, much like *C. magnifolia* of the lower Potomac formation, and it may be the ancestral form of that plant. The following description of it may be given, based on the fragment of an ultimate twig 1 cm. long, which is the only portion of it that was found:

Stem rather slender, but rigid. Leaves apparently all in one plane,

[1]As the type of Emmons's *Noeggerathia striata* was not found at Williams College, it can only be admitted with doubt into the synonymy, and the names left as they were.

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linear in form, with apparently subacute tips. The texture was thick and leathery. The maximum length of the leaves is 4 cm. and the maximum width, which occurs near their bases, 4 mm. They narrow gradually toward their tips and more suddenly at their bases, which are elliptical in form. They are apparently attached by a very short, twisted petiole. The midnerve is rather slender but distinct, and it is continued to the top of the leaf.

## Family PINACEÆ.

### Genus PALISSYA Endlicher.

#### PALISSYA SPHENOLEPIS (Friedrich Braun) Brongniart.[1]

Pl. XLIV; Pl. XLV, Fig. 1.

Emmons gives, in American Geology, Pt. VI, pp. 105, 106, pl. iv*a*., figs. 72, 73, a description of a plant which he calls *Walchia longifolius*, saying that it is common at Lockville. There are in his collection a number of specimens, including apparently the original of pl. iv*a*, but not those of figs. 72 and 73. If, however, that is the original of pl. iv*a*, it does not show so much of the plant as is given in this plate. Possibly it may have been broken since it was drawn. In Mon. U. S. Geol. Survey, Vol. VI, p. 107, I stated that I thought that this plant is *Palissya Braunii*. A study of the specimen confirms me in that opinion. The plant was evidently, as Emmons states, common. The largest impression of it is that given in Fig. 1 of Pl. XLIV, which is the supposed original of Emmons's pl. iv*a*. It shows a principal stem to which a penultimate twig is attached on the right-hand side. There are several large penultimate twigs, so placed on this side that they would unite with the principal stem if it were prolonged lower down. On the left-hand side there is a stout twig of penultimate order that apparently once joined the main stem lower down. The smaller stems are more or less thickly clothed with leaves. Most of the leaves, however, which were present when the fragment was entombed have disappeared. The appearance of the fossil indicates that the main stem and its branches were all thickly clothed with leaves of the same character. The larger stems are represented mainly by their imprints, but in some places a portion of the woody matter remains, which sometimes carries leaves on its sides. The leaves are distichous in the plane of cleavage of the rock. They vary slightly in dimensions and shape. The longest are 15 mm. long and 1 mm. wide in their widest portion, which is at the base. Some, however, are 5 mm. shorter, and some are rather wider and tend to an elliptical form. Perhaps some of these variations are due to distortion. The normal leaves are thin

[1] For synonymy, see supra, p. 249.

in texture, slightly falcate, linear-lanceolate, narrowing to a subacute tip, and widening to their bases. They are slightly decurrent, with their bases overlapping one another. There is a slender but distinct midnerve. These leaves are strikingly like those of *P. Braunii*, given by Saporta in his Flore Jurassique, Pal. Française, Vol. III, pl. lxviii, figs. 2, 3. There is little doubt that the plant is that species. Pl. XLIV, Fig. 2, represents an ultimate leafy twig, with leaves of the largest size, and Pl. XLV, Fig. 1, shows a portion of a stem of largest size, which still retains remains of leaves. These are pressed close to the stem and their shape is disguised. On his field labels, on some specimens, Emmons has written *Voltzia acutifolia* Brongn. No plant of this name is mentioned in American Geology, Pt. VI, and he probably changed it. The specimens so marked are *Palissya Braunii* (*P. sphenolepis*), with leaves somewhat shorter and smaller than the normal ones.

### PALISSYA DIFFUSA (Emmons) Fontaine.[1]

Pl. XLV, Figs. 2, 3.

To judge from the large number of specimens in Emmons's collection, the most abundant conifer in the North Carolina beds is one with minute leaves that he in American Geology, Pt. VI, p. 105, pl. iii, fig. 2, describes as *Walchia diffusus*. It is the same as the plant that he describes as *Walchia gracile* in the same work, p. 108, fig. 75. In Mon. U. S. Geol. Survey, Vol. VI, pp. 106, 107, discussing *Walchia diffusus*, and aided only by Emmons's figure, I regarded this plant as probably a Palissya, suggesting that it be called *P. diffusa*. In the same monograph, p. 108, I gave the opinion that Emmons's *Walchia gracile* is a small form of *Cheirolepis Muensteri*, as I then thought that *Palissya brevifolia* was that plant. A careful inspection of the fossils leads me to think that the *Walchia gracile* is a small form of the rather variable *Palissya diffusa*. This latter plant is of the same general type as *P. Braunii* and *P. brevifolia*, although it differs decidedly from them in some points. It is probable that the abundance of this plant in the fossils collected is, in part, due to the nature of the tissue. The leaves are thick and leather-like, so that they remain in the form of a dense shining film that may be peeled off like paper from the stone. They seem to have been very durable. Only fragments of penultimate twigs, carrying numerous ultimate twigs, were seen. I did not see the original of Emmons's pl. iii, fig. 2, but one of the specimens seen, that given on Pl. XLV, Fig. 2, of this paper, is as large as that. Emmons's fig. 2 gives the facies of the plant very well, and shows accurately the appearance of the leaves on the ultimate twigs, with their characteristic curvature away from the stems, but he does not

[1] For synonymy, see supra, p. 250.

give the midrib of the leaves, which is distinct, although slender. He gives on the main stem leaves that are longer and straighter than those on the ultimate twigs. I did not see such leaves. They are not well preserved on the main stems of the specimens seen, but appear to be of the same nature as those on the smaller twigs, although somewhat larger. For a plant having such small leaves and slender ultimate branches the penultimate ones had remarkably large stems. One was seen 7 mm. wide. The plant may be described as follows:

Stems of the penultimate branches very stout and rigid. Ultimate branches numerous, closely placed in one plane, alternating with one another on opposite sides of the penultimate stem. They are slender and rather short, about 55 mm. long, with tips not preserved, and very uniform in length. They are thickly clothed with leaves on very slender stems. These ultimate branches have sometimes short lateral branches, with rather smaller leaves. These leaves, and those toward the tips of the ultimate branches, are smaller than the normal ones on the latter, and are often shorter, more distinct, and broadly elliptical, sometimes almost circular in form. The normal leaves on the ultimate branches are about 1 mm. wide and 3 mm. long. They are oblong-elliptical in form, with very obtuse tips. They curve strongly away from the stem, so as to stand almost at right angles with it. The midrib is distinct. As in the Palissya, above described, the leaves are decurrent at base, so as to overlap one another and cover the stem. All the leaves are remarkably firm and leathery in texture. Pl. XLV, Fig. 3, gives a penultimate twig smaller than that shown in Fig. 2.

### PALISSYA BREVIFOLIA (Emmons) Fontaine.

Pl. XLV, Fig. 4.

1857. *Walchia brevifolia* Emm.: American Geology, Pt. VI, p. 107, fig. 74.
1883. *Cheirolepis Muensteri* Font. non (Schenk) Schimp.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 108, pl. liii, fig. 3.

The original of Emmons's *Walchia brevifolia*, as described in American Geology, Pt. VI, p. 107, fig. 74, was not seen in his collection at Williams College, but there are in it specimens of a plant that agrees so closely with it that there is little doubt that it is the same species. This fossil has no label showing its locality, but it occurs on rock exactly like that from Lockville which contains *Palissya Braunii* (*P. sphenolepis*). Only one specimen of it was seen. The specimen is a fragment of a penultimate twig, with a portion of several ultimate branches. All the branches contain leaves. The ultimate twigs are fully clothed with well-preserved ones. This plant clearly belongs to the same genus with the fossil above described as *Palissya sphenolepis*, and the leaves have the same arrangement and mode of attachment as those of that form. In other respects they are different. They are much smaller. The largest are 5 mm. long and a little over 1 mm. in width. In form they are linear-oblong, with obtuse tips. They are in two rows, with slightly decurrent bases that overlap one another. The leaves are slightly falcate and their texture is thick and leathery. They have a distinct but slender midnerve running to their tips.

To judge from the portions of ultimate twigs that are preserved, they must have been long and slender. It is possible that this may be a small form of *Palissya Braunii*, but the differences in the leaves are too many and great for one to regard it as a species. It seems best to regard it as a species of Palissya, retaining Emmons's specific name *brevifolia*, which is applicable. In Mon. U. S. Geol. Survey, Vol. VI, pp. 107, 108, I stated that I regarded it as *Cheirolepis Muensteri* Schimp. This opinion was based on Emmons's figure of the plant, which makes the leaves too acute at their tips and misses their shape.

There are two previously described plants which are sufficiently like this fossil to suggest an affinity, but not specific identity. One is *Cyparissidium septentrionale* (Agardh) Nath.[1] The form shown in Nathorst's fig. 10 is most like our plant. The other is *Palissya conferta* Feistm.[2] Feistmantel's fig. 6, pl. xlv, gives the form of *P. conferta* that is nearest to the North Carolina fossil.

### Genus PAGIOPHYLLUM Heer.

#### PAGIOPHYLLUM PEREGRINUM (Lindley and Hutton) Schenk.

Pl. XLVI.

1833. *Araucaria peregrina* L. and H.: Foss. Fl. of Great Britain, Vol. II, p. 19, pl. lxxxviii.
1849. *Brachyphyllum peregrinum* (L. and H.) Brongn.: Tableau, p. 69.
1857. *Walchia variabilis* Emm.: American Geology, Pt. VI, p. 108, fig. 76.
1870. *Pachyphyllum peregrinum* (L. and H.) Schimp.: Traité de Paléontologie Végétale, Vol. II, p. 250.
1884. *Pagiophyllum peregrinum* (L. and H.) Schenk in Zittel: Handbuch der Palæontologie, Abth. II, p. 276, fig. 192a.

Emmons gives, on page 108, fig. 76, of his work, a description of a plant which he calls *Walchia variabilis*. The specimen figured by him, and another containing a number of ultimate twigs of this conifer, are in the Williams College collection. The imprint figured is 4 cm. longer than his figure represents it to be. In Mon. U. S. Geol. Survey, Vol. VI, p. 108, I stated my conclusion, judging from this figure, that the plant is *Pagiophyllum peregrinum*, the *Araucaria peregrina* of Lindley and Hutton. An inspection of the original and of the other specimen confirms me in that conclusion. Emmons's figure does not give very well the facies of the specimen drawn. The facial leaves show

[1] Floran vid Höganäs, p. 29, pl. iv, figs. 4-15.

[2] Foss. Fl. Gondw. Syst., Vol. I, Pt. II, Pal. Indica, 2d series, pp. 85-86, pl. xxxii, figs. 9, 10; pl. xlv, figs. 4-8, 8a; pl. xlviii, fig. 4.

on the upper surface of the twig, but they are not so close together or so conspicuous as is indicated in fig. 76. They are broadly elliptical in form, and are pressed close to the stem. No doubt the elliptical form is due to the pressure. They are really of the same character as the lateral ones or those that lie in the cleavage plane of the rock. These latter are very thick and leathery in texture, with more or less of a triangular form. They are very wide toward the base and decurrent, while toward their ends they narrow rapidly and are incurved at their tips. They are markedly uniform in shape. They have a strong midnerve, which becomes very much stronger at the base. The second specimen now in the Williams College collection is a large fragment of a very fissile, argillaceous sandstone, of fine grain, that contains a number of fragments of ultimate twigs, with numerous leaves, mostly lateral or in the plane of cleavage. These twigs show very well the character given for the lateral leaves. They seem to have been quite long, and when covered with their thick, leather-like leaves, must have been rope-like. Some of the twigs on this fragment are represented on Pl. XLVI of this paper.

### Genus ABIETITES Hisinger.

#### ABIETITES CAROLINENSIS Fontaine.

#### Pl. XLVII, Fig. 1.

1857. *Pachypteris* sp.? Emm.: American Geology, Pt. VI, p. 112, fig. 80.

1883. *Palissya carolinensis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 109, pl. li, fig. 5.

In American Geology, Pt. VI, p. 112, fig. 80, Emmons described a fragment of a conifer which he regarded doubtfully as a Pachypteris. In Mon. U. S. Geol. Survey, Vol. VI, p. 109, I suggested that this plant is a Palissya, and that it might be called *P. carolinensis.* The original of Emmons's figure is in the Williams College collection, and is the only specimen of the plant there. It is very imperfect, showing only a fragment of a stout ultimate twig, from which most of the leaves have been removed, those remaining being fragmentary. Emmons's figure does not give very accurately the character of the plant. Pl. XLVII, Fig. 1, is given to represent it. As Emmons states, the stem is strong. It is even stronger than is represented in his figure. The leaves are short, very thick, and coriaceous in texture. They are of the same width from base to tip, and at each end are abruptly and obtusely rounded off. They are attached by a short petiole and the midnerve is very strong and continuous to the end of the leaf. The leaves seem to be arranged in two rows, which lie in the same plane. Only the lowest right-hand leaf is entire enough to give an idea of its character. This, however, has its base defective, as it has been crushed down on the stem, and it is broken across about midway of its length. The leaves, however, were probably originally not much longer than this, and had pretty much the same shape. The plant is apparently an Abietites not hitherto described, and it may be called *Abietites carolinensis.*

## PLANTS OF DOUBTFUL AFFINITY.

### Genus ACTINOPTERIS Schenk.

#### ACTINOPTERIS QUADRIFOLIA (Emmons) Fontaine.

Pl. XLVII, Fig. 2.

1856. *Sphenoglossum quadrifolium* Emm.: Geological Report of the Midland Counties of North Carolina, p. 335, pl. i, fig. 2.

1857. *Sphenoglossum quadrifolium* Emm.: American Geology, Pt. VI, p. 134, pl. v, fig. 2.

1883. *Actinopteris quadrifoliata* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol VI, pp. 120, 121, pl. lii, fig. 3.

Emmons gives, in American Geology, Pt. VI, p. 134, a description of a plant which he calls *Sphenoglossum quadrifolium.* He gives a figure of the plant in pl. v, fig. 2. Of this plant he says: "The layer upon which the plant is preserved is soft, and hence has suffered from abrasions; but many specimens were found in the upper marly sandstone (Keuper), some single, some in two, and others with three leaves, and the base of the fourth. One is therefore restored in the figure."

In Mon. U. S. Geol. Survey, Vol. VI, pp. 120, 121, I expressed the opinion that the plant is probably an Actinopteris and suggested that it be called *Actinopteris quadrifoliata.*

In the Emmons collection at Williams College there is a specimen of this plant, the only one seen. It shows one nearly complete leaf and fragments of two others. They are wedge-shaped and grouped around a central point, which seems to be the top of a stem. There is a vacant space which seems to have been occupied by a fourth leaf, for it is placed like the leaves that are present, and the size of it suggests a missing leaf. If there had been originally a fourth leaf present they would have stood opposite one another and the four would have nearly filled a circular space, with their edges almost touching. The specimen contains now no trace of carbonaceous matter of the leaves; only an impression of them is shown. This may be the original of Emmons's figure. I could, however, see no trace of the fourth leaf mentioned by Emmons as showing its base. I am not sure that the original termination is now shown on the most complete leaf. If so, then it would be rounded in the form depicted in Emmons's figure. The leaves show distinctly only striations. There are obscure indications of nerves. If these really are nerves, then they radiate in fan shape from the base of the leaf, repeatedly forking like those of the living Gingko. Pl. XLVII, Fig. 2, represents the specimen seen.

## Genus COMEPHYLLUM Emmons.

### COMEPHYLLUM CRISTATUM Emmons.

### Pl. XLVII, Fig. 3.

1857. *Comephyllum cristatum* Emm.: American Geology, Pt. VI, p. 128, fig. 97.

A single specimen of an imprint of Emmons's plant *Comephyllum cristatum* was seen in his collection. It bears his field label with that name. It may be the original of his fig. 97 of the plant described in American Geology, Pt. VI, p. 128. If so, it does not agree in some points with the figure given. This may be due to the splitting off of some portions of the shale after the drawing was made. The specimen as it now exists does not show any stem, and the narrow basal portion of the supposed leaf and the imprints Emmons supposed to be nerves, that curve to the leaf, are wanting. The imprint is too vague to show, with the small amount of material, the character of the plant. Hence I leave it with Emmons's name. The fossil seems to be a bundle of narrow pine-like leaves, each with a single nerve, that diverge from a common point and curve around to the right. The group gives the appearance of a cock's tail. There is no trace of a membrane or lamina between the leaves. The linear imprints are not nerves, but appear to be acicular leaves. It is most like *Schizolepis Braunii* and may be that plant. Pl. XLVII, Fig. 3, represents the specimen.

## Genus LEPACYCLOTES Emmons.

### LEPACYCLOTES CIRCULARIS Emmons.[1]

### Pl. XLVII, Fig. 4.

1856. *Lepacyclotes circularis* Emm.: Geological Report of the Midland Counties of North Carolina, p. 332, pl. iii, fig. 4.

1857. *Lepacyclotes circularis* Emm.: American Geology, Pt. VI, p. 130, pl. iii, fig. 4.

1883. *Araucarites carolinensis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, p. 119, pl. xlix, fig. 8.

### LEPACYCLOTES ELLIPTICUS Emmons.

### Pl. XLVII, Fig. 5; Pl. XLVIII.

1856. *Lepacyclotes ellipticus* Emm.: Geological Report of the Midland Counties of North Carolina, p. 332, pl. iii, fig. 6.

1857. *Lepacyclotes ellipticus* Emm.. American Geology, Pt. VI, p. 129, fig. 98; pl. iii, fig. 6.

1883. *Araucarites carolinensis* Font.: Older Mesozoic Flora of Virginia, Mon. U. S. Geol. Survey, Vol. VI, pp. 118, 119, pl. iii, figs. 4, 4a.

Emmons describes certain singular plant fossils in American Geology, Pt. VI, p. 129, as a new genus, which he calls Lepacyclotes. He gives

[1] Described in connection with *L. ellipticus*, below.

two species, *L. ellipticus* and *L. circularis*. These he describes on p. 130. In fig. 98, on p. 129, he gives a representation of a complete form of *L. ellipticus*, and in pl. iii, fig. 6, he depicts two scales of it. In pl. iii, fig. 4, he represents a complete specimen of *L. circularis*. The genus he describes as—

A disk or discoidal plane, formed of distinct and separate wedge-form grooved scales, arranged in a circle or ellipse, and the scales terminating outwardly in triangular laminæ, and forming around the main disk a collar of pointed scallops.

His description of *L. ellipticus* is as follows:

Disk elliptical, scales attached to an elliptical nucleus. Disk supported by or attached to a stem, which passes through the middle in the direction of its long axis. The number of scales of the disk is from twenty to twenty-four. The stem is not always visible.

His description of *L. circularis* is:

Disk or circle, formed of scales, as in the preceding, but they appear to radiate from its center. In this specimen a dark-colored, flattish, or circular body is connected to the central termination of the scales, which may have been the fruit or seed.

In addition he says:

There are certain facts connected with this plant, which are not rationally explained, on the natural supposition that they are analogous to the cones of pines or fruit-bearing bodies; for the same species of disks with their scales occur, which are less than half an inch in diameter, and in another instance the disk is formed of three concentric tiers of scales, the center one similar to the figure given, but the outer one bordering it, formed of shorter scales. It is 7 inches in diameter, and another, formed of a single row of scales, is 5 inches in the longest diameter.

Still farther on he says the detached scales are very numerous.

In Mon. U. S. Geol. Survey, Vol. VI, pp. 118, 119, I stated my opinion that these fossils are cones of some conifer near to Araucaria, the cones being mashed flat in the direction of their longer axis. I also stated my belief that the two supposed species are the same. This opinion of the fossil was based upon the assumption that Emmons found the imprints, commonly, in the complete state figured, with the features given in the descriptions.

There are in Emmons's collection numerous specimens of these fossils, some of them still bearing his field label, with the name Lepacyclotes. I examined them carefully and could find no specimen anything like his fig. 98. One specimen, that given in Pl. XLVII, Fig. 4, of this paper, is evidently the original of pl. iii, fig. 4, which represents Emmons's *L. circularis*. The other specimens are either the so-called scales detached, or attached to a circular or elliptical ring. Only a few of the latter kind were seen, and in no case was the ring complete. It is evident that the exact shape, whether it be circular or elliptical, is not significant. They both were originally circular, and the elliptic form comes from distortion. The detached parts, the so-called scales, are by far the most common forms of the plant, and Emmons has collected a large number of them. In order to give some idea of the fossil, it will be best to begin with the detached, single object, which, for convenience of description and for lack of a name, we may call a scale. There is no evidence, however, that it is a scale like that of the cone of a conifer. The epidermal tissue of the scales, which is in many cases preserved, is exactly like that of *Equisetum Rogersii*, which is seen when the exterior surface of the sheaths of this plant is shown. One of the scales is represented in Pl. XLVII, Fig. 5, which gives a complete form, as made out from a number of imperfect ones. The scale is long and narrow, gradually diminishing from one end to the other, so as to have a wedge shape. The broader end has a curving cord-like termination, which may or may not have attached to it a patch of epidermal tissue, which is approximately triangular in form. From the broad end it narrows gradually, as stated, to greater or less lengths, and in the case of detached single scales terminates with no particular shape. The detached scales have very varying lengths, which seem to depend upon the accidental mode of preservation, rather than upon any definite original length. When the scales are grouped and attached they, with the single exception of the disk depicted in Pl. XLVII, Fig. 4, have their narrower ends radiating from a poorly defined depressed ring, which is apparently the imprint of a hollow cylinder, which stood at right angles to the plane of cleavage of the shale. This ring may be approximately circular or elliptical. It is of various sizes, and there is no indication that the space within it ever contained any carbonaceous matter. Figs. 1 and 2 of Pl. XLVIII give portions of such rings, with scales radiating from them. These are the most complete specimens seen, and the nearest approach to Emmons's *L. ellipticus* that were seen. In each scale there is a keel that starts in the cord-like rim of its broad end. Where it springs from the rim it is very broad, but narrows suddenly, and then continues narrowing very gradually until it disappears toward the narrow end of the scale. These keels look much like casts in relief of the depressed lines of the sheath of *Equisetum Rogersii* that run down between each tooth. From an examination of all the specimens I got the impression that Emmons's *L. ellipticus*, when most complete, is composed of more or less closely placed scales, radiating from the central rim, and having their cord-like terminations at the free ends connected more or less fully to form an outer ring. It is, of course, difficult to judge of the correctness of Emmons's description and figure of *L. ellipticus* unless one knows what he actually saw. It also makes a great difference in judging the character of a plant if one collects the specimens himself. Much may be seen in the rock that is ruined in collecting, and much that is significant may be neglected. Hence I feel a hesitation in coming to a conclusion in this case. If, however, I must judge from the specimens, I think his fig. 98 is ideal in large part and is a restoration that is erroneous.

The specimen of *L. circularis*, given in Fig. 4 of Pl. XLVII, and which, as stated, is probably the basis of Emmons's description quoted above, differs from the forms he calls *L. ellipticus*. The imprint is on a piece of rather soft shale, which, in the vicinity of the fossil, has a tendency to split off. It apparently has split away to some extent, carrying off a portion of the disk-like fossil, so that at present only a portion of the imprint is shown. Evidently it was originally a complete circle, 4 cm. in diameter. This circle has at its circumference a depressed cord-like groove, which corresponds to the cord-like elevated line seen at the tips of the scales of *L. ellipticus*. On the exterior of this depression there is a faint indication of a ragged fringe of epidermal tissue, but there is nothing definite like the circle of triangular teeth given by Emmons. Within the marginal circle there are narrow wedge-shaped imprints of the same general character as those of the scales of *L. ellipticus*, but much smaller and less distinct. These imprints converge to the center of the circle, touching one another, so that they completely fill the circular space which forms the disk composing the fossil. The imprints of the scales seem to have keels like those of *L. ellipticus*, but they are much less distinct and more slender. These imprints of scales disappear under an irregularly shaped patch of coal, in the form of a structureless layer, which is located around the center of the disk. This layer once evidently extended over the whole disk, but it has suffered much from handling, so that only a patch of it remains toward the central part of the disk. It is thickest on its outer edges, and thins away to nothing in the center of the disk, where the scale shows through it. There is on these imprints of scales no epidermal tissue like that on the scales of *L. ellipticus*. The dark-colored, flattish, or circular body, mentioned by Emmons as connected with the central termination of the scales, is apparently this patch of coal. It presents no appearance of being a fruit or seed, but is without structure, and has no significant shape.

The great variation in the diameter of the disks mentioned by Emmons, varying from half an inch to 7 inches, and the fact that three concentric tiers of scales were found on one disk, indicate that the plant is not a cone or inflorescence. Heer gives, in Flor. Foss. Helvetiæ, Die Pflanzen der Trias, some figures of Equisetum that may throw some light on these North Carolina plants. In pl. xxvi, fig. 2, he gives a diaphragm of Equisetum with its disk striated by lines narrowing from the circumference, converging toward the center. The outer margin of the disk has three concentric rows of triangular teeth. Pl. xxvii, fig. 2, gives a diaphragm in the form of a disk composed of ribs, which radiate from a central area, bare of carbonaceous matter, and which has attached to its circumference a row of triangular teeth.

Taking everything into consideration, I think that the detached scales, and those that radiate from a central ring, called *L. ellipticus*, are dissected stems of *Equisetum Rogersii*. They seem, while standing erect, with their lower portions buried in mud and partly filled with the same, to have had the part above the mud crushed down by pressure in the direction of the axis of the stem. This split up the free end into strips. The forms such as are depicted in Fig. 4 of Pl. XLVII are detached diaphragms of the same Equisetum.

### THE SOUTHWESTERN AREA.

We will next consider the extensive beds chiefly in New Mexico and Arizona, but probably reaching into Texas on the east, and certainly found in the State of Sonora, in Mexico.[1] They are doubtless also the equivalents of beds much farther south, near the City of Mexico and in Honduras, from which fossil plants have been reported.[2]

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[1] The following correspondence shows that the localities in Sonora are by no means exhausted, and it is much to be hoped that the plant-bearing beds may yet be traced across the Rio Grande into Texas:

NOEL, VIRGINIA, *July 24, 1899.*

Prof. LESTER F. WARD.

DEAR SIR: Some time ago Prof. I. C. White sent me a small box of fossil plants, obtained by Mr. Dumble, from Mexico. There were some six or eight species, mostly new. To judge from a slight study of them, I was struck with the perfection of their preservation and the adaptation of the slate to give good specimens. I sent a letter, through Professor White, saying that I thought the nearest plants to them were Newberry's New Mexican copper mine fossils. As the material was so promising and seemed to yield so many good plants, I asked Mr. Dumble if he could get more specimens. I send you his reply. Please return it after reading. The slate splits almost like roofing slate, and seems full of plants. A good collection of it would, I think, help immensely to our knowledge of the Triassic flora of America, giving splendid material.

Yours truly, WM. M. FONTAINE.

HOUSTON, TEXAS, *July 18, 1899.*

Prof. WM. M. FONTAINE,
*Noel, Virginia.*

DEAR SIR: Dr. I. C. White has inclosed me your letter of July 3. The plants are from the Triassic coal beds of Sonora, Mexico, the most of them being from La Barranca, where I am now working, and only a few miles from the locality at which the plants described by Dr. Newberry were collected. I have been unable to secure a copy of his paper, but a list of his determinations is given by Aguilera in his Geological Sketch of Mexico, and I have copied it in my Notes on the Geology of Sonora, New York meeting of the A. I. M. E., of which I will send you a copy as soon as my separates arrive. The field is a very interesting one, as it contains large bodies of anthracite coal and of natural coke. I have found no less than 31 distinct beds of coal, the most of which are more than 4 feet thick. The igneous rock has been forced in along the bedding planes and produces quantities of excellent coke, one bed of which I have opened to a depth of 130 feet and find it has an average thickness of over 8 feet. The slates are filled with well-preserved plant impressions and there are many large silicified tree trunks in the sands.

I will probably spend the next winter in the field, and if you would like to study the plants we can probably arrange to get you as large a collection as you can possibly wish.

Yours very truly, E. T. DUMBLE.

[2] See a letter from Professor Fontaine in the Eighth Ann. Rept. U. S. Geol. Survey, for 1886–87, Washington, 1889, p. 825, relative to a collection made in the vicinity of the City of Mexico and brought to Washington by Señor Mariano Barcena in 1884. In 1890 Señor Castillo brought another collection, which I examined, and Castillo and Aguilera, in their Bosquejo Geológico de Mexico (Boletin del Instituto Geológico de México, Nos. 4, 5, and 6, Mexico, 1897), p. 203, give a list of the species which they were able to identify from these beds. See also Dr. Newberry's article in the Am. Jour. Sci., November, 1888, 3d series, Vol. XXXVI, pp. 342–351, pl. viii.

Mr. Jules Marcou in 1853[1] describes these beds as Lias or Jurassic, and says:

According to the collection of fossil plants made by the officers of the United States Army, the beds of coal which are found at Raton Mountain, on the route from Missouri to Santa Fe, and at Muddy River, on the route to Oregon, have been recognized as also belonging to the Jurassic epoch (p. 43).

On his map he colors a small area, on the one hundred and fourth meridian and on and below the thirty-eighth parallel of latitude, which falls chiefly in the State of Colorado, but probably extends into New Mexico.

His extended paper in the Bulletin of the Geological Society of France[2] is not a translation of the work already mentioned. It was communicated to the society on May 21, 1855, and contains the general results of three expeditions made by him to the West between the years 1848 and 1854. In treating of what he calls the "terrain du nouveau Grès Rouge," he mentions the occurrence on one of the little affluents of the False Washita River, near Antelope Hills, of a silicified tree which had preserved the branches adhering to the trunk, and which, when polished, presents sections having the greatest resemblance to those of *Pinites Fleurotii* (p. 869). As near as can be judged from his description, this locality is in the western part of Indian Territory, or possibly in the Panhandle of Texas, and simply shows the extension of these deposits to the eastward.

On page 871 of the same volume he says:

One often meets in the sandstones of this stage abundant débris of silicified wood, frequently whole trees; thus on the western slope of the Sierra Madre, between Zuñi and the Little Colorado River, I encountered a veritable silicified forest, with trees 30 to 40 feet long, divided into sections 6 to 10 feet in length, and having a diameter of 3 to 4 feet. The cellular tissue has almost entirely disappeared and the wood has been replaced by a very compact silex, extremely brilliant in color, presenting magnificent specimens for jewelry work. The Indians of this region make use of them for stone ornaments and also chip arrow heads from them. These trees, some of which are seen erect embedded in the sandstone, almost all belong to the family of conifers, some to that of ferns with arborescent trunks, and to Calamodendron.

In his Geology of North America,[3] published the same year, he speaks, on page 57, of finding at his camp No. 28, at Alamo, near the Rio Puerco, "numerous fragments of fossil silicified trees," in a gray marl which he refers to the Upper Cretaceous, but says that the camp No. 28 "is again on the New Red Sandstone rocks."

Möllhausen, in his journal of a voyage[4] across the continent in 1853,

[1] A Geological Map of the United States and the British Provinces of North America, with an Explanatory Text, etc., Boston, 1853, pp. 42–44.

[2] Résumé explicatif d'une carte géologique des États-Unis et des provinces anglaises de l'Amérique du Nord, avec un profil géologique allant de la vallée du Mississippi aux côtes du Pacifique et une planche de fossiles; par M. Jules Marcou: Bull. Soc. géol. de France, 2d series, Vol. XII, 1854–55, pp. 813–936.

[3] Geology of North America, by Jules Marcou, Zurich, 1858.

[4] Tagebuch einer Reise vom Mississippi nach den Küsten der Südsee, von Balduin Möllhausen, Leipzig, 1858, p. 300.

gives a somewhat glowing account of what he saw in the valley of the Rio Secco (which is probably the Rio Puerco), accompanied by a colored plate, representing a prostrate trunk broken into sections and a stump or short projecting upright portion. Such sights are now known to be common throughout that region. Specimens of this petrified wood procured by him were conveyed to Europe and placed in the hands of Dr. Göppert, who subjected them to microscopic examination, and furnished a short report as to their internal structure and probable nature, which was published as a note at the end of this volume, on page 492.[1] Only one species was distinguished from this material, which was identified as belonging to the genus Araucarites, and which in a footnote he named, after the explorer, *Araucarites Mœllhausianus*. He did not, however, furnish the character, and it remains a *nomen nudum*.

In the geological report made by Dr. J. S. Newberry in what is known as the Macomb Report,[2] impressions of leaves or plants other than fossil wood are first mentioned (p. 69). Of the 14 species of fossil plants described in this report,[3] only 2 were found within the territory of the United States, the rest having all come from Sonora, in Mexico, collected at a point called Yaki. The American species were found in and about the copper mines in the vicinity of Abiquin, New Mexico, and there is little doubt that the Sonora specimens represent a western extension of the same great formation (see supra, p. 315, for later development of these beds).

Dr. Newberry's geological report of the Macomb expedition forms a volume by itself. It was prepared soon after the close of the expedition, but owing to the breaking out of the civil war it was not published until 1876. It consists chiefly of an itinerary. On page 69 he refers to the fossil plants from the copper mines near Abiquiu, and makes the following remarks:

> The most interesting incident of our visit to this copper mine was the discovery in the shale roof stone of thousands of impressions of plants, of which abundant specimens were procured. They are mostly cycadaceous—Otozamites and Pterozamites—with a few conifers (Brachyphyllum and Voltzia?). The species are probably new, and will not afford the means of determining with precision the age of the stratum containing them, but the discovery is of great geological interest, as showing the wide distribution of the cycadaceous flora of the Triassic and Jurassic epochs, and gives additional confirmation of the generalization of Brongniart, who characterized this epoch in the botanical history of the world as the reign of Gymnosperms.

In a footnote to this remark he says:

> Descriptions of these plants will be found in another chapter, where it is shown that the most conspicuous species (*Otozamites Macombii*) is the same with one found

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[1] Ueber die von Möllhausen mitgebrachten Fragmente des Holzes aus dem versteinerten Walde, von H. R. Göppert.

[2] Report of the Exploring Expedition from Santa Fe, New Mexico, to the Junction of the Grand and Green Rivers of the Great Colorado of the West, in 1859, under the Command of Capt. J. N. Macomb; Geological Report by Prof. J. S. Newberry, Geologist of the Expedition, Washington, 1876.

[3] Pp. 141–148, pls. iv–viii.

in the Triassic strata of Los Bronces, Sonora, where it occurs in company with *Pecopteris Stuttgardiensis*, *Tæniopteris magnifolia*, and other well-known Triassic plants of Virginia, North Carolina, and Europe. We have, therefore, in these plants evidence of the Triassic age of all the variegated gypsiferous rocks of Northern New Mexico; for the Lower Cretaceous sandstones immediately overlie the plant bed of the Cobre.

In this report Dr. Newberry mentions (p. 69) and figures (pl. v, figs. 4, 5; pl. vi, fig. 9) some twigs and cones of a plant that he doubtfully refers to the genus Pachyphyllum, without assigning any specific name. For more convenient reference I will supply a specific name here, and as the genus Pachyphyllum is preoccupied and all the species are being referred to Heer's substitute, Pagiophyllum, I will call the plant *Pagiophyllum Newberryi*, assuming that the specimens all belonged to one species, although they may have represented more than one.

Major Powell, in the Geology of the Uinta Mountains, 1876,[1] was the first to give a local name to these extensive deposits. He calls them the Shinarump formation, and thus describes them:

The summit of the Shinarump group is a series of gypsiferous sandstones exceedingly friable. They have often been called marls, and the separation between them and the massive vermilion sandstone is never very distinct. The difficulty is much greater where the gypsum disappears from the lower beds, as it does in places, where they are also found to be more indurated and more or less massive sandstones. The conglomerate which is found in the middle of the group is persistent over a very large area, and the whole group is characterized throughout the entire province by the occurrence of silicified wood in large quantities. Sometimes trunks of trees from 50 to 100 feet in length are found. The Shinarump conglomerate is usually very hard, and weathers in such a manner as to form hog backs or cliffs, and the softer gypsiferous beds above, when carried away by rains, leave behind fragments of this silicified wood, so that the Shinarump conglomerate is often covered with great quantities of this material. Shinarump means literally "Shin-au-av's rocks." Shin-au-av is one of the gods of the Indians of this country, and they believe these tree trunks to have been his arrows (pp. 68–69).

As already remarked, the silicified wood, which is found in Arizona and New Mexico, has long been the subject of popular admiration, and has been mentioned in many periodicals ever since emigration commenced to cross the plains. Some of this petrified wood is very beautiful, admits of a high polish, and is capable of being worked into a variety of useful objects. Two large trunks of this material were shipped in 1879 by the War Department to the Smithsonian Institution, an account of which will be found in Vol. V (1882) of the Proceedings of the United States National Museum, by Lieuts. J. T. C. Hegewald and P. T. Swain.[2]

With regard to these silicified and agatized trunks, the economic point of view has been particularly dwelt upon by Mr. George F.

[1] Report on the Geology of the Eastern Portion of the Uinta Mountains and a Region of Country Adjacent thereto, by J. W. Powell. U. S. Geog. and Geol. Surv. Rocky Mountain Region. Washington, 1876, 4.°

[2] Information concerning some fossil trees in the United States National Museum, by Lieut. Col. P. T. Swain, U. S. A., and Lieut. J. T. C. Hegewald, U. S. A.: Proc. U. S. Nat. Mus., 1882, pp. 1-3.

Kunz in a series of notes and papers[1] on jasperized and agatized woods of Arizona, and in his work on Gems and Precious Stones of North America, New York, 1890, pp. 135ff; more especially in the second edition, 1889, pp. 135, 137, and Appendix, pp. 352–355.

Portions of these trunks, which were long on exhibition at the National Museum, were examined by Dr. F. H. Knowlton and found to exhibit internal structure with sufficient clearness to be capable of microscopic study. Slides were prepared and the results of his investigation were published in the Proceedings of the Museum.[2] Both trunks appear to have the same structure and belong to the same species, and the generic determination was practically the same as that of Möllhausen, viz, Araucarioxylon, formerly called Araucarites. But as Göppert failed to describe or figure Möllhausen's specimens, it was impossible for Dr. Knowlton to tell whether he had the identical species or not; he was therefore obliged to give it a specific name, and called it *Araucarioxylon arizonicum.*

A collection of fossil plants was made by Major Powell in the fall of 1886 in the vicinity of Abiquiu, New Mexico, among the copper mines. It consists largely of vegetable impressions belonging to the Cycadaceæ, etc. A second collection was made in 1889 by Dr. F. H. Knowlton, both in the same region last mentioned and also among the petrified forests of Arizona and New Mexico. This latter collection is quite large and very important, especially that of the silicified wood, as he visited nearly all of the best localities, and with his practiced eye selected only such material as was capable of successful scientific investigation. The plant impressions of both these collections have been examined by Professor Fontaine, and Dr. Knowlton has found the wood of the copper mines to be the same as that thus far identified from the plains.[3]

There is no part of the American Trias that possesses greater interest for the geologist and paleontologist than this great southwestern area, and yet we have, as the above record shows, exceedingly meager scientific data respecting it. The petrified forests of Arizona are now celebrated, and a movement has been set on foot to have the most important tract in that Territory set apart as a national park. Before I had heard of this movement I had planned to make at least a reconnaissance into the region on my return from the Pacific coast in the fall of 1899, but before I left Washington in August the matter had been brought forcibly to my attention by a letter from the honorable Commissioner of the General Land Office to the Secretary of the

[1] Trans. New York Acad. Sci., Vol. V, 1885, pp. 9–11: Pop. Sci. Monthly, January, 1886, Vol. XXVIII, pp. 362–367 (copied in Scientific American Supplement, Vol. XXI, February 6, 1886, p. 8418); Exchangers' Monthly, Vol. I, Nos. 6–8, 1886.

[2] New species of fossil wood (Araucarioxylon arizonicum) from Arizona and New Mexico, by F. H. Knowlton: Proc. U. S. Nat. Mus., Vol. XI, 1888, pp. 1–4, pl. i.

[3] Notes on Triassic plants from New Mexico, by Wm. M. Fontaine and F. H. Knowlton: Proc. U. S. Nat. Mus., No. 821, Vol. XIII, 1890, pp. 281–285, pls. xxii–xxvi.

Smithsonian Institution, which the latter had referred to me. On stating my intention to visit the region, I was requested, and subsequently instructed, to collect data and make a report covering both the scientific and the practical aspects. This I did, and my report was submitted to the Director of the United States Geological Survey on December 12, 1899.[1]

An account of the results of my operations in this field will have a considerably broader scope than that of the report just mentioned, as they covered a large amount of territory more or less remote from the region popularly known as the petrified forests, extending as far west as Supai, and north to the Grand and Marble canyons, including an expedition down the Litttle Colorado on its right bank to the crossing of the Lee's Ferry road, 70 miles below Winslow.

Owing to the almost entirely volcanic character of the great region occupied by the Bill Williams Mountain, San Francisco Mountain, Kendricks Peak, and the Elden Mesa, it was impossible for me in so short a time to work out the stratigraphy of that region, but that there are Triassic remnants in it seems certain. Petrified wood was found at the most westerly point examined, viz, a mile northwest of Supai. I was informed from a reliable source that large silicified logs occur 3 miles west of Williams.

The Colorado Plateau to the north, as is well known, is occupied by Carboniferous limestone, and this extends eastward to near the Little Colorado. Dr. Newberry observed that this limestone—

descending from the San Francisco Mountain, * * * showed a dip to the northeast of at least 100 feet to the mile; and before reaching the [Little Colorado] river it passed under beds of red shale and sandstone, which are conformable with it. This sandstone is deep blood red in color, is soft, and eroded into fantastic blocks and masses, of which the surfaces are most curiously etched and carved by weathering. Above these heavier beds are soft, red, argillaceous shales, with layers of red and green, foliated, ripple-marked, fine-grained, micaceous sandstones, all without fossils. Such is the geology of the south bank of the river. On the north bank the red shales appear at intervals, but are usually concealed by alluvial soil, sand, and gravel. About 7 miles from the river the valley is bounded by a mesa wall nearly 1,000 feet in height, of which the base is formed by the red shales and sandstones before described.[2]

The party were then on the northeast side of San Francisco Mountain, and the Permian beds are reached some distance southwest of the Little Colorado. On the south side of the volcanic area, the principal vents of which formed the San Francisco and Kendricks peaks, Mount Sitgreaves, the Elden Mesa, and Bill Williams Mountain, no one seems to have reported any sedimentary strata higher than the Upper Carbon-

[1] Report on the Petrified Forests of Arizona, by Lester F. Ward, Paleontologist, U. S. Geological Survey; Department of the Interior, Washington, 1900; 23 pages, 8°.

[2] Report upon the Colorado River of the West, explored in 1857 and 1858 by Lieut. Joseph C. Ives, Washington, 1861, 4°. Part III, Geological Report, by J. S. Newberry, p. 75.

iferous limestones which overspread the Colorado and Kaibab plateaus and stretch away for many miles to the south and southeast, but the presence of Permian and Mesozoic remnants in many parts of this great Paleozoic terrane is one of the best-attested facts in the geology of this region,[1] and its importance as constituting the principal evidence of the former integrity of the sedimentation over this entire country has not been overlooked.

East of the volcanic area on its south side the descent to the Little Colorado is on an average about 40 feet to the mile, but the dip of the strata is still greater, and the Carboniferous passes under the red shales of the next overlying formation before the bed of that stream is reached. This holds true for the lower portions of the river at least as far northwest as the crossing of the Lee's Ferry road, 30 miles above its mouth.

I examined these red sandstones and shales on the left bank of the river from Winslow to a point 40 miles below, which practically corresponds to the space between Camp 89 and Camp 85 of the Ives Expedition, and I found scattered blocks and small pieces of fossil wood at many points. They were usually weathered out and lay on the surface, and may have all been below the horizon in which they were actually embedded, but the evidence that they belonged to the formation in which they were found is strong. The fact that this wood is not found on the Carboniferous terrane to the west, but is met with only in the sandstones, confirms this view and makes the assumption that it belongs to a higher formation which formerly overlay them improbable, to say the least. No such assumption could arise but for the fact that almost all the geologists who have treated the region have referred these saliferous red sandstones to the Permian. If they are such the wood also is probably Permian.

Below this point for many miles the east side of the valley is covered with a sheet of lava and black basaltic rock, and the surface on both sides is strewn with black bowlders of all sizes, which at Black Falls form the bed of the river. On the right bank, however, there arise terraces several hundred feet high, presenting bold escarpments of brownish-red sandstones, with occasional white limestone and gypsum beds and variegated marls. One of the gypsum beds is 10 feet in thickness. Petrified wood occurs at nearly all points, and I observed many logs in place. Still farther down on the same side, and for more than 10 miles above and below the crossing of the Lee's Ferry road, there is an exceedingly interesting series of buttes, consisting of remnants of the mesa on the northeast, which rises in successive terraces some thousand feet above the river bed, the nearest bluff being 150 feet high. Scattered over the plain at its base, with a width of more than

[1] Tertiary history of the Grand Cañon district, by Clarence E. Dutton: Mon. U. S. Geol. Survey, Vol. II, Washington, 1882 4°, pp. 46, 68, 117ff.

a mile, stand these symmetrical cones, buttes, and knolls of variegated marls, often almost wholly of blue clay. This blue-clay stratum, 20 feet in thickness, can be seen along the base of the general escarpment overlain by red marls, and these in turn by brown or reddish sandstones, the topmost stratum being a massive sandstone. The taller buttes have the blue clay at the base and the red marls above.

Immense quantities of fossil wood occur on and around these eroded buttes, and in many cases large, much disintegrated logs occupy their immediate summits, and have been the occasion of their preservation.

At the foot of one of these buttes I found a specimen that I consider to be a petrified cone, but only the upper portion is represented for a length of 3 cm. It is somewhat compressed laterally, and the longer diameter is 3 cm., while the shorter is only a trifle over 2 cm. The transverse fracture is uneven, consisting of two unequal planes, rising at different angles toward the apex and forming an obtuse reentrant angle on one side of the center, which passes across the cone in the direction of the minor axis. On the larger face of the fracture the radiate structure is clearly shown. The surface is occupied by the thick, irregularly rhombic scales, arranged in quincunx order, varying somewhat in size, but averaging 12 mm. wide by 8 mm. high, and often showing the polygonal scars of the deciduous tips.

So far as the cone itself is concerned, it might, except for its small size, be referred to the living genus Araucaria, and the form and general appearance of the scales approach very close to those of *A. cretacea* Brongn., as figured by Saporta in Schimper's Traité de Paléontologie Végétale, Atlas, pl. lxxvi, fig. 2 (see text, Vol. II, p. 255), which comes from the Greensand (Neocomian) of Nogent-le-Rotrou (Eure-et-Loir), in France. Considering the age of these beds, however, it is more probable that it represents the ancestral form of the present genus, and it is safer to refer it to the extinct genus Araucarites. I will give it the name *Araucarites Chiquito*, which refers to the Colorado Chiquito, or Little Colorado, on whose banks it was found, and also emphasizes its relatively small size.

That this cone was actually borne on some one of the many trees among the petrified remains of which it lay when I picked it up can not, of course, be doubted, but it is equally obvious that no means are at hand for connecting it with specimens of wood collected at the same time and place.

I also found in these denuded hillocks petrified bones. They come from the red marls over the blue clay, and were seen in place. No attempt was made to excavate the beds, but an expert collector of vertebrate remains could in all probability do this with success. The specimens collected were weathered out of the sides of the buttes and lay at their base. They were mere fragments, but included one complete vertebra.

I submitted the material to Mr. F. A. Lucas, curator of the Department of Comparative Anatomy in the United States National Museum, who kindly examined them and reported as follows:

> The majority of the fragments are from a species of Belodon, apparently related to, possibly identical with, a peculiar genus and species (*Heterodontosuchus ganei* Lucas) described by me from the Trias of Utah. The Belodonta are Triassic.
>
> There is also the vertebra of a small Dinosaur and two dermal spines of some Dinosaur, undescribed, but suggestive of a genus having some affinities with the Stegosaurs.
>
> None of the specimens indicate genera older than the Trias.

The geological position of these beds is one of special importance, because, according to all the determinations hitherto made and all the maps that have appeared, this locality would fall on the extreme western border of the Permian, next to the Carboniferous and many miles from the nearest Mesozoic deposits. As already remarked, the red sandstones cross the river at this point and extend some distance still farther to the southwest, but I did not attempt to follow them to their contact with the Carboniferous, because at the time I was there I was not aware that the area had been mapped as Permian, and assumed that the occurrence of Mesozoic strata there was what was to be expected.

It was easy to follow the quite persistent bands of white, blue, red, and brown along the bluffs to the southeast. They dip very slightly in the opposite direction, but the dip is less than the fall in the river, and as a consequence the lower strata successively disappear in ascending the stream.[1] Twenty miles above the crossing the blue clay was no longer seen and the red marls became the basal member of the cliffs. This would give about 1 foot to the mile as the rate at which one rises in a southeasterly direction, which would make the lowest beds at Winslow some 70 feet higher than those at the crossing of the Lee's Ferry road.

The course of the Little Colorado above Winslow is more westerly, so that Holbrook, 35 miles above, is only 8 miles farther south, and the formation spreads out some distance on the left or south side of the river. Still its most important exposures are on the right bank, and they occupy a broad area to the northeast, finally passing under the higher Jurassic and Cretaceous beds of the Rabbit Ear Mesa region. The red saliferous sandstones are overlain by alternating marls and sandstones, but there is strict conformity, and if the former are Permian we must have in this series the entire Triassic system, because there is, according to all accounts, complete conformity, also, of the overlying beds.[2]

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[1] This fact was observed by Dr. Newberry, who says: "The fall of the river * * * is somewhat more rapid than the dip of the strata, so that, following it toward its sources, we were constantly ascending in the geological series." Ives Report, p. 74.

[2] See Newberry's sections in the Ives Report, pp. 77-85, and compare Dutton, op. cit., Chap. XII.

PETRIFIED FORESTS OF ARIZONA.

As already remarked, fossil wood is almost universal. I examined a fine forest less than a mile from Holbrook on the first terrace above the valley below that place. The valley is here half a mile wide on the north side. Most of this is occupied by an alkaline flat covered with greasewoods and saltweeds. The bluff is 50 feet high and precipitous. Many chips and blocks of petrified wood lie about its base weathered out, also detained in their fall at all elevations on the sides of the escarpment. The beds are brownish-red sandstones with thin seams of white or blue clay shales. On top lie immense petrified logs in great profusion, usually much split and broken, sometimes reduced to heaps of splinters. I collected a number of specimens that seemed to show structure perfectly. In a few cases the wood is red and jasperized. The hill back of the first terrace rises by a gradual slope for another 50 feet, and is chiefly covered by blown sand, but as far as I went I found fossil wood wherever the surface was exposed. None of this material seems to be in place, and its true source is probably still higher.

The junction of the Rio Puerco with the Little Colorado is 2 miles above and nearly due east of Holbrook. There is running water in the latter at this point all the year round, but it all comes from a spring a few miles above, and from there on the Little Colorado is a dry run except in the rainy season. The Rio Puerco is dry at its mouth and for most of its length, but in most such streams water can be reached by digging a few feet in the gravelly bed, and it is said that horses have the instinct to paw out the gravel until they make a trough in which water will stand in sufficient quantities for them to drink.

The Whipple expedition of 1853, in coming from Zuñi on the south, crossed the Rio Puerco at Navajo Springs and followed it down on its right or north bank. It was some 20 or 30 miles above its mouth that the party passed through the remarkable petrified forests described in the reports of Lieutenant Whipple and Mr. Marcou,[1] and also by Möllhausen, who accompanied the expedition. Here was the Lithodendron Creek, named by Lieutenant Whipple (op. cit., Pt. I, p. 73.), and so frequently mentioned in connection with the petrified forests of Arizona, but which in reality is not located in the heart of what is now called the petrified forest, but is on the other side of the Rio Puerco and some distance farther west.[2]

It is now well known that petrified wood is exceedingly abundant

[1] Reports of Explorations and Surveys to ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, Vol. III, 1856, Pt. I, pp. 73-75; Pt. II, p. 28; Pt. IV, pp. 43, 150, 151, 167.

[2] It is difficult to identify on modern maps, but a careful study of the map accompanying the Whipple report and of Lieutenant Whipple's description given in the itinerary (p. 73) seems to require the assumption that his "Carriso Creek" is what is now called Dead Creek on the Land Office map, and that Lithodendron Creek was what is now called Carrizo Creek or Carrizo Wash.

throughout the entire region and will be met with whatever route one may take, but there are differences in the degrees of abundance and of perfection or intensity of coloration of the wood at different points or centers of accumulation. The climax in all these respects, so far as has yet been discovered, is reached in an area lying between the Rio Puerco and the Little Colorado, but nearer to the former. It is bounded on the east by the meridian of 109° 45′ west from Greenwich, is nearly square, and its center falls in about latitude 34° 52′, longitude 109° 49′. Its western border is about 15 miles east of the junction of the two rivers and 17 miles east of Holbrook. Its northern boundary is 6 miles due south of the Rio Puerco at Adamana Station on the Santa Fe Pacific Railroad. The area is about 8 miles square and falls chiefly within township 17 N., range 24 E., but extends a short distance on the south into township 16 N., and on the west into range 23 E.

This region consists of the ruins of a former plain having an altitude above sea level of 5,700 to 5,750 feet. This plain has undergone extensive erosion, being worn down to a maximum depth of nearly 700 feet, and is cut into innumerable ridges, buttes, and small mesas, with valleys, gorges, and gulches between. The strata consist of alternating beds of variegated marls, sandstone shales, and massive sandstones. The marls are purple, white, and blue, the reddish tints predominating, the white and blue forming bands of different thickness between the others, which give to the cliffs a lively and pleasing effect. The sandstones are chiefly of a reddish-brown color and closely resemble the brownstone of the Portland and Newark quarries, or the red sandstone of the Seneca quarries on the Potomac River and at Brentsville in Virginia, but some are light brown, gray, or whitish in color. The mesas are formed by the resistance to erosive agencies of the massive sandstone layers, of which there are several at different horizons, and which vary in size from mere capstones of small buttes to tables several miles in extent, stretching to the east and to the northwest.

The drainage of the area is to the south, and in the middle of it, having a nearly due southern course, but winding much among buttes, is the arroyo which has been mistaken for the famous Lithodendron Creek named by Lieutenant Whipple in 1853, as already explained. This arroyo or creek is dry most of the year, but has a gravelly bed often 20 feet in width, and, as with many other streams in this region, if holes are dug in this gravel to a depth of 4 or 5 feet water will accumulate and stand in them.

The valley of this creek is narrow in the northern and central parts of the area and there are several short branches or affluents, but at the southern end it broadens out and its rugged, spurred, and canyoned slopes are highly picturesque. Here is located the principal petrified forest, and this is the region that has been characterized by some as

Chalcedony Park. The petrified logs are countless at all horizons and lie in the greatest profusion on the knolls, buttes, and spurs and in the ravines and gulches, while the ground seems to be everywhere studded with gems consisting of broken fragments of all shapes and sizes and exhibiting all the colors of the rainbow. When we remember that this special area is several square miles in extent some idea can be formed of the enormous quantity of this material that it contains.

Although much fossil wood occurs throughout the whole region as above delimited, still for several miles to the north of this Chalcedony Park it is less abundant, and it is not until the northern end of the area is reached that another center of accumulation occurs. This lies between two mesas, in a valley that opens out upon the general plain which stretches north to the Rio Puerco. It is much smaller in extent than the southern park, but substantially the same general features are presented.

There is still a third center of accumulation, called the "middle forest," which lies some 2 miles southeast of this last and extends to the eastern margin of the general region. It occupies the western slope of the table-land on the east, and is very extensive, stretching a mile or more in a north-south direction and having a width of half a mile in places. It presents many interesting novelties.

All the petrified forests thus far described are, geologically speaking, entirely out of place, and the trunks bear every evidence of having dropped down to their present position from a higher horizon in which they were originally entombed and from which they have been subsequently washed out. Nor is their original position to be discovered by ascending the several mesas included in the area, although some of these rise 400 feet above the lowest ground. It is not until the still higher plateau is reached which bounds the whole region and lies more than 700 feet above the valley that the stratum is at last found which actually holds the fossil wood. A geologist might therefore traverse the entire area from north to south, visit all three of the principal forests, and go out with the impression that everything was out of place, and with no correct idea of the true source of the fossil wood. Even on the east it would be difficult to settle this question, on account of the paucity of the trunks in that direction, but it could doubtless be done by prolonged and careful search. On the west side, however, and directly west of the southernmost area, the plateau is only about 2 miles wide and has a western escarpment, with another valley extending both south and west of it. This plateau or elongated mesa is highest on its western side, rising to the 5,750-foot contour line immediately above the escarpment, and here is exposed a fine series of petrified trunks fringing the mesa, with many weathered out on the slope or rolled down into the valley below. A few feet below the actual summit is a bed, some 20 feet thick, of coarse, gray, conglomeratic, cross-bedded sandstone, at many places in which were found, firmly embedded, logs and branches of the petrified wood, often projecting from it in the cliffs, and clearly in place. This, then, is the true source of the fossil wood, and after several days' study on all sides of the area I became convinced that no other layer holds any of it, at least in this region.

This bed was found at nearly all points where the requisite elevation can be attained, but the petrified logs do not occur in the same abundance throughout. They are massed or collected together in groups or heaps at certain points and may be altogether absent at others. From their great abundance in the three areas above described, which may be called the upper, lower, and middle forest, respectively, but in all of which they are out of place and lie several hundred feet below their proper position, it must be inferred that the stratum which held them was especially rich and that the trunks must have lain in heaps upon one another. This bed may have been considerably thicker in these areas than it is farther out on the margins where it is now found in place.

At only two points within the general petrified forest area did I find remnants of this bed which had not been broken down and disintegrated. One of these is at the extreme northern end, half a mile northeast of the upper forest. Here there is a small mesa, which lies at an elevation of nearly 5,700 feet, or about 400 feet above the valley that contains the upper forest. It is isolated, and its nearly flat top, which is approximately circular, is about half a mile in diameter. The coarse conglomeratic sandstone stratum, 20 to 30 feet in thickness, occupies the summit of this mesa and is often hardened into rock, but in all essential respects it is identical with that of the elongated mesa on the southwest side of the area above described. The petrified wood is less abundant here, but sufficiently common, and is embedded in and often projects from the sandstone ledges.

Besides the fact that this bed lies wholly within the petrified forest area, there is another important circumstance which serves to give it special prominence. One of the most celebrated objects in this entire region is the well-known "Natural Bridge," mentioned by so many travelers, consisting of a great petrified trunk lying across a canyon and forming a natural footbridge, on which men may easily cross. This occurs on the northeast side of the above-mentioned mesa, near its rim, and the bed in which it lies is the coarse sandstone which holds all the petrified wood. The Natural Bridge therefore possesses the added interest of being in place, which can be said of very few of the other petrified logs of this region.

It was observed in the southwestern exposure and at other points that all the petrified logs and blocks lying in the sandstone or only recently washed out of it are surrounded by a coating of the sandstone firmly cemented to the exterior. The absence of this coating from most of those in the principal forests is due to their long exposure to climatic influences, which ultimately disintegrate and detach the sand-rock adhering to them and strip them clean to the body of the trunks themselves. That this process requires ages of time is proved by the fact that the Natural Bridge is still coated over a large part of its surface by the remains of the cemented sand rock in which it was once completely embedded. This is true chiefly of the lower portion, and farther up the trunk it has nearly all disappeared. The trunk is in an excellent state of preservation and is complete to the base, where it is abruptly enlarged and shows the manner in which the roots were attached. This portion still lies partially buried in the sandstone, which is the same in character as that which still adheres to the lower 20 feet. The canyon or gulch has a due north direction and is very precipitous, beginning only 200 yards above the bridge and rapidly broadening in its descent. At the point where the bridge crosses it is about 30 feet wide, but the trunk lies diagonally across and measures 44 feet between the points at which it rests on the sides of the canyon. The angle is nearly 45°, and the tree lies with its roots to the south-east and its top to the northwest. The canyon is here about 20 feet deep, and from its bottom and slopes several small trees are growing, some of which rise considerably above the bridge. The trees are mostly cedars, but there is one cottonwood (*Populus angustifolia*). The root is quite near the brink of the canyon, but rests on a solid ledge for a distance of 4 feet, so that there is no probability that in this dry region it will be endangered by further erosion. The total length exposed is 111 feet, so that more than 60 feet of the upper part lie out on the left bank of the canyon. At about the middle of the canyon, and above where the coating of sandstone still adheres, it measures 10 feet in circumference, giving a diameter of over 3 feet. At the base it is now 4 feet in diameter, but the thickness of the incrustation is not exactly known. At the extreme summit the diameter is reduced to 18 inches. As in the case of practically all the petrified logs of the region, there are no indications of limbs or branches at the top. The significance of this fact will be noted later.

A conspicuous characteristic of all the petrified trunks, not only of this area and of the general Triassic terrane of Arizona and New Mexico, but of all petrified forests, is their tendency to break across into sections or blocks of greater or less length. All travelers have remarked this, and the sketches given by Möllhausen and in the Pacific Railroad reports show them thus divided. Some observers have noted the fact that the Natural Bridge has several of these transverse cracks, and all the good photographic views of it show them. I counted four, but most of them seem to be as yet only partial and probably do not extend entirely through the trunk. There is one, however, near the left bank of the canyon which has the appearance of doing so, and the trunk is probably only kept from parting at this point by the mechanical adjustment which causes the adjacent faces to perform the office of a keystone to an arch. Any considerable shrinkage due to climatic or other causes would overcome this influence and the entire bridge would crash to the bottom of the canyon and roll down the escarpment in a number of huge segments.

An examination of the relations of the Natural Bridge to the gulch which it spans shows clearly that the trunk was primarily entombed in the sandstone bed covering this entire region, and that, with the progress of erosion, which ultimately carried away the entire plain to the north as well as in other directions, leaving this small mesa, it was at last exposed and lay for a great period near the rim of the escarpment. At first it was only partially buried and later came to lie on the surface of the ground. As the land rises somewhat to the south of it rills were formed above, and in times of floods or heavy rain it obstructed the flow of the water, forming a sort of dam. The water lying against the trunk long after it had ceased to overflow it, tended to disintegrate the rock upon which the trunk lay, until eventually it found its way through beneath the trunk at some one point. The smallest opening of this nature would soon become a free passage for the water, and a simple continuation of this process of local erosion would ultimately result in the formation of the entire gorge as it exists to-day.

The other case which I observed of the presence of the conglomeratic sandstone within the general petrified forest area occurs near its center, about midway between the upper and lower forests, along the narrow portion of the valley of the creek above described, on both sides of the canyon and near the level of its bed, at an altitude of about 5,300 feet. The exposure is typical in all respects, and logs were seen projecting from the canyon walls, from one of which specimens were collected. As this exposure is 400 feet below that in which the Natural Bridge occurs and 450 feet below that on the southwestern mesa, its presence there can be accounted for only on one of two hypotheses—either that of the existence of another exactly similar stratum at this horizon, or that of a fault, or what would amount to the same thing, a slide or slipping down of a large block of the uppermost beds in such a manner as not to disturb their stratigraphical arrangement.

The first of these hypotheses is rendered improbable by the fact that a careful study of the beds at the same horizon in other places revealed no such stratum, and it could scarcely be so local as not to be found elsewhere. The second hypothesis seems in every way probable, as in such a much-disturbed region it would be easy for the erosive agencies to undermine a small outlier or mesa and cause it to sink down intact to a lower level. The question, however, requires more detailed investigation than I was able to give it.

Leaving this phenomenon out of the account, therefore, and considering the two exposures in which there is no question as to their natural position, we may use them as a means of determining whether the strata have any dip and to some extent in ascertaining the amount and direction of the dip. The topographic map has a 250-foot contour interval, which is too large to be employed with any very great accuracy, and an aneroid can hardly be depended upon for measurements made six hours apart, as had to be done in this case, but, as nearly as I could judge from all sources of information, the Natural Bridge mesa seems to be between 50 and 100 feet lower than the southwestern mesa. As the distance is about 5 miles, the dip to the northeast is somewhere between 5 and 10 feet to the mile. As, however, the strike was not accurately determined, there is no certainty that this is the true dip of the strata, and more precise observations on a much larger scale will be necessary to settle this question.

Although there is no longer any question as to the true stratigraphical position of these profuse vegetable remains, there are many facts which stand in the way of the supposition that the trees actually grew where we now find them. Several accounts[1] profess that stumps occur erect, with their roots in the ground, showing that they grew and were buried and petrified on the spot, but I was unable to confirm any such observations, and on careful inquiry of residents of the country who had minutely examined every part of the area I was unable to learn of a single indisputable instance of such an occurrence. The only trunk that I saw standing on end was one that was inverted and had its roots high in air. In fact, from the nature of the case, as I have just shown, there would be no use looking for any such phenomenon in any of the principal fossil forests, since they all lie from 100 to 400 feet below where they were originally deposited. It is only in the beds of coarse sandstone that hold them, therefore, that the evidence need be sought. This I did with the utmost care, but even here I found no example of an upright trunk.

In this, as I was glad to learn after my return on looking the matter up, I was only confirming the observations and conclusions of Dr. J. S. Newberry, made in 1858 and published in 1861.[2]

Dr. Newberry's statement is as follows:

> I examined these specimens with some care to determine, if possible, whether they had grown on the spot, as those of Lithodendron Creek are supposed to have done by the members of Captain Whipple's party, or whether they had been transported

[1] Möllhausen, loc. cit. Marcou, Bull. Soc. géol. France, 2d series, Vol. XII, 1855, p. 871. Repeated in Geology of North America, etc., Zurich, 1858, p. 13.

[2] Newberry, in the Ives Report, p. 80.

to their positions. In all that came under my observation I failed to find any evidence that they had grown in the vicinity. All the trunks are stripped of their branches and exhibit precisely the appearance of those transported to some distance by the agency of water. In confirmation of this view I should also say I found in the marls, with the entire trunks, rounded and water-worn fragments of wood, in some instances silicified and in others converted into lignite.

I gathered the same impression from all the collections of silicified wood which I observed in this formation in western New Mexico, viz, that all had been transported, but not far removed from their place of growth.

Although it is easy to find petrified limbs and small twigs among the other objects, still these occur sporadically and accidentally at any and all points. They are no more likely to be found beyond the termination of the tall trunks than anywhere else, as would be the case if the trees lay near where they grew. In fact, it happened that I never found small twigs in this position, although I searched in hundreds of cases. I found no petrified cones, but I heard vague reports of their having been found. It would be strange if none were preserved in such a vast mass of trunks of cone-bearing trees.

Finally, the great abundance of the material would seem to negative the idea that it could have all grown on the same area. Even if every tree had been preserved, there are places where it would have been impossible for them to stand as thickly as they lie on the surface, not to speak of the space that trees in a forest require in order to thrive, as these trees evidently did thrive. And while there is now no place where they lie so thickly in the original bed of sandstone, still, even here they are not only all prostrate, but lie in little collections and huddles, quite differently from what should be expected if they were precisely where they grew.

The preservation of a forest in situ with the trunks erect could scarcely take place except by some sudden, commonly eruptive agency. Such agencies have undoubtedly operated in the preservation of the petrified forests of the Yellowstone Park, and of others that I have visited in Wyoming and elsewhere, in which the stumps and sometimes tall trunks do stand in position with their roots in the ground, but in the region under consideration there are only faint indications of eruptive agencies, certainly not sufficient to account for the phenomena.

The indications, therefore, all point to some degree of transportation of this material by water antecedent to petrifaction, and the great amount of it at this particular place argues for the existence there of such a condition as would arrest the process and cause the floating logs to accumulate in masses, as often happens in great eddies or the deltas of rivers. The character of the bed in which they occur further supports this view. The coarse sand and gravel, highly favorable to the process of silicification, denotes the proximity of the land, and the cross bedding bears witness to the existence of rapid and changing currents. As this stratum occupies the highest elevations in this region, the nature of the overlying beds is not revealed, and the question whether the period was followed by one of general subsidence can be settled only by a study of the higher plains lying some distance to the east and north, but it is probable that the bed sank and that finer deposits ultimately buried it at the bottom of the Mesozoic sea, there to remain until the Tertiary epeirogenic movement raised the entire country from 5,000 to 6,000 feet above sea level.

### THE TAYLORSVILLE,[1] CALIFORNIA, AREA.

The Mesozoic beds, believed to be of Triassic age, in the vicinity of Taylorsville, Plumas County, California, and now generally known by the name of that town, are the only ones of that age as yet known to me in California from which fossil plants have been collected. Lying near the fortieth parallel, the region was naturally entered by the geologists of the Fortieth Parallel Survey at an early date, and those of the California State surveys also passed over it and made important discoveries, including, approximately, that of the age of the rocks and some collections of animal fossils.

Dr. George F. Becker, in 1885,[2] mentions Triassic fossils from the Genesee Valley, Plumas County; and Prof. J. S. Diller, who made his first excursion through this region in 1885, gave some account of it the following year.[3] Shortly after this the region was visited by Prof. I. C. Russell, Prof. Alpheus Hyatt, Mr. H. W. Turner, and Dr. Cooper Curtice, and large collections of animal remains were made.

Dr. Curtice, in 1890, and again in 1891, was successful in securing a few fossil plants, but all proved to be in an imperfect state of preservation. The localities from which Dr. Curtice obtained his plants, as recorded on his labels, are as follows: "Hillside north of a hut near Mr. Forman's house, near Taylorville," 1890. "On trail opposite Bostwicks Bar, near Reynolds Ferry, Stanislaus River," 1891. "Six miles from Copperopolis, on route to Sonora, and on grade to Angels Creek," 1891. "Stanislaus River, near canyon opposite mouth of Bear Creek," 1891.

In 1891 Messrs. E. G. Paul and James Storrs made still another collection of fossil plants from the same general region, their labels giving the locality as "Formans, North Arm of Indian Valley, near Taylorville."

All these collections came ultimately into my hands, and every effort was made to determine them and ascertain their bearing on the age of

[1] In all collections from this place and in Professor Diller's published papers the name is written Taylorville, but it is called Taylorsville in the U. S. Postal Guide.

[2] Notes on the stratigraphy of California: Bull. U. S. Geol. Survey No. 19, 1885, p. 21.

[3] Notes on the geology of northern California: Bull. U. S. Geol. Survey No. 33, 1886, pp. 9–21.

the beds. The first installment received was sent to Professor Fontaine for determination, and he reported upon it, under date of December 8, 1891, as follows:

I have carefully examined the small collection of fossil plants made by Mr. J. S. Diller in northern California, which you sent to me for determination.

The plants are very fragmentary, and most of them are poorly preserved. The most distinct are a small Equisetum and several ferns with small pinnules. The ferns are the most numerous, but unfortunately they present mostly such portions as the tips of pinnæ and detached fragments of pinnæ. The amount of material is not sufficient to enable one to determine with positiveness their relations to previously described forms, for ferns are so notoriously variable in foliage that a considerable amount of material is needed to make reliable determinations. Still, taking the collection as a whole, and looking to the nearest relationships with previously known fossil plants, we may arrive at some results with a considerable degree of certainty.

The plants are certainly younger than Paleozoic, and as the elements of the flora are ferns, equiseta, cycads, and conifers, with no trace of dicotyledons, they are Mesozoic, most probably older than Cretaceous, with the possible exception of its very base.

Owing to the imperfection of the material and the absence of the type forms, I can not come to a positive conclusion as to the exact position in the Mesozoic of these plants, but I think the weight of evidence is strongly in favor of the flora being Rhetic or uppermost Trias.

The following enumeration of determinable forms will give the reasons for this conclusion:

1. *Equisetum Muensteri* (Sternb.) Brongn.? This Equisetum is one of the most common and best-preserved fossils in the Forman slates. It has a small stem, the largest imprints indicating a diameter not greater than one inch. The character of the teeth and the small size cause it to differ decidedly from the large equiseta of the Older Trias. There are no good characters separating it from *E. Muensteri*, as figured by Schenk in his Grenzschichten, while some of the imprints remind one of *E. Lyellii.*

2. Podozamites or Pterophyllum. This is a strap-shaped fragment showing no base and no tips. Hence its true place can not be determined. The nerves are parallel, and appear to fork at one end of the leaf, which is probably the basal end. The imprint is most probably that of a Podozamites, but it may be a Pterophyllum. It seems to be very rare.[1]

3. A small fern. This has very small pinnules shown on small detached fragments of pinnæ, which have the general aspect of those of a Pecopteris. They show no nerves, and are granulated with what seem to be sori covering the surface of the pinnules. This is probably the fructification of Acrostichites, to which genus we may perhaps regard the fern as belonging. It is, however, smaller in pinnules than any previously described Acrostichites. It is rare.[2]

4. A small fern. This, in the form of its pinnules, resembles a Sphenopteris, but the fructified forms show the pinnules apparently covered with sori, producing a granulation, which makes this, too, probably an Acrostichites. The sterile pinnules of this fern remind one of Schenk's *Coniopteris Braunii.*[3]

5. A small fern. This has small pinnules, or segments of pinnæ, which are in shape similar to *Acrostichites microphyllus* of the Virginia Rhetic formation, as described in in Mon. U. S. Geol. Survey, Vol. VI, but the species is a new one, with ultimate pinnæ shorter than those of any previously described Acrostichites. It seems to be clearly an Acrostichites, for the fructified pinnules show the characteristic granulation. In

[1] We will call this *Podozamites ? taylorsvillensis* Ward, n. sp.

[2] This may be called *Acrostichites ? fructifer* Ward, n. sp.

[3] Let this bear the name *Acrostichites ? coniopteroides* Ward, n. sp.

the form of its sterile pinnules it is a good deal like Schenk's *Sphenopteris Rœssertiana*, described in his Foss. Fl. d. Grenzschichten. This is quite rare.[1]

6. *Acrostichites princeps* (Presl) Schenk? This fern is one of the most common and best preserved. In both the shape of the pinnules and the granulation that covers the fructified pinnules it agrees pretty closely with Schenk's *Acrostichites princeps*, from the Rhetic of Europe. The pinnules, like those of the latter, are small, with margins more or less undulating, and when fructified, as they mostly are, they are covered with sori. The amount of material does not suffice, I think, to make the identification positive.

7. Sagenopteris or Cheiropteris. This is a fragrant of what seems to have been a rather large leaf with very thin texture. It shows a border which may be a portion of the extremity of the leaf or of a lateral margin. The nerves are approximately parallel, thin, and not distinct. They anastomose at considerable intervals, so as to give long meshes. The nervation seems nearer that of Sagenopteris than any other fern. If it is a Sagenopteris the leaflets are larger than those of any described species of that genus. Only one specimen was seen.[2]

According to this list; the plants now in question would seem to find their nearest affinities in the Rhetic flora of Franconia, as described by Dr. Schenk.

Professor Diller, in a paper published the following year,[3] gives (p. 374) a condensed statement of Professor Fontaine's report, but it has never before been published entire. Another collection was made in 1893, but the material was even poorer than the rest, and it has been impossible to determine it. The record will, therefore, have to close with Professor Fontaine's report above, but it is greatly to be hoped that some better locality may yet be found and further light shed on the flora of these beds.

# PART II.

## THE JURASSIC FLORA.

### PLANT-BEARING DEPOSITS SUPPOSED TO BE JURASSIC.

It is not, of course, proposed here to go over the ground so long under discussion relative to the Triassic deposits considered in the last chapter, although the Richmond coal field was first regarded by Rogers as Oolite, and Mr. Marcou first referred those of the Southwest to the Jurassic. This question we will consider as settled, and whether, with Professor Fontaine, we place the highest of them in the Rhetic or regard them all as more probably representing the Keuper, we may at least include them all in the American Trias.

The deposits now to be considered are recognized by all as lying above these last, and the ones that have been under discussion are so much higher that the question has always been whether to regard them as Jurassic or as Cretaceous. Neither do I now propose to open up the questions relative to the alleged Jurassic age of the Potomac formation

[1] This can bear the name *Acrostichites brevipennis* Ward, n. sp.

[2] From the large leaflets this may be called *Sagenopteris? magnifoliola* Ward, n. sp..

[3] Geology of the Taylorville region of California: Bull. Geol. Soc. America, Vol. III, 1892, pp. 369-394.

and of the cycad-bearing beds of the Black Hills (Lakota formation of Darton). The former of these questions has been much discussed and it will suffice to refer to its recent literature.[1]

Mr. Jules Marcou, in a somewhat acrimonious article on the Triassic flora of Richmond, Virginia, published in 1890,[2] alludes (p. 161) to a "Jurassic florula" found by Dr. Newberry in 1858 at the Moqui Pueblo in New Mexico. Although I presumed he referred to Dr. Newberry's report in the Report of the Colorado River of the West by Lieutenant Ives, 1861, still there was some uncertainty, and I therefore called Dr. Newberry's attention to the matter and asked him whether he recognized any true Jurassic floras in America. There was some further correspondence, and some extracts from his letters are well worth publishing in the present connection. He says:

The fossil plants to which you refer are described in the geological part of the Ives Colorado report, page 129, pl. iii. The deposit from which this handful of plants was taken is quite near to the Moqui villages, a few miles south of the table-land on which are situated the towns known as "Mooshanove" and "Shungopave," and at a point where the Moquis obtained clay for their pottery. The Dakota sandstone, with its dicotyledonous leaves, rests on these clays and they contain much lignite; below them are the highly colored marls which form the top of the Trias.

The Jurassic ("Atlantosaurus") beds—sandstones and shales with Saurian bones—occur just beneath the Dakota and upon the Triassic marls 150 miles north from this locality, but they are fresh-water deposits and local. No Jurassic rocks have been detected in that part of Arizona where these plants occur, and the Jurassic rocks seem to thin out toward the south and not to cross the north line of Arizona or New Mexico. At Abiquiu, 60 miles north and west of Santa Fe, the Dakota sandstone rests upon strata which contain unmistakable Triassic plants, but all are different from those at the Moqui villages. As that group of plants and the clay and lignite in which they occur have not been recognized anywhere else we are absolutely without proof of their age. Because these plants are different from those known to be Upper Triassic in New Mexico I have been inclined to regard them as Jurassic, but have never asserted that they were such, nor indeed that they were Triassic or anything else.

I have always been doubtful about the geological position of the lignites and the clay beds at the Moqui villages. This doubt is due to the facts that the lignite and clay beds have not been identified elsewhere, and that the small number of plants obtained from them are different specifically from any found elsewhere in the world. It will be impossible, therefore, for any man, however learned and wise, to assign an age to the Moqui florula without more facts to base a conclusion on.

I never really regarded the Moqui plants as Cretaceous, because the beds which contain them are overlain by the Dakota sandstone, which, when my report was written,

[1] See papers by Prof. O. C. Marsh in the Sixteenth Ann. Rept. U. S. Geol. Survey for 1894–95, Pt. I, 1896, pp. 133–414; Am. Jour. Sci., 4th Ser., Vol. II, October, 1896, pp. 295–298; November, 1896, pp. 375–377; December, 1896, pp. 433–447; Vol. VI, August, 1898, pp. 105–115, 197; Science, N. S., Vol. VIII, August 5, 1898, pp. 145–154—by G. K. Gilbert in Science, N. S., Vol. IV, December 11, 1896, pp. 875–877—by Jules Marcou in Am. Jour. Sci., 4th Ser., Vol. IV, September, 1897, pp. 197–212—by Robert T. Hill in Science, N. S., Vol. IV, December 18, 1896, pp. 918–920; Am. Jour. Sci., 4th Ser., Vol. IV, December, 1897, pp. 449–469—by Lester F. Ward in Science, N. S., Vol. V, March 12, 1897, pp. 411–423; Nineteenth Ann. Rept. U. S. Geol. Survey for 1897–98, Pt. II, 1899, pp. 521–946—by William B. Clark in The Physical Features of Maryland, Maryland Geological Survey, April, 1897, 4°—by Clark and Bibbins in Journal of Geology, Vol. V, July–August, 1897, pp. 479–506—by Arthur Hollick in Proc. Am. Assn. Adv. Sci., Vol. XLVII, 1898, pp. 292–293.

[2] Am. Geologist, Vol. V, March, 1890, pp. 160–174.

was supposed to be the oldest member of the Cretaceous system on this continent. The question in my mind has been: Are they Jurassic or Triassic? No Jurassic plants, unless these are such, have been found in America, and the Triassic flora of Abiquiu and Sonora is Keuper, so there is a possibility, not to say probability, that we here get our first glimpse of the flora which covered the land while the Jurassic limestones of the Black Hills and the Wasatch were accumulating in the sea, and the Atlantosaurus beds were filling up fresh-water lakes around which was land that supported a luxuriant vegetation. This was so because the Jurassic fresh-water beds contain the remains of the largest herbivores known. Atlantosaurus was 100 feet or more in length, stood 30 feet in height, and must have consumed several tons of vegetable tissue per day. This shows how much we have to learn in regard to the vegetation of our continent in geological times. Knowing the herbivorous character of the great Jurassic Dinosaurs, I have been on the lookout to find traces of their food, but the Atlantosaurus beds, where I have examined them, contain no plants. Somewhere they will be found, however, and I envy the man who first gets a view of them.[1]

The localities where I have seen the fresh-water Jurassic strata are near Canyon City in Canyon Pintado, north of the Sierra Abajo and in South Canyon, near Glenwood Springs. In none of the localities did I find any remains of plants, but I had very little time to look, and I beg you will make a note of these places, as well as that of the Moqui plants, as deserving of further search.

The so-called Jurassic florula lies in No. 15 of the section on pages 84 and 85; all above that is unquestionably Cretaceous. No. 14 is Dakota, as is proven by its numerous dicotyledonous leaves and by its relation to the overlying shales, which represent the Colorado group and contain its characteristic fossils. No. 12 of the section on page 85 contains numerous plant remains, some of which are represented on pl. iii, but they have nothing to do with the flora found in the clays and lignites (No. 15) which lie below all the strata of the Moqui table-lands. Only the plants of which the figures are numbered 1, 2, 3, 4, 4a on pl. iii are from this horizon. None of the plants taken from this stratum have been found elsewhere, so I can not say to-day any more than when my Colorado report was written whether this florula is Jurassic or Triassic. I have never asserted that it was one or the other, and no one else is warranted in taking any other ground than I took in that report, viz, that further collections must be made from this deposit before the question can be decided. I hope you will keep the locality in mind and some time be able to send one of the employees of the Geological Survey there and gather more material. I shall be delighted if the flora of this deposit shall prove to be Jurassic, for as yet we have not obtained a glimpse of the great flora that must have prevailed on this continent during the Jurassic age and which afforded subsistence to the great herbivores, Atlantosaurus, Stegosaurus, etc.

Soon after this I had some correspondence with Professor Fontaine relative to the probable affinities of the plants figured in the Ives report. He made a careful examination of the figures and the text, and wrote me as follows:

I have examined carefully the figures of the fossil plants described by Dr. Newberry in the Ives report on the Colorado River of the West, which are given on pl. iii, figs. 1–4, and have read all that Newberry says about them. I should say decidedly that they are neither true Triassic nor Rhetic in age, but beyond this I can not speak with conviction. There is not enough material figured to fix the character of the flora, and the plants figured are not identical with any described species known

[1] This prediction has now been fulfilled by the discovery of the cycads and fossil wood described in this paper. L. F. W.

to me. Besides this, the notice by Dr. Newberry of the fossils found by him with these, but not figured, adds to the doubt in my mind.

The plant figured in figs. 1 and 2 is certainly not a Cyclopteris. It is probably a fern and, if so, has quite a modern look, resembling more than others some of the living Adiantums. For shape it may be compared with the living *A. asarifolium* Willd., and for the possession of a basal midrib, with the living *A. Wilsoni* Hook. It may, however, be some old Proteaceous type, for it has something of the habit of a dicotyledonous leaf.

Figs. 3 and 4 probably represent a Gleichenia, and they look something like some of Heer's forms from Kome, with, however, decided differences. If I were compelled to determine the age from the figured plants alone, I should say it is lowest Cretaceous or Neocomian.

Newberry says that the dicotyledonous leaf given in fig. 6 comes from the lignite beds that furnished the other plants of the flora now in question (see p. 131, under *Phyllites venosissimus.*)

The nervation and shape of this reminds me of some of the forms of Sapindopsis of the Potomac. If this leaf was really found in the lignite bed, and not higher up in the Dakota group, its evidence would point to a Cretaceous age.

In connection with this I may refer to what Newberry says at the top of page 131, in closing his remarks on his *Pecopteris cycloloba*, the possible Gleichenia. He says of this plant that it is associated with Clathropteris of Jurassic affinities, and the first-appearing species of the dicotyledonous plants of the Cretaceous epoch, etc. He does not put the lignite bed and underlying strata in the same group with the beds of the uppermost mesa, which yielded him dicotyledons, so that I infer that he means to say that he found dicotyledons with *P. cycloloba*, but I can not understand why he does not lay stress on that fact. Again, on page 132, he mentions finding Clathropteris in the lignite bed, yielding the above-mentioned plants, but he says that the fragments were too imperfect for description. If this is in fact a Clathropteris, then it would indicate strongly that the age of the bed is Jurassic. I would suggest, however, that under some conditions a Clathropteris might, if imperfectly preserved, be similar to some imperfectly preserved dicotyledons, and these fragments may be really no more Clathropteris than the dicotyledonous leaf given in pl. iii, fig. 5 is a Neuropteris.

Dr. Newberry, in his letter to you, in which he says that the plants were obtained in No. 15 of the section on pages 84, 85, seems to have forgotten the section obtained at camp 92, before reaching the Moqui villages, given on page 81, where he found the same plants as in No. 15, and he overlooked the statement made at the bottom of page 131, which attributes *Phyllites venosissimus* to the same lignite bed. He says in his letter that only the plants figured in Nos. 1 to 4 come from this horizon. Are we to take his present recollections or his statement made then? Of course the presence of this dicotyledon may be accounted for by supposing that it came really from the Cretaceous strata above, but got mixed up with the lignite plants.

Have you noted the fact that Newberry, on page 131, says that his *Phyllites venosissimus*, pl. iii, fig. 6, comes from the beds with the supposed Jurassic plants? This Phyllites is apparently a dicotyledon like the Potomac Sapindopsis. Is what he says of the Clathropteris, page 132, all that is known of it? I wish I could feel sure that it is really a Clathropteris. It may be no more that plant than *Neuropteris angulata*, pl. iii, fig. 5, is a Neuropteris, for this is a small dicotyledonous leaf.

Now, if the supposed Clathropteris is really one, it would be worth more than his Cyclopteris and Pecopteris in deciding age. All the supposed Jurassic plants seem to come from No. 2 of the section at camp No. 92 (see p. 81).

I am afraid that *Cyclopteris moquensis* (which is of course no Cyclopteris) and *Pecopteris cycloloba* will be of no help in making out age. Has it occurred to you that the plants may be Potomac?

I have been struck with the general resemblance that Newberry's *Cheiropteris Williamsii* bears to his *Cyclopteris moquensis* from the Moqui villages. I refer especially to the specimen given in fig. 11, pl. xiv, of his recent paper on the Flora of the Great Falls coal field, published in the Am. Jour. Sci. (3d series, Vol. XLI, March, 1891). The anastomosis of the veins of *Cheiropteris Williamsii* occurs at such long intervals that it might easily have been overlooked in *Cyclopteris moquensis*.

From all this I think it may be safely concluded that the claims of any of these plant-bearing beds to a Jurassic age are very slender, and it is probable that they are not Jurassic, whatever their real age may be.

The following correspondence will give the history of the only other case within my knowledge of fossil plants occurring at a horizon which is near the boundary line between the Jurassic and the Cretaceous, and the true position of which is not yet settled:

BERKELEY, CALIFORNIA, *January 21, 1896.*

Prof. LESTER F. WARD,
*Washington, D. C.*

DEAR SIR: I have forwarded to your address to-day four specimens of fossil plants collected by Mr. H. W. Fairbanks in rocks underlying the Knoxville in California. We are very anxious to know what they are and what their probable age is. The fauna associated with them is, peculiarly enough, rather of Cretaceous than Jurassic aspect.

Would you kindly look at them and send me your opinion as soon as possible? Full credit will be given to you in a note to be published.

Very sincerely yours, JOHN C. MERRIAM.

WASHINGTON, D. C., *February 10, 1896.*

Prof. JOHN C. MERRIAM,
*University of California, Berkeley, California.*

MY DEAR SIR: I am much interested in the specimens you send. I can hardly trust myself to determine them for you, and will take the liberty of sending them to Professor Fontaine, who is working up all my collections from California. I obtained several specimens in the Shasta group that somewhat resemble them, but I also found a very few imperfect impressions in the Mariposa slates that look like them. I presume it will turn out with the plants as Dr. Stanton says it has with the shells, that they are not wholly diagnostic of the age of the beds. It seems to be a conifer, perhaps the descendant of the old Voltzia and the somewhat later Palissya, foreshadowing the Lower Cretaceous Geinitzia and the more modern Sequoias. But what Professor Fontaine will call it I do not know. It is a highly transitional form, and all your specimens are the same, I think. As soon as I hear from Professor Fontaine on the subject I will let you know.

Very sincerely yours, LESTER F. WARD.

WASHINGTON, D. C., *February 11, 1896.*

Prof. WM. M. FONTAINE,
*University of Virginia, Virginia.*

MY DEAR PROFESSOR FONTAINE: I send you a little package containing four specimens of fossil plants from beds underlying the Knoxville of California. They were sent to me by Prof. John C. Merriam, of the University of California, with a letter, of which the inclosed is a copy, which you need not return. I am as anxious as he to know what the plants signify. I got some things a little like them in my collection from the Knoxville beds, which are all boxed up and ready to go to you. I also got a very few minute fragments of the tips of branches that resemble these from the true Mariposa beds (Jurassic). I hardly know what genus to refer them to. Will you please look at them and see whether you recognize them readily, and say what they seem to be most like?

Very sincerely yours,

LESTER F. WARD.

CHARLOTTESVILLE, VIRGINIA, *February 12, 1896.*

DEAR MR. WARD: I return the specimens of Mr. Merriam by this day's mail.

The only Jurassic genus known to me that may contain these fossils is Elatides of Heer, provided we grant that he correctly places in it the leafy twigs, which he describes in Vol. IV, Pt. II, Flor. Foss. Arct., page 79, and figures on pl. xiv, figs. 6, 6b, 6d. Heer founded the genus on cones, but there is nothing except his experience to call for the association of these branches with the cones.

The leaves are most strikingly like those of *Sequoia Reichenbachi*, especially those of the Potomac form, which I made the variety *longifolia* (see pl. cxvii, fig. 8, of Mon. U. S. Geol. Survey, Vol. XV). I see no difference. The leaves of Merriam's fossils are probably not shown in their full width, owing to imperfect preservation. They appear fully as long as the longest of the Potomac form. They are too long and narrow for the typical *S. Reichenbachi.* Clearly the plant is a Sequoia of the *Reichenbachi* type, and if it were a true *S. Reichenbachi* I do not think that would forbid the conclusion that the strata are uppermost Jurassic, as this Sequoia persists so long. Still, under the circumstances, I would not identify it with *S. Reichenbachi*, even as a variety, but would consider it provisionally a new species of the well-marked *Reichenbachi* type. It may be an ancestral form of that species. I do not think that these fossils can throw any light of value on the question of the age of the beds. So far as they show any indication, they rather incline to lowest Cretaceous.

Yours truly,

WM. M. FONTAINE.

WASHINGTON, D. C., *February 15, 1896.*

Prof. JOHN C. MERRIAM, *Berkeley, California.*

MY DEAR PROFESSOR MERRIAM: I return herewith, by mail, the fossils from beds below the Knoxville, and inclose Professor Fontaine's report thereon. You will see how nearly it agrees with what I said, and while it may not be very comforting, you can rest assured that it is the best that can be done in the present state of science.

I have talked with Dr. Stanton, who has seen the shells from the same beds, and he makes almost exactly the same statement with regard to them. He says they rather point to lowest Cretaceous, and I think, perhaps, it may be safe to say that these beds form a transition from the Jurassic to the Cretaceous. However, I do not feel confident, from the small amount of evidence which has thus far been produced.

Very sincerely yours,

LESTER F. WARD.

As in the former case, so in this, while there is some doubt, the weight of evidence thus far appears to be against the Jurassic age of this plant-bearing deposit.

### PLANT-BEARING DEPOSITS OF UNDOUBTED JURASSIC AGE.

One of Mr. H. W. Turner's assistants, A. I. Oliver, collected in 1894 in the Mariposa beds of California in Yaqui Gulch, Mariposa County, 5 miles south of Princeton (Bullion Mountain), a small fragment of a fern, which came in due time into my hands. In his letter, dated January 31, 1895, to the Director of the Survey, transmitting it, Mr. Turner says: "The age of the slates from which the specimen came is Jurassic (Mariposa formation)."

In the early part of October, 1895, I joined Mr. Turner's party for a time while operating in this same general region, having with me Mr. James Storrs, who was with Mr. Turner at the time the fern was collected, although neither of them were with Mr. Oliver when he found it. Still, the exact gulch in which it was found was known to Mr. Storrs and we made a prolonged search for additional material. The shales are so transformed that scarcely any impressions are retained and we were mainly unsuccessful, but did find a few faint impressions of a vegetable nature, one of which was a fern nearly as well preserved as the original specimen. All this material, including the original specimen, was sent to Professor Fontaine, who reports upon it as follows:

I have examined the specimens of fossil plants collected from the Mariposa slates, near Princeton, California. They are very few in number and very fragmentary and poorly preserved. The plant fragments before entombment had evidently drifted some distance. It is therefore not possible to make positive determinations.

The specimen collected by Mr. Oliver, of Mr. Turner's party, in 1894, from Yaqui Gulch, Mariposa County, shows the end of an ultimate pinna of a fern. Several pinnules on each side of the rachis and the terminal one are preserved. No fructification is shown. The pinnules indicate that the plant is a Dicksonia. It agrees very well, so far as the character is shown, with *D. Saportana* Heer,[1] from the Jurassic of the upper Amur of eastern Siberia, and may be provisionally identified with that species.

One of the specimens collected by Messrs. Ward and Storrs in 1895, at nearly the same place as the last, shows the terminal portion, in a small fragment, of an ultimate twig of some conifer. It has several leaves of thick texture placed in two ranks on each side of the stem. They are widest at base, and decurrent, while they narrow to an acute tip. The terminal portion of the leaves is strongly incurved after the fashion of Pagiophyllum, to which genus it seems to belong. It resembles the specimen of *P. peregrinum*, given by Saporta in Paléontologie Française, Végétaux, Plantes Jurassiques, Tome III, Atlas, pl. clxxvi, fig. 3, and may be doubtfully identified with that species.

There is one other very problematic plant in that collection. It is a small bit of a twig, carrying on one side three small round bodies, which may be the cones of some conifer. They may be those of Leptostrobus. The mode of attachment and form indicate this, and the plant, for the sake of a name, may be called *Leptostrobus? mariposensis* Font. n. sp.

The above form all the identifiable plant impressions in the material sent.

### THE OROVILLE FLORA.

On the 9th of October, 1894, Dr. T. W. Stanton, assisted by Messrs. Storrs and Oliver, made two small collections of fossil plants from the blue gold-bearing shales on the Feather River, in Butte County, California, 4 miles above the town of Oroville, the true age of which was

[1] Heer, Flora Fossilis Arctica, Vol. IV, Pt. II, pp. 89, 90, pl. xvii, figs. 1, 2; pl. xviii, figs. 1-3.

wholly unsettled. One of these collections was made at the stamp mill of the Banner mine, and the other half a mile south of the Banner mine, on the right or north bank of Feather River. These collections came to Washington, and were transmitted to me through the Geological Survey, by Mr. Turner, at the end of January, 1895, along with the Mariposa fern above mentioned. They were sent to Professor Fontaine for determination on April 9, and his report upon them bears date April 22, 1895.

In an article on the Age and Succession of the Igneous Rocks of the Sierra Nevada,[1] Mr. Turner, to whom I sent a copy of the report, published it in full (pp. 395, 396). Professor Fontaine's conclusion, as expressed in the last paragraph of this report, is as follows:

> Taking all the evidence, I think it can be positively said that this flora is not older than the uppermost Trias, and not younger than the Oolite. I feel pretty sure that it is true Rhetic, somewhat younger than the Los Bronces flora of Newberry, and the Virginia Mesozoic coal strata. It is much like the Rhetic flora of France, made known by Saporta. At any rate, this is a new grouping of plants that certainly deserves to be carefully collected. I do not think the fossils now in hand suffice to fix narrowly the age, which may be lower Jurassic.

While operating in the Sacramento Valley in the autumn of that same year, having Mr. James Storrs as my assistant, I thought best, in view of the meagerness of the previous collections and of the importance of this, the only paleontological evidence that these beds furnish, to visit the localities and endeavor to obtain more and better material. We reached Oroville on September 25, and proceeded on the 26th to the Banner mine. We spent three days in the work, first collecting from the dumps around the deep shafts, then on the bank of the river, with some measure of success. At last we entered a deep ravine that leads from the mine to the river, and here we found the rocks far better exposed and made a very fine collection, containing large slabs with impressions of great spreading pinnæ of Ctenis, Ctenophyllum, Tæniopteris, Macrotæniopteris, etc. Six large boxes were thus quickly filled and were shipped to Washington, arriving in good condition in November.

I worked this material over with much care during the winter, and not wishing to reship it on account of its fragile nature, I arranged with Professor Fontaine to come to Washington during his summer vacation of 1896 and elaborate it in the United States National Museum. This he did in July. As it would necessarily be some time before the drawings could be made and the first report published, Professor Fontaine consented to prepare a preliminary paper embodying the principal results, which appeared in October of that year.[2] It unfortunately seemed necessary to publish the list of species, including the new ones,

[1] Jour. Geol., Vol. III, May-June, 1895, pp. 385-414.

[2] Notes on some Mesozoic plants from near Oroville, California, by Wm. M. Fontaine: Am. Jour. Sci., October, 1896, 4th series, Vol. II, pp. 273-275.

in this article without descriptions, and as such they are mere *nomina nuda*, but the types are at the National Museum duly labeled and accessible to all, so that there could be no question as to identification. The closing paragraph of this article shows that in the course of his examination of this thoroughly representative collection, with the original small collection in his hands at the same time, Professor Fontaine was induced to regard the deposit as somewhat higher than he formerly supposed:

> From this it will be seen that the evidence that the age is Jurassic is stronger than for any other, and as the Oolitic plants predominate, we may assume with considerable probability that it is rather late Jurassic, being about that of the lower Oolite (p. 275).

All this, taken in connection with the close lithological resemblances, seems to point to the practical identity of these auriferous slates with the typical Mariposa slates farther south.

There are many causes that have delayed progress in bringing out the final report on the Oroville collections. Professor Fontaine's manuscript containing the full descriptions and directions for illustration was submitted August 11, 1896, but the Division of Illustrations was unable to take them up until the fall of 1897, and owing to prolonged interruptions they were not completed until the spring of 1899. The drawings were submitted to Professor Fontaine for revision and all steps taken to render them as perfect as possible. Having worked out the synonymy with special care I introduce the report into this paper in the following form:

### NOTES ON MESOZOIC PLANTS FROM OROVILLE, CALIFORNIA.

By Wm. M. Fontaine.

The plants described in this paper were collected in September, 1895, by Mr. Lester F. Ward, assisted by Mr. James Storrs. They were obtained near Oroville, California, from a formation which for convenience of reference I will call the Oroville beds. They were collected from four localities, which are all near together. The following are the localities:

1. The old dump at the Banner mine, near Feather River, 5 miles east of Oroville, California.
2. The new dump, 300 yards farther north than the old dump.
3. Bank of Feather River, one-half mile south of the Banner mine.
4. In the bed of a ravine that leads from the Banner mine to the Feather River, from one-fourth to one-half mile south of that mine.

All the fossils occur on the same horizon. Mr. Ward says in a note that these Oroville beds closely resemble the Jurassic Mariposa slates, but the identity is not made out. According to oral statements made by him, the formation where the plants were collected is in the form of a narrow belt, perhaps 500 yards wide, with a dip of from 70° to 80°.

The beds contain no fossils besides the plants. They are not connected stratigraphically with any known formation, and their age, so far as yet known, must be determined from the plant fossils.

Mr. H. W. Turner, in a paper on The Age and Succession of the Igneous Rocks of the Sierra Nevada, published in the Journal of Geology, Vol. III, No. 4, May–June, 1895, p. 394, speaking of the eruptive rocks of the Smartsville area, says:

> These rocks, largely augite-porphyrites and their tuffs, are presumed to have covered, as with a mantle, the underlying Paleozoic formation. There are some streaks of slates among the eruptive masses, but these have not in the Smartsville area afforded any fossils. However, during the past season, in the north extension of the same area, in a belt of clay-slate interbedded with augite-breccia and tuff, fossil plants were collected by T. W. Stanton. The exact locality is by the stage road south of the Oroville Table Mountain, near the Banner gold quartz mine.

The locality referred to by Mr. Turner is that from which Mr. Ward collected. The plants collected by Dr. Stanton were submitted by Mr. Ward to me for determination. They will be noticed further on.

The rock material carrying the plants described in this paper shows some chemical disturbance, so that the fossils, especially in the coarser matrix, are sometimes poorly preserved in their more delicate parts. They are a good deal rubbed, crushed, and distorted. The rocks show considerable induration, the finer argillaceous material being in the condition of a fine slate. The tuffs have the aspect of a hard sandstone. The slate varies in color from lead-gray to black, the latter having much carbon in a diffused state. It looks much like the roof slates of a coal bed.

To judge from the specimens collected by Messrs. Ward and Storrs, most of the rock of the Oroville beds that carries plants consists of alternations of sandy-looking beds with layers of slate. The former are probably the tuffs noticed by Mr. Turner. I will refer to this material as tuffs in describing the plants.

## DESCRIPTIONS OF THE SPECIES.

### Subkingdom PTERIDOPHYTA (Ferns and Fern Allies).

### Class FILICALES.

### Family FILICES (Ferns).

### Genus THYRSOPTERIS Kuntze.

#### THYRSOPTERIS MAAKIANA Heer?

Pl. XLIX, Fig. 1.

1876. *Thyrsopteris Maakiana* Heer: Jura-Flora Ostsibiriens, Fl. Foss. Arct., Vol. IV, Pt. II, pp. 23, 31, 118, pl. i, figs. 1a, 1b; pl. ii, figs. 5, 5b, 6.

This plant was found in one specimen at the locality "In the bed of a ravine that leads from the Banner mine," etc., and in three specimens from the locality "Bank of Feather River," etc. It is too fragmentary and too poorly preserved to permit its character to be made out fully. It most resembles the *Thyrsopteris Maakiana* of Heer, from the Jurassic of Siberia,[1] but the pinnules are more entire, probably because they are higher up on the frond.

The most complete specimen is the one figured. This occurs on a fragment of indurated tuff that has the physical character of sandstone, hence the imprint is not distinct and is somewhat distorted. This imprint shows a portion of a penultimate pinna, with several ultimate pinnæ on each side of the rachis. These are lanceolate in form and alternate in position, with lobes and teeth cut obliquely into an oblong or ovate shape. The basal upper pinnules are decidedly larger than any of the rest. Toward the ends of the ultimate pinnæ the pinnules become entire, or nearly so. The incision of the lamina is made to varying depths, according to position, so that the lobes pass to teeth higher up.

## Genus ADIANTITES Göppert.

### ADIANTITES OROVILLENSIS Fontaine.

Pl. XLIX, Figs. 2, 3.

1896. *Adiantites orovillensis* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Frond tripinnate, primary and secondary rachises strong and rigid. The principal rachis was seen with a thickness up to 5 mm. The primary pinnæ are long and lanceolate in form. Their mode of insertion was not seen. The ultimate pinnæ are subopposite and oblong in form, with 4 to 5 pinnules on a side that do not diminish much in size from the base to the summit of the pinnæ. They are terminated by a spatulate pinnule that is nearly as large as the rest, an unusual feature in ferns. The pinnules are round to reniform in shape and subopposite. They are rather remote and decurrent to form a narrow wing. They are small, about 6 mm. wide and 4 mm. in height. Their nervation was not clearly made out, but seems to be composed of a bundle that spreads in the lamina of the pinnule, in a flabellate manner, forking once in each branch.

This elegant little fern was found in only one specimen at the locality "Bank of Feather River, one-half mile south of the Banner mine." Pl. XLIX, Fig. 2, gives this specimen, and Fig. 3 represents one of the pinnules magnified to show details.

This plant seems to be new and not very near any described form.

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[1] Flora Foss. Arct., Vol. IV, Beiträge zur Jura-Flora Ostsib. und des Amurlandes, p. 31, pl. i, fig. 1a; pl. ii, fig. 6.

## Genus CLADOPHLEBIS Brongniart.

### Cladophlebis spectabilis (Heer) Fontaine.

Pl. XLIX, Figs. 4, 5.

1876. *Asplenium* (*Diplazium*) *spectabile* Heer: Jura-Flora Ostsibiriens, Fl. Foss. Arct., Vol. IV, Pt. II, pp. 96, 120, pl. xxi, figs. 1, 2a, 2c, 2d.
1896. *Cladophlebis spectabilis* (Heer) Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

This beautiful and well-characterized fern was found in two pretty well-preserved specimens at the locality "Bank of Feather River, one-half mile south of the Banner mine." The specimens show only detached portions of ultimate pinnæ. The specimen given in Pl. XLIX, Fig. 4, shows portions of three ultimate pinnæ in a position that they would have if they had been attached to a principal rachis. This specimen shows that the fern was at least bipinnate. The plant was clearly a large one, and it was probably subarborescent. The rachises are strong and rigid. The pinnules are large and closely placed, but separate to their bases. Their ends are very obtuse and their texture seems to have been thin. The midnerve of the pinnules is sharply defined, but not very thick. The lateral nerves are very distinct, but not strong; they fork twice, the forking taking place near the midnerve. The branches diverge suddenly, and then go nearly parallel until they reach the margins of the pinnules.

The general aspect of this plant is not common among ferns, and hence it can be easily recognized, and there is not much danger of confounding it with other species. This fact gives to even small fragments a value not possessed by less well-defined forms.

Fig. 4 gives the most complete specimen, and Fig. 5 a pinnule of the same, magnified to show details.

This plant is no doubt identical with that described by Heer as *Asplenium spectabile* from the Jurassic formation on the upper Amur, in Siberia.[1] Heer regards the species as an Asplenium on the strength of supposed sori that he saw on his specimens. Nothing resembling sori was seen on the Oroville plants. The species clearly belongs to the Cladophlebis type of fern. I prefer to call all ferns of this type Cladophlebis and not to identify them with living species in the absence of satisfactory proof.

### Cladophlebis argutula (Heer) Fontaine.

Pl. L, Figs. 1–6.

1876. *Asplenium argutulum* Heer: Jura-Flora Ostsibiriens, Fl. Foss. Arct., Vol. IV, Pt. II, pp. 24, 41, 96, 118, 120, pl. iii, figs. 7, 7b, 7c, 7d; pl. xix, figs. 1, 1b, 2, 3, 3b, 3c, 4.
1896. *Cladophlebis argutulus* (Heer) Fontaine: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

[1] Flora Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostsib. und des Amurlandes, pp. 96, 97, pl. xxi, figs. 1, 2a.

A considerable number of specimens of a small fern were obtained that agree so well with Heer's *Asplenium argutulum* that it may without much hesitation be identified with it. Heer's plant was obtained from the Jurassic formation on the upper Amur River, the same that yielded *C. spectabilis*.[1] Most of the Oroville specimens are fragmentary and distorted by pressure. This is the case with the form represented in Fig. 1, and in consequence of this the pinnules appear more united and wider than in Heer's normal forms.

This is the most common small-leaved fern at the Oroville localities. It occurs at most of them, but is most abundant at the locality "In the bed of a ravine that leads from the Banner mine to the Feather River," etc.

Fig. 1 gives the upper part of a compound pinna. Fig. 3 represents several detached ultimate pinnæ from the lower part of the frond, and Fig. 4 gives a pinnule of the same enlarged to show details.[2]

### CLADOPHLEBIS WHITBIENSIS TENUIS var. a Heer?[3]

### Pl. L, Fig. 7.

1876. *Asplenium (Diplazium) whitbiense tenue* var. a Heer: Jura-Flora Ostsibiriens, Fl. Foss. Arct., Vol. IV, Pt. II, pp. 24, 39, 95, 118, 120, pl. iii, figs. 3, 3b; pl. xx, figs. 2, 3a; pl. xxi, figs. 3a, 3b, 4, 4b.

1896. *Cladophlebis whitbiensis tenuis* var. a (Heer) Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Two small fragments of a fern that is without doubt of the *whitbiensis* type were found at "The old dump at the Banner mine." Both are the terminations of ultimate pinnæ, parts of ferns that have little value in fixing character, and hence, as the amount of material is so small, the identity of this fern must remain in doubt. It is, however, clearly different from the other ferns found at Oroville, and is so much like the form described by Heer[4] from the Jurassic of Siberia that it may be provisionally identified with it. The Oroville plant may be compared with fig. 2 of Heer's pl. xx. The plant has a sharply defined character marked by the possession of pinnules that are very broad at

[1] Flora Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostsib. und des Amurlandes, p. 96, pl. xix, figs 1-4.

[2] After Professor Fontaine had studied the specimens it was observed that there was a counterpart of the upper part of the specimen, Fig. 1, which shows the details somewhat better, and this is shown in Fig 2. A small piece on the left of the portion of the large slab, designated Fig. 3 by Professor Fontaine, split off, revealing the pinna included in that figure, which lies in the opposite direction and is not in the same plane as the others on the rock. The reverse of this on the small piece thus split off shows more than the side adhering to the large slab, and is represented in Fig. 5. The perfect pinnule near the top of this on the left is given in Fig. 6, enlarged two diameters.
L. F. W.

[3] It is not worth while to attempt to work out the synonymy of this form, as it is clearly different from the original *Pecopteris tenuis* Schouw, Mss., based on a specimen in Prince Christian's Museum and figured by Brongniart in his Hist. Vég. Foss., Vol. I, pl. cx, fig. 4, and the whole group needs revision.
L. F. W.

[4] Flora Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostib. und des Amurlandes, p. 95, pl. xx, figs. 2, 3a.

base with acute tips. At the same time they are inclined forward in a peculiar manner. They can not be united with *Cladophlebis spectabilis*, the plant nearest to it that occurs at Oroville.

This fern belongs evidently to that well-marked Jurassic type brought under the comprehensive name *Cladophlebis whitbiensis*, and resembles Brongniart's form more than that of Lindley and Hutton.

### CLADOPHLEBIS DENSIFOLIA Fontaine.

Pl. LI.

1896. *Cladophlebis densifolia* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Frond tripinnate at least. The largest primary rachis seen, given in Pl. LI, Fig. 1, has a width of 6 mm. The primary pinnæ are alternate and very long. The largest portions found were 14 cm. in length, with the basal and terminal portions not preserved. This portion does not change in width much throughout its length, and hence must belong to a pinna that was much larger than the part seen. The primary pinnæ were probably linear-lanceolate in form, and tapered very gradually from base to tip. They are closely placed, so that they overlap. The rachises are strong and rigid, going off from the principal rachis at an angle of 45° and curving away from it. The secondary pinnæ are alternate to subopposite and very closely placed so as to overlap. They gradually diminish in length and size from their insertions on the primary pinnæ to their ends. The longest basal ones are about 2 cm. in length and the width of these is about 2 mm. In shape they are oblong with subacute ends. They are inserted at about an angle of 45°, and are falcately curved toward the ends of the primary pinnæ. The lowest, basal, ultimate pinnæ are cut in their lower portions down to the midrib into ovate subfalcate and subacute pinnules that are closely placed, but the portions higher up have the lamina of the leaf more and more entire, the incisions passing, at the tips of the ultimate pinnæ, into teeth. Higher up on the frond and more toward the ends of the primary pinnæ the ultimate ones become more and more entire and pass into lobed and dentate pinnules. The tip of the primary pinna has pinnules and lobes like those of the ultimate pinnæ lower down. The nervation could not be made out.

Fig. 1 represents a portion of a primary pinna. Fig. 2 gives several secondary pinnæ, placed as if they had been attached to a principal rachis. Fig. 3 gives the terminal portion of a frond, or of one of the lower primary pinnæ. Fig. 4 gives a portion of a lower ultimate pinna magnified to show details.

This is one of the most abundant small-leaved ferns in the formation, and it shows larger portions better preserved than any of the small ferns.

The plant previously known that is perhaps nearest to this is the sterile form of *Pecopteris lobata* Oldh., of the Rajmahal flora.[1] The enlarged pinnules on pl. xxx, of Oldham and Morris, allowing for their evident distortion, are much like those of the Oroville fossils. At the same time the density of the lobes and pinnules in the ultimate pinnæ, the shape of the ultimate pinnæ, their close position, and mode of insertion, are much like features shown in the plant from Oroville. The Indian plant is mostly fructified, but this feature is wanting in the fossil now being described. While these points show that the two are probably near together, it seems the better usage, in the case of plants growing in regions as far apart, and in the absence of stronger proof of identity, to regard them as distinct species. *Cladophlebis densifolia* is found at the locality "Bank of Feather River, one-half mile south of the Banner mine."

### CLADOPHLEBIS INDICA (Oldham and Morris) Fontaine?

Pl. LII, Fig. 1.

1862. *Pecopteris (Alethopteris) indica* Oldh. and Morr.: Palæontologia Indica, Ser. II. Foss. Fl. Gondw. Syst., Vol. I, Pt. I, Foss. Fl. Rajmahal Series, p. 47, pl. xxvii.
1869. *Alethopteris indica* (Oldh. and Morr.) Schimp.: Traité de Pal. Vég., Vol. I, p. 568.
1896. *Cladophlebis indica* (Oldh. and Morr.) Font.?: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

A single specimen was obtained from the locality: "In the bed of a ravine that leads from the Banner mine," etc., of a fern that seems identical with the typical *Pecopteris indica*[2] of Oldham and Morris, from the Rajmahal series of India. It is especially like fig, 1 of pl. xxvii of the Fossil Flora of the Rajmahal Series. The specimen is an imprint of the middle portion of an ultimate pinna that shows several pinnules. These are united at the base. They are pretty large, and show little diminution in width from their bases to their tips. They are strongly falcate, but show no nerves, except a pretty strong midrib. There is not enough material to permit a positive identification of this species to be made.

## Genus TÆNIOPTERIS Brongniart.

### TÆNIOPTERIS OROVILLENSIS Fontaine.

Pl. LII, Figs. 2–4.

1896. *Tæniopteris orovillensis* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

The fronds vary in length * from 1 to 4 cm. The maximum length seen is 13 cm. on fragments of fronds. The largest were probably at

[1] Fossil Flora of the Rajmahal Series, p. 52, pl. xxviii, fig. 1; pl. xxix; pl. xxx.
[2] Op. cit., p. 47, pl. xxvii.

* Should read "vary in width"
see XX Ann. Report Geol. Survey, 1905
Page 79.

least 26 cm. long. The fronds taper gradually from near the middle toward their base and tip, so that they are narrowly elliptical in shape. The midrib is strong, prominent, and rounded. The lateral nerves go off nearly at right angles, curve slightly away from the midrib, and then, near the margin, curve slightly toward the ends of the fronds. They are parallel throughout their course, very fine but distinct, and very closely placed, being about three in the space of 1 mm. The leaf substance is thick and durable, giving the pinnule a rigid aspect. No entire specimen was seen.

This plant is by far the most common fossil at Oroville. It occurs abundantly at the localities "Bank of Feather River," etc., and "In the bed of a ravine that leads from the Banner mine," etc. It is very near the plant figured and described by Saporta[1] as *Tæniopteris tenuinervis* Brauns, from the Infralias of France. From an inspection of the material afforded by Stanton's collection it was regarded as identical with Saporta's plant. This species varies a good deal in dimensions, and from the imperfect material in the above-mentioned collection the writer supposed that another species figured by Saporta from the same formation, viz, *T. stenoneura* Schenk, was also present. The very abundant and well-preserved material collected by Messrs. Ward and Storrs establishes a complete gradation between all the forms of Tæniopteris found at Oroville, and shows that only one species exists there. In addition, it makes it pretty clear that this is a new species. The larger specimens much surpass in size any of Saporta's, and, what is of more importance, the nerves are finer, more closely placed, and they do not fork at any point.

Fig. 2 gives a portion of one of the small fronds, not the smallest, and Fig. 3 represents the average of the largest forms. It shows well the mode of tapering toward the base of the frond, while it gives as much of the stipe as is seen on any of the specimens. Fig. 4 gives an enlarged fragment, to show the nervation.

### Genus MACROTÆNIOPTERIS Schimper.

#### MACROTÆNIOPTERIS CALIFORNICA Fontaine.

Pl. LIII, Fig. 1; Pl. LIV, Figs. 1, 2.

1896. *Macrotæniopteris californica* Font.. Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Fronds variable in width, mostly large. The largest seen had a midrib 1 cm. in width and a leaf at least 15 cm. wide. Only fragments were seen. The smallest form had a width toward its base of only 4 cm. The widest leaves were not entire, so that their maximum width

[1] Paléontologie Française, 2e Série, Végétaux, Vol. I, p. 441, pl. lxiii, figs. 1-5.

probably surpassed the greatest dimensions seen. The nerves are about three-fourths of a millimeter apart. They are slender but sharply defined. They go off nearly at right angles with the midrib and then arch slightly forward toward the end of the frond. They are parallel in their course and are nearly all unbranched. Very few branch and nearly all that fork do so before reaching the middle of the lamina of the frond.

Several specimens of this plant were found at the locality "In the bed of a ravine that leads from the Banner mine," etc., but all were quite fragmentary and poorly preserved. The varying size of the fronds is no doubt due to the varying age of the same.

This fossil, although probably a new species, seems to be quite near to *Tæniopteris lata* Oldh. and Morr.,[1] of India, but the midrib is wider and not so rigid as that of the plant from the Rajmahal flora.

Pl. LIV, Fig. 1, gives the basal portion of a small form, and Pl. LIII, Fig. 1, a fragment of one of the largest leaves.

### MACROTÆNIOPTERIS NERVOSA Fontaine.

Pl. LIV, Fig. 3; Pl. LV, Fig. 1.

1896. *Macrotæniopteris nervosa* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Leaf very large, dimensions not made out. Midrib very large. The largest imprint of it seen had a width of 15 mm. Not enough of the frond was seen to show the entire course of the lateral nerves. As seen, they go off from the midrib at a large angle, then arch slightly away from it and are parallel for all their course seen. They sometimes have a common point of insertion for two adjacent lateral nerves, which are then single. Sometimes each nerve has an independent point of insertion, and then these may fork near the midrib. The lateral nerves are very thick and cord-like and very remote.

No known Macrotæniopteris has nerves anything like those of this plant. The fragments found were evidently but small portions of the original fronds. They indicate for it a gigantic size.

Two fragments were found, one at the locality "Bank of Feather River," etc., and one at the locality "In the bed of a ravine that leads from the Banner mine," etc., that must have belonged to gigantic fronds. Pl. LIV, Fig. 3, and Pl. LV, Fig. 1, give the two most perfect specimens, which have a midrib 8 mm. wide.

[1] Fossil Flora of the Rajmahal Series, pl. ii, fig. 1.

## Genus ANGIOPTERIDIUM Schimper.

### ANGIOPTERIDIUM CALIFORNICUM Fontaine.

Pl. LV, Figs. 2–5.

1896. *Angiopteridium californicum* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Two fragments of a fern that seems to be an Angiopteridium were found at the locality "In the bed of a ravine that leads from the Banner mine," etc. One of these is the fragment of the middle portion of a sterile pinnule. This is 25 mm. wide. It has very distinct, but slender, lax, and rather remote lateral nerves that go off at a large angle from the midrib, curve away from it, and then, near the margin of the lamina, bend slightly toward the tip of the pinnule. In general aspect the fragment looks much like *Tæniopteris orovillensis*, but the nerves are quite different. The lateral nerves leave from a common point on the midrib, and then are either single or fork at varying distances from the midrib, but only once, and mostly halfway between the midrib and margin. The branches are, approximately, parallel. This sterile form resembles somewhat *Angiopteridium nervosum* Font., of the Potomac formation of Virginia.

The other fragment seems to be the fertile form of the same species as the sterile portion just described. It has the same nervation as the sterile fragment, and is the imprint of a portion of a frond, about 2 cm. wide in its widest portion. The imprint shows a length of 85 mm., with the basal and terminal portions not preserved. It bears, at the margins of the pinnule, elliptical sori of large size. They are carried on the ends of the lateral nerves.

This fertile form resembles *Angiopteridium McClellandi* (Oldh. and Morr.) Schimp. It should be stated that the sterile form is a good deal like that depicted by Feistmantel on pl. xlvi, fig. 5, of the Jurassic Flora of the Rajmahal Group, which he supposes is a form of *A. McClellandi*.

Pl. LV, Fig. 2, gives the sterile form, and Fig. 3 an enlarged fragment to show the nerves. Fig. 4 represents the fertile form, and Fig. 5 an enlarged portion to show the sori.

## Genus SAGENOPTERIS Presl.

### SAGENOPTERIS NILSONIANA (Brongniart) Ward n. comb.[1]

Pl. LVI, Fig. 1; Pl. LXVII, Fig. 2.

1820. *Bladaftryck (folium ovatum,* etc.) Nilsson: K. Vet.-Acad. Handlingar, Stockholm, Vol. I, p. 115, pl. v, figs. 2, 3.
1825. *Filicites Nilsoniana* Brongn.: Ann. Sci. Nat. de Paris, Vol. IV, p. 218, pl. xii, fig. 1.
1828. *Glossopteris Nilsoniana* Brongn.: Prodrome, pp. 54, 194; Hist. Vég. Foss., Vol. I, p. 225, pl. lxiii, figs. 3, 3A.
1834. *Glossopteris latifolia* Münst.: N. Jahrb. f. Min., 1834, p. 43.
1836. *Glossopteris elongata* Münst.: Op. cit., 1836, p. 510.
1836. *Acrostichites inæquilaterus* Sternb. in Göppert: Syst. Fil. Foss., p. 287.
1836. *Aspidites Nilsonianus* Göpp.: Op. cit., p. 354.
1838. *Sagenopteris rhoifolia* Presl in Sternberg: Flora der Vorwelt, Vol. II, pp. 165, 210, pl. xxxv, fig. 1.
1838. *Sagenopteris diphylla* Presl: Op. cit., p. 165, pl. xxxv, fig. 4.
1838. *Sagenopteris semicordata* Presl: Op. cit., p. 165, pl. xxxv, fig. 2.
1838. *Sagenopteris acuminata* Presl: Op. cit., p. 165, pl. xxxv, fig. 3.
1843. *Sagenopteris elongata* Münst.. Beitr. z. Petrefactenkunde, Vol. II. Pt. VI, p. 28.
1845. *Acrostichites? (Sagenopteris) diphylla* (Presl) Ung.: Synops. Pl. Foss., p. 77.
1845. *Acrostichites? (Sagenopteris) semicordata* (Presl) Ung.: Loc. cit.
1845. *Acrostichites? (Sagenopteris) acuminata* (Presl) Ung.: Loc. cit.
1849. *Phyllopteris Nilsoniana* Brongn.: Tableau, pp. 22, 103.

Several poorly preserved specimens of a Sagenopteris are found at the locality "In the bed of a ravine that leads from the Banner mine," etc. They occur in the form of detached pinnules on indurated tuff, and the nervation is poorly shown, but is very dense. Pl. LVI, Fig. 1, gives one of the most perfect pinnules, and Pl. LXVII, Fig. 2, a large pinnule in which the anastomosis is not visible. This plant seems to be quite near *Sagenopteris rhoifolia elongata* Münst.[2] The midrib in the Oroville plant is less strong, the nervation denser, and the pinnules are on an average smaller. It may be a new species, but there is not enough material to fix positively the character of the plant.

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[1] Schimper (Traité de Pal. Vég., Vol. I, p. 642) says:

"Le *Glossopteris (Phyllopteris) Nilssoniana* Brongn. appartient sans aucun doute à cette espèce. J'en ai pu examiner dans la collection de M. Nilsson à Lund de très-bons échantillons, qui m'ont convaincu que la plante de la Suède ne diffère en rien de celle de l'Allemagne."

As the *Filicites Nilsoniana* of Brongniart (1825) was the earliest name given to the plant, and as all are now agreed that it belongs to Presl's genus Sagenopteris (1838), there is no way of escaping this combination for the plant that has so long gone by the name *Sagenopteris rhoifolia*, which Professor Fontaine continues to apply to it. The synonymy here given rests entirely on the authority of Presl and Schenk. Presl himself admitted that his plant was the same as Sternberg's *Acrostichites inæquilaterus* (1836), which he had shown to Göppert and allowed him to describe. This alone condemns Presl's specific name. Schimper confirms all that Schenk says as to the other names, and the former worked over the original material. In the synonymy here given I have not taken account of the three varieties that Schenk distinguishes. It is sufficiently doubtful whether the American forms really belong to this widespread polymorphous species or not. L. F. W.

[2] See Schenk, Fossil Flora der Grenzschichten, pl. xii, fig. 1.

## Genus DIDYMOSORUS Debey and Ettingshausen.

### DIDYMOSORUS ? BINDRABUNENSIS ACUTIFOLIUS Fontaine.

Pl. LVI, Figs. 2, 3.

1860. *Pecopteris* (*Gleichenites*) *linearis* Oldh.: Mem. Geol. Survey of India, Vol. II, Pt. II, p. 324.

1863. *Pecopteris* (*Gleichenites*) *gleichenoides* Oldh. and Morr.: Op. cit., Pal. Ind., Ser. II, Foss. Fl. Gondw. Syst., Vol. I, Pt. I, Foss. Fl. Rajmahal Series, p. 45, pl. xxv; pl. xxvi, figs. 1, 3.

1869. *Gleichenia bindrabunensis* Schimp.: Traité de Pal. Vég., Vol. I, p. 670.

1875. *Gleichenites bindrabunensis* (Schimp.) Feistm.: Verh. d. k.-k. Geol. Reichsanst., Wien, Jahrg. 1875, p. 190.

1877. *Gleichenites* (*Gleichenia*) *bindrabunensis* (Schimp.) Feistm.: Mem. Geol. Survey of India, Pal. Ind., Ser. II, Foss. Fl. Gondw. Syst., Vol. I, Pt. II, p. 93 (Jur. Fl. Rajm. Group, p. 41).

1888. *Didymosorus ? gleichenoides* (Oldh. and Morr.) Etheridge, var.: Proc. Linn. Soc. N. S. W., 2d Ser., Vol. III, Pt. III, p. 1308, pl. xxxviii, fig. 3.

1892. *Didymosorus ? gleichenioides* (Oldh. and Morr.) Jack and Etheridge, var.: Geology and Palæontology of Queensland and New Guinea, p. 557.[1]

Only a small fragment of this plant was found at the locality "In the bed of a ravine that leads from the Banner mine," etc. The specimen is an imprint of a small fragment of the terminal portion of a penultimate pinna that contains several ultimate pinnæ. The latter are very small and narrowly linear. The largest are about 2 cm. long and not more than 4 mm. wide. They are not very distinctly preserved, as they occur on indurated tuff. They are also somewhat distorted by pressure. The nervation was not made out. The plant resembles *Pecopteris gleichenoides* Oldh. and Morr.[2] It is probably an acute form of the Indian fern. This latter has pinnules with obtuse tips. It is most like the plant from the Rajmahal series figured on pl. xxvi, fig. 3, but is smaller than that. The narrow pinnæ are cut into narrow ovate-acute lobes or pinnules. Should it prove to be a form of the Indian fern it might be called variety *acutifolius*.

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[1] Jack and Etheridge here change the spelling of the specific name so that the combination becomes identical with *Didymosorus gleichenioides* Debey and Ettinghausen in their memoir, Die Urweltlichen Acrobryen des Kreidebirges von Aachen und Maestricht, p. 10 (Denkschr. Wien. Akad., Vol. XVII, p. 190, pl. i, figs. 1–5), with which no one has compared it, and which is a different plant. Neither Oldham and Morris nor Etheridge seemed to have observed that Debey and Ettinghausen gave this name to one of the original forms on which they based the genus, although these authors refer to this memoir and call attention to other species. As the specific name *linearis* is also preoccupied, the only remaining name is that of Schimper, and this therefore must be retained. L. F. W.

[2] Fossil Flora of the Rajmahal Series, p. 45, pl. xxv; pl. xxvi, figs. 1, 3.

## Subkingdom SPERMATOPHYTA.

## Subdivision GYMNOSPERMAE.

## Class CYCADALES.

## Family CYCADACEÆ.

### Genus PTEROPHYLLUM Brongniart.

#### PTEROPHYLLUM RAJMAHALENSE Morris?

Pl. LVI, Figs. 4, 5.

1863. *Pterophyllum rajmahalense* Morr.: Mem. Geol. Survey of India, Pal. Ind., Ser. II, Foss. Fl. Gondw. Syst., Vol. I, Pt. I, Foss. Fl. Rajm. Series, p. 25, pl. xiii, figs. 3–5; pl. xiv.

Several specimens of a Pterophyllum, which can hardly be separated from *P. rajmahalense* Morr.[1] of the Rajmahal flora, were found at the locality "Bank of Feather River," etc. They are imprints of small portions of leaves, showing several leaflets on each side of a rather slender midrib. They agree especially well with the small form given on pl. xiii, fig. 4, of the work of Oldham and Morris. The Oroville plant has its leaflets opposite to one another and going off at right angles with the stem. They are about 15 mm. long and 5 mm. wide. The nerves are about 12 in number. They make right angles with the midrib and are slender but distinct. They are parallel throughout their entire course and single. The points of difference between the Oroville and Indian plants are the smaller size of the midrib in the former and the somewhat fewer nerves. The amount of material, however, is not sufficient to permit the full character of the plant to be made out and its identification must remain in doubt for the present.

### Genus CTENIS Lindley and Hutton.

#### CTENIS GRANDIFOLIA Fontaine.

Pl. LIII, Fig. 2; Pl. LVI, Figs. 6, 7; Pl. LVII.

1896. *Ctenis grandifolia* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Only fragments of leaves were seen, hence the character of the entire leaf can not be determined. The segments, or leaflets, are large and ribbon shaped. Their terminations were not seen. They are attached by their entire base to the sides of a moderately strong midrib. The strongest midrib seen had a width of 4 mm. They go off nearly at right angles and then curve slightly toward the summit of the compound leaf, so as to have a falcate form. They are slightly

[1] Fossil Flora of the Rajmahal Series, p. 25, pl. xiii, figs. 3, 4, 5.

expanded at base, closely placed, and in some cases touch one another. The leaflets vary in width. The largest obtained has a width of 4 cm. and a length of 20 cm., being only a fragment with the terminal part not preserved. This is represented in Pl. LVI, Fig. 6. The nerves are very strong and single. They go off at a large angle and are approximately parallel in their course. They anastomose at long intervals, so as to form very much elongated meshes. The mode of anastomosis was not fully made out. It is apparently as follows: A nerve forks dichotomously, one branch continues the course of the original nerve, the other coalesces with an adjacent one. This union takes place rarely near the bases of the leaves, and more freely at a distance of 3 or 4 cm. above the base of the leaflet. This more frequent anastomosis appears to occur also at the same interval, toward the middle and terminal portions of the leaflets. This, however, could not be clearly made out, owing to the fragmentary condition and imperfect preservation of the leaflets.

A number of fragments of this fine cycadaceous plant were found at the locality "In the bed of a ravine that leads from the Banner mine," etc., that indicate that it obtained a gigantic size. Pl. LVII shows a leaf with several leaflets in fragments, only the basal portions being represented. The leaflets here are of the smallest size. Pl. LVI, Fig. 6, gives a portion of a leaflet of the largest size. Fig. 7 represents the restoration of a portion of a leaflet, to show the nervation and mode of insertion. Pl. LIII, Fig. 2, shows the general habit of the plant.

This plant and the two to be next described belong to a type that is not common, and which seems to be complex in character. The general aspect reminds one of the large Pterophylla of the Rajmahal series, especially of *Pterophyllum princeps* Oldh. and Morr.,[1] but this does not have similar nerves. Perhaps they should be placed in a new genus, but they are near enough to the *Ctenis falcata* of Lindley and Hutton[2] to be placed in the same genus with it. The chief difference is the much greater size of the Oroville plant. Nathorst's *Ctenis fallax* and *Ctenis imbricata* Font. of the Potomac of Virginia belong to the same type, but are specifically different. A noteworthy feature of this plant is the unequal width of the leaflets, and in this respect it resembles Nilsonia.

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1 Fossil Flora of the Rajmahal Series, pl. x, fig. 3.
2 Fossil Flora of Great Britain, Vol. III, pl. ciii.

## CTENIS AURICULATA Fontaine.

Pl. LVIII, Figs. 1–3.

1896. *Ctenis auriculata* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Only portions of leaflets were seen. The most complete specimen, given in Pl. LVIII, Fig. 2, shows a portion of the compound leaf, with the basal parts and attachment of two leaflets. The plant must have reached a large size, but the true dimensions can not be made out. Only the basal portions of the leaflets were seen, and in these portions they show some variation. The form represented in Fig. 1 has the least narrowing at base and the least auriculate form, having somewhat the shape of the bases of the leaflets of *C. grandifolia*. The bases of the leaflets in the form represented in Fig. 2 are considerably rounded off and narrowed at their insertion, so that they have a pronounced auriculate form. The nerves are quite different from those of *C. grandifolia*, but the general plan of anastomosis is similar, although more abundant. The nerves, near their attachment, are rather remote and straggling. They go off at a large angle and are, near their bases, mostly single, but above branch more or less copiously. Those in the middle and upper sides of the lamina of the leaflet are less copiously branched, but those in the lower portion branch repeatedly in a flabellate manner, curving outward and downward in the more auriculate leaves to fill the expanded base. This description applies only to the basal portions of the leaflets, for only these were seen. The nerves are very strong and cord-like, being considerably stronger than those of *C. grandifolia*. They anastomose by one of the branches of a forking nerve coalescing with an adjacent nerve to form elongate meshes, after the general fashion seen in *C. grandifolia*, but there is no regularity in the intervals at which this takes place, and the union of nerves is more common.

A considerable number of specimens of this plant are found at the locality "In the bed of a ravine that leads from the Banner mine," etc. The specimens are not complete enough to show the full character of the plant, but they are enough so to indicate that it is quite different from *C. grandifolia*, and, indeed, from any hitherto-known species. The auriculate form of the bases of the leaflets reminds one of *C. imbricata* Font. of the Potomac formation, but there is hardly any other feature of resemblance except the existence of a reticulation of the Ctenis type.

Fig. 3 gives a portion of a leaflet above the base and shows well the copious reticulation of that portion.

### Ctenis orovillensis Fontaine.

Pl. LVIII, Fig. 4.

1896. *Ctenis orovillensis* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

The most complete specimen, given in Fig. 4, shows the basal portions of several leaflets, placed on each side of the midrib of the compound leaf. They are subopposite, closely placed, at right angles with the midrib, and have expanded bases, so that they are separated by a V-shaped sinus, while at their bases they are apparently united to form a narrow wing. The leaflets vary somewhat in width, but not so much as those of *C. grandifolia*. The nerves are strong and distinct, but not so much so as those of the two previously described species. Those in the middle portion of the lamina go off at right angles, while those near the upper and lower margins of the same go off at obtuse angles and arch away from the midrib to enter the leaflet. The nerves anastomose rather rarely at and near the midrib and more freely at the distance of about 25 mm. above the midrib. They anastomose again more freely at about 5 cm. above the midrib. Hence the free anastomosis occurs at intervals of about 25 mm., forming elongate meshes, with a similar length.

Several specimens of this plant are found at the locality "In the bed of a ravine that leads from the Banner mine," etc. Like *C. grandifolia*, this plant reminds one of the large Pterophylla of the Rajmahal series. It may be a form of *C. grandifolia*, but has not the facies of that plant. The leaflets also are smaller, with a thinner texture, and they are of more uniform width. The leaflets in shape, size, and texture resemble those of *Ctenophyllum Wardii*, which will be next described, but this latter has no reticulation in the nerves.

## Genus CTENOPHYLLUM Schimper.

### Ctenophyllum Wardii Fontaine.

Pl. LIX; Pl. LX; Pl. LXVII, Fig. 5.

1896. *Ctenophyllum Wardii* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Entire leaves not seen. Probably they were nearly a meter long. The largest fragment seen showed only the middle portion of a leaf, with no sensible diminution in the leaflets from one end to the other. It is 26 cm. long, with a slender midrib, not more than 2 mm. wide. A number of leaflets go off on each side of this, none of which are entire. The leaflets are quite far apart, having a distance of about 15 mm. They are subopposite and ribbon-shaped. They are separate to their bases, which are decurrent on their lower sides and slightly rounded off on the upper ones. They do not alter in width throughout their length. The maximum length seen was 13 cm. The leaflets go off at an angle of about 60°, and then turn slightly away from the midrib. Their width is somewhat variable. The average width is 2 cm. and the maximum 3 cm. The nerves are fine, but distinct and very numerous. They go off at an angle of 45°, and immediately after leaving the midrib turn strongly away from it, and then are parallel throughout their course. They fork once near their bases. No additional forking was certainly made out. If it takes place it must occur at long intervals and irregularly.

Several specimens of this splendid plant were found at the locality "In the bed of a ravine that leads from the Banner mine," etc. Pl. LIX gives the most complete form and Pl. LX that with the widest leaflets. A few fragments of leaflets of this species are also seen on Pl. LXVII, Fig. 5.

This fine plant is one of several species found at the Oroville locality which are evidently allied and probably belong to the same genus. The genus Ctenophyllum, as defined by Schimper, seems to be the one in which they must be placed; that is, provided we may translate his description, "foliolis lateri rachis superiori, oblique adfixis," by: leaflets attached obliquely to the upper side (not face) of the rachis. The leaflets are attached obliquely to the sides of the rachis in the plane of the upper face of the same. It must be admitted that these plants are of a very different type from *Ctenophyllum Braunianum*, so far as their general aspect is concerned.

The plant now in question is nearer *C. latifolium* Font.[1] of the Potomac of Virginia than any other hitherto known, but the leaflets do not vary so much in width and the nerves are more slender and closely placed.

The plant is named for Mr. Lester F. Ward, by whose efforts the fine collection from Oroville was obtained.

### CTENOPHYLLUM DENSIFOLIUM Fontaine.

### Pl. LXI.

1896. *Ctenophyllum densifolium* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

The size of the leaf is unknown, as all the specimens were fragments. The most complete portion found is a fragment of a compound leaf, 29 cm. long, from the middle part. This indicates that the plant must have been very large. It is apparently the largest Ctenophyllum occurring at Oroville. It shows a number of leaflets on a side, the largest of which, with the upper portion of it not preserved, is 13 cm. long. Notwithstanding the considerable size of this specimen, it shows no diminution from base to summit in the size of the midrib and of

[1] Mon. U. S. Geol. Survey, Vol. XV p. 175, pl. lxviii, figs. 2, 3.

the leaflets. The leaflets go off nearly at right angles with the midrib, have the same width throughout their length, and are closely placed, being only 1 mm. apart. They are 1 cm. wide, and are very uniform in width. The nerves go off nearly at right angles. They are slender, but strongly defined, unbranched, and parallel throughout their course, being about 10 in number. This fine plant is rather abundant at the locality "In the bed of a ravine that leads from the Banner mine," etc. It occurs in large specimens, the finest of which is given on Pl. LXI. It is nearly allied to *C. grandifolium*, but is clearly a different species.

### CTENOPHYLLUM GRANDIFOLIUM STORRSII Fontaine.

Pl. LIII, Fig. 3; Pl. LXII; Pl. LXIII, Fig. 1; Pl. LXVI, Fig. 3.

1896. *Ctenophyllum grandifolium Storrsii* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

This plant can not be distinguished specifically from *C. grandifolium* Font., of the Older Mesozoic of Virginia,[1] but although it evidently attained a very large size, it was inferior to the Virginia plant, and had uniformly narrower leaflets, with fewer nerves. The midrib was wide and flat, with apparently no great amount of wood tissue. The leaflets go off nearly at right angles with the midrib. They are placed far apart and are separate, being mostly 5 mm. from one to another. Throughout most of their length they are strap-shaped and narrow, near their bases they grow narrower, and at their base, where they unite with the midrib, they are slightly widened. The narrowed portion appears to have been thick and fleshy. The leaflets must have been very long, equaling the Virginia plant in that respect. The width of the leaflets, even on the same midrib, was not constant, but varied irregularly, although slightly, resembling in this point the Virginia fossil. The nerves are very strong, 5 or 6 in number, and either single or forking once, at various distances from the midrib. Near the midrib they are almost always single, and go off nearly at right angles with the midrib, being then parallel. This nervation differs from that of the Virginia plant, in which the nerves fork once at their bases and are then single.

This fine plant was found with several specimens at the locality "In the bed of a ravine that leads from the Banner mine," etc. Pl. LXII represents the most complete fragment found, and Pl. LXIII, Fig. 1, a portion of a leaflet enlarged to show the nervation. Other less perfect fragments are represented by Pl. LIII, Fig. 3, and Pl. LXVI, Fig 3.

The variety is named for Mr. James Storrs, the intelligent assistant of Mr. Ward in collecting the Oroville fossils.

[1] Mon. U. S. Geol. Survey, Vol. VI, pp. 73-76, pl. xxxix, figs. 1-3; pl. xl; pl. xli; pl. xlii, fig. 1.

### CTENOPHYLLUM ANGUSTIFOLIUM Fontaine.

Pl. LXIII, Figs. 2, 3.

1896. *Ctenophyllum angustifolium* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

This plant was found in two small imprints, occurring on the same fragment of rock at the locality "Bank of Feather River," etc. Although the amount of material is so small, it is enough to show certainly that the plant is quite different from any other cycad occurring in the Oroville region. The most complete specimen, shown in Pl. LXIII, Fig. 2, has a midrib 4 cm. long and 1 mm. wide, with several leaflets going off on each side. Only the basal portions of these are preserved, the largest being only 35 mm. long. The leaflets make right angles with the midrib, are only 1 mm. wide, and are slightly expanded at base. The nerves are only three or four in number and strong, but they are not very distinctly shown.

This plant is plainly one of the narrow-leaved Ctenophylla of the type of *Ctenophyllum Braunianum*. It is especially like the form depicted in Mon. U. S. Geol. Survey, Vol. VI, pl. xxxiv, fig. 4, but the leaflets are closer in the Oroville plant.

## Genus PODOZAMITES Friedrich Braun.

### PODOZAMITES LANCEOLATUS (Lindley and Hutton) Friedrich Braun.

Pl. LXIII, Fig. 4; Pl. LXIV, Fig. 1; Pl. LXVI, Fig. 4; Pl. LXVII, Figs. 3, 4.

1836. *Zamia lanceolata* L. and H.: Foss. Fl. Gt. Brit., Vol. III, p. 121, pl. cxciv.

1840. *Zamites lanceolatus* (L. and H.) Fr. Braun: Verzeichniss Kreis-Nat.-Samml. Bayreuth Petrefact., p. 100.

1843. *Podozamites lanceolatus* (L. and H.) Fr. Braun in Münster: Beitr. z. Petrefactenkunde, Vol. II, Pt. VI, p. 33.

A large number of imprints of this plant are found at the locality "In the bed of a ravine that leads from the Banner mine," etc., and at least one was obtained from the locality "Bank of Feather River," etc. The most common are detached leaflets, but some imprints are found with the leaflets attached. The leaves are rather variable in size, but the average, or normal forms, can not be distinguished from those that Heer describes from Cape Boheman.[1] The larger leaflets are exactly like the larger ones from Cape Boheman and surpass in size any of the species of *P. Emmonsii* or of the type form of Lindley and Hutton.

This plant is of special importance in fixing the age of the strata containing it, as, next to *Tæniopteris orovillensis*, it is the most abun-

[1] Flora Foss. Arct., Vol. IV, Pt. I, Beiträge zur Foss. Flor. Spitzbergens, p. 35, pl. vii, figs. 1-7.

dant fossil. Heer regards the Cape Boheman Jurassic as Middle Brown Jura (Bathonian) in age.

Pl. LXIII, Fig. 4, gives one of the most complete forms, and Pl. LXIV, Fig. 1, represents a form with somewhat narrower leaflets. An imperfect specimen is seen at Fig. 4 of Pl. LXVI, and it seems probable that the parts of leaves represented by Figs. 3 and 4 of Pl. LXVII belong to this plant.

PODOZAMITES LANCEOLATUS LATIFOLIUS (Brongniart) Heer.

Pl. LXIV, Fig. 2.

1828. *Tæniopteris latifolia* Brongn.: Prodrome, pp. 62, 199; Hist. Vég. Foss., Vol. I, p. 266, pl. lxxxii, fig. 6.
1833. *Odontopteris latifolia* (Brongn.) Sternb.: Flora der Vorwelt, Vol. II, p. 79.
1838. *Zamites latifolius* (Brongn.) Presl: Op. cit., Vol. II, p. 199.
1867. *Podozamites distans latifolia* (Brongn.) Schenk: Foss. Fl. der Grenzschichten des Keupers und Lias, p. 162, pl. xxxvi, fig. 10.
1876. *Podozamites lanceolatus latifolius* (Brongn.) Heer: Jura-Flora Ostsibiriens, Fl. Foss. Arct., Vol. IV, Pt. II, pp. 109, 120, pl. xxvi, figs. 5, 6, 8b, 8c.

Two or three detached leaflets of a Podozamites of the type of *P. lanceolatus* were found at the locality "In the bed of a ravine that leads from the Banner mine," etc., which seem to differ at least varietally from the narrow *P. lanceolatus*, being broader and shorter. They agree well with the leaflets described by Heer[1] from the Jura formation on the Upper Amur as a variety *latifolius* of *P. lanceolatus*.

## Class GINKGOALES.

## Family GINKGOACEÆ.

### Genus BAIERA Friedrich Braun.

BAIERA MULTIFIDA Fontaine?

Pl. LXV, Figs. 1, 2.

1883. *Baiera multifida* Font.: Mon. U. S. Geol. Survey, Vol. VI, p. 87, pl. xlv, fig. 3; pl. xlvi; pl. xlvii, figs. 1, 2.

Portions of a plant that appears to be a Baiera, near *B. multifida* Font., of the Older Mesozoic of Virginia, were found in two specimens; one, showing the basal part, given in Pl. LXV, Fig. 1, was obtained at the locality "In the bed of a ravine that leads from the Banner mine," etc., and the other, showing laciniæ, represented in Fig. 2, at the locality "Bank of Feather River," etc. The amount of material is too small to permit a positive determination of the plant. It is, however, a coarse, large form, that reminds one strongly of *Baiera multifida* Font.

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[1] Flora Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostsib. und des Amurlandes, p. 109, pl. xxvi, figs. 5, 6, 8b, 8c.

## Class CONIFERÆ.

## Family PINACEÆ.

### Genus PAGIOPHYLLUM Heer.

#### PAGIOPHYLLUM WILLIAMSONIS (Brongniart) Fontaine.

Pl. LXVI, Figs. 1, 2.

1828. *Lycopodites Williamsonis* Brongn.: Prodrome, pp. 83, 199.
1829. *Lycopodites uncifolius* Phillips: Geology of Yorkshire, pp. 147, 167, pl. viii, figs. 3, 3a.
1833. *Lycopodites Williamsonis* Brongn. in Lindley and Hutton: Foss. Fl. Gt. Brit., Vol. II, p. 33, pl. xciii.
1849. *Palissya? Williamsonis* Brongn.: Tableau, pp. 68, 106.
1870. *Pachyphyllum Williamsoni* Schimp.: Traité de Paléontologie Végétale, Vol. II, p. 251.
1896. *Pagiophyllum Williamsoni* (Schimp.) Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

Several impressions of a conifer strongly resembling *Pagiophyllum Williamsonis* were found at the locality "In the bed of a ravine that leads from the Banner mine," etc. The largest imprint is that of a stem 8 cm. long. This has portions of several branches and one entire branch. The latter is 15 mm. long and bears at its summit an elliptical, scaly cone, of the same shape and dimensions as that depicted by Lindley and Hutton on a branch of their *Lycopodites Williamsonis* on pl. xciii of the second volume of the Fossil Flora of Great Britain. This, as Schimper showed, is not a Lycopodites, but a conifer, of the type he named Pachyphyllum, and for which, owing to the preoccupation of the name Pachyphyllum, the appellation Pagiophyllum of Heer is now chosen.

The stems carry one-ribbed, curved, and stiff leaves, in the Oroville specimens. There is no doubt that they belong to the genus Pagiophyllum, and are very near to the English plant.

### Genus PINUS Linnæus.

#### PINUS NORDENSKIÖLDI Heer ?

Pl. LXV, Fig. 3.

1876. *Pinus Nordenskiöldi* Heer: Beitr. zur Foss. Fl. Spitzbergens, Fl. Foss. Arct., Vol. IV, Pt. I, pp. 45, 135, pl. ix, figs. 1, 1b, 2, 2b, 3, 3b, 4, 5, 5b, 6.

Several detached fragments of a broad-leaved Pinus were found at the localities "In the bed of a ravine that leads from the Banner mine," etc., and "The old dump at the Banner mine," etc. They show neither their bases nor their tips. They belong to broad, stiff, one-nerved Pinus leaves that agree well with Heer's plant.[1] Of course no positive determination can be made from such imperfect material.

[1] Flor. Foss. Arct., Vol. IV, Pt. I, Beiträge zur Foss. Flor. Spitzbergens, p. 45, pl. ix, figs. 1-6.

### Genus LEPTOSTROBUS Heer.

#### LEPTOSTROBUS ? sp. Fontaine.

#### Pl. LXVII, Fig. 1.

1896. Undetermined cone Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

A rather vague imprint occurs at the locality "In the bed of a ravine that leads from the Banner mine," etc., which, although it shows no structure, in shape and the arrangement of its parts, looks something like a cone of Leptostrobus. It may be compared with the cone of *Leptostrobus crassipes* Heer, as given in Flor. Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostsibiriens, pl. xiii, fig. 14.

## PLANTS OF UNCERTAIN AFFINITY.

### Genus CARPOLITHUS Stokes and Webb.[1]

#### CARPOLITHUS STORRSII Fontaine.

#### Pl. LXV, Figs. 4–6.

1896. *Carpolithus Storrsii* Font.: Am. Jour. Sci., 4th Ser., Vol. II, p. 274.

A considerable number of imprints of an aggregation of nut-like fruits was found at the locality "In the bed of a ravine that leads from the Banner mine," etc. The nut-like seeds appear to have been borne in pairs at the summit of short pedicels, arranged at considerable intervals and spirally, around a flexuous axis. The thickest axis seen has a diameter of 3 mm. The pedicels are stout and about 5 mm.

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[1] In the Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 691, this genus was credited to Artis, whose use of this orthography in his Antediluvian Phytology, 1825, pp. XV and 22, was then thought to be the earliest. I have since observed that it was so spelled by Stokes and Webb in their Description of some Fossil Vegetables of the Tilgate Forest in Sussex (Trans. Geol. Soc. London, 2d series, Vol. I, 1824, p. 423) one year earlier. Schimper (Traité de Pal. Vég., Vol. II, p. 225) credits it to Sternberg, but he wrote the name *Carpolites* (Flora der Vorwelt, Vol. I, Tentamen, p. XL, 1825). Schlotheim, in 1820, wrote *Carpolithes* (Petrefactenkunde, p. 418), and this seems to be the earliest date at which fossil fruits were systematically treated. Parkinson, in his Organic Remains, Vol. I, 1804, figured a considerable number on pl. vi, but an examination of the letterpress fails to indicate that he attempted to give them even a generic name. In Bronn's Index Palaeontologicus (Nomenclator, pp. 238–241) most of these are named under Carpolithes and credited to Parkinson, with reference to pl. vi of the Organic Remains, but without reference to the text, and it seems probable that Göppert named them from the figures and is to be credited with the names.

The form *Carpolithus* seems preferable to *Carpolithes* or *Carpolites*, but if it is to be treated as a genus it should conform to the law of priority in use. It is retained here only on the assumption that it may ultimately be found to have priority when the investigation is complete. In fact, there is some justification for this, since Walch, in 1771 (Die Naturgeschichte der Versteinerungen zur Erläuterung der Knorrischen Sammlung von Merkwürdigkeiten der Natur, herausgegeben von Johann Ernst Immanuel Walch, Dritter Theil, Nürnberg, 1771, p. 51), uses this term in the plural, "Carpolithi," for fossil fruits in general, taking pains on page 91 to give the Greek derivation from καρπος and λιθος, but he does not seem to have used the singular, which would of course be Carpolithus. As, however, his treatment was not systematic (binomial) it may be questioned whether this constitutes the earliest use of the genus. L. F. W.

long. The fruits are elliptical or fusiform, about 8 mm. long and 4 mm. thick in their thickest portions. They are mostly much distorted by pressure, but some show their former and true shape.

There are several known fossils with which this may be compared, but from which it is almost certainly, at least specifically, different. It resembles an aggregation of nut-like fruits that Heer[1] ascribes to *Czekanowskia rigida*, for no reason except that it is found on the same rock specimen with leaves of that plant. Heer's plant, however, has smaller nut-like seeds and the pairs are placed much farther apart than they are in the plant from the California locality. Heer's fossil has also the axis on which the pedicels are placed much straighter than that of the plant now in question. This latter may also be compared with *Stachyopitys Preslii* Schenk, as figured by Schenk in Fossil Flora der Grenzschichten, pl. xliv, fig. 12, but the two plants are clearly different species, for that of Schenk has smaller ribbed seeds of ovate shape.

Fig. 4 gives a form showing the double nuts, and Fig. 6 represents a more complete form of larger size.

### GENERAL REMARKS AND CONCLUSIONS.

The collection referred to in the preceding pages, that was made by Mr. Stanton and referred by Mr. Ward to me for determination, was a small and imperfect one. A study of it left me in doubt as to its precise age. The conclusion to which I came was expressed in the following words, quoted from a report made to Mr. Ward:

> This flora is not older than the uppermost Trias and not younger than the Oolite. I feel pretty sure that it is true Rhetic, somewhat younger than the Los Bronces flora of Newberry and the Virginia Mesozoic coal flora. It is much like the Rhetic flora of France made known by Saporta. It is a new grouping of plants. I do not think the fossils now in hand suffice to fix narrowly the age, which may be lower Jurassic.

The much more complete collection and better-preserved fossils obtained by Mr. Ward from the same beds give more satisfactory data, although the evidence is not sufficient to fix conclusively within narrow limits the age of the formation. The collection made by Mr. Ward, although much larger than that made by Mr. Stanton, and containing better-preserved plants, is still not large enough to be exhaustive. Correcting the results obtained from the examination of Mr. Stanton's collection by the facts made known by the study of that of Mr. Ward, we find 28 distinct forms in the Oroville beds (see table below, p. 367).

[1] Flora Foss. Arct., Vol. IV, Pt. II, Beiträge zur Jura-Flora Ostsibir. und des Amurlandes, p. 116, pl. XXI, fig. 8a.

Of these 28 different plants—for they are different, whatever may be their true place and affinities—14 are new and of no value for fixing age by identity. Counting out the undetermined cone, we have only 12 forms that may be compared with previously known ones. Seven of these, viz, *Cladophlebis spectabilis*, *C. argutula*, *C. whitbiensis tenuis* var. a?, *Thyrsopteris Maakiana*, *Podozamites lanceolatus*, *Podozamites lanceolatus latifolius*, *Pinus Nordenskiöldi?*, were found by Heer in the Jurassic formation, which he regarded as middle Brown Jura, which is about the equivalent of the lower Oolite of Scarborough. Of these, *Cladophlebis spectabilis* and *Podozamites lanceolatus* are especially valuable for fixing age by determination of identity. *Cladophlebis spectabilis*, as stated in the notice of the species, is a type not common among ferns, and it has a character that enables its identity to be fixed by a small amount of material. The Podozamites also is a form readily distinguished, while it is, at Oroville, very abundant and well preserved. Three of the plants whose identity with previously known ones is more or less fully made out are: *Didymosorus? bindrabunensis?*, *Cladophlebis indica?*, and *Pterophyllum rajmahalense?* They were all originally made known from the Rajmahal beds of India. These Feistmantel regards as of Liassic age. None of the forms from Oroville are well enough preserved to enable us to make a very close comparison with the India fossils. Although the establishment of identity is not certain, yet the existence of a close resemblance in type has considerable value in determining age. This fact will be again noticed farther on. The Pagiophyllum type of conifer is highly characteristic of the Jurassic, and it is significant that the Oolitic form *P. Williamsonis* is the only conifer of importance in the Oroville flora. It will be noticed that the proportion of conifers in this flora is remarkably small, the ferns and cycads making up most of the plants. This is a feature that is more characteristic of the Older Mesozoic than of any other flora. The only remaining plant possibly identical with a known one is the doubtful *Sagenopteris Nilsoniana*. This Sagenopteris is most characteristic of the Rhetic. The Oroville specimen, standing alone and being doubtful, can not have much weight.

Turning now to the plants which must be regarded as new, we find that, although we can not derive any evidence from their identity with known forms, they are not without indications that may be taken as evidence of age. As was stated before, the prevalence of a particular type is of value as indicating age. We find that certain types abound in the floras of particular ages, and are absent or rare in others. For example, the Alethopteris, Neuropteris, and Pecopteris types of ferns are most characteristic of the Carboniferous. The Thyrsopteris and Cladophlebis type is conspicuous in the Mesozoic and most characteristic of the Jurassic.

Macrotæniopteris is a type of fern that, in typical forms, can not be mistaken for any other. Its range in time seems to have been from uppermost Trias to Oolite, reaching its maximum development, if Feistmantel is right as to the age of the Rajmahal series, in the Lias. Now, although the amount of material obtained showing it in the Oroville flora was not large, it was evidently a conspicuous plant in that flora. The most common species, *M. californica*, is nearer *Macrotæniopteris* (*Tæniopteris*) *lata* of the Rajmahal flora than any other plant. *M. nervosa* is unique. Even if neither of these species bore any resemblance to known forms, the very fact that Macrotæniopteris is an important type in a flora is evidence favorable for the age being Jurassic.

The common Tæniopteris in the Oroville flora is so near *T. tenuinervis*, the characteristic one of the Infralias (Rhetic) of France, that it may be considered its representative, modified by differences in its surroundings. As this is a common type as late as the Oolite, its presence need not indicate an age greater than the Lias. *Cladophlebis densifolia*, if it has any relationship to known species, is best compared with *Pecopteris lobata* Oldh., of the Rajmahal series.

*Adiantites orovillensis* seems to be unique and not very near any known species. The Angiopteridium has *A. McClellandi* of the Rajmahal series as its nearest plant.

The three new species of Ctenis belong to a type that begins in the Rhetic with the peculiar *C. fallax* of Nathorst and exists in the basal Cretaceous in at least one species, *C. imbricata* Font., of the Potomac of Virginia. Except in its inferior size, the Oolitic plant of Lindley and Hutton, *Ctenis falcata*, seems to be the form nearest to the Oroville type.

It should be noted, however, that in their general facies these plants are close to the large Pterophylla of the Rajmahal series, the anastomosis of the nerves, which may be a special development, being the principal difference.

The large Ctenophylla were evidently common and very important plants in the flora. *Ctenophyllum densifolium* and *C. grandifolium Storrsii* were related to the *C. grandifolium* of the Virginia older Mesozoic, the variety *Storrsii* being near enough to be regarded as a variety of the latter.

The small *Ctenophyllum angustifolium* has probably a near relationship to another Older Mesozoic plant, viz, *C. Braunianum*.

*Carpolithus Storrsii* appears to be unique. So far as any relationship can be made out for it it is with a Jurassic plant.

Putting the Oroville plants in the form of a table that shows the age of the plants nearest to them or identical with them, we may denote identity by the letter i and related forms by r, getting the following results:

*Age of plants nearest to or identical with Oroville plants.*

| Species. | Uppermost Trias and Rhetic. | Potomac. | Lias. | Oolite. | Age not identified by relationship. |
|---|---|---|---|---|---|
| 1. Thyrsopteris Maakiana Heer | | | | i? | |
| 2. Adiantites orovillensis Font | | | | | × |
| 3. Cladophlebis spectabilis (Heer) Font | | | | i | |
| 4. Cladophlebis argutula (Heer) Font | | | | i | |
| 5. Cladophlebis whitbiensis tenuis var. a Heer | | | | i? | |
| 6. Cladophlebis densifolia Font | | | r | | |
| 7. Cladophlebis indica (Oldh. and Morr.) Font | | | | i? | |
| 8. Tæniopteris orovillensis Font | r | | | | |
| 9. Macrotæniopteris californica Font | | | r | | |
| 10. Macrotæniopteris nervosa Font | | | | | × |
| 11. Angiopteridium californicum Font | | | r | | |
| 12. Sagenopteris Nilsoniana (Brongn.) Ward | i? | | | | |
| 13. Didymosorus? bindrabunensis acutifolius Font | | | i? | | |
| 14. Pterophyllum rajmahalense Morr | | | i? | | |
| 15. Ctenis grandifolia Font | | | | | × |
| 16. Ctenis auriculata Font | | | | | × |
| 17. Ctenis orovillensis Font | | | | | × |
| 18. Ctenophyllum Wardii Font | | r | | | |
| 19. Ctenophyllum densifolium | r | | | | |
| 20. Ctenophyllum grandifolium Storrsii Font | r | | | | |
| 21. Ctenophyllum angustifolium Font | r | | | | |
| 22. Podozamites lanceolatus (L. and H.) Fr. Braun | | | | i | |
| 23. Podozamites lanceolatus latifolius (Brongn.) Heer | | | | i | |
| 24. Baiera multifida Font | | i? | | | |
| 25. Pagiophyllum Williamsonis (Brongn.) Font | | | | i | |
| 26. Pinus Nordenskiöldi Heer | | | | i? | |
| 27. Leptostrobus? sp. Font. Undetermined cone | | | | | × |
| 28. Carpolithus Storrsii Font | | | | | × |

The comparison of the Oroville plants with known floras shows that most of the forms for which any relationship with known plants can be made out find their like in the Lias and Oolite, or, without distinguishing these, in the Jurassic. As the Oolitic forms are predominant, we may conclude that the age of the flora is not only Jurassic but rather late Jurassic, probably about the age of lower Oolite. If this be correct, we may regard the fossils showing Rhetic affinities as survivors.[1]

## THE JURASSIC FLORA OF OREGON.

As far back as 1872 and in subsequent years, Mr. Aurelius Todd, a mining engineer, then living in Oregon, now a resident of Florida, while prospecting among the mountains of Douglas County, Oregon, made collections of fossils from numerous points, and among these were many fossil plants. Some of the latter were collected on Buck Mountain, which forms part of the watershed between Cow Creek and Lookingglass Creek, two principal tributaries of the South Fork of the Umpqua River. Buck Mountain is about 8 miles nearly due west of the town of Riddles. It has an altitude of about 3,500 feet above the level of the sea, and rises 2,000 feet above the beds of the streams that flow along its base. On the west side, flowing north, is Olalla Creek, a tributary of Lookingglass Creek. A branch of this, locally called Thomson Creek, but named Hunter Creek on the Land Office

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[1] The careful reader of this paper who may be acquainted with Professor Fontaine's brief report on the first collection from Oroville made by Dr. Stanton's party as above set forth (see Journal of Geology, Vol. III, pp. 395–396) may observe that Professor Fontaine does not explain specifically the changes made in his determinations, but only states that the new and more abundant collections required the conclusions drawn from the early small collection to be modified and extended. It is, therefore, perhaps worth while to attempt to clear the matter up at this time lest some one might ascribe to the Oroville florula species mentioned in the first report that have not as yet really been found there. The only such species as to which Professor Fontaine spoke with any degree of confidence are the following:

Tæniopteris tenuinervis Brauns.
Tæniopteris stenoneura Schenk.
Danæopsis marantacea Presl.
Ctenophyllum grandifolium Font.
Podozamites Emmonsii Newb.
Podozamites tenuistriatus Font.

It happened that at the time Professor Fontaine was in Washington working up the large collection made by Mr. Storrs and myself, the small collection was still at the University of Virginia, a fact which I had overlooked until he arrived. I therefore requested him on his return to reexamine the original collection at once, while the results of his study of the new one were fresh in his mind and with his own sketches before him. This he did and reported that he found nothing additional in the first collection. To make this all the more certain, he then and there attached labels to all the specimens of Dr. Stanton's collection and subsequently returned the whole and I embodied it in the general collection.

I have been to the pains to go through, while preparing this paper, and note all the species, as thus labeled by him, that he found to occur in the original collection. They are the following:

Thyrsopteris Maakiana Heer.?
Cladophlebis argutula (Heer) Font.
Cladophlebis densifolia Font.
Cladophlebis indica (Oldh. and Morr.) Font.
Tæniopteris orovillensis Font.
Angiopteridium californicum Font.
Ctenis grandifolia Font.
Ctenis auriculata Font.
Ctenophyllum densifolium Font.
Podozamites lanceolatus (L. and H.) Fr. Braun.
Baiera multifida Font.?
Carpolithus Storrsii Font.

A comparison of the two lists given will doubtless be sufficient to enable anyone at all acquainted with these forms to decide to which ones of those on the second list those on the first list most probably correspond.

L. F. W.

map, flows westward along its base on the north side. On the south side two streams called Buck Creek and Doe Creek rise near its base, flow south, and join Cow Creek below Nichols station on the Southern Pacific Railroad. The mountain lies in latitude 43° 57′ N., longitude 123° 30′ W., from Greenwich, and in township 30 S., range 7 W., of Willamette meridian.

The locality at which Mr. Todd collected his specimens of fossil plants on Buck Mountain is about 300 feet below the summit on the east side, in a gulch which it has been agreed to call Todd Gulch. It lies north of Seven Spring Ridge, over which a trail runs from the east, making the ascent of the mountain easy. Mr. Todd revisited the locality in 1886 and made additional collections.

A single specimen from among Mr. Todd's collections from this locality came into my hands in 1885 through Prof. W. H. Dall, who turned it over with some shells to Dr. T. W. Stanton, and the latter passed it on to me. It was a pretty little fern, and Professor Fontaine subsequently identified it with *Dryopteris monocarpa* (*Aspidium monocarpum* Font., Proc. U. S. Nat. Mus., Vol. XV, 1892, p. 490, pl. lxxxiii, figs. 4–6, 6a), from the Kootanie of Great Falls, Montana. The specimen is recorded as No. 972 in the locality or lot catalogue of the Division of Paleobotany of the United States Geological Survey.

There are two other specimens now in my hands which I believe to have been collected at the same locality. They were received from Prof. J. S. Diller through Dr. T. W. Stanton, and were turned over to me by the former in 1893. They bear the locality number 568, and were recorded from data accompanying them as "from about sec. 16, T. 30 S., R. 7 W., Oregon Nickel mines, Riddles, Douglas County, Oregon, elevation about 2,000 feet." This accords sufficiently closely with the Todd locality to admit of no serious doubt. The specimens are covered by the same fern and the rock is of precisely the same character, but unfortunately the original label did not state when or by whom they were collected. It is certain that they did not come from the Oregon Nickel mines, which lie in range 6, 5 miles east of Buck Mountain, and no fossil plants have ever been found in that vicinity. Professor Fontaine, while studying this material, observed the similarity in these specimens, and in a letter to me dated January 26, 1898, he says:

In studying the Oregon plants for description, I had regarded the fern visible on the two specimens credited to the Nickel mine, and numbered 568, as the same with that on the specimen numbered 972, and credited to Todd's locality, i. e., Bucks Peak, 300 feet below its summit. On comparing these specimens again, after washing them, to see if they were really the same ferns, I found on the Nickel mine specimens inconspicuous imprints of a conifer, *Sphenolepidium Kurrianum*, that I had not observed before. This led me to examine the supposed Todd specimen carefully, to see if any conifers were shown on that. I had begun to suspect that the specimens all came from the same place, as the ferns are identical and the shale carrying them is exactly similar. I found on Todd's specimen the same conifer, obviously the counterpart of the impression on the Nickel mine specimens, but not exactly corresponding to them in dimension. On trying to fit the specimens together I found they nearly fitted. The conifer impressions occur on all the specimens on the side opposite to that which carries the much more distinct fern impressions. On this side there is a thin layer of soft, flaky shale, in which the conifer impressions occur. Rubbing in transportation had almost hidden the imprints previously obscure. Hence they were overlooked in the former examination. Either in the original splitting of the rock to obtain the specimens, or in subsequent transport, flakes of the soft shale layer carrying the coniferous imprints had been removed from the rock specimens, hence they do not exactly fit together, and the conifer imprints do not exactly correspond.

I have fully confirmed this description by a careful comparison of the specimens since they were returned, and I no longer doubt that they are all parts of the same piece of shale. They were, of course, probably all collected by Todd at the same time, but it might have happened that a subsequent collector picked up the two additional pieces left by Mr. Todd.

A large number of other small collections had been made from time to time in Douglas County, but they were either from the marine shell-bearing Knoxville and Horsetown beds or from the Eocene rocks of that region and therefore do not concern us here, but those from the Cretaceous will be treated in the second paper (Part II) of this series. There was considerable confusion in the labels of all these plants and for a long time all the Mesozoic forms were believed to represent the Shasta group (Knoxville and Horsetown beds), but the Buck Mountain region presented some serious stratigraphical difficulties. These Professor Diller was very anxious to clear up before mapping the region. In 1896 he visited the Buck Mountain district and made a somewhat hurried reconnaissance. A fossil-plant bed was discovered by Mr. James Storrs, of his party, and a small collection made and shipped to Washington. In transmitting this collection to me through the Director of the Survey he says, in his letter to the Director dated November 18, 1896, that the specimens "were obtained from rocks which appear to underlie the Lower Cretaceous," and adds:

These fossils come from a locality which promises to yield a rich harvest to the collector. They were found too late in the day to make a more extensive collection, but it is hoped that enough were obtained to indicate the geological age. No other fossils whatever were found in the same or immediately associated strata.

This locality is at the base of Buck Mountain on the northwest side, in section 3 of the same township and range, on the tributary of Olalla[1] Creek above referred to as Thompson or Hunter Creek. These plants came into my hands in the autumn of that year and I made a

[1] The beds at this point will for convenience be referred to as the Olalla Creek beds. Olalla is the Indian word for *berries*, the black raspberry and other berries being abundant in this region, and it is said that the term originally applied to the country all about the head of Olalla Creek and that all the streams went by that name.

somewhat careful preliminary study of them before sending them to Professor Fontaine for final determination. In my letter to him dated January 8, 1897, transmitting them, I said:

There is a Tæniopteris that seems to be *T. orovillensis* or something very near that, and it is the commonest plant in the collection. The other things are different in the main from the Oroville plants, but I believe they are as old.

I wish you could look over this collection pretty soon and let me know whether you think it is Jurassic and whether you think it important, because Mr. Storrs made it all in one day in a great hurry, and I understand there is plenty more.

Professor Fontaine made the following prompt preliminary report on this collection:

I have examined the Douglas County fossils and have no doubt that this is essentially the same flora as that of Oroville. The material is coarse and does not preserve the plants very well, but so far as I can judge from the impressions, there is a remarkably large number of identical forms here and at Oroville. Of course I would not like to give a final decision on forms from such imperfect material, but it seems to me that *Tæniopteris orovillensis* occurs here and perhaps a larger form. *Ctenophyllum angustifolium* seems to be common. Several of the small ferns seem identical with Oroville forms. The Oroville Sagenopteris almost certainly occurs here, also an Angiopteridium like that of Oroville. Some fragments look much like the Ctenophylla of Oroville with coarse nerves. *Pterophyllum rajmahalense* is probably found here.

The Oroville plants ought to be figured for comparison before these are worked up. I certainly think that a larger collection ought to be made before a final determination can be formed. I should think that the strata would yield some shale bands which would preserve the fossils better. However, for a "haphazard" collection in one day, this is a remarkable yield.

Professor Diller was informed of these results and the importance of increasing the amount of material and of making a more careful study of the stratigraphical position of these beds and their relation to the bed near the summit of Buck Mountain yielding the specimens collected by Mr. Todd. On June 30, 1897, Mr. Storrs returned to the locality and made a much larger collection, which was at once transmitted to me, through the Director of the Survey. In his letter to the Director, dated July 4, 1897, Professor Diller says:

By this mail I have the honor to transmit seven packages of specimens of fossil plants from the locality on Olalla Creek, at which a number of similar specimens were collected last year by Mr. Storrs. I respectfully request that they be referred to Professor Ward for study and report. For his information I desire to say that the plant beds appear to belong to the series of strata containing Aucella. Specimens of the Aucella were collected in shales which appear to underlie the leaf beds and will be sent also by this mail for examination. The Aucellæ are from Buck Peak, at the base of which the leaves occur, and do not appear to have the characteristics of the Jurassic Aucellæ, but rather those of the Knoxville beds.

As a consequence of all this a lively correspondence took place during the summer of 1897, participated in by Professors Diller and Fontaine, Mr. Storrs, and myself, as to the probable age of the plant-bearing beds, and in the course of which Professer Diller succeeded in locating Mr. Aurelius Todd at Dunedin, Florida, and obtaining from him, through a letter dated September 12, a full statement of his early operations in this field. In this letter Mr. Todd says:

Yours of August 18 at hand. Inclosed I send you a drawing as I remember the place and which I think you will find very nearly correct. I revisited the place in 1896, and got all I could find in half an hour, but as they are in a solid bluff I think you will have little trouble if persevering in getting all you want. However, if you fail I have a lot in Eugene, Oregon, which you are quite welcome to if you can find them, but they will have to be sent me here for identification, I fear, as they are not all labeled. If you have occasion to visit Eugene go to Professor Condon and make your wants known. Then go to Horn & Pain's gun store (Sporting Emporium) and look through the specimens I left there. Then go to the house on the corner of Fourteenth and Hilyard streets. I left some boxes there containing my duplicates packed up in their barn in boxes. Go through them and take what there is you want. All the Aucella in conglomerate came from Big Buck Mountain; those in lime from near Riddles or Big Pine; the ferns in shale from Big Buck Mountain. I gave Dr. Snapp, of Cottage Grove, Oregon, an order for these things, but I think he has never moved them nor does he care for the specimens. I know you can get them if they have not been destroyed. I have forgotten the man's name who owns the house now. I am very sorry I did not get to accompany you in your work in that section. I have found it one of much interest.

Let me hear of your success in visiting the old Buck Mountain fossils. I spent many an interesting day and night roaming those hills, prospecting, hunting, and mining, during the early seventies, and my older brother was killed in Lookingglass the day I discovered this same fossil bed and about the time of day—thrown from a horse and dragged—in August, 1872.

It will be seen that this last statement in Mr. Todd's letter fixes the date of his collections. The drawing that accompanied the letter is remarkably accurate, considering that it was made twenty-four years after the collections were made, and eleven years since he had seen the place. It also contained directions how to go to find the place without danger of mistake. Professor Diller received this letter while in the field at Myrtle Point.

Armed with this document, Mr. Storrs, very soon after its arrival, revisited the Buck Mountain region. He had no difficulty in finding and identifying Mr. Todd's locality, and he collected quite a number of plants, chiefly ferns, from it. He also revisited his other localities on Olalla Creek and made further collections there, extending the range considerably. These specimens were subjected to a critical preliminary examination by both Professor Fontaine and myself. The occurrence of a number of ferns associated with the cycadean forms in the Olalla Creek beds and having much the same *facies* as those from Todd Gulch on the mountain began to shake the hitherto somewhat settled opinion that the two beds must be of different age, the latter never having been suspected of being Jurassic. After further study of the collections from both localities, Professor Fontaine, in a letter dated January 7, 1898, says:

I have been including Todd's specimen and the other Oregon plants in the description of the Shasta flora, because they were sent as occurring in that group. There is, however, nothing in the nature of these plants to compel one to regard them as Lower Cretaceous. They may very well be of the age of the Oroville plants. They are pretty old looking. Why may not Todd's plant bed be the same as that on Olalla Creek (Diller's No. 2 bed), with the plants like those of Oroville, and both Jurassic?

At a little later date (January 26) he reported more fully as follows:

I have examined all the collections from the horizon (Olalla Creek), apparently above the Aucella beds of Buck Peak, and find that they indicate a flora of essentially the same age, and that it is apparently Jurassic, of the same age with that of Oroville. Mr. Storrs has made a pretty good collection from Todd's old locality. Unfortunately, nearly all of the fossils from this place are ferns, and ferns are not the best kind of fossils to determine geological age. The plants from this locality seem to belong to a flora of essentially the same age as that from the Olalla Creek, and to be Jurassic and not Cretaceous. Many of them, it is true, are different from those of Olalla Creek, but a number are the same, and my impression, from this preliminary examination, decidedly is that the floras of the Todd locality and Olalla Creek are not essentially different in age from that of Oroville. Mr. Storrs has got some fine plants from Olalla Creek. Among them are fine Ginkgos, probably of more than one species, with broad lobes, of the type of the Jurassic Ginkgos, *G. digitata* and *G. Huttoni*."

During the season of 1898 additional collections from the Olalla Creek beds were made by Mr. Will Q. Brown, of Riddles, Oregon, and Mr. Claude Rice, which they offered to send to Washington for determination, but, in view of the amount of material already in hand and the still existing confusion as to the stratigraphy, no effort was made to secure them. Mr. Brown, however, collected and turned over to Professor Diller a few plant remains from a railroad cut half a mile north of Nichols station, just south of the whistling post for that station. The railroad here follows the left bank of Cow Creek, and the locality is close to that stream. Nichols station is 7 miles exactly due south of the plant beds on Olalla Creek, and also due south of the locality on Bucks Peak. The plants from this locality closely resemble those obtained at the more northern points, and hence had an especial interest. They were sent to Professor Fontaine, and, in a letter by him to Professor Diller, dated April 12, 1899, he says:

The locality, "Railroad cut near whistling post, one-half mile north of Nichols, Douglas County, Oregon," is a very promising one and seems to contain a great variety of plants. The specimens sent are quite fragmentary, but they indicate over 20 different species, which, I think, show that the strata are of Horsetown age. This locality should have additional collections made from it.

Commenting on this report, Professor Diller wrote me, on April 14, as follows:

These fossils Mr. Brown expected to be Jurassic. It seems much more probable that they are Cretaceous. If the ones from the Olalla region are the same as those at Oroville, this locality assumes very great importance in furnishing an opportunity to study the flora which will connect the Upper Jurassic and the Cretaceous. Were it not for the fossil plants I should not hesitate to put all of the rocks in the Cretaceous. If they are not Cretaceous, however, it is important that the line should be drawn between them and their relation determined, for it is between the upper

Jurassic and the Cretaceous that some of the most important movements of the Pacific coast have occurred. I have just dictated a letter to the Director requesting that, if possible, arrangements be made to have that field studied this summer by some paleobotanist.

On April 19 Professor Fontaine again writes:

I wish you would go out and collect from Mr. Brown's localities. I was especially struck with his locality, "Railroad cut near whistling post, one-half mile north of Nichols," etc. He got about 24 specimens from that place and nearly all of them were different species. Some of them seem to be new species and genera. The material seems to preserve the plants well. I am sure fine and interesting plants can be gotten there.

Such was the condition of things at the beginning of the field season of 1899, and acting upon the suggestions of Professor Diller and Professor Fontaine I presented the matter to the Director on May 1, in the following form:

There is a small region in the vicinity of Riddles, including Buck Mountain, Olalla Creek, Cow Creek, etc., in which the strata are much disturbed, but which seems to be the key to the geology of that whole country. The geologists have not been able to work it out. There are few animal fossils, but an abundance of vegetable fossils; these latter are clear and fairly diagnostic, and seem to indicate two or three horizons extending down to the Jurassic. A large number of small collections have been made from this region at various times by different collectors, some of them amateurs, others geologists making hasty reconnoissances, and in only a few cases by collectors who have any skill in selecting material. What is needed is, as I stated in my previous letter, for someone to go there who can recognize the species and carefully work out the stratigraphical relations of the different classes of material. If this could be done, even though no collections at all were made, the object which Professor Diller wishes to secure would be accomplished. Still, it would be better to make additional collections at critical points, especially as Professor Fontaine, in working up the material, has carefully indicated the localities from which further collections need to be made.

I received instructions to visit this region, and arranged with Mr. Will Q. Brown, mining engineer, at Riddles, Oregon, to provide an outfit and accompany me as guide and scientific assistant. I also wrote to Professor Diller at his camp at Myrtle Point, on the coast due west of there, urging him, if possible, to join us, in the hope that all of us working together might succeed in tracing out the complicated stratigraphy. Owing to work in hand that must be finished before I could go, and to the necessity of stopping for a week in Wyoming to examine the Jurassic cycad locality in the Freezeout Hills, I was unable to reach Riddles until September 10. Mr. Brown had the outfit in readiness and Professor Diller and Mr. Storrs were on the ground. The party left Riddles on the 11th and proceeded at once with pack and riding animals to the Buck Mountain region, distant only 9 miles by a mountain trail, and camped at the foot of the mountain on the north side, on the branch of Olalla Creek called Thompson or Hunter Creek, in the bed of which, some distance below, Mr. Storrs had first obtained the plants denoting a Jurassic age. Five days were spent here, and all the localities were visited, several new ones found, and the whole district searchingly explored. Buck Mountain was several times climbed, the original locality of Mr. Todd carefully worked, and other plant-bearing beds discovered in the Todd Gulch below, and at other points both north and south of this. The collections from this region were no longer confined to ferns, but included several of the other distinctively Jurassic types of vegetation found below.

The most extensive collections were made in beds of slate overlying heavy conglomerates on the above-mentioned stream nearly due north of Buck Peak. The Day Hydraulic Gold Mining Company has dammed the stream at this point and built a conduit to the mines some distance below. The plant-bearing slates commence immediately below the dam, and it was in this first or stratigraphically lowest bed that Mr. Storrs made his principal previous collections. The beds have a dip toward the coast of from 35° to 40° and the strike is from 15° to 20° east of north, but in tracing them up the mountain side the strike was found to vary considerably. This plant-bearing stratum is only a few feet thick, and is overlain by a bed of conglomerate 50 feet or more in thickness. Following the bed of the stream down, this is crossed and another bed of slate is encountered, similar in general appearance to the first. This is also plant-bearing, and yielded by far the larger part of the specimens collected. It also preserved them better, and the most complete impressions were found here. Although the principal plant-yielding strata of the two beds of slate are separated by about 75 feet of vertical thickness, no very marked difference in the flora was apparent. Certain ferns in the lower bed were less common in the upper, and the latter yielded a larger proportion of broad-leaved cycadean genera, such as Ctenis, Ctenophyllum, and perhaps Pterophyllum. The species of Ginkgo, mentioned by Professor Fontaine (supra, p. 373) as occurring in Mr. Storrs's collection, is one of the most abundant fossils of this upper horizon, and very fine specimens were obtained. It is possible, as he suggests, that more than one species are represented, as some specimens have shorter, blunt lobes and others long and pointed ones.

This form, although not found in the Oroville flora, really constitutes one of the strongest proofs that we have of the Jurassic age of the beds. The digitate-leaved Ginkgos are an ancient type and mark a special stage in the progress from the Baiera of the Rhetic to the only slightly lobed Ginkgo of the late Cretaceous, the Tertiary, and the present. It is characteristic of the Brown Jura (Lias or early Oolite) of Siberia. Associated with this form were found fruits which may have been borne by them.

It may be added that these Ginkgo forms were also found on Buck Mountain. Professor Diller and Mr. Brown brought in a specimen on the 13th, which they collected in a gulch some distance north of

Todd Gulch, and on the 15th Mr. Storrs and I found them not only in the original Todd locality, but lower in the same gulch at two horizons, one 20 feet and the other 30 feet lower in the beds.

Professor Diller and Mr. Brown devoted the greater part of the time to carefully working out the stratigraphy. They followed the plant-bearing slates all the way from Olalla Creek to the Todd Gulch and proved their complete continuity. On Olalla Creek these slates are immediately overlain by the Eocene, only a short distance below the uppermost plant bed. On Buck Mountain, on the contrary, they are overlain by a bed of conglomerate, doubtless of the same age, which underlies the Aucella-bearing Knoxville beds on which the Eocene here rests. Everywhere to the east is a very thick bed of conglomerate, through which is intruded a great thickness of eruptive rock, principally serpentine. Still farther east, on the Nickel Mountain, are other Aucella beds, as if occupying the eastern slope of a great Mesozoic anticline, and when the bed of Cow Creek is reached at Riddles the higher Horsetown beds appear in force.

Such seems to be a general view of the much-discussed stratigraphy of the Buck Mountain region, and thus far the fossil plants furnish the only evidence of the existence of a great Jurassic deposit running through the State of Oregon; but this evidence is not only conclusive from a paleontological point of view, but when correlated with all the remaining facts and worked out, as was done by our party, it proves to be perfectly harmonious and consistent.

There remained the problem presented by Mr. Brown's collection from near Nichols station, on Cow Creek, 14 miles above and nearly southwest from Riddles. A glance at the map shows that Nichols station is exactly due south of Buck Peak, and all the plant localities in the Buck Mountain region are arranged along a nearly north-south line. The strike of the slates, as was shown, varies considerably even in short distances, but probably averages nearly north and south. The distance in a straight line from the Olalla bed to the Nichols bed is nearly 7 miles due south. We were unable to follow the strike with our pack train, but were obliged to go down one of the tributaries of Doe Creek from the eastern slope of Buck Mountain and then to follow Doe Creek to its junction with Cow Creek, 3 miles below Nichols station, thus avoiding the great Table Mountain on the west.

Very little additional to Mr. Brown's collection was found in the railroad cutting, but it was seen that we had here the same slates as those of the Buck Mountain district and that they came in in a regular way from the north. At this point Cow Creek has a course slightly west of north and the slates cross its channel very obliquely and even follow the bed of the stream for some distance. At the point where they emerge on the right bank to the north they expose their upturned edges for a long distance over that portion of the stream bed which is not overflowed in the dry season. Here was a fine opportunity to examine them, and although it is usually difficult to obtain large slabs lying in such a position, yet, from the easy cleavage and generally workable character of these slates, we were able to work out fine pieces and secure good specimens. The slates here are nearly vertical; in fact, there seems to be an easterly dip, as if they were tilted more than 90°. They have a thickness of about 200 feet, with no conglomerate bands. They are full of plants of typical Jurassic types. Most of the Olalla Creek forms occur, including the Ginkgo and the leading cycadaceous genera, Ctenis, Ctenophyllum, Pterozamites, Pterophyllum, etc. Some of the same ferns, notably a narrow Angiopteridium, were found present at nearly all the Buck Mountain localities. Besides these, a number of forms not seen farther north were collected, including many long, narrow coniferous leaves resembling those of Cephalotaxus or Taxodium, but showing fine transverse striæ on both sides of the midrib. A large collection was made.

Professor Diller and Mr. Brown worked out the stratigraphy in the same manner as in the Buck Mountain district. It is more complicated, and the Knoxville beds occur on Iron Mountain Creek not more than a mile east of the Jurassic outcrop. Eocene plant-bearing beds lie on the hills on both sides of Cow Creek, and it is evident that much still remains to be done before all will be made clear, but the general fact seems established that a Jurassic deposit of unknown extent and of considerable thickness trends through these mountains from north to south, which can no longer be overlooked in treating the geology of Oregon.

### CYCADEAN TRUNKS FROM THE JURASSIC.

A considerable number of cycadean trunks have been found in beds that are referred with more or less certainty to the Jurassic. There are as yet, however, only two sources of such material, and one of these is of doubtful age and is only represented by a single specimen. This locality is in Colorado. The other locality is in Wyoming, and there is no doubt as to its Jurassic age. I will treat the Colorado trunk first.

#### THE BOULDER CYCAD.

Early in the summer of 1896 Dr. F. H. Knowlton and Dr. T. W. Stanton, in passing through the museum of the State School of Mines at Golden, Colorado, observed a cycadean trunk on exhibition there, and made inquiries relative to its source. In a letter which I received from Dr. Knowlton soon after this, dated June 18, 1896, he says:

Dr. Stanton and I visited Golden yesterday, and as a preliminary went through the collections belonging to the State Mining School. One of the first things that I saw was a beautiful silicified cycad trunk. It was about 2 feet in height, regularly oval in cross section, the long diameter being about 12 inches and the short diameter about 8 inches. It came from the vicinity of Boulder, Colorado, and it is said to have been two or three times as long as now when first discovered. It was found in excavating for a railroad, and was smashed and buried—all but this piece—before its value was recognized. It is the same size throughout, and is hardly at all worn. It looks very much like one of the Black Hills specimens.

Knowing that Professor Jenney, who had shown so much interest in the cycads of the Black Hills, was at the time in Denver, and presuming that he was familiar with matters at the Colorado State School of Mines, I immediately wrote to him and asked him to assist me in securing, if possible, the loan of this specimen to the Geological Survey or National Museum long enough to describe it and report upon it. He communicated with President Regis Chauvenet, of the State School of Mines, and prepared the way for a correspondence on the subject. I wrote to President Chauvenet in September, and received a reply from Prof. Horace B. Patton, dated September 30, 1896, in which he says:

Your letter of recent date, asking for the loan of the cycad in the possession of the Colorado State School of Mines, has been received, also the photographs of cycads, for which please accept our thanks. We take pleasure in sending the cycad as you suggest. It was accordingly shipped several days ago by freight to the National Museum. I am sorry that I can not tell much as to the locality where it was found. It was secured by a certain J. Alden Smith in a railroad excavation near Boulder, Colorado. Mr. Smith was able to secure only one piece, although he was told by workmen that others belonging to the same piece had been found, but they were covered up somewhere in the dump. This was probably not less than ten or twelve years ago. Mr. Smith has been dead for some years. The above information I secured from President Chauvenet of this school, who bought the cycad with the rest of a large collection from Mr. Smith.

The specimen arrived in due time and is still in my hands, awaiting an appropriate occasion to publish a description of it. The description here given was written in 1897, and the photographs used in illustrating it were taken by Mr. T. W. Smillie, in the gallery of the U. S. National Museum, soon after the specimen was received.

## Genus CYCADEOIDEA Buckland.[1]

### Cycadeoidea nigra Ward n. sp.

Pl. LXVIII; Pl. LXIX.

Trunk large and rather tall, simple, much compressed laterally, thoroughly silicified, of a uniform black color externally and internally, very hard and heavy, 1 meter or more in height, 40 to 50 cm. in greater diameter, 25 to 30 cm. in lesser, with a girth of about 1 meter; organs of the armor descending below the middle; leaf scars arranged in two regular and distinct spiral rows around the

[1] For the systematic position of Cycadeoidea see supra, p. 302.

trunk, those passing from left to right forming an angle of about 30° and those from right to left of about 45° with the vertical axis; scars of the usual size, nearly triangular in shape, rarely somewhat arched above, but sometimes concave, so as to appear inversely heart-shaped, the upper side of the triangle nearly horizontal, the other two sides in line with the rows of scars, thus making different angles with the axis, the three angles all sharp, averaging 20 mm. wide by 15 mm. high, while the right and left sides of the triangle are respectively 16 mm. and 18 mm.; leaf bases always present 1 to 3 cm. below the surface, their summits level or slightly concave indicating a natural plane of disarticulation, presenting a roughened or spongy surface without pits or visible bundle scars, usually traversed by thin longitudinal dikes crossing one another at varying angles; ramentaceous walls very thick, 5 to 8 mm., with thickenings in the angles of the scars often as large as the scars themselves, rough and wrinkled on the outer edges, homogeneous but having a very thin (0.5 mm.) layer lining the inside of the scars, which may be the periderm of the petioles; reproductive organs very abundant and well developed, one in the axil of each leaf standing over the upper side of the scar and sometimes depressing it so as to cause the inversely heart-shaped appearance of the scars, making the walls on that side very thin or removing them altogether and exposing the bud on the upper side of the scar, elliptical in cross-section, 25 mm. in horizontal and 15 mm. in vertical thickness, their summits flush with the upper edges of the walls or rising slightly above them, rarely projecting, always filled with the remains of the organs composing them and showing a concentric structure with a heterogeneous center, the crescent-shaped involucral bract scars mostly at the ends of the ellipses and extending far out along the walls, sometimes aggregated at other points denoting abortive buds; armor very thick, 5 to 6 cm., separated from the axis by a definite but irregular or jagged line; woody zone 2 to 7 cm. thick, consisting of a homogeneous, black, cherty or partially chalcedonized substance showing concoidal fracture without division into rings or traces of bundles or medullary rays; medulla faintly distinguishable from the wood, compressed into a slab 3 cm. thick and 20 to 25 cm. wide in the only specimen known.

A large specimen of a trunk that was much compressed laterally, containing more than half the basal portion. It is broken by a somewhat even vertical fracture in the plane of the minor diameter a little to one side of the center, and also broken across obliquely above, so that the vertical fracture constitutes the shorter side. The amount that is wanting above is unknown, but Dr. Knowlton's statement that "it is said to have been two or three times as long," was probably an exaggeration on the part of his informant. Still, it might well have been considerably longer. It is scarcely at all worn, and is in an excellent state of preservation. It is of a nearly uniform black color, thoroughly silicified, with a cherty aspect in places, and high specific gravity. The total weight is 34.93 kilograms.

Its maximum height is 40 cm., but the base is 5 cm. lower in the middle than elsewhere, and the upper fracture is oblique both ways, so that the length of the minor face is only 28 cm., and that of the side opposite 32 cm. The partial major axis, which is nearly the same at all points, is about 26 cm., and the minor axis varies from 20 to 24 cm., being greatest near the base. The partial girth (exclusive of the broken inner face) is from 58 to 60 cm.

The organs of the armor are slightly declined throughout the entire length, the angle diminishing upward. They were probably horizontal on the lost upper portion of the trunk. The leaf scars are arranged in two regular and distinct spiral rows around the trunk, those ascending from left to right forming an angle of about 30°, those from right to left of about 45° with the vertical axis. One of the former would make a revolution in about 1 meter, one of the latter in about 65 cm.

The scars are of about the normal size and nearly triangular, rarely somewhat arched above, but sometimes concave, so as to appear inversely heart-shaped. The upper side of the triangle is nearly horizontal and the other two sides are in the line of the two rows of scars respectively, what may be called the right side being steeper than the left, and the lower angle a little to the right of the center of the upper side. The sides are thus of slightly different lengths, the upper longer than either of the others and the left longer than the right. Where the upper side is 20 mm., which is about the average, the left side will be 18 mm. and the right side 16 mm. The distance from the lower angle to the center of the upper side averages about 15 mm.

The leaf bases are always present at a certain depth, usually 1 cm. but sometimes 3 cm. or more. Their summits are nearly level or slightly concave, and there seems to be a joint at which they are usually disarticulated. They present a roughened or spongy appearance without pits or bundle scars, but in some cases they seem to be traversed by thin longitudinal dikes crossing one another at varying angles.

The walls are very thick, 5 to 8 mm., with large thickenings in the angles of the scars, often as large as the scars themselves. The scars are lined with a layer 0.5 mm. thick, the union of which with the walls can generally be seen; otherwise the walls are nearly homogeneous and rough on the outer edges.

Reproductive organs are very abundant and well developed. There is practically one in the axil of every leaf. They stand for the most part directly over the upper side of the scar, and sometimes depress that side, but usually the effect is confined to a considerable thinning of the wall on that side, and in a few cases the wall has disappeared here, leaving the bud exposed on the upper side of the leaf scar. The buds are elliptical in form and average about 25 mm. in horizontal and 15 mm. in vertical thickness (major and minor axes of cross section). They are flush with the upper edges of the walls and sometimes rise a little above them, but rarely project; still they serve to give the trunk a rough, uneven surface. They are never wanting so as to leave a cavity, and they all clearly show a concentric structure with a heterogeneous center, due to the form of the essential organs. Crescent-shaped bract scars occur, especially at the ends of the ellipse, but are not generally arranged all round the organ. The bases of the bracts are often preserved flush with the surface. The bract scars sometimes straggle away to some distance and appear in the walls remote from the buds, and there are a few abortive buds represented only by such scars.

The armor is very thick and nearly the same on the flattened sides as on the rounded edge of the trunk. It is everywhere between 5 cm. and 6 cm., and some of the leaf bases exceed 6 cm. in length. It is beautifully shown all round the broken portions, where the leaf basis, the walls, and the reproductive organs are exposed. The last named are usually much decayed, at least in their outer portions, but the central parts may be preserved. Some of them resemble the *Bennetties Morierei* fruit studied by Lignier.

The axis is well exposed over the whole surface of the vertical and oblique fracture, a length of 46 cm., and the somewhat regular line separating the armor from it is fairly distinct, but the internal tissue is an apparently homogeneous black, cherty, or partially chalcedonized rock, showing conchoidal fracture and revealing to macroscopic inspection no differentiation into layers or rings and no traces of bundles. There is a faint indication of the distinction between wood and pith. As seen along this broken surface, whether on the vertical fracture showing the longitudinal section or near the summit where the fracture makes an angle of about 45° to the axis, the thickness is nearly uniform throughout and does not exceed 7 cm. Of this the medulla probably occupies about 3 cm., leaving the wood on an average 2 cm. thick. The axis, therefore, has the form of a flat slab, which may have been 20 or 25 cm. wide. The width to the vertical fracture is over 15 cm.

In February of the present year (1900) Mr. George R. Wieland, who is engaged in working out the internal structure of the cycadean trunks at the Yale Museum, visited Washington for the purpose of examining the material in the United States National Museum, and when shown this trunk he expressed the belief that it would probably show structure, especially in some of the numerous fruits, and offered to examine it from this point of view if supplied with such parts as he should select from near the fractured surface that could be easily detached without injury to the specimen. I had taken the precaution to obtain permission from the State School of Mines of Colorado to have sections cut in case this seemed advisable, and Mr. Wieland took to New Haven several detached fruits, which he has carefully examined. While the proofs of this paper were passing through my hands I received a letter from him, dated March 17, 1900, giving the results of his investigations, which I am glad to introduce here as a fitting supplement to the above description, and as a welcome addition to our knowledge of this interesting specimen. Mr. Wieland says:

I am unable to find even basal portions of fruits in the Boulder cycad, only the peduncles surrounded by very large bracts. The sections made, even when quite thin, show the dense blackness and require very careful polishing to reach the thinness requisite to bring out structure. Each of those axes which seemed so much like fruits in a rather early stage is then seen to consist of a rather slender peduncle, surrounded by five or more bracts, whose transverse section is almost as large as that of the peduncle itself. The whole is deeply embedded in ramentum resembling that of the Wyoming cycads in the large number of cells seen in transverse section. The bract ramental hairs are apparently thinner than those belonging to the leaf bases. The peduncles are subequilateral-triangular in transverse section, the bracts the same, or in part of crescentic transverse section, with the horns of the crescent gracefully rounded. There are slight differences in the arrangement of the xylem and phloem of the peduncle, as compared with the Black Hills cycads, *Cycadeoidea Paynei* and *C. Wielandi*, which I presume compare most nearly with this form in general outline of the trunk and appearance of the fruiting axes. There is a strong suggestion that the fruits when mature must have hung well out from the trunk, very much as a *Zamia angustifolia* cone.

*Cycadeoidea nigra* is certainly well named. The sections as thin as paper are still black. It is, moreover, a very distinct species—a very interesting cycad. I am sorry that I could not catch so much as a parenchymatous cushion.

Pl. LXVIII shows the best side of the trunk and brings out the leaf scars with their arrangements and the reproductive organs very clearly. Pl. LXIX represents the vertical fracture and shows all that can be seen of the internal structure. The indistinctness at the summit is due to the oblique direction of the fracture at that point, sloping back from the camera so as to become out of focus.

### JURASSIC CYCADS FROM WYOMING.

A considerable number of fossil cycadean trunks have been obtained from the Jurassic of Wyoming. The locality is in what are called the

Freezeout Hills of Carbon County, 25 miles nearly due north of Medicine Bow.

The history of the discovery of these fossil trunks dates back only to 1898. The first intimation that I had of it was contained in a telegram from Prof. O. C. Marsh, dated July 15, 1898, as follows: "Have two small cycads, apparently new, from the new Wyoming locality; will send them by express if you can use them in your report." The "report" alluded to is the description of the Black Hills cycads in the Nineteenth Annual Report of the U. S. Geological Survey (Pt. II, pp. 594–641, pls. lxi–clvii), which had gone to the printer before the telegram was received. As the new locality is not in the Black Hills, it would not have been appropriate to include the Wyoming cycads in that paper, and I so informed Professor Marsh.

Professor Marsh promptly made public all the information he had on this subject in the "Postscript" to his paper on "The Jurassic Formation on the Atlantic Coast—Supplement," which he had read before the National Academy of Sciences on November 18, 1897. This "Supplement" with the "Postscript" appeared in the American Journal of Science for August, 1898 (4th ser., Vol. VI, pp. 105–115), and also in Science of August 5, 1898 (N. S., Vol. VIII, pp. 145–154).

The next reminder I had of the existence of these vegetable fossils was through Dr. F. H. Knowlton, who had received a letter from Prof. Wilbur C. Knight, State geologist of Wyoming, dated September 3, 1898, in which he said: "Recently my assistant made a very rich find of Jurassic cycads. Would you care to describe the species, or possibly several species? I have some fine ones. One on my desk is 8 by 6 by 12 inches or larger."

Dr. Knowlton showed me this letter, and, knowing that it referred to the same locality as that from which Professor Marsh had obtained his specimens, I immediately wrote to Professor Knight and offered to describe the specimens if he could find a way of placing them in my hands. As a result a negotiation was entered into with the authorities of the United States National Museum as to conditions on which the material would be received, and it was not until the 16th of March, 1899, that the collection finally arrived.

In a letter from Professor Knight, dated October 18, 1898, in answer to questions I had asked him relative to the age of the beds, he says:

There is no question as to the horizon of the find; it is in the Jurassic fresh-water beds, and near the bottom. In the locality where this bed has been opened there is a typical Jurassic exposure, and the fresh-water and marine beds can be sectioned to a foot. I have not visited the cycad beds yet, but I am well acquainted with the locality and have made rough sections many times. In my opinion it is a very excellent find and is well worth a careful study. I am at the present time making a special study of the Jurassic of Wyoming, contemplating a monograph on the subject as soon as it is possible to complete the work. If you wish, I can go to the field and give you an absolute section of the bed.

In another letter dated November 1, 1898, he makes the following more specific statement:

A section through the locality will be about as follows:

| | Feet. |
|---|---|
| Triassic red sandstone | 1,000 |
| Lower Jurassic (marine) | 200 |
| Upper Jurassic (fresh water) | 225 |
| Dakota conglomerate | 50 to 200 |

Your Black Hills section reminds me of the Big Horn Basin country where I found beds that I could not place in the Dakota. In no instance in the section given have I detected any nonconformability, although I anticipate that such exists between the Jurassic and Dakota.

I spent the latter part of November of that year at the Yale Museum describing the new material that Professor Marsh had acquired since my visit in June. This included the two specimens received from Mr. Reed from the Jurassic of Wyoming, and I took as full notes on them as possible. It was apparent at a glance that they had nothing to do with the Black Hills cycads, and that they were very different from anything that I had seen either in this country or in Europe. In some respects they resembled the specimens from the Purbeck beds of the Isle of Portland, especially the small ones that I saw there in 1894, and of which I obtained 20 specimens for the United States National Museum. This, however, had less to do with their botanical than with their mineralogical character, their light color, soft, ashy constitution, and especially their obviously partially calcareous nature. In writing to Professor Knight after my return, in a letter dated December 5, 1898, I said:

I was in New Haven all last week working up a collection of cycads that Professor Marsh has obtained since I was there in June. Among them were the two from Wyoming that Mr. Reed sent him. I took full notes on them. One is immature and the other a fragment, and neither ought to form the basis for a species, although they seem to be specifically different from each other and also from any other cycads known to me. If there is any prospect of my handling your full collection, or any considerable part of it, I shall delay describing these until I have seen more material.

While I was in New Haven in November, 1898, Professor Marsh requested me to name one of the Wyoming species, should there prove to be a new one, for Mr. Reed, the original collector. I have complied with this request in the present paper. I should have naturally done so, in conformity with the general practice of naming species after the collector, but in the present case, since Professor Marsh so strongly requested it, it becomes an obligation, as it certainly is a pleasure.

Although from Professor Knight's representation, and from all accounts, there was little doubt as to the Jurassic age of the cycad bed in the Freezeout Hills of Wyoming, still my desire to visit the spot and obtain a clear first-hand idea of it and of its relations to other deposits was very great, and I gladly availed myself of Professor Knight's generous offer to go with me to the locality. An arrangement was made to meet him at Laramie September 1, 1899, for this purpose. I was there at the appointed time, and a small party started on the 2d and reached the Freezeout Hills on the 3d.

The Freezeout Hills occupy an area some 10 miles square in about latitude 42° 7′ N., longitude 106° 15′ W. from Greenwich, and lie principally in T. 25 N., R. 79 W. Its topographic position is between the Big and Little Medicine rivers, which unite to form Rock Creek 10 miles due south of its central portion; but Muddy Creek, a branch of the Little Medicine, bounds the area on the north and east sides, while tributaries of the Big Medicine have their origin in its western portion. The highest of the hills is called Freezeout Mountain, the name being derived from a somewhat vague tradition that in early times an entire party of men were frozen to death in its immediate vicinity. The general uplift, which nowhere exceeds 8,000 feet, extends in a southeasterly direction to Medicine Bow and beyond. It is in one of the spurs of it, 7 miles east of the last-named place, and opposite the station called Aurora, on the Union Pacific Railroad, in the valley of Rock Creek, that the famous Como Bluff is located, in which dinosaurian remains were early found, and which furnished the well-known section so often published by Professor Marsh.

In traveling north from Medicine Bow, areas of Fort Benton and Dakota are passed over before reaching the Little Medicine, 5 miles from that place, in the valley of which the Jurassic is exposed, underlain by the Red Beds, both of which look very familiar to one acquainted with the Black Hills. The beds dip rapidly to the south, and there is an anticline to the north of the Little Medicine, the summit of which consists of a curious white sandy limestone, probably Permian in age, and comparable to some of the Permian beds of Kansas. Beyond this there is a wide plain, over which, at favorable places, the Jurassic and the Red Beds again successively make their appearance. Crossing this plain, a distance of some 12 miles, the southeastern border of the Freezeout Hills is reached. They are somewhat isolated and slope gradually to the east, while the west end of the spurs presents a ragged escarpment. The wagon road passes around them on the east, while at their western bases there is a somewhat narrow valley. As the geology can be much better studied on the west side, several members of the party, including Professor Knight and myself, took through this valley on foot from Trabing Brothers' ranch to the cabin which had been erected by the University of Wyoming on the north side of the hills, a distance of 6 miles. We thus passed along the foot of Freezeout Mountain, which rises 600 feet above the plain. The strata were seen dipping to the southeast, exposing at the base of the cliffs heavy beds of massive light-colored limestone, which weathers red and is supposed to belong to the Trias. The marine Jurassic rests upon this, and over it is the fresh-water Jurassic, which everywhere throughout this region holds saurian bones. The whole is capped by a formation which is called Dakota, but which in all essential respects resembles the Lower Cretaceous of the Black Hills. In some places, however, it has a different appearance and can be compared with phases of the Kansas deposits underlying the Dakota, especially as exposed at the head of the Medicine Lodge River.[1]

The cycad locality is in the northern portion of the hills and only half a mile from the cabin, and is located on section 13 of the township and range above mentioned. It occupies a rectangular area some 300 yards long east and west and 50 yards wide north and south, a little below and on the north side of the summit of a low rounded ridge in a sort of gap near the west end of the most northerly spur of the Freezeout Hills. This spur is much higher to the east of this gap, with a western scarp like the rest, and is capped by Cretaceous rocks, as shown in the section opposite. It lies near the middle of the fresh-water Jurassic. The cycadean trunks are buried in a loose and soft reddish-gray calcareous sand, easy of excavation, and a considerable number were dug out with a mattock. There are doubtless many more beneath the surface, and Professor Knight proposed to have the entire area turned over with a subsoil plow in the hope of bringing them to light.

This loose calcareous sand is so different from the material on the ridge above and below the cycad bed as to make it apparent that it consisted of a disintegrated stratum which was unlike those of the underlying and overlying beds, and I set about tracing it to the east, where the northern slope of the spur is much steeper and the strata are better exposed. I had no difficulty in doing this, and soon found the bed well exposed and continuing uniformly through the hill on its northern flank. It forms a ledge much of the way, and consists of a coarse, reddish-brown, cross-bedded sandstone with streaks of small, white, calcareous flecks, or small pellets. In some places these pellets are larger and give the rock somewhat the appearance of a conglomerate. There are also black carbonaceous streaks, containing compressed bits of lignitized wood. Silicified wood is very abundant in the cycad bed proper and is occasionally seen in the ledges.

After familiarizing myself with this important stratum I crossed over to the low hills north of the valley in which the cabin is located, and found it occupying the summit of some of them. It is much thicker there and forms crags. No cycads were found there, but large trunks of silicified wood lie embedded in the rock, and the gulches below are strewn with them and with blocks of the wood that have weathered out.

[1] See Science, new series, Vol. VI, Nov. 26, 1897, p. 815, and the paper of Mr. C. N. Gould On a series of transition beds from the Comanche to the Dakota Cretaceous in southwest Kansas: Am. Jour. Sci., March, 1898, 4th series, Vol. V, pp. 169-175.

A somewhat careful section was made east of the cycad locality at the point where the spur attains it greatest elevation, which is where it suddenly breaks away and exposes its western end down to the level of the low ridge holding the cycadean trunks. The following is the section:

*Section of the Freezeout Hills, Wyoming.*

| | Feet. |
|---|---|
| Cretaceous capping the hill | 50 |
| Fresh-water Jurassic (190 feet): | |
| Top of cycad stratum to base of Cretaceous | 100 |
| Cycad stratum | 10 |
| Top of marine Jurassic to bottom of cycad stratum | 80 |
| Marine Jurassic from Red Beds exposed in bottom of valley to base of fresh-water Jurassic | 115 |
| Total exposure | 355 |

The fresh-water Jurassic consists of fine soft sandstones, white, reddish, or yellowish, and olive-gray calcareous shales, at nearly all parts of which occur lenses or extensive beds of dark marls holding saurian bones and other vertebrate remains in great numbers. Some of these occupy a position above and others below that of the cycad-bearing stratum, and a number of bones were found in the cycad bed itself at its eastern end. These, however, may not have been in place, as no marls occur at this point.

I may add that there was no part of the section that is not practically paralleled in the Black Hills, and it does not differ more in general geological character or in the thickness of the several members from those I made in several parts of the Black Hills than those sections differ from one another.[1] The conclusion seems inevitable that practically the same general geological conditions obtain over a vast region of the Rocky Mountain uplift. Not less important to the paleontologist is the other general inference which so naturally flows from all the facts observed, that the life, both animal and vegetable, of this enormous period, extending, apparently unbroken, from the Permian to the Tertiary, has left its record, and will ultimately be known with a high degree of certainty. The marked difference that we shall presently see to exist between the cycadean forms of the Jurassic and those of the Lower Cretaceous fully attests the rapid change that took place during the comparatively short interval that separates them.

The material collected on this expedition was shipped to the National Museum by Mr. Charles Schuchert, who was a member of the party. Several other trunks were collected by Mr. Charles Gilmore before my arrival, and are at the University of Wyoming awaiting shipment. These I have not seen, nor have I had time since my return to study

[1] See Nineteenth Ann. Rept. U. S. Geol. Survey, Part II, pp. 554-565.

the others. The following account will therefore be confined to the original collections of Mr. W. H. Reed, sent me by Professor Knight, and the two specimens which Mr. Reed sent to Professor Marsh. The former of these collections consists of 83 specimens of cycads and 3 specimens of silicified wood. The specimens of cycads bear the numbers 500.1 to 500.83, and those of the wood the numbers 500.85 to 500.87, of the Museum of the School of Mines of the University of Wyoming, at Laramie, Wyoming. They are for the most part fragments, but there are a few entire trunks. The three largest, Nos. 500.1, 500.2, and 500.65, though all present, are each broken in two pieces which fit together perfectly. In a number of cases complementary parts had been detected and, unfortunately for their convenient study, glued together. In others such complements had been recognized and given the same number. It was obvious, however, that many fragments that belong together had not been identified, and much time was spent in finding and joining these counterparts. This study ultimately resulted in finding about 25 such cases. In addition to these there are a number which, although they do not actually fit together, nevertheless evidently belong to the same trunk, the structure being continuous and explicable on the assumption of the loss of intermediate portions. Putting these two classes together, the number of independent trunks and fragments is reduced to 61. In several cases more than 2 fragments belong together; for example, in three cases there are 3 and in two cases there are 5 separately numbered pieces of the same trunk.

A large proportion of the specimens were covered on the side on which they lay in the field by an incrustation of lime. This completely obscured the structure, and it was necessary to remove it. This was the case with many of the Black Hills cycads, but it presented no serious difficulty beyond the labor and expense of placing the trunks in a vat of hydrochloric acid and leaving them there until the lime was removed, the pure silica of those trunks being wholly unaffected by the process. But, as already remarked, the Jurassic trunks, although mainly silicified, contain calcareous matter, and the acid unavoidably etches the surface somewhat. If this had been all it would have been a comparatively small matter. The worst difficulty arises from the fact that the oxidation of the specimens turns the parts affected by the acid black or dull brown, and thereby more or less obscures the markings of the surface, on which the different organs normally have a different shade of color, which brings them out distinctly. After the acid bath, although the lime is removed and the surface little eaten or injured, all the organs have this uniform black or brown color. It is, however, fortunate that, while this interferes seriously with an ordinary macroscopic examination, the application of a lens removes the obscurity to a considerable degree, and in photographing the specimens it is observed that the dark surfaces come out almost as clearly as the light or variegated ones.

Besides the lime incrustations on the under surface, there was usually a coating of lichens on the surface which lay uppermost, and this, where it existed, was quite as fatal to an examination of the parts thus concealed as the coating of lime. This, though somewhat more difficult to remove, yields to a strong alkali, which has no effect upon the underlying structures.

The cleaning of the specimens by both the processes employed was undertaken as soon as possible after the collection had been unpacked, and I commenced the systematic study of the trunks almost at once, thoroughly noting and recording the characters and peculiarities of every specimen and of all parts of each, and by the end of May, 1899, I had completed this part of the work. I have compiled tables of the characters, and the subdivision into specific groups has been based mainly upon such characters. Notwithstanding considerable sameness among these characters, it is possible to classify them, and there seems no doubt that, could their foliage and reproductive organs be known, the cycadean flora of the Jurassic of Wyoming would be represented by a considerable number of species if not of genera, although it would be rash to assert that the lines would be drawn in all cases where we must draw them here.

The most marked feature that struck me on first casual inspection of these trunks, aside from their relatively small size, light color, and soft calcareous structure, was the frequency of a sort of smooth, to the naked eye structureless, dull, uniform covering that invests their outer surfaces and cuts off the view of the normal organs of the armor. A closer examination revealed the fact that this was not an occasional condition, but the normal state of these cycads, and that the cases in which this outer coating is wanting represent the abnormal state. It further became clear that there really are no cases in which it is naturally absent, and that its absence is always due to some external influence acting upon the surface which has removed it. There is an abundance of proof of this, and most of the specimens show parts over which the external coating still adheres and other parts where it is absent. The latter usually reveal the nature of the agency that has removed the coating—whether a sudden and violent concussion, gradual erosion, or a process of weathering. The contact of the outer layer with the surface of the armor proper is always marked by a clear plane of separation, and usually by an open structure or even a partially void space. This becomes a natural plane of cleavage, and almost any influence will cause the outer coating to scale off like the outer bark of a tree.

In the specimens of the Yale Museum this outer coating had almost entirely disappeared, though not absolutely, so that the phenomenon did not specially strike me, and I noted only that the surfaces were obscure in places. Through the kindness of Dr. C. E. Beecher these specimens were sent to me for further examination and comparison with those of the large collection from Professor Knight. Some of the important results of this comparison will be noted later on, but it is sufficient to state here that they form no exception or anomaly, but are simply part and parcel of the general lot.

Generic characters, with the exception of Bennettites, which is identical with Cycadeoidea except in the accident that seeds have been discovered in the spadices, have generally been based on the shape of the trunk and on the character of the armor, i. e., of the remains of the foliar organs still adhering to the trunk in the fossil state. The former of these characters has proved of less constancy, and, in cases where the latter class of characters is distinctive, authors have not hesitated to ignore variations in the former, as, e. g., *Cycadeoidea gigantea* of Seward, a tall, cylindrical trunk, wholly different in form from other species of that genus. I was obliged to do the same with *C. excelsa* and *C. Jenneyana.*

The second class of characters is relatively constant and diagnostic, and to show the differences in the different genera[1] I will reproduce the descriptions of different authors of these generic characters, translating where necessary:

Bucklandia: scarred-areolate by the scars of the spadices, scales, and petioles (Carruthers).

Yatesia: covered by the scales and persistent bases of the petioles (Carruthers).

Williamsonia: scarred-areolate by the markings of the deciduous petioles (Carruthers).

Bennettites: covered with the persistent bases of the petioles (Carruthers).

Mantellia: same as Bennettites (Carruthers. This was Brongniart's name of Cycadeoidea, which Carruthers adopted).

Raumeria: densely covered or scarred by the persistent bases of the petioles and stipule-shaped, connate scales (Carruthers).

Fittonia: covered by the scales and persistent, large, geniculate bases of the petioles (Carruthers).

Crossozamia: covered by the short, subimbricate bases of the petioles (Carruthers).

Clathraria: marked by transverse rhombic or irregularly pentagonal and hexagonal scars of leaves truncated above the base (Schimper).

Cycadeoidea: enveloped by the basilar remains of the leaves, rhomboidal in cross section (Schimper).[2]

Bolbopodium: completely enveloped by the disjointed rhombic leaf bases of different lengths (Saporta).

Cylindropodium: leaf bases short, densely crowded, with rhombic, convex scars (Saporta).

Clathropodium: leaf bases long-rhombic or elliptical in cross section (Saporta).

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[1] Many of the generic names mentioned here are of course synonyms, but have been described as genera.

[2] Buckland's description was not compact.

The peculiar outer coating or second armor of the Jurassic cycads of Wyoming obviously constitutes a good generic character. At the same time, as is seen by the above descriptions, it is wholly different from that of any other genus of cycadean trunks, and it is therefore necessary to regard it as a new genus, altogether different in its most essential generic characters from any other. From the generally small size of these trunks, especially when compared with the giant forms of the Black Hills, I have concluded to call this new genus *Cycadella.*

Although a macroscopic examination is sufficient to show this generic distinction, still it does not immediately indicate the true nature of this supplementary envelop. I was at first disposed to think that it consisted of matted leaves. I observed that the leaf bases were always present, filling the scars, and sometimes projecting somewhat above the general surface, and I did not know but that expanded portions of them might have also persisted and been rolled and packed against the trunks in the process of entombment in a manner to produce the observed effect. But a strong glass failed to bring out the difference on the surface that would be expected if such had been the case: striations, folds, leaf margins, etc. Moreover, the fractured margins often showed the darker leaf bases coming out to the surface of the true armor but never continuing across the line of separation and mingling with the tissue of the outer layer, which is sometimes more than a centimeter in thickness.

Since, aside from the reproductive organs, less abundant than in the Cretaceous cycads, the armor consists of nothing else than the leaf bases and the ramentum that is attached to them and constitutes the walls, this last must have furnished the covering which forms the outer coat. It has been observed that these fine scales or hairs are always the most certain to be preserved, and whatever the degree of imperfection in the state of preservation in other respects, the walls are usually intact. This accounts for the large number of trunks that consist of these walls penetrated to a great depth by the rhombic or triangular cavities, looking like petrified honeycomb or sponges. This is a most fortunate circumstance, since otherwise we should in such cases have nothing but the woody cylinder of the trunk, and would be entirely incapable of determining the true nature of the objects.

This special susceptibility to petrification on the part of the ramentum explains the presence of the external covering of the Wyoming Jurassic cycads, since it seems actually to consist of a matted mass of these ramentaceous hairs, which in some way developed so luxuriantly upon the sides of the petioles as to push out beyond the surface and roll over the spaces formerly occupied by the leaves and fruits. It seems necessary to assume that this occurred long after the fall of the leaves, and, indeed, this latter doubtless took place much as it does in living cycads, the leaves always forming a crown to the trunks and falling away as the trunk elongates, leaving only their persistent bases to form a false bark. These are not wholly dead, but manifest vegetative activity, and doubtless have some physiological function. The development of copious ramentaceous hairs would form a protection to the trunk both from cold and from violence.

Something analogous to this may be seen in living cycads and in tree ferns; also in some palms, and a similar function is sometimes performed in other ways, as by the coat of wax on the wax palms. At any rate, we are confronted with the fact that Cycadella developed an exuberant growth of fine scales or hairs from the bases of its old petioles below the apex, which formed a woolly or mossy covering of considerable thickness, sufficient when tightly appressed to the trunk and petrified there to form a layer 5 to 15 mm. thick all over the fossil trunks.

As already remarked, there is usually a clean line of separation between the armor proper and this outer covering, but if the latter consists of ramentum there must be points at which it crossed this boundary and reappeared in the superficial layer. Such points are not easy to find in the collection, but the fractured surfaces of a few specimens reveal the process of transition in a more or less imperfect way. Such specimens were carefully searched out and the most promising cases were sectioned and the surfaces polished. Slides were also made, and the whole process is as fully illustrated as the nature of the material will permit.

The following is the description of the new genus Cycadella and the species distinguished in the collections examined:

## Genus CYCADELLA Ward.[1]

### Pl. LXX.

1900. *Cycadella* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 263, pl. xiv.

Trunks relatively small, bulbous, subspheroidal, or subconical, variously compressed, incased in a layer 5 to 15 mm. thick of dense tissue, consisting of the chaffy ramentum exuberantly developed from the leaf bases and extruded from the armor, massed and matted in the fossil state so as to form a thick outer covering to the trunk; leaf bases always filling the scars, occasionally caught in the meshes of the outer coating, but normally truncated below, and constituting, with the ramentum walls, a dense armor 1 to 5 cm. thick; otherwise as in Cycadeoidea.

Pl. LXX merely illustrates the nature of the ramentaceous chaff and the great length that it attains, but it would be obviously impossible

[1] The systematic position of Cycadella is the same as that of Cycadeoidea (see supra, p. 302).

to show the full length with a power of 90 diameters. The manner in which the chaffy hairs protrude from the armor and pour over the surface of the trunk, upon which they lie in mats of wavy lines, is shown on Pls. XCIV and XCV, illustrating *C. Knowltoniana.* The phenomena will be more fully described under that species.

I am indebted to Dr. F. H. Knowlton for the drawing of Pl. LXX, made from slides of the two species, *C. Knowltoniana* (Figs. 1–3) and *C. ramentosa* (Figs. 4, 5), under the compound microscope. For further details see description of that plate.

### CYCADELLA REEDII Ward.

### Pl. LXXI–LXXVI.

1900. *Cycadella Reedii* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 264, pl. xv.

Trunks small (8 to 12 cm. high, 6 to 16 cm. in diameter), subspheroidal or subconical, unbranched, usually more or less laterally compressed, the axis oblique; rock substance rather soft, light colored, of low specific gravity; organs of the armor ascending; leaf scars arranged in rows around the trunk nearly at right angles to the axis, subrhombic, 15 to 20 mm. wide, 6 to 10 mm. high; leaf bases porous; walls 1 to 3 mm. thick, hard and fine-grained, often flinty, usually white and somewhat striate; reproductive organs very obscure; armor 1 to 3 cm. thick, separated from the axis by a definite line; wood 2 to 3 cm. thick; cortical parenchyma 1 to 2 cm. thick; fibrous zone divided into two or three rings of fine, more or less distinctly radiate structure; medulla 2 to 4 cm. in diameter, nearly circular, consisting of fine-grained homogeneous tissue.

To this species are referred five of the specimens. One of these, which is taken as the type, is the more complete of two originally sent to Professor Marsh by Mr. W. H. Reed, for whom the species is named. It is No. 127 of the Yale collection. The other specimens are Nos. 500.6, 500.10, 500.19, and 500.29 of the Museum of the State University of Wyoming. The Yale specimen is larger than any of the others, weighing 2.04 kilograms, while No. 500.10 is the smallest trunk in either collection and weighs only 0.37 kilogram. No. 500.6 weighs 1.48, No. 500.19, 1.56, and No. 500.29, 1.67 kilograms.

Pl. LXXI represents the best side of the Yale specimen, with the eccentric medulla projecting. Pl. LXXII shows the side opposite this, which is considerably obscured by remains of the outer coat. Pl. LXXIII, Fig. 1, shows a side view of No. 500.29, of the Museum of the University of Wyoming, and Fig. 2 is a view of the base. Pl. LXXIV gives two views of opposite sides of No. 500.6, the base being faintly visible in both. Pl. LXXV, Fig. 1, represents the best-preserved side of No. 500.19, and Fig. 2 the base. Pl. LXXVI shows the two opposite broadest sides of the small No. 500.10.

### CYCADELLA BEECHERIANA Ward.

### Pl. LXXVII; Pl. LXXVIII.

1900. *Cycadella Beecheriana* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 265, pl. xvi.

Trunk cylindrical, contracted at base and summit, somewhat laterally compressed, unbranched, 35 cm. high, 18 by 22 cm. in diameter; rock substance soft, generally light colored with darker stripes and spots strongly contrasting, of low specific gravity; organs of the armor horizontal; phyllotaxy concealed by the outer coating of ramentum; leaf scars subrhombic or somewhat elliptical, 15 to 20 mm. wide, 5 to 10 mm. high; leaf bases dark colored, punctate; walls about 5 mm. thick, firm, white, sometimes with a median line; reproductive organs well developed, somewhat raised above the general surface, elliptical in cross section, 2 by 3 cm. in diameter, surrounded by subrhombic bract scars in several rows, the central portion heterogeneous and more or less crystallized; armor 3 to 4 cm. thick, joining the axis by an irregular line; wood 3 to 4 cm. thick; cortical parenchyma 1 to 2 cm. thick; fibrous zone 2 cm. thick, not differentiated into rings, firm and dark colored; medulla mostly wanting in the only specimen known, the preserved remains flinty and white.

Of this species there has thus far been found less than half of one trunk. The upper two-thirds of this consists of the fragment No. 128 of the Yale collection. When I studied this fragment in November, 1898, it was all in one piece, but subsequently broke into two nearly equal pieces by an oblique transverse fracture, and a small lump came out of the lower one of these pieces. While studying the larger collection at Washington in June, 1899, I felt the need of again seeing the two Yale specimens in order to correlate them with the rest, and at my request Dr. C. E. Beecher kindly sent them to me for the purpose. As soon as I saw this fragment I at once recognized its resemblance to a smaller fragment of the Knight collection, No. 500.54, which I had been unable to class with any of the rest. On confronting them it was found that No. 500.54 of the Wyoming collection fitted perfectly on the lower end of No. 128 of the Yale collection, thus nearly completing it in that direction, but still leaving a small part of the base unrepresented. Thus restored the specimen represents nearly half of the original trunk, which was split down quite evenly from summit to base on a longitudinal plane a trifle on one side of the center. On the fractured surface thus presented the internal characters are exposed with great clearness.

As a partial recognition of the interest taken by Dr. Beecher in the subject of cycads in general and in the Wyoming specimens in particular, I dedicate this species to him.

The Yale specimen weighs 3.18 and the Knight specimen 1.45 kilograms.

Pl. LXXVII represents the inner fractured surface of the specimen as restored, the lines separating all four of the pieces being distinctly visible. Pl. LXXVIII shows the outer surface of the same.

### CYCADELLA WYOMINGENSIS Ward.

Pls. LXXIX–XC.

1900. *Cycadella wyomingensis* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 266, pl. xvii.

Trunks relatively large (25 to 30 cm. high, 15 to 25 cm. in diameter), short-conical or slightly contracted at the base, more or less laterally compressed, unbranched or with a few projecting secondary axes; rock substance hard and fine-grained, generally light colored but with varying shades, of medium specific gravity; organs of the armor slightly ascending; rows of scars from left to right making an angle with the axis of 70° to 80°, those from right to left of 45°; leaf scars subrhombic, 15 to 20 mm. wide, 8 to 12 mm. high; leaf bases relatively dark, affected with black or sometimes white tubular punctations; walls 2 to 4 mm. thick, light colored and striate but without any proper commissure; reproductive organs few but often well developed, sometimes projecting or passing through the outer coating, elliptical in cross-section, 2 by 3 cm. in diameter, surrounded by mostly obscure, rather large involucral bract scars of variable shape, the central portion solid but heterogeneous in structure; armor 3 to 6 cm. thick, joined to the axis by a definite but usually irregular, sometimes scalloped, line; wood 3 to 4 cm. thick; cortical parenchyma 10 to 15 mm. thick; fibrous zone 1 to 2 cm. thick, usually consisting of two rings, one or both radiate in structure, the medullary rays often distinct; medulla 5 to 10 cm. in diameter, the cross-section elliptical in the compressed specimens, of a nearly homogeneous fine-grained structure.

This species includes some of the handsomest specimens in the collection, having about a medium size, and therefore being fairly representative of the Jurassic cycads. Nos. 500.3, 500.14, and 500.15 are nearly perfect trunks. The rest are fragments. Nos. 500.7 and 500.20 are somewhat thin segments bounded by transverse fractures, and almost certainly belong to the same trunk at different elevations. No. 500.26 may be a lower segment of the same trunk, but if so it must have been contracted at the base, as is the case with No. 500.3. Nos. 500.8 and 500.67 fit each other, and the former, which was shattered when received, has come in three pieces. It represents a section between two oblique but chiefly vertical fractures. No. 500.52, a thick, somewhat cubical piece, almost certainly belongs to No. 500.8, as shown by the identical structure of its principal fracture.

The weights of the specimens are as follows:

| | Kilograms. |
|---|---|
| No. 500.3 | 11.03 |
| No. 500.7 | 2.41 |
| No. 500.8 | 1.28 |
| No. 500.14 | 12.00 |
| No. 500.15 | 8.89 |
| No. 500.20 | 3.57 |
| No. 500.26 | 4.00 |
| No. 500.52 | 1.13 |
| No. 500.67 | 0.40 |

Pls. LXXIX and LXXX illustrate two of the sides and the base of No. 500.3. Pls. LXXXI to LXXXIII do the same for No. 500.14. In Pl. LXXXI, which is a side view of No. 500.14, the distinction between the parts covered with the ramentaceous cortex on the right and those from which this has peeled off on the left, with the exposed edge of this layer, is clearly brought out. In Pl. LXXXII the compressed leafy summit of the trunk, broken down on one side, is made clear, and the circular area near the top represents the probable eccentric terminal bud or end of the main axis with small scars. Pls. LXXXIV and LXXXV show the broadest side and the base of No. 500.15. Pls. LXXXVI to XC illustrate the segmentary fragments Nos. 500.7, 500.8, 500.20, 500.26, and 500.52, several of which probably represent the same trunk.

### CYCADELLA KNOWLTONIANA Ward.

Pl. LXX, Figs. 1–3; Pls. XCI–XCV.

1900. *Cycadella Knowltoniana* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 267, pls. xviii–xx.

Trunks medium size (25 cm. in diameter), cylindrical, bearing a few small secondary axes; rock soft, light colored without, dark and variegated within; organs of the armor horizontal; leaf scars subrhombic, 8 to 12 mm. wide, 4 to 6 mm. high; leaf bases relatively dark, punctate with minute white-walled tubes; walls thick, sometimes 5 mm., soft, white on their outer edges, brown within as shown on the fractures, contrasting strongly with the nearly black leaf bases, the ramentaceous hairs very distinct, showing their mode of origin in the petioles and their passage from the armor into the outer coating which they form, to a thickness in places of nearly 2 cm.; reproductive organs few but distinct, usually raised, 16 by 25 mm. in diameter, surrounded by two or more rows of narrow involucral bract scars, the bracts distinctly traceable in longitudinal section to their origin in the receptacle, from which also proceed the essential organs in an advanced stage of decay and mineralization; armor 3 to 4 cm. thick, joined to the axis by a very irregular but somewhat definite line, the petioles emerging from different depths as projections of the wood substance;

wood 2 to 3 cm. thick, very imperfectly differentiated into two zones, the inner wall, exposed in one specimen, showing large scars of the medullary rays, consisting of elongated alternating depressions, 10 to 15 mm. long, 5 to 8 mm. wide, each with a raised point or cushion above the middle; medulla 4 cm. in diameter, hard, fine-grained, and homogeneous.

This species consists of Nos. 500.62 and 500.76, which seem to belong to the same trunk, but are not exactly contiguous. They probably belong end to end, No. 500.62 being the upper segment and reaching nearly to the apex of the trunk, while No. 500.76 falls considerably short of reaching the base. The trunk probably had a height of about 20 cm. No. 500.62 has lost the medulla, thus exposing the inner wall of the woody axis as described. Both specimens are nearly covered without by the coating of ramentum, and the transverse fractures reveal its nature better than in any other specimens in the collection. One of these surfaces (the upper fracture of No. 500.76) has been cut across and polished, and microscopic slides prepared from the region which most clearly shows the transition of the ramentum to the outer investiture (see Pl. LXX, Figs. 1–3). This polished surface was photographed natural size and also enlarged four times linear, and the most instructive portions of the large view have been selected to illustrate the behavior of the ramentaceous chaff in forming the external layer.

On account of the great interest taken by Dr. F. H. Knowlton in the question of the true nature of this peculiar generic character, the material assistance he has rendered me in preparing and examining microscopic slides illustrating it, and the fact that the most successful of these investigations have been made on specimens of this species, I have thought it a proper recognition of his services that the species should bear his name.

The weight of No. 500.62 is 1.22 kilograms, and that of No. 500.76 (before cutting) 1.39 kilograms.

Pl. XCI shows the outer surface of No. 500.62, which is completely encased in the ramentaceous layer, so that none of the scars are visible. Fig. 2 represents the inner wall of the woody zone with the scars of the medullary rays. Pl. XCII, Fig. 1, presents the lower transverse fracture of the same specimen, which shows very clearly the leaf bases and walls in longitudinal section overlain by the investing case of matted ramentum.

Pl. XCII, Fig. 2, and Pls. XCIII to XCV, illustrate the instructive specimen No. 500.76, which probably belongs lower in the same trunk as the last. The polished surface of the upper transverse fracture, from which the microscopic slides were taken, is represented by Pl. XCII, Fig. 2. The figure is somewhat enlarged, and even here the origin of the ramentum from the sides of the leaf bases is distinctly visible without a lens. The line dividing the armor from the outer layer is clear, and a good general idea of the nature of the latter can be gained from this view. The irregular attachment of the armor to the axis is also well shown. Pl. XCIII, Fig 1, shows this same surface as it appeared before it was polished. Fig. 2 gives the outer surface invested by the ramentum layer, but a few organs are visible, having forced their way through it or been disarticulated near its outer surface.

Pls. XCIV and XCV represent two areas of the polished upper transverse plane enlarged 4 diameters. An inspection of Pl. XCII, Fig. 2, shows that there is a short interval near the center of the specimen over which, for some reason, there is no outer layer, to the left of which it extends entirely to the margin, and on the right of which it fills a deep depression in the surface. Pl. XCIV includes the greater part of the portion on the left where this layer is present, and Pl. XCV covers the area on the right. All the characters, generic and specific, are admirably brought out in these two enlarged areas, especially the nature of the ramentum outside of the armor, and its wavy, crinkled character as determined by the irregularities of the surface and the unknown agencies that compressed it from without and packed it down against the trunk. In several places portions of leaf bases and perhaps of reproductive organs, detached from the armor and caught, as it were, in the meshes of chaff, can be seen lodged in the outer coat. These show their normal vascular structure under the compound microscope. Owing to inequalities of pressure and unexplained conditions, the long strands of matted chaff are differentiated into bands of different color and density that lie parallel to one another and zigzag across the exposed cross sections of the investing layer. Near the left margin of Pl. XCV there is a region where one of the petioles is clearly seen to cross the boundary line between the armor and the ramentaceous covering, and the chaff that developed from its left side can also be traced across this boundary and out into the outer layer. This is particularly instructive from the point of view of the origin of the latter. Upon the whole, these several illustrations afford a tolerably clear idea of the character of this remarkable group of extinct plants.

### Cycadella compressa Ward.

### Pl. XCVI; Pl. XCVII.

1900. *Cycadella compressa* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 269.

Trunks small (10 to 20 cm. high, with major diameter 12 to 15 cm.), originally conical, all much compressed laterally or sometimes vertically or obliquely, unbranched; rock soft, light colored, of low specific gravity; organs of the armor tightly appressed to the trunk for the most part upwardly, obscuring their arrangement; leaf scars subrhombic, where normal 15 to 20 mm. wide and 8 to 12 mm. high; leaf bases soft, rough or porous; walls 1 to 2 mm. thick, soft-sandy or decayed and depressed, light colored or yellowish; reproductive organs few and obscure, sometimes slightly elevated, elliptical in cross section, 12 by 20 mm. in diameter, with or without visible bract scars, the central portion obscure; armor very variable in thickness (5 to 25 mm.), joined to the axis by a definite but more or less irregular line; wood 2 cm. thick; cortical parenchyma 1 cm. thick; fibrous zone 1 cm. thick, not differentiated; medulla in laterally compressed specimens a thin slab 5 mm. thick and 7 cm. long, in vertically compressed specimens circular, 2 cm. in diameter.

This species embraces 6 much-flattened specimens, viz, Nos. 500.4, 500.18, 500.22, 500.35, 500.68, and 500.69. Of these Nos. 500.4, 500.18, and 500.35 are nearly complete trunks, No. 500.18 being vertically or somewhat obliquely compressed. All the rest are laterally compressed. Nos. 500.22, 500.68, and 500.69 may all belong to the same trunk, the last two especially resembling each other, but none of them are contiguous. They all bear a general resemblance to one or other of the species already described, but aside from their great compression and small size, not specific characters in themselves, there are numerous features which forbid their union with any of these.

The weights are as follows:

| | Kilograms. |
|---|---|
| No. 500.4 | 1.11 |
| No. 500.18 | 1.14 |
| No. 500.22 | 0.79 |
| No. 500.35 | 0.88 |
| No. 500.68 | 0.59 |
| No. 500.69 | 0.56 |

The only specimens that it was thought worth while to illustrate are Nos. 500.4 and 500.18. The former is shown on Pl. XCVI. The figure gives an exaggerated idea of the specimen, which is flat and thin, and only the broad side was taken. Pl. XCVII illustrates No. 500.18, Fig. 1 showing the upper side which below is a side view, but near the top the apex is turned toward the observer and the terminal bud may be seen a little on the left. The lack of perspective causes its true form to be obscured.

### CYCADELLA JURASSICA Ward.

### Pls. XCVIII–CXII.

1900. *Cycadella jurassica* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 270.

Trunks rather small (10 to 15 cm. high, 10 to 20 cm. in diameter), very irregular in shape, more or less compressed in various directions and distorted, often much branched with several primary axes, sometimes with secondary axes only, the branches usually terminating in regular buds; rock substance soft except where excessively mineralized, light ash colored with dark, sharply contrasting stripes and spots, usually of low specific gravity; organs of the armor mostly ascending and adjusted to the axes of the branches; phyllotaxy not generally traceable except in secondary arrangement around certain branches; leaf scars subrhombic or somewhat elliptical, 15 to 20 mm. wide, 8 to 12 mm. high; leaf bases dark and affected with white fistular punctations; walls 2 to 4 mm. thick, soft-sandy, white or yellowish, striate, often with a median groove, depression, or crack; reproductive organs somewhat rare, often well-developed, either flush with the surface or raised above it, elliptical in cross section, variable in size, 15 to 30 mm. in diameter, surrounded by large triangular bract scars, the central portion solid and marked by the scars of the essential organs; armor 4 to 6 cm. thick, joined to the axis by an uneven, more or less definite line; wood 2 to 3 cm. thick; cortical parenchyma 1 to 2 cm. thick; fibrous zone 1 to 2 cm. thick, sometimes in two rings with radiate structure; medulla 3 to 6 cm. in diameter, fine-grained and homogeneous.

This species is one of the most common in the Jurassic of Wyoming, and is typical of the smaller branching forms. It embraces Nos. 500.5, 500.23, 500.30, 500.36, 500.38, 500.41, 500.49, 500.70, 500.77, 500.78, 500.80, and 500.82. Nos. 500.49 and 500.77 fit together, and No. 500.41 evidently belongs to the same trunk. A small piece has become detached from No. 500.49. Nos. 500.78 and 500.82 also fit together, and No. 500.70 seems to form a cap to this small trunk, but a portion is lost between them. The rest are all single. Nos. 500.5 and 500.23 are practically complete trunks. Nos. 500.36 and 500.38 are parts of two of the largest trunks of the species, and No. 500.30 is over half of another nearly as large. They are all very handsome specimens, presenting the regular mottled striped or spotted appearance due to contrast between the dark leaf bases and the light-colored walls. No. 500.23 is nearly unbranched and is anomalous in several respects. It may represent a different species, but can not be identified with any other specific group.

The weights of the specimens are as follows:

| | Kilograms. |
|---|---|
| No. 500.5 | 2.41 |
| No. 500.23 | 1.05 |
| No. 500.30 | 2.30 |
| No. 500.36 | 3.43 |
| No. 500.38 | 3.32 |
| No. 500.41 | 0.37 |
| No. 500.49 | 1.84 |
| No. 500.70 | 0.56 |
| No. 500.77 | 1.14 |
| No. 500.78 | 0.79 |
| No. 500.80 | 0.79 |
| No. 500.82 | 0.62 |

Pls. XCVIII and XCIX represent the two opposite broadest sides of the specimen No. 500.5; Pls. C and CI afford side views of the fine branching trunk No. 500.38, and Pl. CII shows the interior from the fractured side; Pl. CIII shows the outer surface and Pl. CIV the inner fractured surface of No. 500.30; Pl. CV presents the best-preserved side of the trunk No. 500.36 with its broken summit, and Pl. CVI includes the broken base and a portion of the other side. Views of the two sides of the combined Nos. 500.49 and 500.77 are given in Pls. CVII and CVIII, and the internal structure of No. 500.49, as revealed by the transverse fracture, is shown in Pl. CIX. The nearly complete small trunk made up of Nos. 500.78 and 500.82 is well shown on Pl. CX, in which *a* is the former and *b* the latter of these specimens. Pl. CXI represents the specimen No. 500.70, which is believed to be the apex of that trunk extending over portions that are lost in the lower pieces. Fig. 1 is a view from the top showing the rounded summit, and Fig. 2 a view from below showing the concave, partially decayed fracture, corresponding very closely with the upper portion of No. 500.82 as seen in Pl. CX at *b*. The anomalous specimen, No. 500.23, is shown on Pl. CXII, Fig. 1 being a view of the left top and Fig. 2 a view of one side.

## CYCADELLA NODOSA Ward.

Pls. CXIII–CXXII.

1900. *Cycadella nodosa* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 271.

Trunks small, 8 to 14 cm. high, 10 to 20 cm. in diameter, ellipsoidal or conical, somewhat laterally compressed or otherwise distorted, covered with small secondary axes forming prominences or protuberances and giving the specimens a knotty or gnarly appearance; rock hard, light ash colored or brown on weathered surfaces, black within, of medium specific gravity; organs of the armor generally horizontal; leaf scars subrhombic, 15 to 20 mm. wide, 5 to 10 mm. high; leaf bases punctate with small white tubes; walls 1 to 3 mm. thick, firm, light colored, striate, sometimes with a median groove or line; reproductive organs few, obscure, simulating the secondary axes, surrounded by large subrhombic involucral bract scars in several rows passing into leaf scars, central portion solid, heterogeneous; armor 2 to 4 cm. thick, joined to the axis by a definite line; wood 2 to 4 cm. thick; cortical parenchyma 1 cm. thick; fibrous zone 1 to 3 cm. thick, consisting of two or three rings, the outer one showing radiate structure; medulla either circular and 4 cm. in diameter or elliptical in cross section, the lesser diameter 2 to 4 cm. and the greater 3 to 8 cm.

After considerable hesitation I have decided to group together seven of the specimens under this name, although from different states of preservation and degrees of compression they present a so varied aspect. They all agree, however, in the one leading ch of being more or less densely covered with small protruding se axes which greatly obscure and distort all other characters. the species from the character, using the word *nodosa* in its p and more correct sense of *knotty* or *full of knots*, and not in t ondary and less correct sense which most naturalists give it of which should properly be expressed by the Latin word *articul*

The specimens referred to this species, with their weights follows:

| | Kilogra |
|---|---|
| No. 500.9 | 2. |
| No. 500.11 | 1. |
| No. 500.12 | 0. |
| No. 500.17 | 2. |
| No. 500.21 | 2. |
| No. 500.47 | 2. |
| No. 500.48 | 1. |

With the exception of No. 500.21 these are all nearly perfect That one seems to be only the upper part of a trunk larger t rest, but it is impossible to decide how much more there was this, and in fact the base may not have been far away. In th it would have had a low, vertically flattened form, which is d from the rest. No. 500.9 is considerably larger than the oth has fewer branches, but it can not be referred to any other Nos. 500.11, 500.12, and 500.48 are all smaller and have ab same general facies. I would make Nos. 500.17 and 500.47 th of this species. They are very similar in all respects and disp specific characters to good advantage. They are much less di by pressure than the other specimens.

Pls. CXIII and CXIV give side views of the two broad sides 500.9; Pls. CXV and CXVI illustrate No. 500.47, the first s the normal shape with contracted base, and the second the nu knotty branches; Pl. CXVII is the only view taken of the sp No. 500.17, very similar to the last; Pl. CXVIII, Fig. 1, sho low rounded apex of No. 500.21, and Fig. 2 the transverse fr The former is covered with little knots, but they do not co well in the photograph. Pls. CXIX and CXX illustrate th specimen No. 500.11, Pl. CXIX giving the broadest side, Pl. Fig. 1, one of the other side views, and Pl. CXX, Fig. 2, a view base. Pl. CXXI, Figs. 1 and 2, show, respectively, the side a of No. 500.48, and Pl. CXXII, Figs. 1 and 2, do the same 1 500.12, the last figure showing the concave and perhaps so decayed base, the axis and lower leaf bases being clearly expos

## CYCADELLA CIRRATA Ward.

Pls. CXXIII–CXXIX.

1900. *Cycadella cirrata* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 272.

Trunks of medium size, short-cylindrical, rounded at the summit, somewhat laterally compressed, unbranched; rock rather hard, drab on the weathered surfaces, dark within with white stripes, of medium specific gravity; organs of the armor ascending, especially above the middle toward the summit, as seen on the fractured surfaces, curving first upward and then gracefully outward in continuation of the clearly marked strands from the interior of the axis; leaf scars subelliptical or subrhombic, 12 to 15 mm. wide, 5 to 6 mm. high; leaf bases hard, dark, and porous; walls 3 to 5 mm. thick, hard and smooth, light colored or nearly white; reproductive organs few and obscure; armor 3 to 5 cm. thick, irregularly joined to the axis; woody zone 2 cm. thick, undifferentiated; medulla 2 to 3 cm. in diameter, black, striped and blotched with white flinty patches.

This species includes the specimens numbered 500.42, 500.46, 500.59, 500.71, and 500.75, but they all probably belong to the same trunk. No. 500.46 matches No. 500.42 and No. 500.75 matches No. 500.46 by a narrow facet with the loss of intervening chips. No. 500.71 has exactly the same markings as No. 500.42 on the side opposite No. 500.46. These markings are too definite and peculiar to recur, and amount to a proof of identity, although a thin plate between has disappeared. No. 500.59 is evidently the downward continuation of No. 500.42. On one side there is almost complete continuity, but a large triangular piece is wanting on the other side.

The specific name, from Latin *cirrus*, curl, refers to the beautiful curving lines and different-colored stripes formed by the various strands and organs of the armor as seen on the fractured surfaces.

The weights of the pieces are as follows:

| | Kilograms. |
|---|---|
| No. 500.42 | 1.53 |
| No. 500.46 | 0.57 |
| No. 500.59 | 1.11 |
| No. 500.71 | 0.28 |
| No. 500.75 | 0.70 |

After all are put together we still probably have less than half the original trunk.

In Pl. CXXIII (*a* to *d*) the four fragments Nos. 500.42, 500.46, 500.59, and 500.75, which all join by fractured surfaces or areas of contact of greater or less extent, are shown in their natural relations. No. 500.59 forms the lowest part. No. 500.42 joins it above, reaching nearly to the apex. No. 500.46 joins No. 500.42 by a longitudinal fracture and reaches to about the center of the trunk. No. 500.75 lies by the side of this, carrying the summit some distance past the center. The figure lies in the position in which the specimens were placed for photographing. There was no other position in which they could be made to lie for that purpose. It is therefore necessary to remember that the base is on the right and the summit on the left, so that in order to see the trunk in the position in which it grew it is necessary to turn the plate.

Pl. CXXIV shows the innermost and approximately central longitudinal fracture of No. 500.42, and Pl. CXXV the outer somewhat tangential longitudinal fracture of the same specimen. Pl. CXXVI shows the two broken sides of No. 500.46, Fig. 1 being the face that matches No. 500.42 and Fig. 2 that which joins No. 500.75. Pl. CXXVII shows the two sides of No. 500.75 in the same way, Fig. 1 being the fracture joining No. 500.42 and Fig. 2 the outer fracture. Pl. CXXVIII presents the two sides of No. 500.71, which very nearly joins No. 500.42 on the opposite side from No. 500.46. Fig. 1 is the broader and Fig. 2 the narrower face. Pl. CXXIX represents the basal specimen, No. 500.59, which is of the same thickness as No. 500.42, and, with some loss, a downward extension of it. Fig. 1 shows the face which constitutes a continuation of the inner fracture of No. 500.42 represented on Pl. CXXIV, and Fig. 2 that of the tangential fracture, which is in like manner a continuation of the side represented in Pl. CXXV.

### Cycadella exogena Ward.

### Pls. CXXX–CXXXVII.

1900. *Cycadella exogena* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 273.

Trunks small or of medium size (12 to 20 cm. high, 8 to 20 cm. in diameter), ellipsoidal, somewhat compressed latterly or (in one specimen) vertically, unbranched; rock hard and fine-grained, light colored on the weathered surfaces, dark within, variegated with brown or white stripes or spots, of medium specific gravity; organs of the armor horizontal; rows of scars making an angle of 50° with the axis in both directions (traceable only in one specimen); leaf scars subrhombic, 12 to 20 mm. wide, 6 to 9 mm. high; leaf bases hard, fine in structure, punctate or porous; walls 1 to 3 mm. thick, soft-sandy, and more or less decayed, light colored, sunken between the leaf bases, striate or wrinkled, sometimes with a median line or commissure; reproductive organs mostly concealed, well developed, generally projecting, 15 by 25 mm. in diameter, surrounded by narrow bract scars, the central portion solid and showing the scars of floral organs; armor 3 to 5 cm. thick, definitely but irregularly joined to the axis, the leaf bases penetrating to different depths; wood 2 to 3 cm. thick, clearly exposed on longitudinal and transverse sections; cortical parenchyma 1 cm. thick, irregular on its outer, even on its inner face; fibrous zone consisting of three very definite exogenous rings of wood, the outer 5 mm. thick, the middle one 2 mm. thick, and the inner one 1 cm. thick, all with radiate structure, the medullary rays visible across the entire zone, the inner wall of which is scalloped by the rounded inner edges of definite woody wedges, 8 mm. wide, and the sharp reentrant angles between them; medulla when circular 4 cm. in diameter, when elliptical 3 by 5 cm., in one specimen 5 by 7 cm. in diameter.

This species is represented by seven different numbers in the collection, but Nos. 500.13 and 500.72, Nos. 500.44 and 500.73, and Nos. 500.53 and 500.61 each match and complement each other. No. 500.37 is larger than the rest and represents most of the lower part of a trunk. With the exception of Nos. 500.53 and 500.61 all the specimens so closely resemble one another that the suspicion arises that they may all belong to the upper part of No. 500.37. But a careful examination negatives this view, and it seems necessary to suppose that they represent at least two different trunks. The combination Nos. 500.44 and 500.73 may be a part of the same trunk as No. 500.37, but the combination Nos. 500.13 and 500.72 must be distinct, as it forms nearly half of a trunk of different shape, with the large mammillary terminal bud and a small portion of the base, which show that this trunk was low and vertically compressed, if at all.

The combination Nos. 500.53 and 500.61 constitute more than two-thirds of a handsome little trunk, broken longitudinally through the center of the axis and one of the halves tranversely above the middle, the fractures being as clear and perfect as if sawn. This specimen shows the internal structure more perfectly than any other in the collection, especially the three exogenous rings of wood, as described.

The weights of the specimens are as follows:

| | Kilograms. |
|---|---|
| No. 500.13 | 1.08 |
| No. 500.37 | 2.41 |
| No. 500.44 | 1.25 |
| No. 500.53 | 1.64 |
| No. 500.61 | 1.16 |
| No. 500.72 | 0.59 |
| No. 500.73 | 0.65 |

Pl. CXXX shows the back or outer surface of No. 500.53 and Pl. CXXXI the base of the nearly complete trunk resulting from the complementary Nos. 500.53 (*a*) and 500.61 (*b*). Pl. CXXXII illustrates the internal structure of the same trunk, Fig. 1 being the longitudinal section offered by No. 500.53 and Fig. 2 the transverse section of No. 500.61, which has already been described. Pl. CXXXIII illustrates in a similar manner the combination Nos. 500.13 (*a*) and 500.72 (*b*). Fig. 1 is a somewhat oblique view, showing the terminal bud and outer surface generally, and Fig. 2 the tranverse fracture. Pl. CXXXIV gives a side view of No. 500.37, Pl. CXXXV, Fig 1, a view of its base, and Fig. 2 the transverse fracture. Pl. CXXXVI, Fig. 1, shows the almost wholly concealed outer surface of the combination Nos. 500.44 (*b*) and 500.73 (*a*), and Fig. 2 the transverse section at top of No. 500.44. Pl. CXXXVII gives the longitudinal fractures of the same two fragments.

### CYCADELLA RAMENTOSA Ward.

### Pl. LXX, Figs. 4, 5; Pls. CXXXVIII–CXLIV.

1900. *Cycadella ramentosa* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 275.

Trunks rather large (15 to 25 cm. high, 2 to 25 cm. in diameter), cylindrical or subellipsoidal, somewhat compressed laterally or vertically, mostly unbranched; rock hard and much mineralized within, dark brown on the surface, the fractured surfaces variegated with black and white, more or less flinty or chalcedonized; specific gravity above the mean; organs of the armor horizontal or radiating from an equatorial zone; leaf scars subelliptical, 10 to 15 mm. wide, 6 to 9 mm. high, hard, dark, rough, punctate with white, tubular pores; walls 1 to 3 mm. thick, firm and smooth, light colored or yellowish, sunk below the leaf bases, with a median line or groove; reproductive organs few, mostly concealed by the ramentum coating, where exposed well developed, raised above the leaf bases, mostly elliptical and 15 by 20 mm. in diameter, inclosed in an involucre of narrowly rhombic bracts visible in transverse and longitudinal section, central portions well shown on fractured surfaces, the interior mostly decayed and somewhat crystallized; armor 4 to 6 cm. thick, attached to the axis by an irregular, somewhat scalloped surface; wood 3 cm. thick, undifferentiated; medulla elliptical in cross section, 3 by 5 cm. in diameter.

This species includes ten numbers of Mr. Knight's collection, but probably only represents three trunks, since five of these fragments (Nos. 500.40, 500.43, 500.45, 500.66, and 500.81) all fit together and may be built up into a single specimen representing nearly half of one trunk, and Nos. 500.50 and 500.60 also match, forming about one-third of another. Nos. 500.39 and 500.55 do not exactly match, but so closely resemble each other that the amount and character of the part lost can be determined with considerable certainty. They can not well belong to either of the other combinations. No. 500.39 is the next most important specimen in the collection in furnishing the generic characters, and slides illustrating them have been prepared from it. From these were obtained the cross sections of the chaff shown by Figs. 4 and 5 of Pl. LXX.

No 500.34 is a small apical portion of a trunk of the same type and may well have formed the top of No. 500.39 and the lost piece that belonged with it, but there was a short interval between them, as they do not exactly match.

The weights of the several fragments in the order of the numbers are as follows:

| | Kilograms. |
|---|---|
| No. 500.34 | 1.02 |
| No. 500.39 | 2.41 |
| No. 500.40 | 2.04 |
| No. 500.43 | 1.50 |
| No. 500.45 | 1.64 |
| No. 500.50 | 2.55 |
| No. 500.55 | 1.70 |
| No. 500.60 | 1.53 |
| No. 500.66 | 2.33 |
| No. 500.81 | 0.68 |

The large combination, therefore, has a total weight of 8.19 kilograms, and Nos. 500.50 and 500.60 together weigh 4.08 kilograms.

The specific name is not meant to imply that there is anything exceptional in the ramentum of this species, although most of the specimens have a well-developed outer coating of it; but some of the fractures afford fine examples, and the detailed study of the generic characters has chiefly been made on this species and *C. Knowltoniana.*

Pl. CXXXVIII illustrates the cylindrical form of the trunk, of which Nos. 500.34, 500.39, and 500.55 are believed to be detached portions. Although none of them fit naturally, their size and general appearance justified this assumption, and it is not probable that the interval is very great between them. No. 500.55, represented by Fig. 3, is considerably thicker than No. 500.39, represented by Fig. 2, i. e., the longitudinal fracture of the latter is nearer the surface exposed, while in the former it falls on the other side of the center. No. 500.34 extends entirely across the trunk, and forms its apex complete. No. 500.55 shows that the trunk was somewhat contracted at the base, but the rapid narrowing of No. 500.39 (Fig. 2) is due to the longitudinal fracture being considerably oblique to the axis, so that the upper end is much thinner, and therefore narrower, than the lower. Only occasionally can any of the organs of the armor be detected. Pl. CXXXIX, Fig. 1, is a view of the upper transverse fracture of No. 500.55, and Fig. 2 of the lower transverse fracture of No. 500.39. It is from this latter that microscopic slides were made after the views had been taken. Reproductive organs may be seen in longitudinal section on both these faces. Pls. CXL and CXLI show the restoration of the portion of a trunk represented by the complementary fragments Nos. 500.45 (*a*), 500.40 (*b*), 500.66 (*c*), 500.43 (*d*), and 500.81 (*e*), forming a good part of another very interesting trunk belonging to this species, the first being a view of the external surface, almost wholly covered with the ramentum layer, and the second a view of the longitudinal fractures. Pl. CXLII, Fig. 1, is a view of the transverse fracture of the lower side of No. 500.66, which fits the upper fracture of No. 500.45, and Fig. 2 shows the longitudinal fracture of No. 500.40, the lower portion of which fits the longitudinal fracture of No. 500.45, but between the upper portion and the longitudinal fracture of No. 500.66 there is an interval of about 1 cm. Pls. CXLIII and CXLIV represent, respectively, the outer and inner surfaces presented by the united complementary fragments Nos. 500.50 (*a*) and 500.60 (*b*).

### CYCADELLA FURRUGINEA Ward.

### Pls. CXLV–CXLVII.

1900. *Cycadella furruginea* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 276.

Trunk small (18 cm. high, 9 by 22 cm. in diameter), ovoid, laterally compressed, unbranched; rock hard, rust-colored without, striped and spotted with the same in the interior, of medium specific gravity; organs of the armor horizontal at the middle, descending below, and erect at the summit; leaf scars subelliptical, 10 mm. wide, 5 mm. high; leaf bases fine-grained, not porous nor punctate; walls 2 to 3 mm. thick, soft, rust-colored, with a median groove; reproductive organs much obscured, sometimes raised, elliptical, 15 by 20 mm. in diameter, surrounded by thin, obscure, involucral bract scars, the central portion clearly shown only on the fractured surfaces, heterogeneous and much altered by mineralization; armor 2 to 3 cm. thick, irregularly joined to the axis; wood 1 cm. thick; cortical parenchyma 5 mm. thick; fibrous zone 5 mm. thick, not clearly differentiated into rings, but longitudinally striate, parallel to the axis of the trunk; medulla a thin slab visible only on the narrow edge, where it is 1 cm. thick, apparently 4 to 5 cm. wide.

This species includes the two fragments Nos. 500.51 and 500.74, exactly alike in all their characters and certainly belonging to the same trunk. The fracture in both cases is longitudinal in the direction of the minor axis, starting in obliquely near the top and becoming vertical near the middle. In No. 500.51 this vertical direction continues to near the base, and then runs out on the same side it went in. In No. 500.74 it describes a sort of curve, cutting in to near the center and out again at a still sharper angle long before it reaches the base. The true base and summit are therefore lost in both specimens. There is one point at which the two pieces probably are actually contiguous, though the surface of contact is not large enough to demonstrate this.

No. 500.51 weighs 1.36, and No. 500.74, 0.81 kilograms; total, 2.17 kilograms.

Named from the ferruginous or rusty color peculiar to these specimens.

Pl. CXLV represents the two specimens side by side as they are supposed to have been related in the perfect trunk, and shows the broad side view. Pl. CXLVI is a view of the longitudinal fracture of No. 500.51. Pl. CXLVII, Fig. 1, shows the back or thin edge of No. 500.74, and Fig. 2 the fracture as has been described above.

### Cycadella contracta Ward.

### Pls. CXLVIII–CLIII.

1900. *Cycadella contracta* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 277.

Trunks of small or medium size (height not known, 15 to 25 cm. in diameter), probably conical above, strongly contracted at the base, laterally compressed, more or less branched; rock hard and fine-grained, of a nearly uniform drab color or dull reddish on the outer surface, of medium specific gravity; organs of the armor ascending at their origin, curving outward and becoming horizontal or declined, rows of scars (traceable in one specimen) from left to right forming an angle of 40° with the axis, those from right to left 55°; leaf scars subrhombic, 12 to 20 mm. wide, 6 to 12 mm. high; leaf bases of uniform color, punctate with white tubular pores; walls 1 to 3 mm. thick, rather soft, depressed, striate, with a median line or crack; reproductive organs imperfectly developed, somewhat raised, 15 by 22 mm. in piameter, surrounded by large bract scars passing into leaf scars, central portion solid, roughened, warty; armor about 3 cm. thick; wood 1 to 3 cm. thick, differentiated in one specimen, the outer zone 5 mm. thick, the inner 1 cm., longitudinally striate; medulla 15 to 30 mm. in diameter, hard, fine-grained, and homogeneous.

The specimens constituting this species are Nos. 500.56, 500.57, 500.58, and 500.79. With the exception of the last their general resemblance is obvious, which probably accounts for the contiguity in the numbers. No. 500.79 is probably a thin segment from much higher on the same trunk as No. 500.56, where the size and shape had considerably changed, but the same structure persists. Nos. 500.57 and 500.58 are portions of the lower end of two different trunks.

The weights of the several fragments, in the order of the numbers, are as follows:

| | Kilograms. |
|---|---|
| No. 500.56 | 1.13 |
| No. 500.57 | 1.25 |
| No. 500.58 | 1.92 |
| No. 500.79 | 0.76 |

The specific name refers to the contracted base.

Pl. CXLVIII, Figs. 1 and 2, show respectively the outer surface and the longitudinal fracture of No. 500.57. Pl. CXLIX is a side view, and Pl. CL a view of the longitudinal fracture of No. 500.58. Pl. CLI is designed to show the relations between Nos. 500.56 and 500.79 as above mentioned, and Figs. 1 and 2 show what seem to be the same side of the two specimens. The interval between them was of course larger than it was possible to place between the two figures. Pl. CLII shows the other broad side of No. 500.56, and Pl. CLIII gives the upper transverse fracture of No. 500.79.

### Cycadella gravis Ward.

### Pl. CLIV.

1900. *Cycadella gravis* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 277.

Trunk small (12 cm. high, 8 by 13 cm. in diameter), conical-flattened, rounded at the summit, laterally compressed, unbranched; rock very hard, coarse-grained, of a gray color and very high specific gravity; organs of the armor upwardly appressed, especially on one side; rows of scars from left to right making an angle of 35°, those from right to left of 50°, with the axis; scars subrhombic, 18 to 22 mm. wide, 8 to 10 mm. high; leaf bases on the side of the specimen appressed to the trunk but exposed at their summits and on their lower sides, the keel distinct, rough or honeycombed on the exposed ends, but on fresh fractures fine in structure and white-punctate with small, narrowly elliptical, white pores appearing as short white lines; vascular bundles faintly visible, forming a row part way round the petiole on the side next the trunk; walls 1 to 2 mm. thick, striate with alternating light and dark lines; reproductive organs few, poorly developed, sometimes raised, 2 by 3 cm. in diameter, the interior porous or heterogeneous; armor 2 cm. thick, joined to the axis by a definite line of appreciable thickness (libro-cambium layer), wood 2 cm. thick; cortical parnechyma 1 cm. thick, of coarse structure; fibrous zone 1 cm. thick, consisting of two rings of equal thickness separated by a light-colored band, the structure radially disposed; medulla 2 by 6 cm. in diameter, hard and coarse with white punctations or variously shaped markings.

This small specimen, No. 500.63 of the collection, is so totally different from all the rest that it was necessary to regard it as constituting a species by itself. It weighs 1.5 kilograms and has the highest specific gravity observed, feeling almost like heavy spar, whence the specific name.

Pl. CLIV, Fig. 1, shows the best side, and Fig. 2 the base.

### Cycadella verrucosa Ward.

### Pls. CLV–CLVII.

1900. *Cycadella verrucosa* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 278.

Trunks large (30 to 40 cm. high, 20 to 30 cm. in larger diameter), obovate, contracted at the base, much laterally compressed, unbranched or with a few small secondary axes; rock hard and fine at least in the interior, light colored or brown on weathered surfaces, dark or black on freshly exposed ones, of medium specific gravity; organs of the armor horizontal; leaf scars subrhombic, 15 to 20 mm. wide, 7 to 10 mm. high; leaf bases hard, rough or porous, with a raised ridge near the margin indicating the position of the vascular bundles, which are themselves sometimes visible in the form of pits; walls 2 to 5 mm. thick, hard and somewhat porous, light colored with darker striæ; reproductive organs numerous, well developed, prominently projecting in the form of large warty protuberances distorting the arrangement of the leaves, elliptical in cross section, 20 by 30 mm. in diameter, surrounded by large, narrowly subrhombic bract scars in several rows passing into leaf scars, central portions heterogeneous, marked by the scars of the essential organs; armor 2 to 5 cm. thick, clearly but irregularly joined to the axis; woody zone 15 mm. thick, not differentiated; medulla a thin slab 3 to 6 cm. thick, 15 cm. wide, of a fine uniform structure resembling the white iron ore of the Potomac beds of Maryland.

Nos. 500.27, 500.32, and 500.64 are referred to this species. The last is anomalous and shows relatively few of the characters, but it has the same shape. The fruits are little elevated, but otherwise this leading character holds for it. No. 500.27 is probably the top of the same trunk as No. 500.32, but there is an interval between them, and they have been subjected to different conditions since they became fossilized. On a casual view, therefore, they do not seem so closely to resemble each other as they do when carefully inspected. They are then found to have almost exactly the same width, thickness, and general form, so that it is easy to see which sides correspond. All the characters also agree except that the fruiting axes are more prominent on No. 500.32, representing the lower portion. This is partly due to the fact that this specimen has suffered more from erosion, and owing to the greater hardness of these organs they are made to stand out more conspicuously. It was the appearance thus produced that suggested the specific name.

No. 500.27 weighs 5.19, No. 500.32, 8.31, and No. 500.64, 4.68 kilograms.

In Pls. CLV and CLVI the two specimens, Nos. 500.32 and 500.27, are represented from opposite broad sides in the position in which they are supposed to have existed as a trunk, but for want of space on the plate they had to be brought practically together, whereas, as already stated, the theory of their identity requires the assumption of a certain amount of loss between these parts. Pl. CLV, Fig. 1, shows the warty projections better than any other. Pl. CLVII is the only view taken of No. 500.64 and represents its best side.

### Cycadella jejuna Ward.

Pls. CLVIII-CLXI.

1900. *Cycadella jejuna* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 279.

Trunks of medium size (18 cm. high, 7 to 12 cm. in lesser, and 16 to 20 cm. in greater diameter), ovoid or subconical, laterally compressed, unbranched; rock hard, gray on weathered surfaces, drab in the interior, black on fresh exposures, with rather high specific gravity; organs of the armor horizontal; rows of scars forming an angle in either direction of 45° to 50°; leaf scars subrhombic, 15 to 20 mm. wide, 7 to 9 mm. high; leaf bases hard and firm, rough on the exposed ends; walls 2 to 4 mm. thick, light colored and contrasting with the leaf bases, sometimes with a median ridge; reproductive organs few and poorly preserved; armor 2 to 4 cm. thick, joined to the axis by a clear line; wood 15 to 20 mm. thick; outer zone 5 mm. thick, traversed by rays or vessels; inner zone consisting of two rings, the outer 5 mm. thick with fine radiate structure showing medullary rays and woody wedges, the inner 5 to 10 mm. thick of a less definite structure; medulla elliptical in cross section, lesser diameter 2 to 3 cm., greater 8 cm., homogeneous.

The two specimens, Nos. 500.28 and 500.31, which I have brought together here, have at first view very little to mark them or interest the student, but while they differ essentially from all others in the collection, they resemble each other in all the main points. No. 500.28 is smaller and more compressed, and is mostly black on the outer surface, but the outer coating has pretty much entirely disappeared and the leaf scars are clearly exposed. The fracture at the base also reveals some very definite internal structure. No. 500.31 shows much less, but so far as visible the characters are the same. The former weighs 2.33 and the latter 3.97 kilograms. The specific name refers to the somewhat negative and meager character of the specimens.

Pls. CLVIII and CLIX show opposite sides of No. 500.28, and Pls. CLX and CLXI those of No. 500.31. In the former of these specimens scarcely any ramentum remains on the surface and the leaf scars are quite clearly shown. The same is true for one side of No. 500.31, but the other side, represented on Pl. CLXI, shows the area over which it has been scaled off along a definite line, and the edge of it is distinctly visible.

### Cycadella concinna Ward.

Pl. CLXII.

1900. *Cycadella concinna* Ward: Proc. Wash. Acad. Sci., Vol I, p. 280.

Trunk small (12 cm. high, 14 by 15 cm. in diameter), irregularly and obliquely short-conical, somewhat vertically compressed, unbranched, broad at the concave base, terminating in an imperfect bud; rock soft on the surface, harder within, dark colored or bluish except a light weathered area, the specific gravity above the normal; organs of the armor at right angles to the oblique axis; rows of scars from left to right making an angle with the axis of 75° to 80°, those from right to left of 30° to 40°; leaf scars narrowly subrhombic, very small, 12 to 13 mm. wide, 3 to 5 mm. high; leaf bases dark, firm but porous; walls 3 to 5 mm. thick, of denser structure than the leaves, lighter colored, sometimes with darker stripes; reproductive organs doubtful and practically wanting; armor 2 cm. thick, joined to the axis by a definite line; wood 2 cm. thick, undifferentiated; medulla elliptical, 3 by 6 cm. thick, smooth and homogeneous.

It has been necessary to regard the nearly perfect, compact, and rather handsome little trunk, No. 500.16, as constituting a species by itself, and it is much to be hoped that other specimens of the same may be found. It weighs 2.18 kilograms.

Pl. CLXII, Fig. 1, gives a good idea of it as seen from one side, and Fig. 2 shows the somewhat concave base.

### CYCADELLA CREPIDARIA Ward.

### Pl. CLXIII; Pl. CLXIV.

1900. *Cycadella crepidaria* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 280.

Trunk small, elliptical in cross section, much vertically compressed, having the form, when inverted, of a shoe or moccasin, having a height (thickness) of 7 cm., a width (lesser diameter) of 12 cm., and a length (greater diameter) of 19 cm., with two lateral axes nearly at right angles to the primary axis, the terminal bud forming a large raised area, the base projecting downward in a rounded protuberance; rock soft and coarse-grained, dark brown or nearly black, bluish within, of low specific gravity; organs of the armor mostly appressed or concealed; leaf scars where visible distorted and abnormal in shape, subelliptical, 12 to 15 mm. wide, 4 to 5 mm. high; leaf bases coarse and homogeneous in texture; walls 1 to 3 mm. thick, relatively hard and light colored; reproductive organs few, abortive or immature; thickness of armor unknown; wood 3 cm. thick; outer zone 1 cm. thick, coarse; inner zone 2 cm. thick, finer, and longitudinally striate; medulla elliptical, 3 by 5 cm. in diameter, coarse and homogeneous.

No. 500.83 of Professor Knight's collection, which constitutes the species, is in all respects a unique specimen, and notwithstanding its apparent deformity there is evidence that this is by no means wholly due to external agencies. The position in which the trunk grew no doubt had much to do with this, but it probably represents a dwarf, flat, branching species, all the members of which would present most of these peculiarities. When inverted and laid on its back, the terminal bud down and the base uppermost, it has much the shape of a broad, low, wooden shoe or sandal, the thicker end representing the heel and the thin, flattened end, which is a sort of terminal bud of one of the lateral branches, representing the toe — a comparison which suggested the specific name.

It weighs 1.45 kilograms.

Pl. CLXIII is a view from the top downward, and Pl. CLXIV from the bottom upward.

### Cycadella gelida Ward.

Pls. CLXV–CLXIX.

1900. *Cycadella gelida* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 281.

Trunks rather large and relatively tall (the largest of the specimens 39 cm. high, 12 by 20 cm. in diameter), subcylindrical, slightly diminishing from base to summit, laterally compressed, having a few secondary axes, terminating in a large conical bud, the base projecting; rock of medium hardness and specific gravity, light brown on weathered surfaces, nearly black within and on freshly exposed portions; organs of the armor slightly ascending; rows of scars from left to right making an angle with the axis of 45°, those from right to left of 50°; leaf scars subrhombic, 20 to 25 mm. wide, 8 to 12 mm. high; leaf bases rough and punctate; walls 1 to 2 mm. thick, friable, white, with a median line or crack; reproductive organs well developed, usually raised or projecting, elliptical in cross section, 2 by 3 cm. in diameter or larger, the involucral bracts not visible, the central portions solid and amorphous; armor 1 to 3 cm. thick, joined to the axis by a more or less definite line, all within it a black undifferentiated mass of cherty and apparently structureless matter which tends to crack into cubes or flake off.

The large fine specimen, No. 500.1, scarcely injured by being broken in two by an obliquely transverse fracture near the base, was at first supposed to be altogether unique, but in my efforts to correlate the fragment, No. 500.24, of a considerably smaller trunk, I found that it had scarcely any affinities except with this, and upon a thorough comparison of all the characters I am convinced that it belongs to the same species. That specimen was broken into three unequal pieces, but mended with glue before sending. A small flake or cap, numbered 500.25, from the light weathered surface of some trunk, having a coarse black structure on the fractured side, resembles No. 500.24 more than any other specimen, but does not exactly fit its broken summit. Rather than leave it wholly unassigned I assume that it belongs here.

No. 500.1 weighs 12.56, No. 500.24, 2.52, and No. 500.25, 0.11 kilograms.

The specific name has a vague reference to the Freezeout Hills, in which the beds occur.

Pls. CLXV and CLXVI are side views of the opposite side of No. 500.1, and Pl. CLXVII is a view of its base. Pls. CLXVIII and CLXIX show the opposite sides of No. 500.24.

### CYCADELLA CARBONENSIS Ward.

Pl. CLXX; Pl. CLXXI.

1900. *Cycadella carbonensis* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 282.

Trunk of maximum size (39 cm. high, 21 by 39 cm. in diameter), subglobular, both laterally and vertically compressed, the principal axis oblique to the plane of compression, having numerous secondary axes forming large short branches or rounded elevations interspersed with smaller ones, the primary axis terminating in a well-developed bud, the base occupied by a circular concavity; rock of medium hardness and specific gravity, nearly black, considerably mineralized in the interior; organs of the armor radiating from an equatorial zone; phyllotaxy not traceable; leaf scars subrhombic, rhombic, or irregular in shape, 30 mm. wide, 15 mm. high; leaf bases rough and porous; walls 2 to 3 mm. thick, firm, and definitely bounded, longitudinally striate with raised white lines, median line higher than the rest; reproductive organs numerous but not well developed, of two kinds, large and small, the former difficult to distinguish from secondary axes, all usually more or less elevated, but occasionally depressed or decayed so as to leave a shallow concavity, elliptical in cross section, the larger ones 3 by 5 cm. in diameter, the smaller about half as large, the former class surrounded by faintly visible large subrhombic involucral bract scars simulating and passing into leaf scars, the central portions solid and heterogeneous; armor 4 to 5 cm. thick, its junction with the axis obscure; woody zone 4 to 5 cm. thick, undifferentiated; medulla nearly circular, 5 to 6 cm. in diameter, smooth and homogeneous in structure.

The largest specimen in the collection, No. 500.2, weighing 37.69 kilograms, is unique also in its form and a considerable number of other characters, and has to form a species by itself. I name it for Carbon County, in which the locality for all the specimens is located. It constitutes an almost complete trunk, but came in two nearly equal pieces, the fracture passing through the narrowest dimension, through the center of the apex, down the back and lower side, and emerging at the center of the basal concavity along a nearly even plane. Unfortunately, the interior thus exposed shows scarcely any structure.

Pl. CLXX shows the broad rounded back of the specimen, and Pl. CLXXI the base and lower portion.

### Cycadella Knightii Ward.

### Pls. CLXXII–CLXXVII.

1900. *Cycadella Knightii* Ward: Proc. Wash. Acad. Sci., Vol. I, p. 283, pl. xxi.

Trunks very large (30 to 40 cm. high, 19 by 28 cm. in diameter), subellipsoidal, somewhat laterally compressed, unbranched, depressed at the summit; axis eccentric; rock hard, somewhat mineralized, dark colored or nearly black, of high specific gravity; organs of the armor horizontal; rows of scars from left to right forming an angle of 45° with the axis, those from right to left of 70°; leaf scars subrhombic or subelliptical, 18 to 20 mm. wide, 8 to 12 mm. high; leaf bases hard, punctate; walls 3 to 5 mm. thick, hard, striate, with or without a median groove; reproductive organs few, poorly developed, flush with the surface or slightly raised, elliptical in cross section, 2 by 3 cm. in diameter, surrounded by large subrhombic involucral bract scars passing into leaf scars, the central portion solid and showing the scars of the floral organs; armor 4 to 6 cm. thick, obscurely attached to the axis; woody zone 3 to 4 cm. thick, undifferentiated; medulla 6 by 10 cm. in diameter, difficult to distinguish from the woody zone, hard and black, with flinty or crystalline areas.

The next largest specimen in the collection, and probably the finest, from the standpoint of symmetry and general appearance, is No. 500.65. It came in two pieces of unequal size, caused by a transverse fracture below the middle. The larger piece weighs 15.48 and the smaller 9.8 kilograms, making the total weight 25.28 kilograms. There was one other specimen, viz, No. 500.33, which so closely resembles this that it is impossible to separate it. It consists of considerably over half of the lower portion of a somewhat smaller trunk, having the base perfect and a nearly horizontal transverse fracture across the trunk above This weighs 8.87 kilograms.

I take great pleasure in dedicating this fine species of Cycadella to Prof. Wilbur C. Knight, State geologist of Wyoming, through whose enterprise the collection was made, and who has so generously placed it in my hands for elaboration.

Pl. CLXXII represents the best-preserved side of No. 500.65, Pl. CLXXIII its base, and Pl. CLXXIV the upper transverse fracture of the lower piece. Pl. CLXXV is the best side view of No. 500.35, Pl. CLXXVI its base, while in Pl. CLXXVII we have a representation of the upper transverse fracture.

The following is a list of the twenty species of Cycadella in the order in which they have been described:

1. Cycadella Reedii.
2. Cycadella Beecheriana.
3. Cycadella wyomingensis.
4. Cycadella Knowltoniana.
5. Cycadella compressa.
6. Cycadella jurassica.

7. Cycadella nodosa.
8. Cycadella cirrata.
9. Cycadella exogena.
10. Cycadella ramentosa.
11. Cycadella ferruginea.
12. Cycadella contracta.
13. Cycadella gravis.
14. Cycadella verrucosa.
15. Cycadella jejuna.
16. Cycadella concinna.
17. Cycadella crepidaria.
18. Cycadella gelida.
19. Cycadella carbonensis.
20. Cycadella Knightii.

The order can scarcely be called a classification. There is, however, something in common in the first twelve, viz, their general light color and calcareous structure, while the last seven are darker, coarser grained, and less calcareous. *C. gravis* and *C. verrucosa* are intermediate in these respects, but the former differs in its high specific gravity. These distinctions all relate rather to the mineral than to the vegetable character, and although there is always some connection between them arising out of differences of structure, still it can scarcely be called a systematic grouping. The strictly botanical characters traverse these more conspicuous ones in such a manner that it is impossible to arrange the species according to both, and it was considered more satisfactory, upon the whole, not to attempt any finer classification until the internal structure can be studied, which should be done, and promises most interesting results.

## FOSSIL WOOD FROM THE JURASSIC.

Fossil wood has been reported from the Jurassic in a number of cases, but I am able to illustrate it at the present time from only two localities.

### FOSSIL WOOD FROM THE CYCAD BEDS OF WYOMING.

Accompanying the cycad collection of Professor Knight were three pieces of fossil wood, numbered 500.85, 500.86, and 500.87 of the Museum of the University of Wyoming. Two of these, Nos. 500.86 and 500.87, were placed in the hands of Dr. F. H. Knowlton, who offered to work out the internal structure and report the result. One of the specimens, No. 500.86, was a small limb somewhat split up and splintered, and it proved difficult to obtain from it slides of the proper character. The other, No. 500.87, is a thick block of wood and has furnished good slides, although the structure is somewhat obscure. Enough was learned from the other specimen to indicate that it belongs to the same species, and the piece which was not treated, No. 500.85, is clearly a part of the same stem as No. 500.86. All the wood, therefore, probably belongs to the same species. No explanation has been made of the source of this wood further than that it accompanied the cycads and is supposed to have been found with them. In fact, it was at first thought possible that they might be found to belong to the interior of cycadean trunks. They are, therefore, of course, of the same age as the cycads.

Dr. Knowlton finds the wood probably to belong to the genus Araucarioxylon, but to be specifically distinct from any hitherto described. His note upon it is as follows:

### DESCRIPTION OF A NEW SPECIES OF ARAUCARIOXYLON FROM THE CYCAD BED OF THE FREEZEOUT HILLS, CARBON COUNTY, WYOMING.

By F. H. Knowlton.

#### Araucarioxylon? obscurum Knowlton n. sp.

Pl. CLXXVIII.

Annual ring not apparent to the naked eye, the line of demarcation between the rings consisting of only four or five slightly modified layers of cells; wood cells very small, approximately square in cross-section, thick walled, provided on the radial walls with a single row of small contiguous or weathered bordered pits; medullary rays in a single series of 1 to 8 superimposed cells; resin cells and resin passages wholly wanting.

Transverse section: The appearance of the wood in this section is well shown in the figure (Pl. CLXXVIII, Fig. 1). The wood cells are seen to be of very uniform size and shape and are quite thick walled. The growth rings can not be made out by the naked eye, but under the microscope they are found to be quite broad (2 to 3 mm.) and to be separated by only four or five layers of slightly thicker cells. The absence of longitudinal resin cells or passages is also well shown in this section. The medullary rays appear as long remotely broken cells.

Radial section: The wood cells as seen in this section are provided with a single row of small bordered pits. Usually they are somewhat remote, as shown in Figs. 1 and 2 of Pl. CLXXVIII, but occasionally they are contiguous and slightly modified in shape by contact with each other. The inner pit is often minute, but the preservation is not good enough to permit measurements. The medullary rays are seen to be made up of relatively long slender-walled cells and probably without markings, although there is some evidence to show that there may have been narrow slits or oblong pores in their cell walls. This evidence, however, is not conclusive.

Tangential section: The wood cells are without pits or markings on this wall, at least so far as can be made out. The medullary rays are very numerous and composed of from one to not more than twelve superimposed cells, and usually the number is from three to perhaps five or six. They are very small and have relatively thick walls.

Discussion: The placing of this wood in the genus Araucarioxylon is open to more or less question, yet as it approaches more closely to this genus, I have tentatively so referred it. It has the obscure growth rings usually to be observed in this genus, but is without certain other characters. The medullary rays are similar to those of numerous species of Araucarioxylon, but the pits with radial walls of the wood cells are not the same as in what may be called typical wood of the genus; that is, they are not in the least hexagonal. The latter feature, however, is somewhat variable, and for the present it seems best to place this wood in Araucarioxylon.

This species resembles in some particulars several of the described species of the genus in this country. Thus it has the same type of tracheids and medullary rays as *A. virginianum* Kn., but has the bordered pits quite unlike that species. On the other hand, the pits are quite similar to those found in *A. Woodworthi* Kn., of the Triassic of Virginia and North Carolina, but the medullary rays are entirely different. From *A. arizonicum* Kn. the species under consideration, which agrees somewhat in the character of the bordered pits, differs in having the ray cells very long instead of short, and further in the absence of pits on the tangential walls of the tracheids. The character of the rays as shown in transverse section is quite similar in all of these species.

*Locality.*—Cycad bed, Freezeout Hills, Carbon County, Wyoming. Collected by W. H. Reed.

#### FOSSIL WOOD FROM THE JURASSIC OF THE BLACK HILLS.

Prof. W. P. Jenney sent a few very imperfectly preserved specimens of fossil wood from his bed No. 5 of the Hay Creek region of Crook County, Wyoming, in the Black Hills, and noted its occurrence in that bed in the ample notes that accompanied his collection.[1] When I was in the Black Hills in October, 1898, Mr. H. F. Wells informed me that he found it frequently in the pink and white sands that overlie the Atlantosaurus beds, and he took me to one locality near his house, three or four miles northwest of Sturgis, South Dakota, where beds of carbonaceous shales containing lignite are overlain by sands in which silicified wood occurs in great quantities and in a perfect state of preservation. I brought away one specimen which shows the annual rings more distinctly than any other fossil wood I have ever seen. This Dr. Knowlton also consented to treat microscopically for this paper. When I obtained it I had no doubt of the Jurassic age of the bed in which it occurred, but Dr. Knowlton finds the internal structure very modern in character, scarcely distinguishable from that of Pinus except in the absence of fusiform rays. I hesitate, therefore, to assert that the age is certainly Jurassic, and reserve my final decision on this point until a more thorough investigation can be made than was possible at the time I was there. Still, I think there was no mistake, and that this specimen simply represents a Jurassic ancestor of Pinus which has persisted to the present day with little modification. Dr. Knowlton proposes for it the name *Pinoxylon*, as a new genus, this name not having been used, so far as we can learn.

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[1] See Nineteenth Ann. Rept. U. S. Geol. Survey, Pt. II, pp. 573, 589, fig. 122 facing p. 593.

The following is his description of the genus and the species:

DESCRIPTION OF A NEW GENUS AND SPECIES OF FOSSIL WOOD FROM THE JURASSIC OF THE BLACK HILLS.
By F. H. KNOWLTON.

## Genus PINOXYLON Knowlton nov. gen.

Internal structure of the wood same as in Pinus, except in the absence of fusiform rays.

## PINOXYLON DACOTENSE Knowlton n. sp.

### Pl. CLXXIX.

Trunks of medium size; annual rings broad, very distinct; tracheids of spring and summer wood very large, thin walled, more or less hexagonal in shape; tracheids of fall wood thick walled, elliptical in outline; bordered pits on radial walls of tracheids, mainly in spring wood, of large size, mostly in two rows, rarely in a single row; medullary rays in a single series; resin cells wanting; resin passages present, scattered, mainly in the fall wood.

Transverse section: In this section the annual rings show very plainly, even to the naked eye, being from 2 to 4.5 mm. in width. The distinction between the spring and fall wood can also be seen with the naked eye, the former appearing as broad white bands and the latter as dense black bands of varying width. Under the microscope the line of demarcation between its fall and spring wood is observed to be very sharp, indeed. The fall wood consists of thick-walled cells of an elliptical or oblong outline and rather loosely placed, as may be seen from the figure (Pl. CLXXIX, Fig. 1). The succeeding spring wood is composed of very large cells with relatively thin walls.

The medullary rays as shown in this section (Fig. 1) are long and quite thick walled. As far as could be ascertained from the sections made there are no resin cells in this wood. The resin passages, however, are present and quite numerous. They do not seem to be confined to any particular portion of the ring, but are scattered, being, perhaps, most abundant in the fall wood. They are of relatively large size and lined with thin-walled epithelium cells (Fig. 2).

Radial section: There is much to be seen in this section. The walls of the cells of spring and summer wood are preserved in most cases with two rather irregular rows of large bordered pits. In rare cases these pits are in a single row, as shown in Fig. 3. The average size of the outer circle is .025±, that of the inner circle about .015±. The rays are seen to advantage in this section. The cells are rather long, covering the width of usually some four or more cells of the spring wood. They are rather thick walled, the walls being strongly dentate or somewhat irregularly thickened. This irregular thickening is well shown in the figures. The ray cells are provided with a few scattered bordered pits, usually only one to the width of a spring cell of the wood, although not rarely there are two in a similar width. They are always in only one row on the ray cells. They are also shown in the figures.

Tangential section: The medullary rays are naturally the most prominent feature in this section. They are always in a single superimposed series. They number from 1 to rarely 30 cells, an average number being from 5 to 12 cells high. None of the rays in sections examined are of the fusiform type, or that in which resin passages are included. The wood cells, as far as can be made out, are without pits or markings of any kind on their walls.

I am not a little in doubt as to the proper disposition that should be made of this interesting wood. It is so beautifully preserved, and the histological elements are so plainly discernible, that it seemed at first an easy matter satisfactorily to place it, but a somewhat prolonged examination has failed to settle it. Before it could be examined microscopically, and basing the conclusion upon its supposed geological position, it was presumed to belong to Araucarioxylon, but a glance at the structure serves to show that this can not be so. This genus is without resin passages, and, moreover, is well characterized by having the bordered pits more or less distinctly hexagonal. This hexagonal form of the pits, of which the living Araucaria may be taken as the type, appears to have had its origin in the Lower Paleozoic in the forms known as Cordaites and Dadoxylon. It is sufficient to say in the present connection that all of these distinctive features are absent from the wood under consideration.

From a number of other types of living wood this is separated by characters of importance. Thus from Sequoia it differs in having very broad instead of narrow growth rings and distinct resin passages, these being either entirely absent or very imperfectly found in both the living Sequoias, and finally the absence of resin cells.

In an exhaustive paper on the Generic Characters of the North American Taxaceæ and Coniferæ,[1] Prof. D. P. Penhallow presents the distinguishing characters of the living genera. They are readily divisible into two groups, as follows: Resin passages and fusiform rays present, including Pseudotsuga, Larix, Picea, Pinus, *Sequoia sempervirens*, and several species of Abies, and those in which these features are wholly wanting, including Taxodium, Sequoia, Libocedrus, Juniperus, Thuja, Cupressus, Tsuga, and most of Abies. The fossil wood under consideration is excluded from the last of these two groups, for it has very pronounced resin passages, and it must therefore be included in the first division in spite of the fact that there are seeming contradictions. This first division is again divisible into three subgroups on characters taken from the presence or absence of the fusi-

[1] Trans. Roy. Soc. Canada, 2d series, Vol. II, Section IV, 1896, pp. 33-57, pls. i-vi.

form rays. Our fossil seems to combine certain of the characters here given as distinct for the living woods; that is, our wood has distinct resin passages, but is without the fusiform rays. But after careful examination it appears to be most closely related to the genus Pinus. It agrees perfectly in having broad growth rings, dentate or irregularly thickened walls to the medullary rays, and prominent resin passages. It differs in the absence of the fusiform rays. From its undoubted resemblance to Pinus I have ventured to regard it as an ancestral form of this genus and to give it the name of Pinoxylon. It may be possible that the absence of this character of the fusiform rays is of such importance that it can not be regarded as the ancestor of our modern pines, but on account of its unquestioned resemblance in other perhaps equally important characters I have so regarded it.

*Locality.*—Three miles northwest of Sturgis, South Dakota. Probably Upper Jurassic. Collected by Lester F. Ward, October 3, 1898.

## DISTRIBUTION OF THE OLDER MESOZOIC FLORAS OF THE UNITED STATES.

To complete this presentation of the status of the Older Mesozoic floras of the United States I introduce a table giving all the species thus far known, with the general region or area in each formation at which they occur.

*Table of distribution of the fossil plants of the Older Mesozoic of the United States.*

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | South-western area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 1 | Abietites carolinensis Font. | | | | | | | × | | | | | | | | |
| 2 | Acrostichites brevipennis Ward n. sp. | | | | | | | | | | × | | | | | |
| 3 | Acrostichites? coniopteroides Ward n. sp. | | | | | | | | | | × | | | | | |
| 4 | Acrostichites densifolius Font. | | | | | | × | | | | | | | | | |
| 5 | Acrostichites ? fructifer Ward n. sp. | | | | | | | | | | × | | | | | |
| 6 | Acrostichites linnææfolius (Bunb.) Font. | | | | × | | × | × | | | | | | | | |
| 7 | Acrostichites microphyllus Font. | | | | ? | | × | | | | | | | | | |
| 8 | Acrostichites princeps (Presl.) Schenk. | | | | | | | | | | ? | | | | | |
| 9 | Acrostichites tenuifolius (Emm.) Font. | | | | | | × | × | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | South-western area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 10 | Acrostichites tenuifolius rarinervis (Font.) Ward n. comb. | | | | | | × | | | | | | | | | |
| 11 | Actinopteris quadrifolia (Emm.) Font. | | | | | | | × | | | | | | | | |
| 12 | Adiantites orovillensis Font. | | | | | | | | | | | | × | | | |
| 13 | Anabacaulus duplicatus Emm. | | | | | | | × | | | | | | | | |
| 14 | Anabacaulus sulcatus Emm. | | | | | | | × | | | | | | | | |
| 15 | Angiopteridium californicum Font. | | | | | | | | | | | | × | | | |
| 16 | Anomozamites? egyptiacus Font. n. sp. | | | | | | | × | | | | | | | | |
| 17 | Anomozamites princeps (Oldh. & Morr.) Schimp. | | | | ? | | | | | | | | | | | |
| 18 | Araucarioxylon arizonicum Kn. | | | | | | | | × | × | | | | | | |
| 19 | Araucarioxylon? obscurum Kn. n. sp. | | | | | | | | | | | | | | × | |
| 20 | Araucarioxylon virginianum Kn. | | | | | | × | × | | | | | | | | |
| 21 | Araucarioxylon Woodworthi Kn. | | | | | | × | × | | | | | | | | |
| 22 | Araucarites Chiquito Ward n. sp. | | | | | | | | | × | | | | | | |
| 23 | Araucarites? pennsylvanicus Font. n. sp. | | | | × | | | | | | | | | | | |
| 24 | Araucarites yorkensis Font. n. sp. | | | | × | | | | | | | | | | | |
| 25 | Asplenites Rœsserti (Presl.) Schenk var. Schenk. | | | | | | | × | | | | | | | | |
| 26 | Asterocarpus falcatus (Emm.) Font. | | | | × | | × | × | | | | | | | | |
| 27 | Asterocarpus falcatus obtusifolius (Font.) Ward n. comb. | | | | | | × | | | | | | | | | |
| 28 | Asterocarpus penticarpus Font. | | | | | | × | | | | | | | | | |
| 29 | Asterocarpus platyrachis Font. | | | | | | × | × | | | | | | | | |
| 30 | Baiera Muensteriana (Presl.) Heer | | × | | ? | | | × | | | | | | | | |
| 31 | Baiera multifida Font. | | | | | | × | ? | | | | | ? | | | |
| 32 | Bambusium? sp. Font. | | | | | | × | | | | | | | | | |
| 33 | Brachyphyllum yorkense Font. n. sp. | | | | × | | | | | | | | | | | |
| 34 | Brachyphyllum? sp. Newb. | | | | | | | | × | | | | | | | |
| 35 | Carpolithus Storrsii Font. n. sp. | | | | | | | | | | | | × | | | |
| 36 | Cephalotaxopsis carolinensis Font. n. sp. | | | | | | | × | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | South-western area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming | South Dakota. |
| 37 | Cheirolepis Muensteri (Schenk) Schimp | ? | ? | × | × | | × | × | × | | | | | | | |
| 38 | Chondrites gracilis Emm | | | | | | | × | | | | | | | | |
| 39 | Chondrites interruptus Emm | | | | | | | × | | | | | | | | |
| 40 | Chondrites ramosus Emm | | | | | | | × | | | | | | | | |
| 41 | Cladophlebis argutula (Heer) Font | | | | | | | | | | | | × | | | |
| 42 | Cladophlebis auriculata Font | | | | | | × | | | | | | | | | |
| 43 | Cladophlebis densifolia Font | | | | | | | | | | | | × | | | |
| 44 | Cladophlebis indica (Oldh. & Morr.) Font | | | | | | | | | | | | ? | | | |
| 45 | Cladophlebis microphylla Font | | | | | | × | | | | | | | | | |
| 46 | Cladophlebis obtusifolia (Andrä) Schimp | | | | | | | × | | | | | | | | |
| 47 | Cladophlebis ovata Font | | | | | | × | | | | | | | | | |
| 48 | Cladophlebis pseudowhitbiensis Font | | | | | | × | | | | | | | | | |
| 49 | Cladophlebis rarinervis Font | | | | | | × | | | | | | | | | |
| 50 | Cladophlebis reticulata Font | | | | × | | | | | | | | | | | |
| 51 | Cladophlebis rotundiloba Font | | | | | | × | | | | | | | | | |
| 52 | Cladophlebis spectabilis (Heer) Font | | | | | | | | | | | | × | | | |
| 53 | Cladolphlebis subfalcata Font | | | | | | × | | | | | | | | | |
| 54 | Cladophlebis whitbiensis tenuis var. a Heer | | | | | | | | | | | | ? | | | |
| 55 | Clathropteris platyphylla (Göpp) Brongn | × | × | × | | | | | | | | | | | | |
| 56 | Clathropteris platyphylla expansa Sap | | | | | | × | | | | | | | | | |
| 57 | Comephyllum cristatum Emm | | | | | | | × | | | | | | | | |
| 58 | Coniferous plants, undetermined | × | | | × | | × | | | | | | | | | |
| 59 | Ctenis auriculata Font | | | | | | | | | | | | × | | | |
| 60 | Ctenis grandifolia Font | | | | | | | | | | | | × | | | |
| 61 | Ctenis orovillensis Font | | | | | | | | | | | | × | | | |
| 62 | Ctenophyllum angustifolium Font | | | | | | | | | | | | × | | | |
| 63 | Ctenophyllum Braunianum abbreviatum (Fr. Braun) Schimp | | | | | | × | × | | | | | | | | |
| 64 | Ctenophyllum Braunianum angustum (Fr. Braun) Schimp | | | | | | × | × | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | South-western area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 65 | Ctenophyllum densifolium Font. | | | | | | | | | | | | × | | | |
| 66 | Ctenophyllum giganteum Font. | | | | | | × | | | | | | | | | |
| 67 | Ctenophyllum grandifolium Font. | | | | × | | × | | ? | | | | | | | |
| 68 | Ctenophyllum grandifolium Storrsii Font. | | | | | | | | | | | | × | | | |
| 69 | Ctenophyllum lineare (Emm.) Font. | | | | | | | × | | | | | | | | |
| 70 | Ctenophyllum robustum (Emm.) Font. | | | | ? | | | × | | | | | | | | |
| 71 | Ctenophyllum taxinum (L. & H.) Font. | | | | | | × | | | | | | | | | |
| 72 | Ctenophyllum truncatum Font. | | | | | | × | | | | | | | | | |
| 73 | Ctenophyllum Wannerianum Font. n. sp. | | | | × | | | | | | | | | | | |
| 74 | Ctenophyllum Wardii Font. | | | | | | | | | | | | × | | | |
| 75 | Ctenophyllum ? sp. Font. | | | | | | | | × | | | | | | | |
| 76 | Cycadella Beecheriana Ward | | | | | | | | | | | | | | × | |
| 77 | Cycadella carbonensis Ward | | | | | | | | | | | | | | × | |
| 78 | Cycadella cirrata Ward | | | | | | | | | | | | | | × | |
| 79 | Cycadella compressa Ward. | | | | | | | | | | | | | | × | |
| 80 | Cycadella concinna Ward. | | | | | | | | | | | | | | × | |
| 81 | Cycadella contracta Ward. | | | | | | | | | | | | | | × | |
| 82 | Cycadella crepidaria Ward. | | | | | | | | | | | | | | × | |
| 83 | Cycadella exogena Ward. | | | | | | | | | | | | | | × | |
| 84 | Cycadella ferruginea Ward. | | | | | | | | | | | | | | × | |
| 85 | Cycadella gelida Ward | | | | | | | | | | | | | | × | |
| 86 | Cycadella gravis Ward | | | | | | | | | | | | | | × | |
| 87 | Cycadella jejuna Ward. | | | | | | | | | | | | | | × | |
| 88 | Cycadella jurassica Ward | | | | | | | | | | | | | | × | |
| 89 | Cycadella Knightii Ward | | | | | | | | | | | | | | × | |
| 90 | Cycadella Knowltoniana Ward | | | | | | | | | | | | | | × | |
| 91 | Cycadella nodosa Ward. | | | | | | | | | | | | | | × | |
| 92 | Cycadella ramentosa Ward. | | | | | | | | | | | | | | × | |
| 93 | Cycadella Reedii Ward. | | | | | | | | | | | | | | × | |
| 94 | Cycadella verrucosa Ward. | | | | | | | | | | | | | | × | |
| 95 | Cycadella wyomingensis Ward | | | | | | | | | | | | | | × | |
| 96 | Cycadeoidea Emmonsi (Font.) Ward. | | | | | | | × | | | | | | | | |
| 97 | Cycadeoidea nigra Ward n. sp | | | | | | | | | | | | | × | | |
| 98 | Cycadeomyelon yorkense Font. n. sp. | | | × | × | | | | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | South-western area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 99 | Cycadeospermum Wanneri Font. n. sp | | | | × | | | | | | | | | | | |
| 100 | Cycadinocarpus Chapini Newb | | × | | | | | | | | | | | | | |
| 101 | Cycadites acutus Emm | | | | | | | × | | | | | | | | |
| 102 | Cycadites tenuinervis Font | | | | | | × | × | | | | | | | | |
| 103 | Cycadites ? sp. Font | | | | | | | | × | | | | | | | |
| 104 | Cyclopteris sp. Conrad | | | × | | | | | | | | | | | | |
| 105 | Danæopsis ? sp. Font | | | | | | | × | | | | | | | | |
| 106 | Dendrophycus Shoemakeri Ward n. sp | | | | | × | | | | | | | | | | |
| 107 | Dendrophycus triassicus Newb | | × | | | | | | | | | | | | | |
| 108 | Dicksonia Saportana Heer | | | | | | | | | | | ? | | | | |
| 109 | Dicranopteris ? sp. Font | | | | | | × | | | | | | | | | |
| 110 | Dictyophyllum ? sp. Font | × | | | | | | | | | | | | | | |
| 111 | Didymosorus ? bindrabunensis acutifolius Font | | | | | | | | | | | | × | | | |
| 112 | Dioonites Carnallianus (Göpp.) Born | | | | × | | | | | | | | | | | |
| 113 | Dyctuocaulus striatus Emm | | | | ? | | | × | | | | | | | | |
| 114 | Echinocarpus sp. Emm | | | | | | | × | | | | | | | | |
| 115 | Equisetum abiquiense Font | | | | | | | | × | | | | | | | |
| 116 | Esquisetum Knowltoni Font | | | | | | | | × | | | | | | | |
| 117 | Equisetum Muensteri (Sternb.) Brongn | | | | | | | | | | ? | | | | | |
| 118 | Equisetum Rogersii (Bunb.) Schimp | | | × | × | | × | × | | | | | | | | |
| 119 | Fucoides connecticutensis Hitchc | | × | | | | | | | | | | | | | |
| 120 | Fucoides Shepardi Hitchc | × | | | | | | | | | | | | | | |
| 121 | Gymnocaulus alternatus Emm | | | | ? | | | × | | | | | | | | |
| 122 | Laccopteris lanceolata (Göpp.) Presl. n. comb | | | | | | | ? | | | | | | | | |
| 123 | Lepacyclotes circularis Emm | | | | | | | × | | | | | | | | |
| 124 | Lepacyclotes ellipticus Emm | | | | | | | × | | | | | | | | |
| 125 | Leptostrobus ? mariposensis Font. n. sp | | | | | | | | | | | × | | | | |
| 126 | Leptostrobus ? sp. Font. (Undetermined cone) | | | | | | | | | | | | × | | | |
| 127 | Lonchopteris oblonga (Emm.) Font | | | | × | | | × | | | | | | | | |
| 128 | Lonchopteris virginiensis (Font.) | | | | | | × | | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. Connecticut Valley area. Massachusetts. | Triassic. Connecticut Valley area. Connecticut. | Triassic. Hudson-Potomac area. New Jersey. | Triassic. Hudson-Potomac area. Pennsylvania. | Triassic. Hudson-Potomac area. Maryland. | Triassic. Virginia area. | Triassic. North Carolina. | Triassic. Southwestern area. New Mexico. | Triassic. Southwestern area. Arizona. | Triassic. Taylorsville, California, area. | Jurassic. Mariposa beds, California. | Jurassic. Oroville, California. | Jurassic. Colorado. | Jurassic. Wyoming. | Jurassic. South Dakota. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 129 | Loperia carolinensis (Font.) Ward n. comb | | × | | ? | | | × | | | | | | | | |
| 130 | Lycopodites Sillimanni Brongn | × | | | | | | | | | | | | | | |
| 131 | Macrotæniopteris californica Font | | | | | | | | | | | | × | | | |
| 132 | Macrotæniopteris crassinervis Feistm | | | | | | × | | | | | | | | | |
| 133 | Macrotæniopteris magnifolia (Rogers) Schimp | | | | × | | × | × | | | | | | | | |
| 134 | Macrotæniopteris nervosa Font | | | | | | | | | | | | × | | | |
| 135 | Mertensides bullatus (Bunb.) Font | | | | ? | | × | ? | | | | | | | | |
| 136 | Mertensides distans Font | | | | | | × | | | | | | | | | |
| 137 | Otozamites brevifolius Fr. Braun | | × | | | | | | | | | | | | | |
| 138 | Otozamites carolinensis Font | | | | | | | × | | | | | | | | |
| 139 | Otozamites latior Sap | | × | | | | | | | | | | | | | |
| 140 | Otozamites Macombii Newb | | | | | | | | × | | | | | | | |
| 141 | Pagiophyllum brevifolium (Newb.) Ward n. comb | × | × | | | | | | | | | | | | | |
| 142 | Pagiophyllum ? Newberryi Ward n. sp | | | | | | | | × | | | | | | | |
| 143 | Pagiophyllum peregrinum (L. & H.) Schenk | | | | | | | × | | | | ? | | | | |
| 144 | Pagiophyllum simile (Newb.) Ward n. comb | × | × | | | | | | | | | | | | | |
| 145 | Pagiophyllum Williamsonis (Brongn.) Font | | | | | | ? | ? | | | | | × | | | |
| 146 | Palæophycus limaciformis Lewis | | | × | | | | | | | | | | | | |
| 147 | Palissya brevifolia (Emm.) Font | | | | | | | × | | | | | | | | |
| 148 | Palissya diffusa (Emm.) Font | ? | ? | ? | × | | | × | | | | | | | | |
| 149 | Palissya sphenolepis (Fr. Braun) Brongn | | | × | × | | | × | | | | | | | | |
| 150 | Palissya sp. Font. (cone) | | | | | | | | × | | | | | | | |
| 151 | Pinoxylon dacotense Kn. n. sp | | | | | | | | | | | | | | | × |
| 152 | Pinus Nordenskiöldi Heer | | | | | | | | | | | | ? | | | |
| 153 | Podozamites ? carolinensis Font. n. sp | | | | | | | × | | | | | | | | |
| 154 | Podozamites distans (Presl) Fr. Braun | | | | ? | | | | | | | | | | | |
| 155 | Podozamites Emmonsii Newb | | | | | | | × | | | | | | | | |
| 156 | Podozamites lanceolatus (L. & H.) Fr. Braun | | | | | | | | | | | | × | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | Southwestern area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 157 | Podozamites lanceolatus latifolius (Brongn.) Heer. | | | | | | | | | | | | × | | | |
| 158 | Podozamites longifolius Emm | | | × | | | × | × | | | | | | | | |
| 159 | Podozamites taylorsvillensis Ward n. sp. | | | | | | | | | | × | | | | | |
| 160 | Podozamites tenuistriatus (Rogers) Font. | | | | | | × | × | | | | | | | | |
| 161 | Pseudodanæopsis obliqua (Emm.) Font. | | | | | | × | × | | | | | | | | |
| 162 | Pseudodanæopsis plana (Emm.) Font. | | | | × | | × | × | | | | | | | | |
| 163 | Pterophyllum affine Nath. | | | | | | × | | | | | | | | | |
| 164 | Pterophyllum Daleanum Ward n. sp. | | | | | | | × | | | | | | | | |
| 165 | Pterophyllum inæquale Font. | | | | × | | × | | | | | | | | | |
| 166 | Pterophyllum rajmahalense Morr. | | | | | | | | | | | | ? | | | |
| 167 | Ramulus rugosus Wanner. | | | | × | | | | | | | | | | | |
| 168 | Sagenopteris Emmonsi Font. n. sp. | | | | | | | × | | | | | | | | |
| 169 | Sagenopteris ? magnifoliola Ward n. sp. | | | | | | | | | | × | | | | | |
| 170 | Sagenopteris Nilsoniana (Brongn.) Ward n. comb | | | | | | × | × | | | | | × | | | |
| 171 | Sagenopteris sp. Font. | | | | × | | | | | | | | | | | |
| 172 | Schizolepis liaso-keuperina Fr. Braun. | | | | × | | | | | | | | | | | |
| 173 | Schizoneura planicostata (Rogers) Font. | × | × | × | × | | × | ? | | | | | | | | |
| 174 | Schizoneura virginiensis Font | | | | | | × | | | | | | | | | |
| 175 | Schizoneura ? sp. Font | | | | | | × | | | | | | | | | |
| 176 | Sphenopteris egyptiaca Emm | | | | | | | × | | | | | | | | |
| 177 | Sphenozamites Rogersianus Font. | | | | × | | × | × | | | | | | | | |
| 178 | Tæniopteris orovillensis Font. | | | | | | | | | | | | × | | | |
| 179 | Tæniopteris vittata Brongn | ? | | | | | | | | | | | | | | |
| 180 | Tæniopteris ? yorkensis Font. n. sp. | | | | × | | | | | | | | | | | |
| 181 | Thinnfeldia ? reticulata Font. n. sp. | | | | × | | | | | | | | | | | |
| 182 | Thyrsopteris Maakiana, Heer. | | | | | | | | | | | | ? | | | |
| 183 | Undetermined stem (cycad ?) Font | | | | | | × | | | | | | | | | |

*Table of distribution of fossil plants of Older Mesozoic of the United States*—Continued.

| No. | Name. | Triassic. | | | | | | | | | | Jurassic. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Connecticut Valley area. | | Hudson-Potomac area. | | | | | Southwestern area. | | | | | | | |
| | | Massachusetts. | Connecticut. | New Jersey. | Pennsylvania. | Maryland. | Virginia area. | North Carolina area. | New Mexico. | Arizona. | Taylorsville, California, area. | Mariposa beds, California. | Oroville, California. | Colorado. | Wyoming. | South Dakota. |
| 184 | Yorkia gramineoides Ward n. sp | | | | × | | | | | | | | | | | |
| 185 | Zamiostrobus virginiensis Font. | | | | | | × | × | | | | | | | | |
| 186 | Zamites occidentalis Newb. | | | | | | | | × | | | | | | | |
| 187 | Zamites pennsylvanicus, Font. n. sp. | | | | × | | | | | | | | | | | |
| 188 | Zamites Powelli Font. | | | | | | | | × | | | | | | | |
| 189 | Zamites yorkensis Font. n. sp | | | | × | | | | | | | | | | | |

## DISCUSSION OF THE TABLE.

In this table there are 189 separate entries. It would be too much to say that it represents that many distinct species, and yet each entry stands for a different form, so far as the nature of the material enables us to judge. Quite a number are early determinations that have not been recently examined, some of them, perhaps, no longer represented by types that can now be found, and therefore they have little real value, but having gone unchallenged into the literature, it seems best to keep them in view, in the hope that they may some time receive attention.

It will be observed that very few species are common to the Triassic and Jurassic as here recorded. *Baiera multifida* Font., of the Richmond coal field, is identified with doubts in the Oroville flora, and *Pagiophyllum Williamsonis* (Brongn.) Font., of the Yorkshire Oolite, found at Oroville, also occurs in doubtful forms in the Trias of both Virginia and North Carolina. *Sagenopteris Nilsoniana*, a polymorphous species, which will doubtless be subdivided into several species, was found in the Richmond and North Carolina coal fields and reappears in the Oroville florula.

Next in interest come the species common to the eastern and western Triassic beds. *Cheirolepis Muensteri* (Schenk) Schimp., found throughout the Newark system, occurs also in the Trias of New Mexico. The same is true of *Ctenophyllum grandifolium* Font., common in the Virginia area, and found by Mr. Wanner in the Trias of York County, Pennsylvania. The splendid variety, *C. grandifolium Storrsii*, from Oroville, shows that this form only underwent certain modifications in passing from the Trias to the Jura, and its exclusively American character gives it great value as an index to plant evolution on this continent in Older Mesozoic time.

As all the other columns of the table represent the Newark system, which is believed to constitute a geological unit from Massachusetts to North Carolina, little interest attaches to the discovery of forms common to the several areas. A large number are found in both the Richmond and the North Carolina coal fields, which was, of course, to be expected, and the rediscovery of the Emmons types has done much to demonstrate the stratigraphical identity of these coal fields. Mr. Wanner's excellent work in Pennsylvania has tended to bring the deposits of York County, Pennsylvania, into substantial harmony with those farther south. The material from the Connecticut Valley and from New Jersey is as yet too meager to make a full comparison possible, and it seems altogether probable that, even on the assumption of identity of age and aside from differences due to geographical distribution, the element of climate may have had some effect in causing the northern and southern areas to differ in their flora in Mesozoic time.

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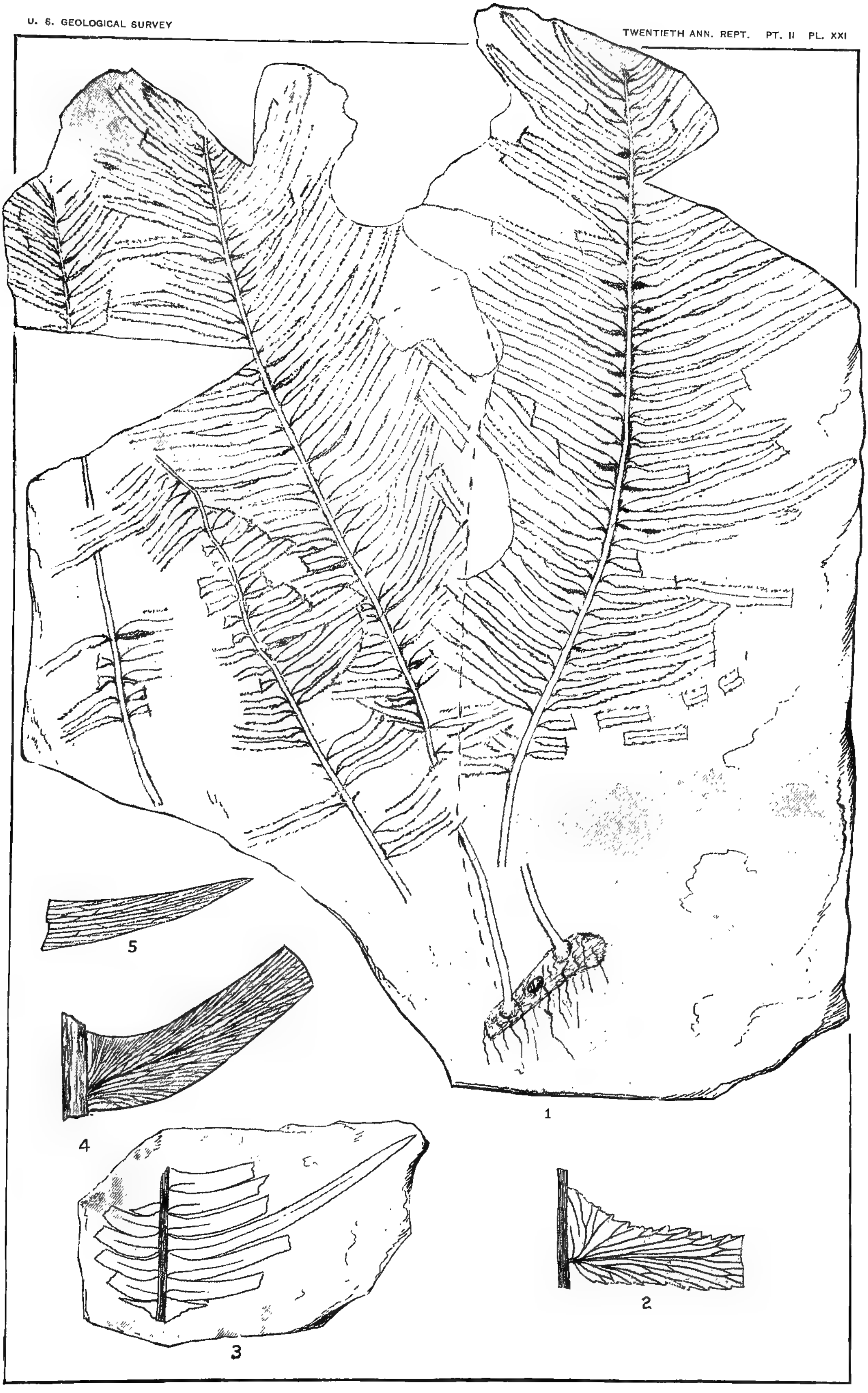
Fig. 2. Base of a leaflet showing auricle, enlarged.

Fig. 3. Portion of a frond, natural size.

Fig. 4. Basal portion of a pinna, enlarged 3 diameters.

Fig. 5. Terminal portion of a pinna, enlarged 3 diameters.

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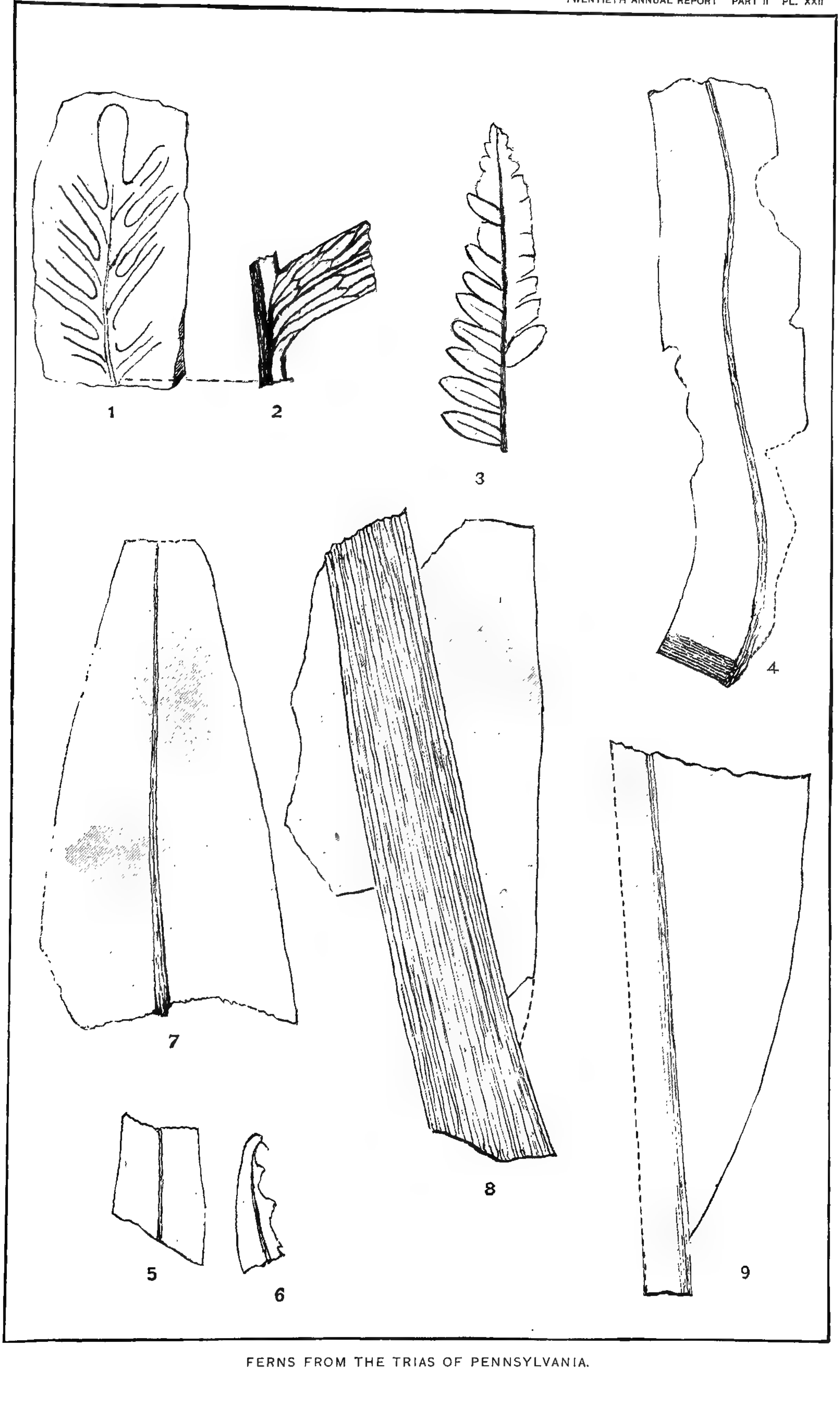


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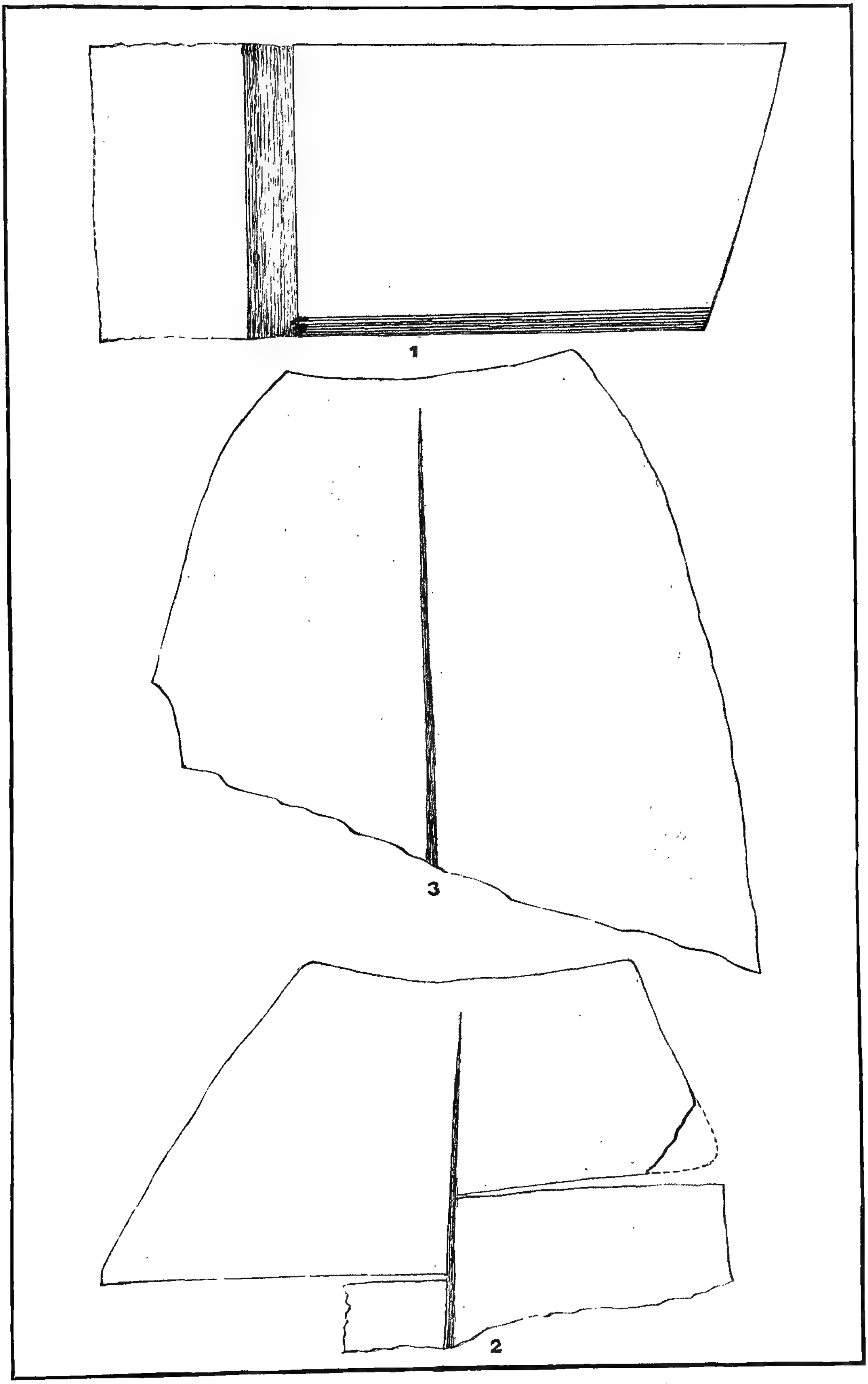


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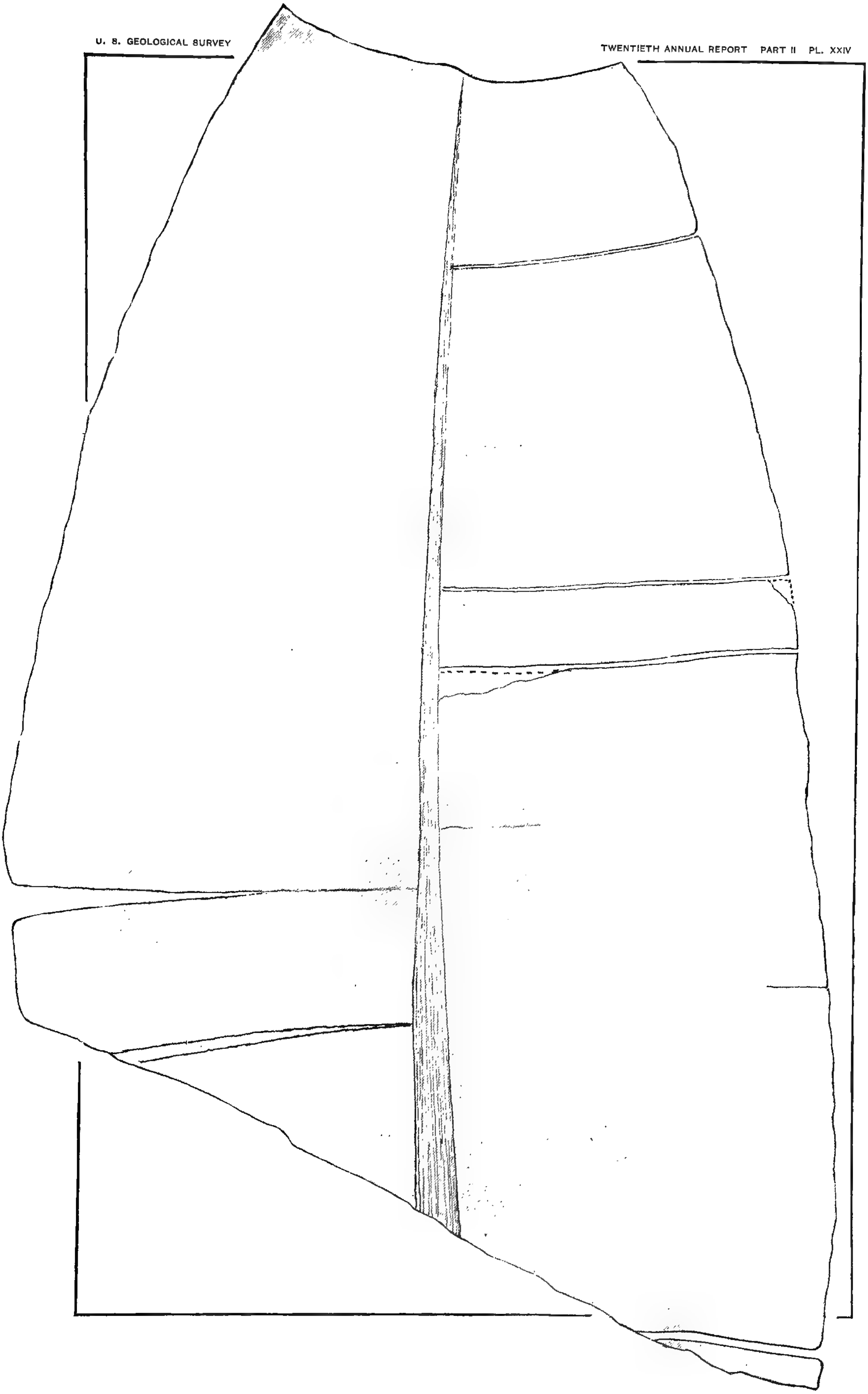

MACROTÆNIOPTERIS MAGNIFOLIA, FROM THE TRIAS OF PENNSYLVANIA.

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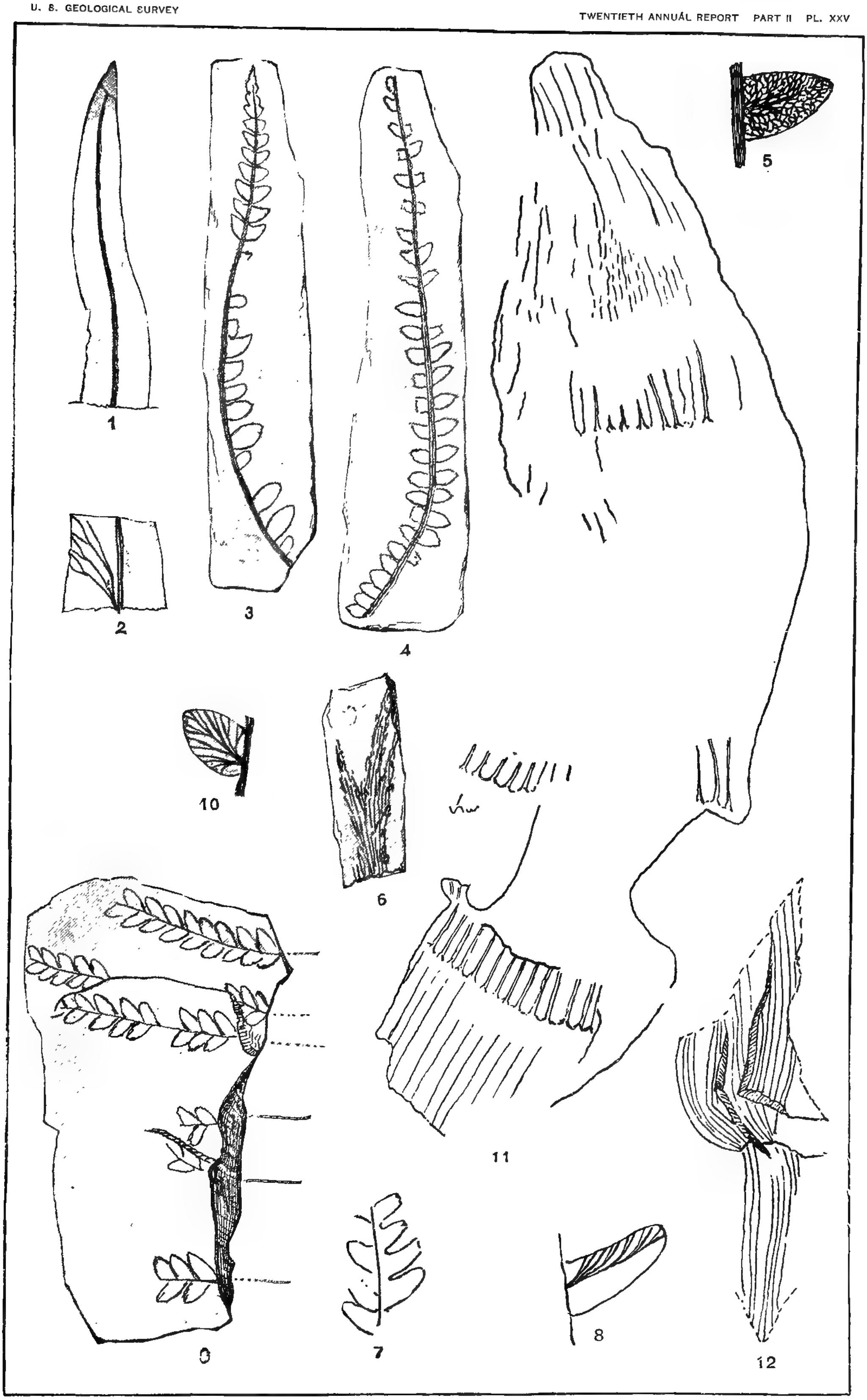


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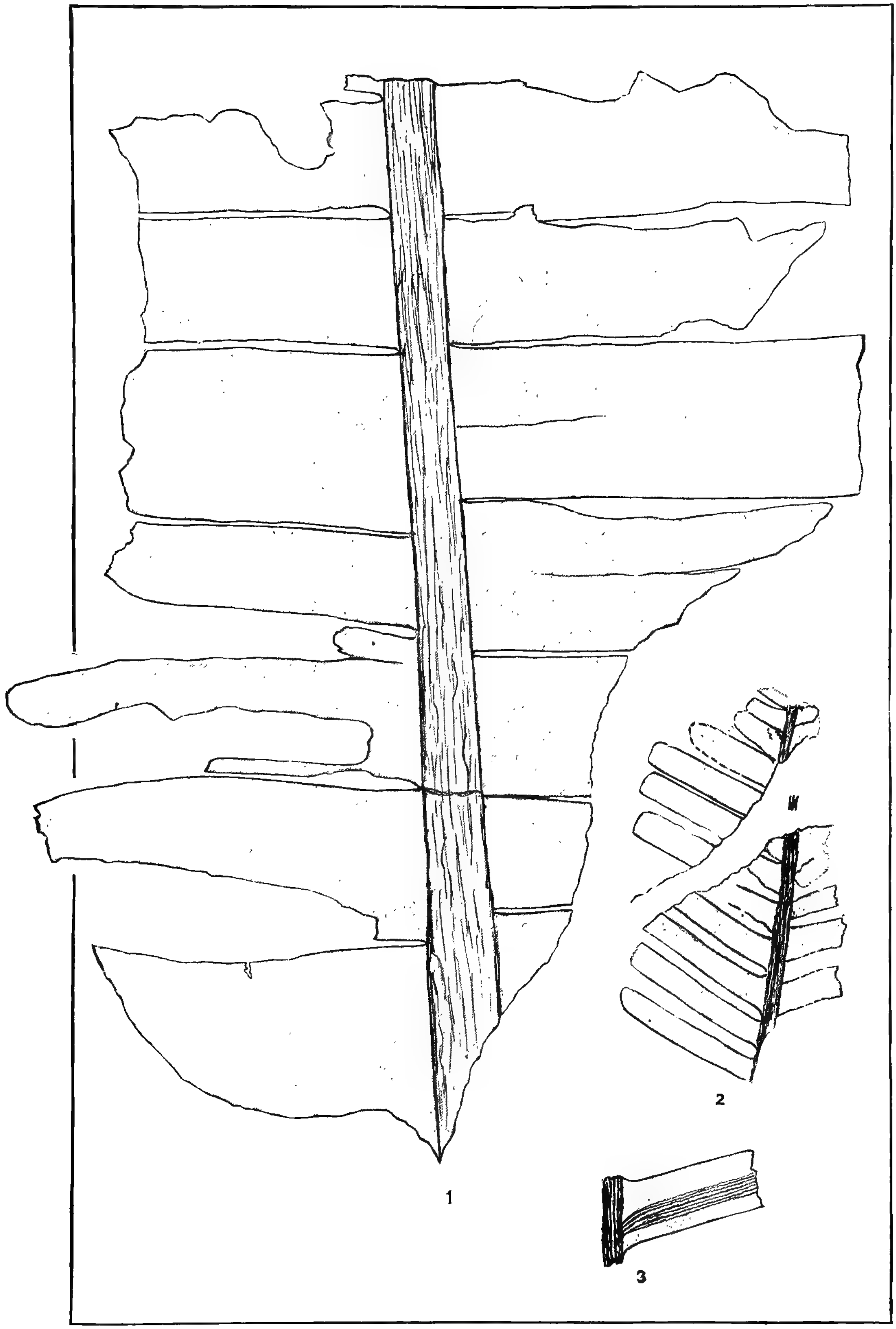

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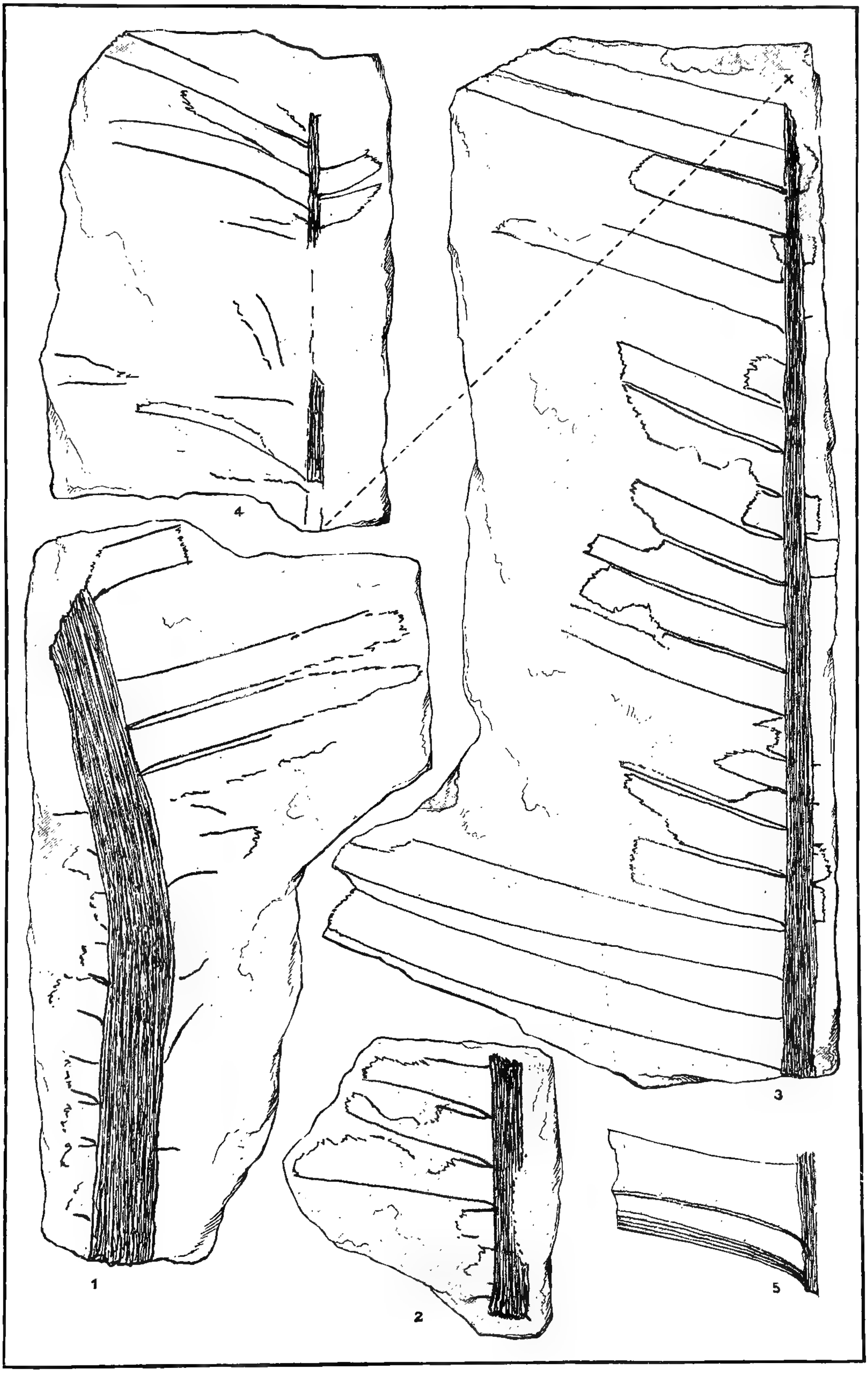


CTENOPHYLLUM GRANDIFOLIUM, FROM THE TRIAS OF PENNSYLVANIA.

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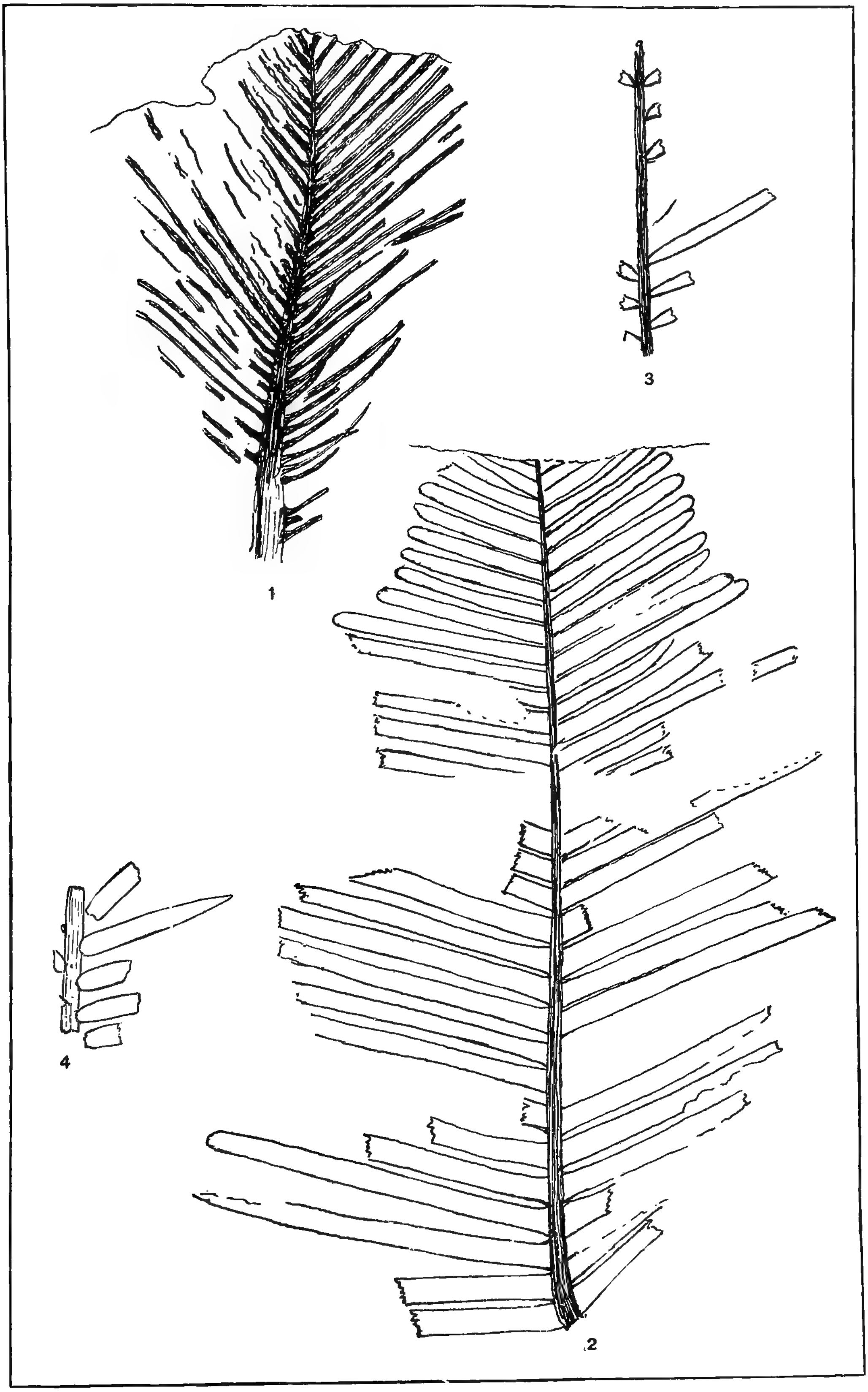


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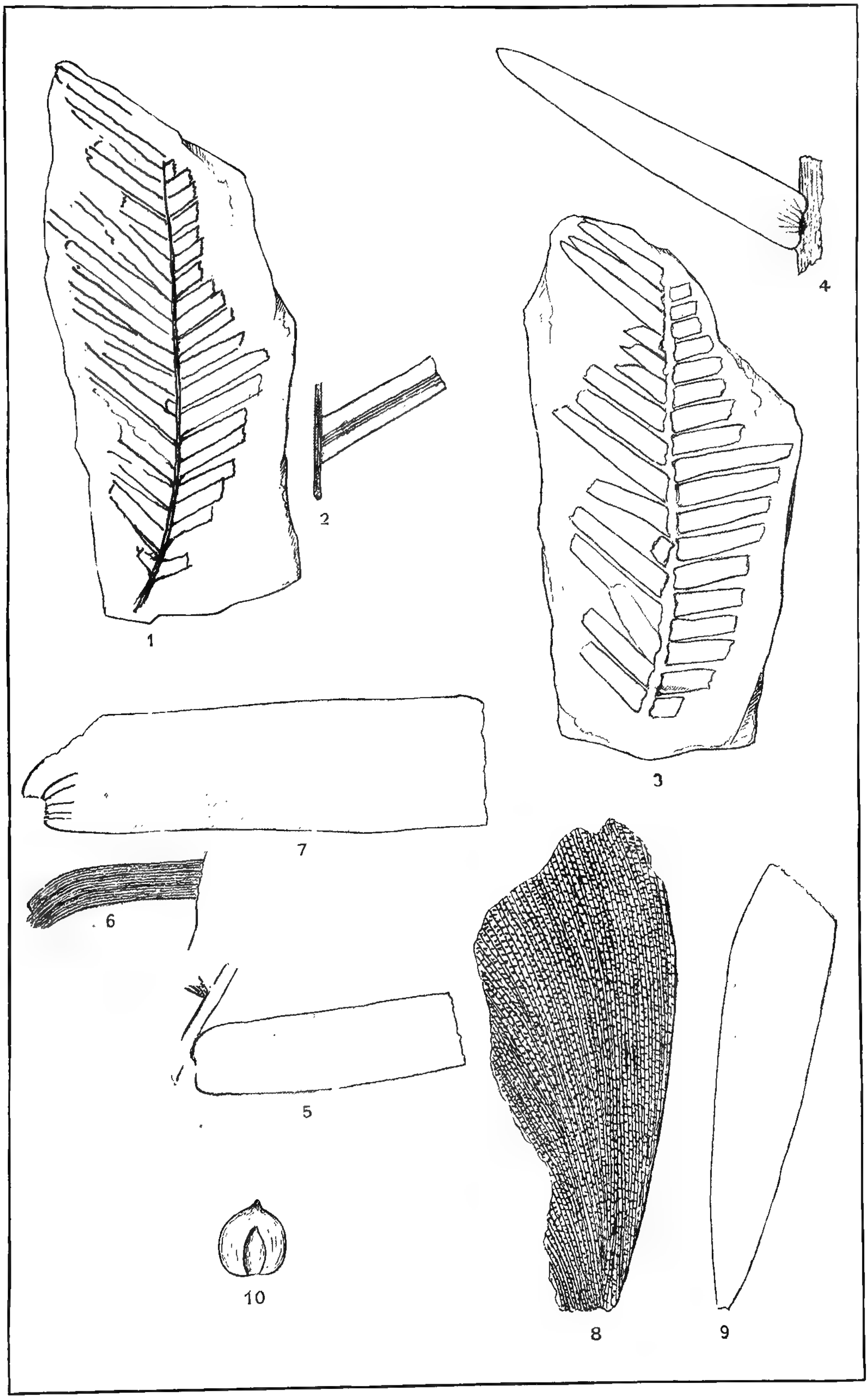


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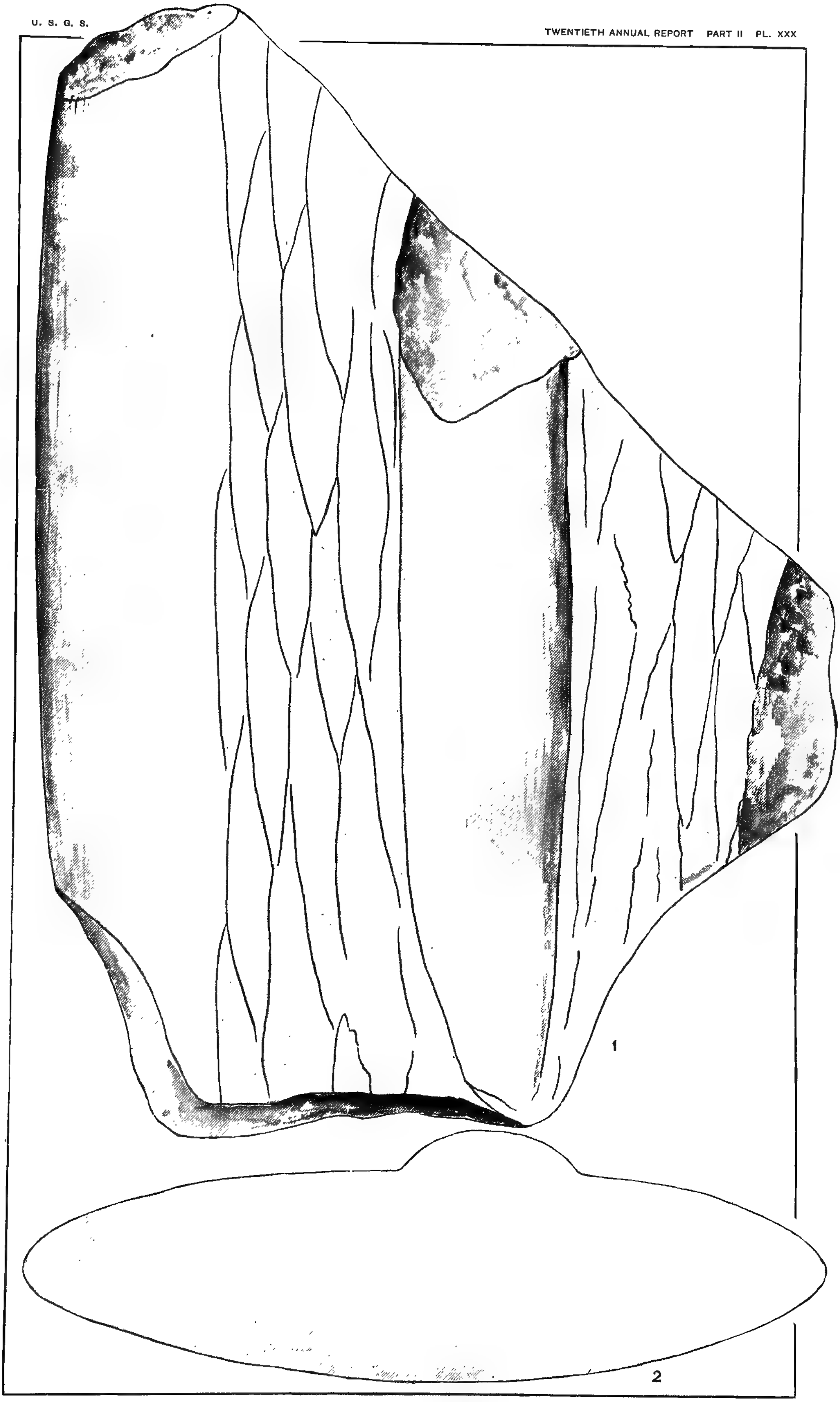


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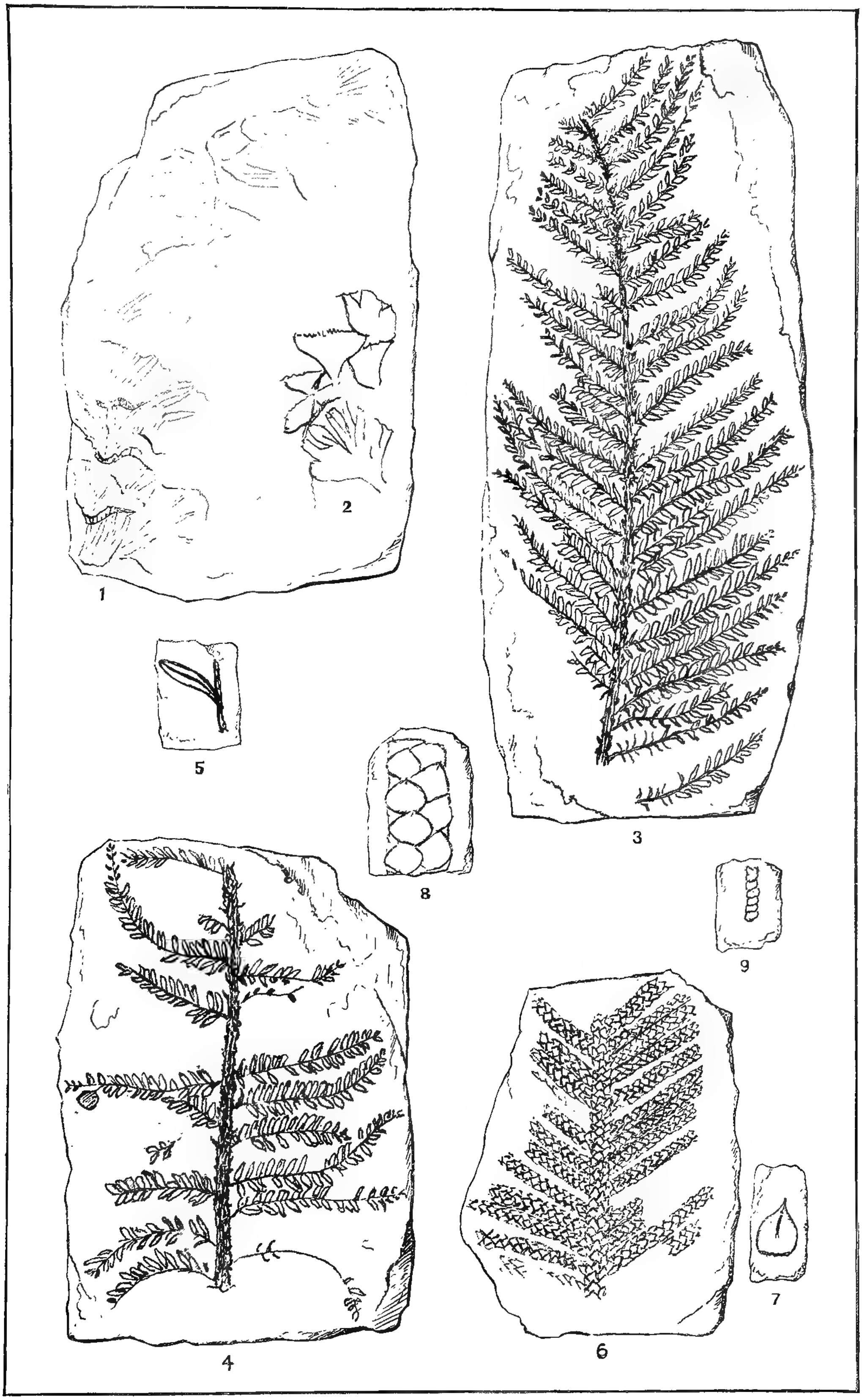


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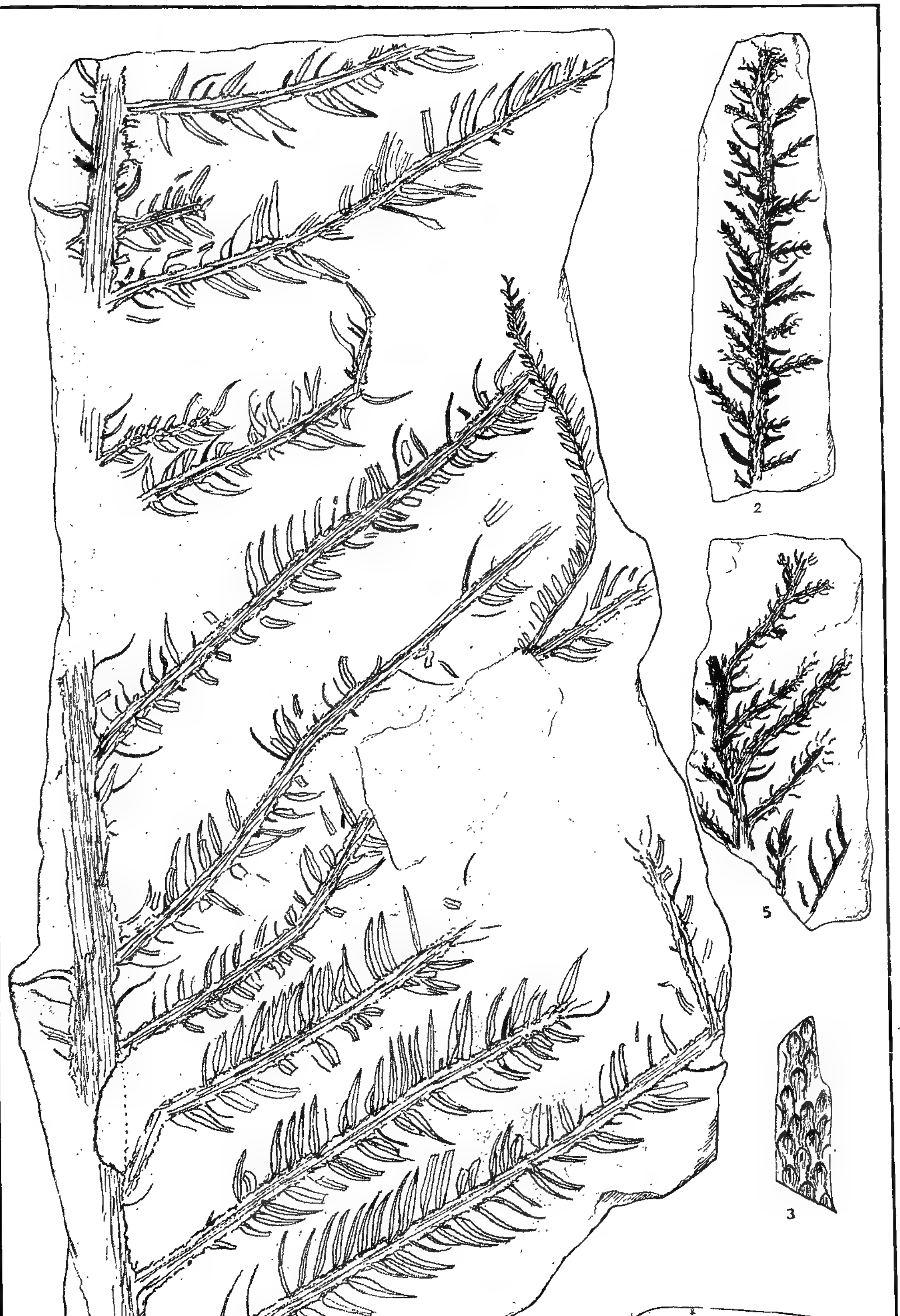


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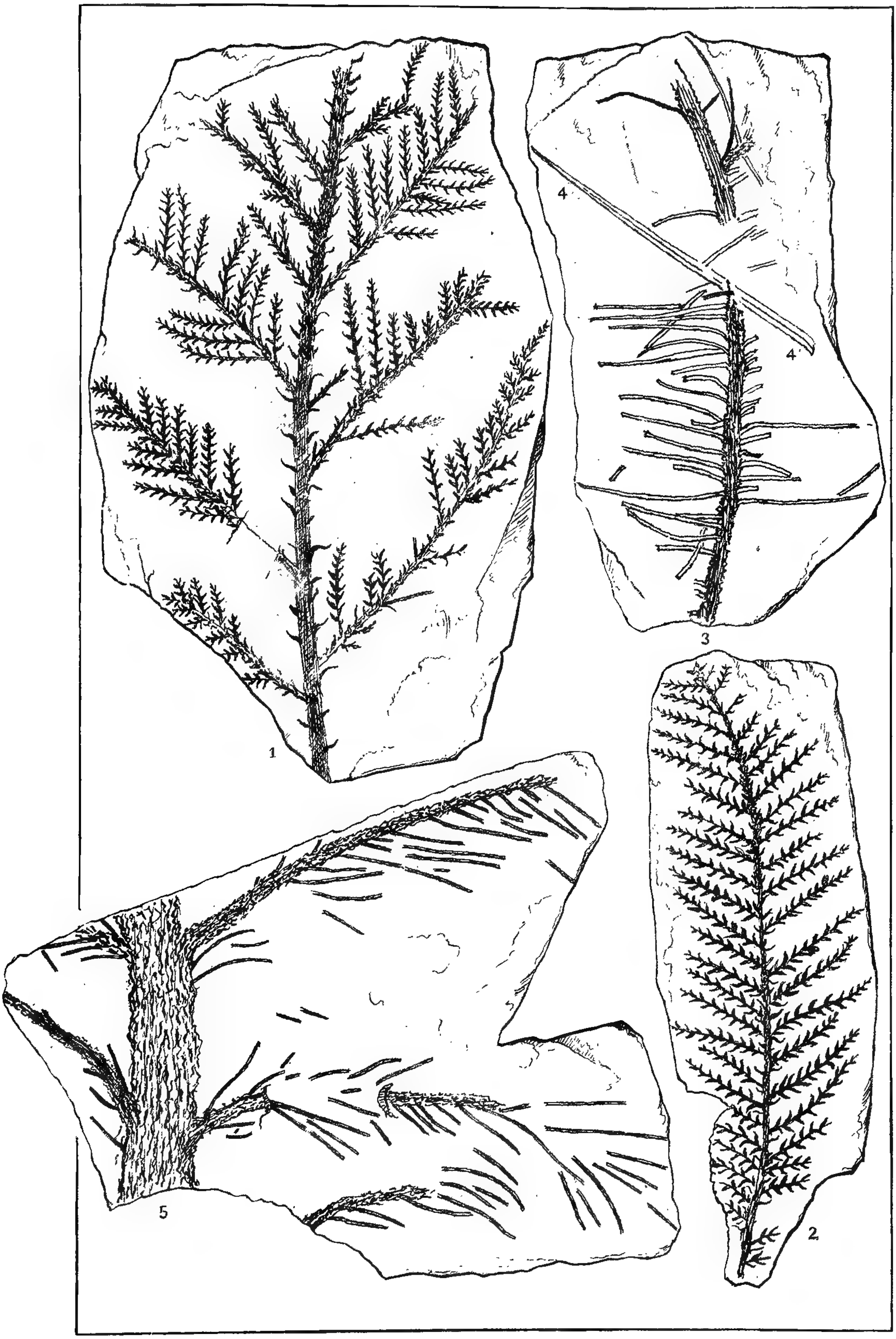


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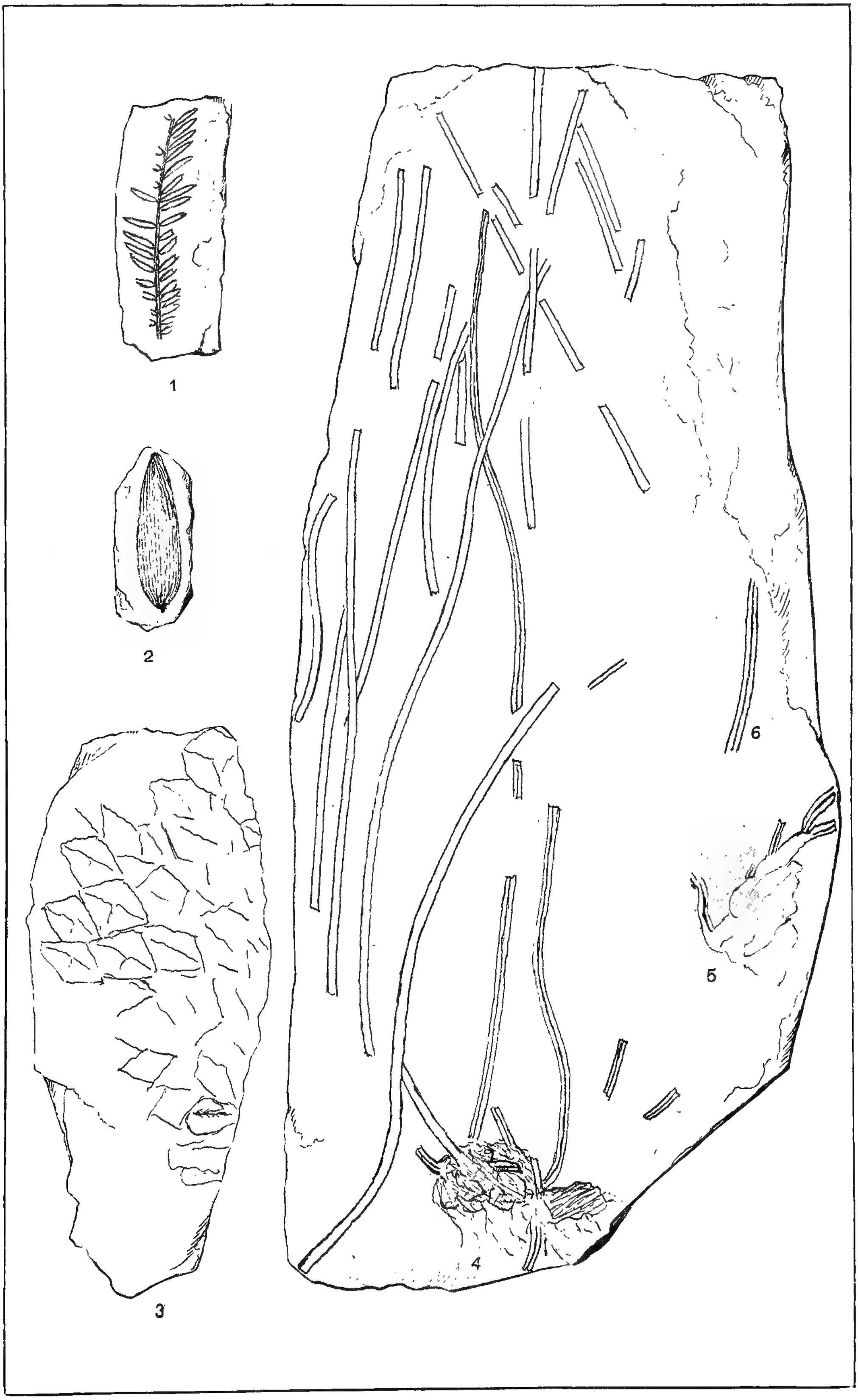


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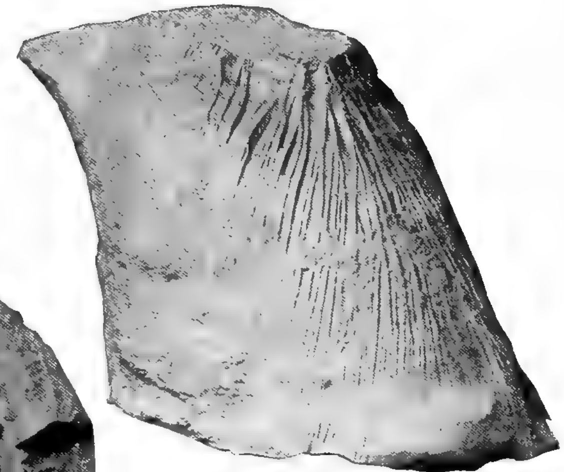

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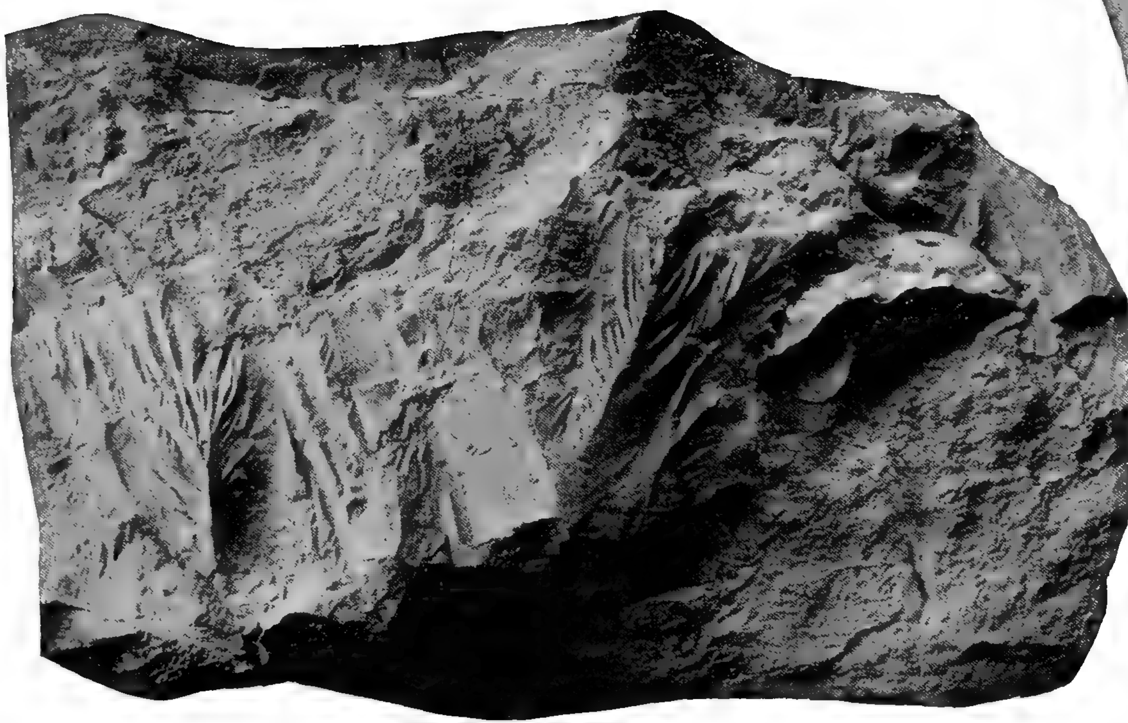

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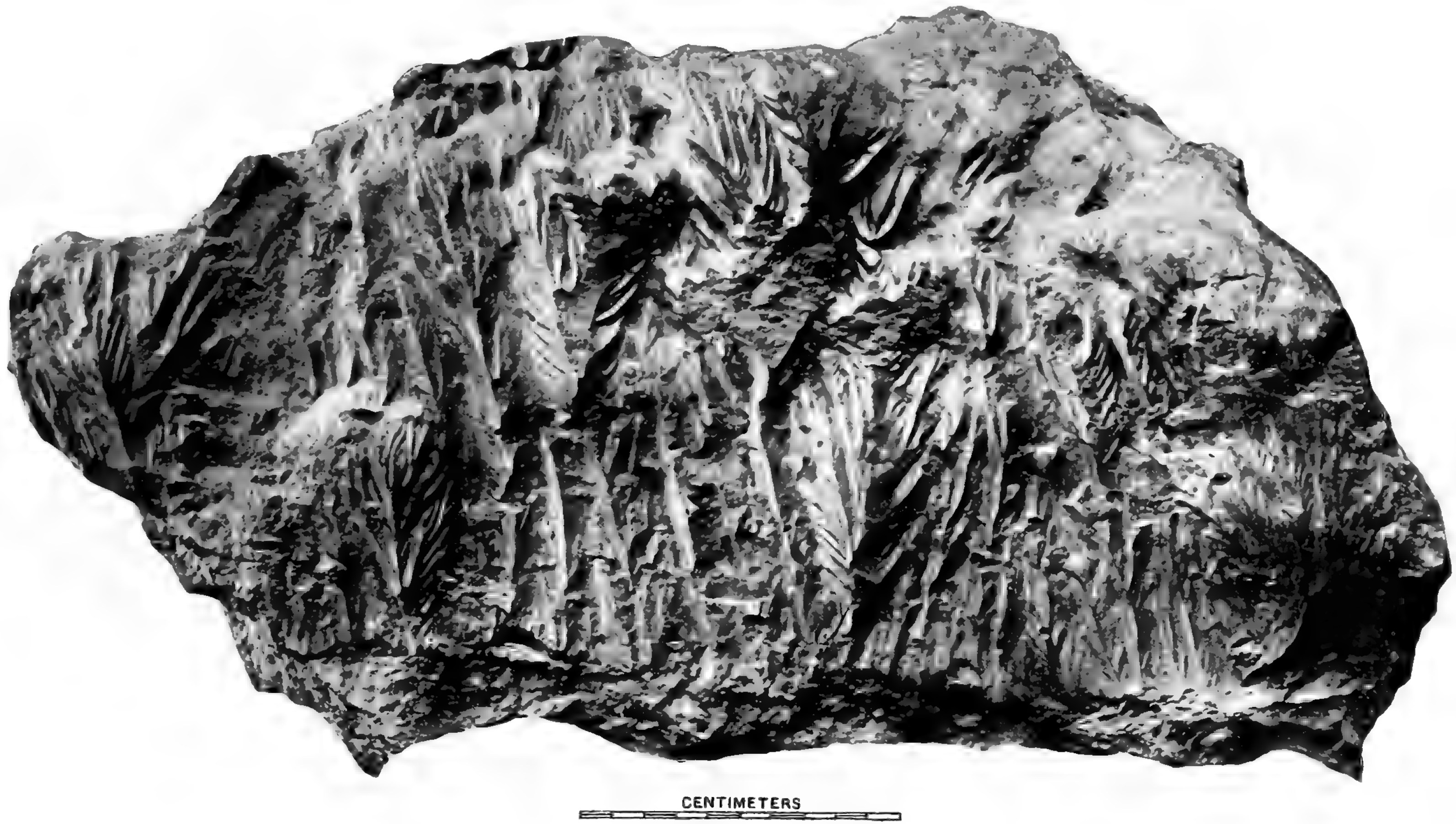


DENDROPHYCUS SHOEMAKERI. FROM THE TRIAS OF MARYLAND

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Fig. 2. Tangential section showing medullary rays and unmarked wood cells. ×90.

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Fig. 4. Radial section. Wood cells with two rows of bordered pits nearly covering the wall. ×310.

Fig. 5. Radial section. Wood cells with one and two rows of bordered pits. ×310.

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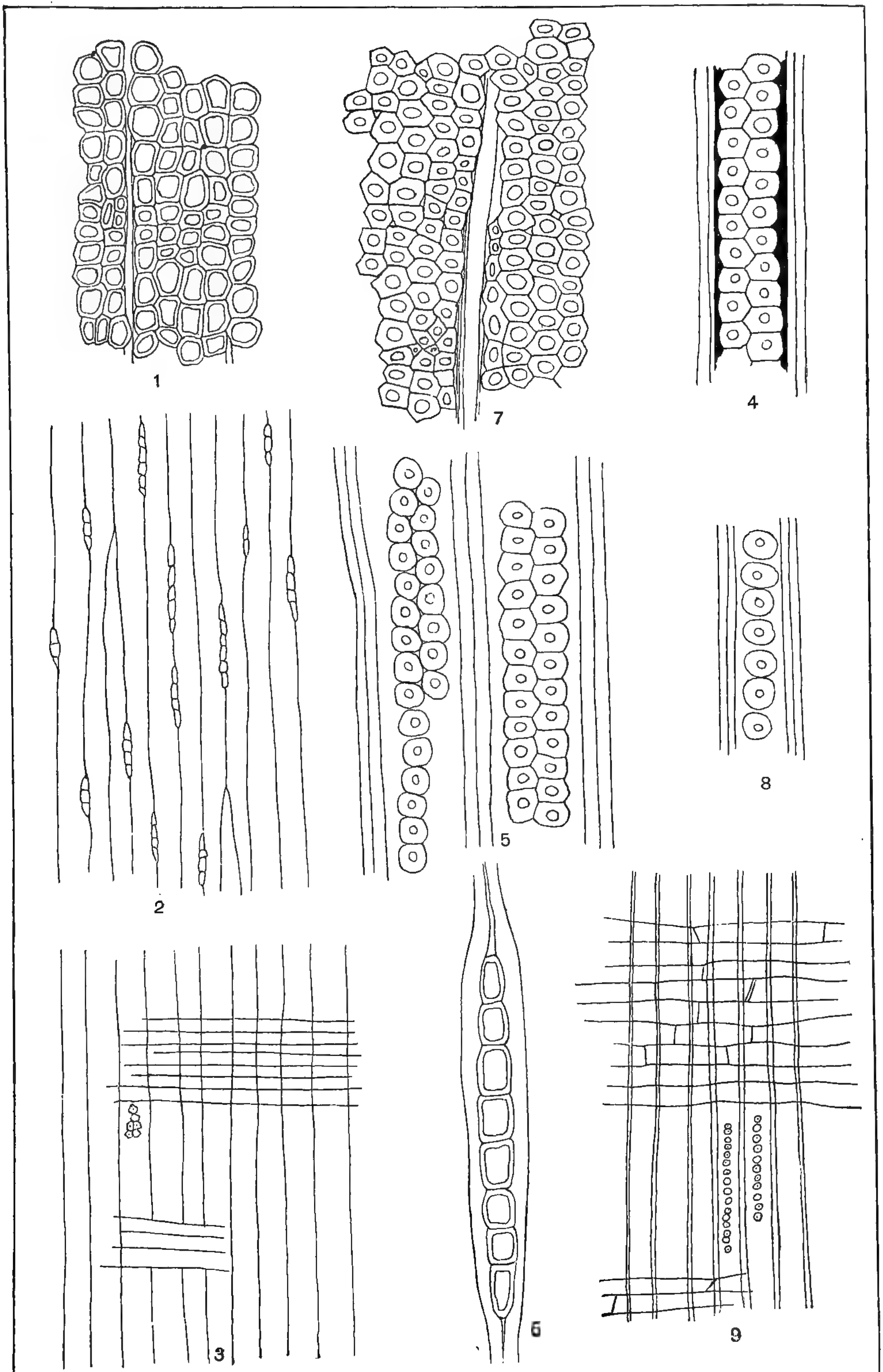
Fig. 8. Radial section of wood cell showing single row of bordered pits. ×310.

Fig. 9. Radial section showing short-celled medullary rays and wood cells with single rows of bordered pits. ×90.




ARAUCARIOXYLON, FROM THE TRIAS OF NORTH CAROLINA.

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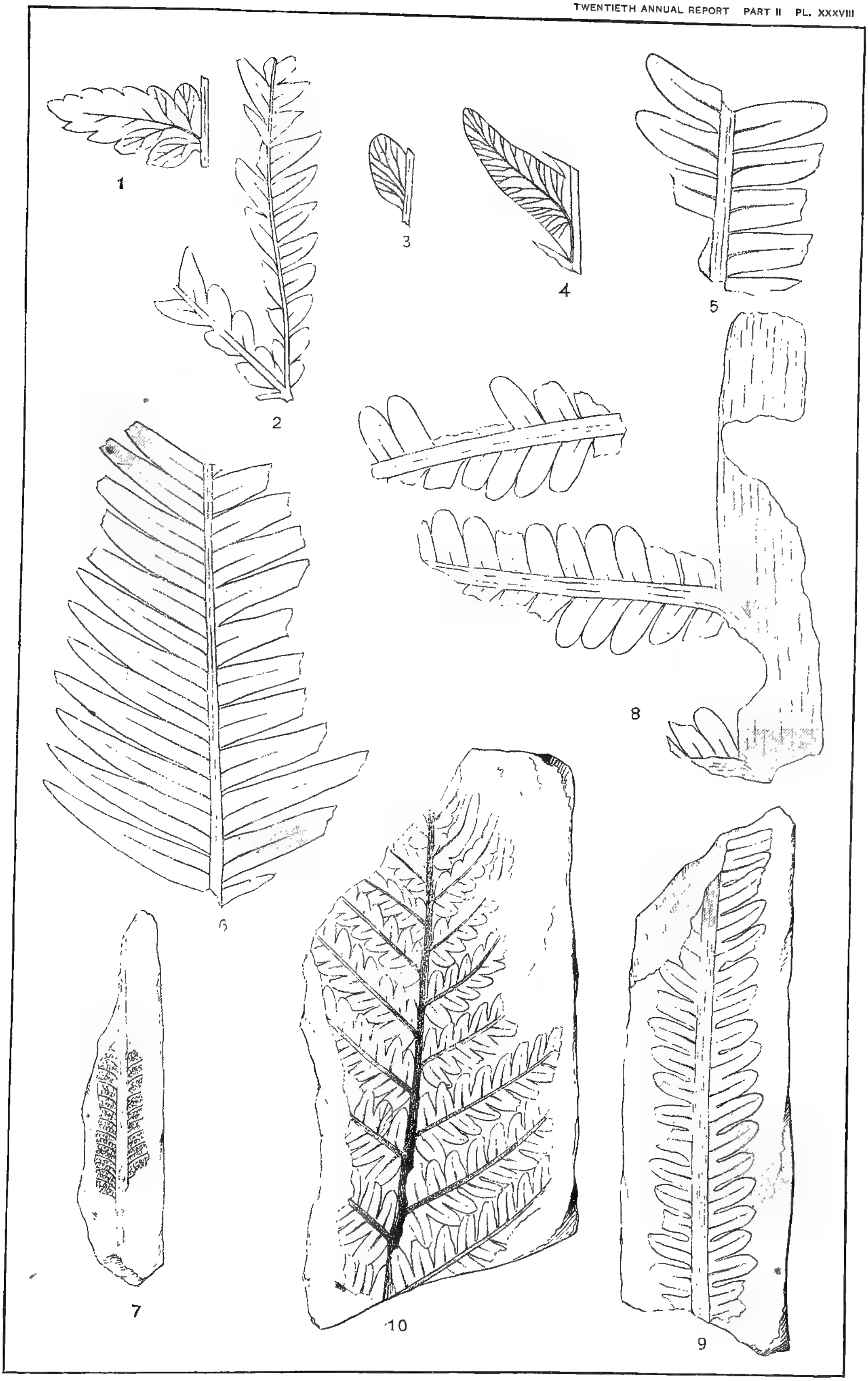


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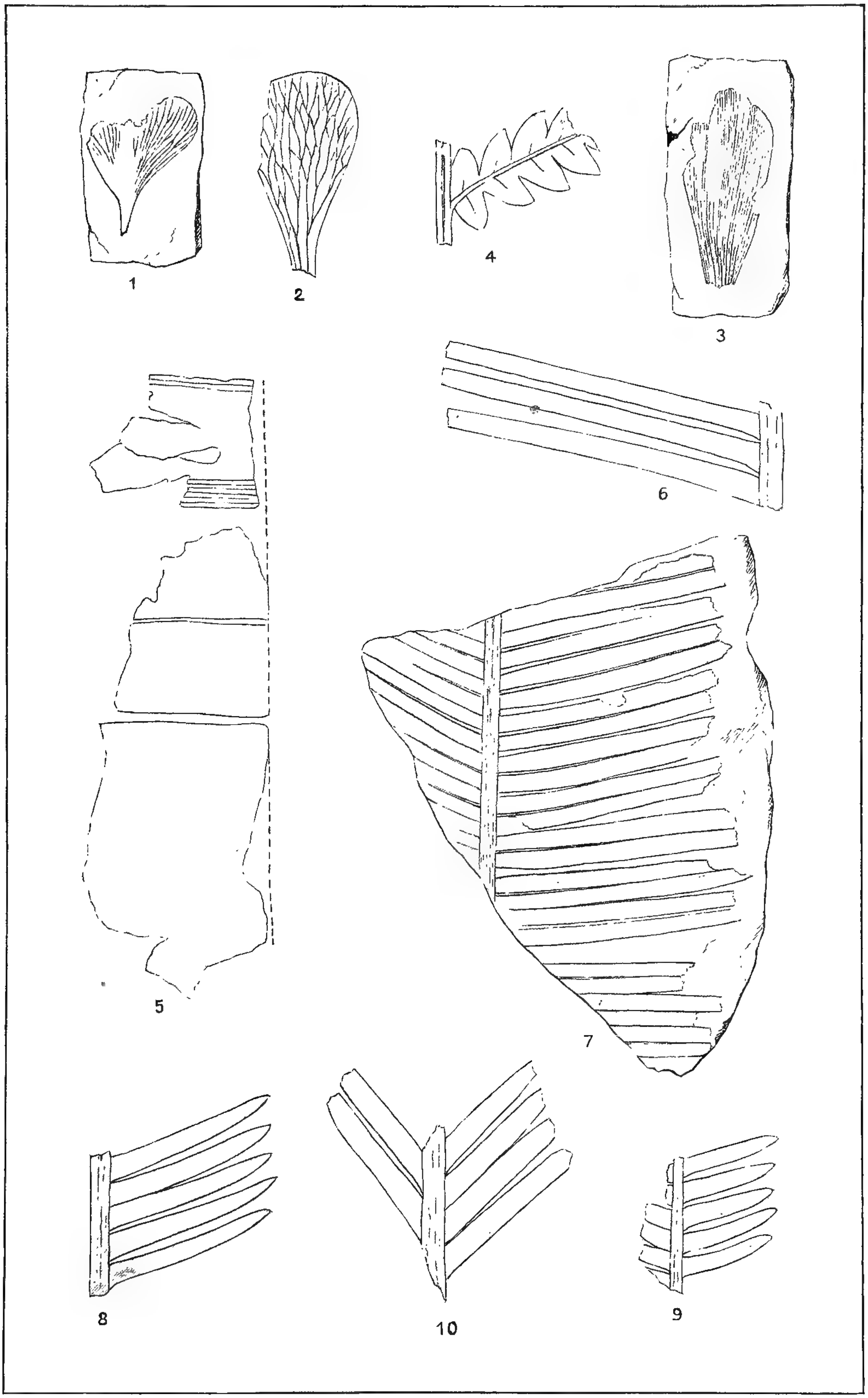


FERNS AND CYCADACEOUS PLANTS FROM THE TRIAS OF NORTH CAROLINA.

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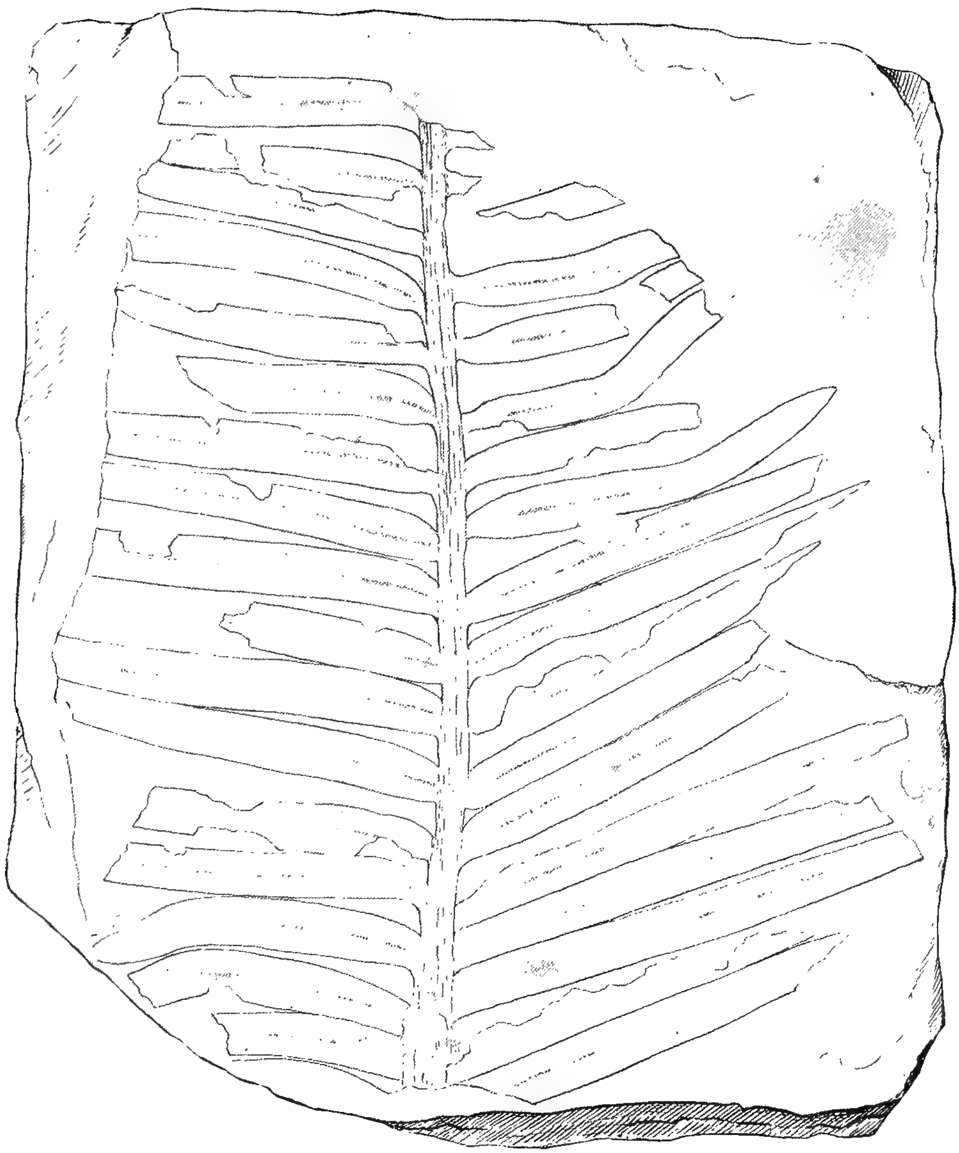

PODOZAMITES LONGIFOLIUS, FROM THE TRIAS OF NORTH CAROLINA.

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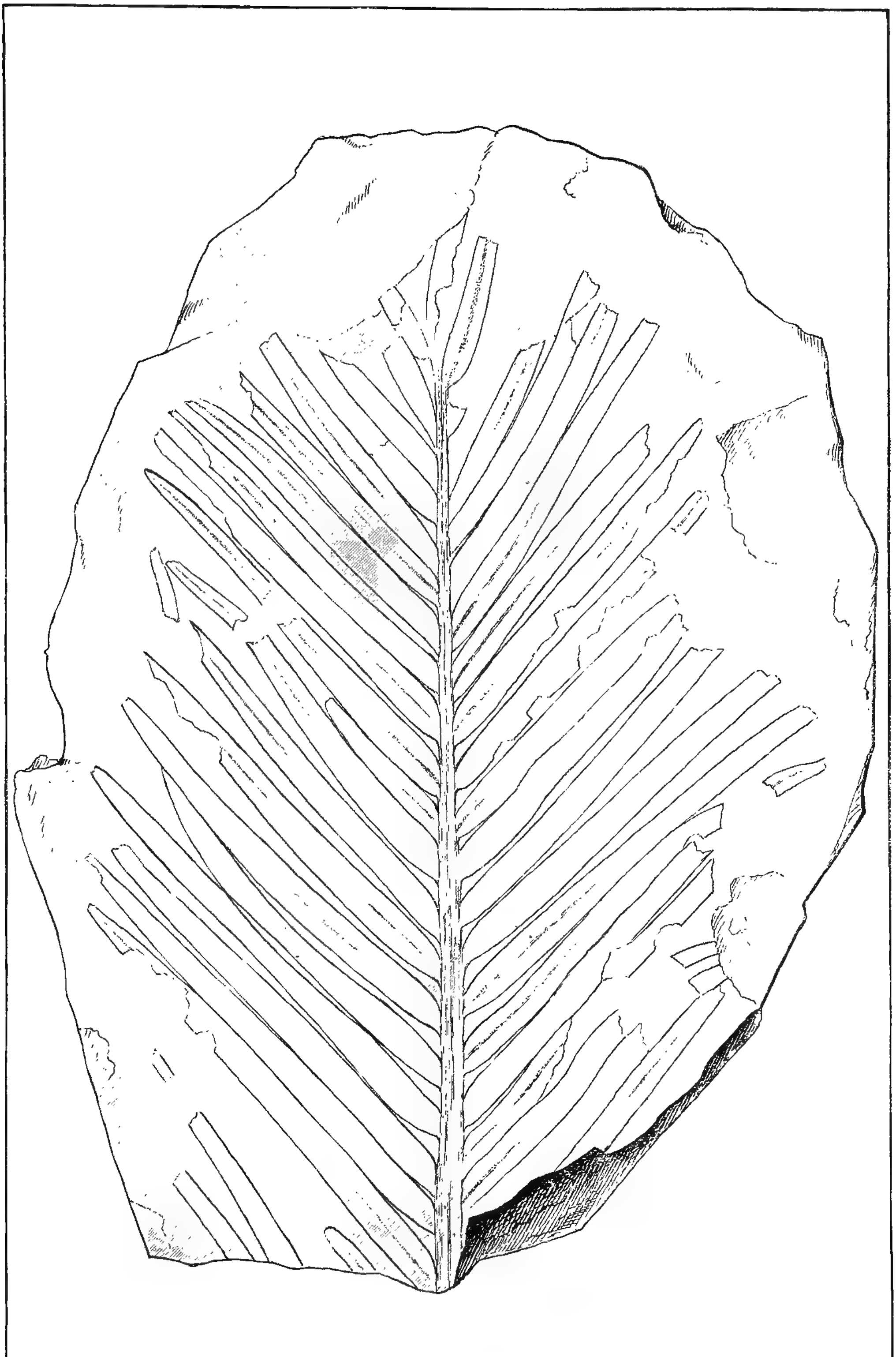

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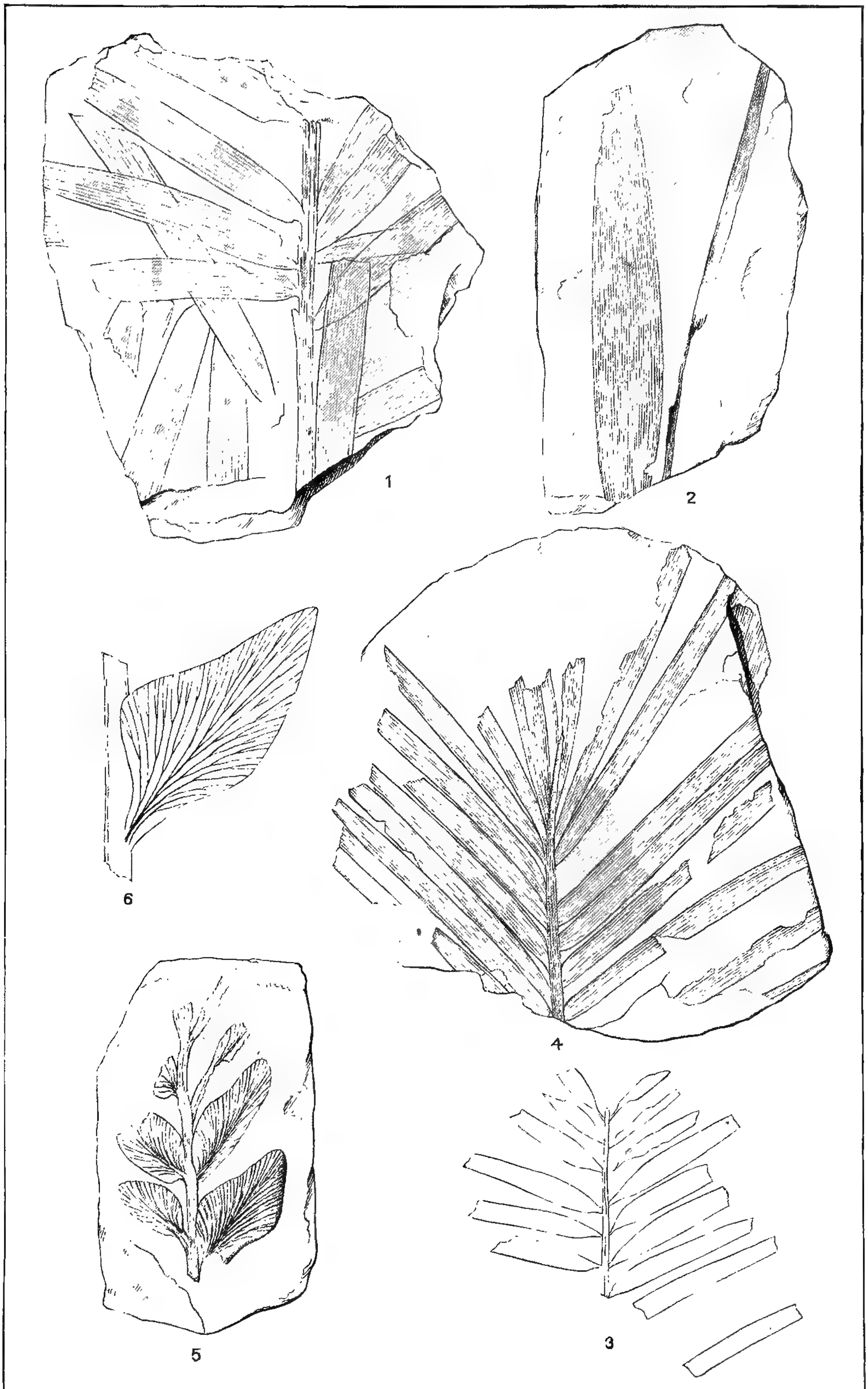


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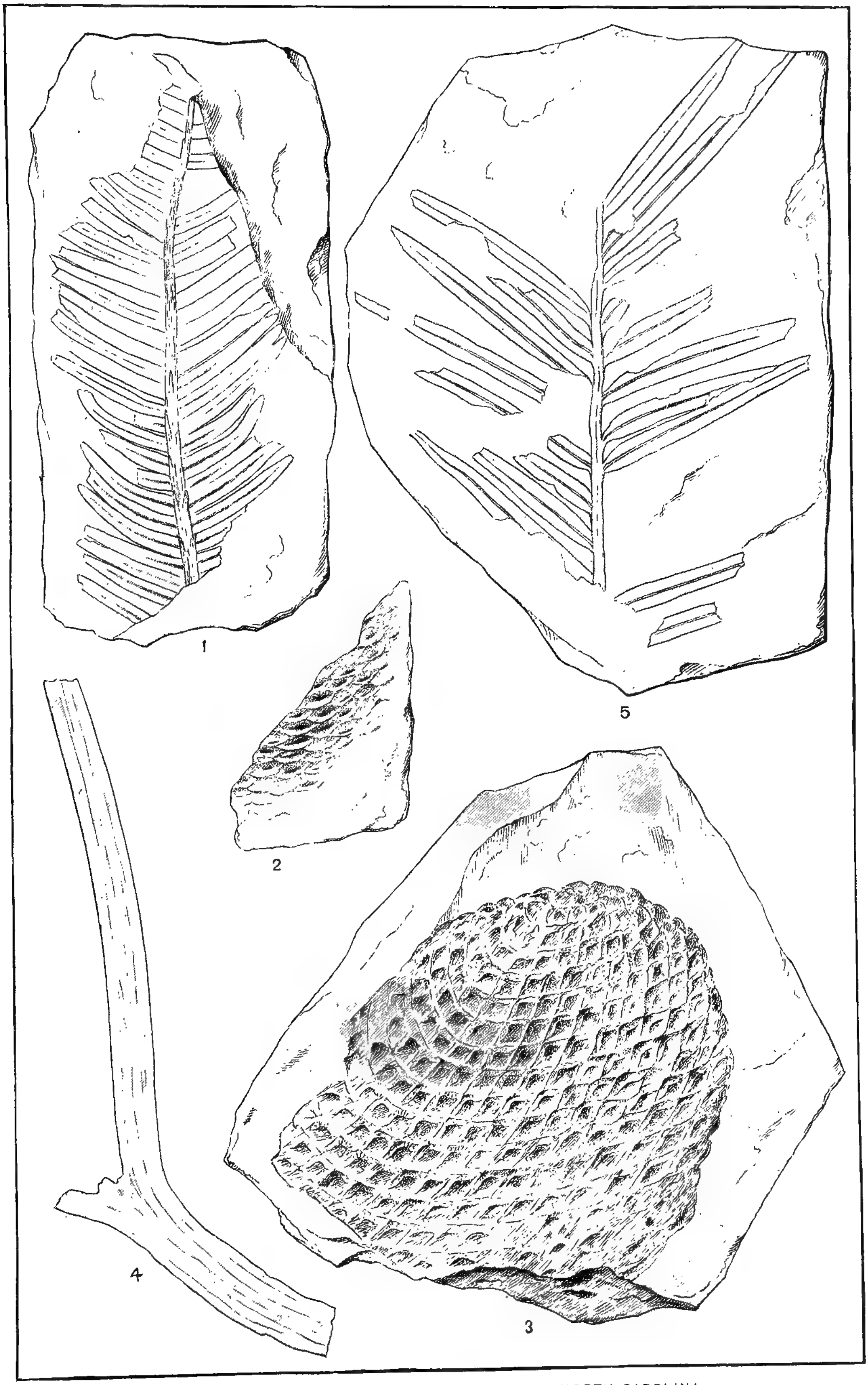


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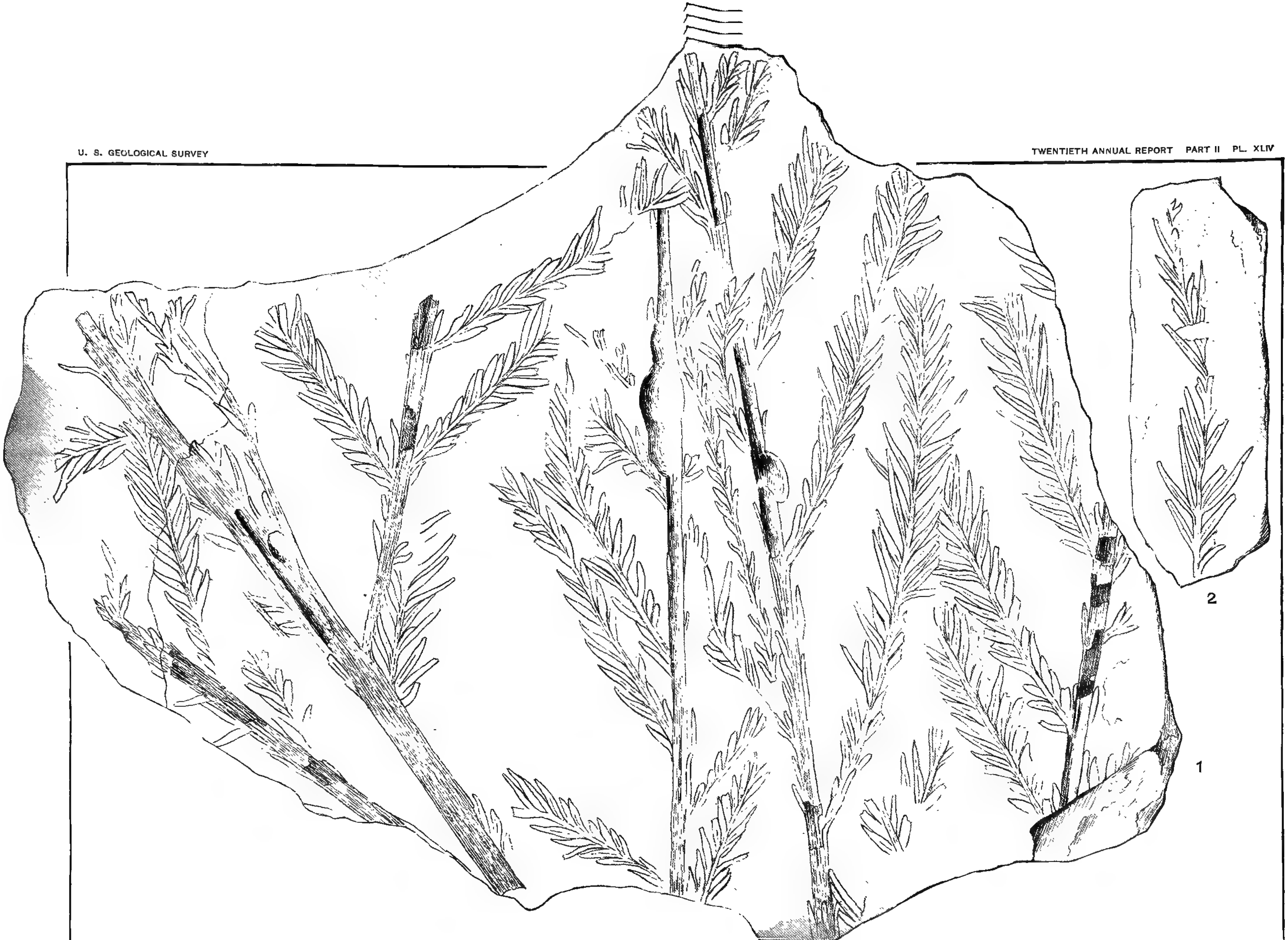


PALISSYA SPHENOLEPIS, FROM THE TRIAS OF NORTH CAROLINA.

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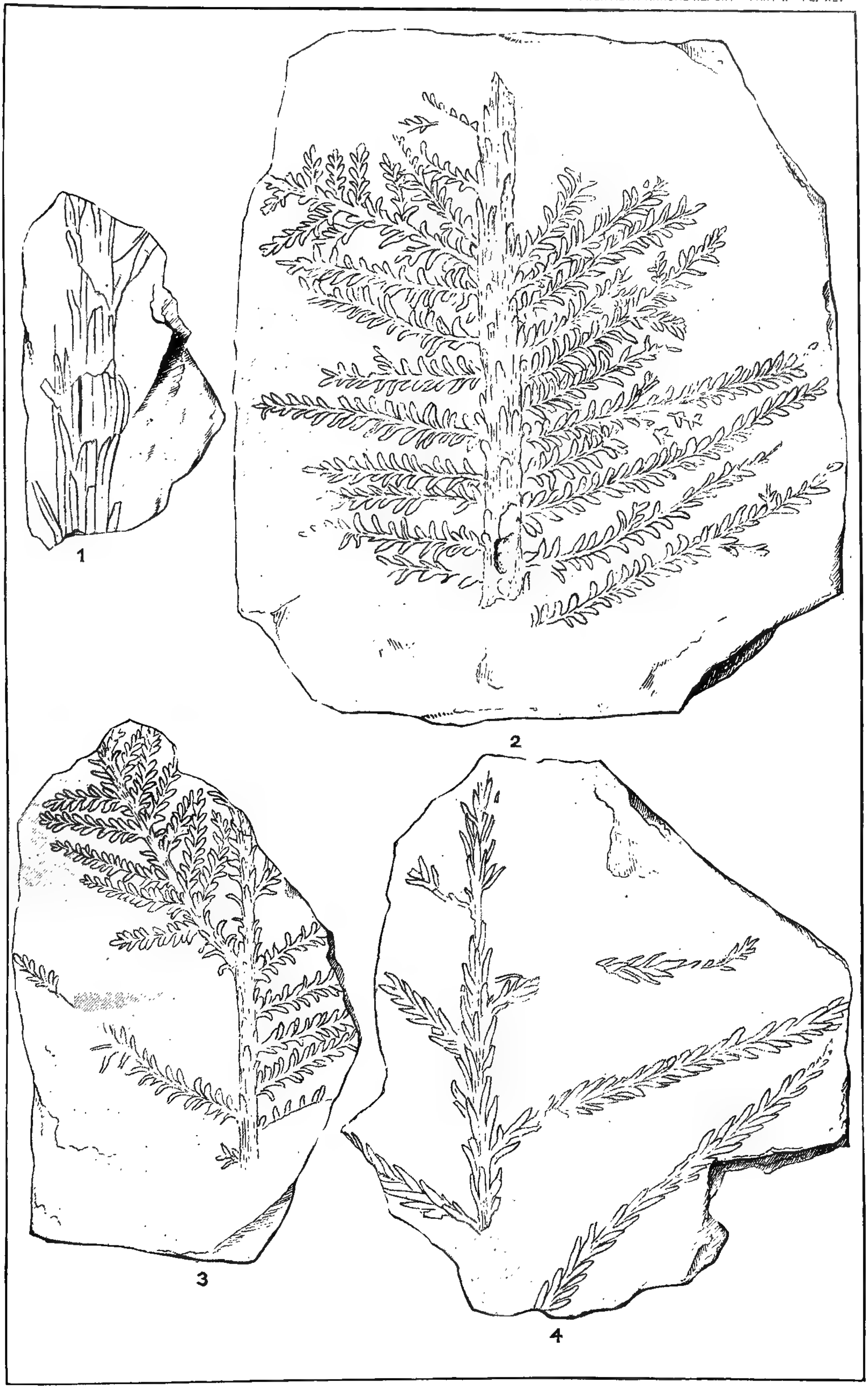


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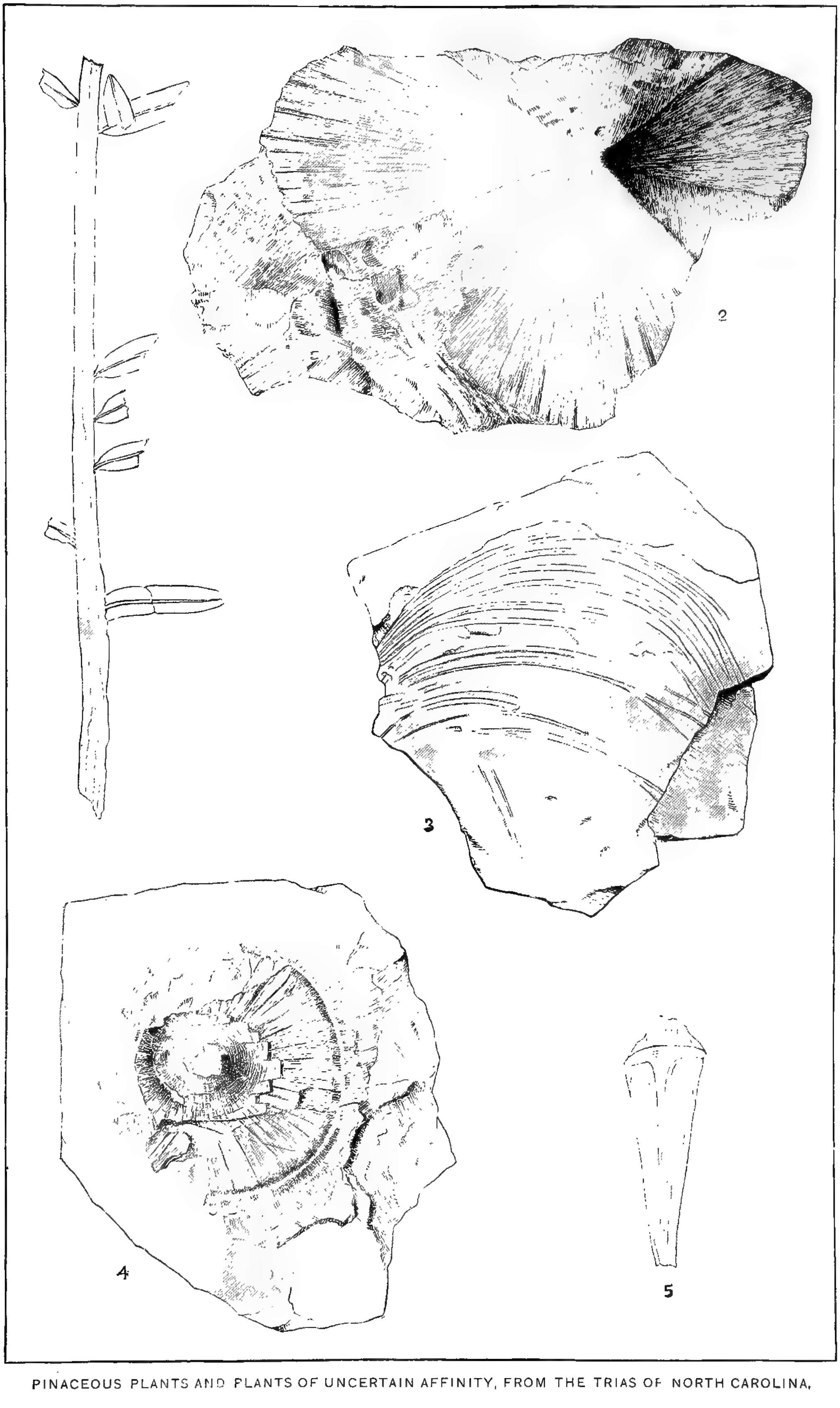


PINACEOUS PLANTS AND PLANTS OF UNCERTAIN AFFINITY, FROM THE TRIAS OF NORTH CAROLINA.

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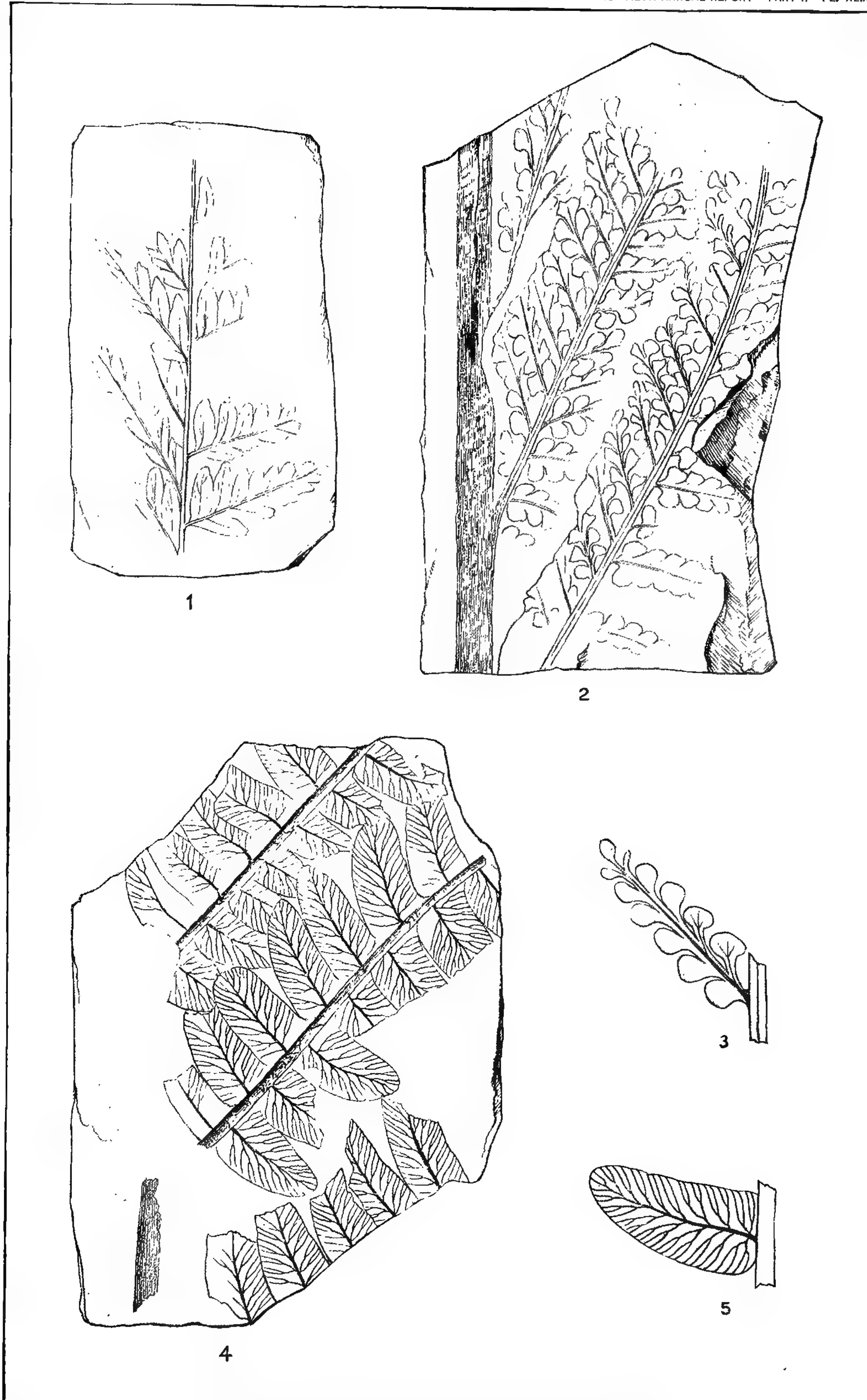


FERNS FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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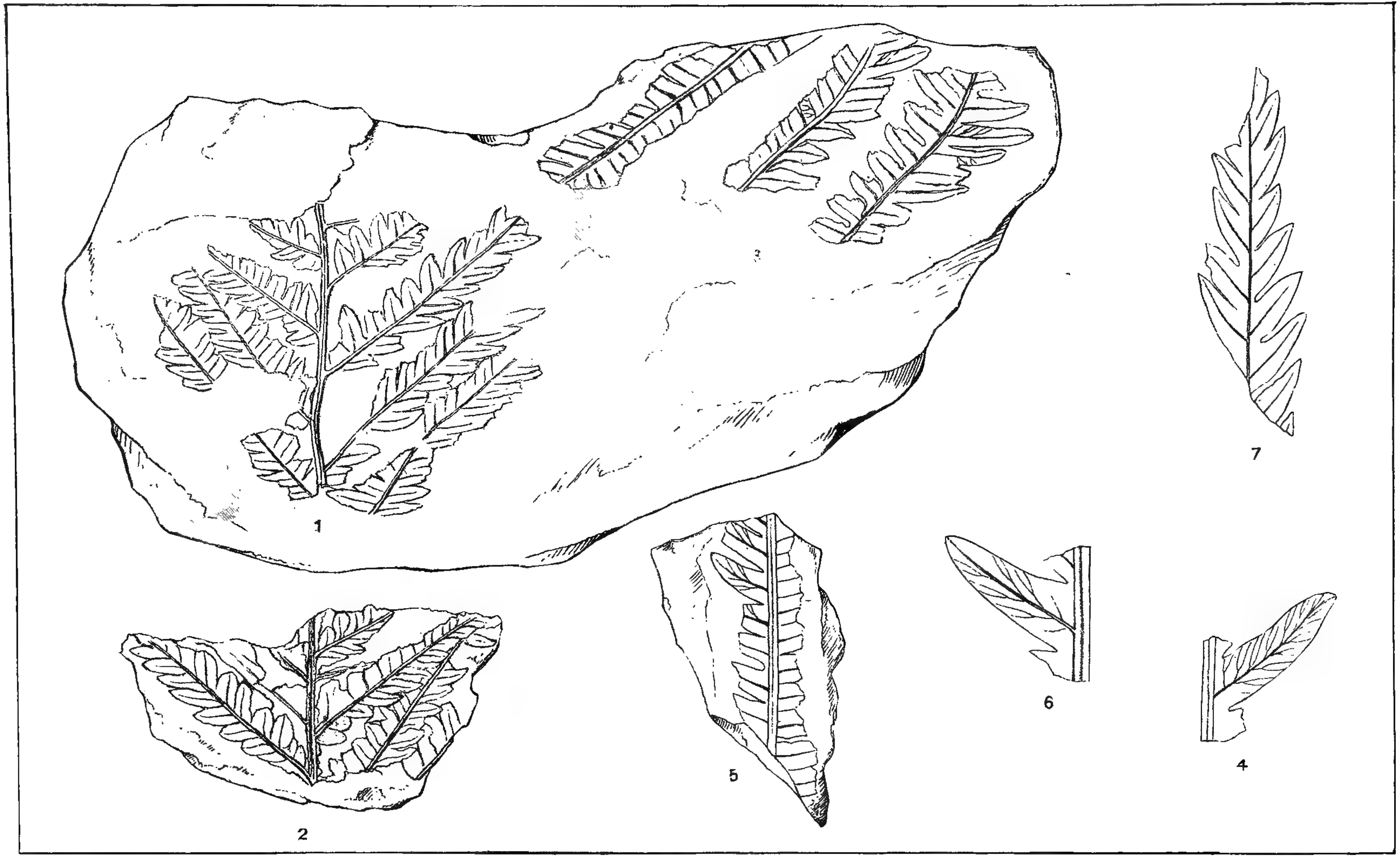


CLADOPHLEBIS, FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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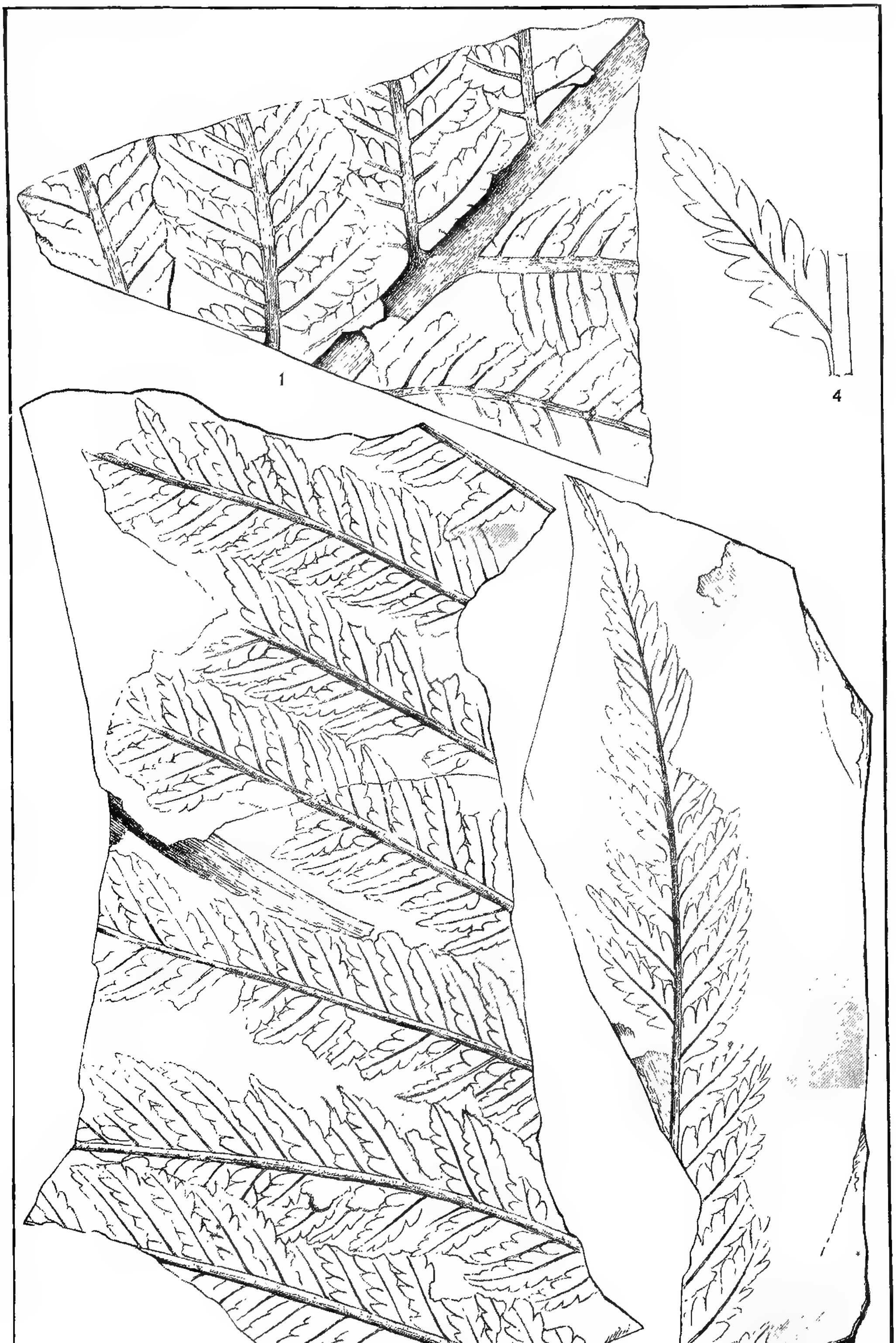


CLADOPHLEBIS DENSIFOLIA, FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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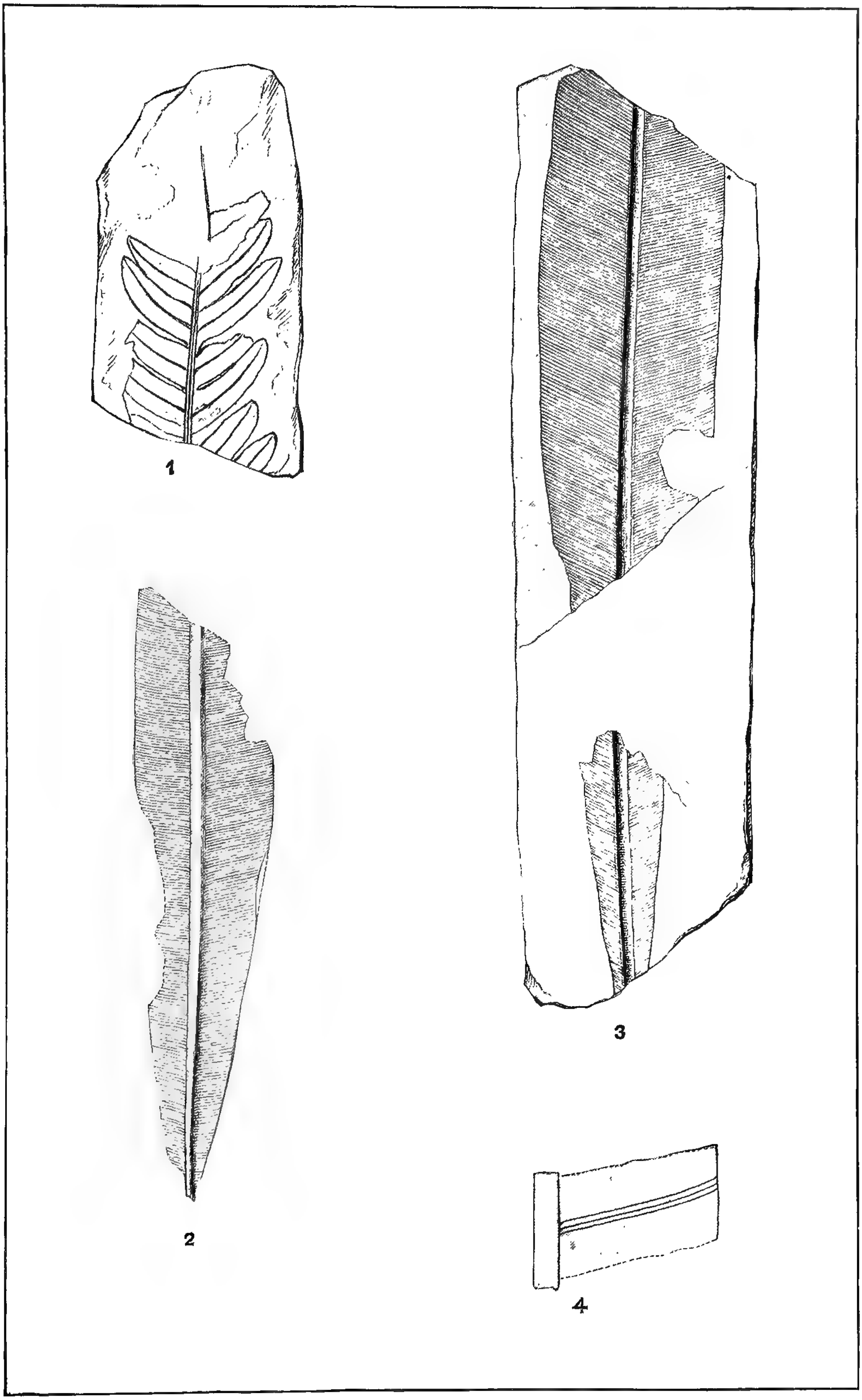


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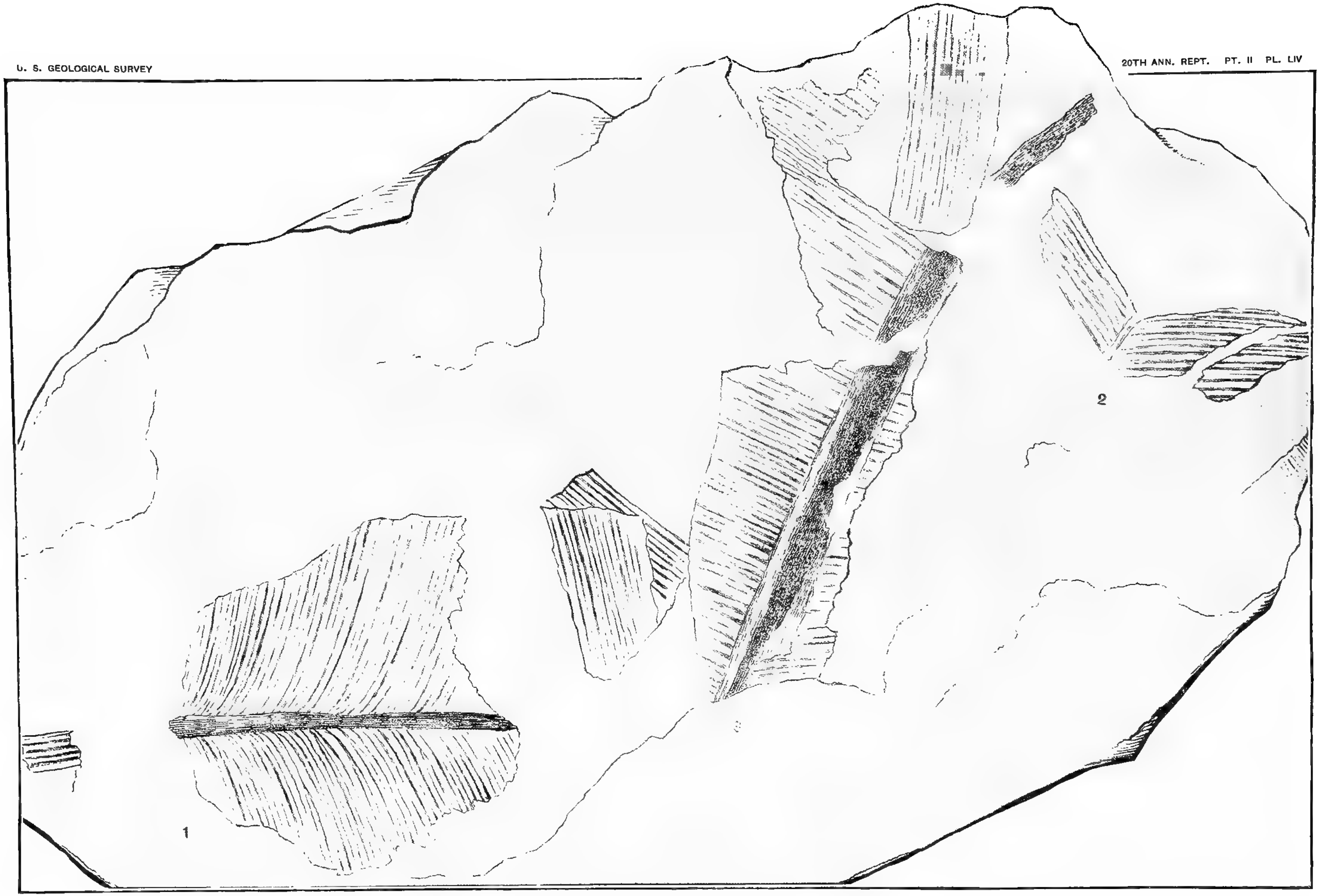


MACROTÆNIOPTERIS, FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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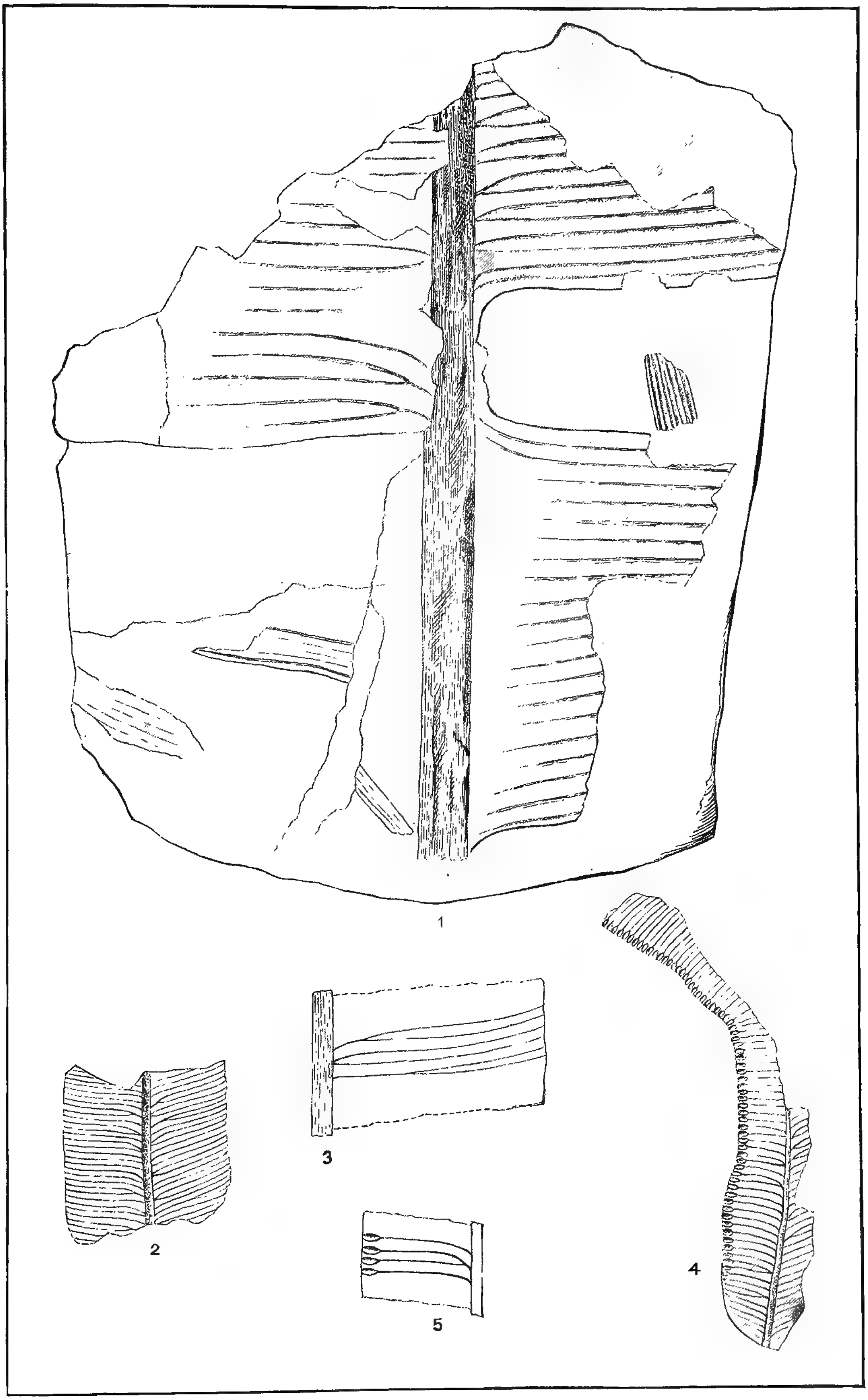


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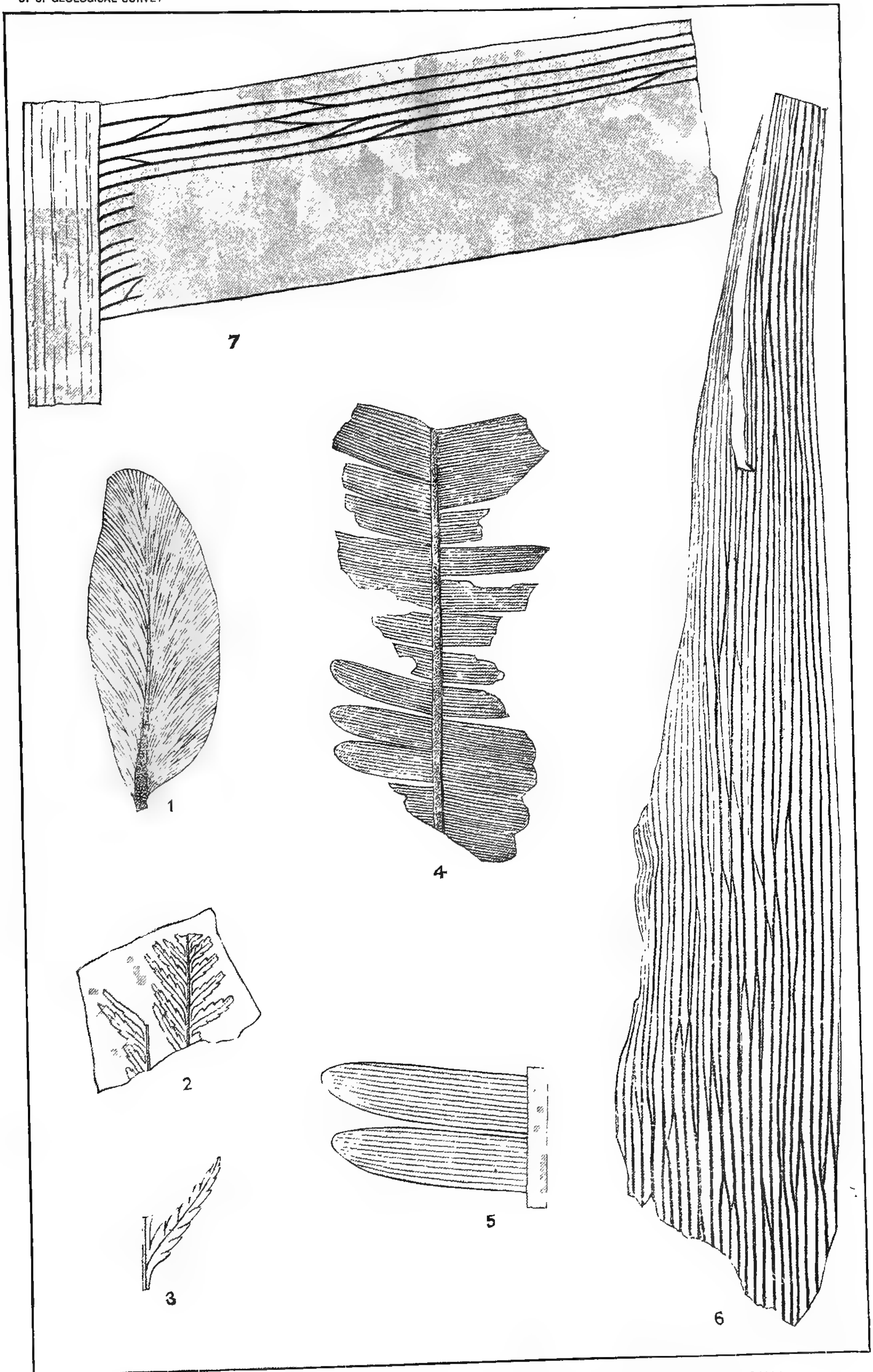


FERNS AND CYCADACEOUS PLANTS FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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CTENIS GRANDIFOLIA, FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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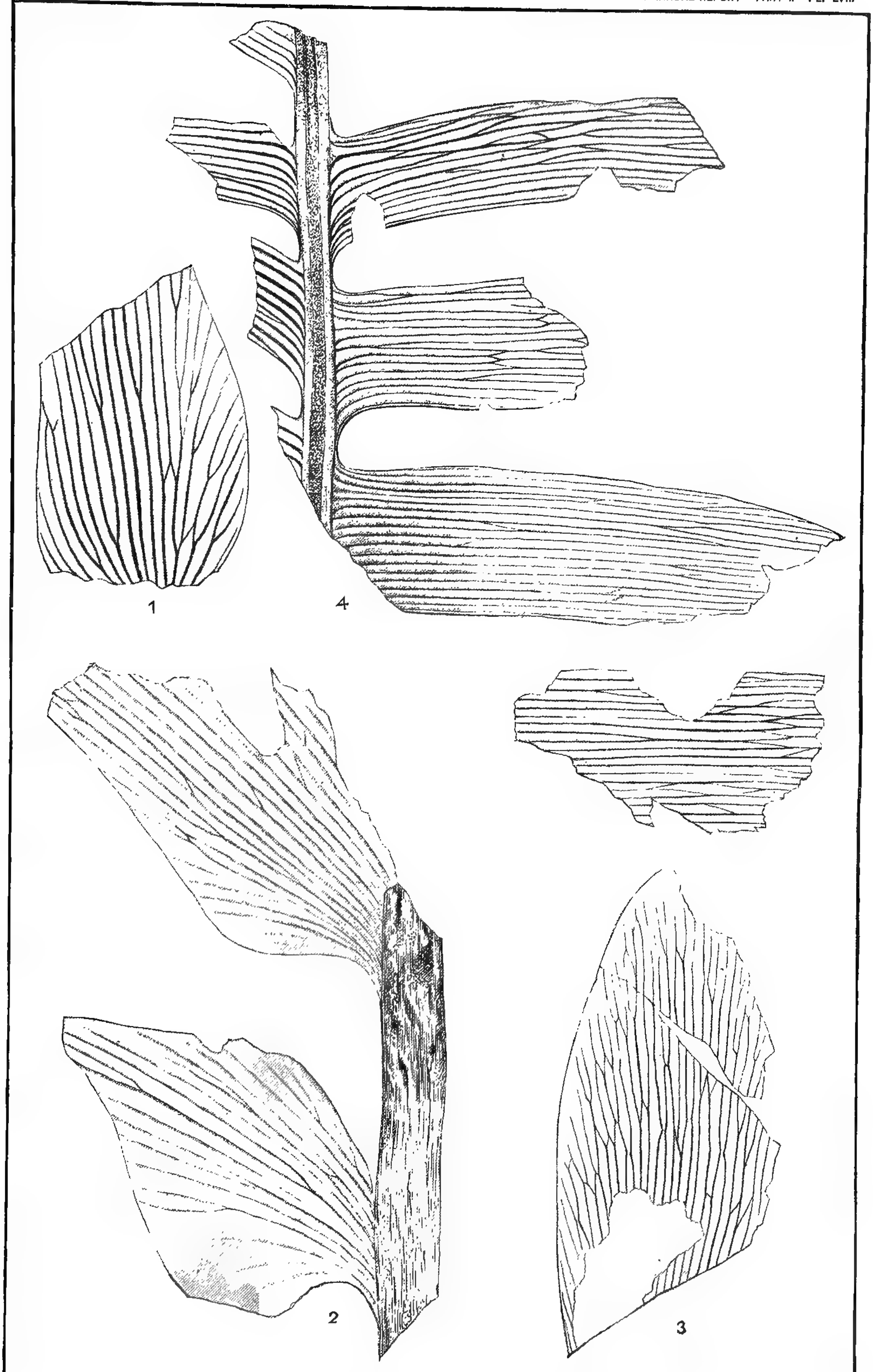


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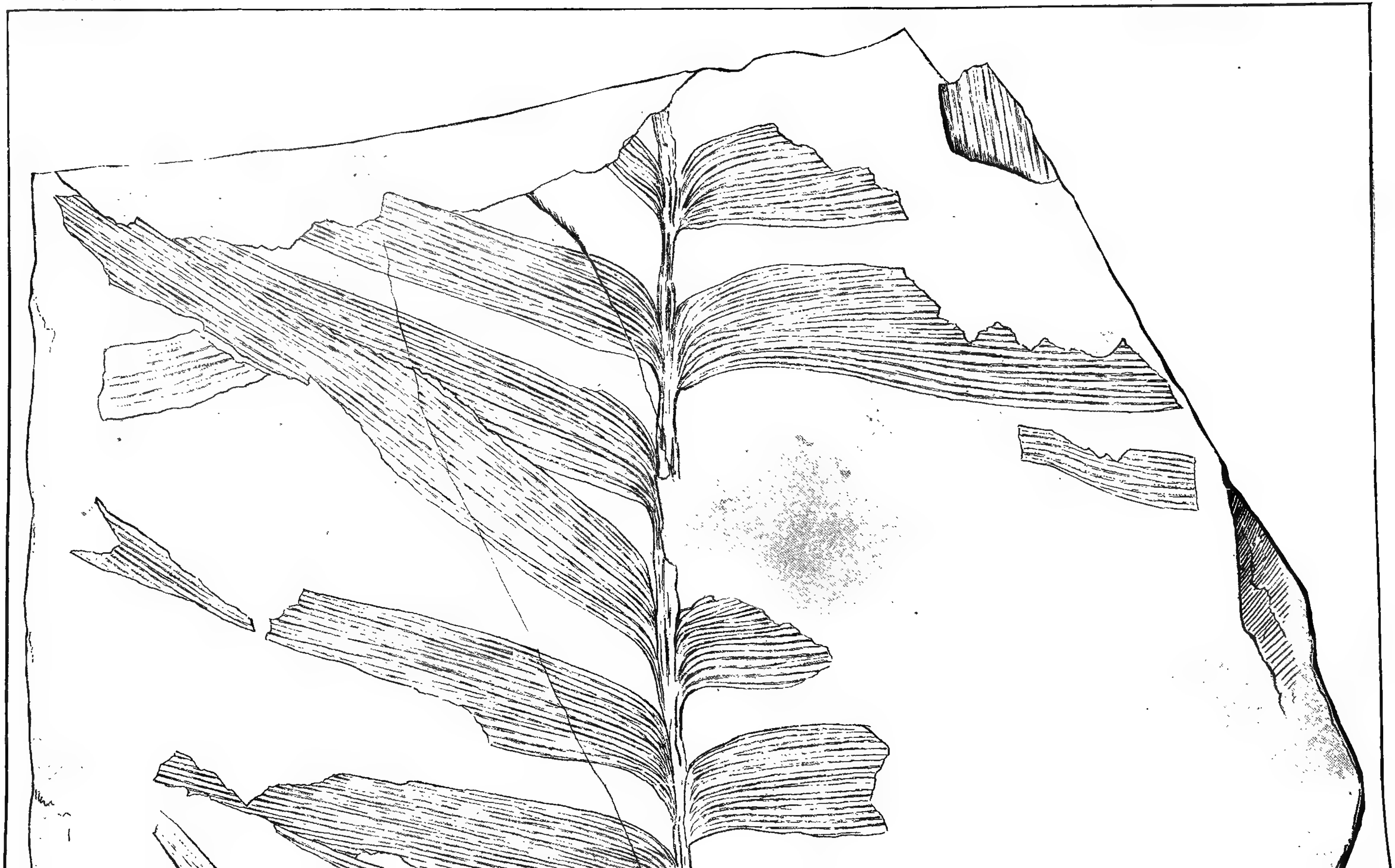

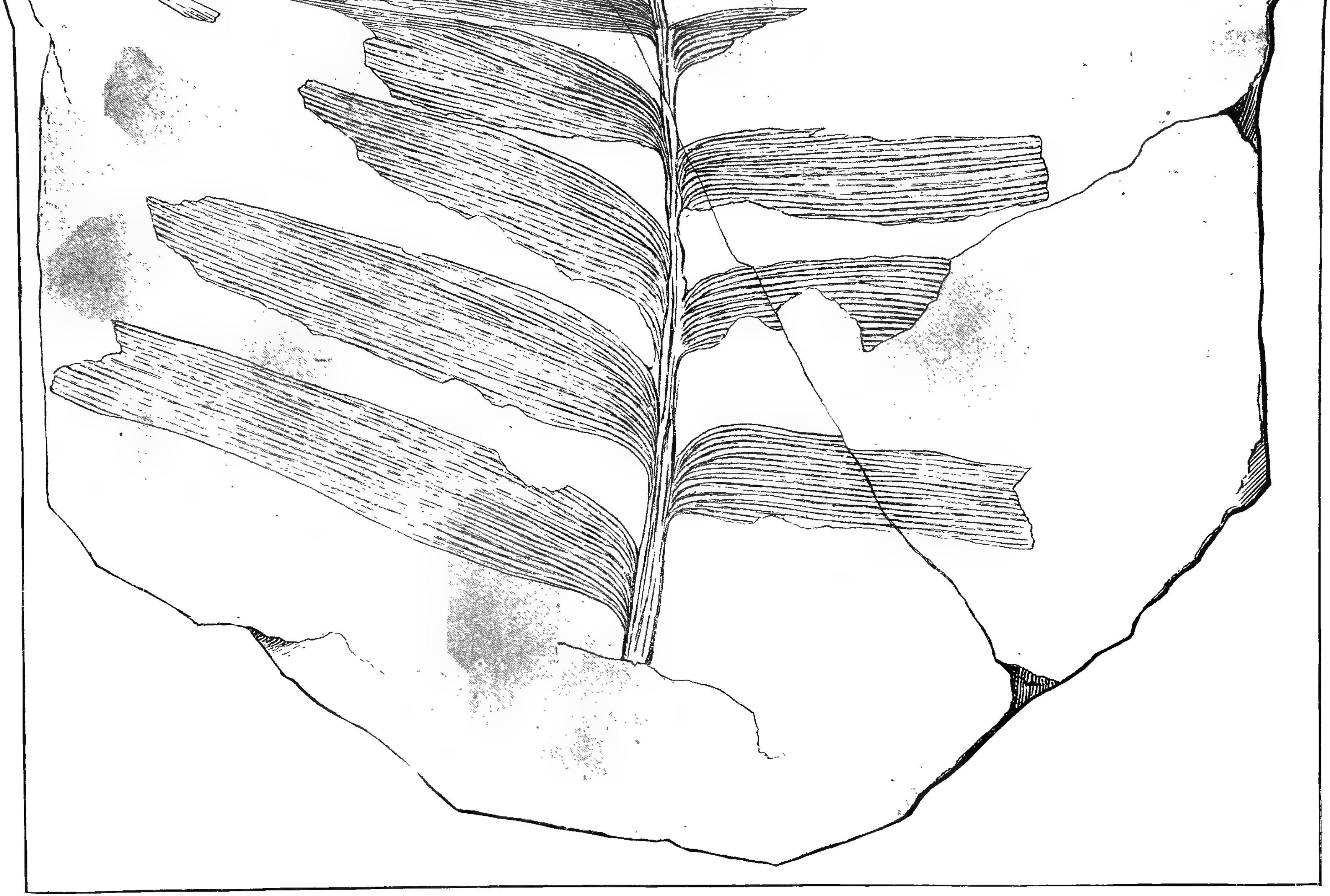

CTENOPHYLLUM WARDII, FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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CTENOPHYLLUM DENSIFOLIUM, FRO

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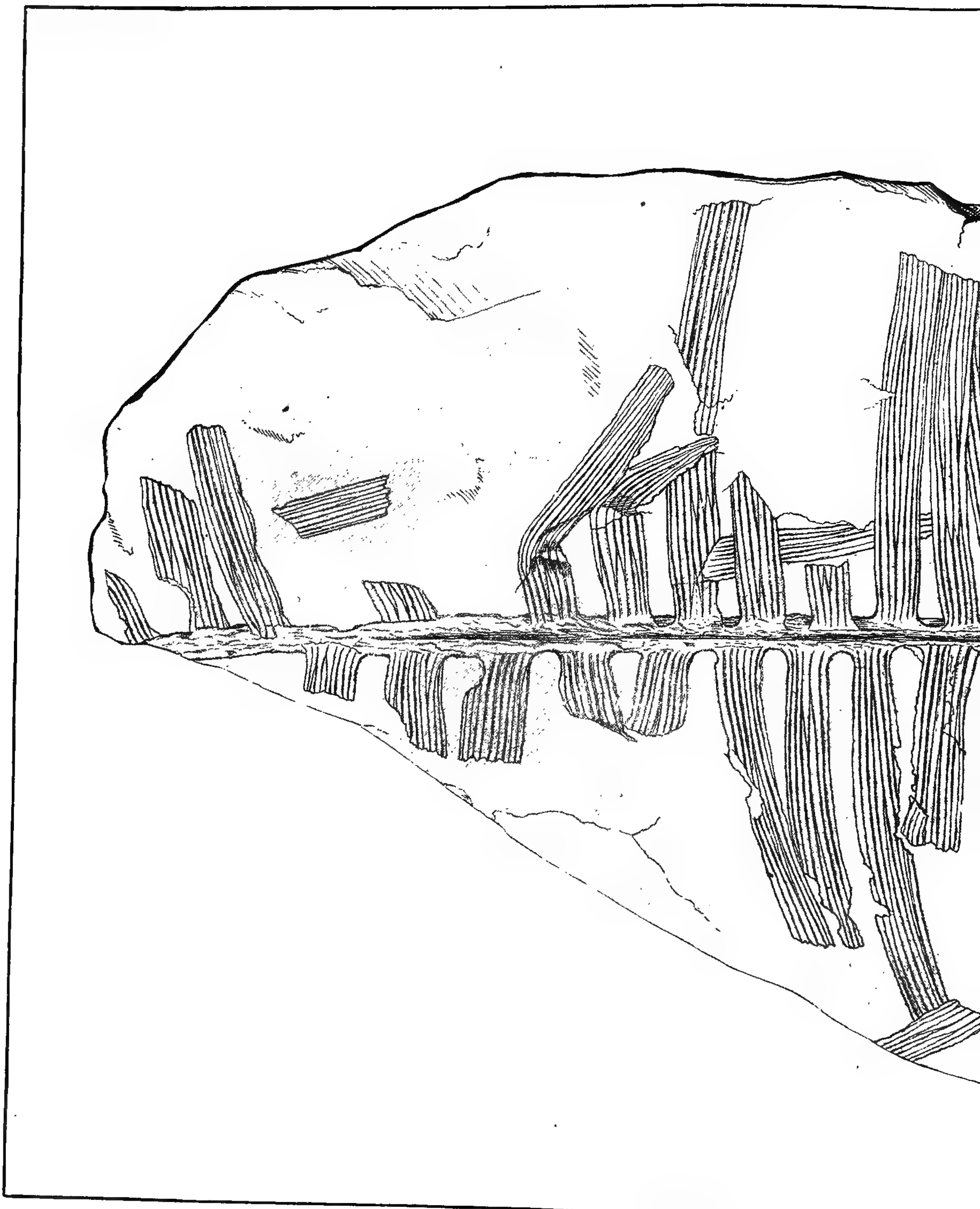
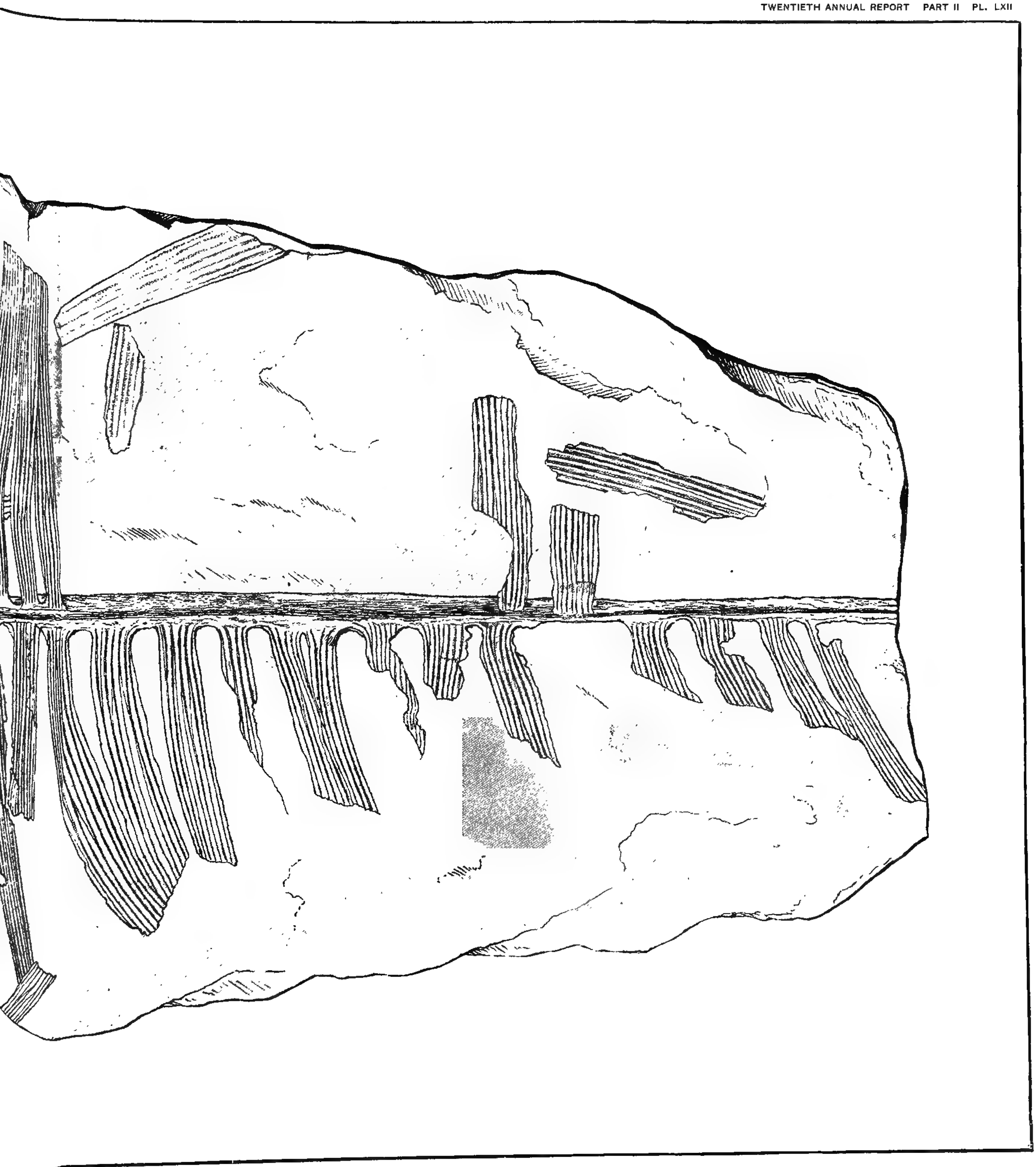


CTENOPHYLLUM GRANDIFOLIUM STORRS



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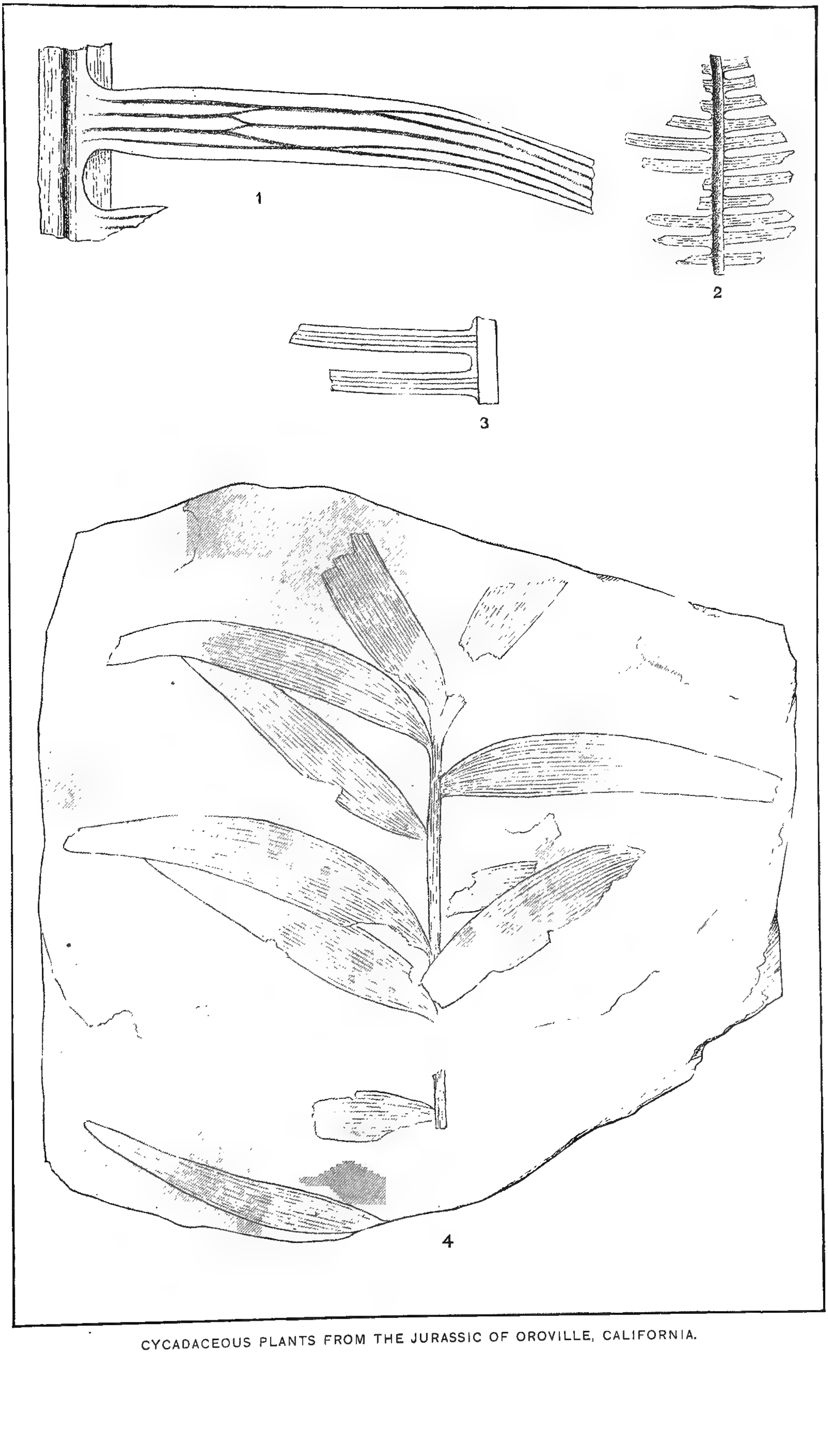


CYCADACEOUS PLANTS FROM THE JURASSIC OF OROVILLE, CALIFORNIA.

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Fig. 1. Epidermal cells of a petiole giving origin to the ramentaceous chaff.

Fig. 2. Ramentum as seen between two leaf bases within the armor.

Fig. 3. Illustration of the relative great length of the chaffy hairs, which might be traced much farther. The one on the left is cut obliquely, showing the parallel cells.

Figs. 4, 5. Cross sections of the chaff, showing their flat, sharp-edged, multicellular character.

NOTE.—Figs. 1–3 were obtained from slides of No. 500.76 of the Museum of the University of Wyoming, and therefore belong to *C. Knowltoniana.* Figs. 4 and 5 are from No. 500.39, and therefore belong to *C. ramentosa.*

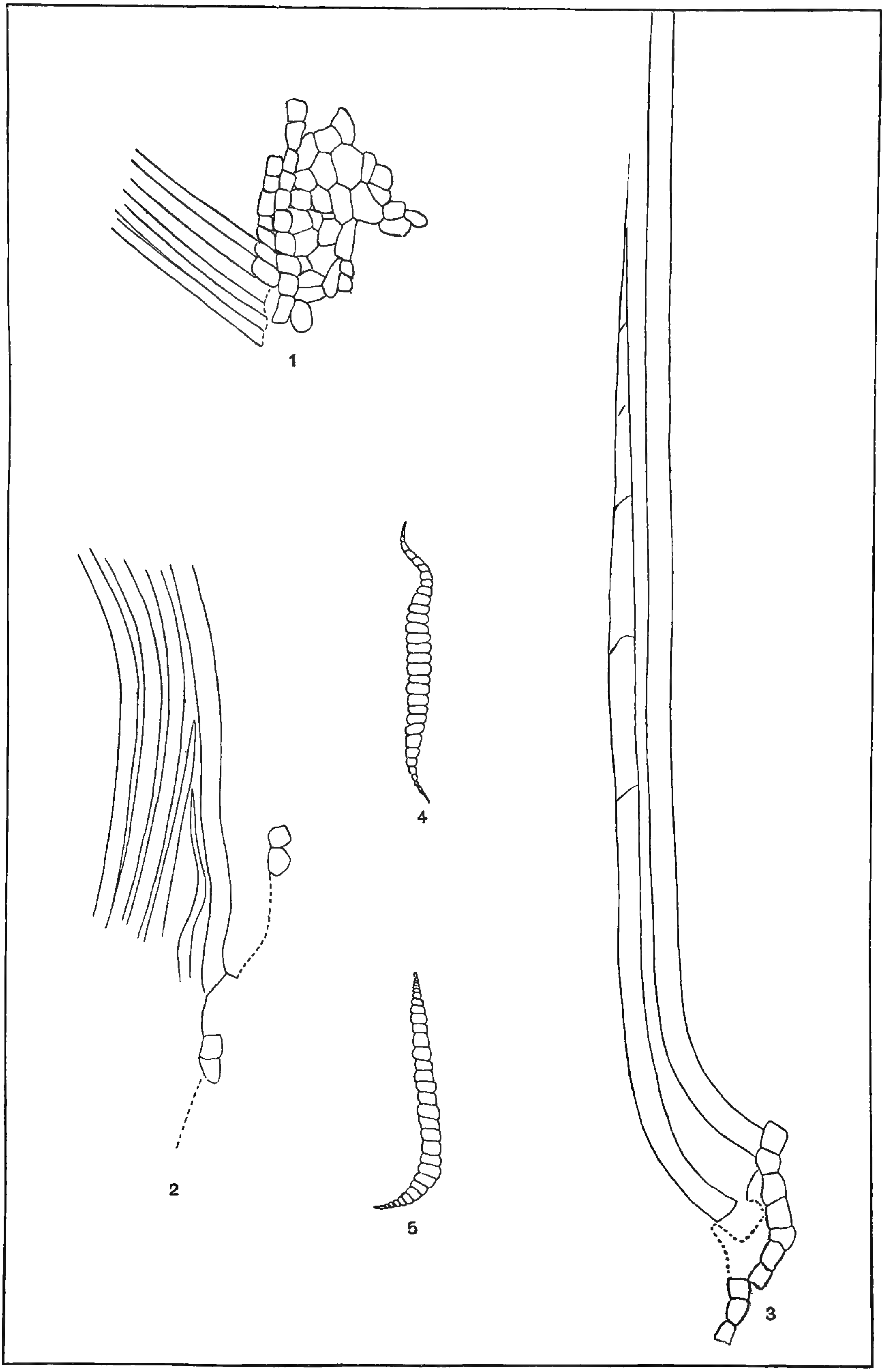


ILLUSTRATION OF THE GENUS CYCADELLA.

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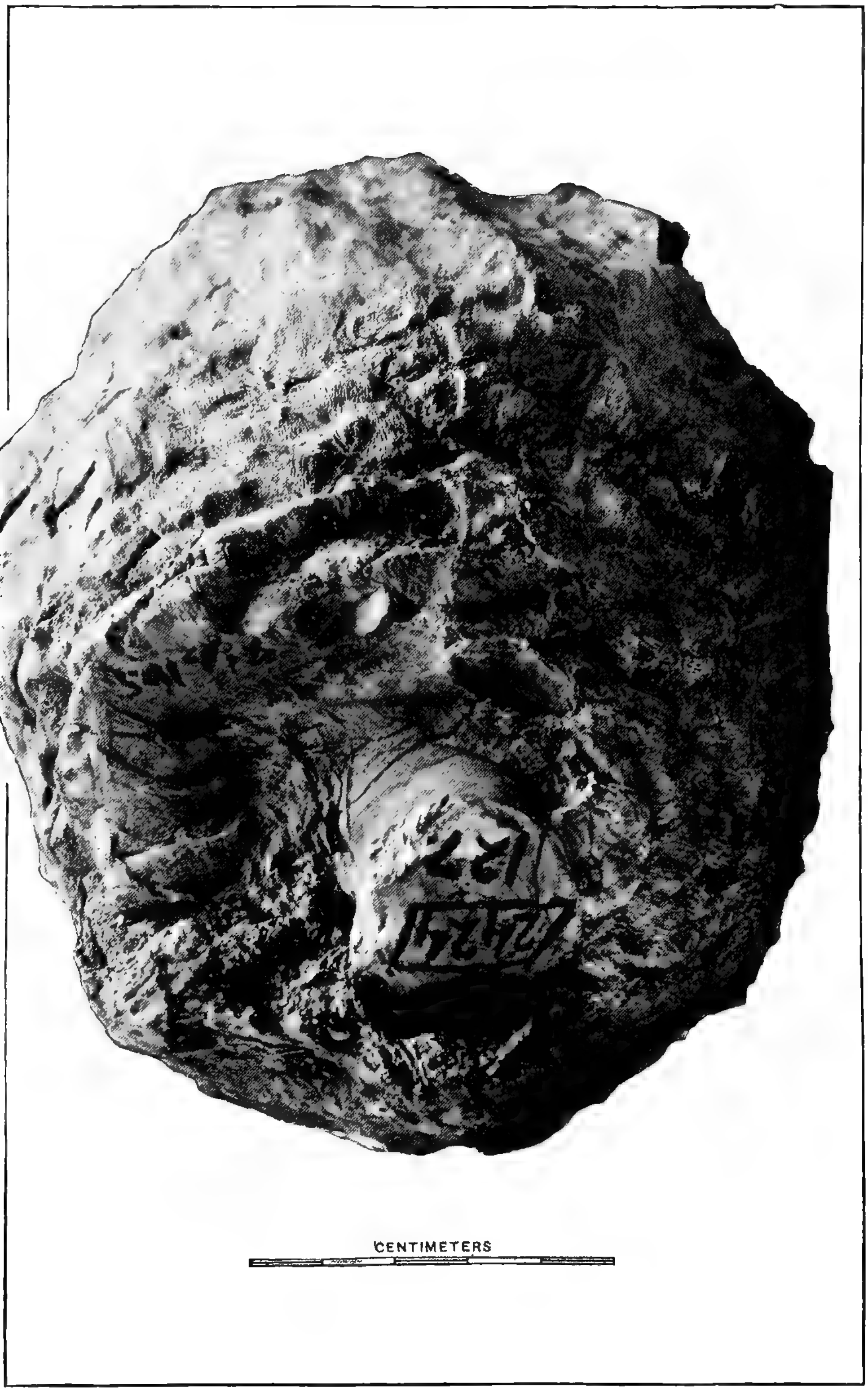
View of the best-preserved side of No. 127 of the Yale collection, including the eccentric base.




CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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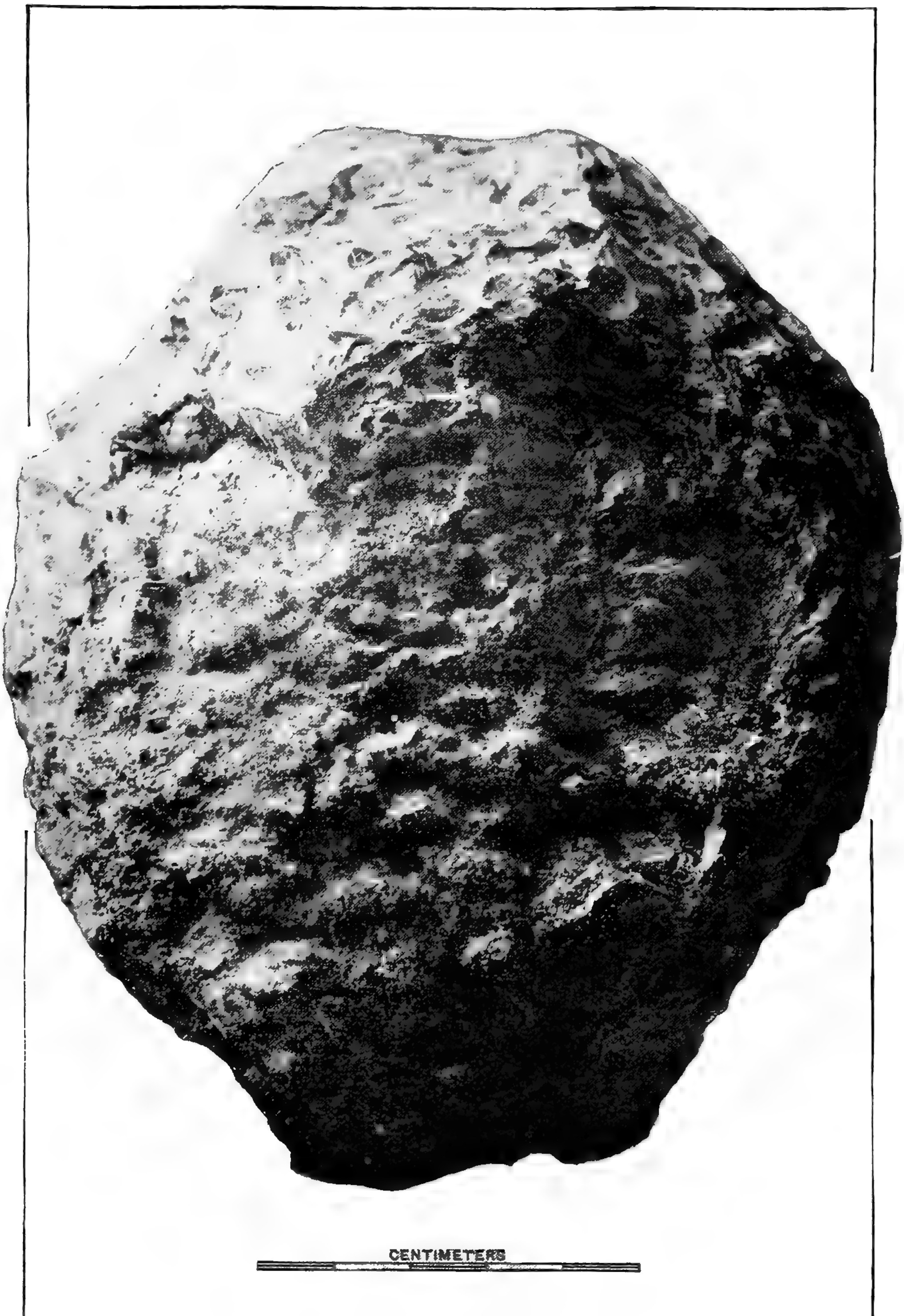
Side view of No. 127 of the Yale collection.




CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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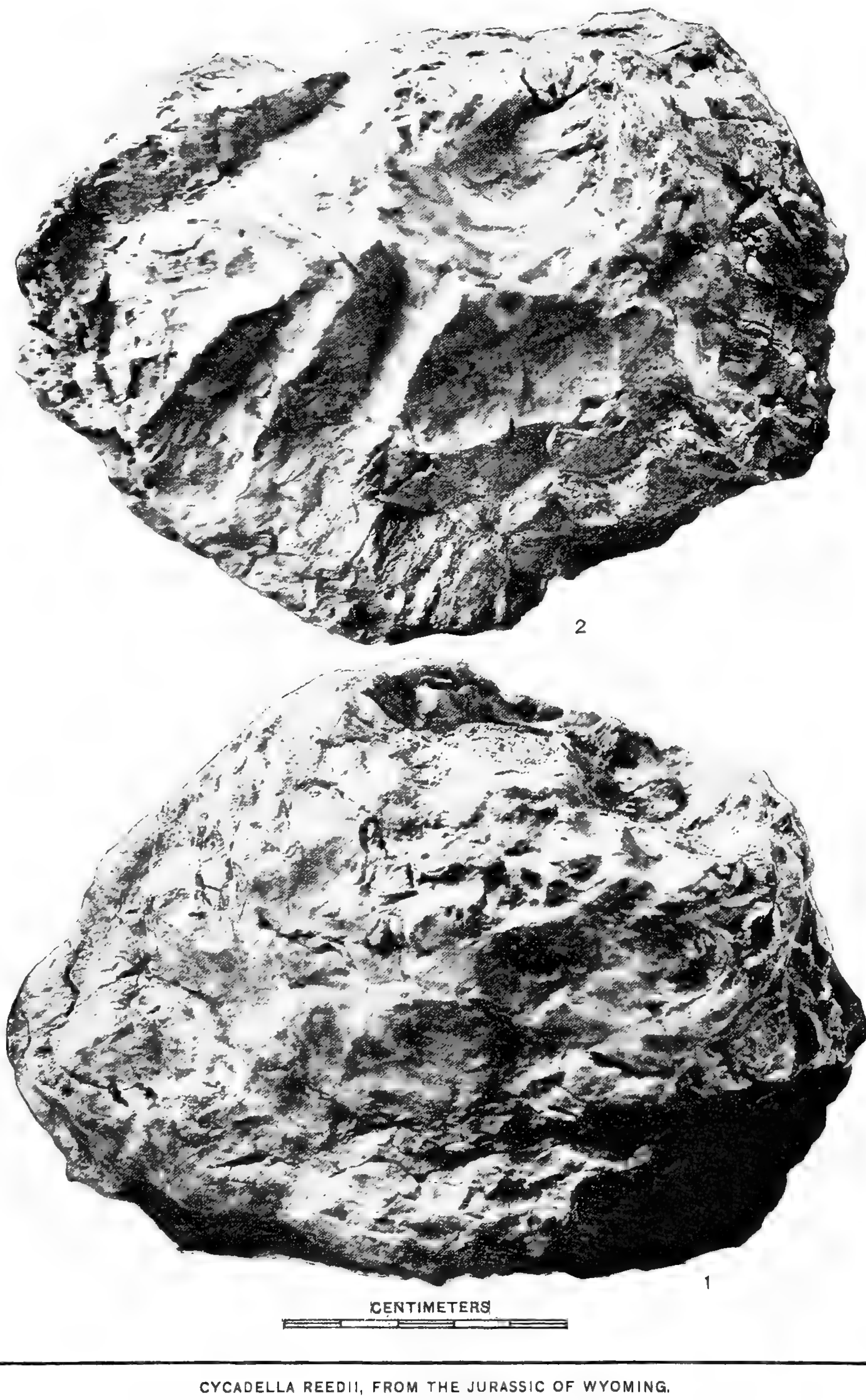
No. 500.29 of the Museum of the University of Wyoming.

Fig. 1. Side view.

Fig. 2. View of the base.




CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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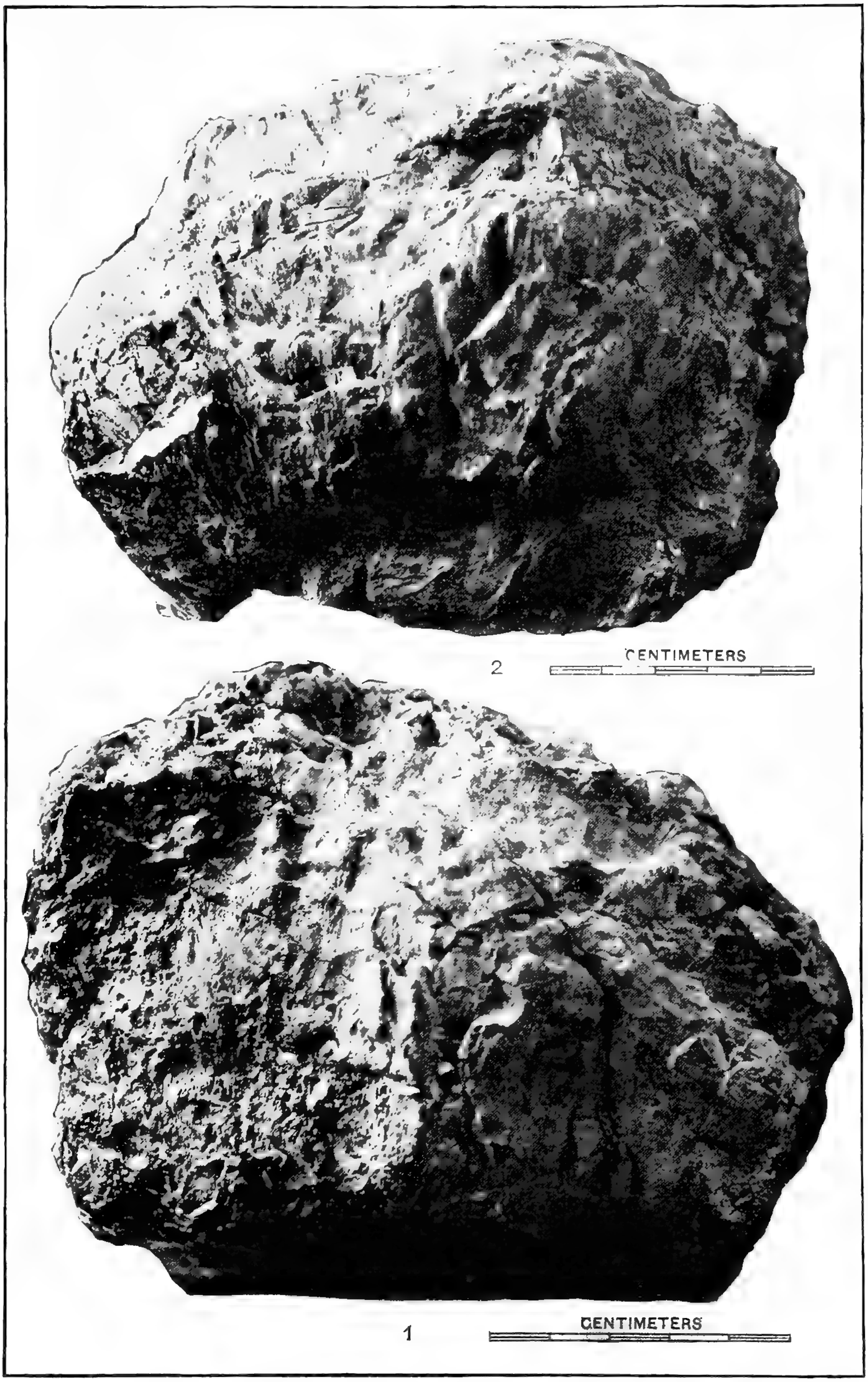
No. 500.6 of the Museum of the University of Wyoming.

Figs. 1 and 2. Views of the opposite broadest sides.




CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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No. 500.19 of the Museum of the University of Wyoming.

Fig. 1. View of the best-preserved side.

Fig. 2. View of the base.

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CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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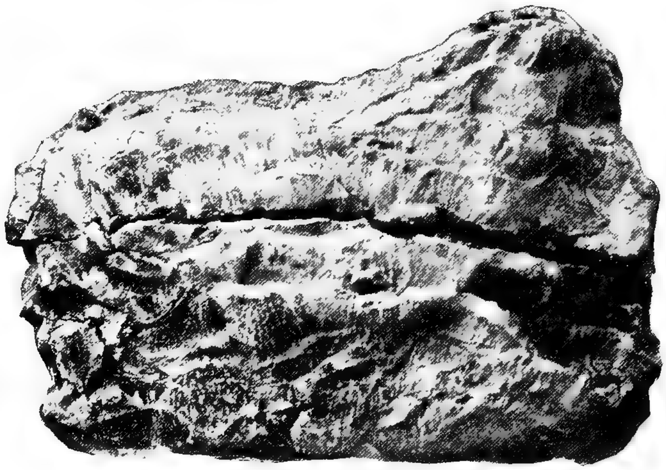
No. 500.10 of the Museum of the University of Wyoming.

Figs. 1 and 2. Views of the opposite broadest sides.



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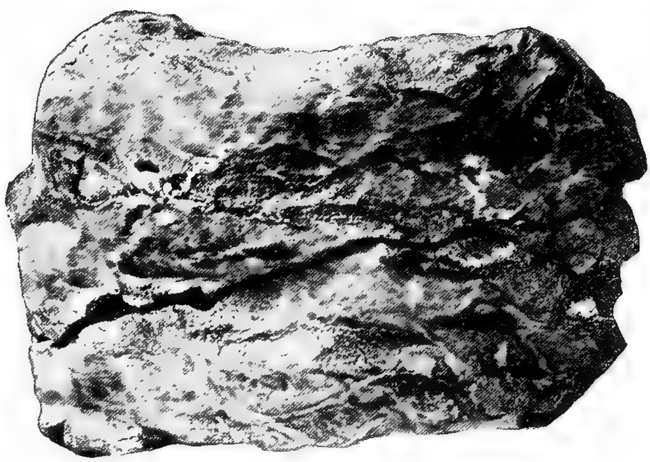

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CYCADELLA REEDII, FROM THE JURASSIC OF WYOMING.

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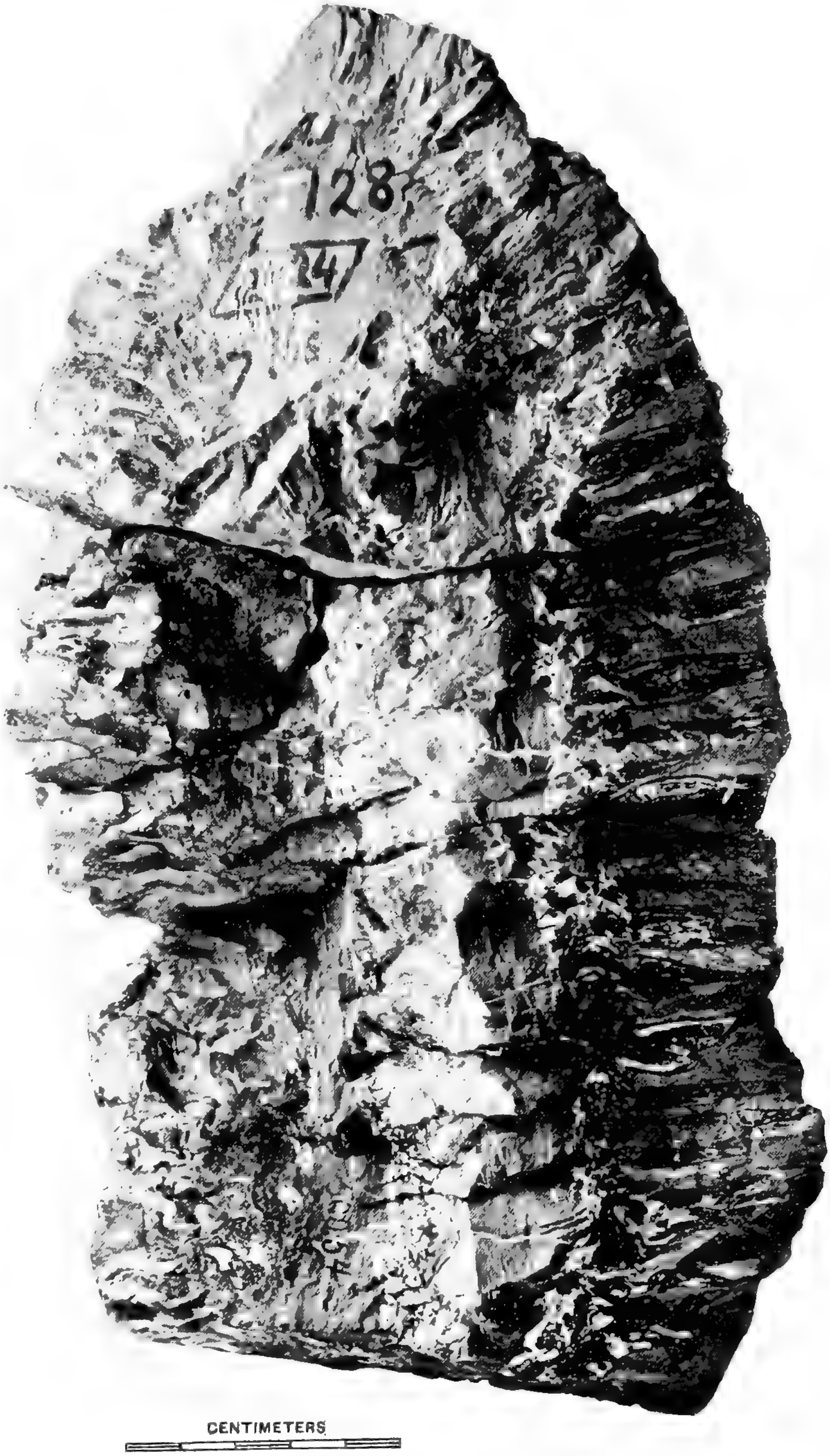
Fractured surface of No. 128 of the Yale collection (three upper pieces), and No. 500.54 of the Museum of the University of Wyoming (lower piece).




CYCADELLA BEECHERIANA, FROM THE JURASSIC OF WYOMING.

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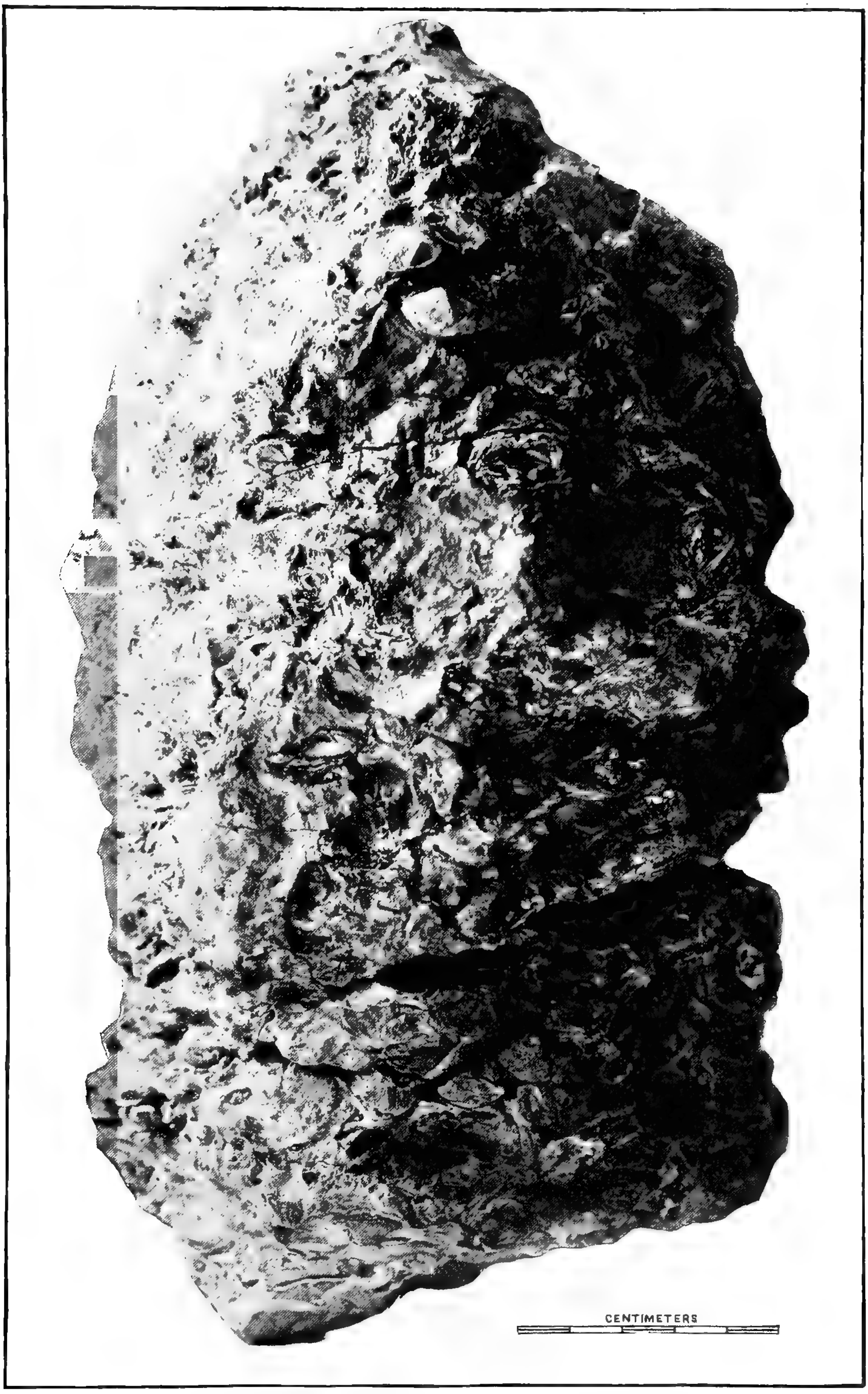
Outer surface of No. 128 of the Yale collection (three upper pieces) and No. 500.54 of the Museum of the University of Wyoming (lower piece).




CYCADELLA BEECHERIANA, FROM THE JURASSIC OF WYOMING.

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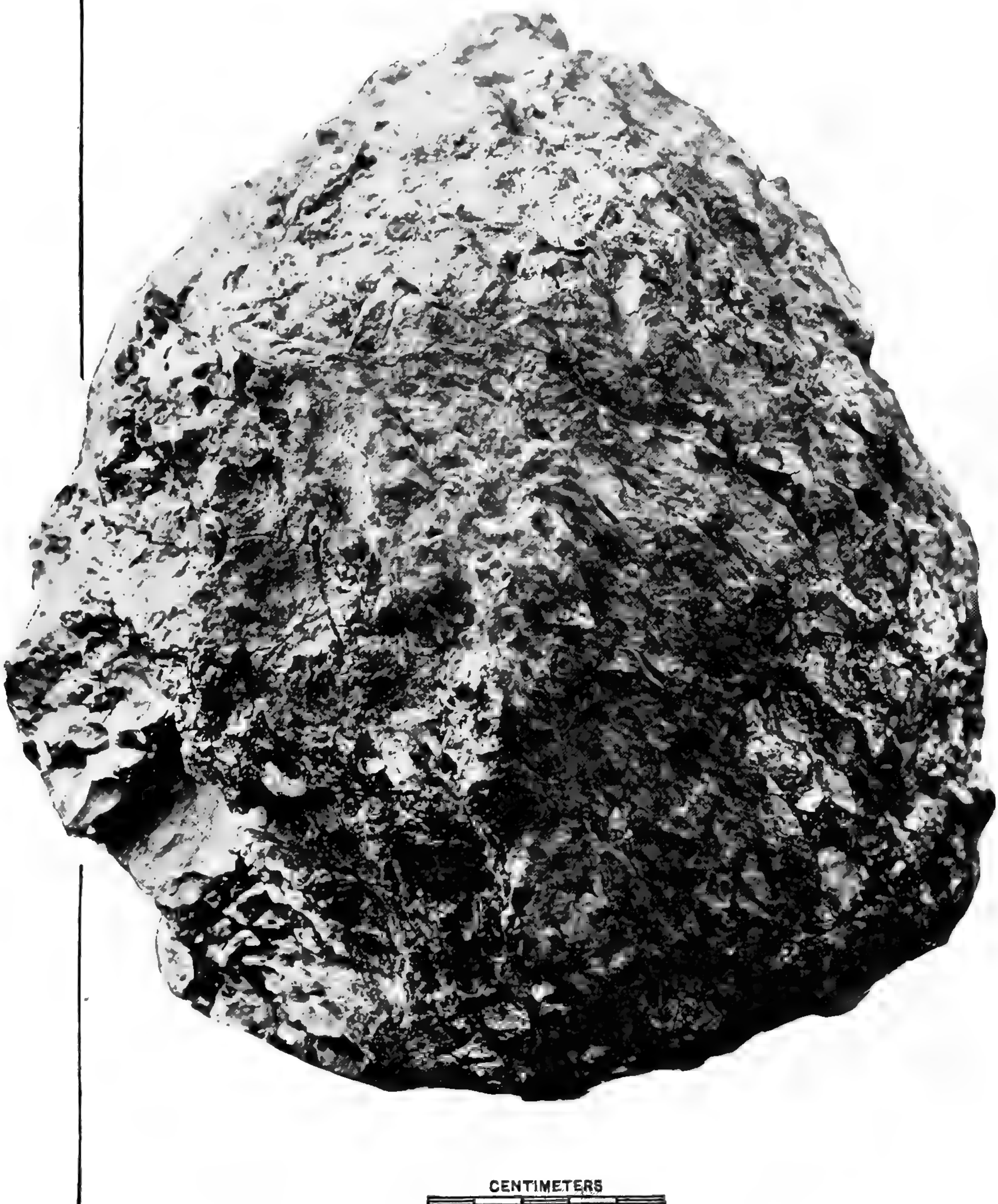
View of the best-preserved side of No. 500.3 of the Museum of the University of Wyoming.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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View of the base and somewhat fractured side of No. 500.3 of the Museum of the University of Wyoming.


CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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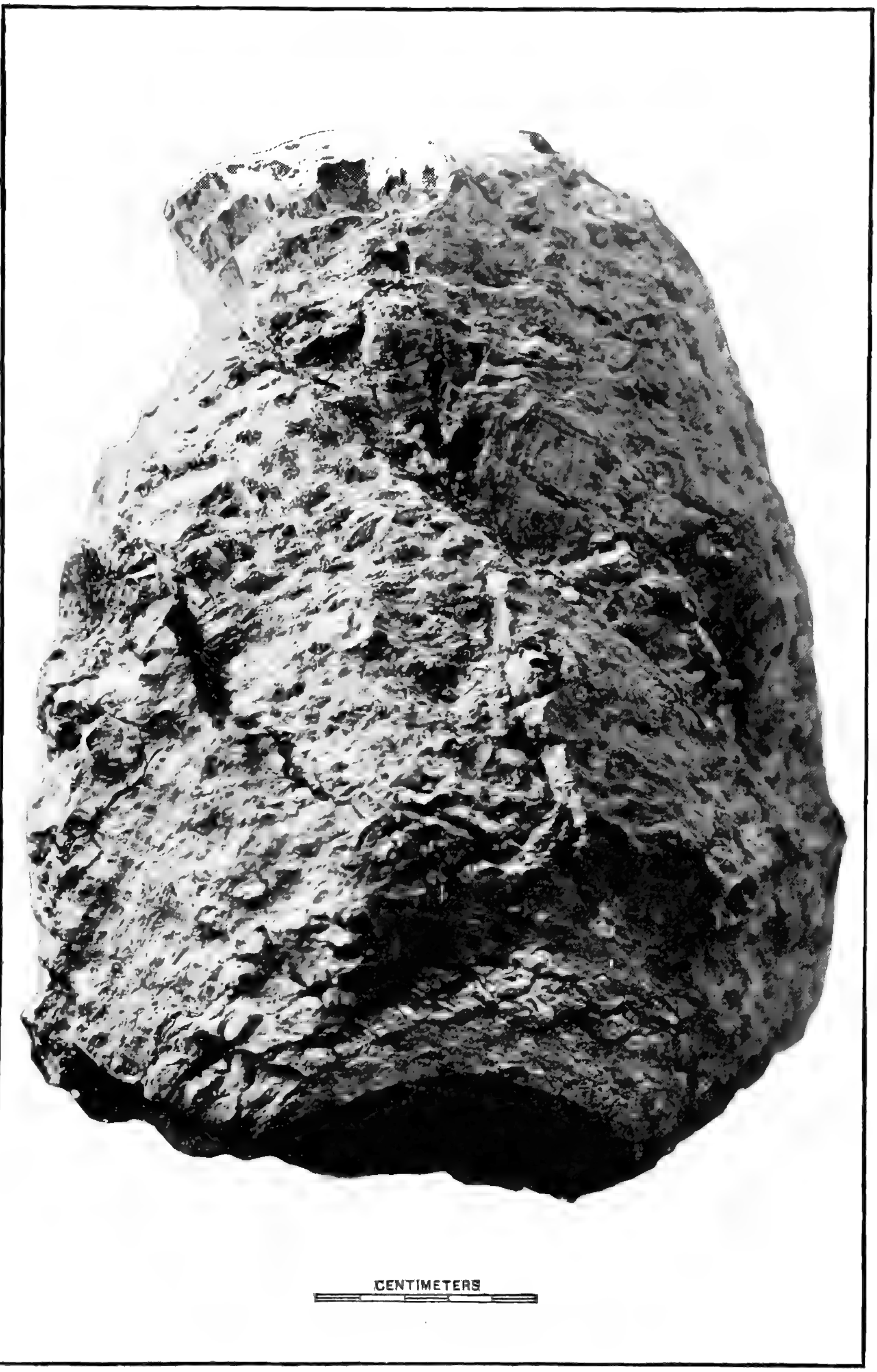
View of one of the sides of No. 500.14 of the Museum of the University of Wyoming, showing portions of the surface from which the outer coat has been scaled off.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING

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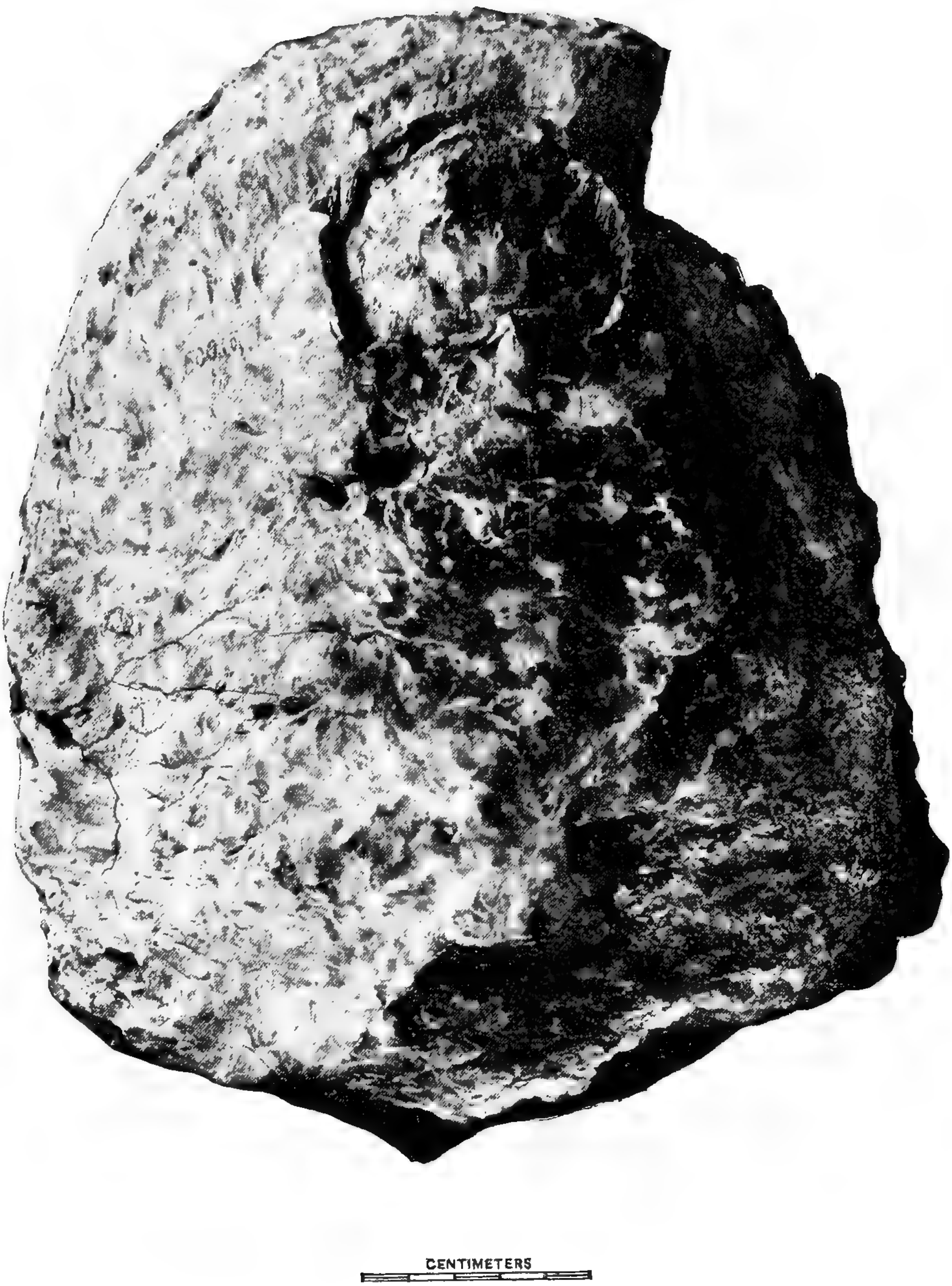
View of the side of No. 500.14 of the Museum of the University of Wyoming, which is nearly all covered with the outer coat, but showing the terminal bud near the summit.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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View of the base of No. 500.14 of the Museum of the University of Wyoming.


CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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View of the best-preserved side of No. 500.15 of the Museum of the University of Wyoming.


CYCADELLA WYOMINGENSIS FROM THE JURASSIC OF WYOMING.

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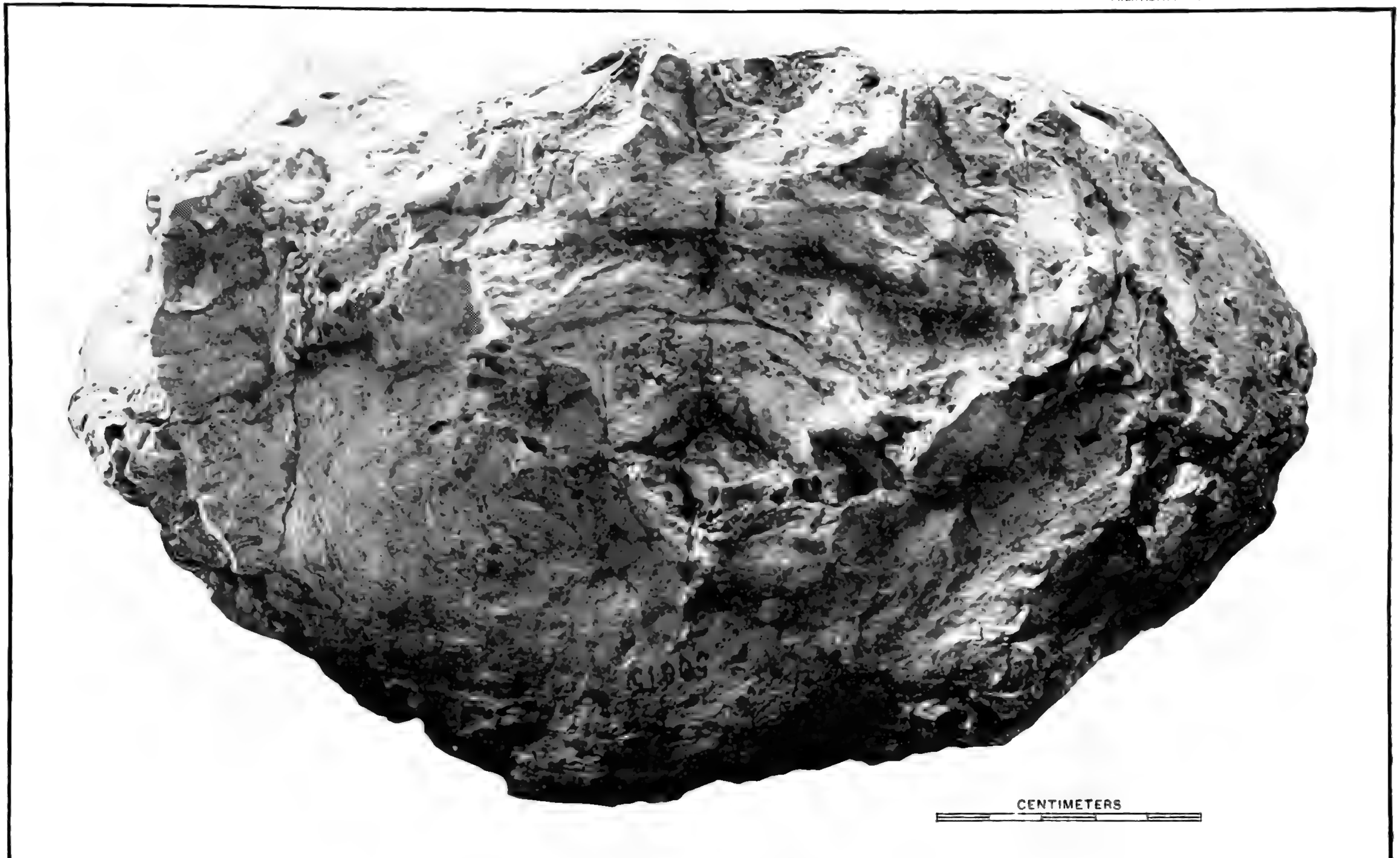
View of the base of No. 500.15 of the Museum of the University of Wyoming.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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## PLATE LXXXVI.


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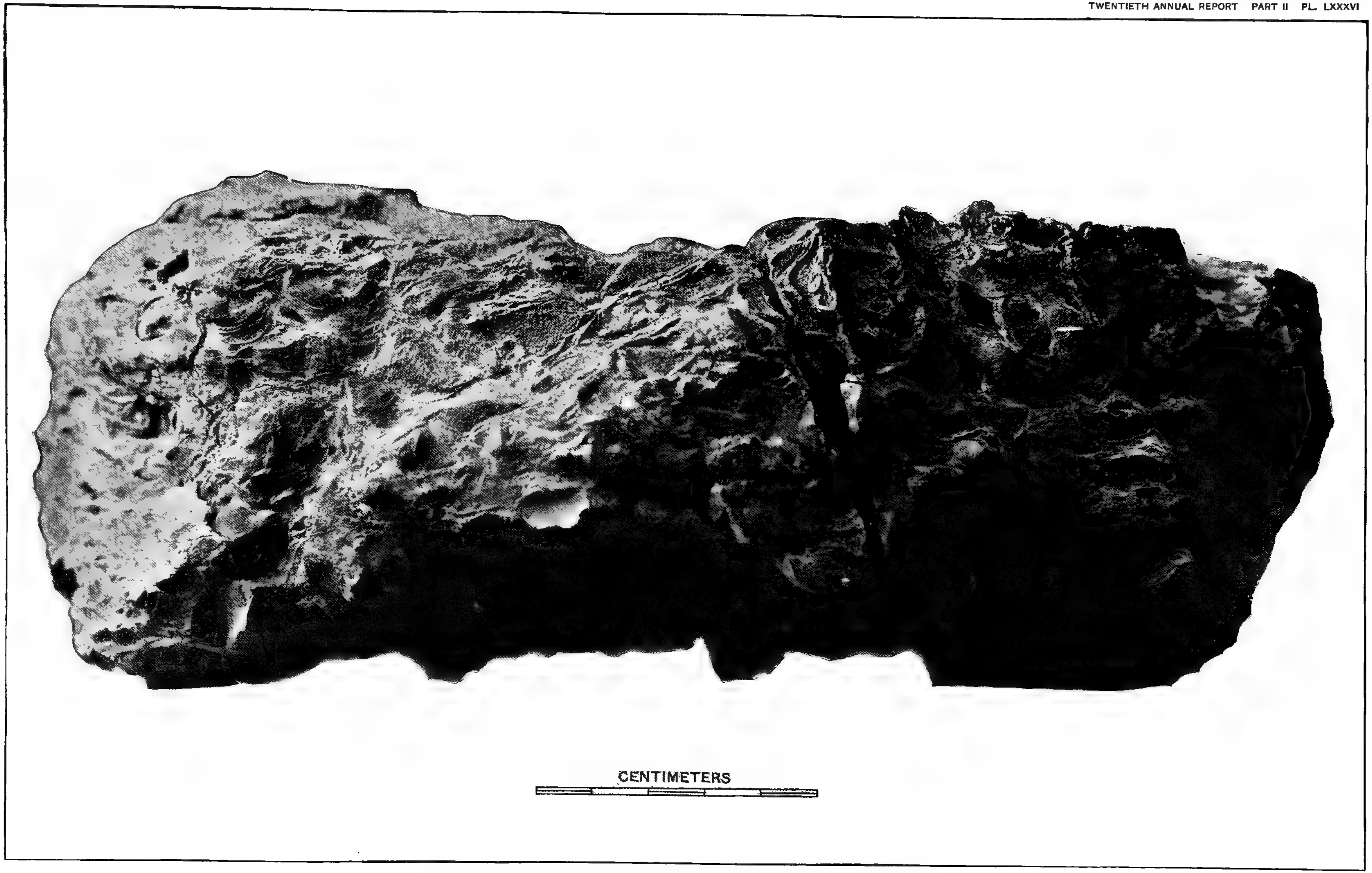
Cycadella wyomingensis Ward.......................................... 395

View of one side of the segment of a trunk, No. 500.26 of the Museum of the University of Wyoming.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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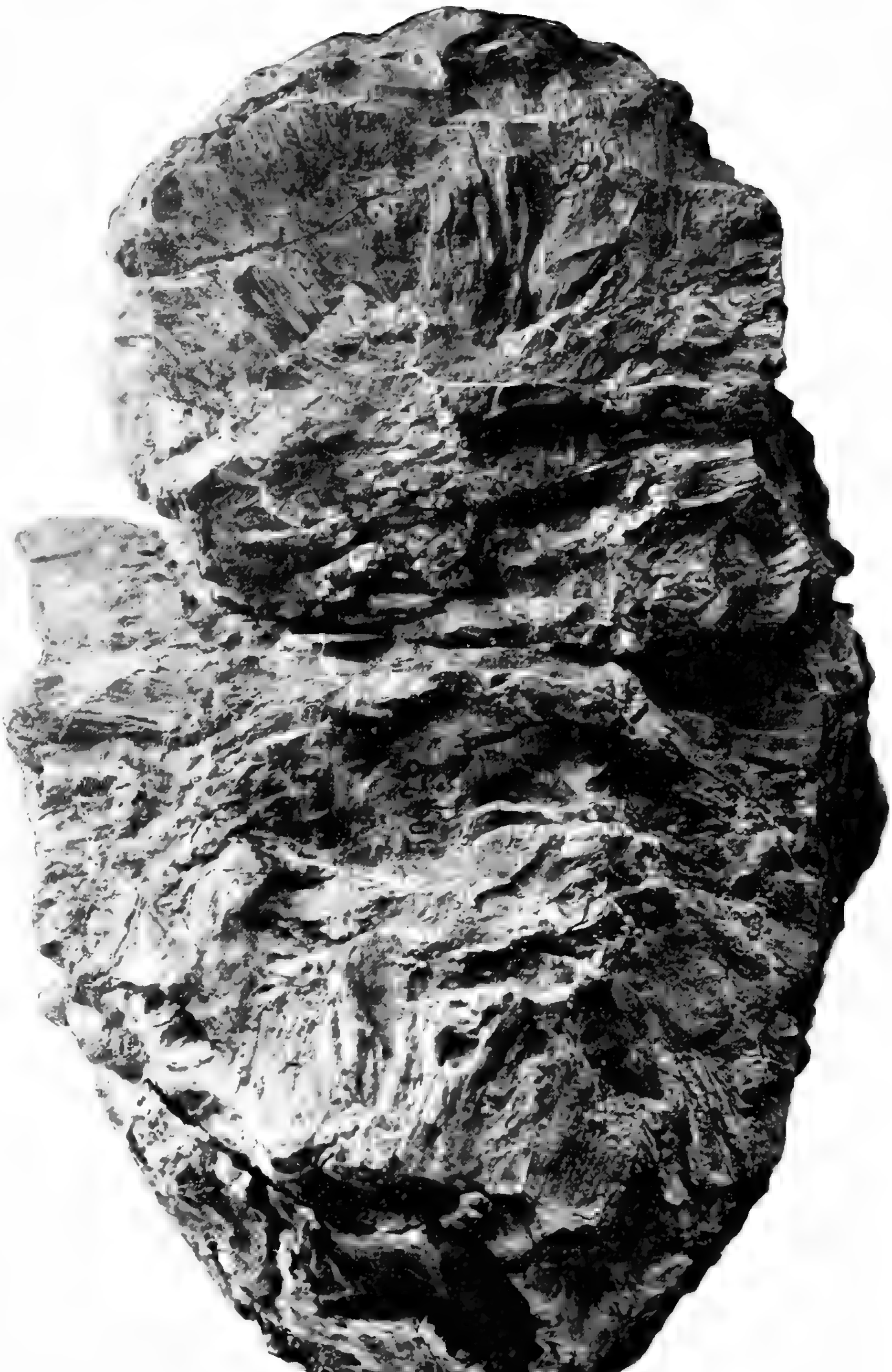
View of the upper fractured surface of No. 500.26 of the Museum of the University of Wyoming.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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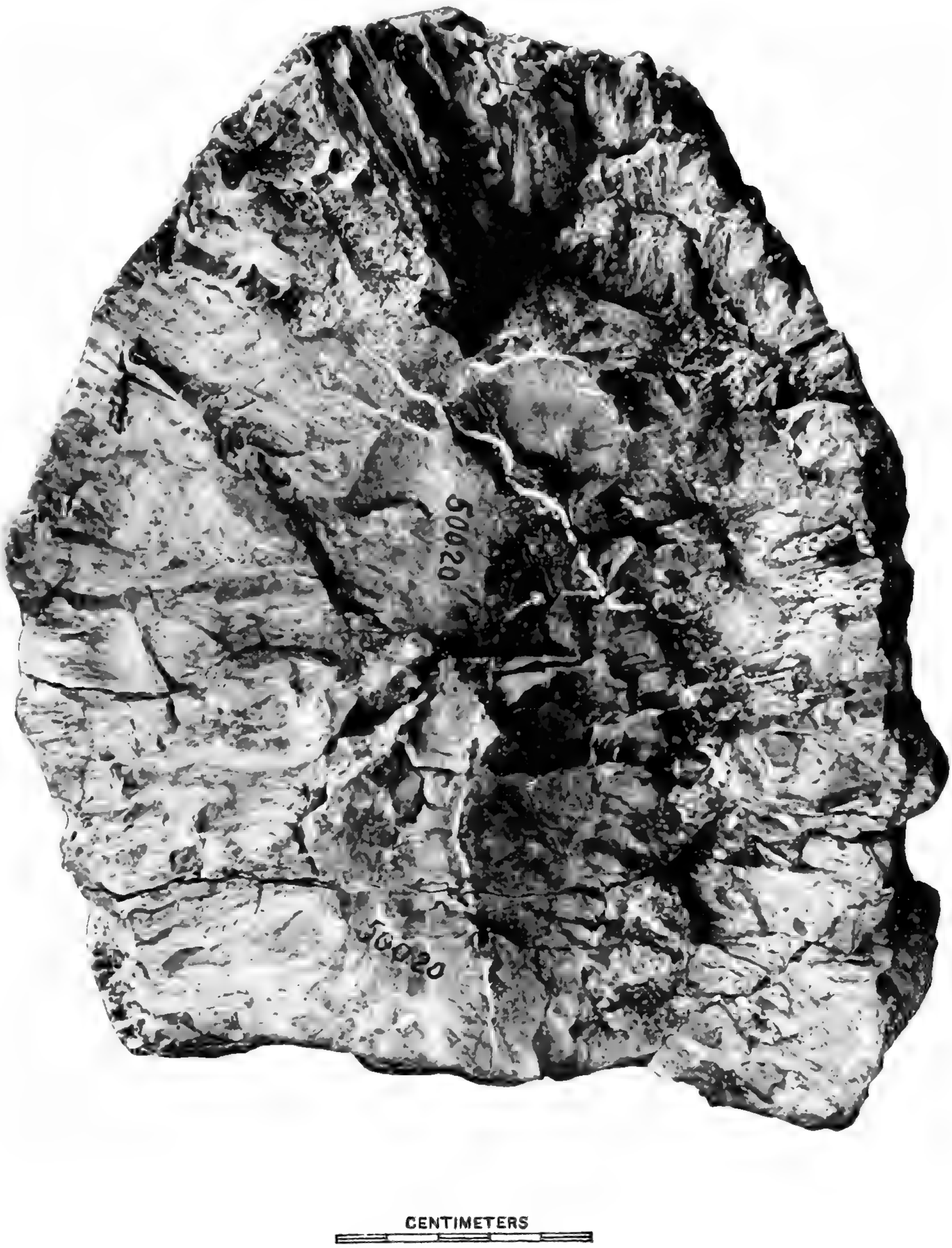
View of the upper fractured surface of the segment of a trunk No. 500.20 of the Museum of the University of Wyoming.




CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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# PLATE LXXXIX.

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Cycadella wyomingensis Ward........................................ 395
View of the lower fractured surface of the thin segment of a trunk No. 500.7 of the Museum of the University of Wyoming.
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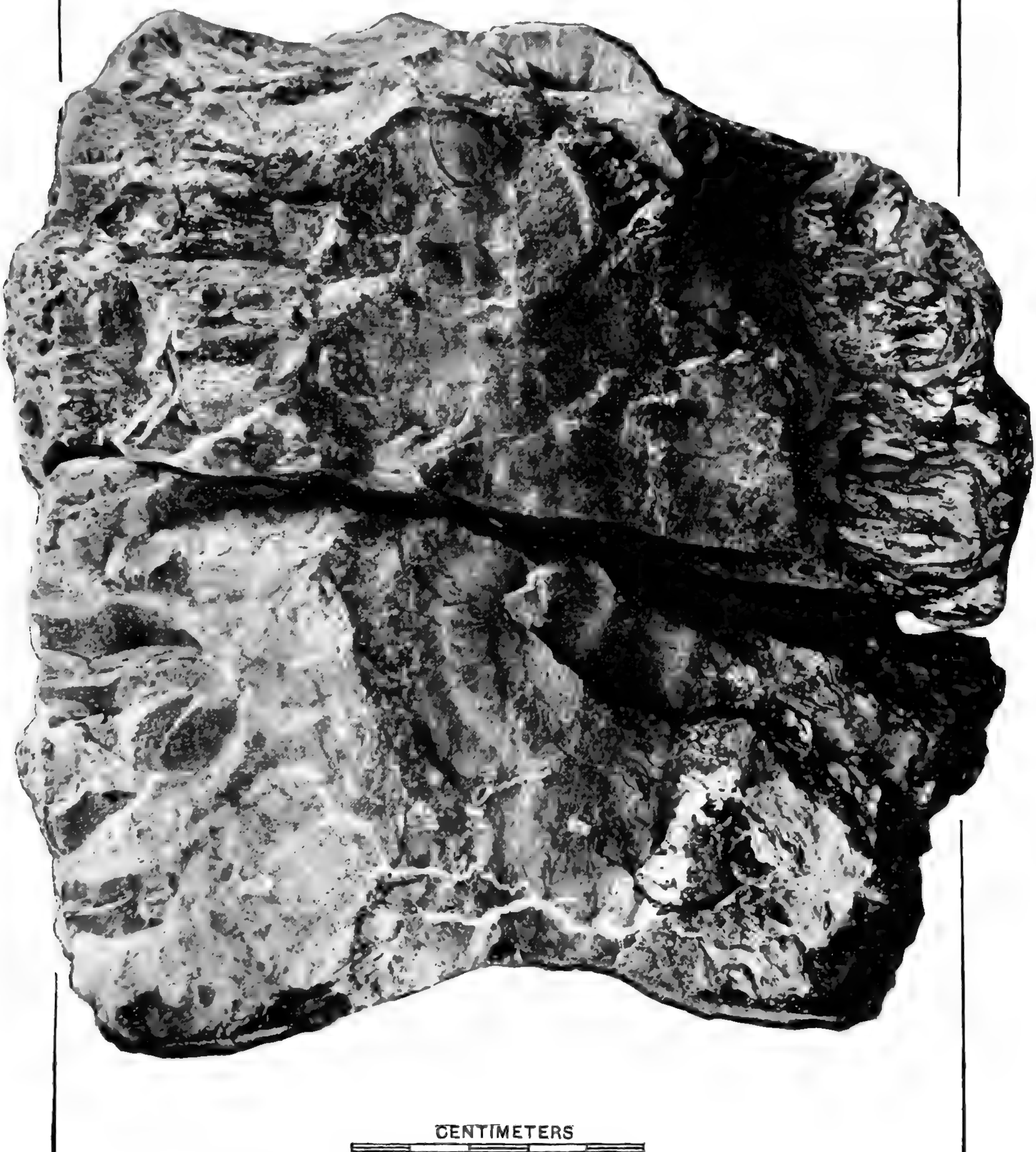


CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

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## PLATE XC.

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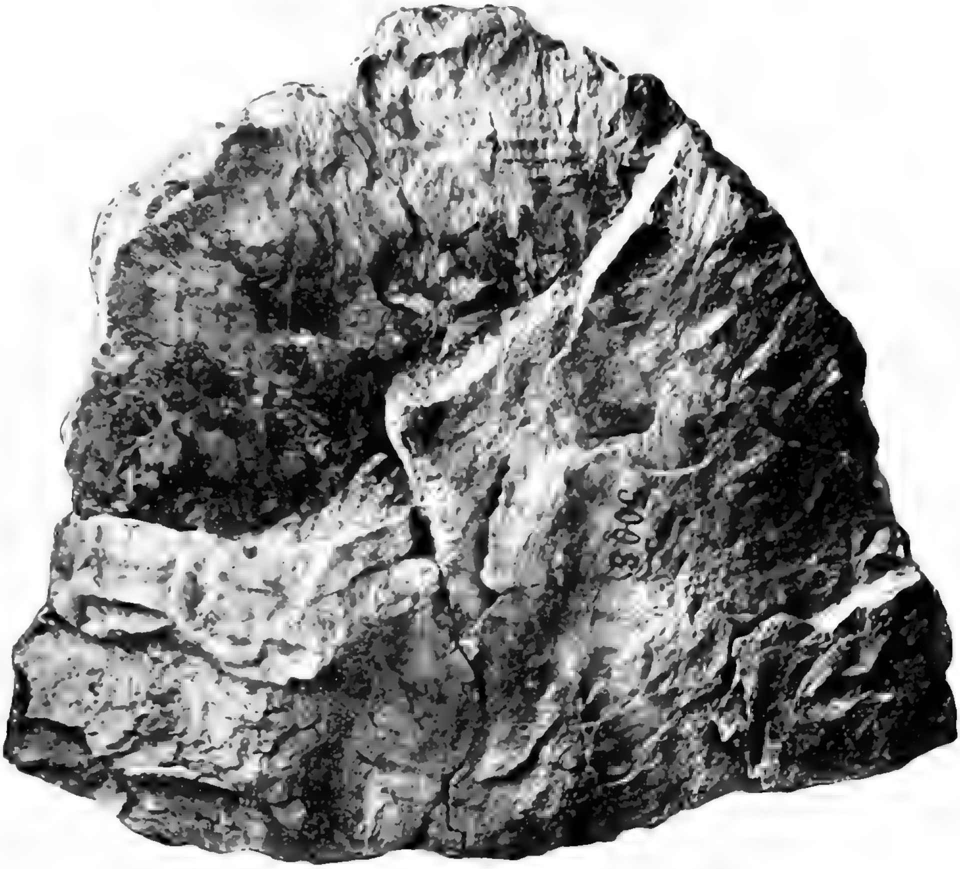
Fig. 1. View of the upper fractured surface of the thin segment of a trunk No. 500.8 of the Museum of the University of Wyoming.

Fig. 2. View of one of the fractured surfaces of No. 500.52, supposed to belong to the same trunk as No. 500.8.



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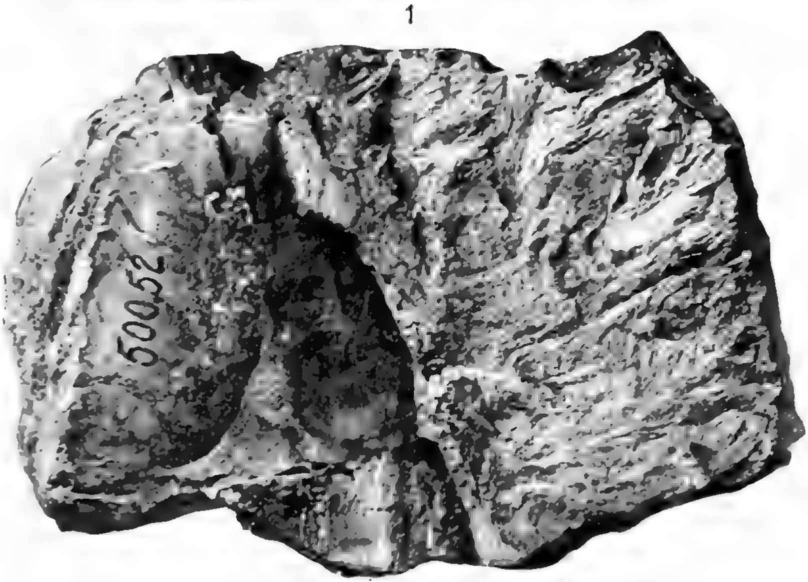


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CYCADELLA WYOMINGENSIS, FROM THE JURASSIC OF WYOMING.

# PLATE XCI.

## PLATE XCI.

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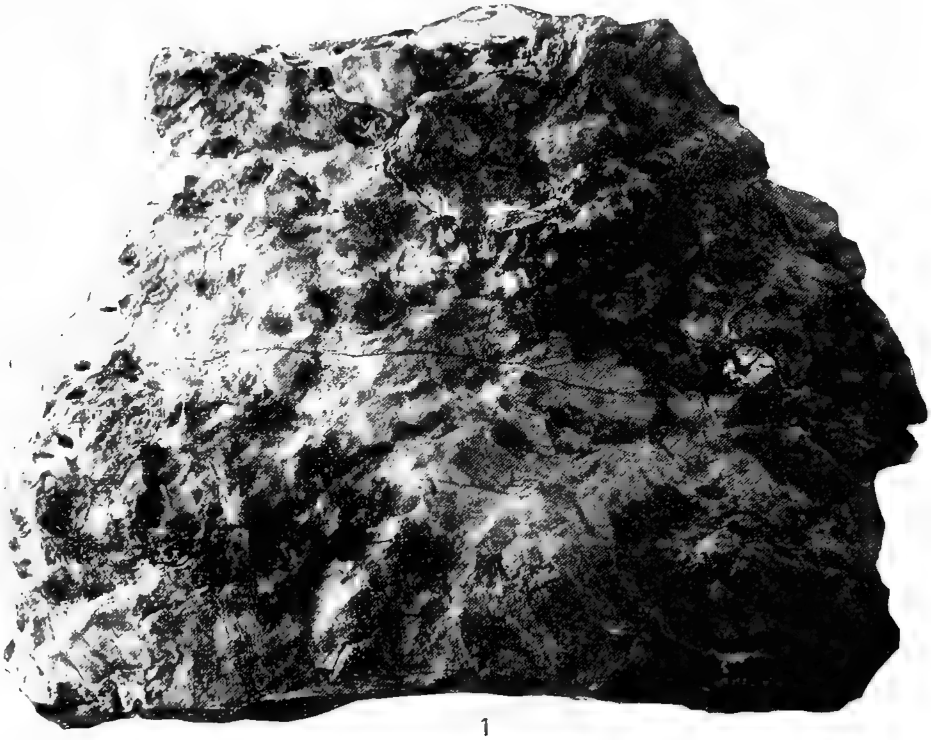
Cycadella Knowltoniana Ward........................................ 396

No. 500.62 of the Museum of the University of Wyoming.

Fig. 1. Side view showing the outer ramentaceous layer completely investing the trunk.

Fig. 2. View of the inner wall of the woody zone, showing scars of the medullary rays.



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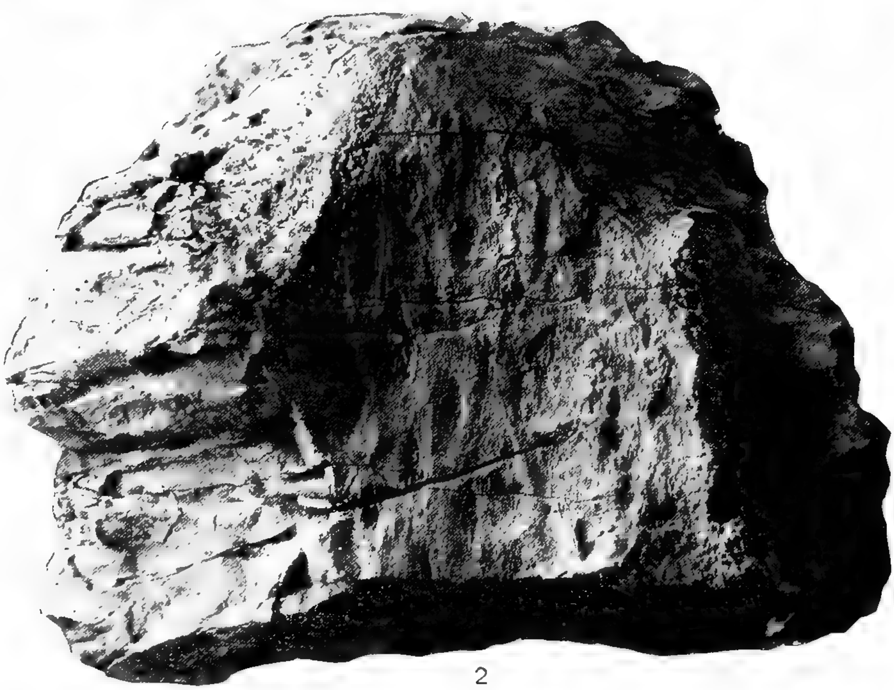

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CYCADELLA KNOWLTONIANA, FROM THE JURASSIC OF WYOMING.

# PLATE XCII.

## PLATE XCII.

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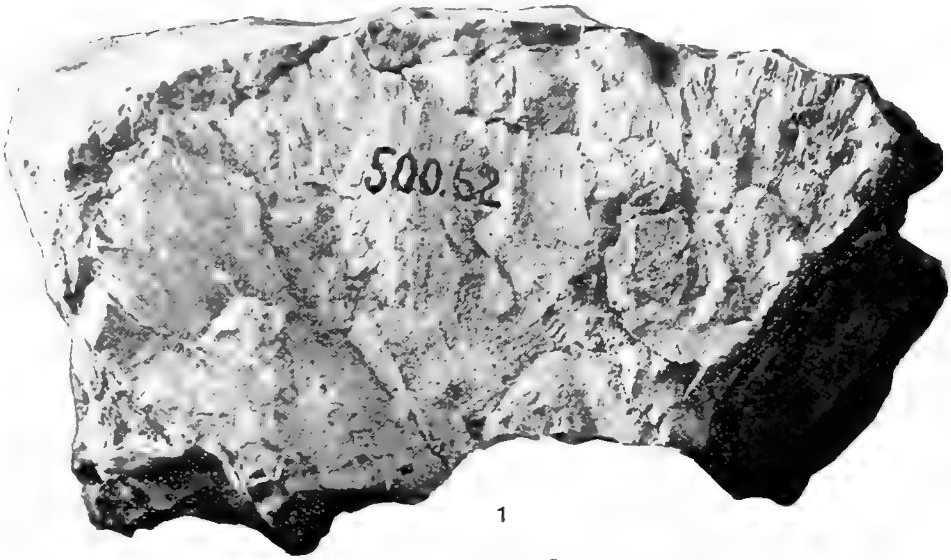
CYCADELLA KNOWLTONIANA Ward........................................ 396

Fig. 1. View of the lower transverse fracture of No. 500.62 of the Museum of the University of Wyoming, showing the leaf bases and walls in longitudinal section overlain by the outer coating.

Fig. 2. View of the polished surface of the upper transverse fracture of No. 500.76, showing the attachment of the armor to the axis, the leaf bases emitting the ramentaceous chaff to form the walls and outer layer.

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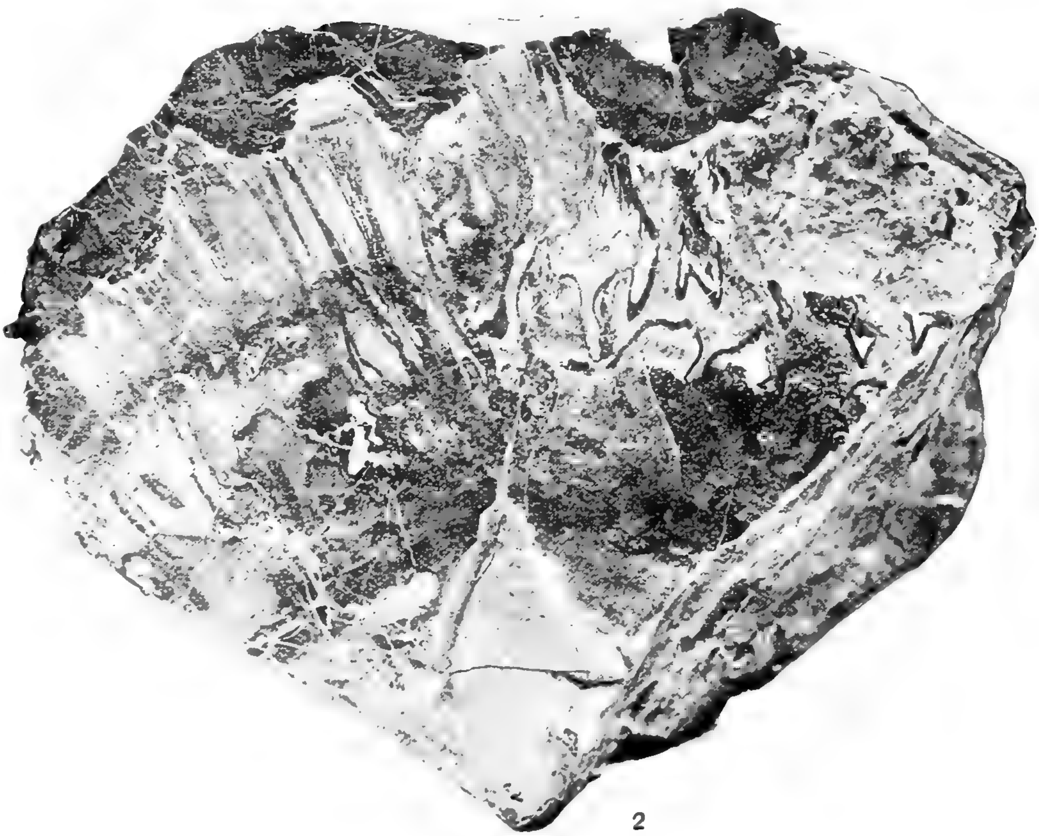

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CENTIMETERS

CYCADELLA KNOWLTONIANA, FROM THE JURASSIC OF WYOMING.

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# PLATE XCIII.

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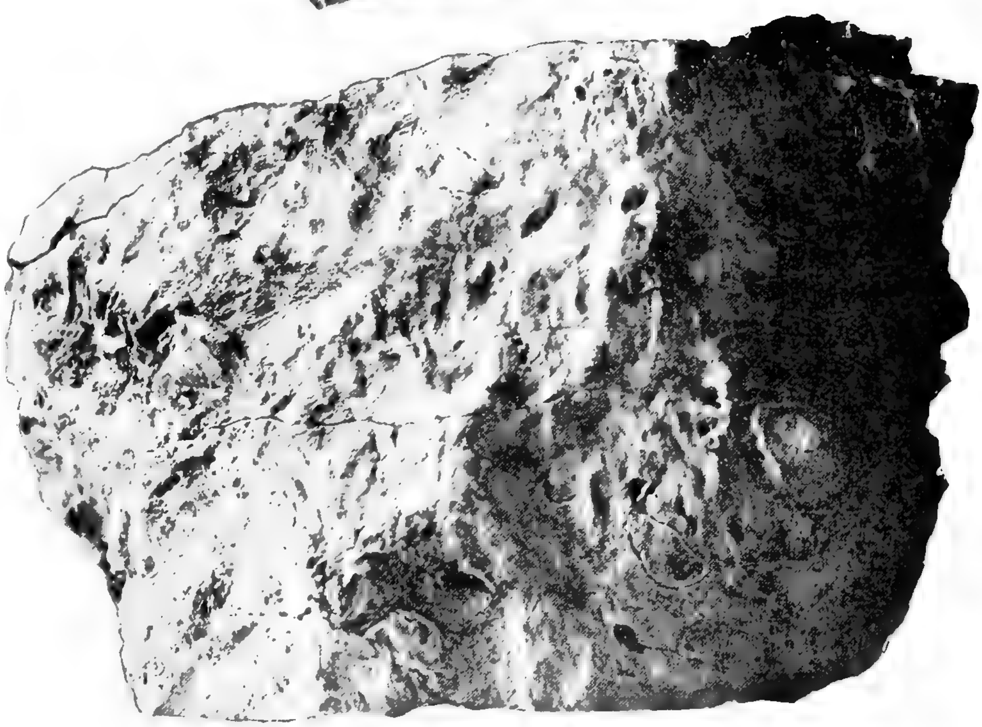
No. 500.76 of the Museum of the University of Wyoming.

Fig. 1. View of the upper transverse fracture before polishing.

Fig. 2. View of the outer surface.

1



2

CENTIMETERS

CYCADELLA KNOWLTONIANA, FROM THE JURASSIC OF WYOMING.

# PLATE XCIV.

## PLATE XCIV

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Cycadella Knowltoniana Ward .................................... 396

View of an area of the polished transverse surface of the upper end of No. 500.76 of the Museum of the University of Wyoming, taken from the left side of the specimen and enlarged four diameters.

CYCADELLA KNOWLTONIANA

THE MERIDEN GRAVURE CO.

# PLATE XCV.

## PLATE XCV.

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Cycadella Knowltoniana Ward .......................................... 396

View of an area of the polished transverse surface of the upper end of No. 500.76 of the Museum of the University of Wyoming, taken from the right side of the specimen and enlarged four diameters.

CYCADELLA KNOWLTONIANA

THE MERIDEN GRAVURE CO

# PLATE XCVI.

## PLATE XCVI.

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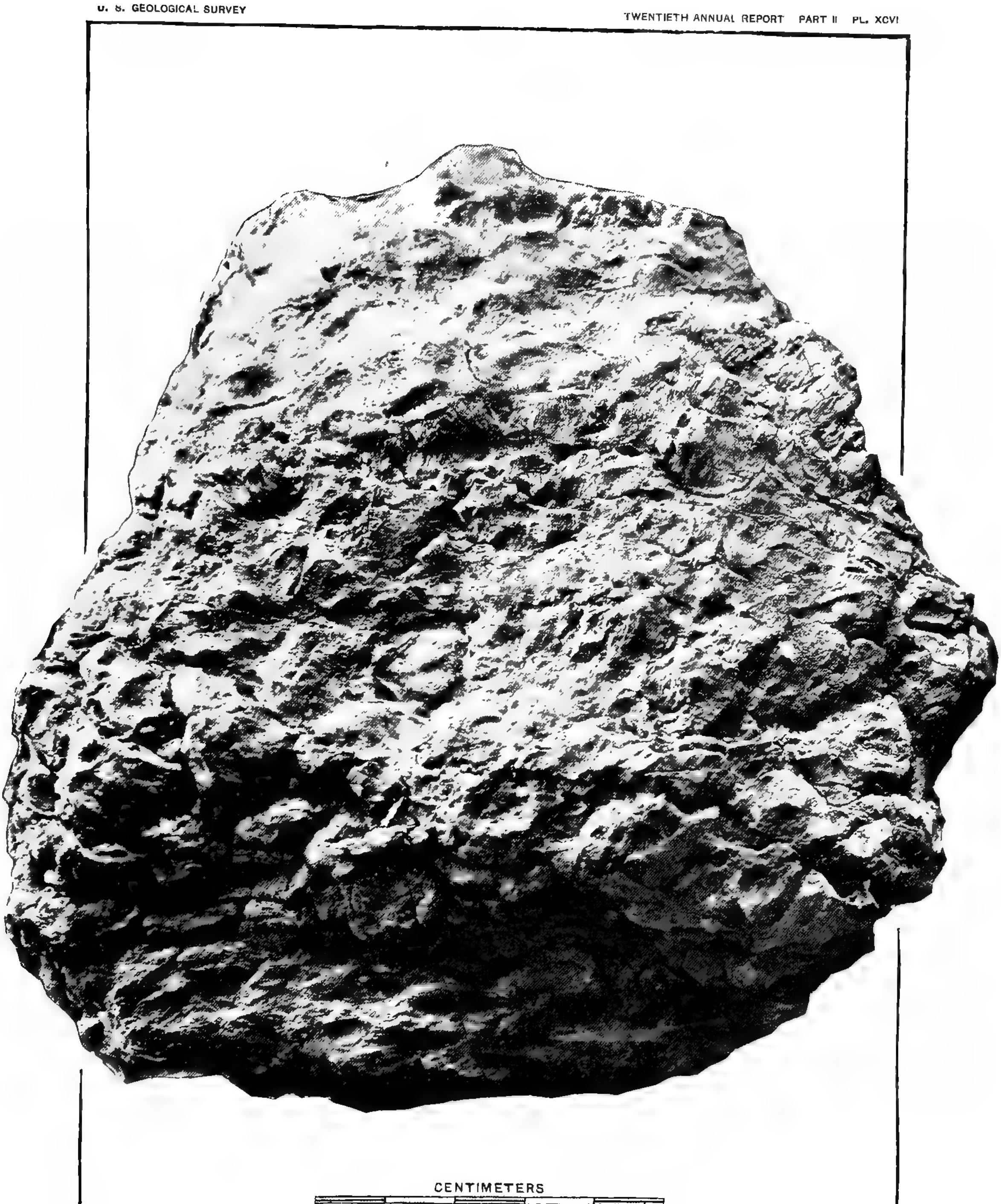
CYCADELLA COMPRESSA Ward ........................................... 398
Side view of No. 500.4 of the Museum of the University of Wyoming.




CYCADELLA COMPRESSA, FROM THE JURASSIC OF WYOMING.

PLATE XCVII.

## PLATE XCVII.

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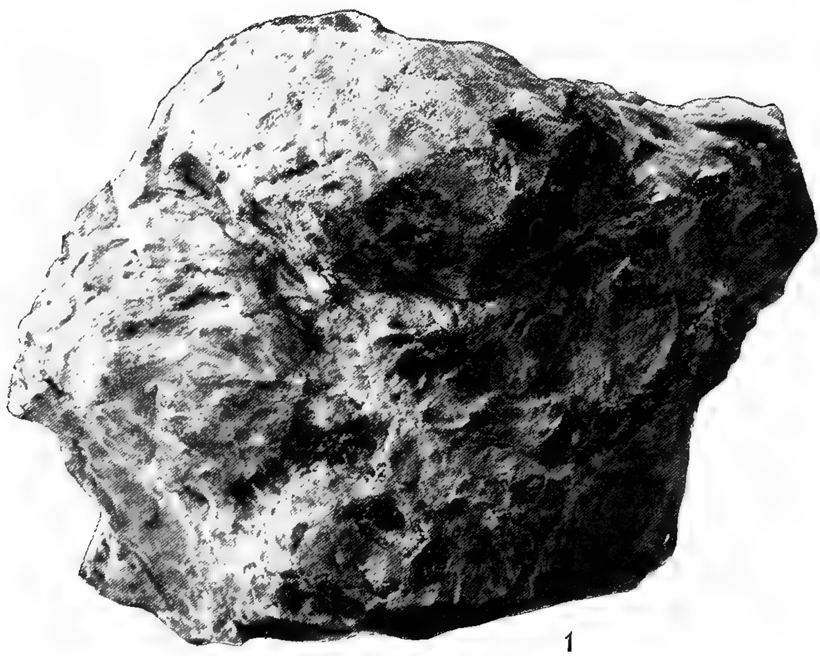
CYCADELLA COMPRESSA Ward .......................................... 398
No. 500.18 of the Museum of the University of Wyoming.
Fig. 1. View of the side and apex. The terminal bud is indistinctly seen on the left above.
Fig. 2. View of the base.

2

CENTIMETERS



1

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CYCADELLA COMPRESSA, FROM THE JURASSIC OF WYOMING.

# PLATE XCVIII.

## PLATE XCVIII.

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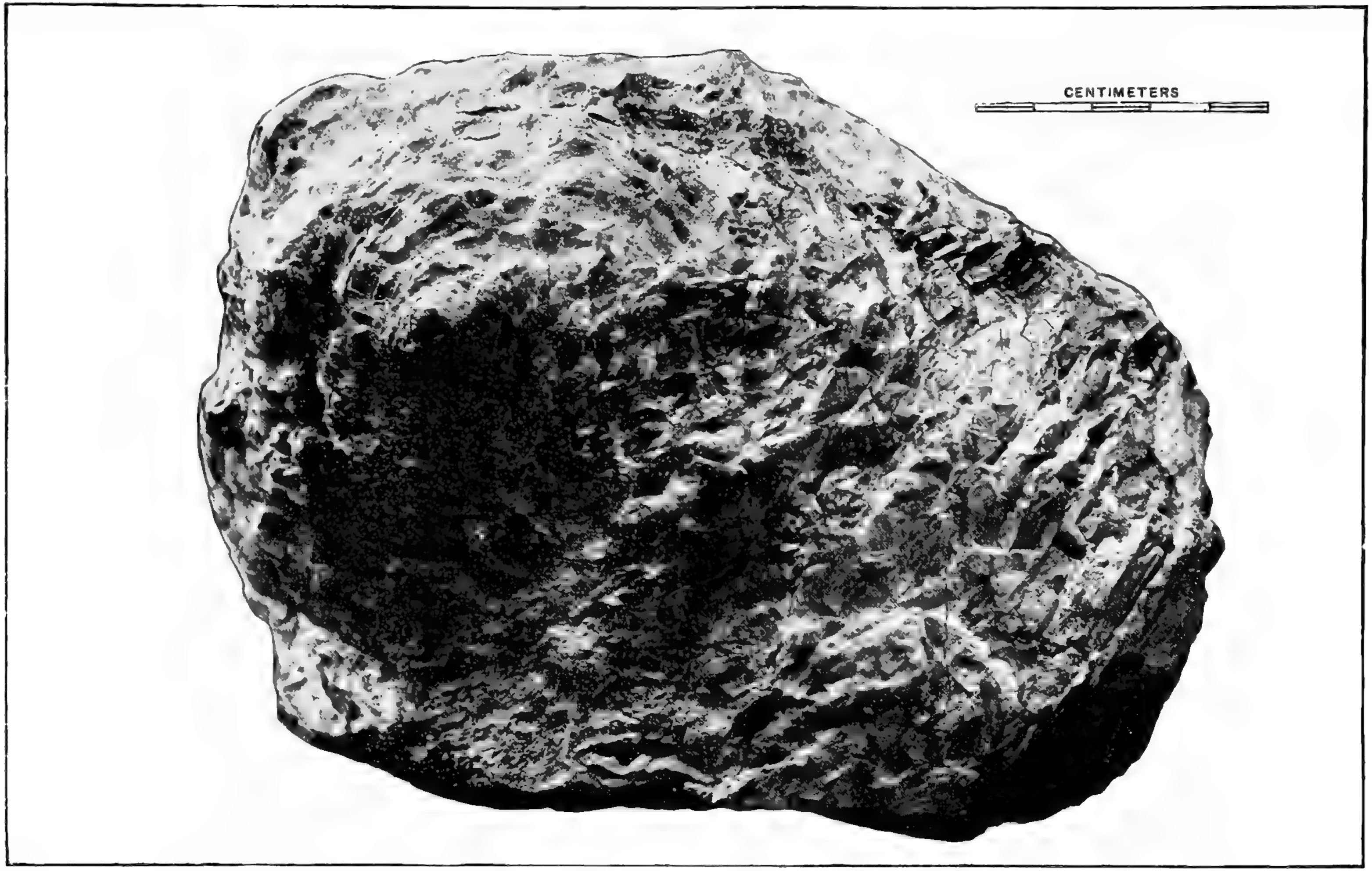
Side view of No. 500.5 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING

# PLATE XCIX.

## PLATE XCIX.

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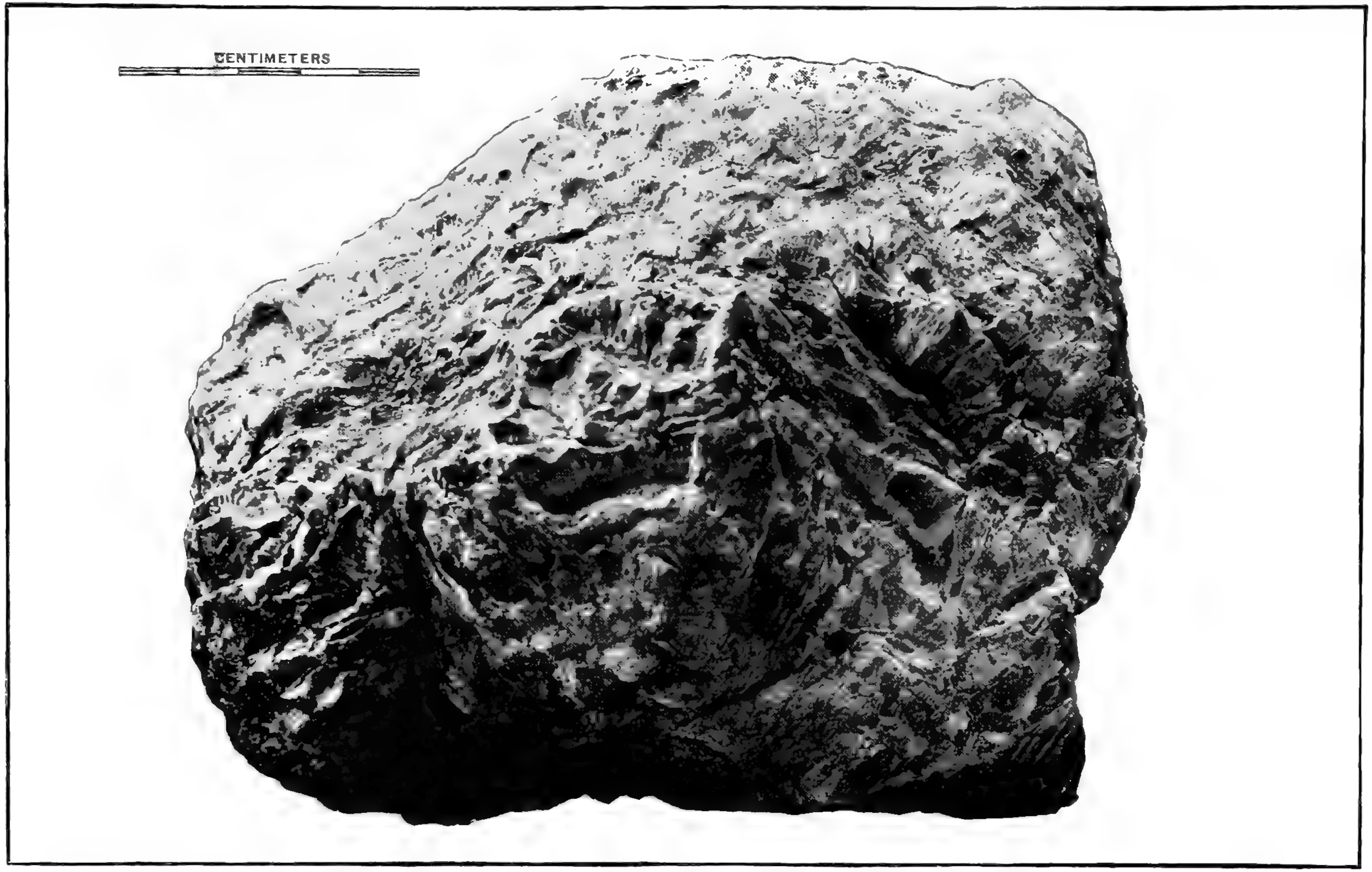
Cycadella jurassica Ward.. ............................................ 399

Side view of No. 500.5 of the Museum of the University of Wyoming, side opposite that shown on Pl. XCVIII.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE C.

## PLATE C.

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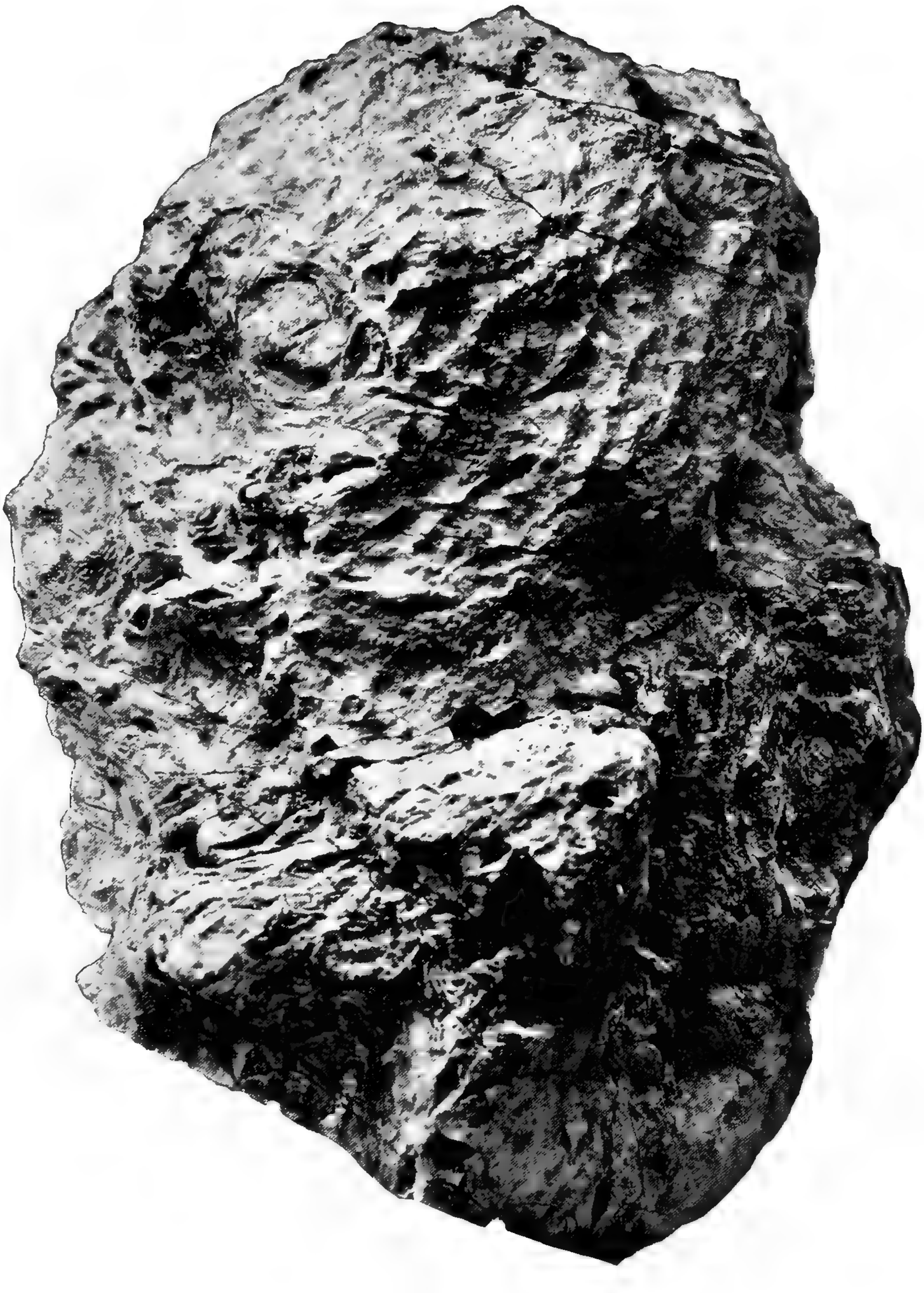
Side view of No. 500.38 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CI.

## PLATE CI.

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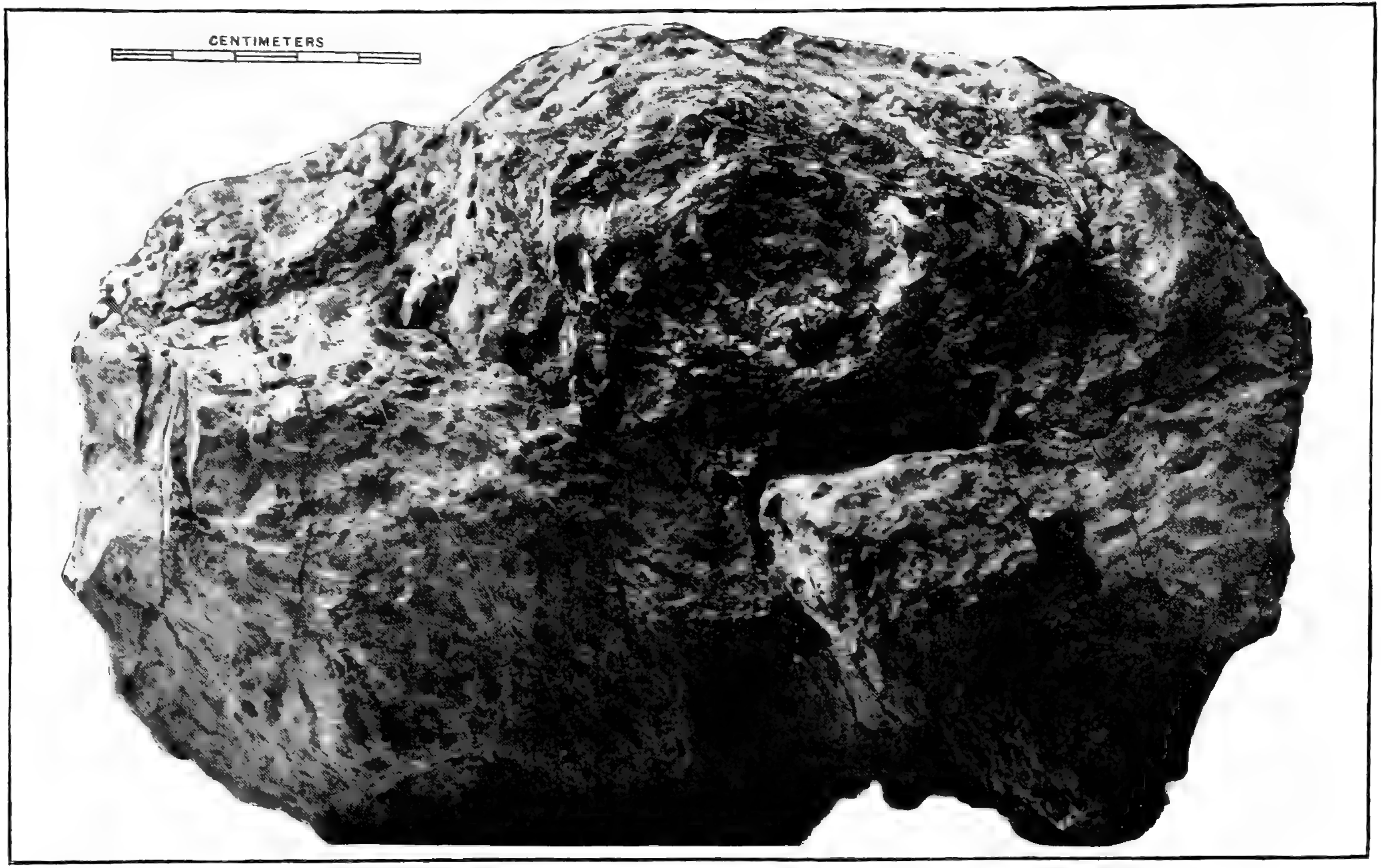
Cycadella jurassica Ward ........................................ 399

Side view of No. 500.38 of the Museum of the University of Wyoming, side opposite that shown on Pl. C.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CII.

## PLATE CII.

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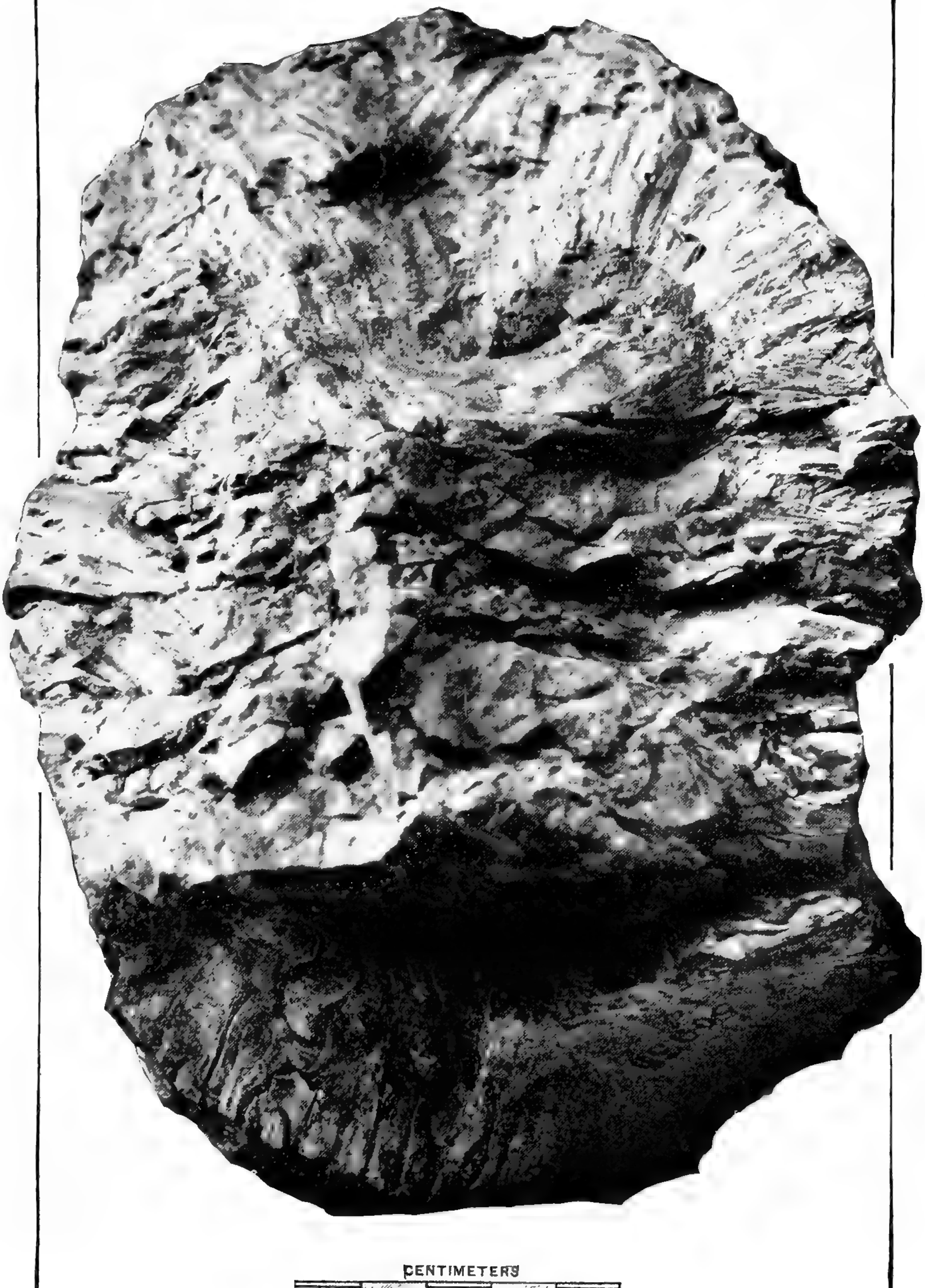
View of the fractured inner face of No. 500.38 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CIII.

## PLATE CIII.

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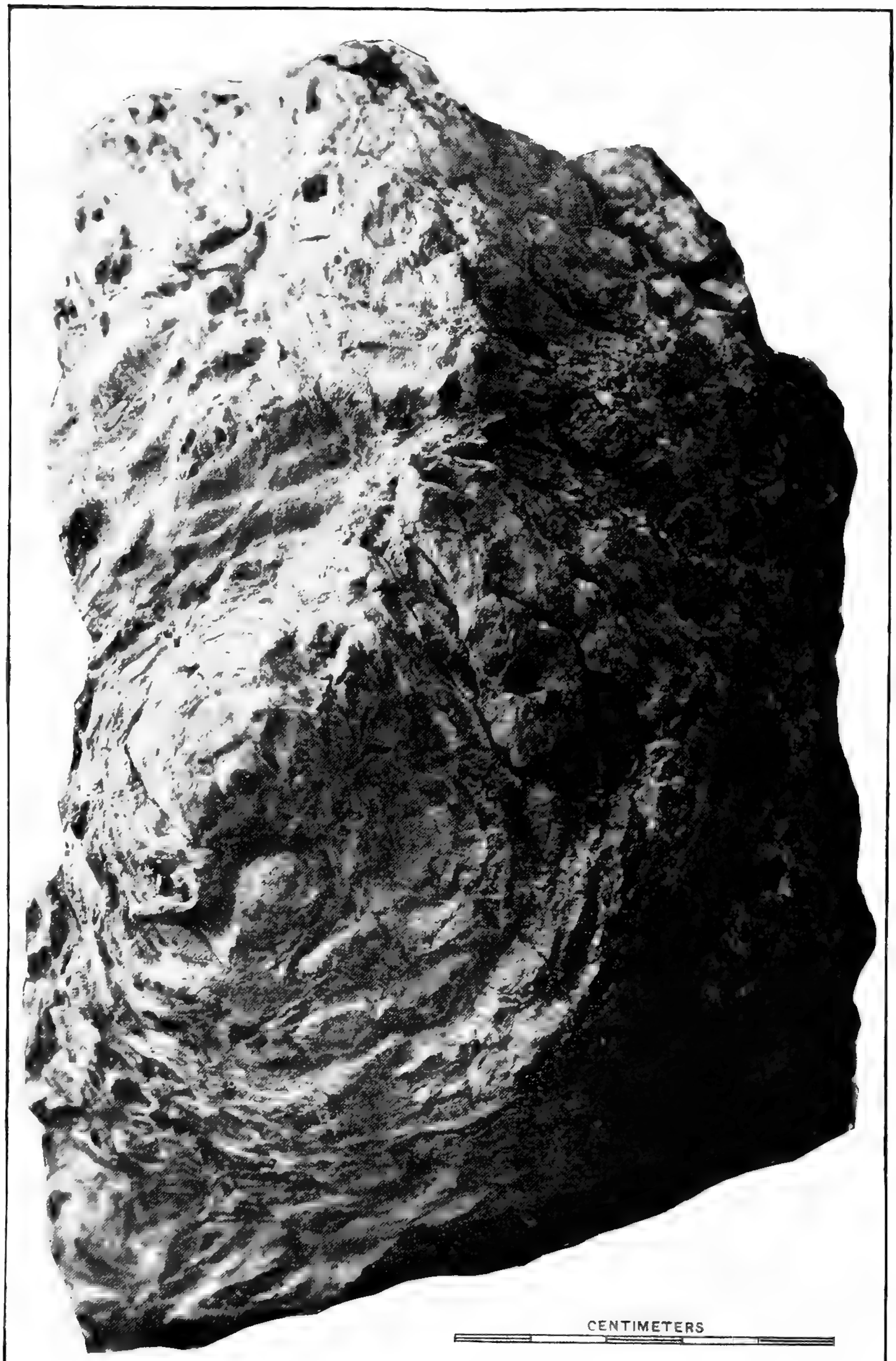
Side view of No. 500.30 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CIV.

## PLATE CIV.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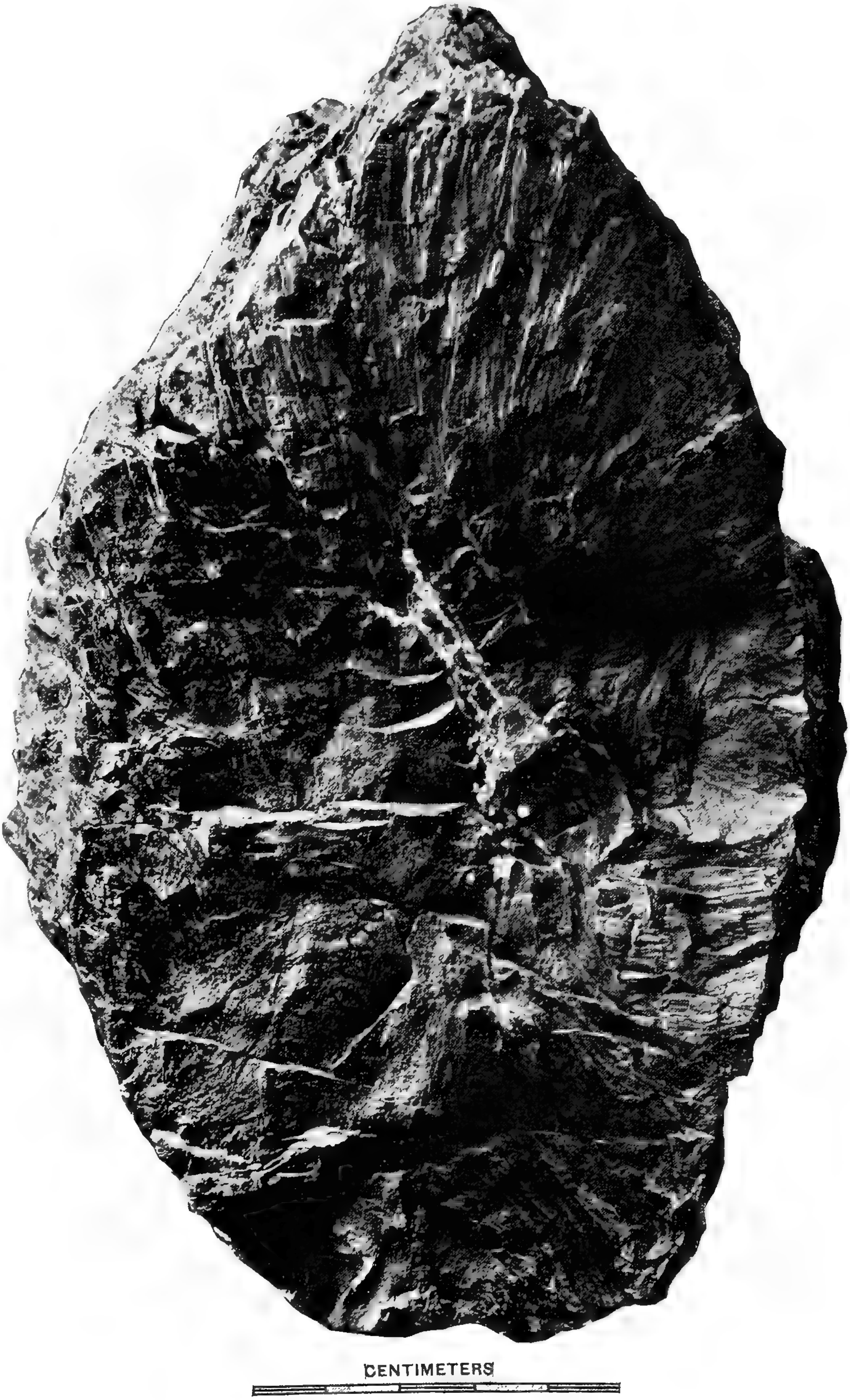
View of the inner fractured surface of No. 500.30 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CV.

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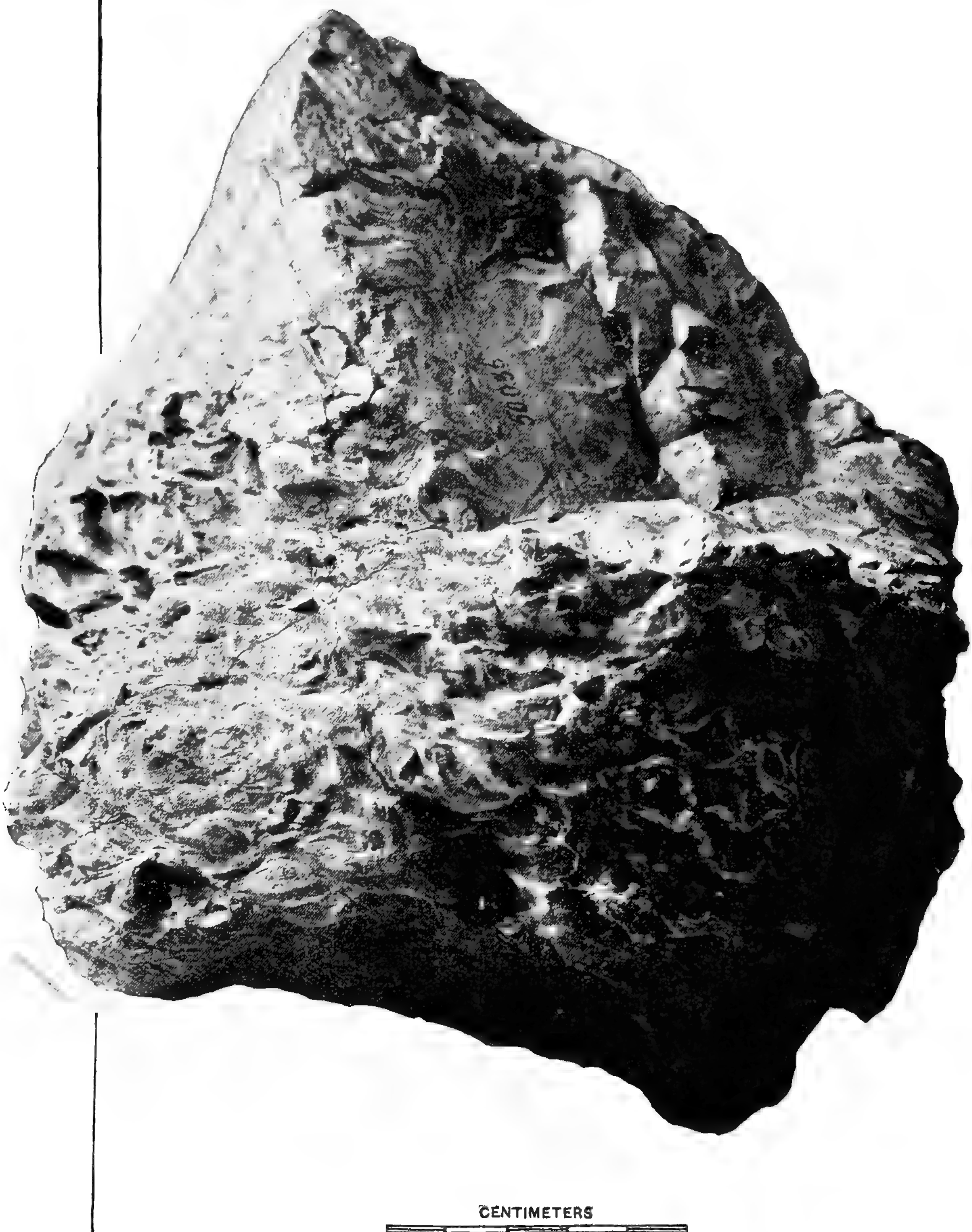
View of one side and the broken summit of No. 500.36 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CVI.

## PLATE CVI.

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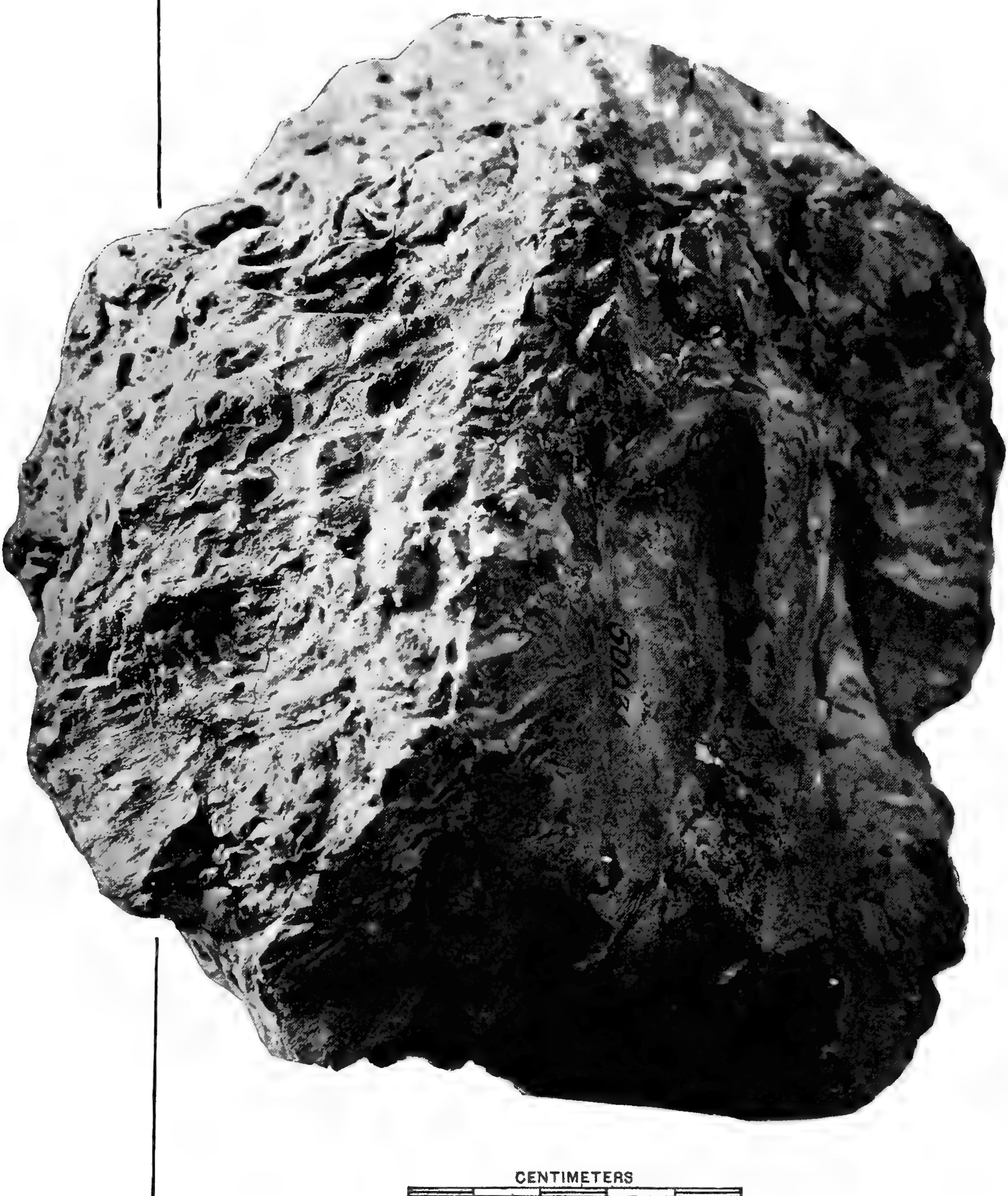
View of the basal fracture and one side of No. 500.36 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CVII.

## PLATE CVII.

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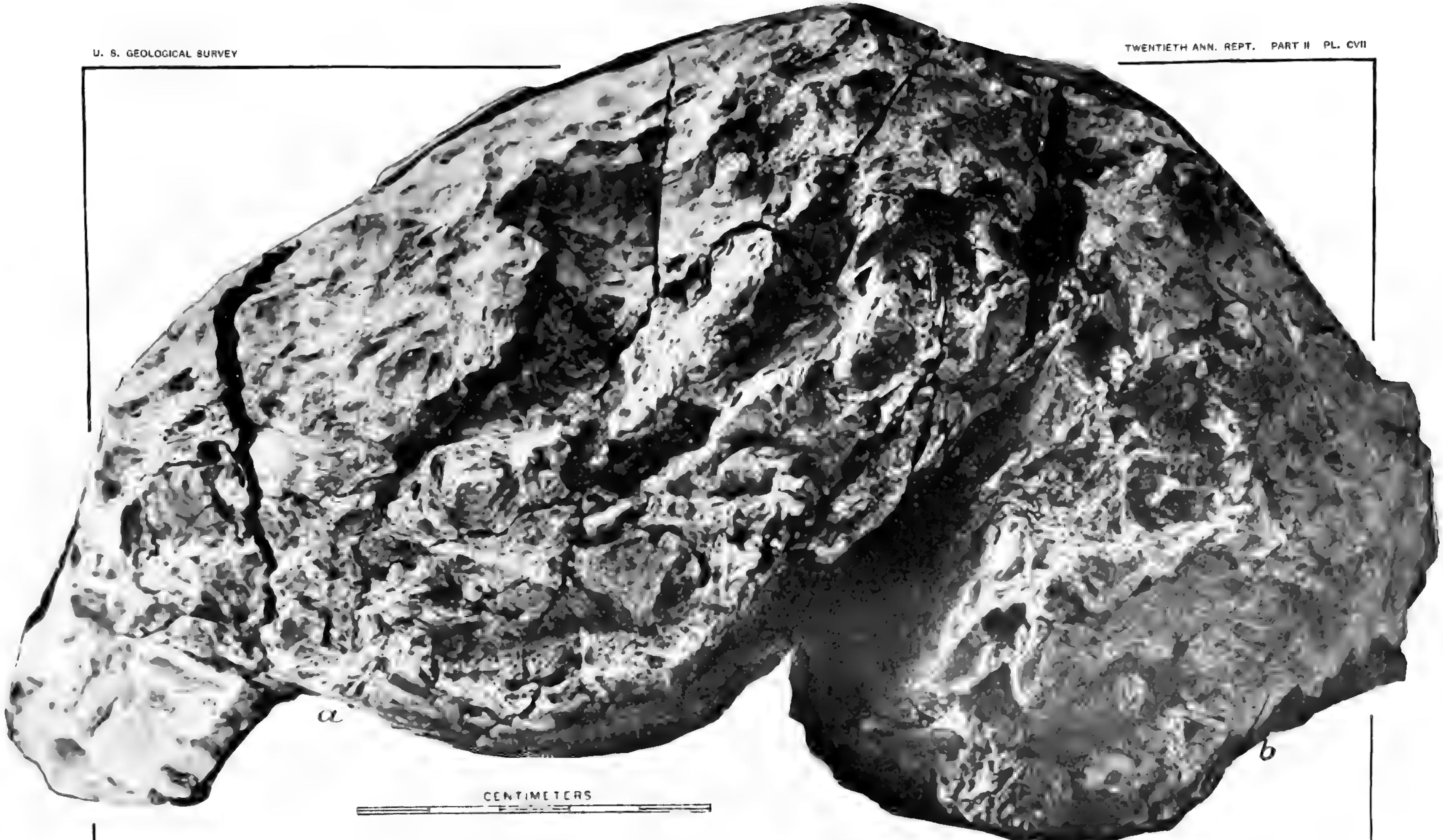
View of one side of the fragment restored by uniting the complementary Nos. 500.49 and 500.77 of the Museum of the University of Wyoming.
(a) No. 500.49; (b) No. 500.77.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CVIII.

## PLATE CVIII.

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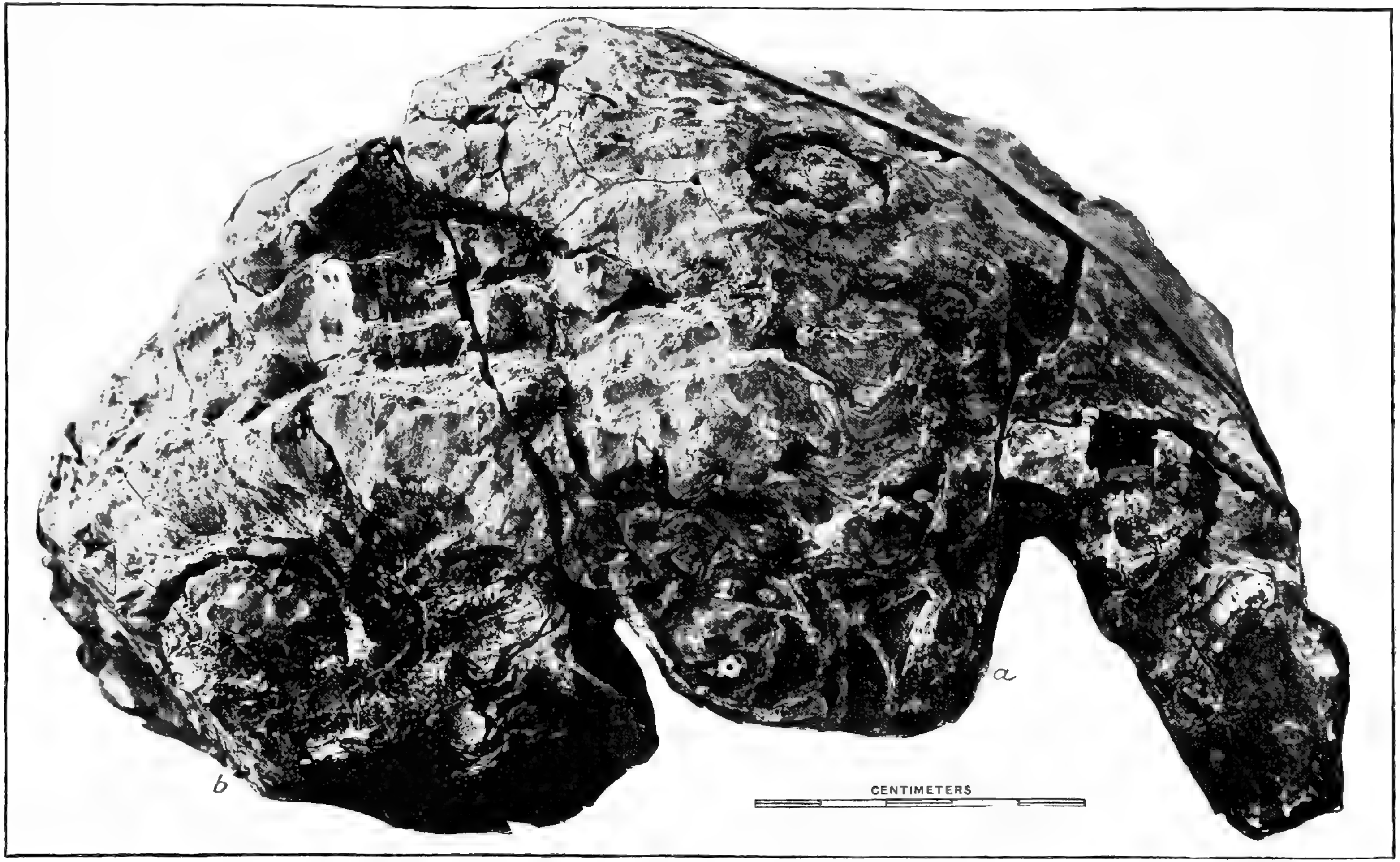
Cycadella jurassica Ward ........................................ 399

View of one side (the side opposite that shown on Pl. CVII) of the fragment restored by uniting the complementary Nos. 500.49 and 500.77 of the Museum of the University of Wyoming.

(*a*) No. 500.49; (*b*) No. 500.77.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CIX.

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# PLATE CIX.

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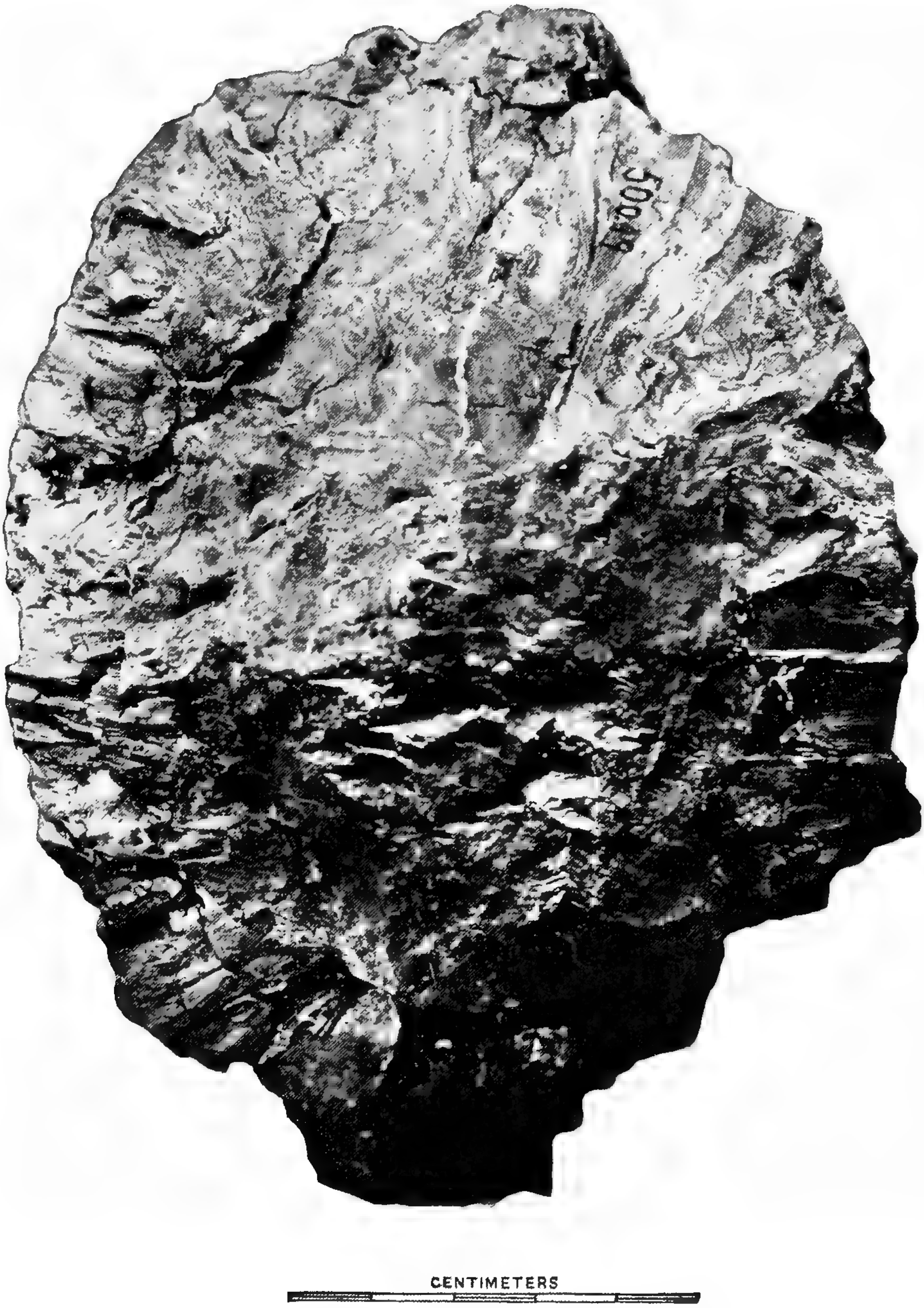
View of the inner fractured surface of No. 500.49 of the Museum of the University of Wyoming.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CX.

# PLATE CX.

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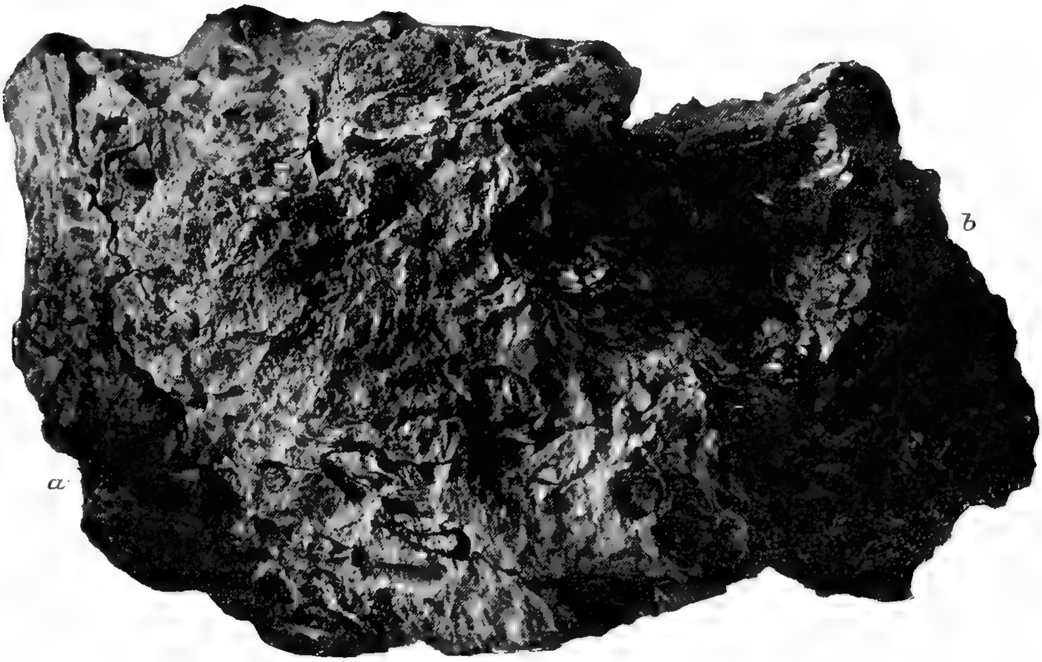
Views of the fragment restored by uniting the complementary Nos. 500.78 and 500.82 of the Museum of the University of Wyoming.

Fig. 1. The external surface.

Fig. 2. The interior as revealed by a longitudinal fracture.

(*a*) No. 500.78; (*b*) No. 500.82.

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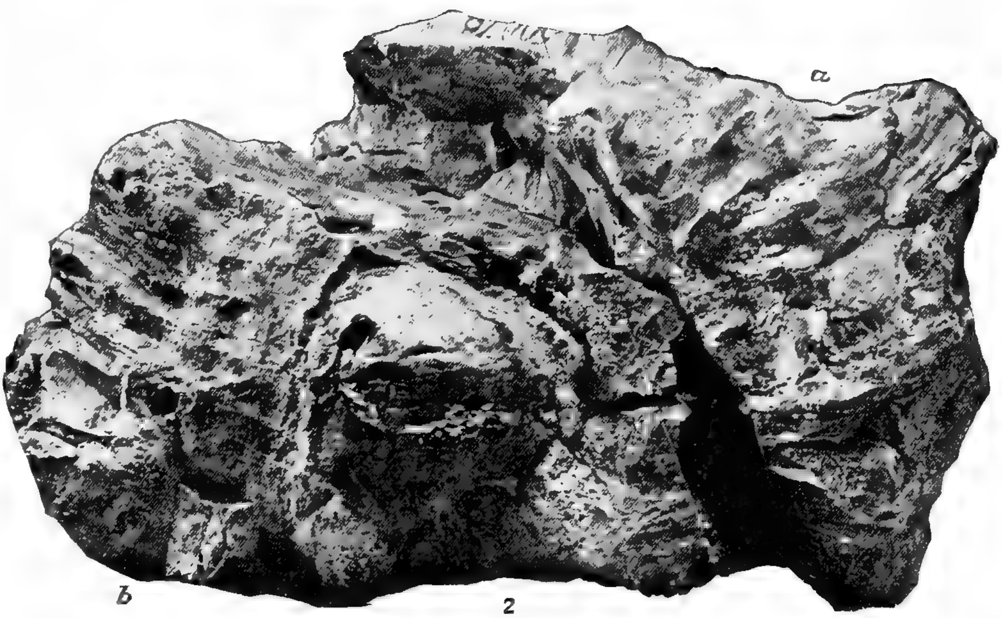


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CENTIMETERS

CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CXI.

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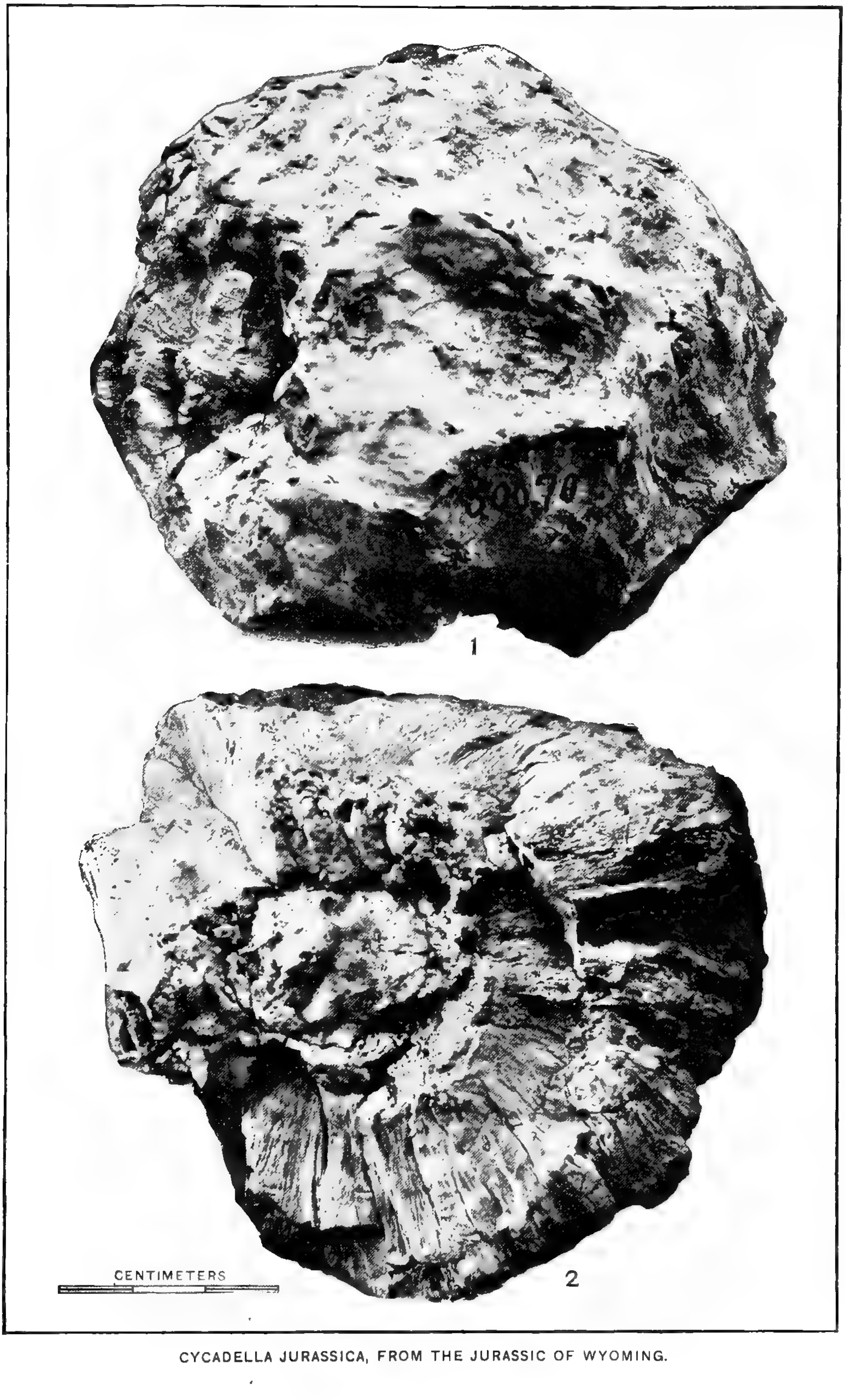
CYCADELLA JURASSICA Ward ........................................................ 399

Views of the fragment No. 500.70 of the Museum of the University of Wyoming, supposed to form the apex of the trunk Nos. 500.78 and 500.82.

Fig. 1. View of the top.

Fig. 2. View of the lower side as broken, showing the internal structure.




CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CXII.

## PLATE CXII.

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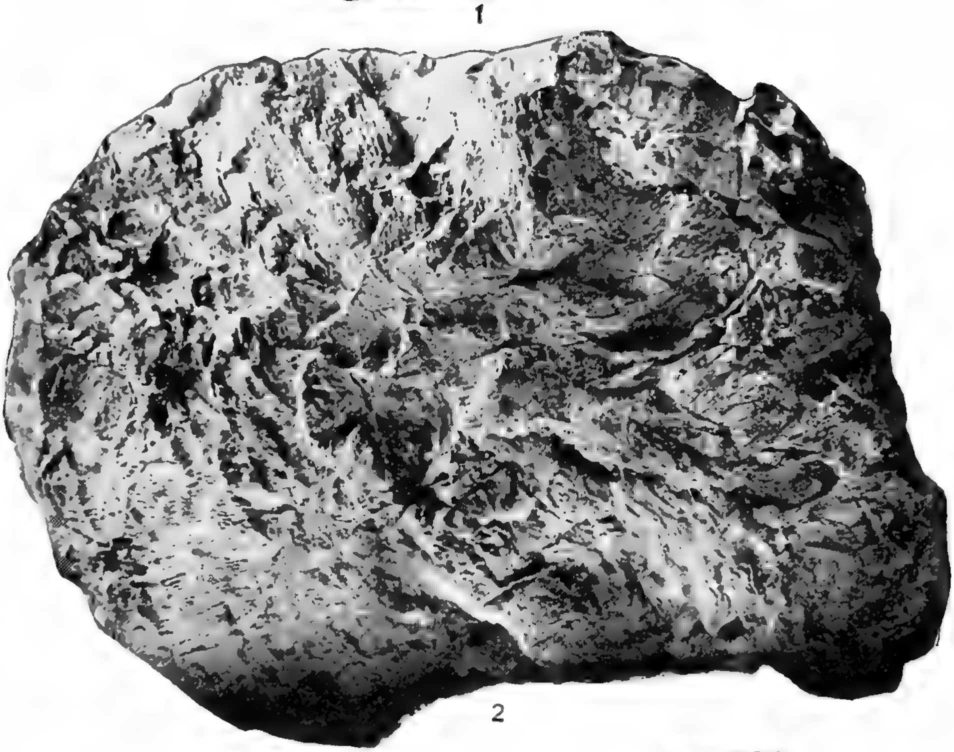
CYCADELLA JURASSICA Ward .................................................. 399

No. 500.23 of the Museum of the University of Wyoming.

Fig. 1. View of the flat top.

Fig. 2. View of one side.

1



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CENTIMETERS

CYCADELLA JURASSICA, FROM THE JURASSIC OF WYOMING.

# PLATE CXIII.

## PLATE CXIII.

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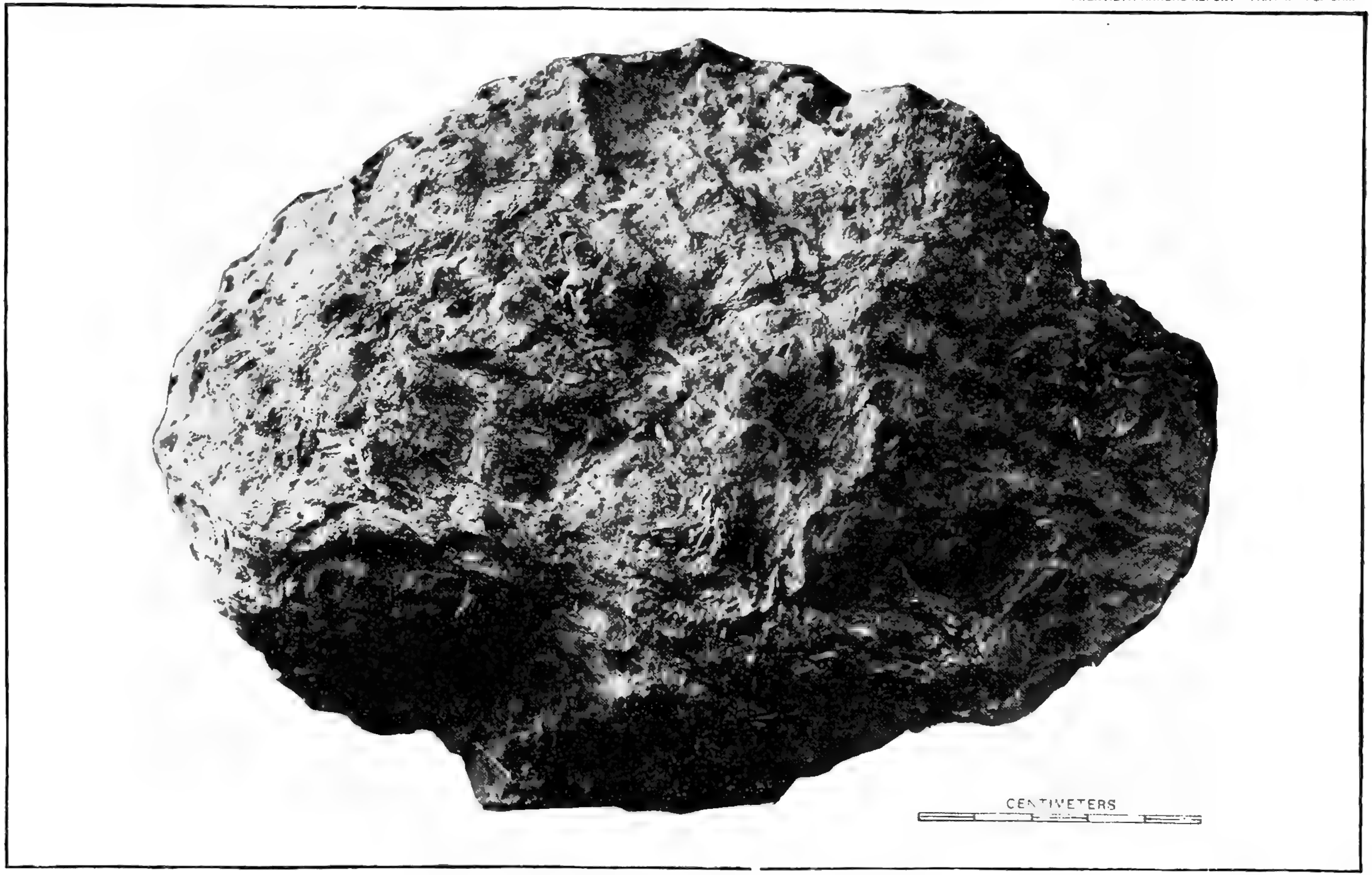
Side view of No. 500.9 of the Museum of the University of Wyoming.




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXIV.

## PLATE CXIV.

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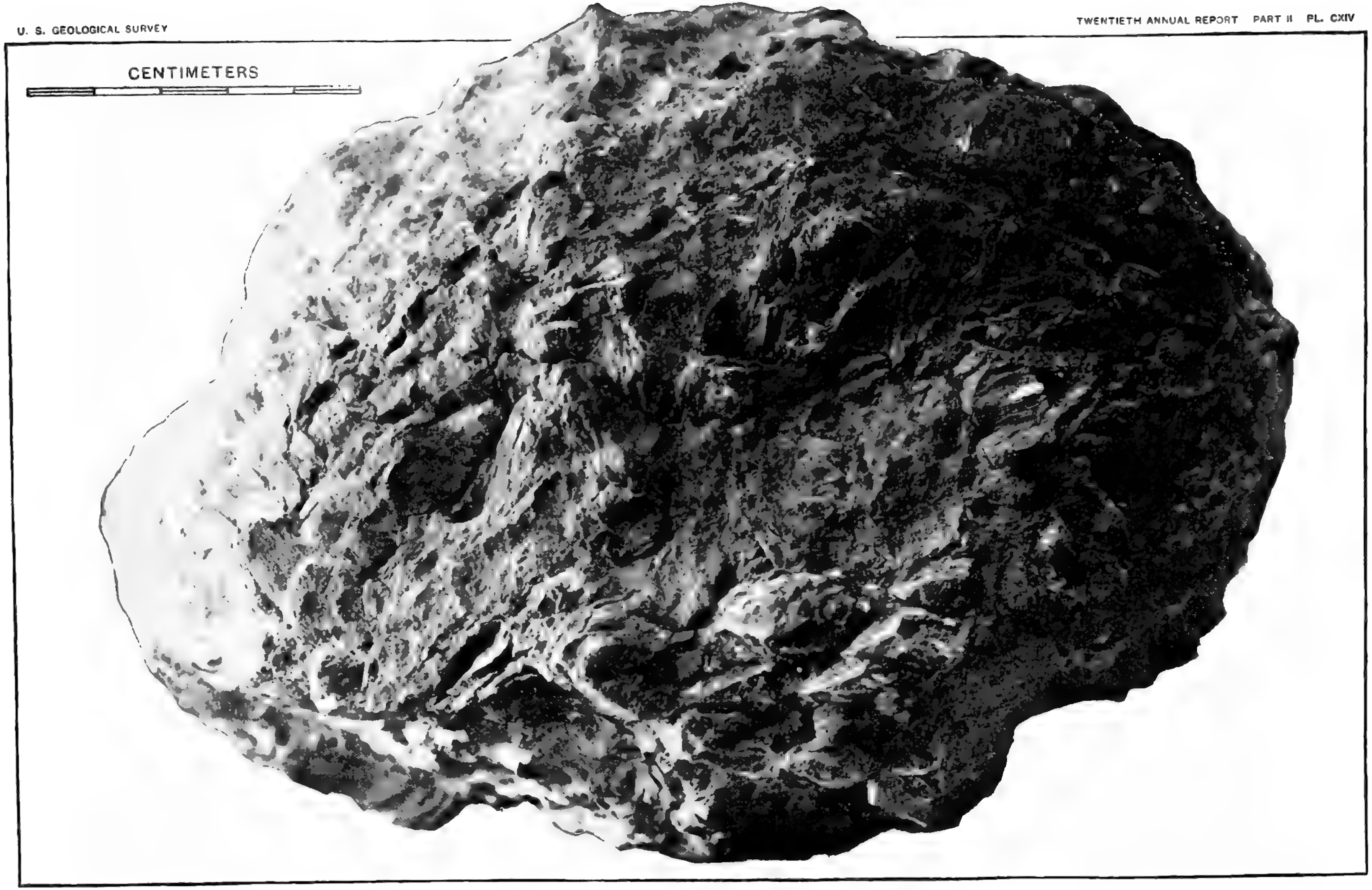
Side view of No. 500.9 of the Museum of the University of Wyoming (the side opposite that shown on Pl. CXIII).




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXV.

## PLATE CXV.

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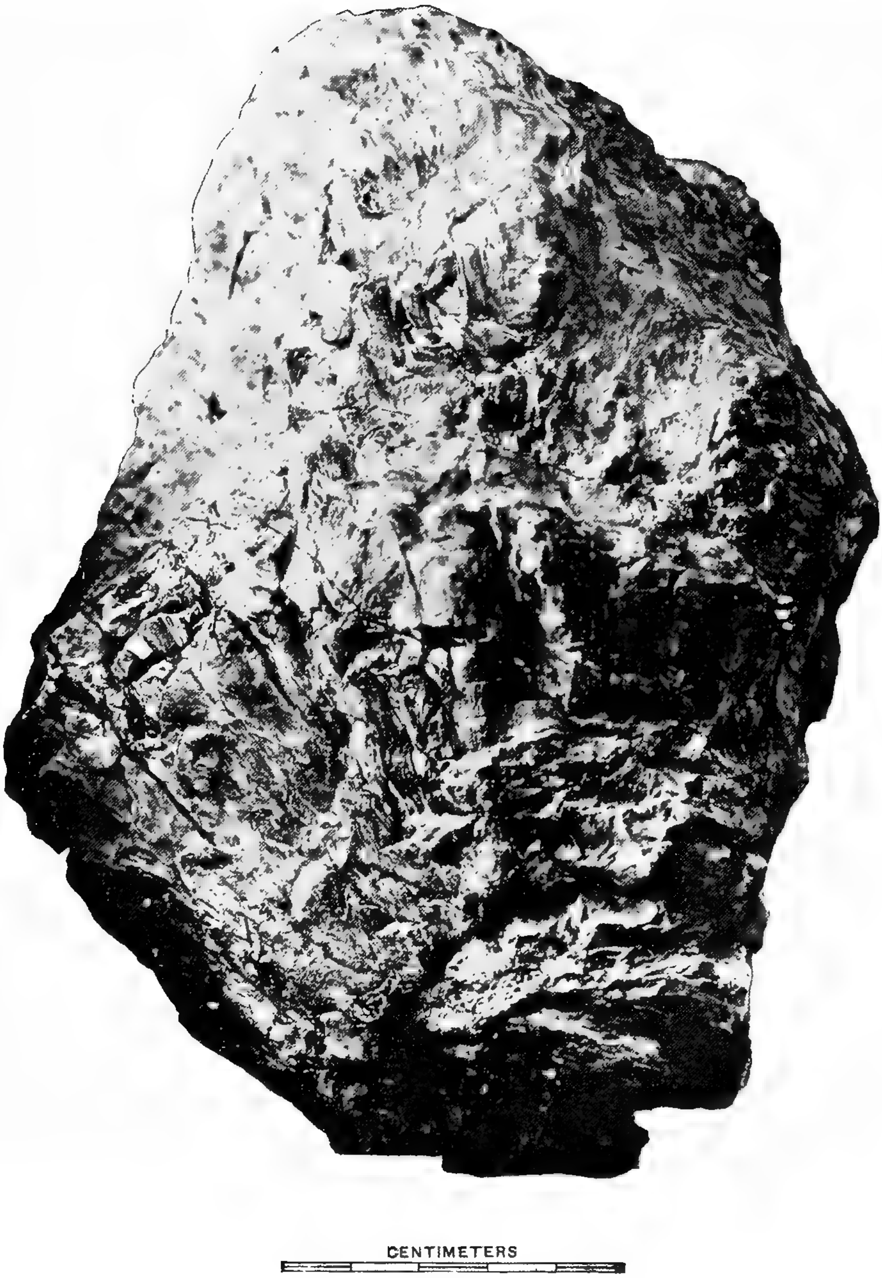
Side view of No. 500.47 of the Museum of the University of Wyoming, showing also a portion of the base.




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXVI.

## PLATE CXVI.

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Side view of No. 500 47 of the Museum of the University of Wyoming, showing the branches and organs of the armor.


CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXVII.

## PLATE CXVII.

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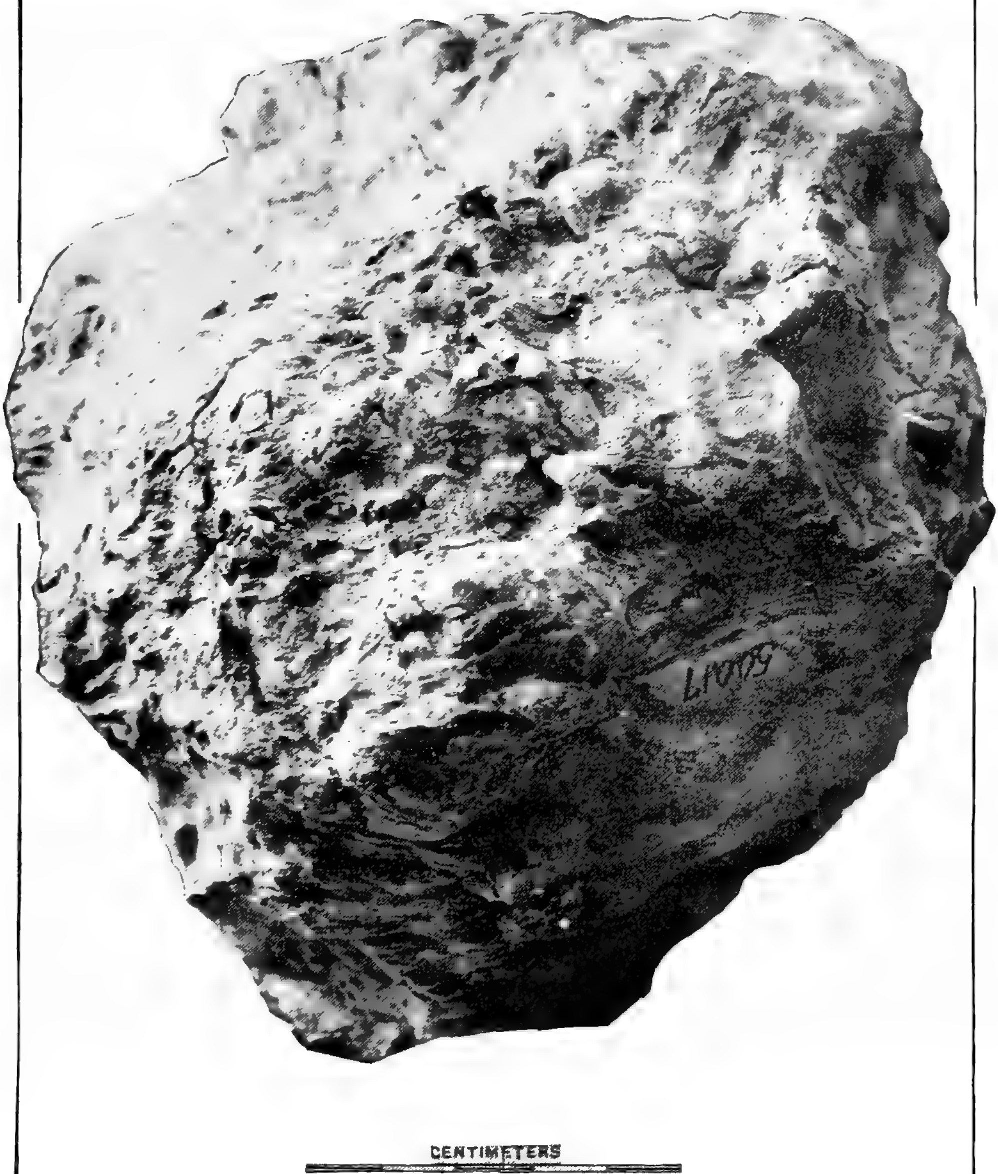
View of the best-preserved side of No. 500.17 of the Museum of the University of Wyoming.




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXVIII.

## PLATE CXVIII.

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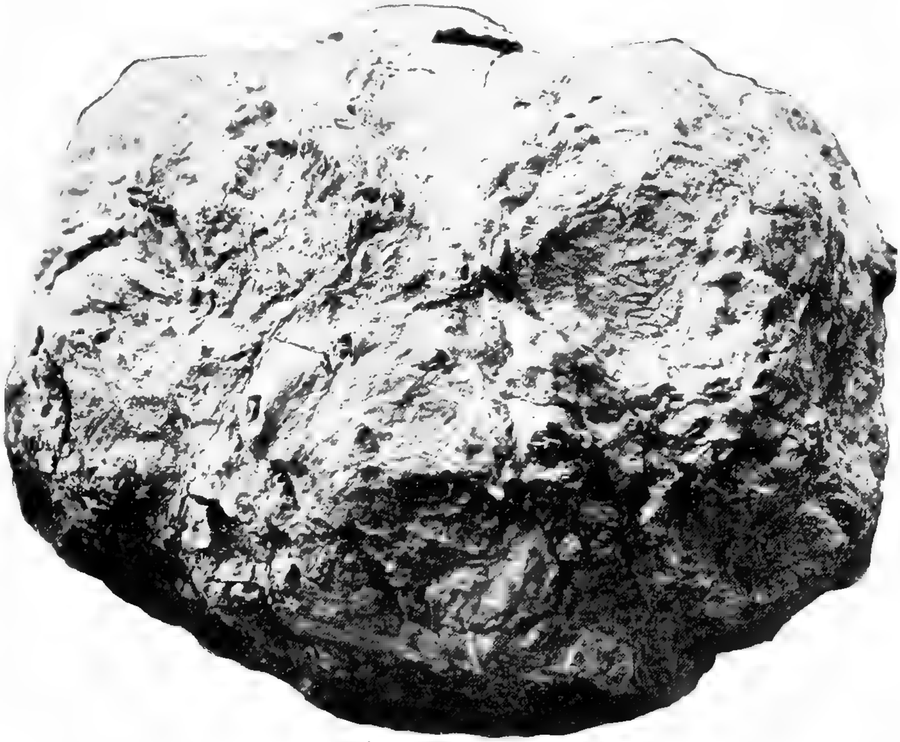
No. 500.21 of the Museum of the University of Wyoming.

Fig. 1. View of the rounded summit, showing the numerous branches.

Fig. 2. View of the transverse fracture.



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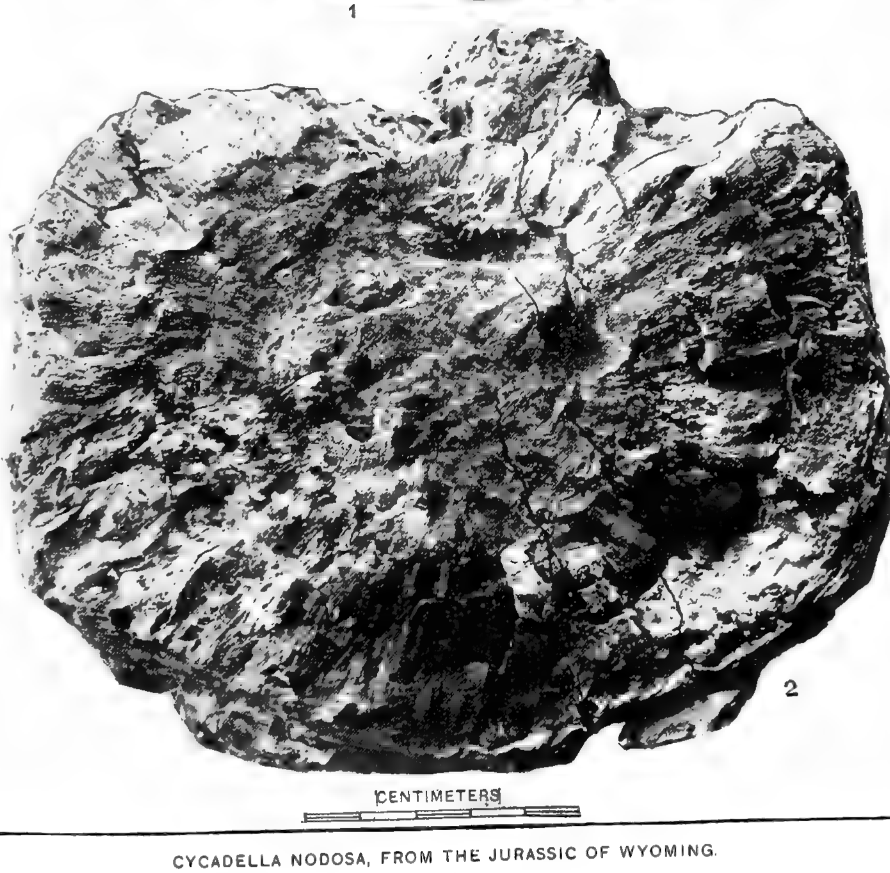

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CENTIMETERS

CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXIX.

## PLATE CXIX.


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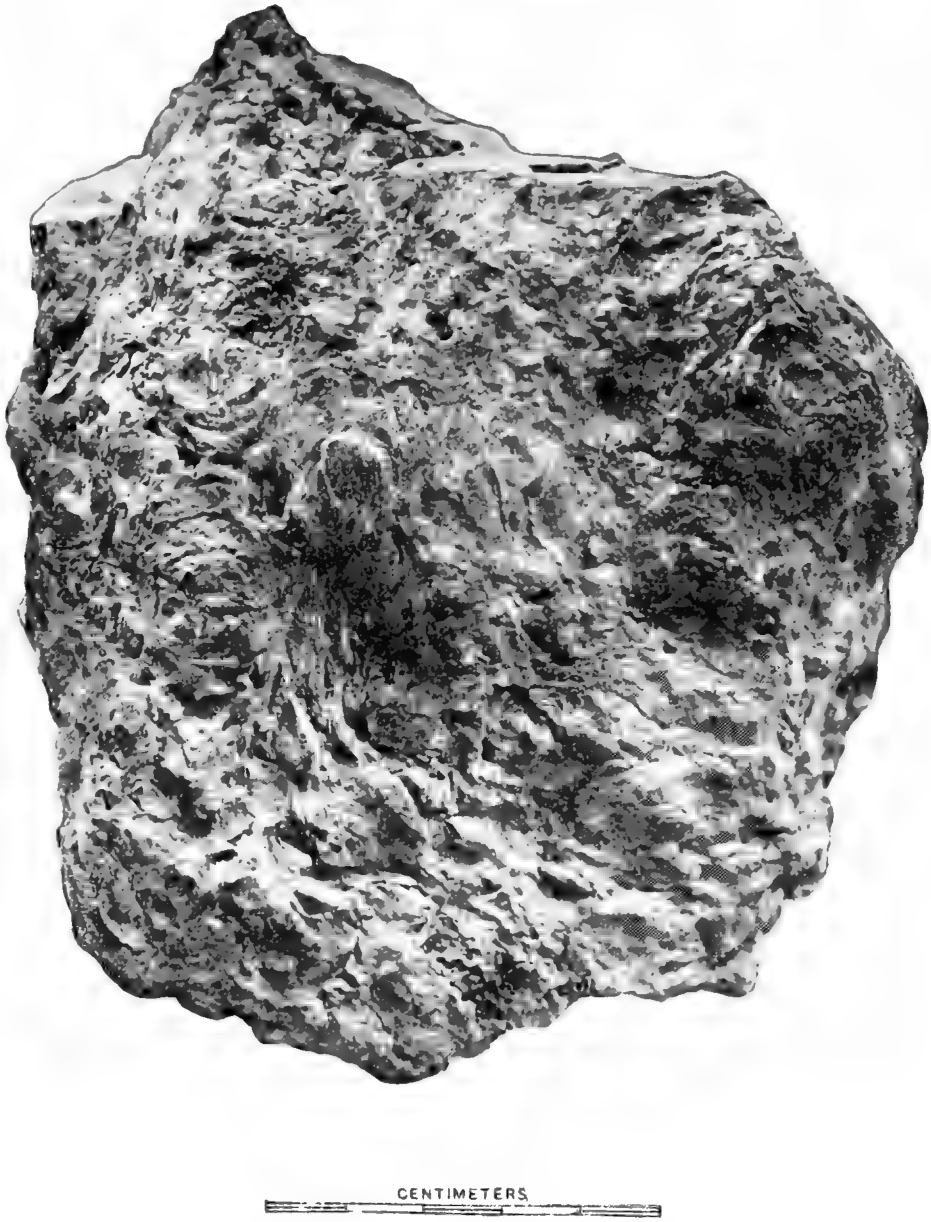
| CYCADELLA NODOSA Ward | 401 |
| View of the broadest side of No. 500.11 of the Museum of the University of Wyoming. | |




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXX.

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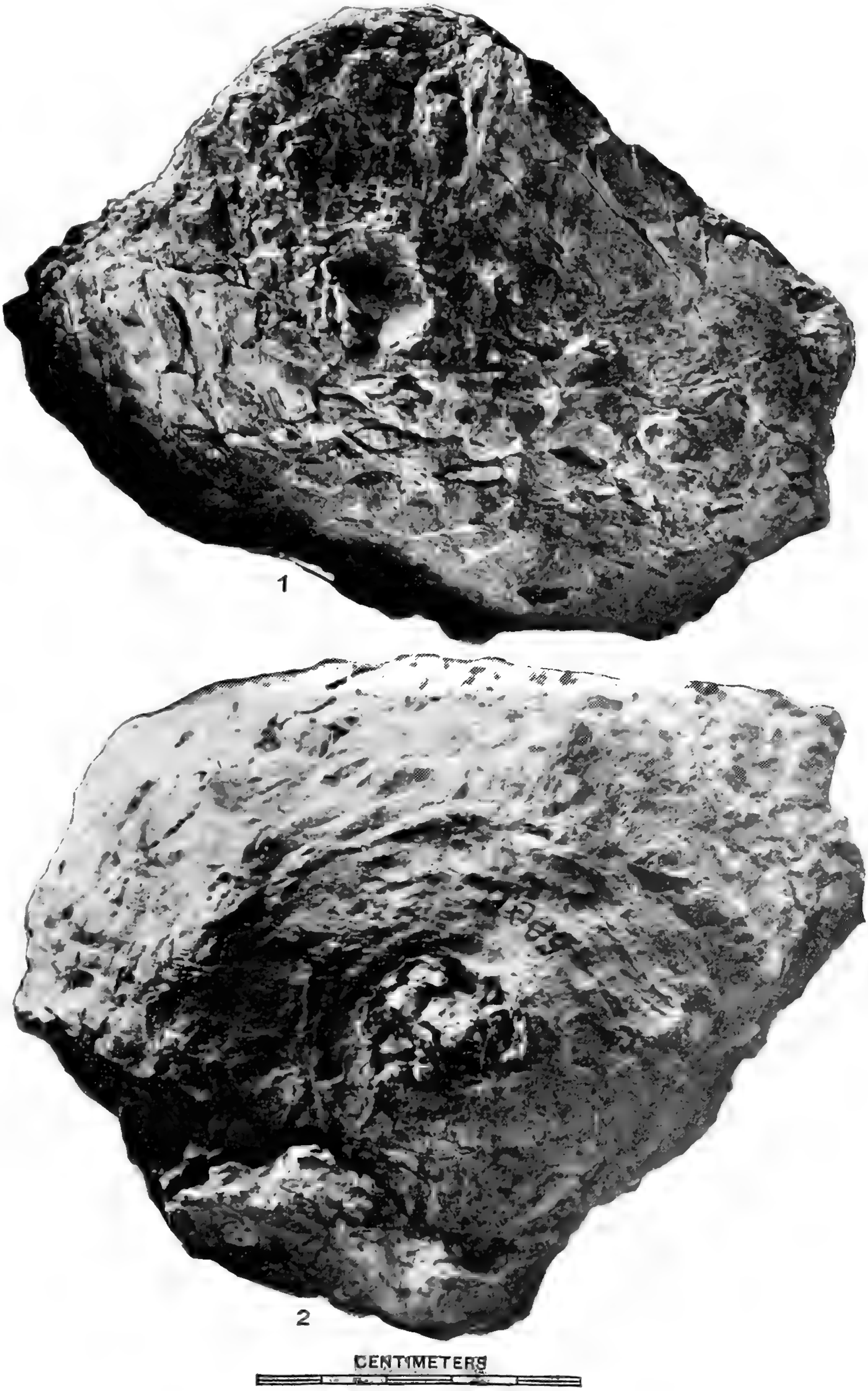
No. 500.11 of the Museum of the University of Wyoming.

Fig. 1. View of one side.

Fig. 2. View of the base.




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXI.

## PLATE CXXI.

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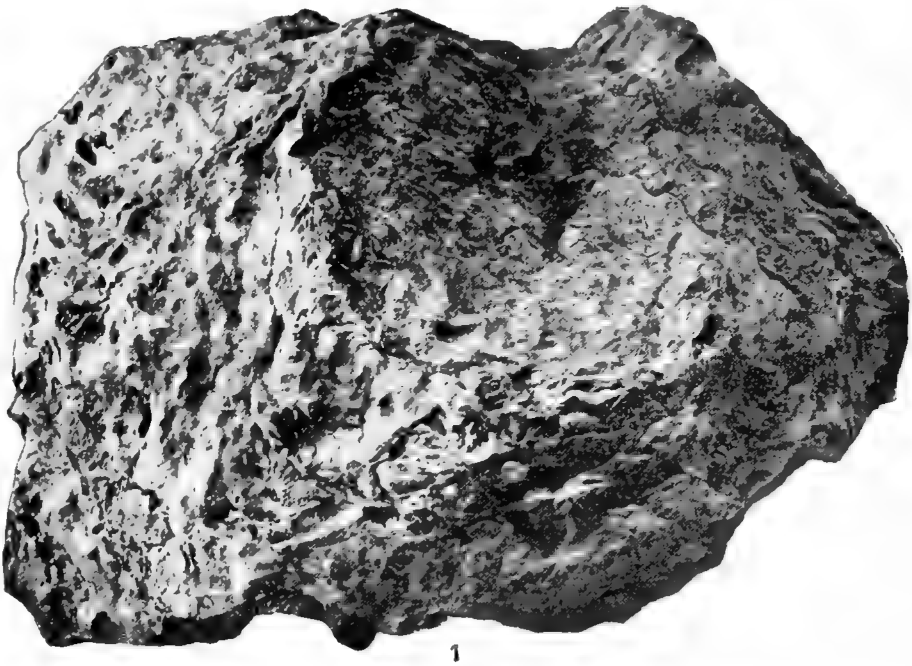
No. 500.48 of the Museum of the University of Wyoming.

Fig. 1. View of one side.

Fig. 2. View of the base.



1

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CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXII.

## PLATE CXXII.

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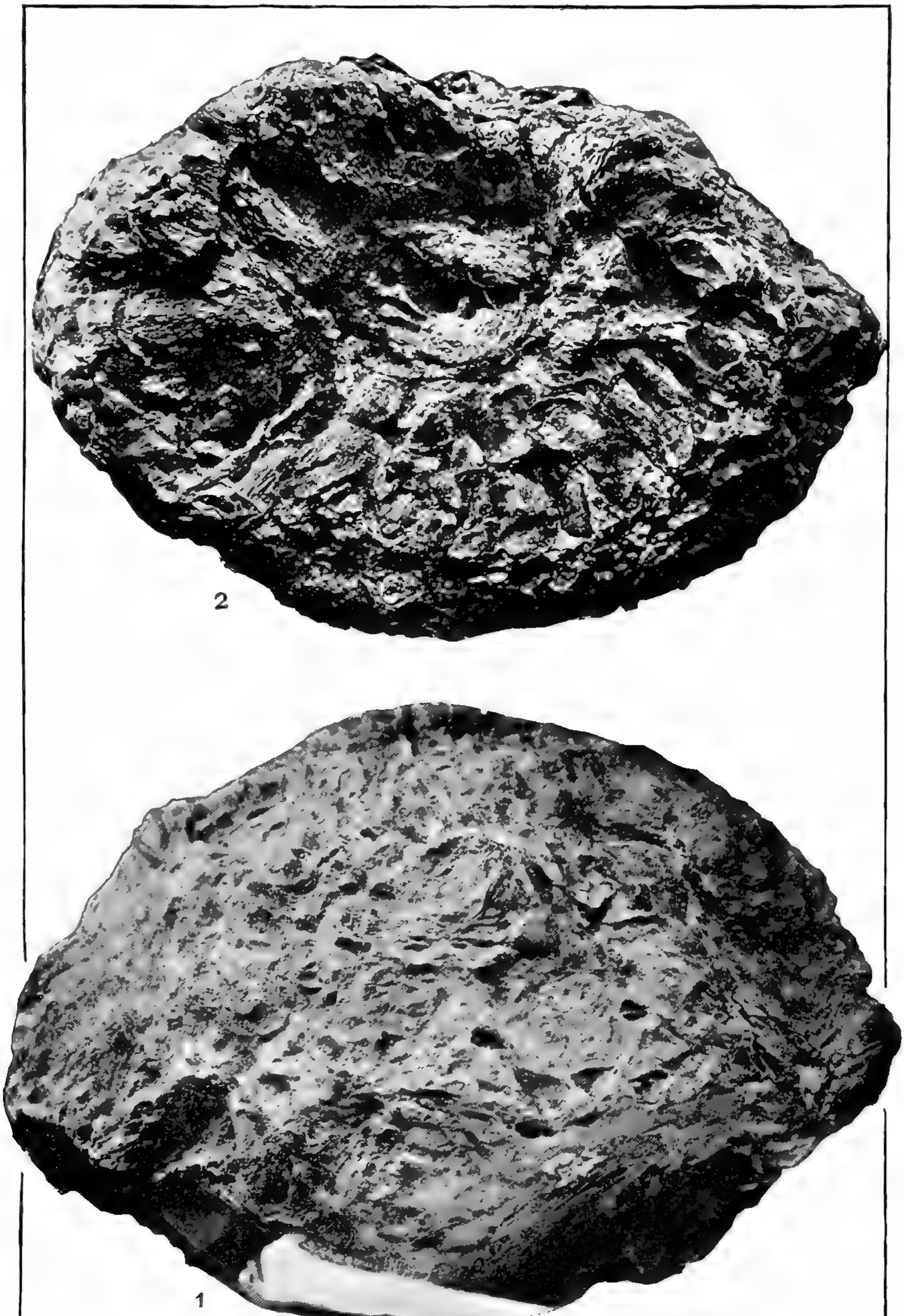
| Cycadella nodosa Ward | 401 |

No. 500.12 of the Museum of the University of Wyoming.

Fig. 1. View of one side.

Fig. 2. View of the concave base.




CYCADELLA NODOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXIII.

## PLATE CXXIII.

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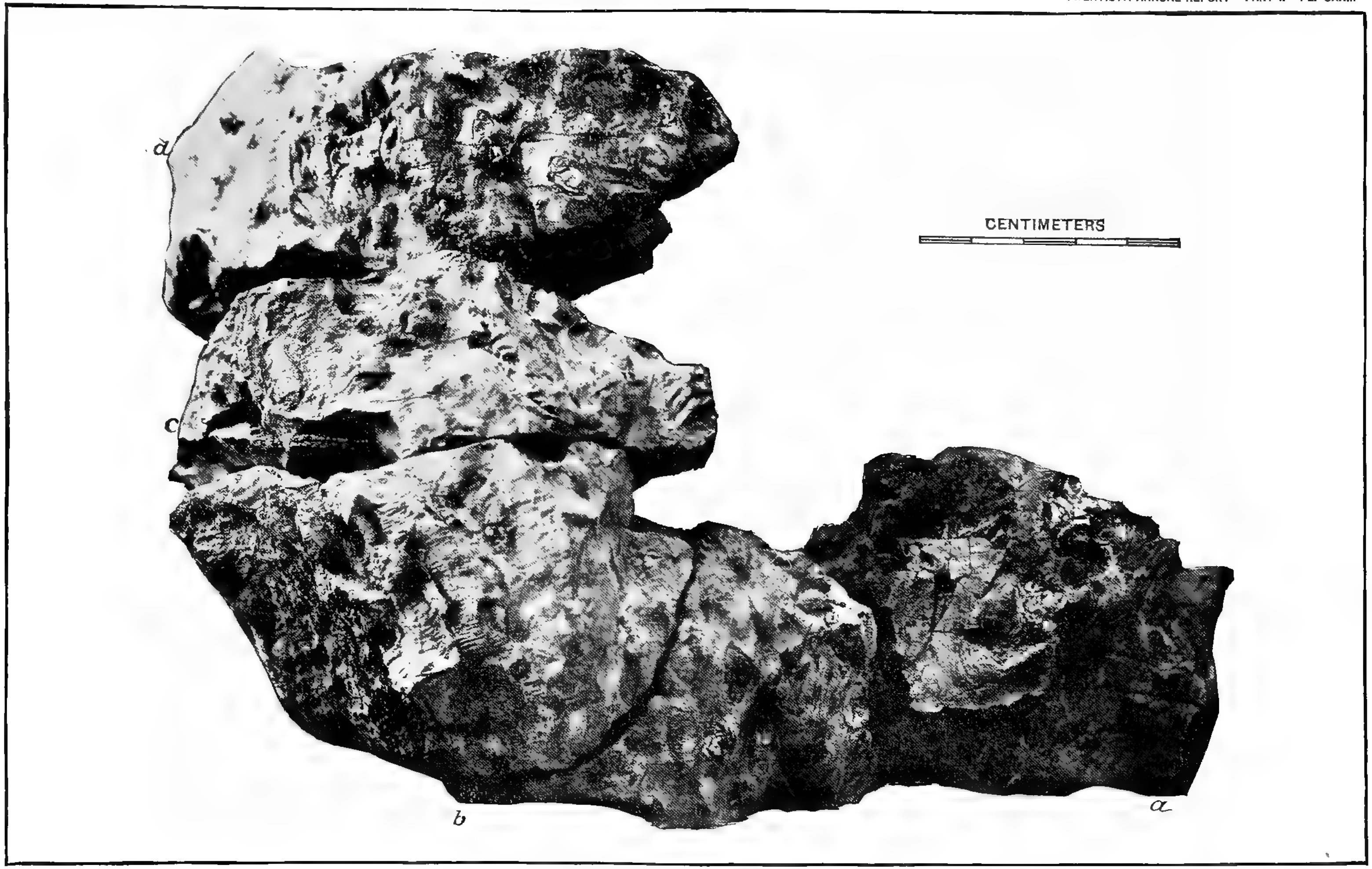
CYCADELLA CIRRATA Ward .................................................. 403

Side view of the portion of a trunk resulting from the union of the complementary Nos. 500.42, 500.46, 500.59, and 500.75 of the Museum of the University of Wyoming.

(*a*) No. 500.59; (*b*) No. 500.42; (*c*) No. 500.46; (*d*) No. 500.75.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

PLATE CXXIV.

## PLATE CXXIV.

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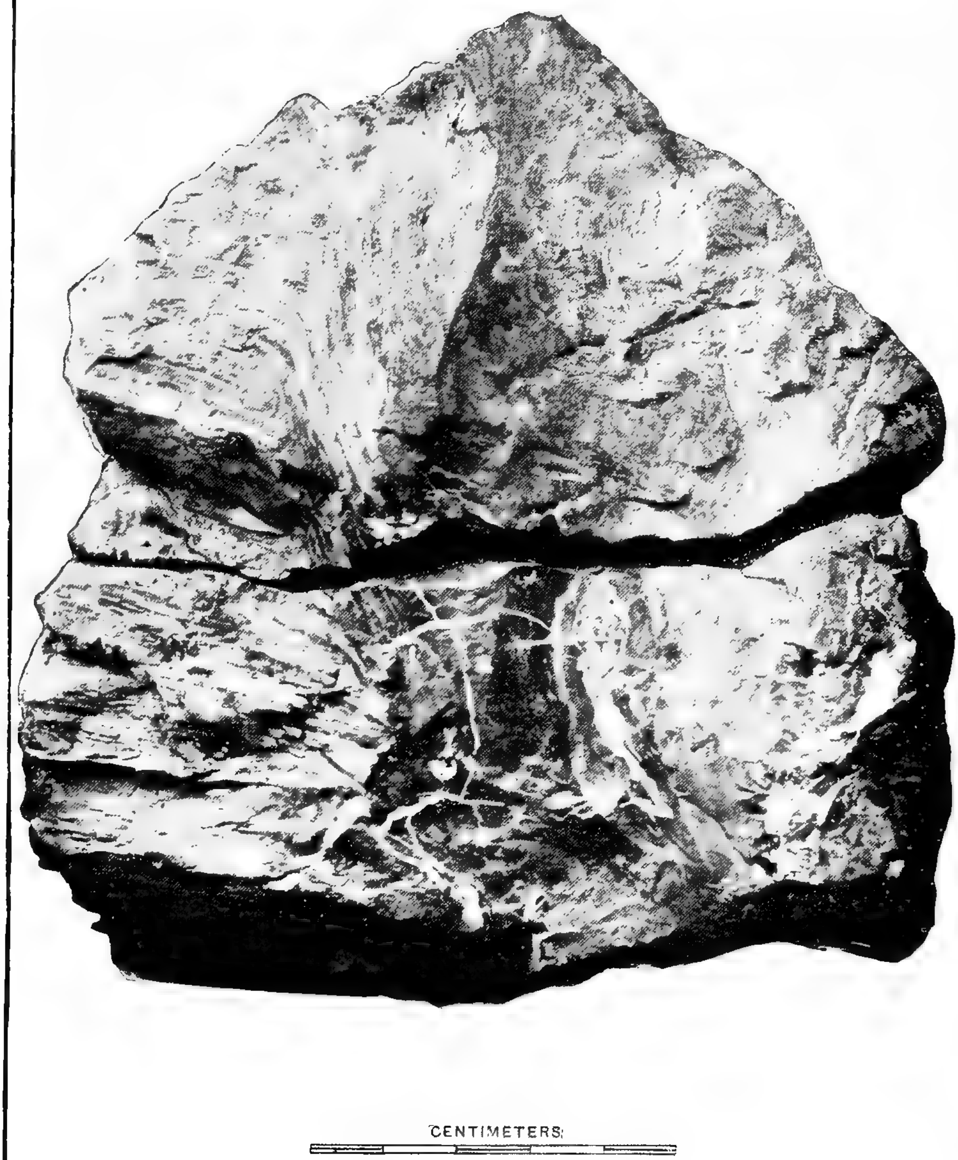
View of the central longitudinal fracture of No. 500.42 of the Museum of the University of Wyoming.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXV.

## PLATE CXXV.

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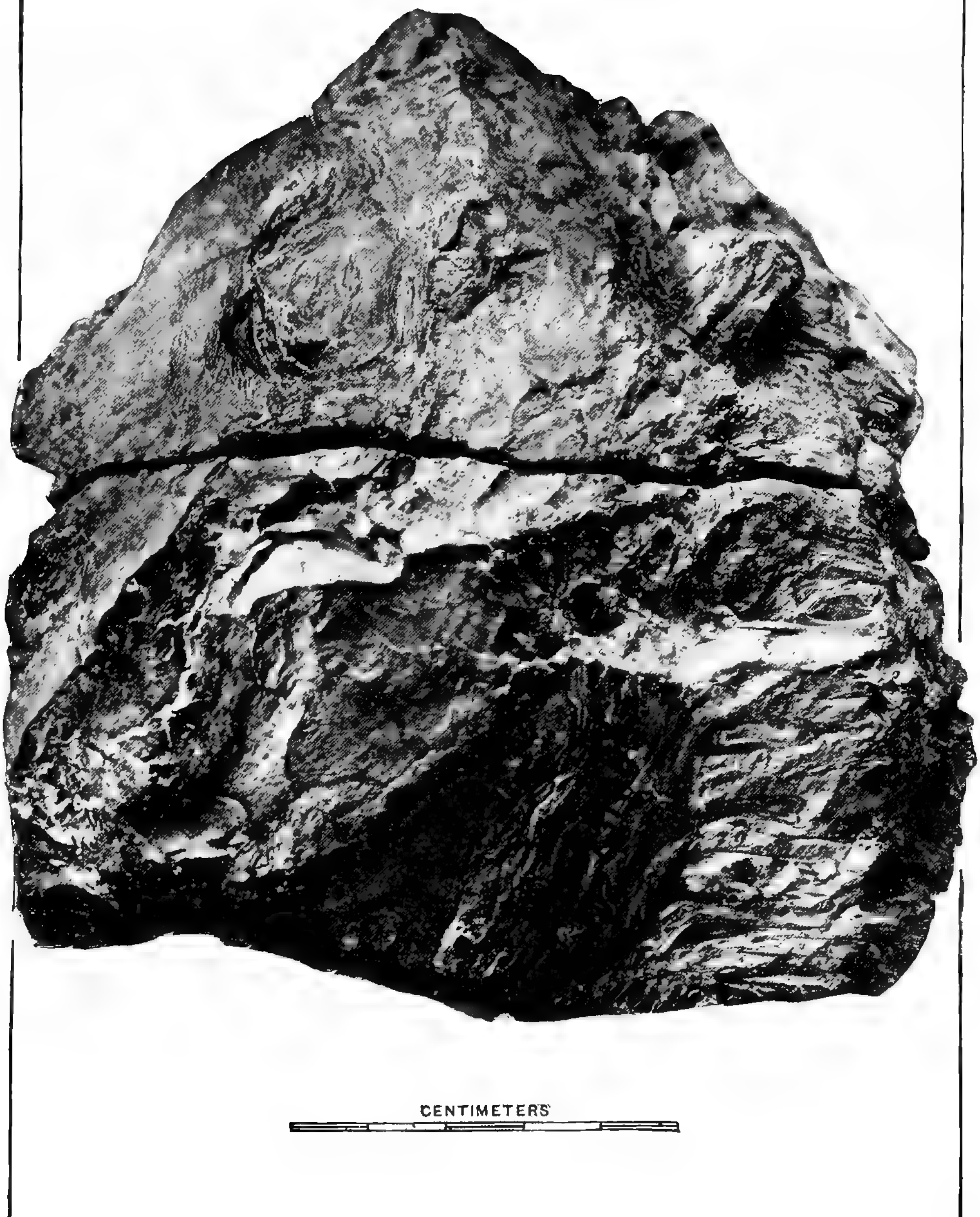
View of the outer longitudinal tangential fracture of No. 500.42 of the Museum of the University of Wyoming.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXVI.

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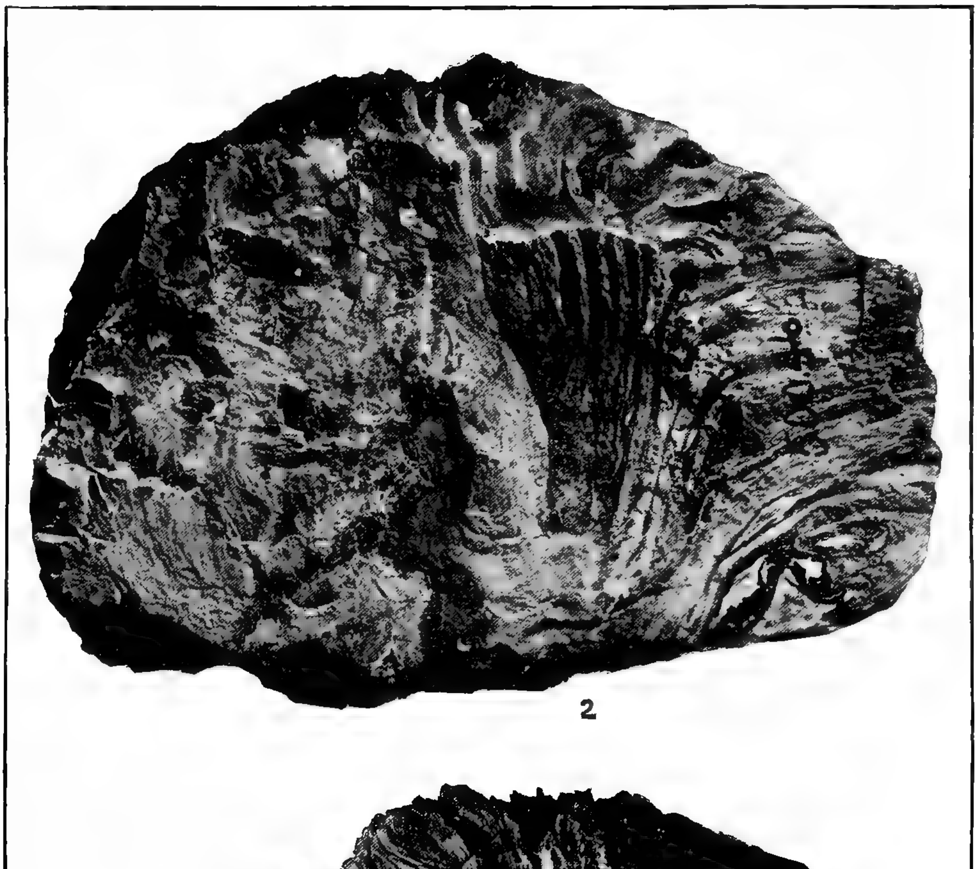
No. 500.46 of the Museum of the University of Wyoming.

Fig. 1. Fracture joining No. 500.42.

Fig. 2. Fracture joining No. 500.75.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXVII.

## PLATE CXXVII.

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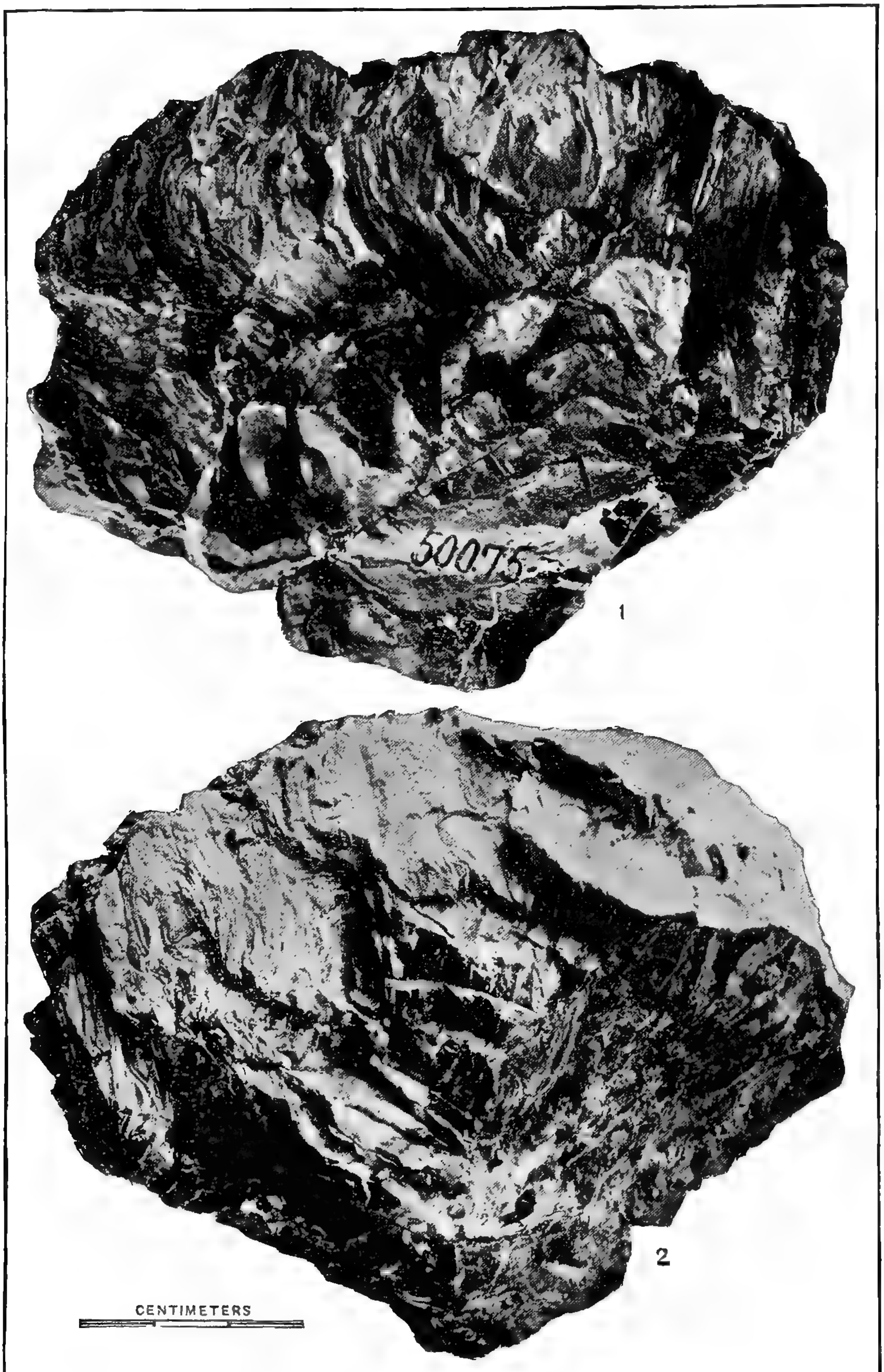
CYCADELLA CIRRATA Ward ........................................................ 403

No. 500.75 of the Museum of the University of Wyoming.

Fig. 1. Fracture joining No. 500.42.

Fig. 2. Outer fracture.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXVIII.

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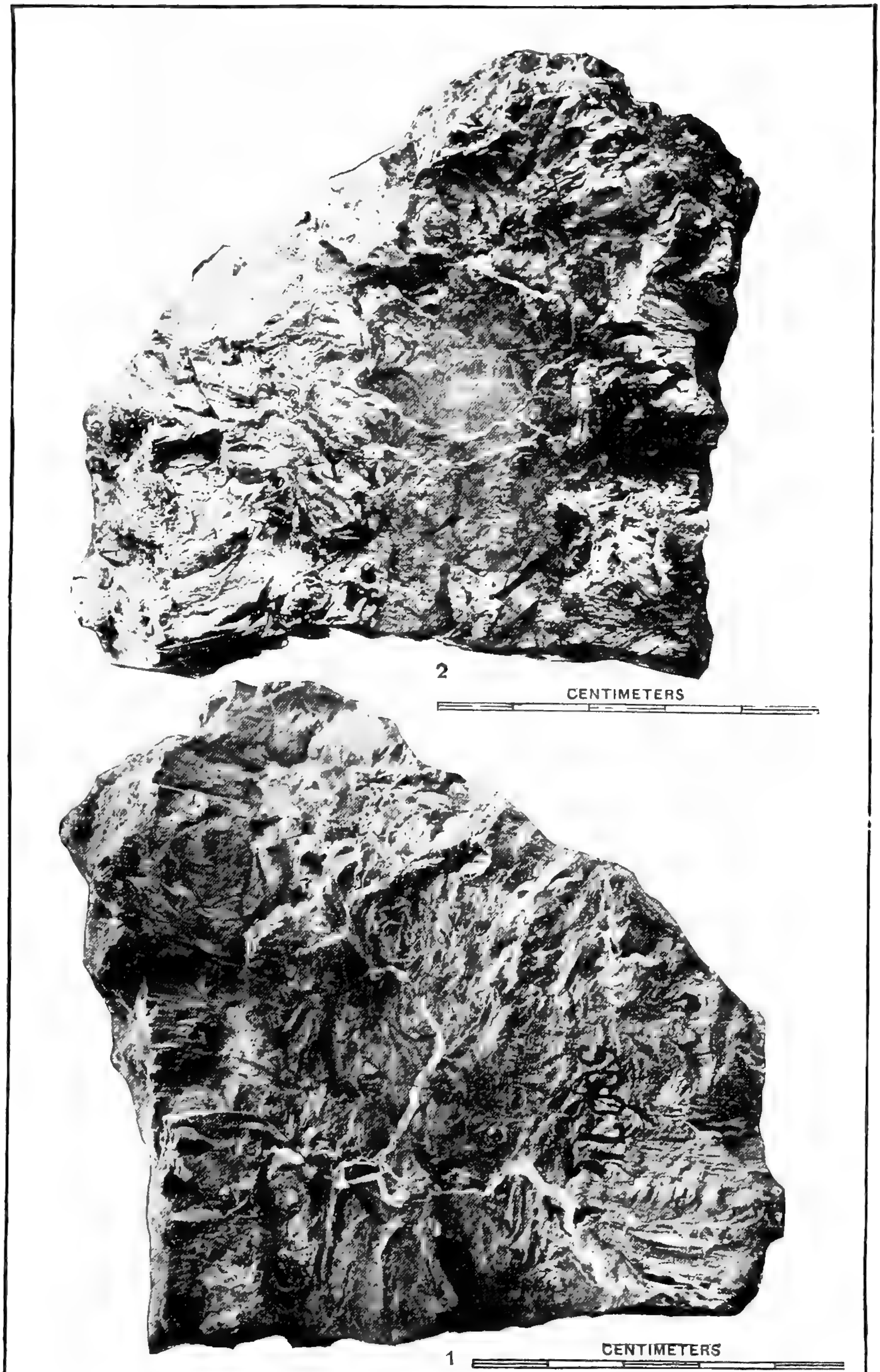
No. 500.71 of the Museum of the University of Wyoming.
Fig. 1. The broader fracture.
Fig. 2. The narrower fracture.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXIX.

## PLATE CXXIX.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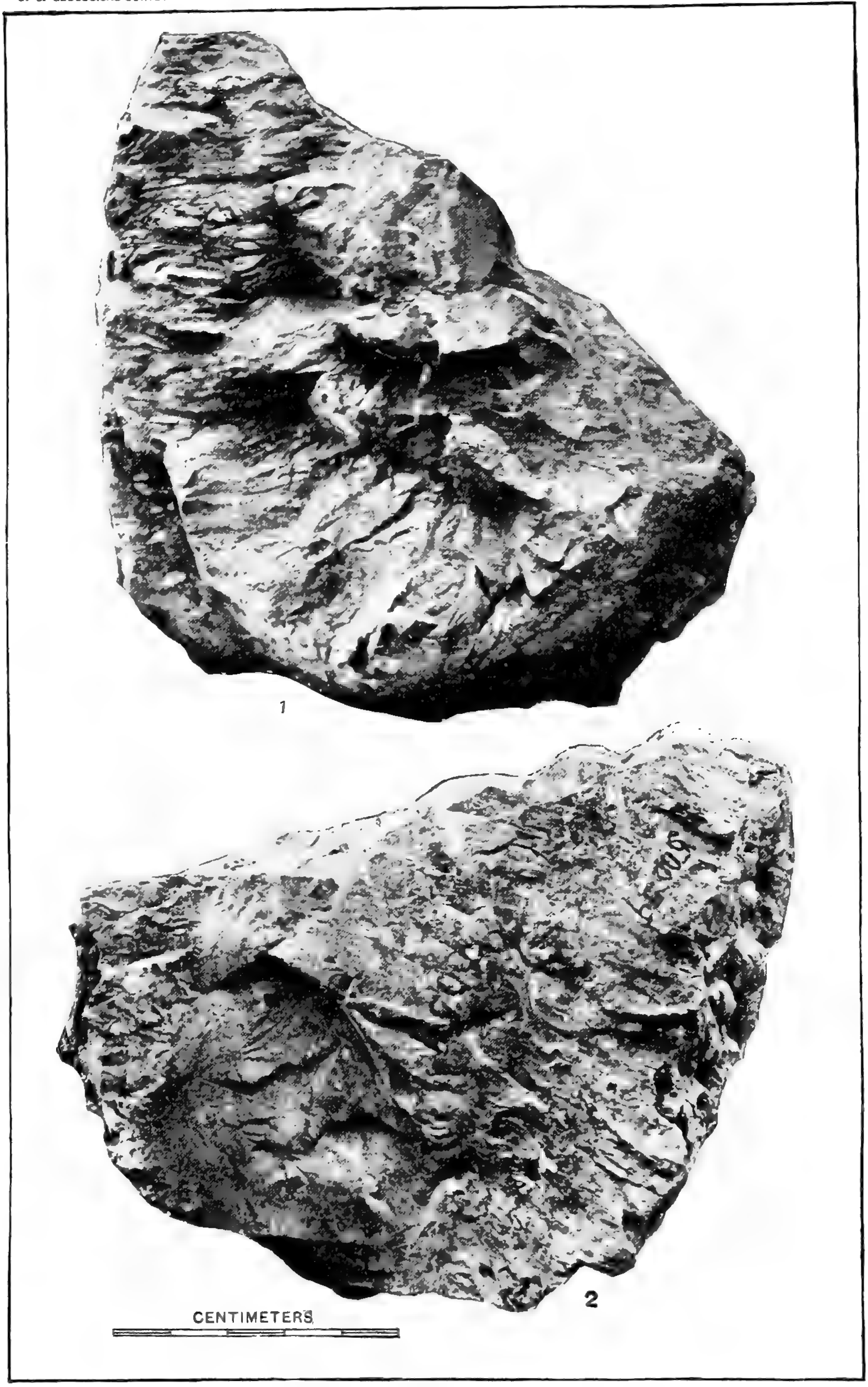
CYCADELLA CIRRATA Ward .......... 403


No. 500.59 of the Museum of the University of Wyoming.

Fig. 1. Central longitudinal fracture in same plane as that of Pl. CXXIV.

Fig. 2. Outer tangential fracture in same plane as that of Pl. CXXV.




CYCADELLA CIRRATA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXX.

## PLATE CXXX.

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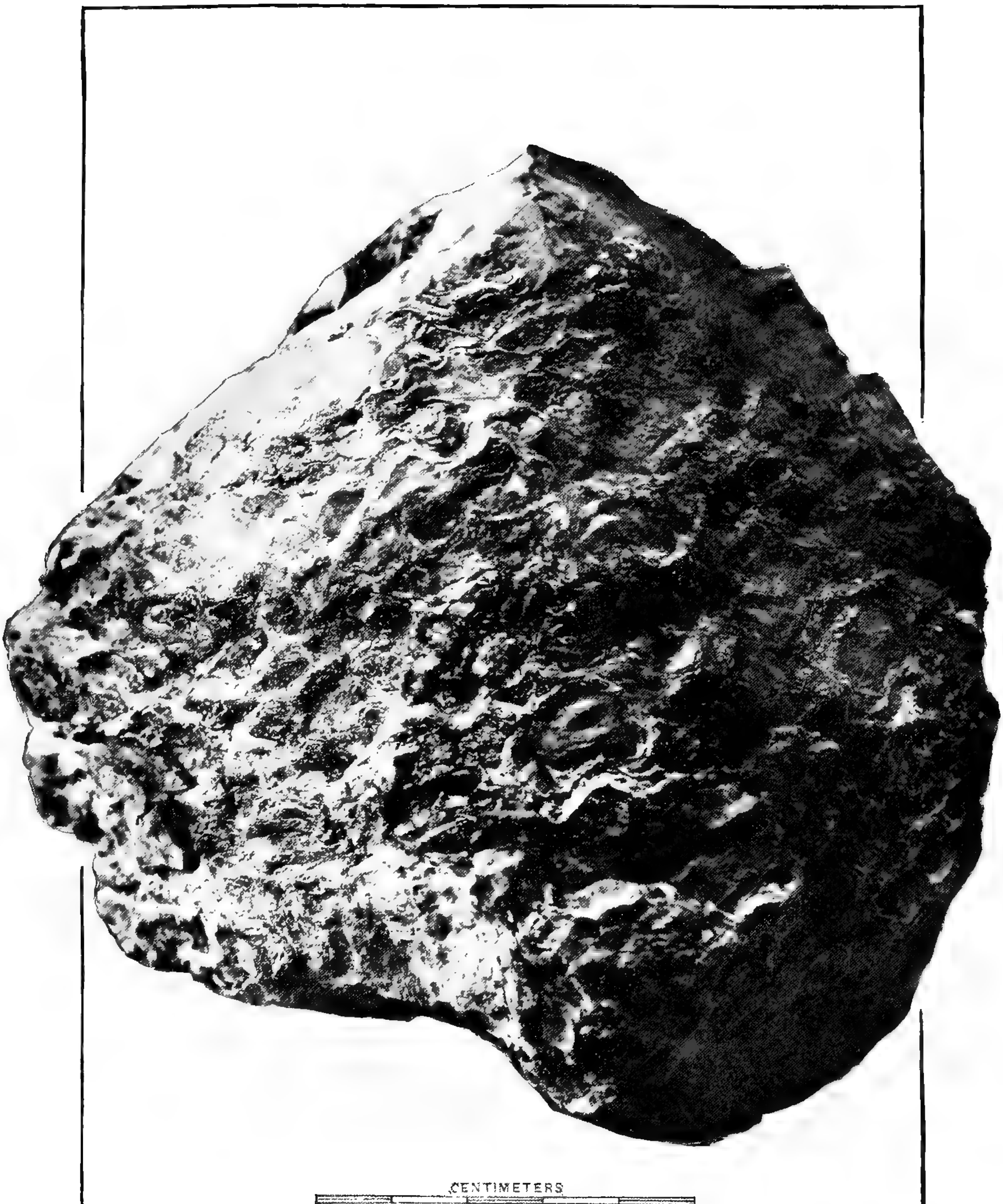
CYCADELLA EXOGENA Ward .......................................... 404

View of the outer surface of the half trunk No. 500.53 of the Museum of the University of Wyoming.




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXI.

## PLATE CXXXI.

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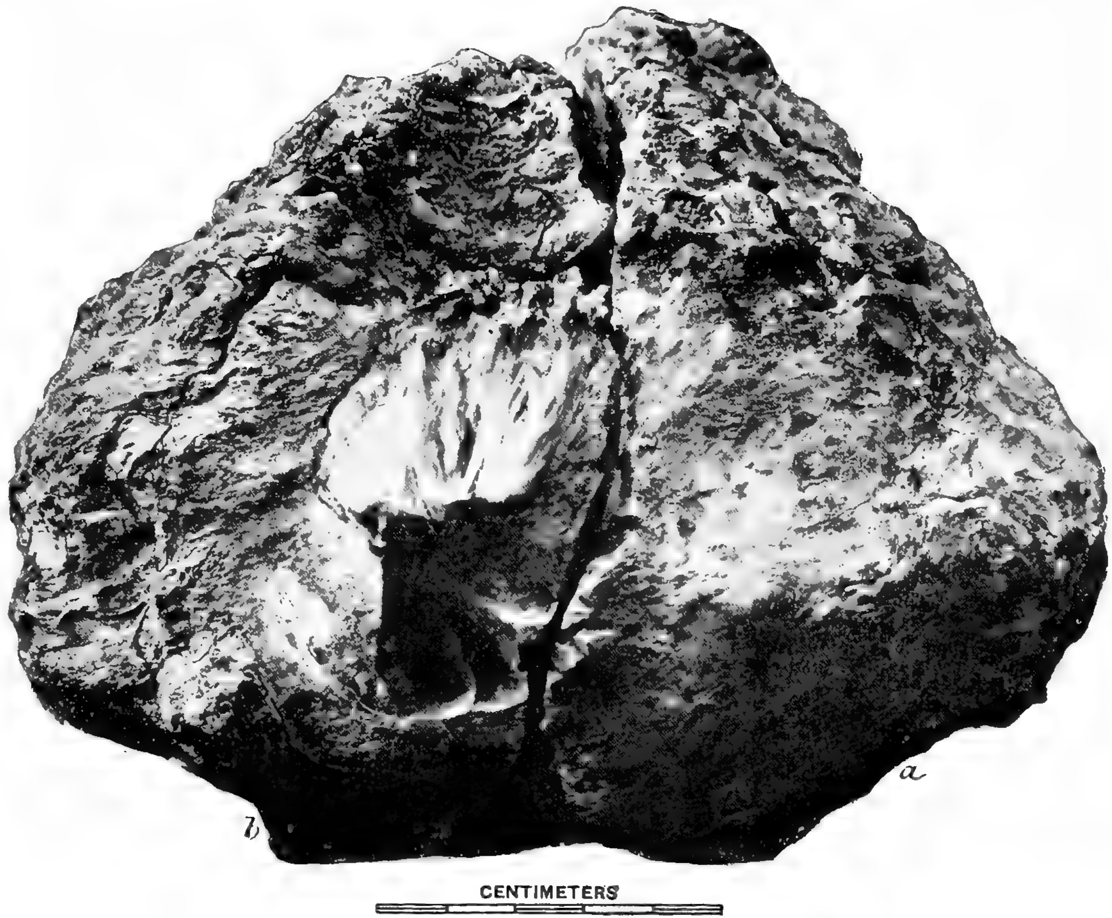
CYCADELLA EXOGENA Ward .......................................................... 404

View of the base of the nearly complete trunk resulting from the union of Nos. 500.53 and 500.61 of the Museum of the University of Wyoming.

(*a*) No. 500.53; (*b*) No. 500.61.




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXII.

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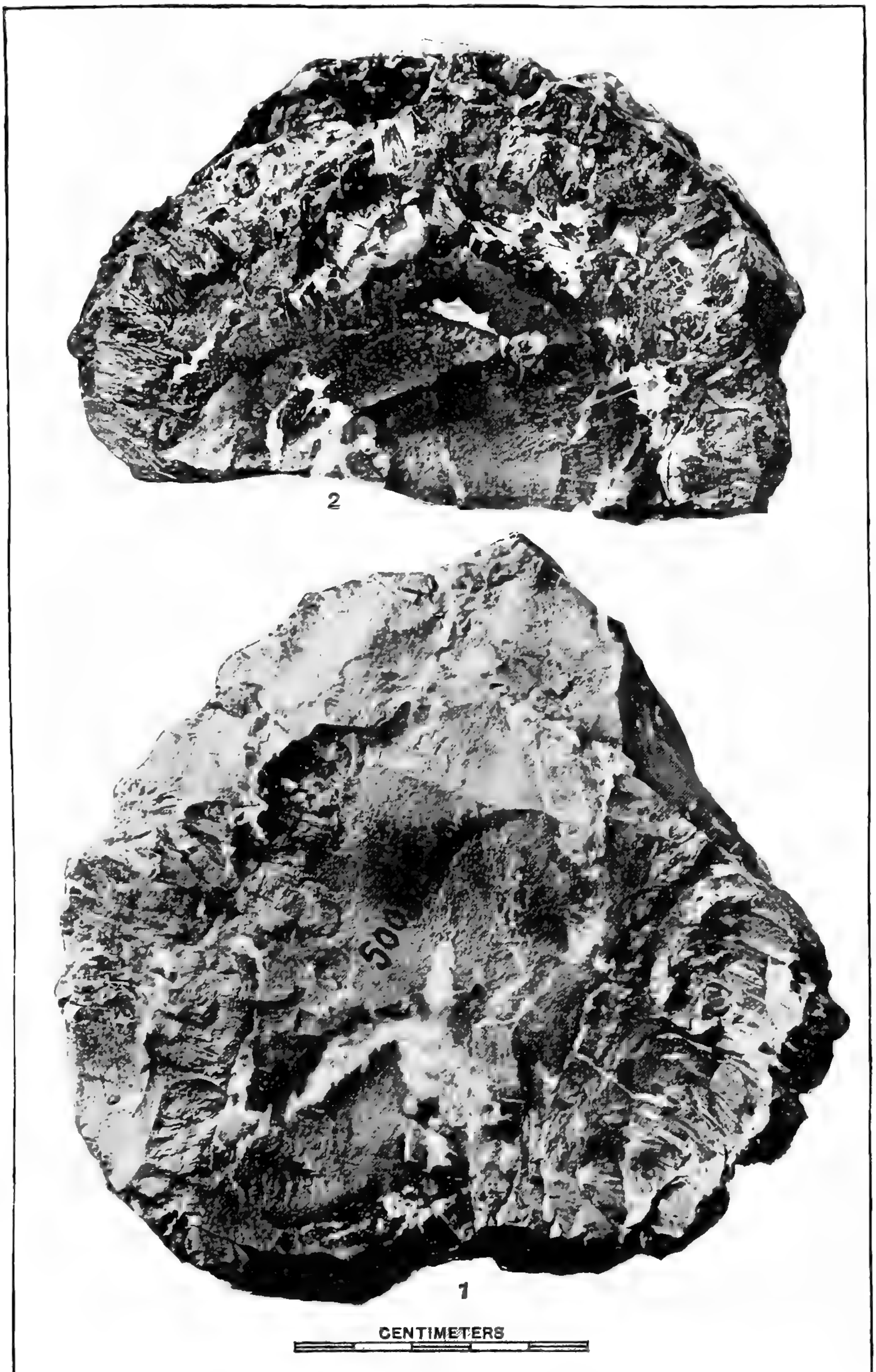
CYADELLA EXOGENA Ward .................................................. 404

Longitudinal and transverse views of the trunk Nos. 500.53 and 500.61 of the Museum of the University of Wyoming.

Fig. 1. Central longitudinal fracture of No. 500.53.

Fig. 2. Transverse fracture of No. 500.61, showing the exogenous structure.




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXIII.

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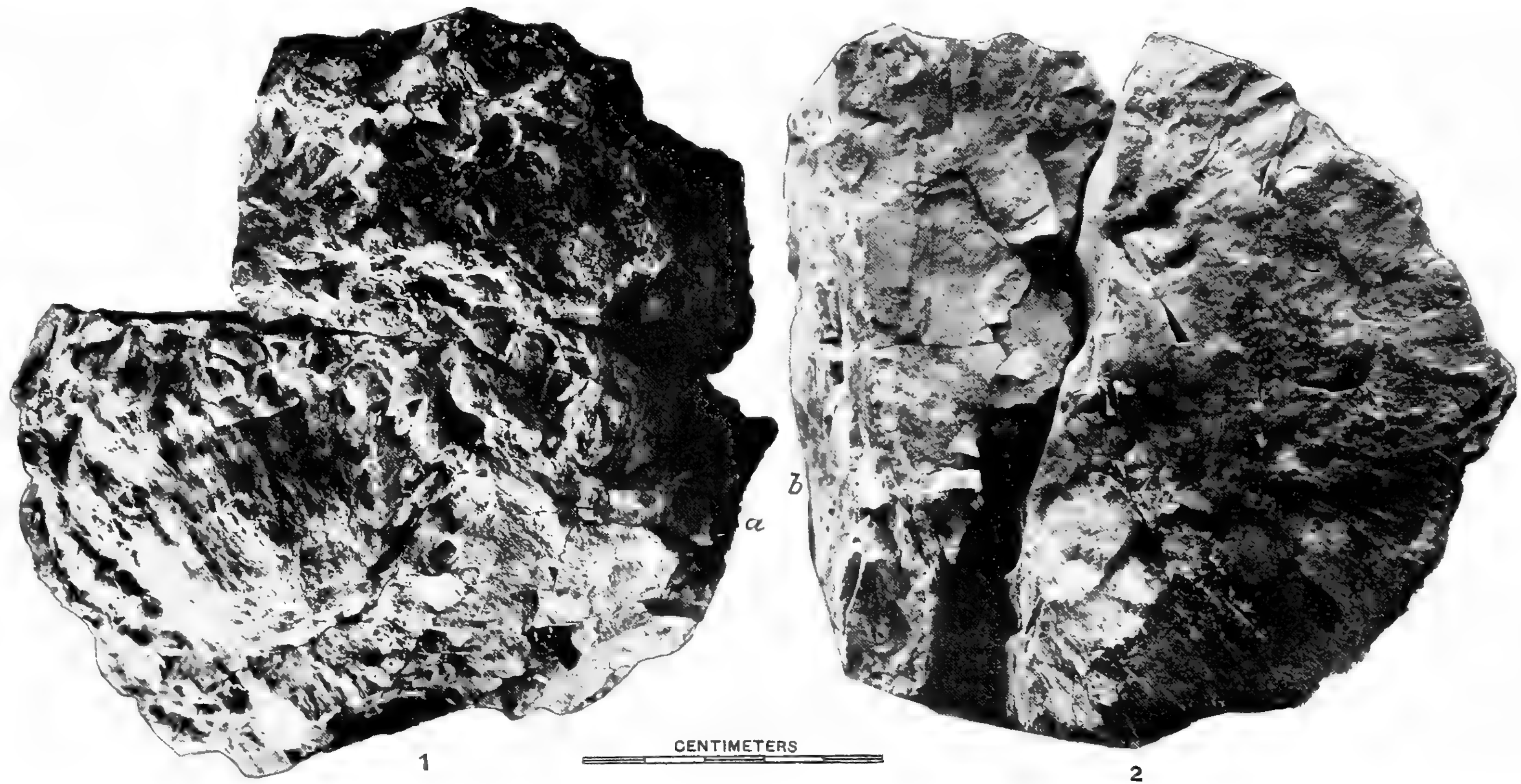
Cycadella exogena Ward ........................................ 404

Nos. 500.13 and 500.72 of the Museum of the University of Wyoming, which are complementary of each other.

Fig. 1. Side and top view, showing the terminal bud.

Fig. 2. View of the fractured surface.

(*a*) No. 500.13; (*b*) No. 500.72.




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXIV.

## PLATE CXXXIV.

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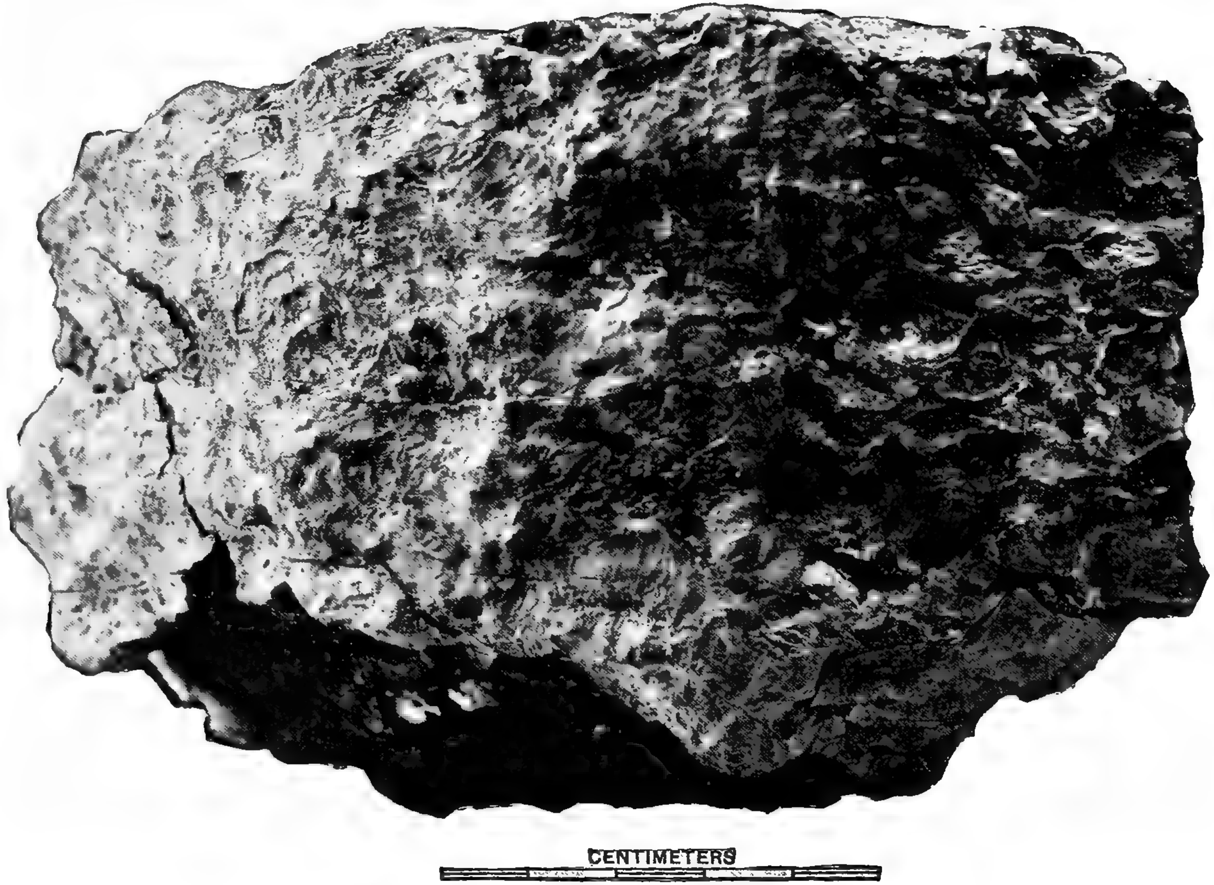
| CYCADELLA EXOGENA Ward | 404 |
| Side view of No. 500.37 of the Museum of the University of Wyoming. | |




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXV.

## PLATE CXXXV.

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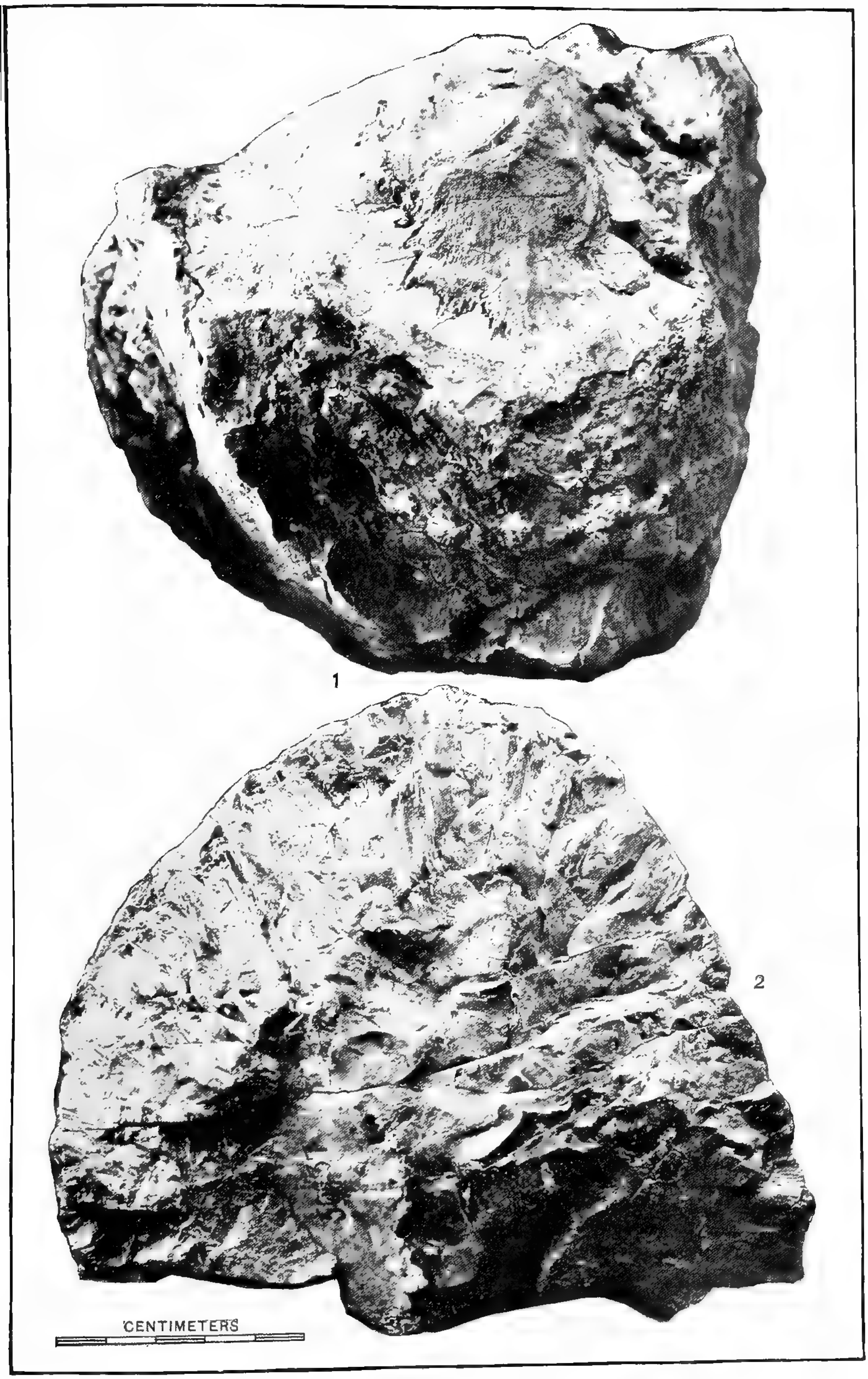
CYCADELLA EXOGENA Ward .................................................. 404

No. 500.37 of the Museum of the University of Wyoming.

Fig. 1. View of the base.

Fig. 2. View of the transverse fracture.




CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

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## PLATE CXXXVI.

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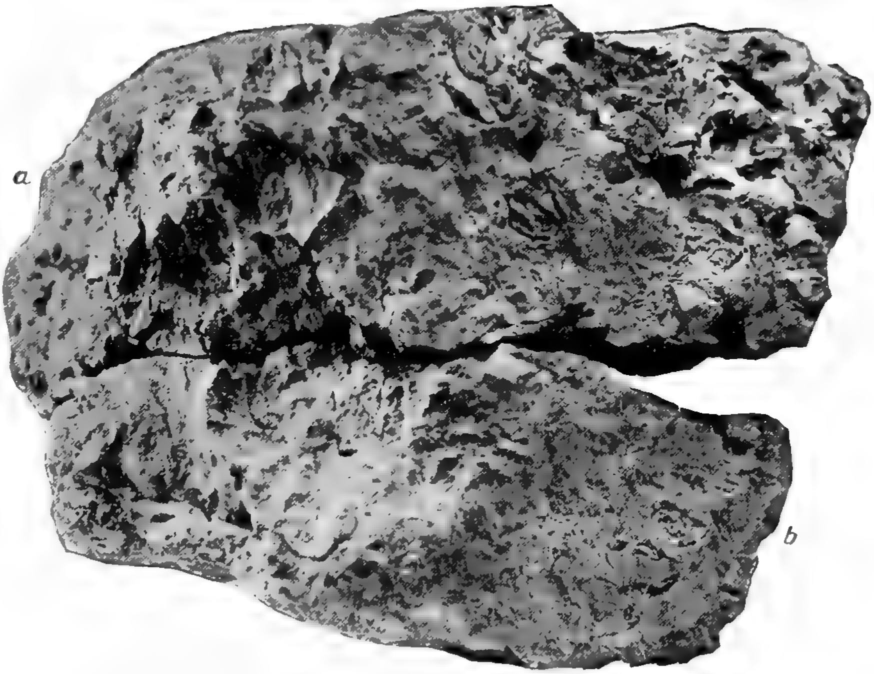
CYCADELLA EXOGENA Ward .................................................. 404

Fig. 1. View of the external surface of the complementary fragments Nos. 500.44 and 500.73 of the Museum of the University of Wyoming. (*a*) No. 500.44; (*b*) No. 500.73.

Fig. 2. View of the upper transverse fracture of No. 500.44.

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CYCADELLA EXOGENA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXVII.

# PLATE CXXXVII.

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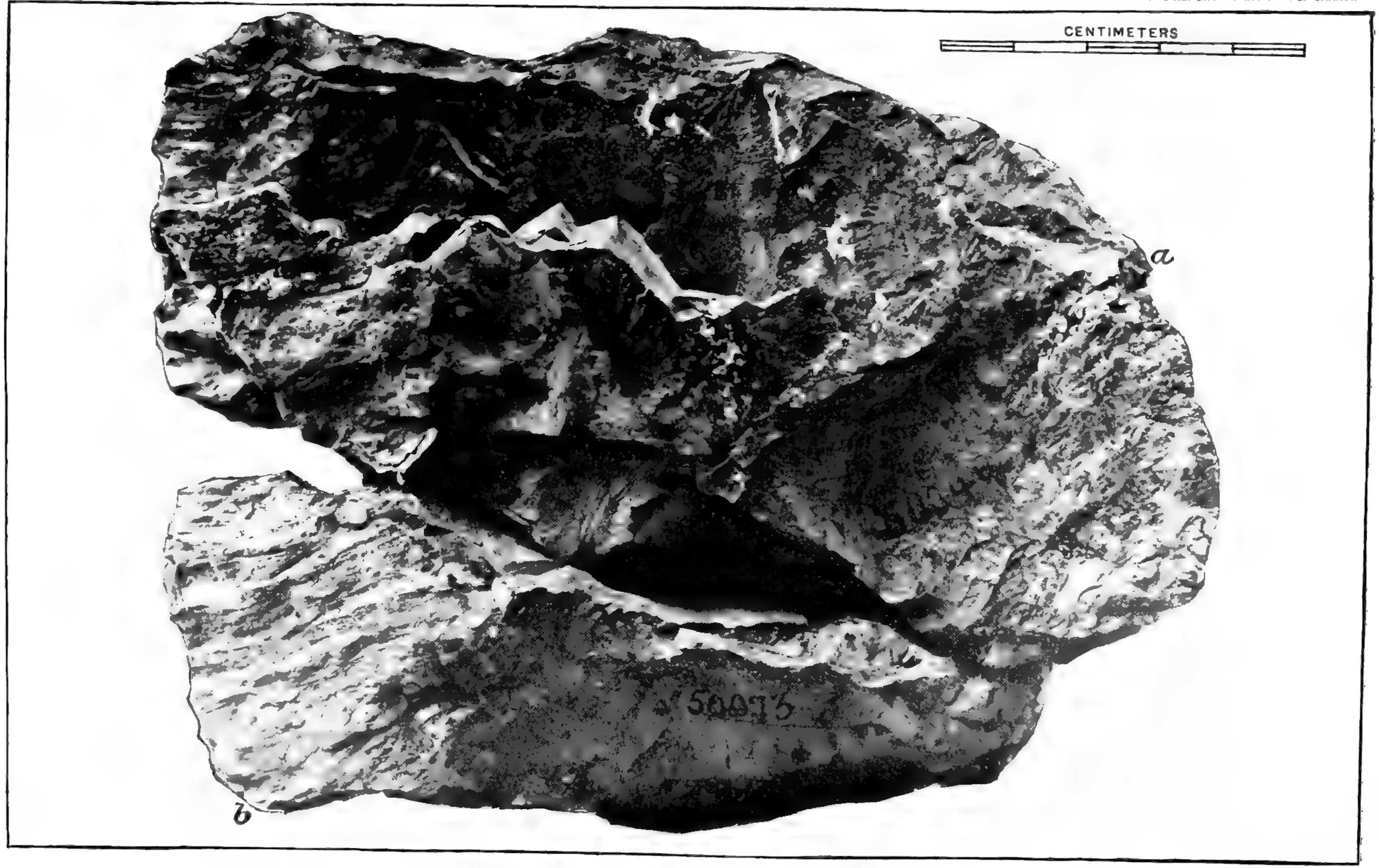
CYCADELLA EXOGENA Ward ........................................................ 404

View of the longitudinal fracture of the complementary fragments Nos. 500.44 and 500.73 of the Museum of the University of Wyoming.

(*a*) No. 500.44; (*b*) No. 500.73.




CYCADELLA EXOGENA. FROM THE JURASSIC OF WYOMING.

# PLATE CXXXVIII.

## PLATE CXXXVIII.

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CYCADELLA RAMENTOSA Ward .......... 406

Fig. 1. Side view of No. 500.34 of the Museum of the University of Wyoming.

Fig. 2. View of the outer surface of No. 500.39, almost wholly covered with the ramentaceous layer.

Fig. 3. View of the outer surface of No. 500.55, mostly covered, but a few organs visible.

NOTE.—These views are arranged in the relations in which the parts they represent are supposed to have had, but the intervals between them were probably somewhat greater.

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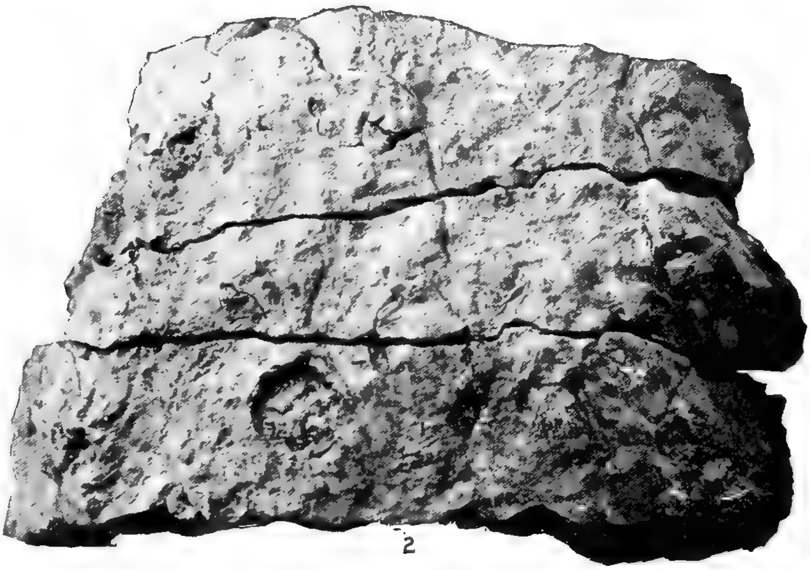

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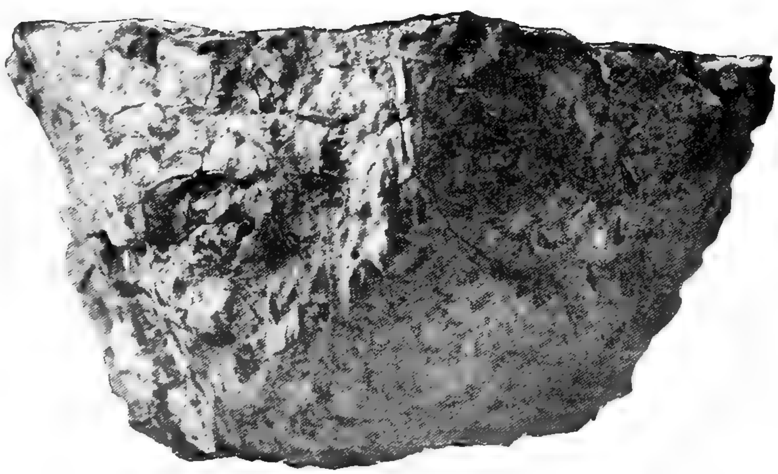

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CENTIMETERS

CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXXXIX.

# PLATE CXXXIX.

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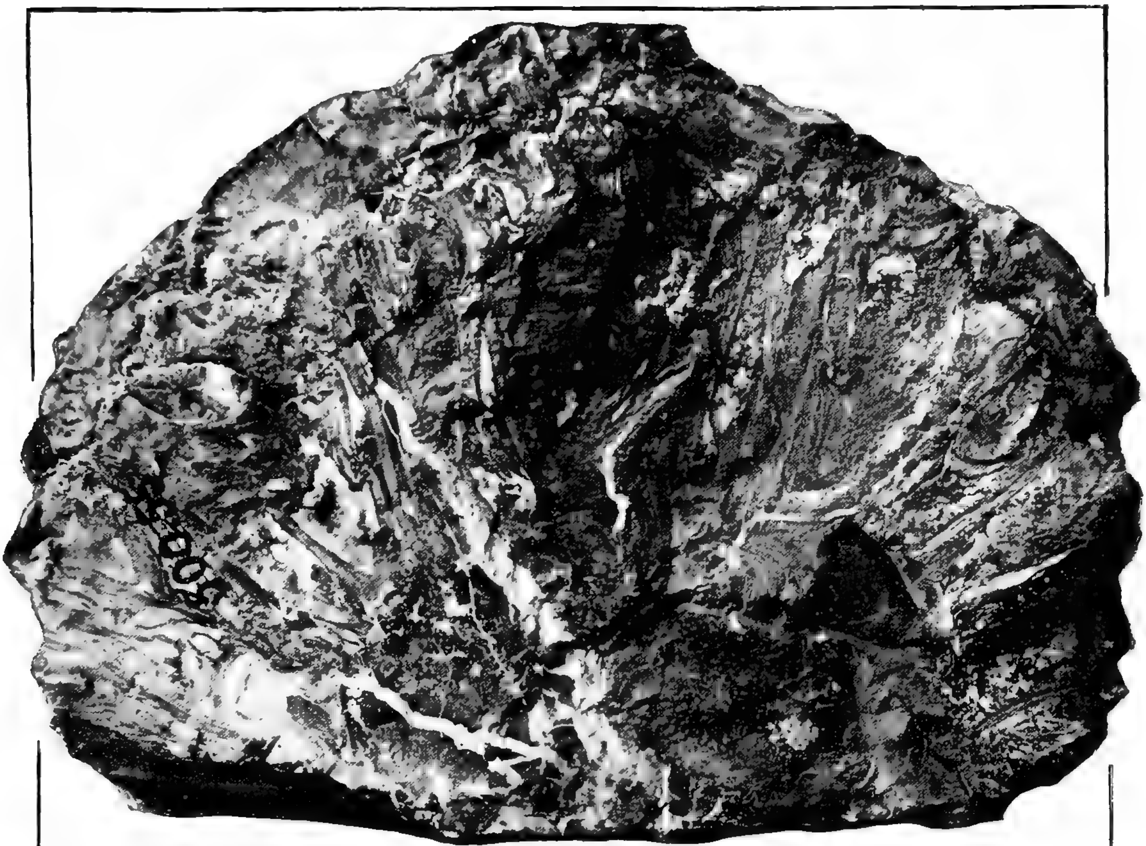
| CYCADELLA RAMENTOSA Ward | 406 |

Fig. 1. View of the upper transverse fracture of No. 500.55 of the Museum of the University of Wyoming.

Fig. 2. View of the lower transverse fracture of No. 500.39.



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CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXL

## PLATE CXL.

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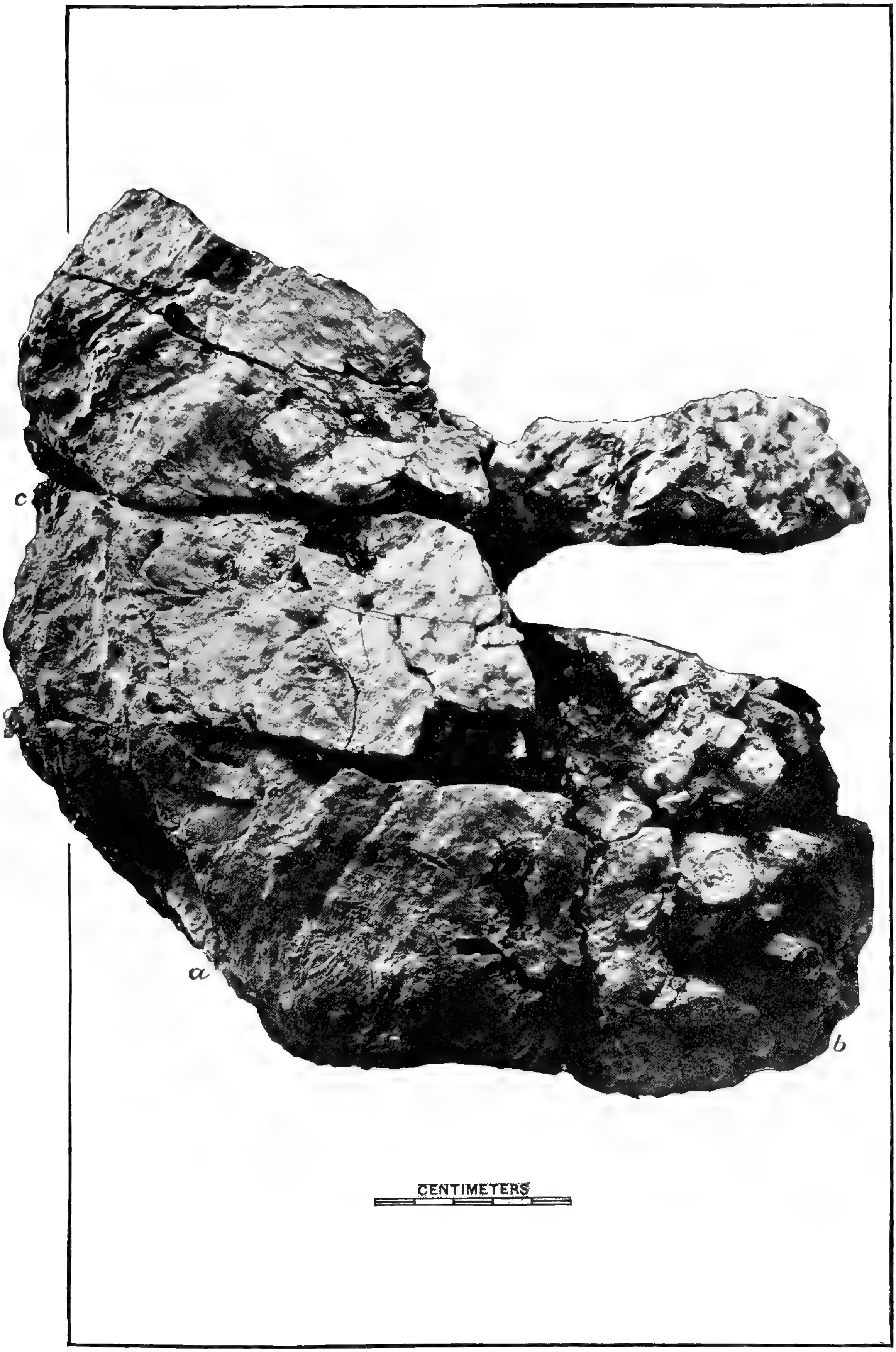
CYCADELLA RAMENTOSA Ward ........................................ 406

View of the outer surface of the portion of a trunk resulting from joining the five complementary fragments, Nos. 500.40, 500.43, 500.45, 500.66, and 500.81 of the Museum of the University of Wyoming.

(*a*) No. 500.45; (*b*) No. 500.40; (*c*) No. 500.66; (*d*) No. 500.43; (*e*) No. 500.81.




CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLI.

## PLATE CXLI.

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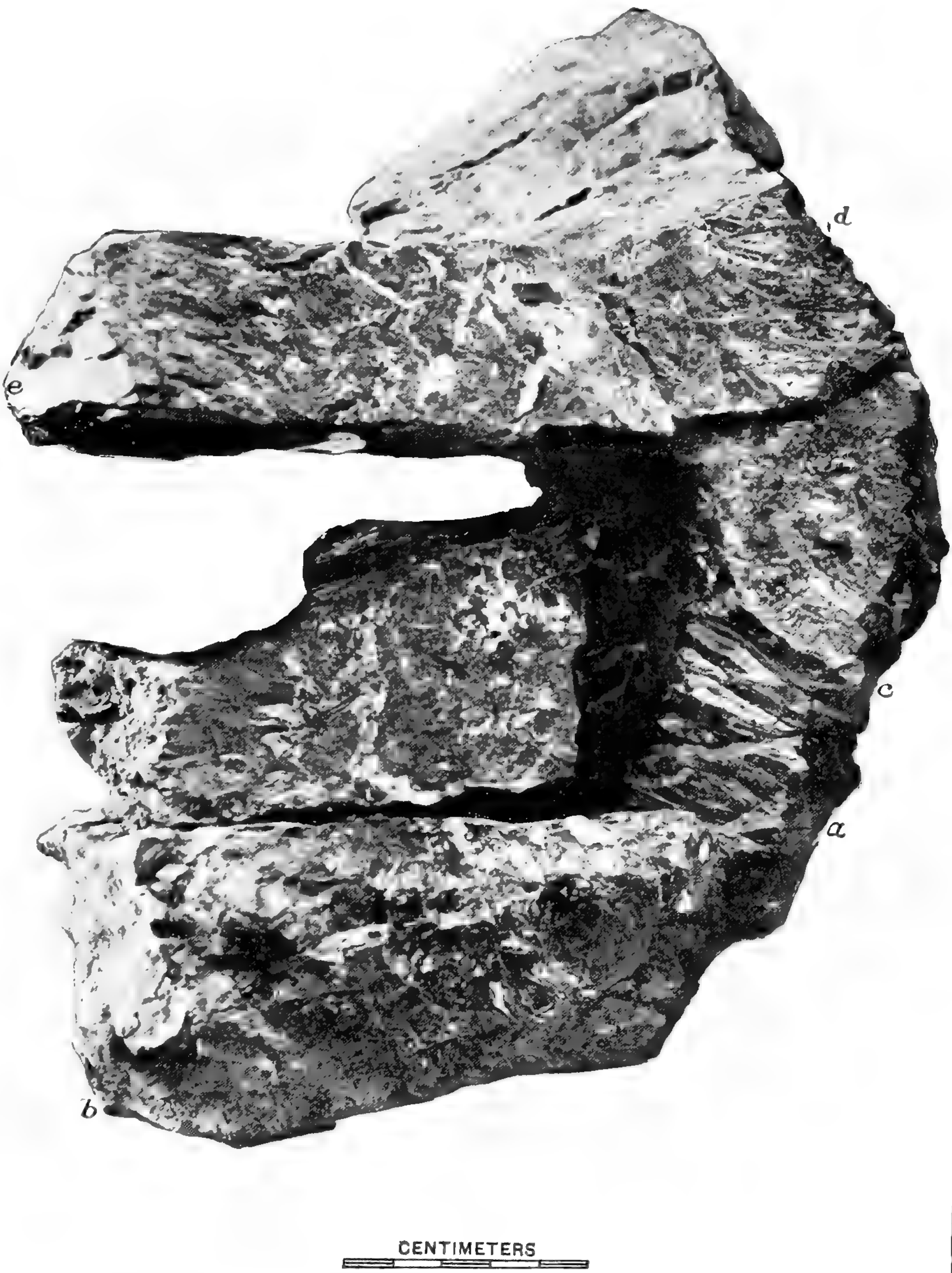
CYCADELLA RAMENTOSA Ward .......................................... 406

View of the inner fractured surfaces of the portion of a trunk resulting from joining the complementary fragments, Nos. 500.40, 500.43, 500.45, 500.66, and 500.81 of the Museum of the University of Wyoming.

(*a*) No. 500.45; (*b*) No. 500.40; (*c*) No. 500.66; (*d*) No. 500.43; (*e*) No. 500.81.




CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLII.

## PLATE CXLII.

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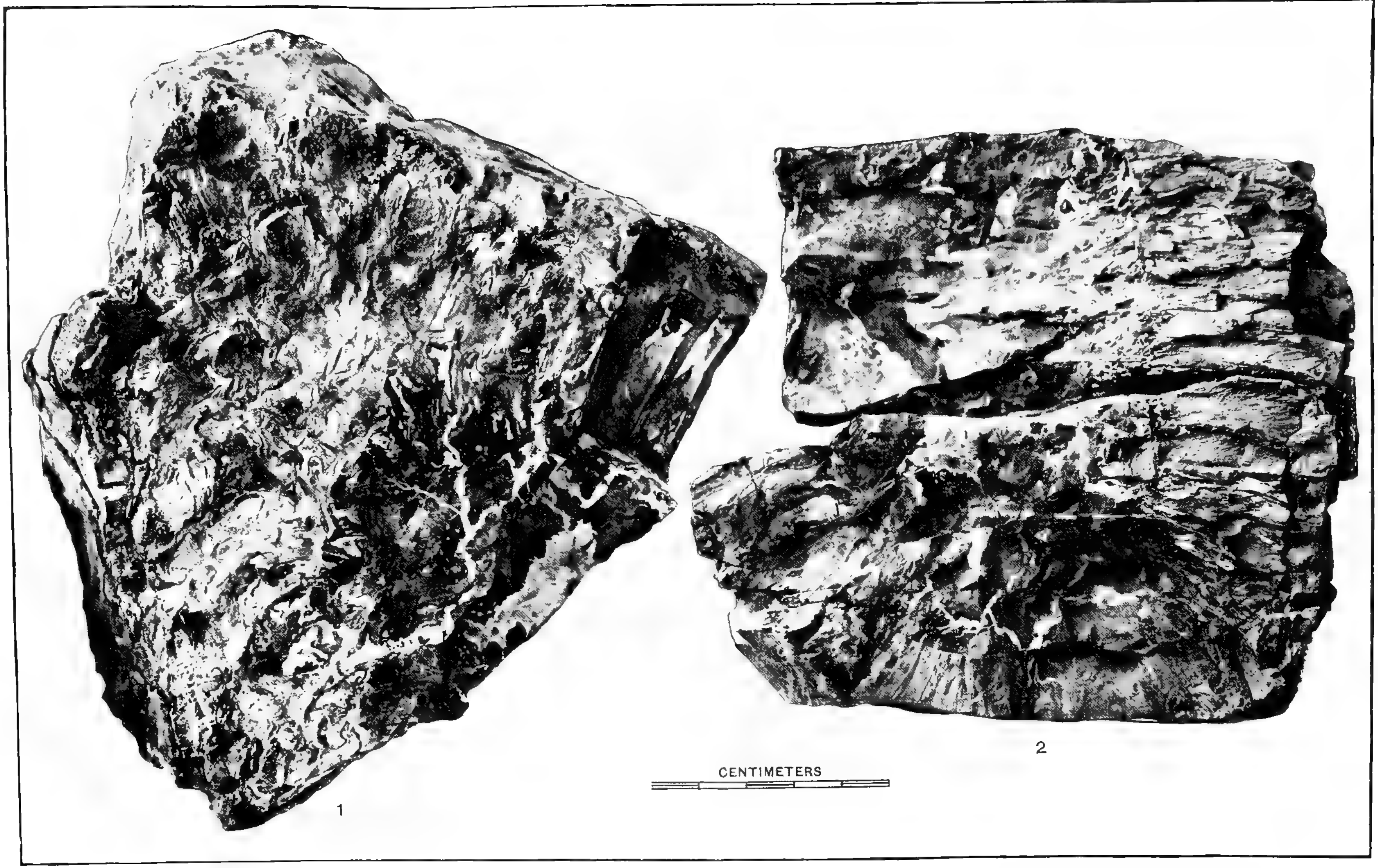
CYCADELLA RAMENTOSA Ward .......................................... 406

Fig. 1. Transverse fracture of the lower side of No. 500.66 of the Museum of the University of Wyoming.

Fig. 2. Longitudinal fracture of No. 500.40.




CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLIII.

## PLATE CXLIII.

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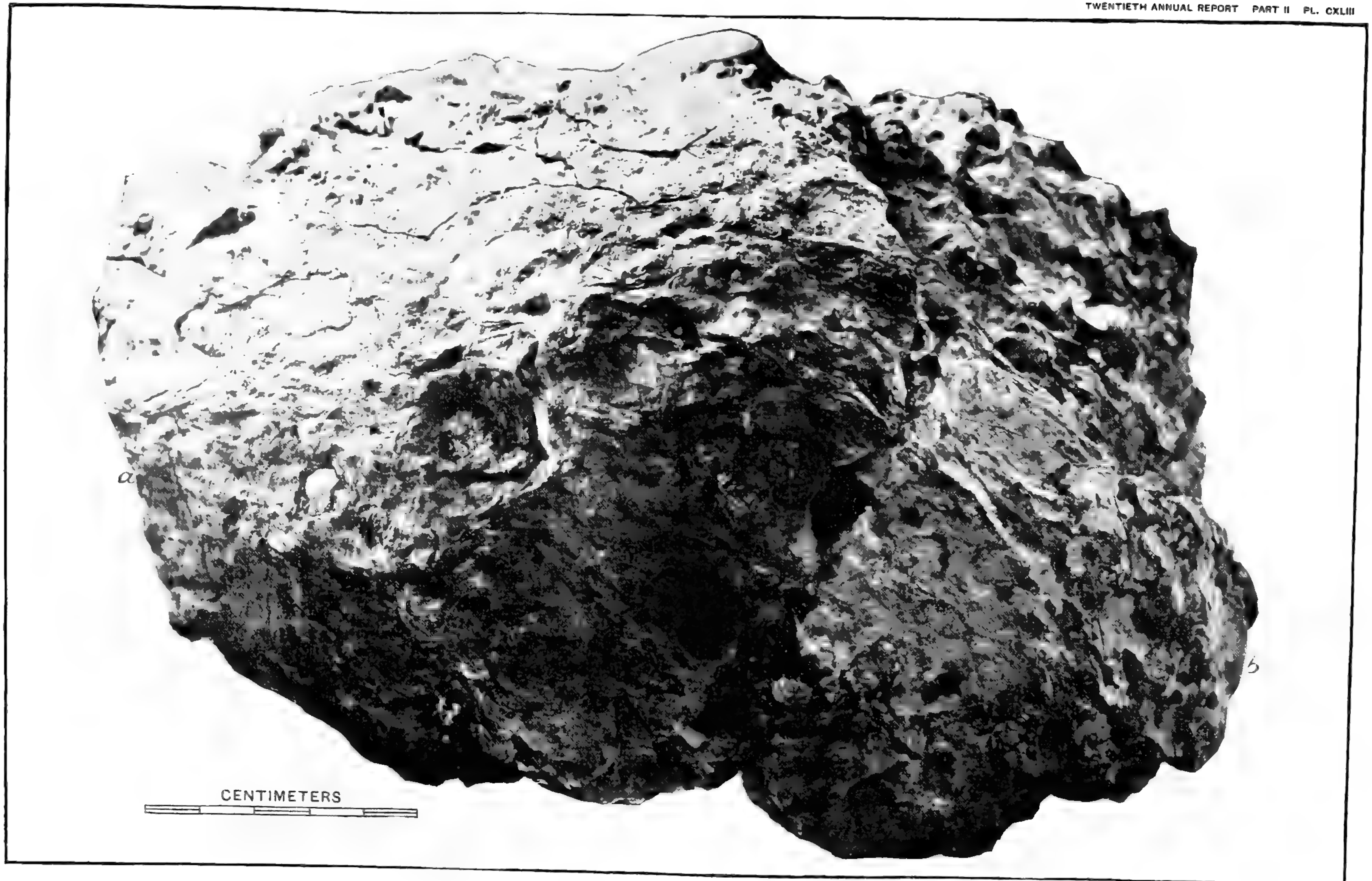
| CYCADELLA RAMENTOSA Ward | 406 |

Side view of the portion of a trunk formed by joining the complementary Nos. 500.50 and 500.60 of the Museum of the University of Wyoming.

(*a*) No. 500.50; (*b*) No. 500.60.




CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLIV.

## PLATE CXLIV.

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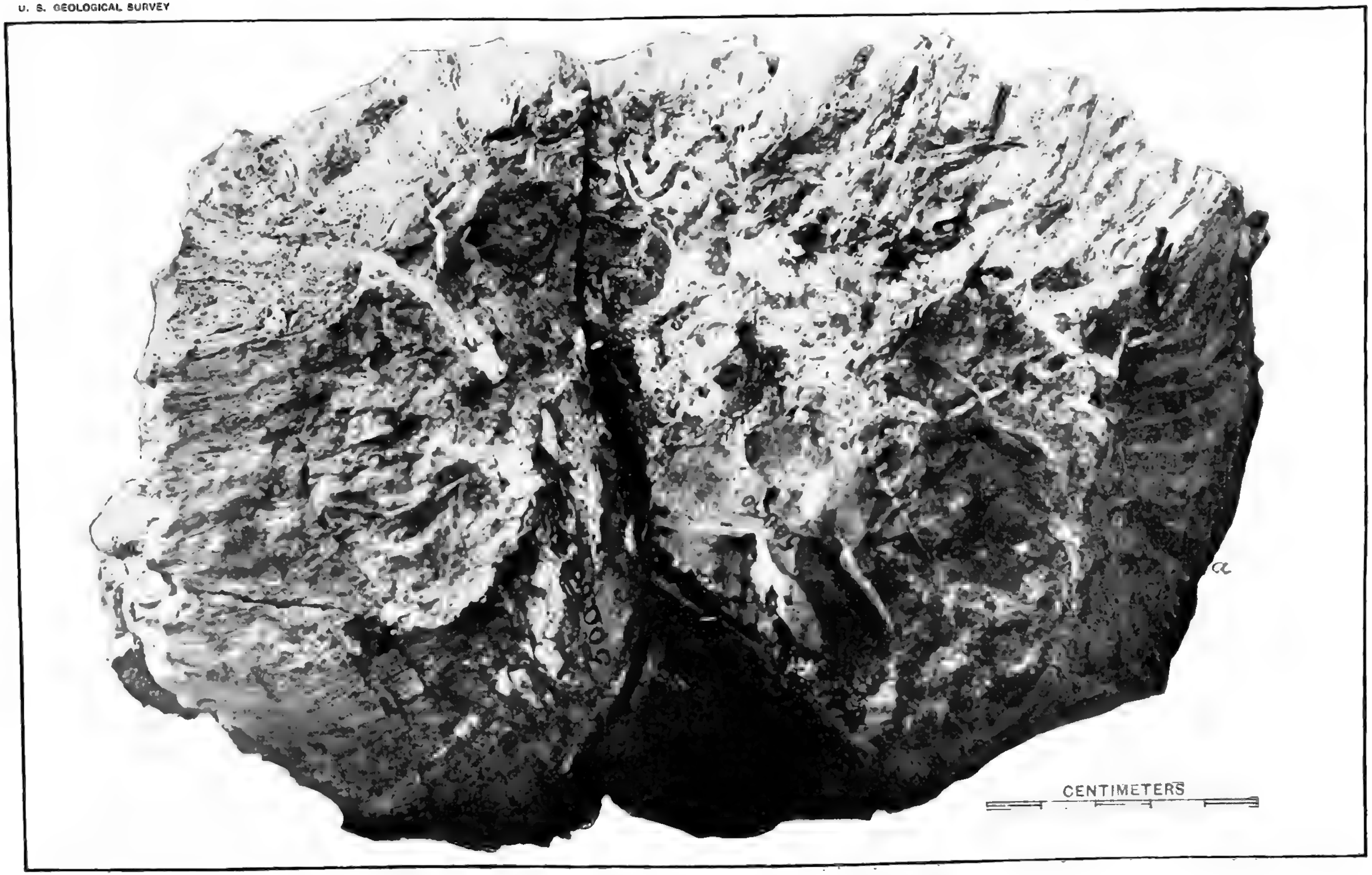
CYCADELLA RAMENTOSA Ward ........................................... 406


View of the inner fractured surface of the portion of a trunk formed by the union of the complementary Nos. 500.50 and 500.60 of the Museum of the University of Wyoming.

(*a*) No. 500.50; (*b*) No. 500.60.




CYCADELLA RAMENTOSA, FROM THE JURASSIC OF WYOMING.

PLATE CXLV.

## PLATE CXLV.

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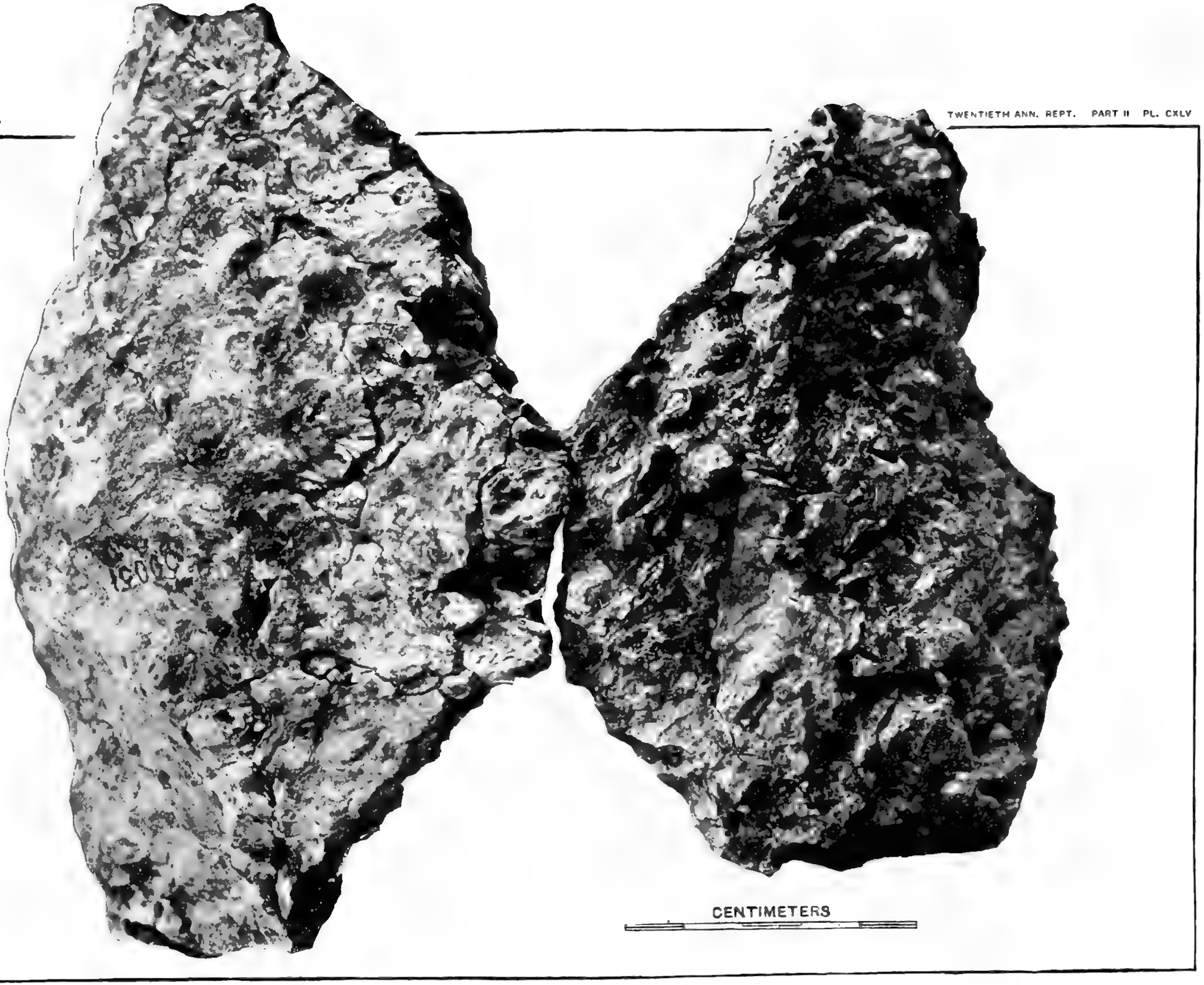
| CYCADELLA FERRUGINEA Ward | 408 |

Fig. 1. View of the outer surface of No. 500.51 of the Museum of the University of Wyoming.

Fig. 2. Similar view of No. 500.74.

NOTE.—These specimens are placed side by side in the position in which they are believed to belong, as constituting part of one and the same trunk.




CYCADELLA FERRUGINEA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLVI.

## PLATE CXLVI.

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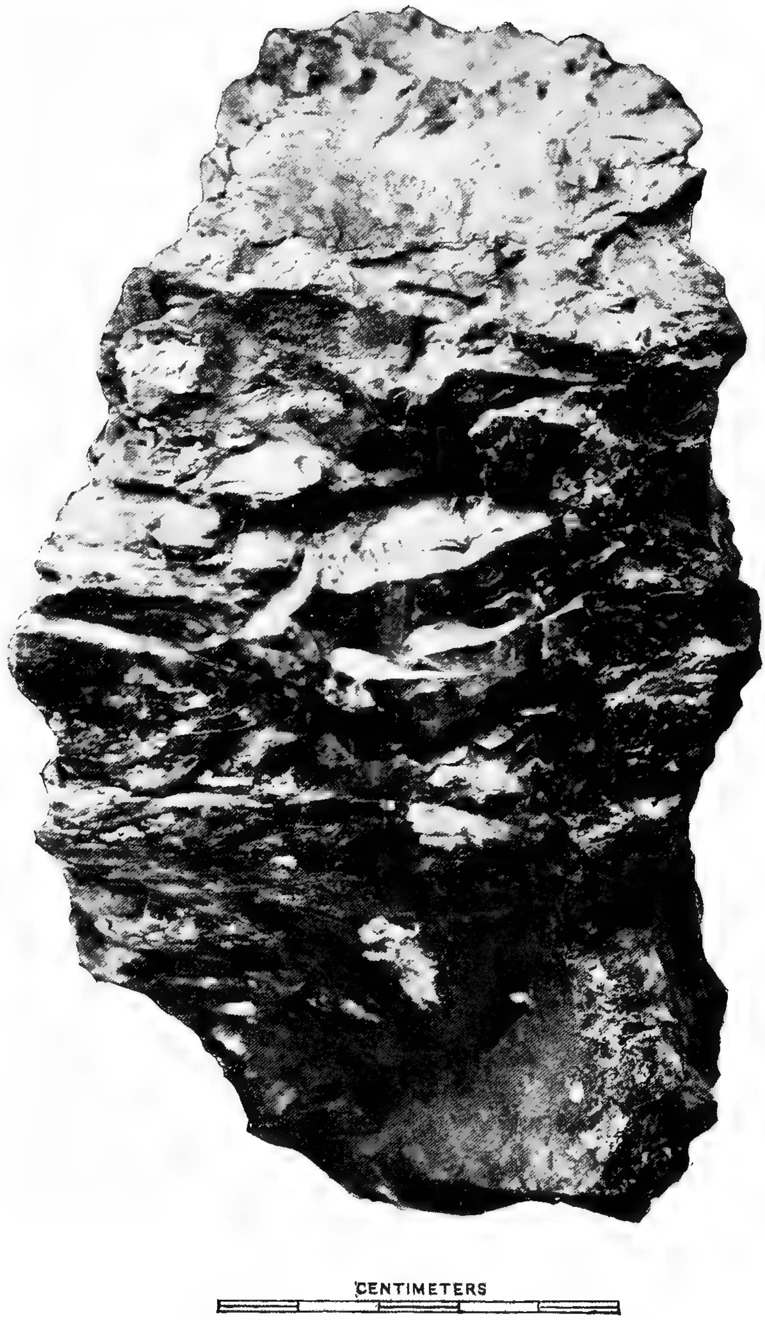
CYCADELLA FERRUGINEA Ward ........................................ 408
View of the longitudinal fracture of No. 500.51 of the Museum of the University of Wyoming.




CYCADELLA FERRUGINEA, FROM THE JURASSIC OF WYOMING.

## PLATE CXLVII.

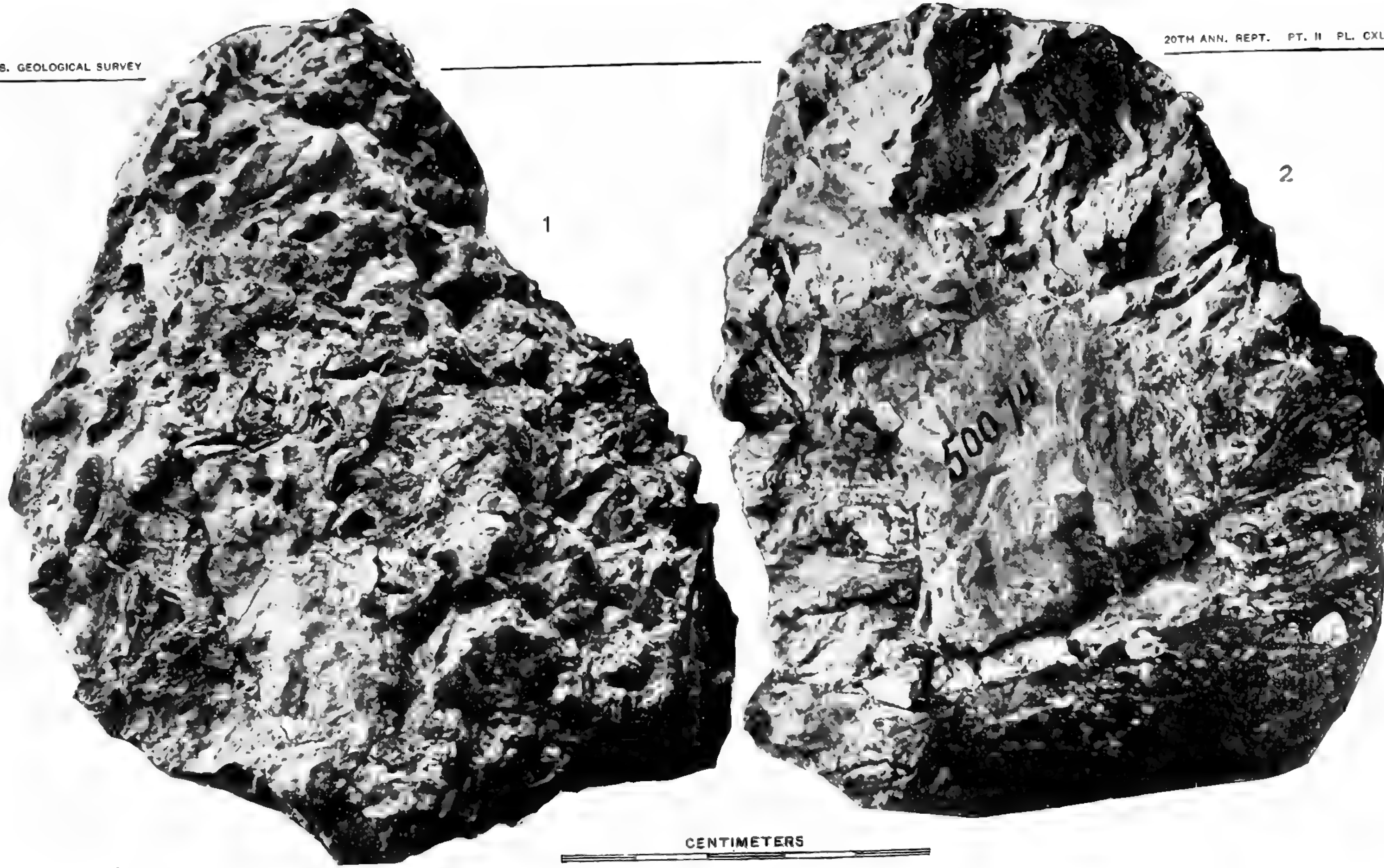
## PLATE CXLVII.

Page.
Cycadella ferruginea Ward ........................................ 408

No. 500.74 of the Museum of the University of Wyoming.

Fig. 1. View of the external surface.

Fig. 2. View of the longitudinal fracture.




CYCADELLA FERRUGINEA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLVIII.

## PLATE CXLVIII.

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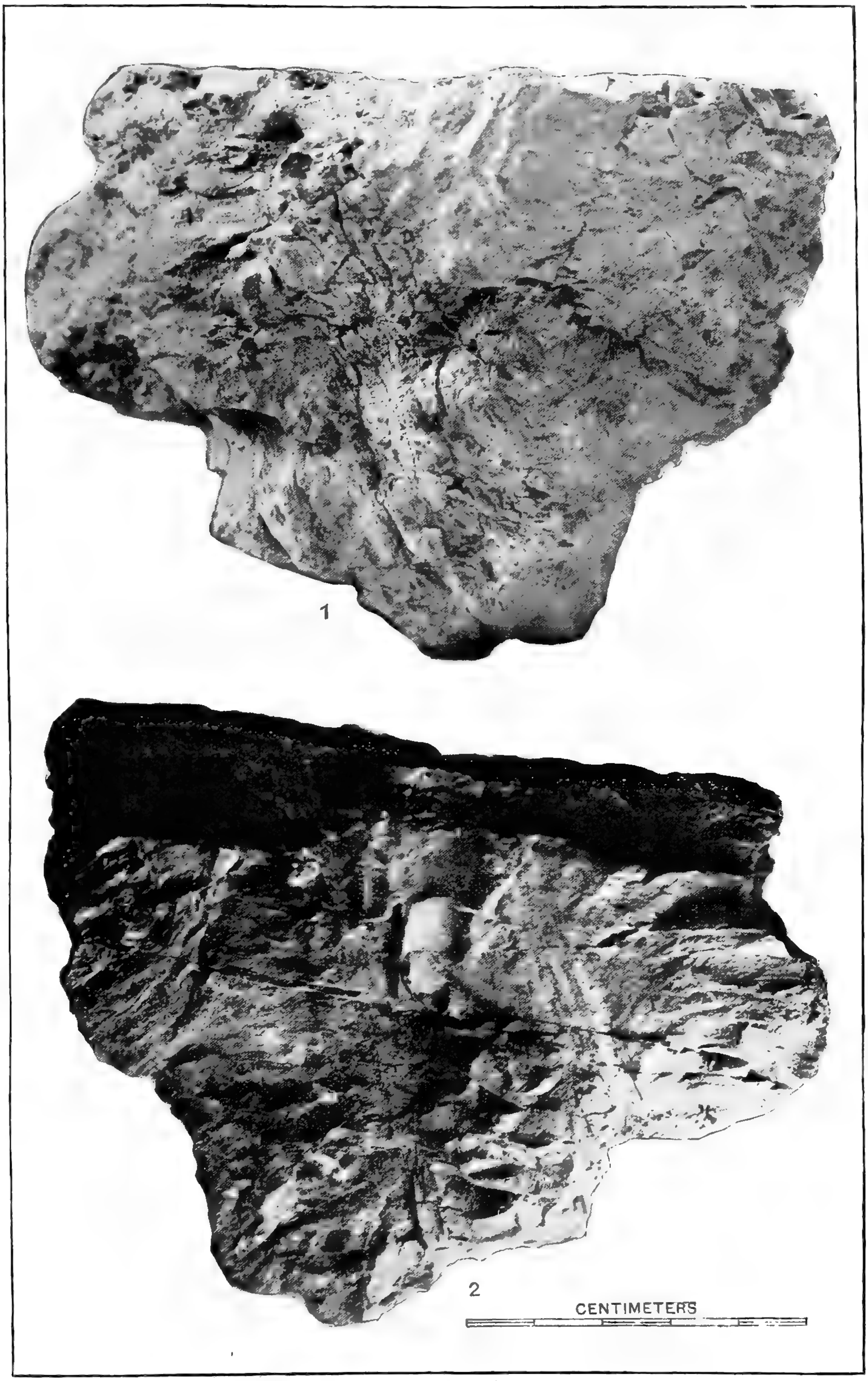
Cycadella contracta Ward ........................................ 409

No. 500.57 of the Museum of the University of Wyoming.

Fig. 1. View of the external surface.

Fig. 2. View of the longitudinal fracture.




CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

# PLATE CXLIX.

## PLATE CXLIX.

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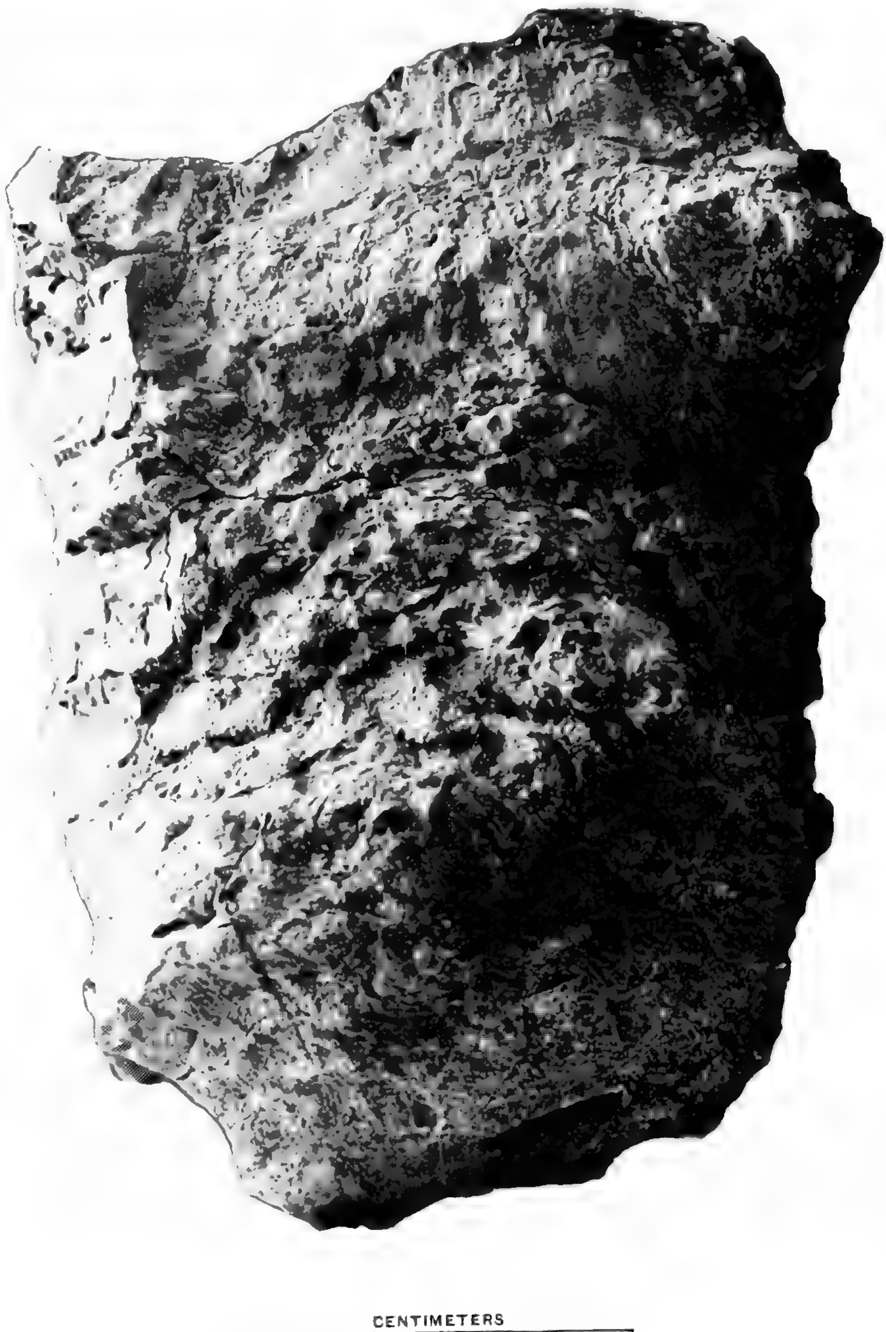
| CYCADELLA CONTRACTA Ward | 409 |
| Side view of No. 500.58 of the Museum of the University of Wyoming. | |



CENTIMETERS

CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

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## PLATE CL.

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Cycadella contracta Ward .............................................. 409

View of the longitudinal fracture of No. 500.58 of the Museum of the University of Wyoming.


CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

# PLATE CLI.

## PLATE CLI.

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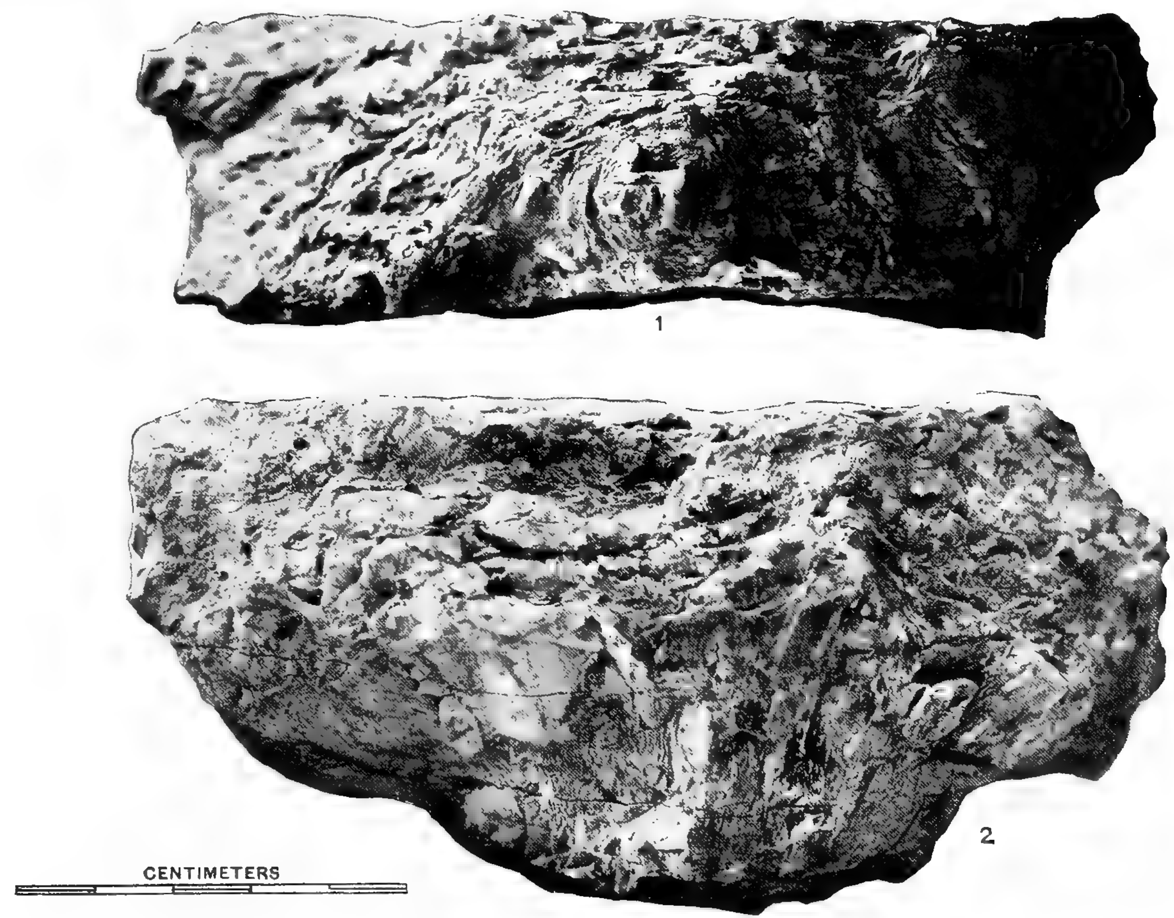
CYCADELLA CONTRACTA Ward. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 409

Fig. 1. View of the external surface of one edge of the segment oi a trunk No. 500.79 of the Museum of the University of Wyoming.

Fig. 2. View of one side of No. 500.56, believed to be the basal portion of the same trunk and to represent the same side as Fig. 1, there being an interval between them.




CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

# PLATE CLII.

## PLATE CLII.

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| CYCADELLA CONTRACTA Ward | 409 |

View of the side of No. 500.56 of the Museum of the University of Wyoming.

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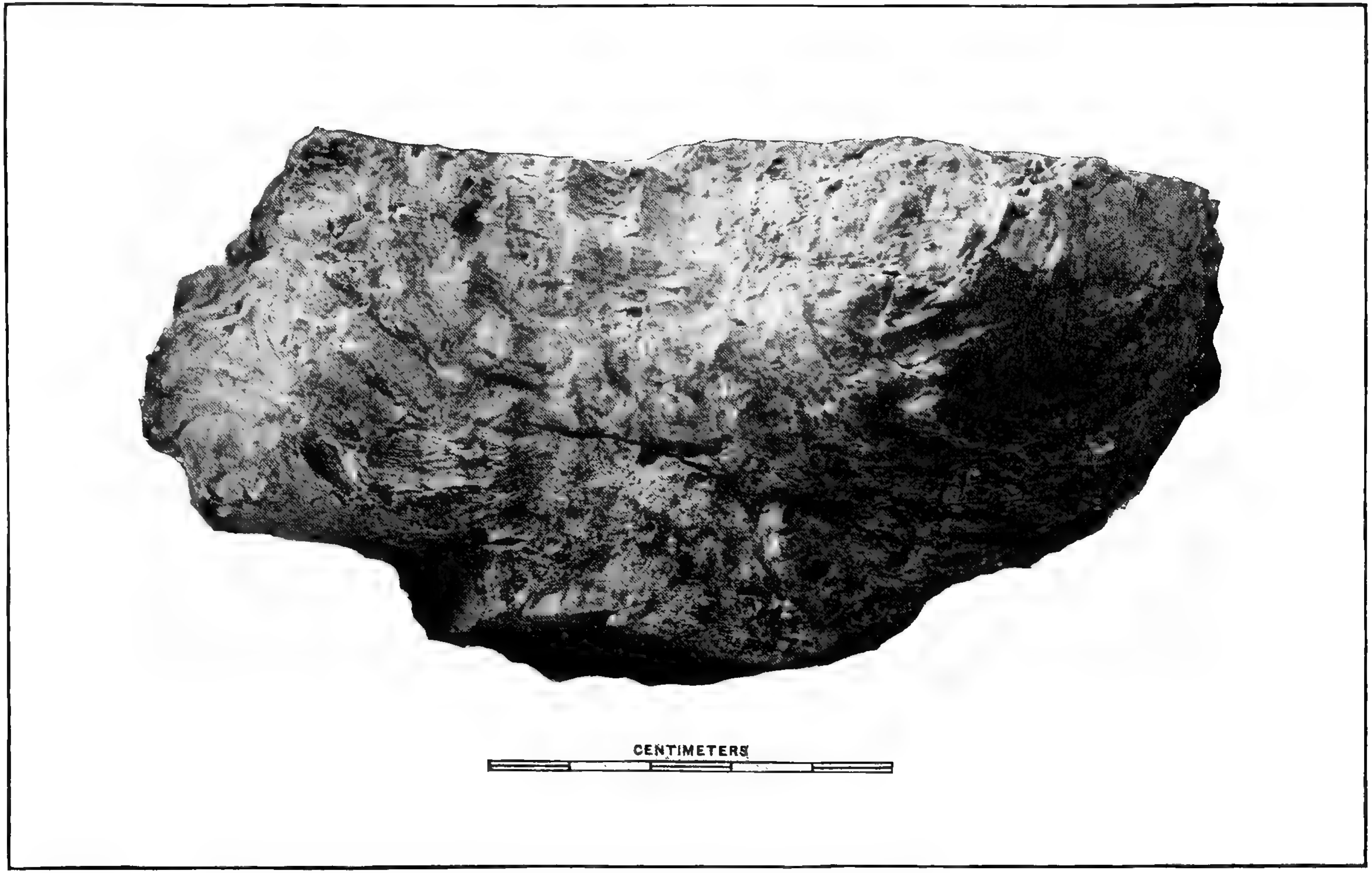


CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

# PLATE CLIII.

# PLATE CLIII.

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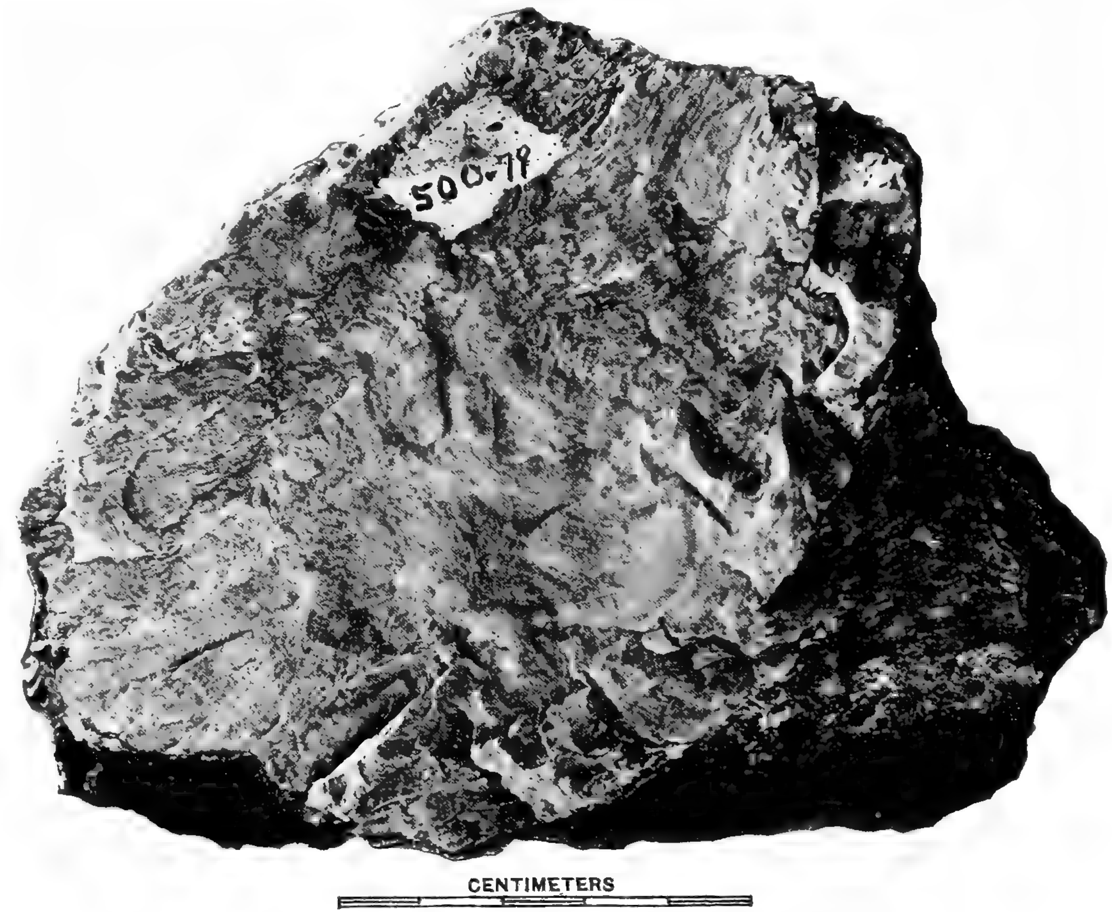
CYCADELLA CONTRACTA Ward ........................................ 409
Upper transverse fracture of No. 500.79 of the Museum of the University of Wyoming.




CYCADELLA CONTRACTA, FROM THE JURASSIC OF WYOMING.

# PLATE CLIV.

## PLATE CLIV.

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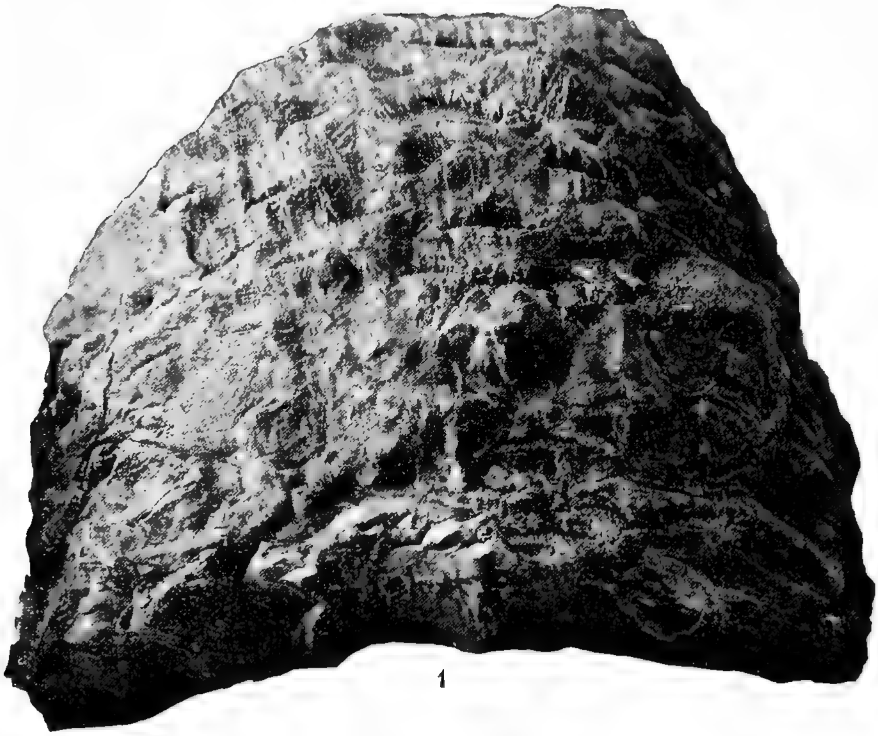
CYCADELLA GRAVIS Ward .......................................... 410

No. 500.63 of the Museum of the University of Wyoming.

Fig. 1. Side view.

Fig. 2. View of the base.



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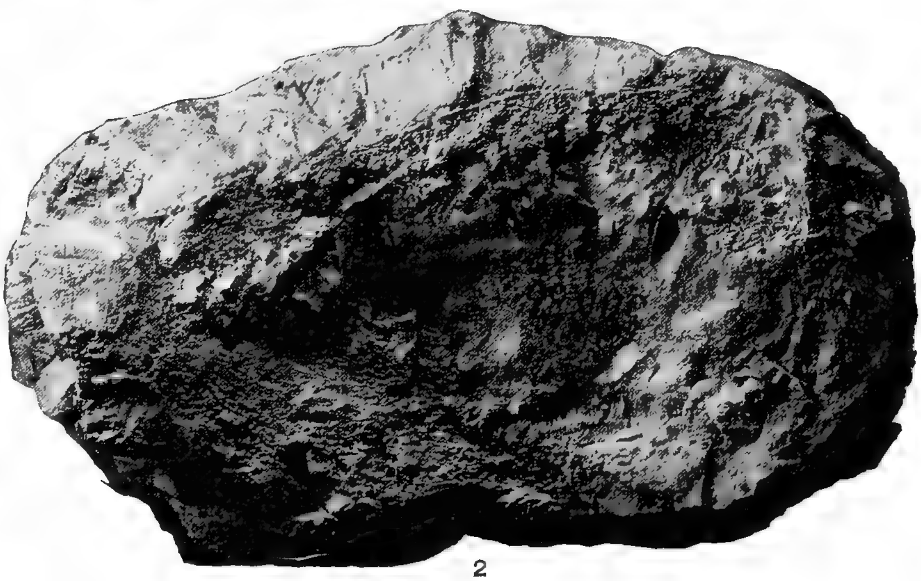

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CENTIMETERS

CYCADELLA GRAVIS, FROM THE JURASSIC OF WYOMING.

# PLATE CLV.

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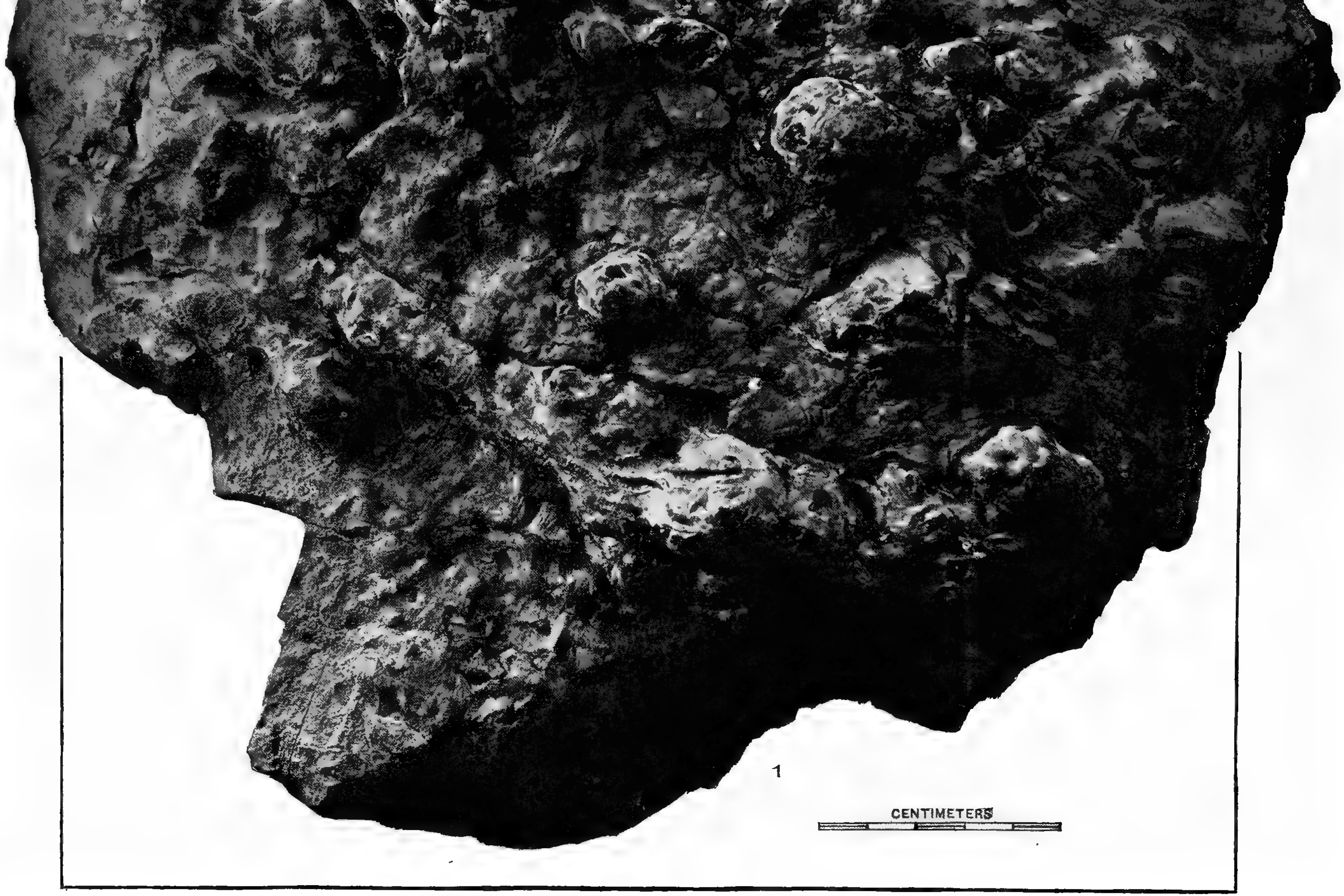


CYCADELLA VERRUCOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CLVI.

## PLATE CLVI.

Page.

CYCADELLA VERRUCOSA Ward ............................................ 410

Fig. 1. Side view of No. 500.32 of the Museum of the University of Wyoming, side opposite that shown on Pl. CLV, Fig. 1.

Fig. 2. Side view of No. 500.27, placed above the last in the position that it is supposed to have had originally, side opposite that shown on Pl. CLV, Fig. 2.

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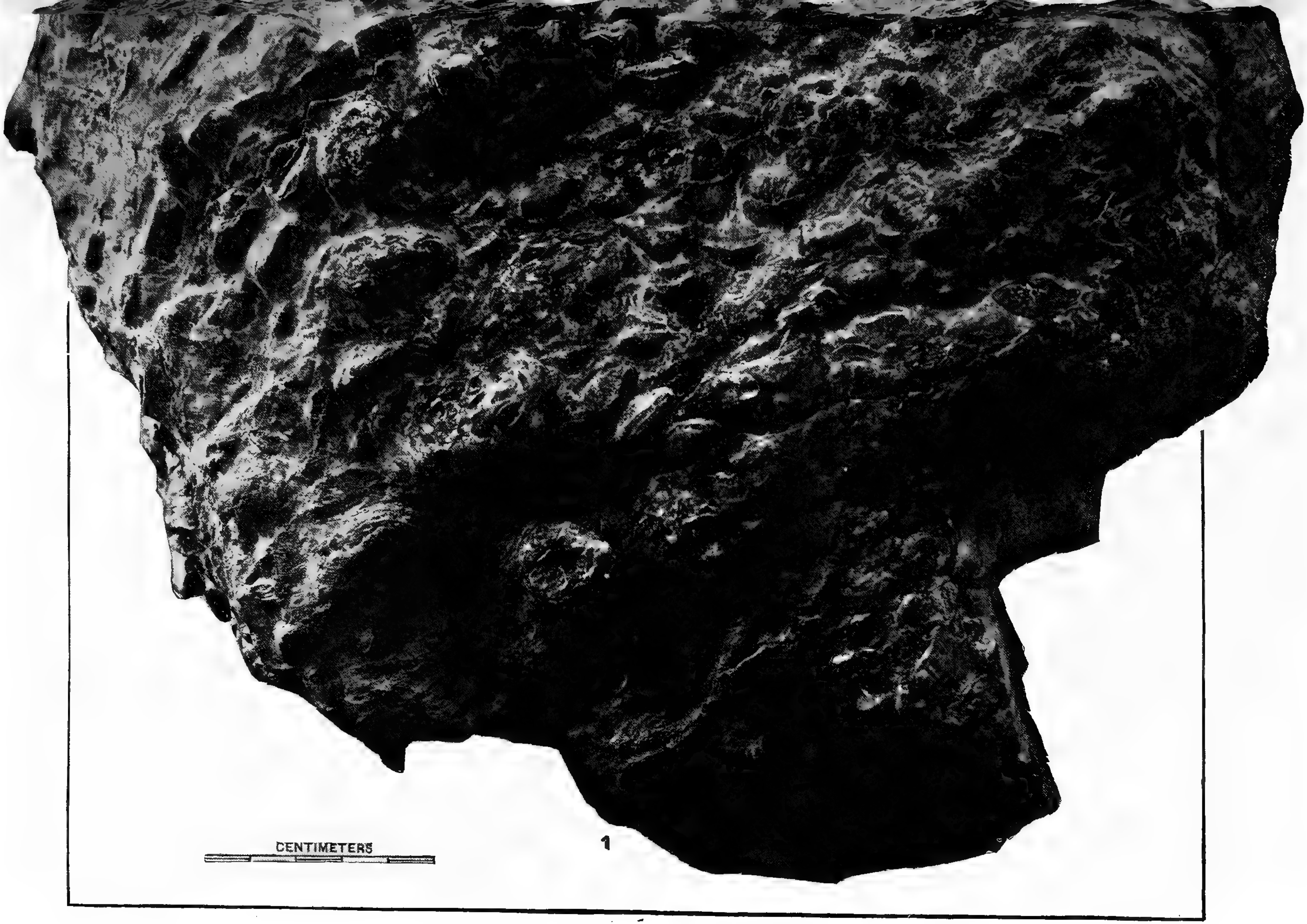


CYCADELLA VERRUCOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CLVII.

## PLATE CLVII.

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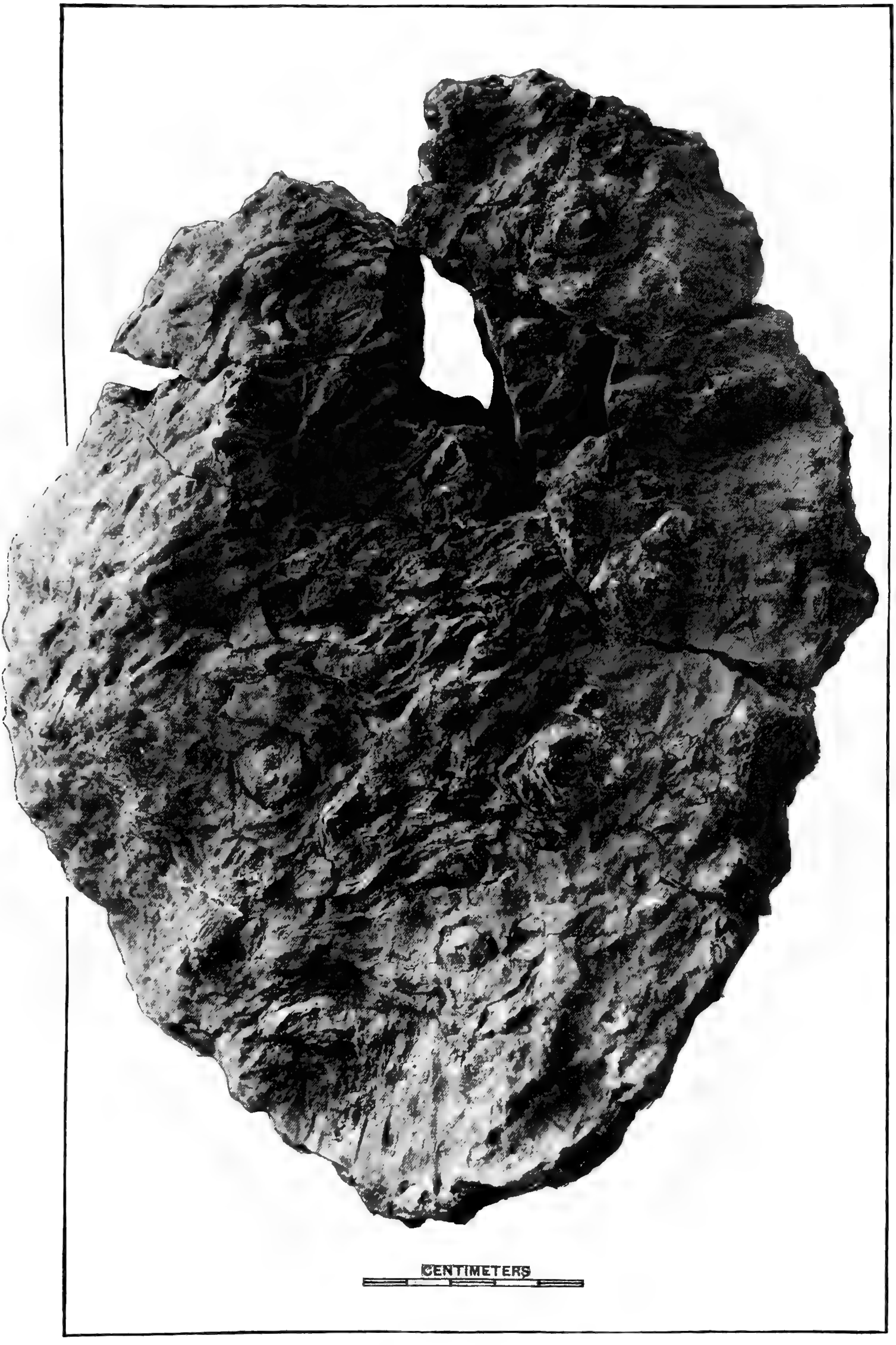
CYCADELLA VERRUCOSA Ward .......................................... 410
Side view of No. 500.64 of the Museum of the University of Wyoming.

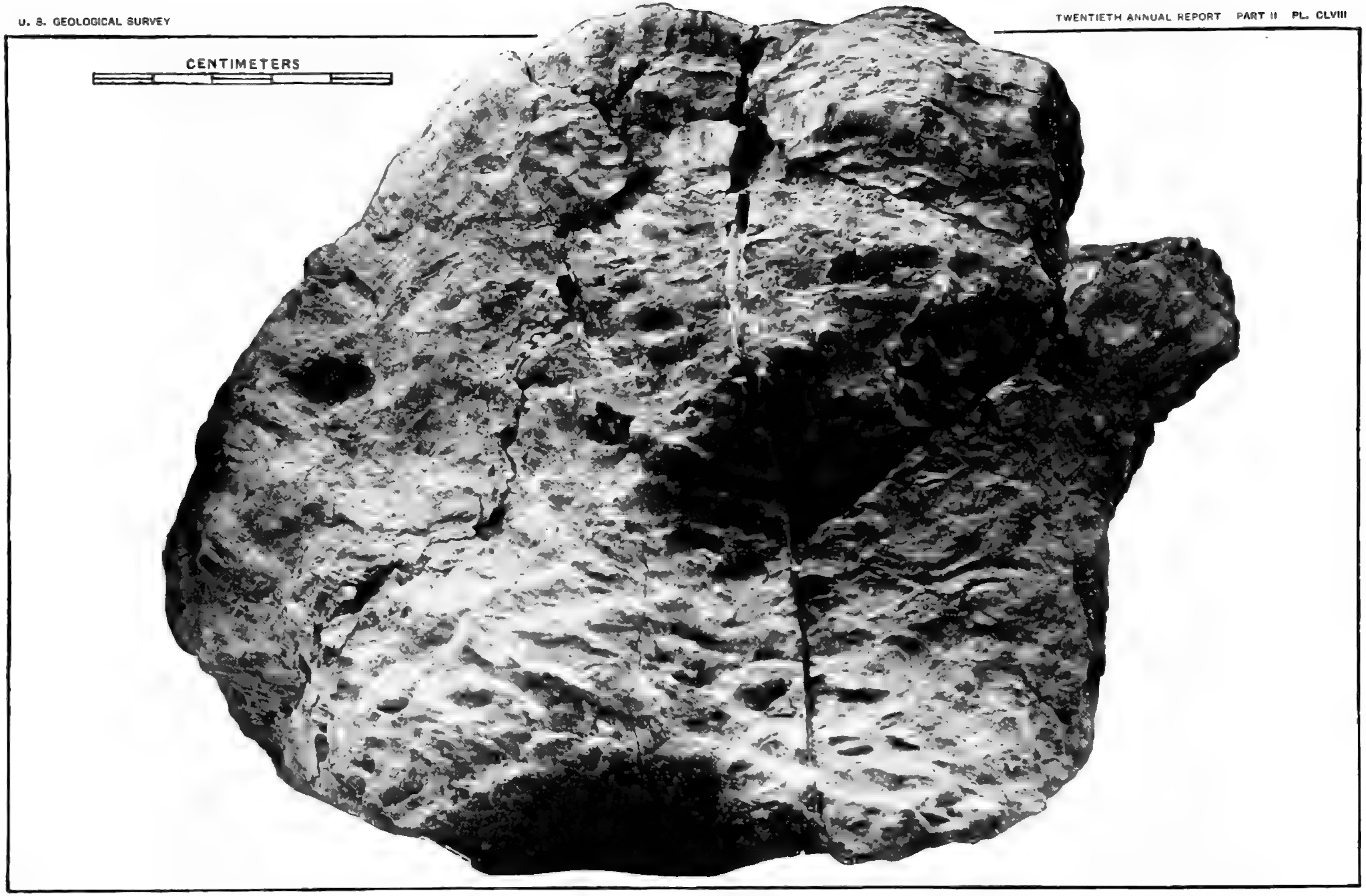



CYCADELLA VERRUCOSA, FROM THE JURASSIC OF WYOMING.

# PLATE CLVIII.

## PLATE CLVIII.

Page.
CYCADELLA JEJUNA Ward .................................................... 412
Side view of No. 500.28 of the Museum of the University of Wyoming.




CYCADELLA JEJUNA, FROM THE JURASSIC OF WYOMING.

# PLATE CLIX.

## PLATE CLIX.

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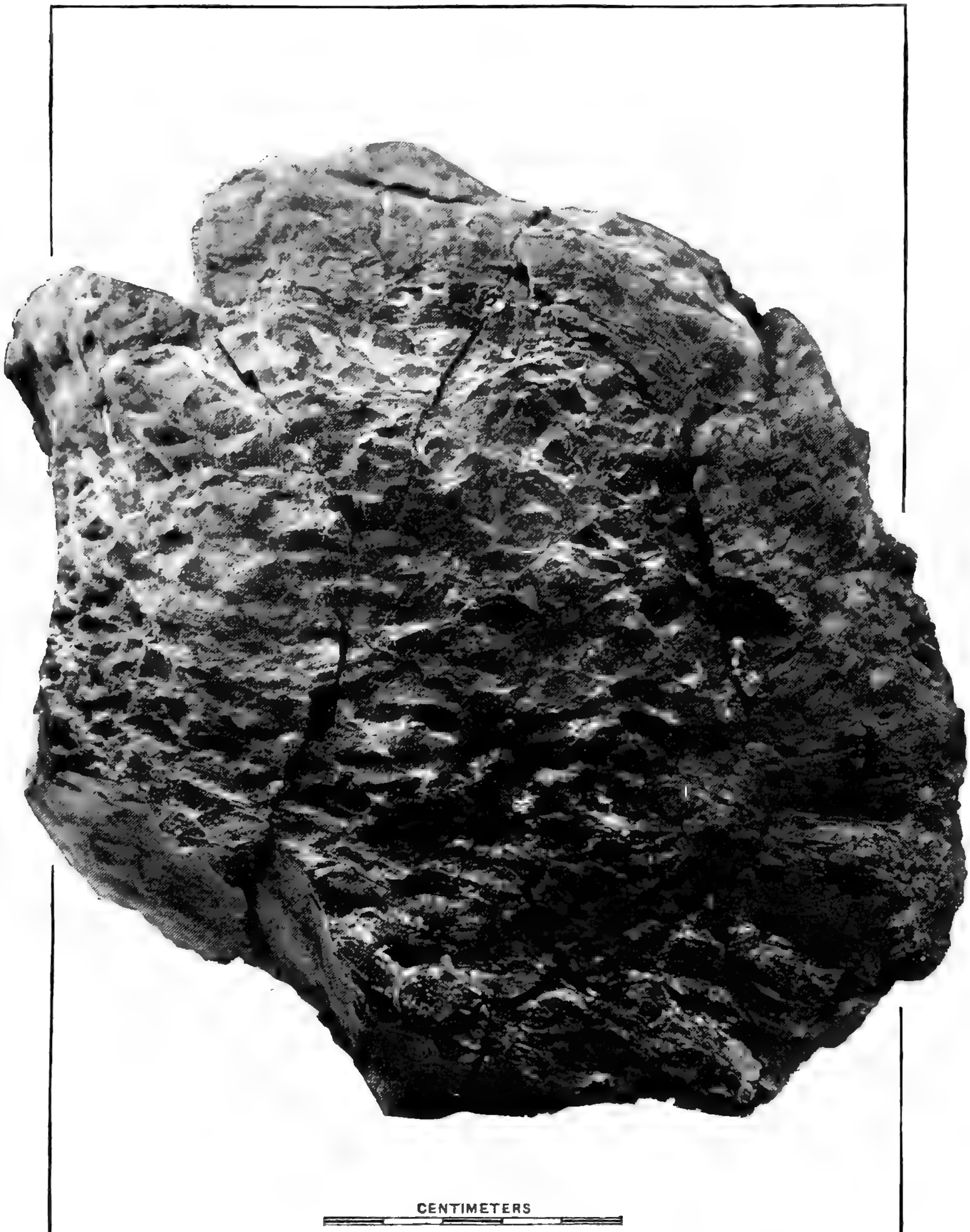
CYCADELLA JEJUNA Ward .................................................. 412
Side view of No. 500.28 of the Museum of the University of Wyoming.




CYCADELLA JEJUNA, FROM THE JURASSIC OF WYOMING.

# PLATE CLX.

## PLATE CLX.

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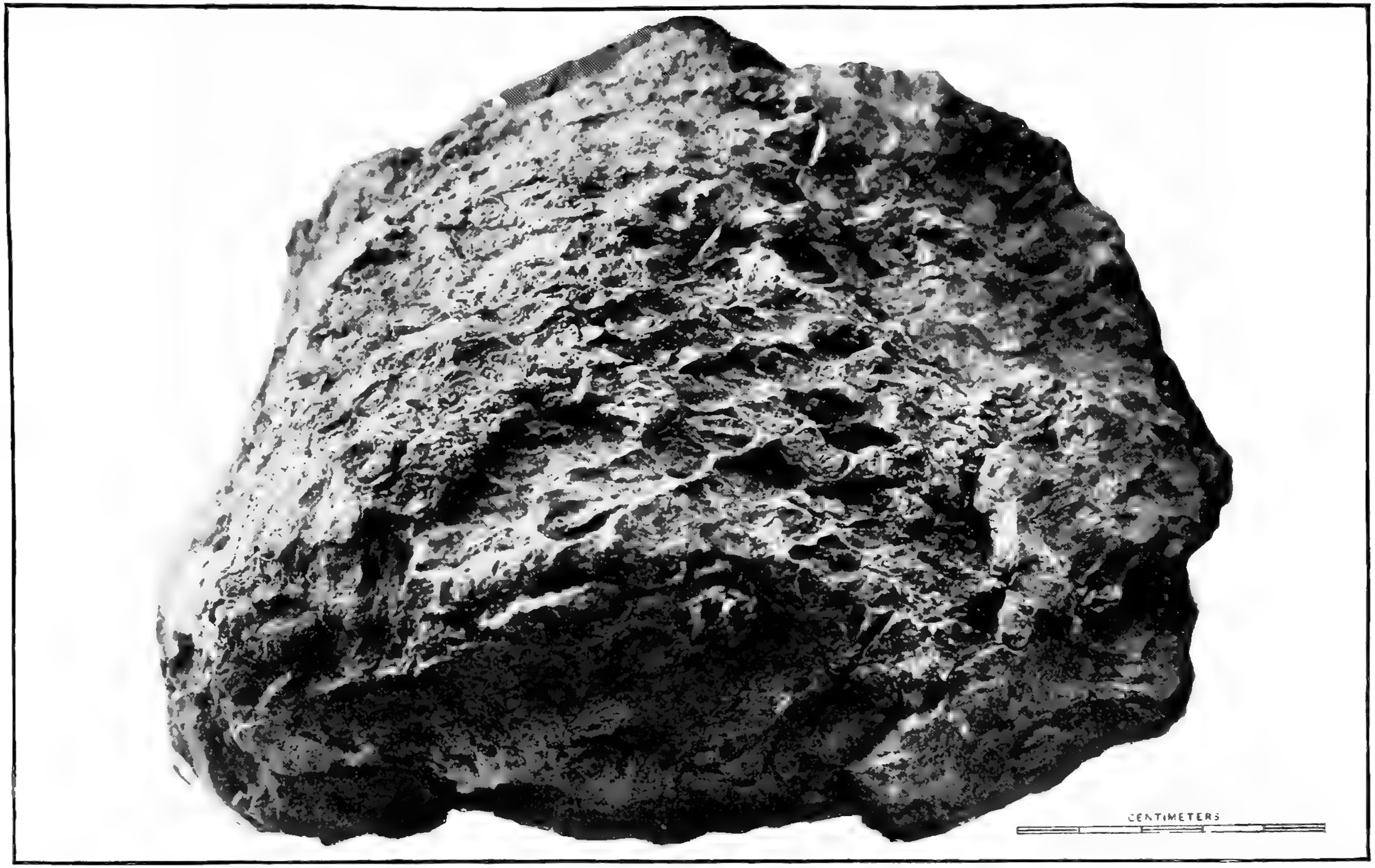
CYCADELLA JEJUNA Ward .......................................................... 412
View of the best-preserved side of No. 500.31 of the Museum of the University of Wyoming.




CYCADELLA JEJUNA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXI.

## PLATE CLXI.

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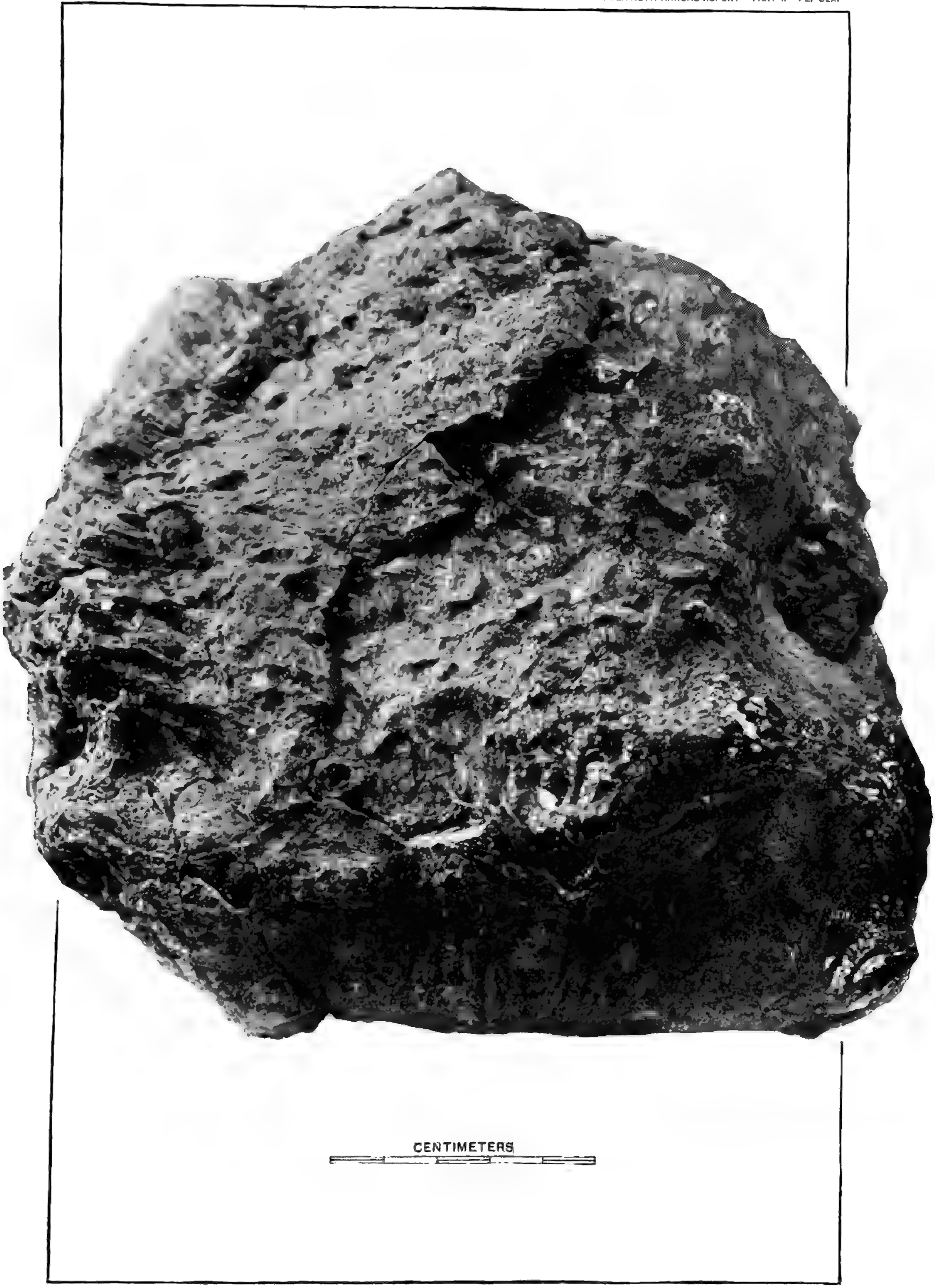
CYCADELLA JEJUNA Ward ........................................................ 412


View of one side of No. 500.31 of the Museum of the University of Wyoming, showing the area from which the ramentum coat has been scaled off and the edge of the portion remaining.




CYCADELLA JEJUNA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXII.

## PLATE CLXII.

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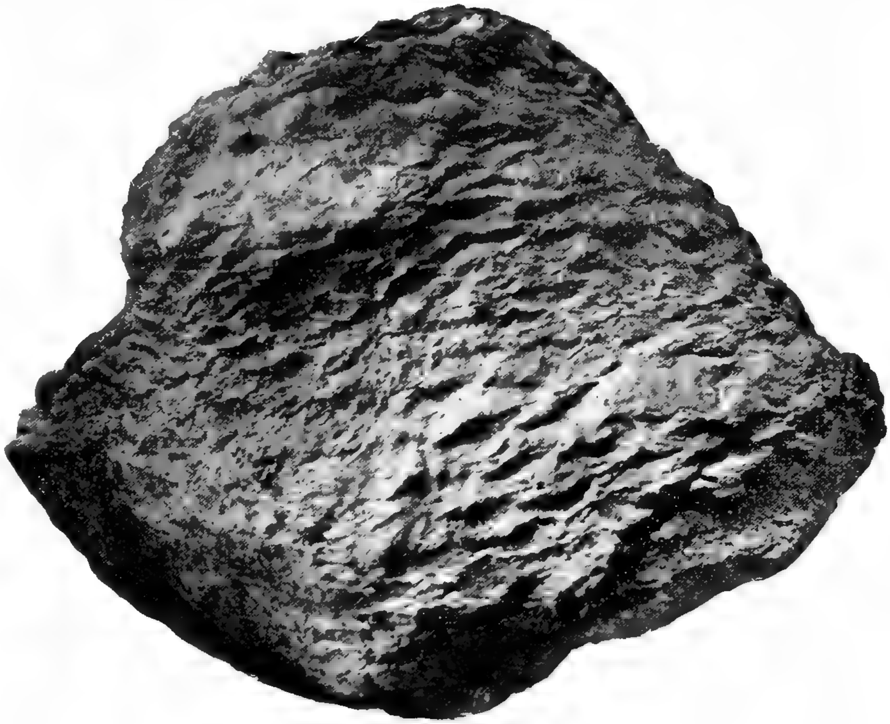
| CYCADELLA CONCINNA Ward | 412 |

No. 500.16 of the Museum of the University of Wyoming.

Fig. 1. Side view.

Fig. 2. View of the base.



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CYCADELLA CONCINNA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXIII.

## PLATE CLXIII.

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CYCADELLA CREPIDARIA Ward .......................................... 413
View of the top of No. 500.83 of the Museum of the University of Wyoming.

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CYCADELLA CREPIDARIA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXIV.

## PLATE CLXIV.

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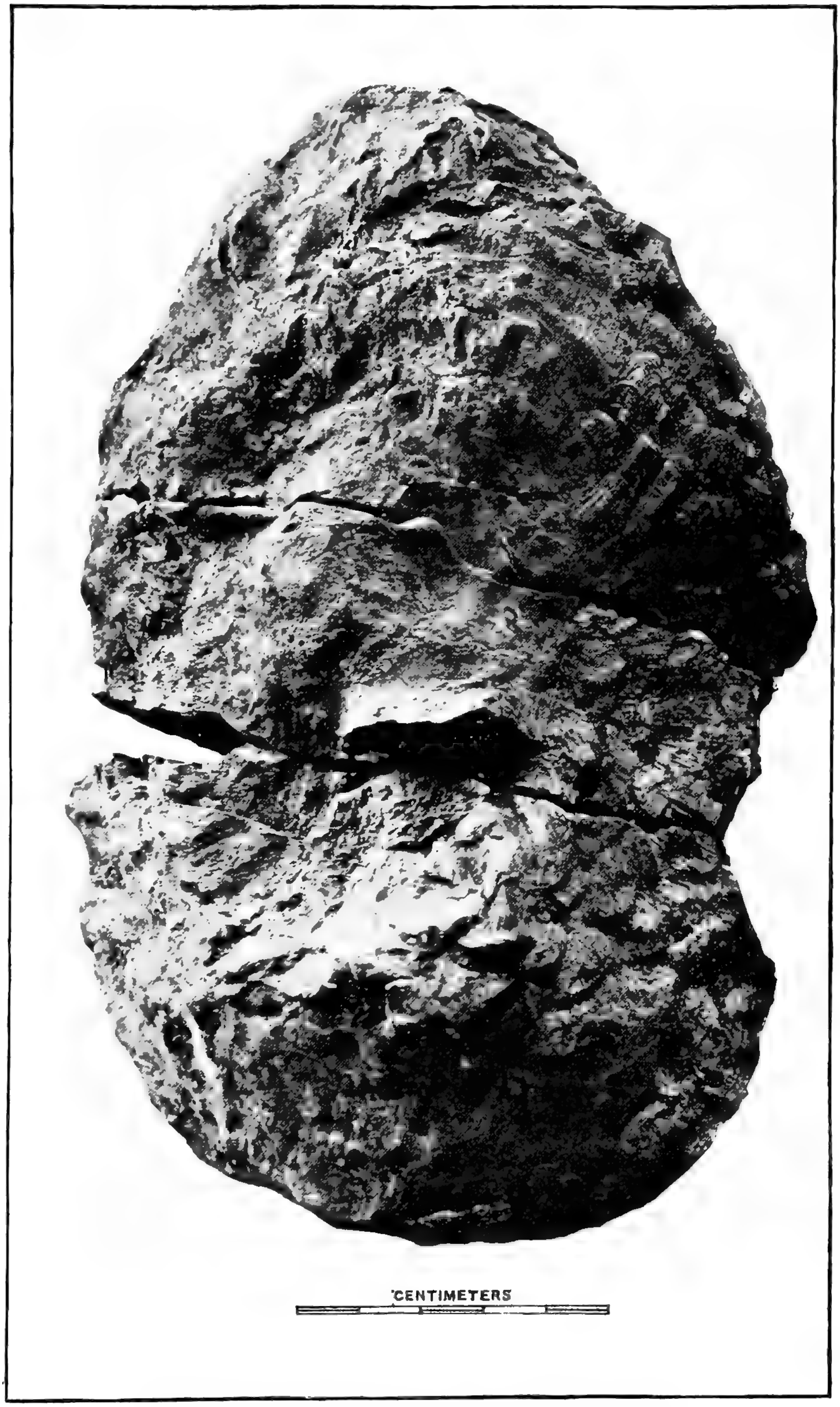
CYCADELLA CREPIDARIA Ward ........................................ 413
View of the base of No. 500.83 of the Museum of the University of Wyoming.




CYCADELLA CREPIDARIA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXV.

## PLATE CLXV.

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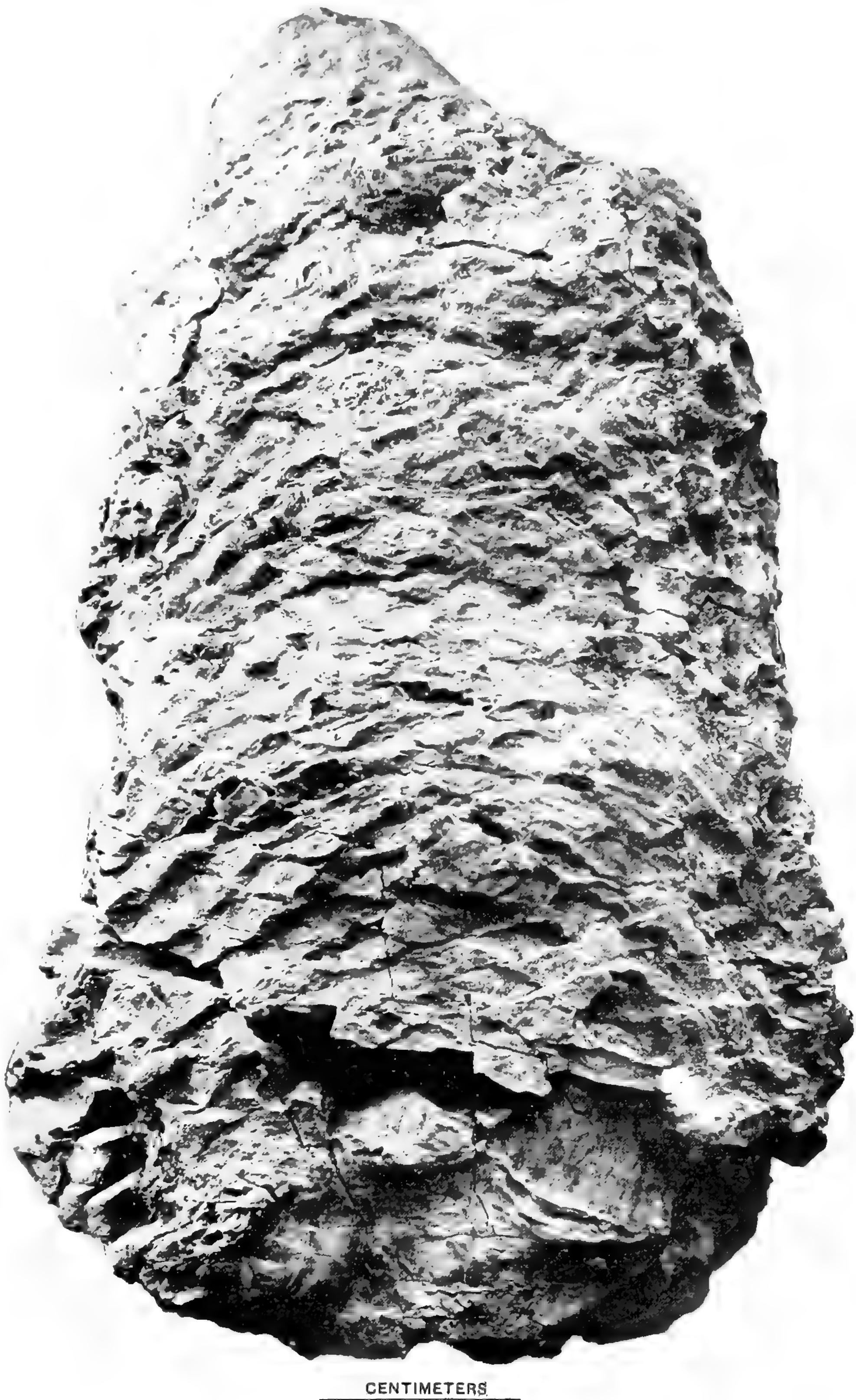
Cycadella gelida Ward .................................................. 414

Side view of No. 500.1 of the Museum of the University of Wyoming.




CYCADELLA GELIDA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXVI.

## PLATE CLXVI.

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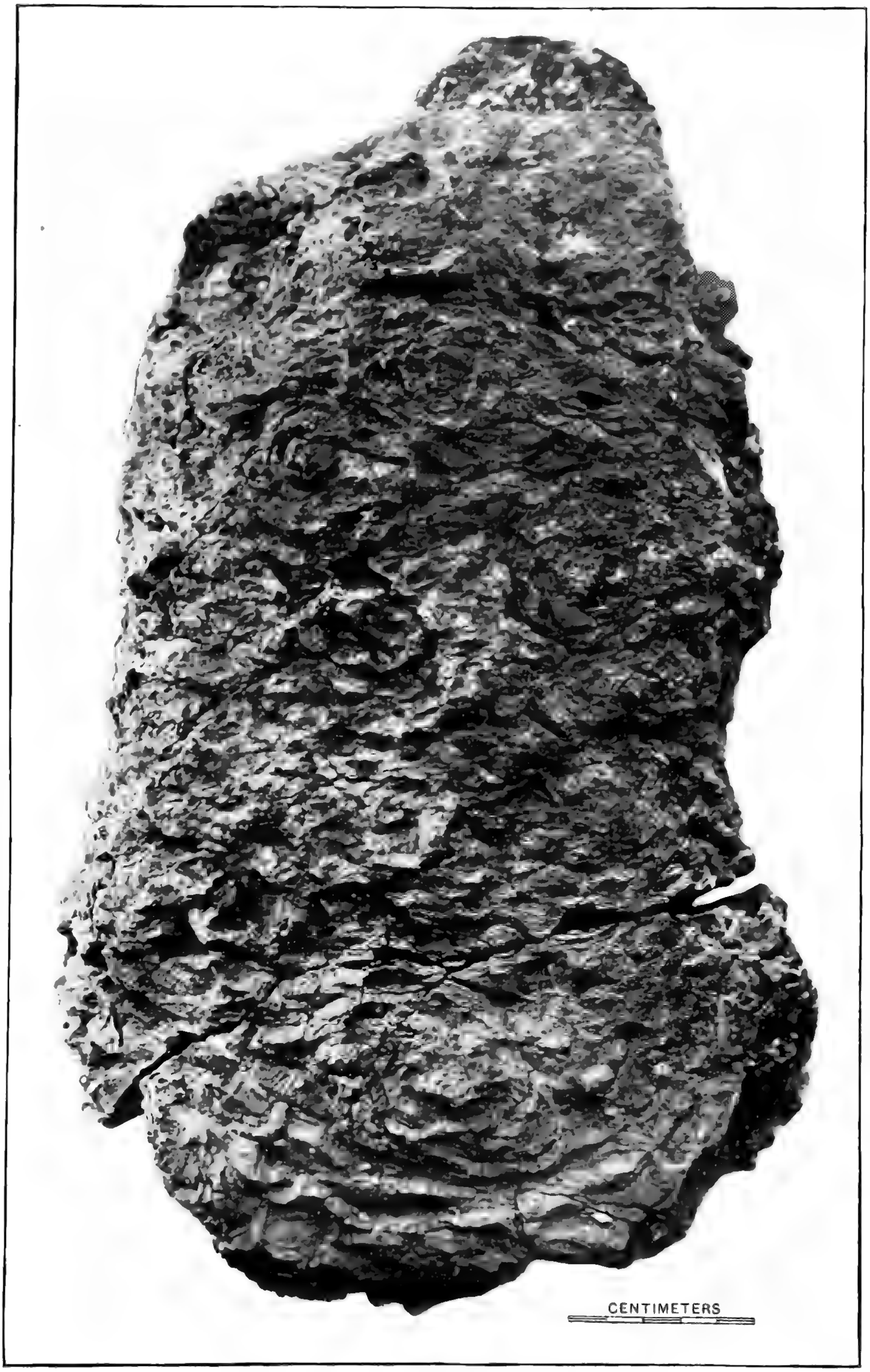
CYCADELLA GELIDA Ward .................................................. 414

Side view of No. 500.1 of the Museum of the University of Wyoming (side opposite that shown on Pl. CLXV.)




CYCADELLA GELIDA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXVII.

## PLATE CLXVII.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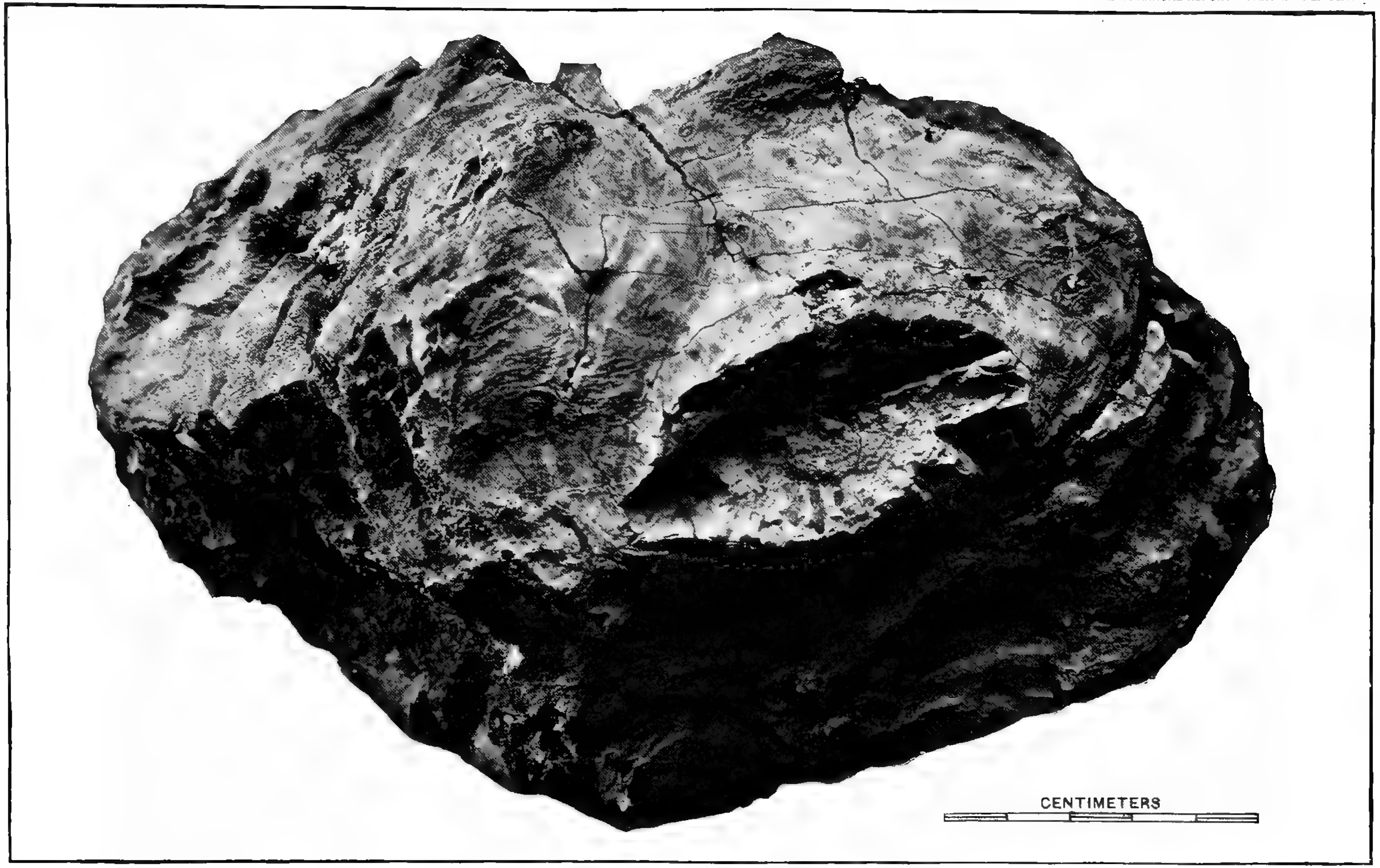
CYCADELLA GELIDA Ward .......................................... 414

View of the base of No. 500.1 of the Museum of the University of Wyoming.




CYCADELLA GELIDA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXVIII.

## PLATE CLXVIII.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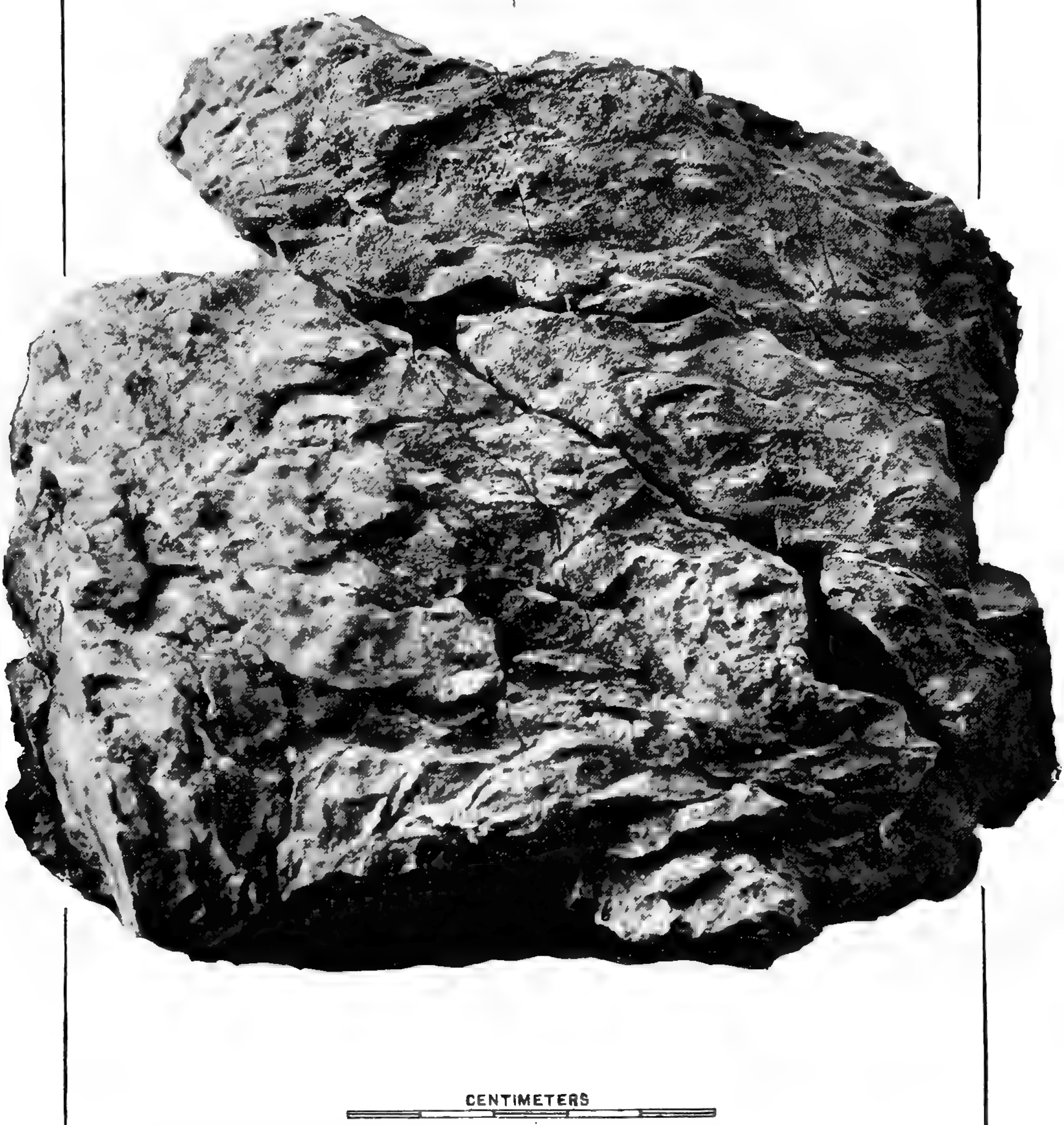
Cycadella gelida Ward .......................................................... 414

Side view of No. 500.24 of the Museum of the University of Wyoming.




CYCADELLA GELIDA, FROM THE JURASSIC OF WYOMING.

# PLATE CLXIX.

## PLATE CLXIX.

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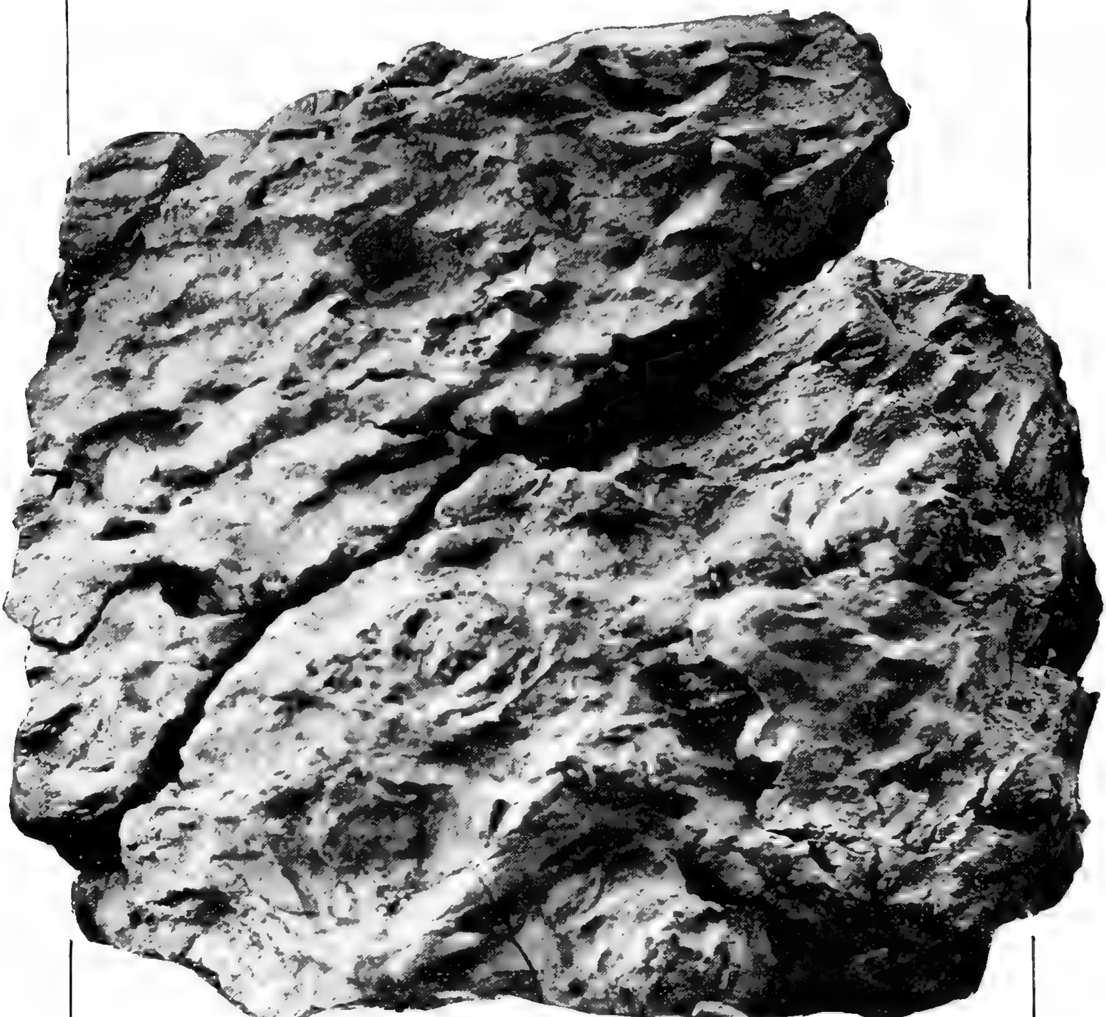
CYCADELLA GELIDA Ward .................................................. 414

Side view of No. 500.24 of the Museum of the University of Wyoming (side opposite that shown on Pl. CLXVIII).



CENTIMETERS

CYCADELLA GELIDA. FROM THE JURASSIC OF WYOMING.

# PLATE CLXX.

# PLATE CLXX.

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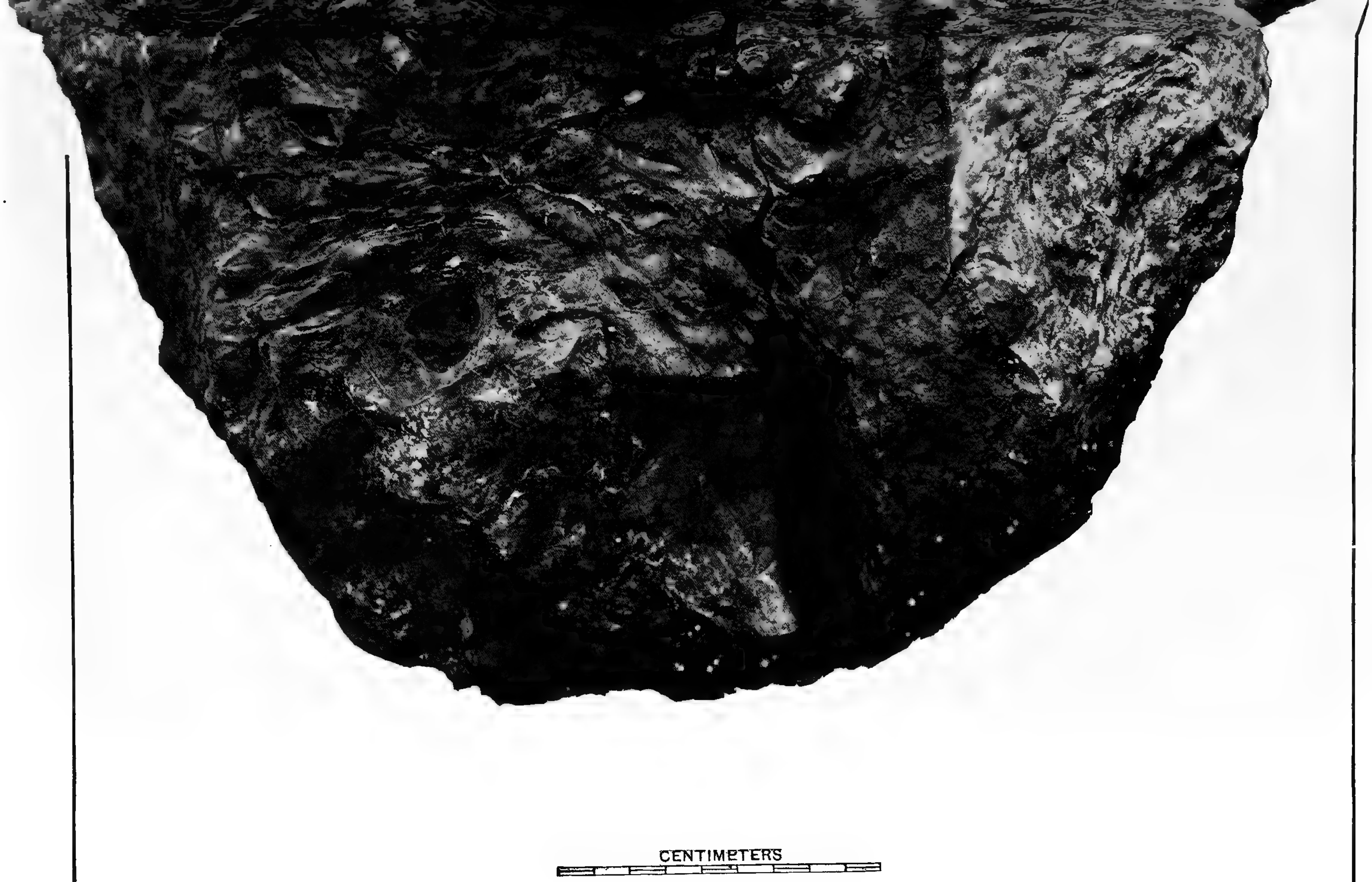
CYCADELLA CARBONENSIS Ward .................................................. 415

View of the best side or back of No. 500.2 of the Museum of the University of Wyoming.


CENTIMETERS

# PLATE CLXXI.

# PLATE CLXXI.

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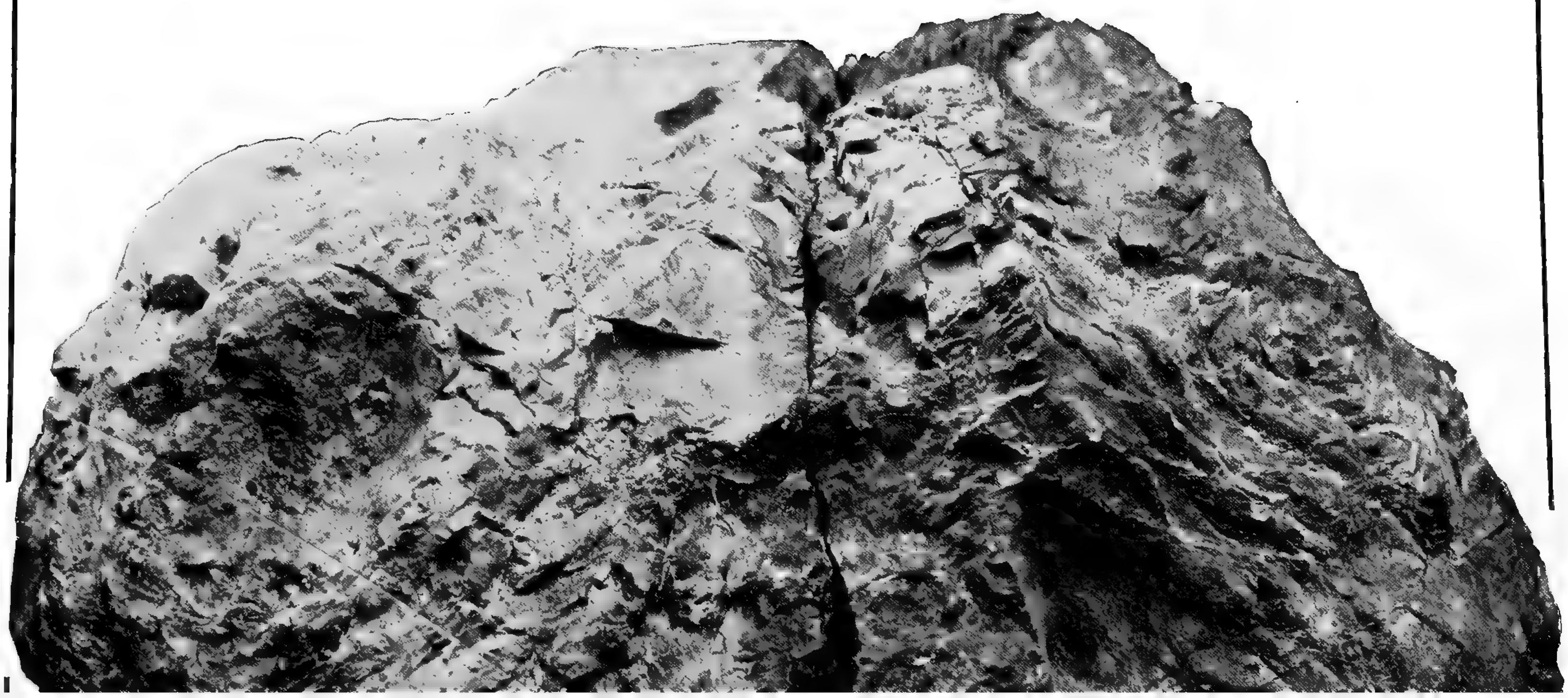
|---|---|
| Cycadella carbonensis Ward | 415 |

View of the lower side, including the base of No. 500.2 of the Museum of the University of Wyoming.




CYCADELLA CARBONENSIS, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXII.

## PLATE CLXXII.

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CYCADELLA KNIGHTII Ward .......................................... 416
Side view of No. 500.65 of the Museum of the University of Wyoming.

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CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXIII.

## PLATE CLXXIII.

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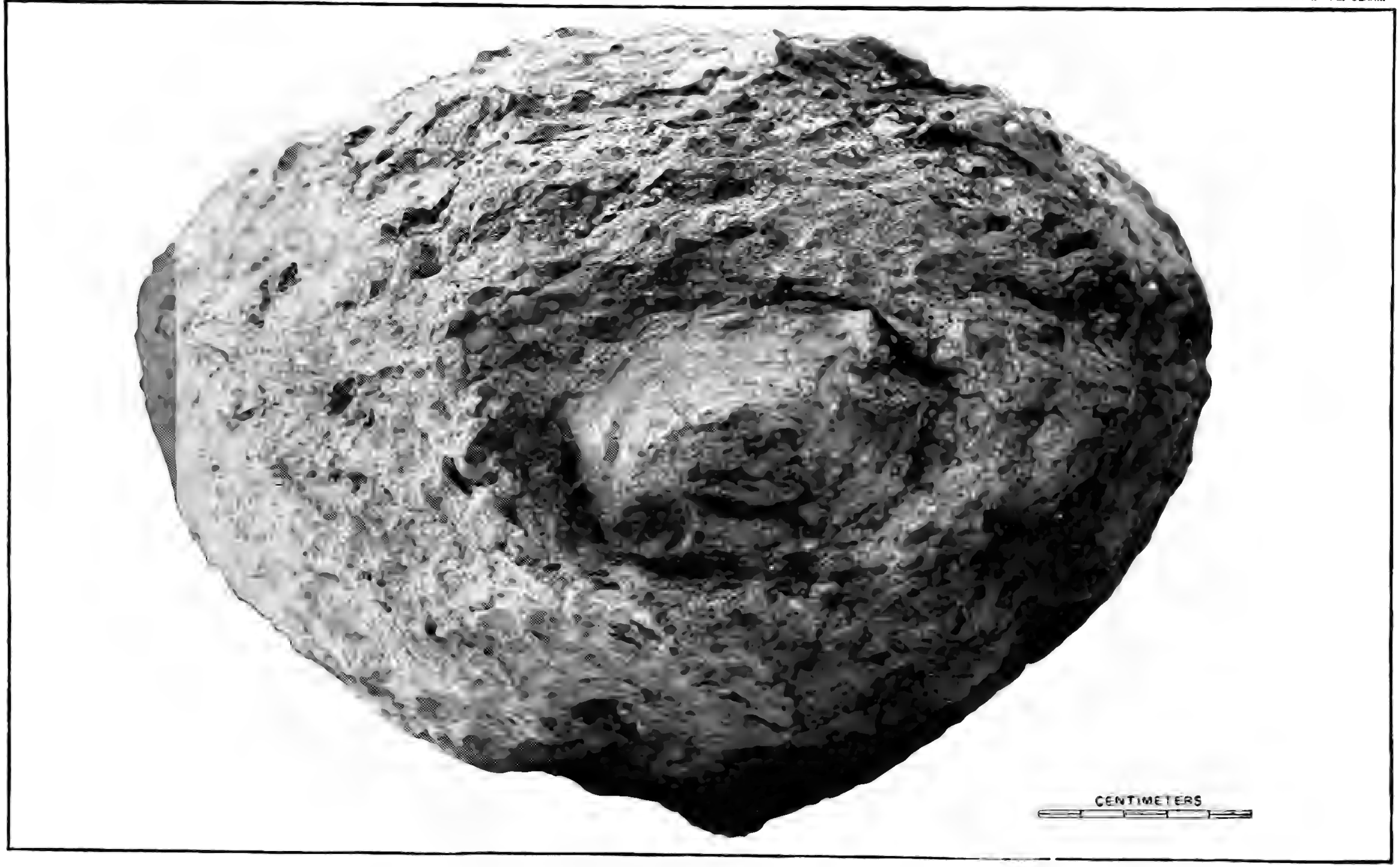
CYCADELLA KNIGHTII Ward .............................................. 416

View of the base of No. 500.65 of the Museum of the University of Wyoming.




CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXIV.

## PLATE CLXXIV.

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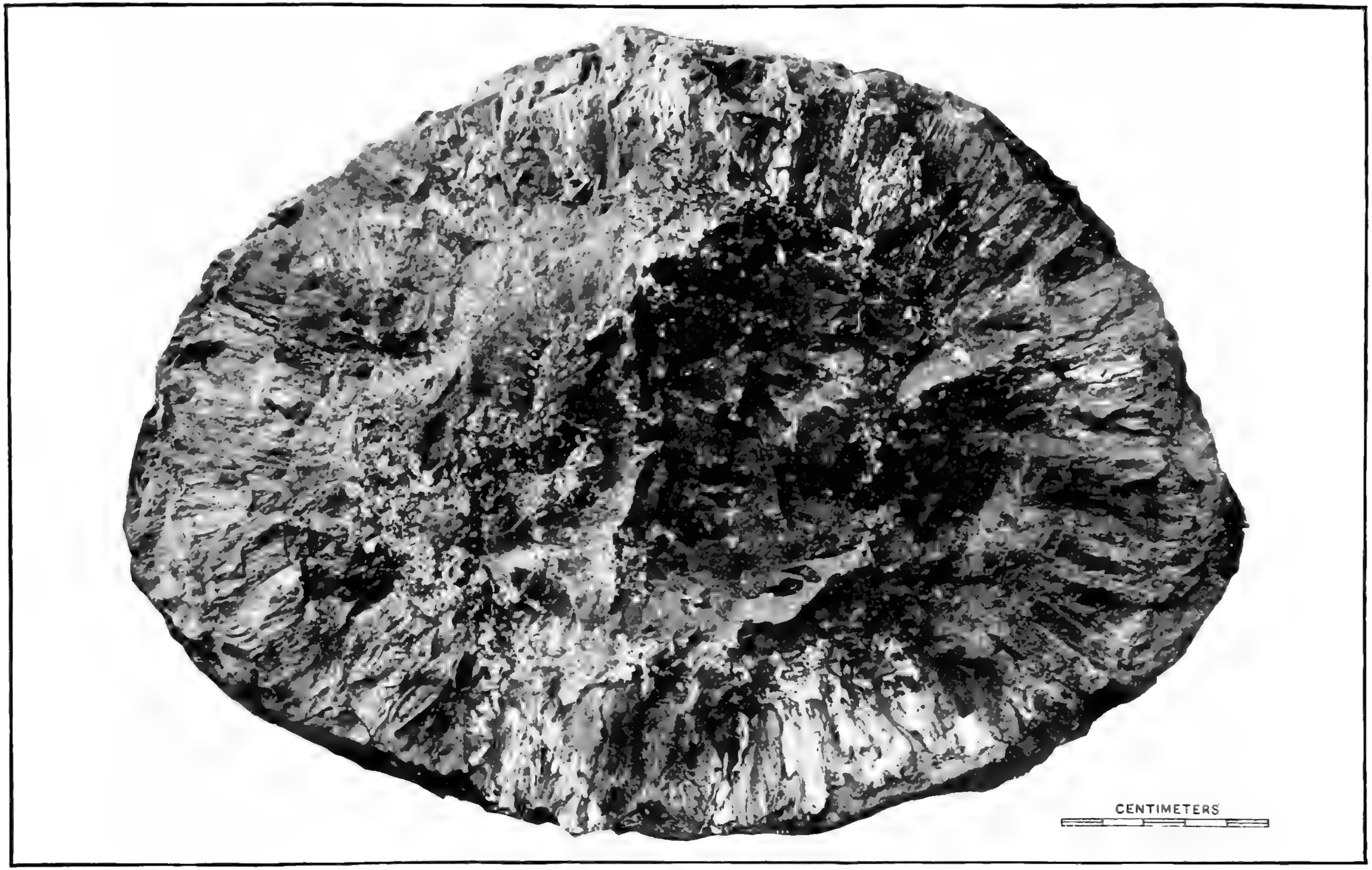
CYCADELLA KNIGHTII Ward .................................................. 416
View of the transverse fracture through No. 500.65 of the Museum of the University of Wyoming, taken from the upper end of the lower piece of the specimen.




CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXV.

## PLATE CLXXV.

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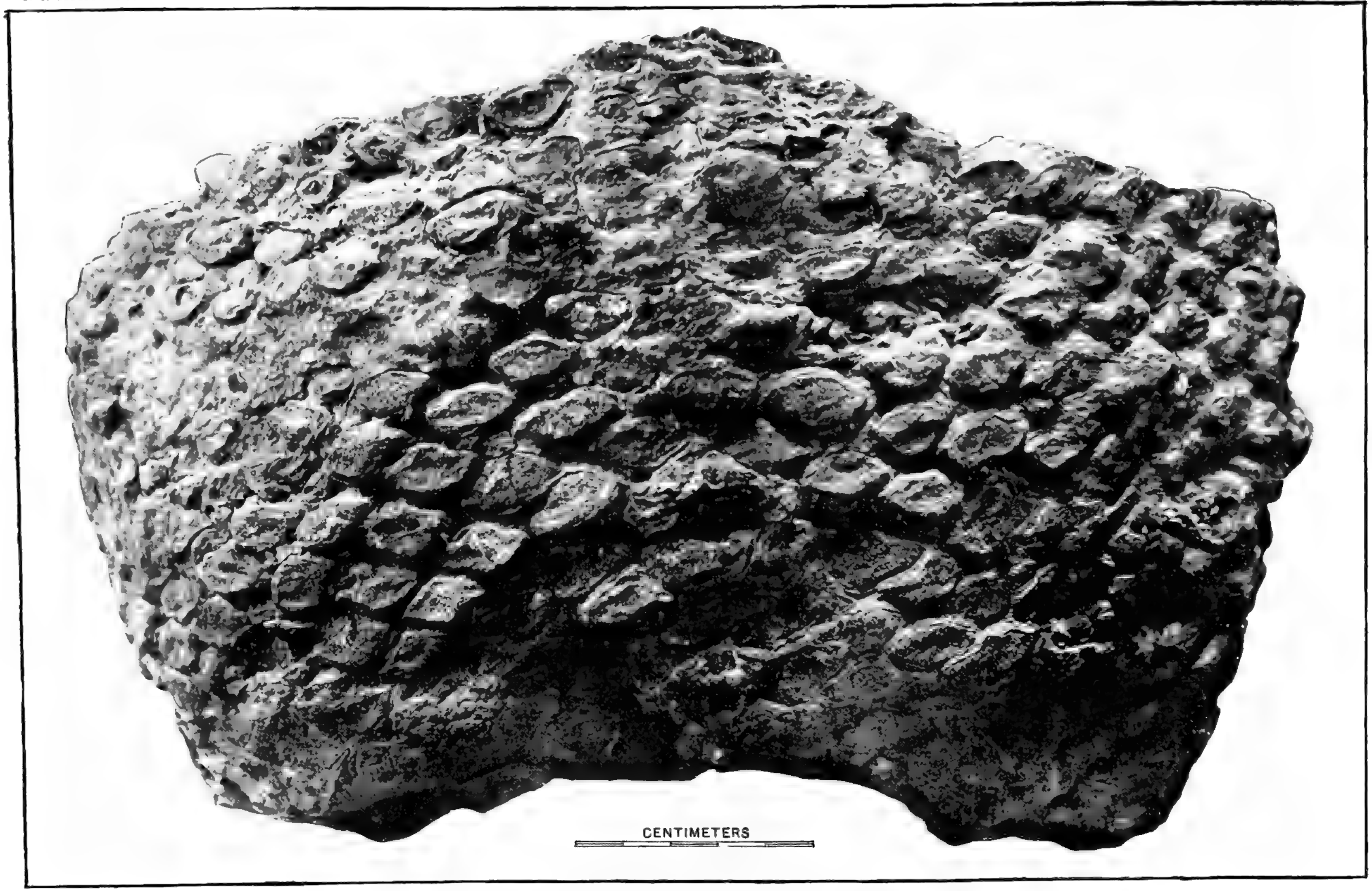
Side view of No. 500.33 of the Museum of the University of Wyoming.




CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXVI.

## PLATE CLXXVI.

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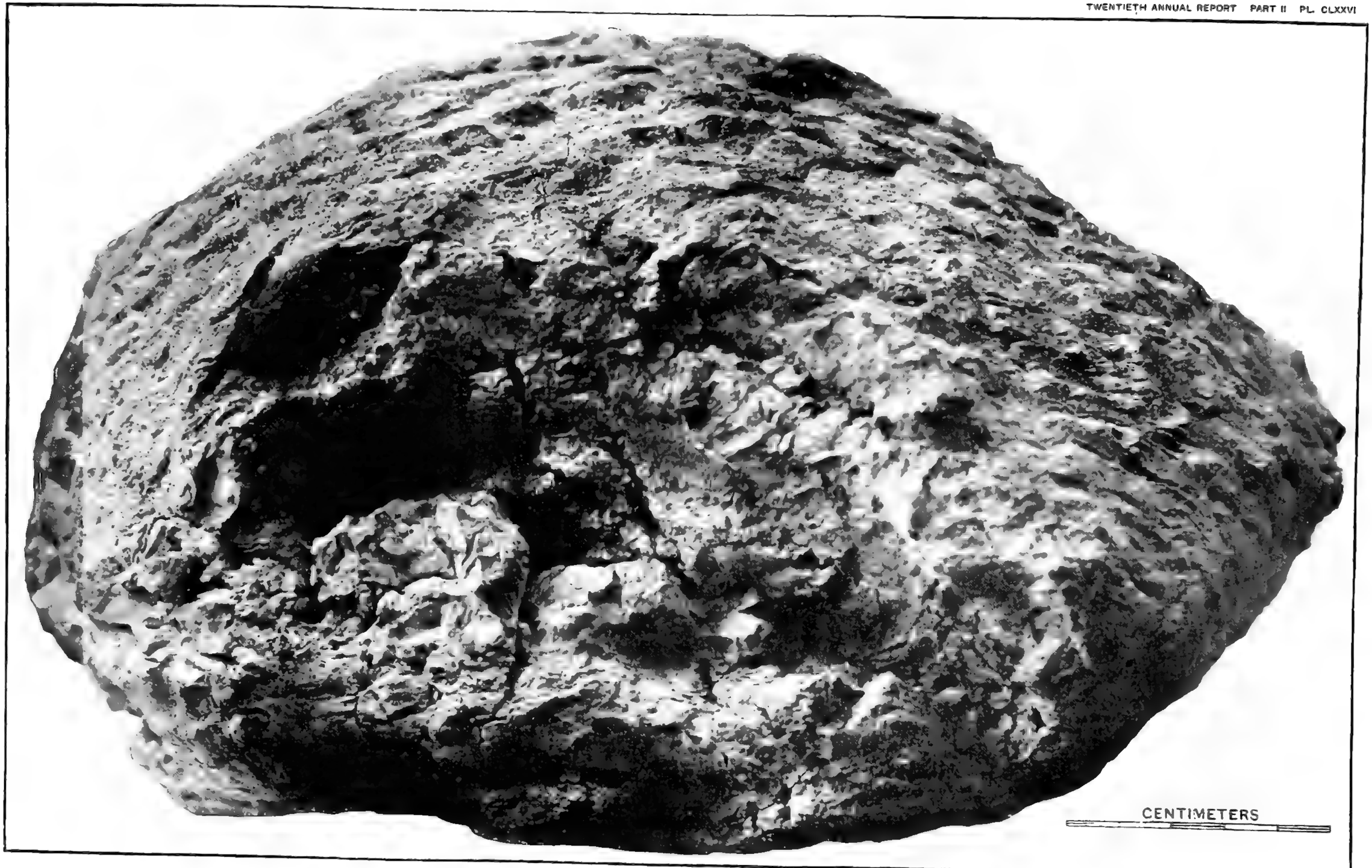
CYCADELLA KNIGHTII Ward ........................................ 416
View of the base of No. 500.33 of the Museum of the University of Wyoming.




CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXVII.

## PLATE CLXXVII.

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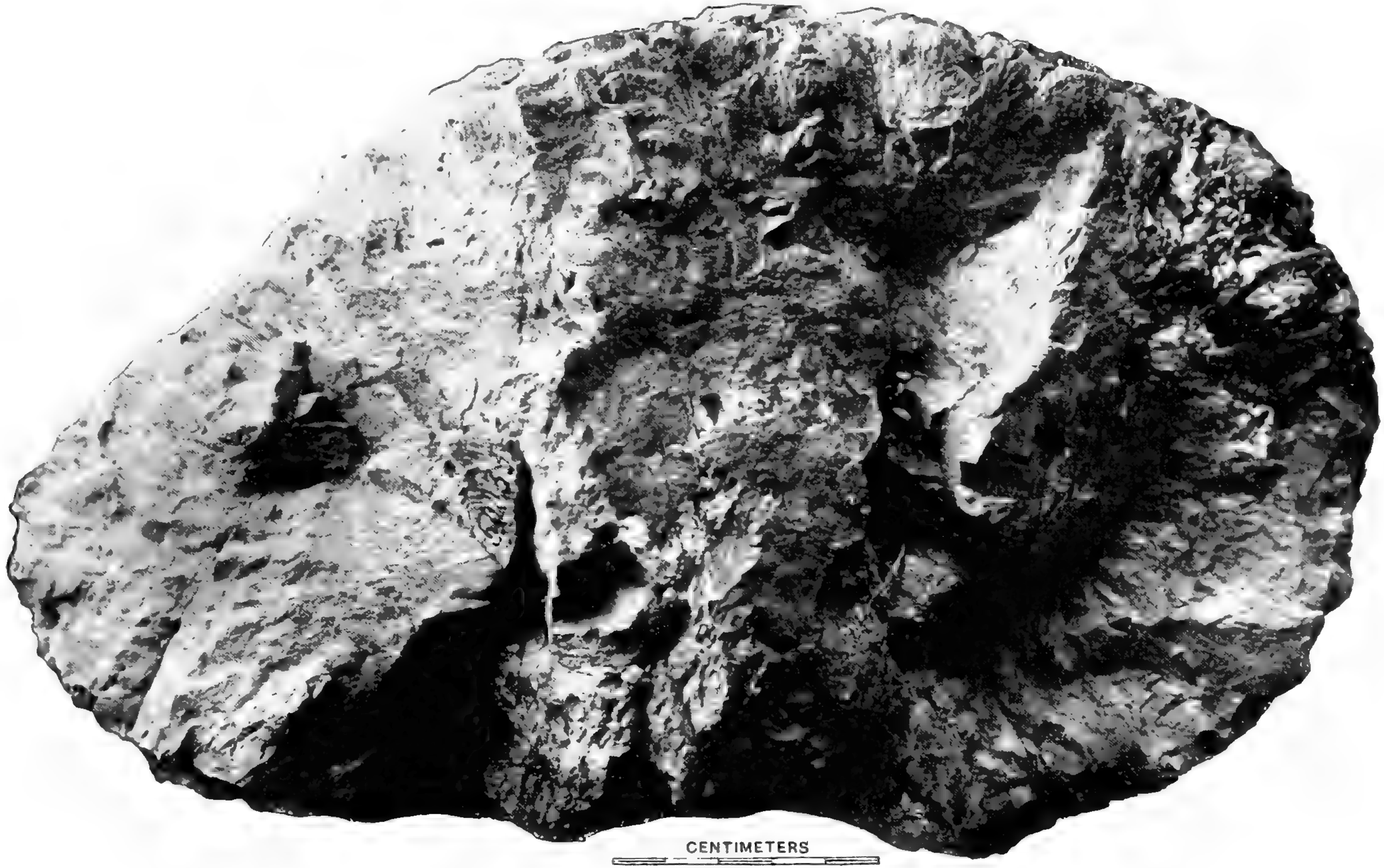
CYCADELLA KNIGHTII Ward .......... 416

View of the upper transverse fracture of No. 500.33 of the Museum of the University of Wyoming.




CYCADELLA KNIGHTII, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXVIII.

## PLATE CLXXVIII.

INTERNAL STRUCTURE OF FOSSIL WOOD FROM THE CYCAD BED OF THE FREEZEOUT HILLS, CARBON COUNTY, WYOMING, AS SHOWN BY SECTIONS MADE FROM NO. 500.85 OF THE MUSEUM OF THE UNIVERSITY OF WYOMING.

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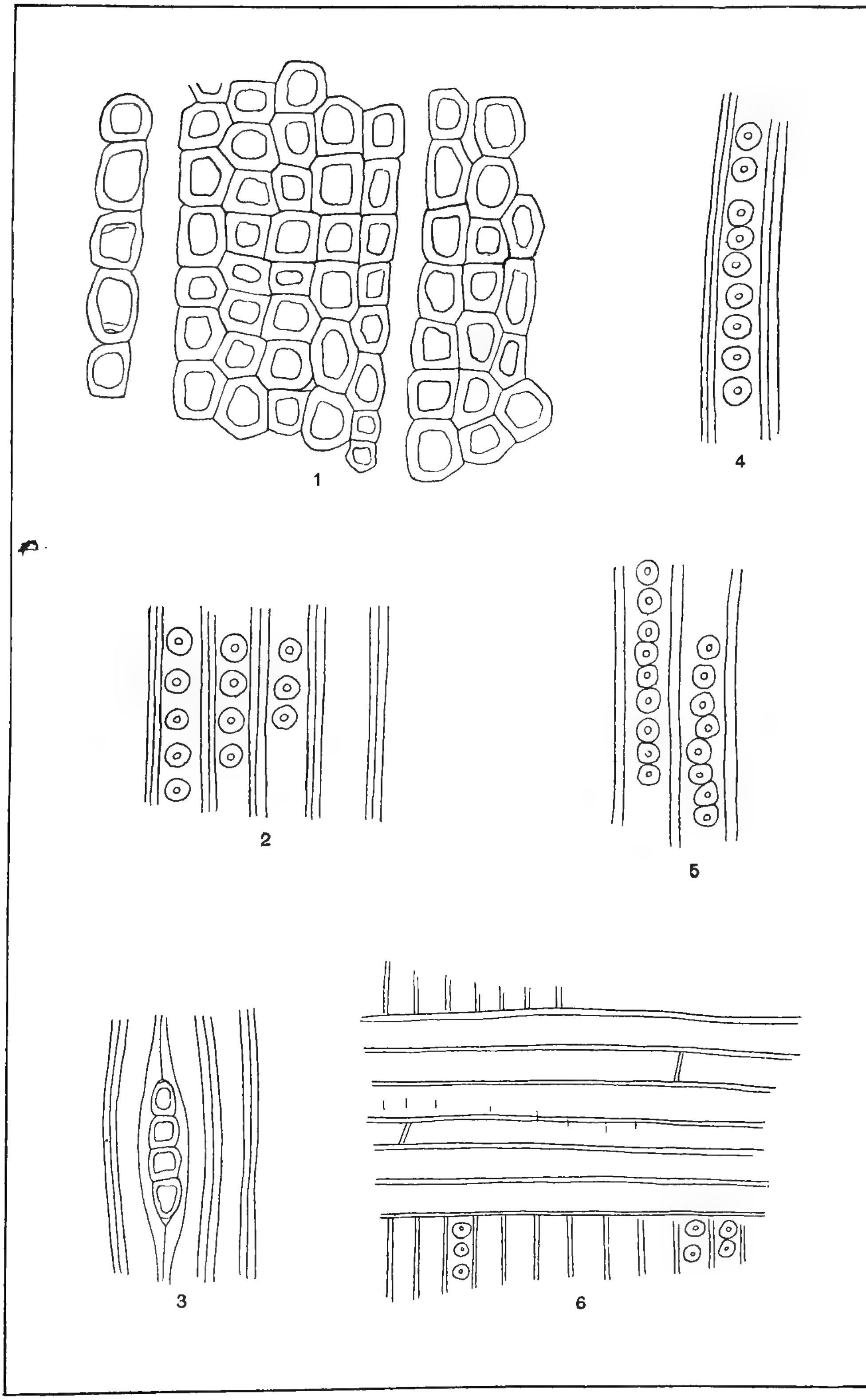
|---|---|
| Figs. 1–6. ARAUCARIOXYLON ? OBSCURUM Kn. n. sp | 418 |

Fig. 1. Transverse section, showing the uniform and thick-walled wood cells. × 320.

Figs. 2, 4, 5. Radial sections, showing the bordered pits in scattered or contiguous rows. × 320.

Fig. 3. Tangential section, showing a single medullary ray. × 320.

Fig. 6. Radial section, showing medullary rays and wood cells with remote bordered pits. × 320.




ARAUCARIOXYLON? OBSCURUM, FROM THE JURASSIC OF WYOMING.

# PLATE CLXXIX.

# PLATE CLXXIX.

## Internal Structure of Fossil Wood from the Jurassic of the Black Hills in South Dakota.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Figs. 1–6. Pinoxylon dacotense Kn. gen. et sp. nov .......................... 420


Fig. 1. Transverse section, showing sharp line of demarcation between fall and spring wood. × 320.

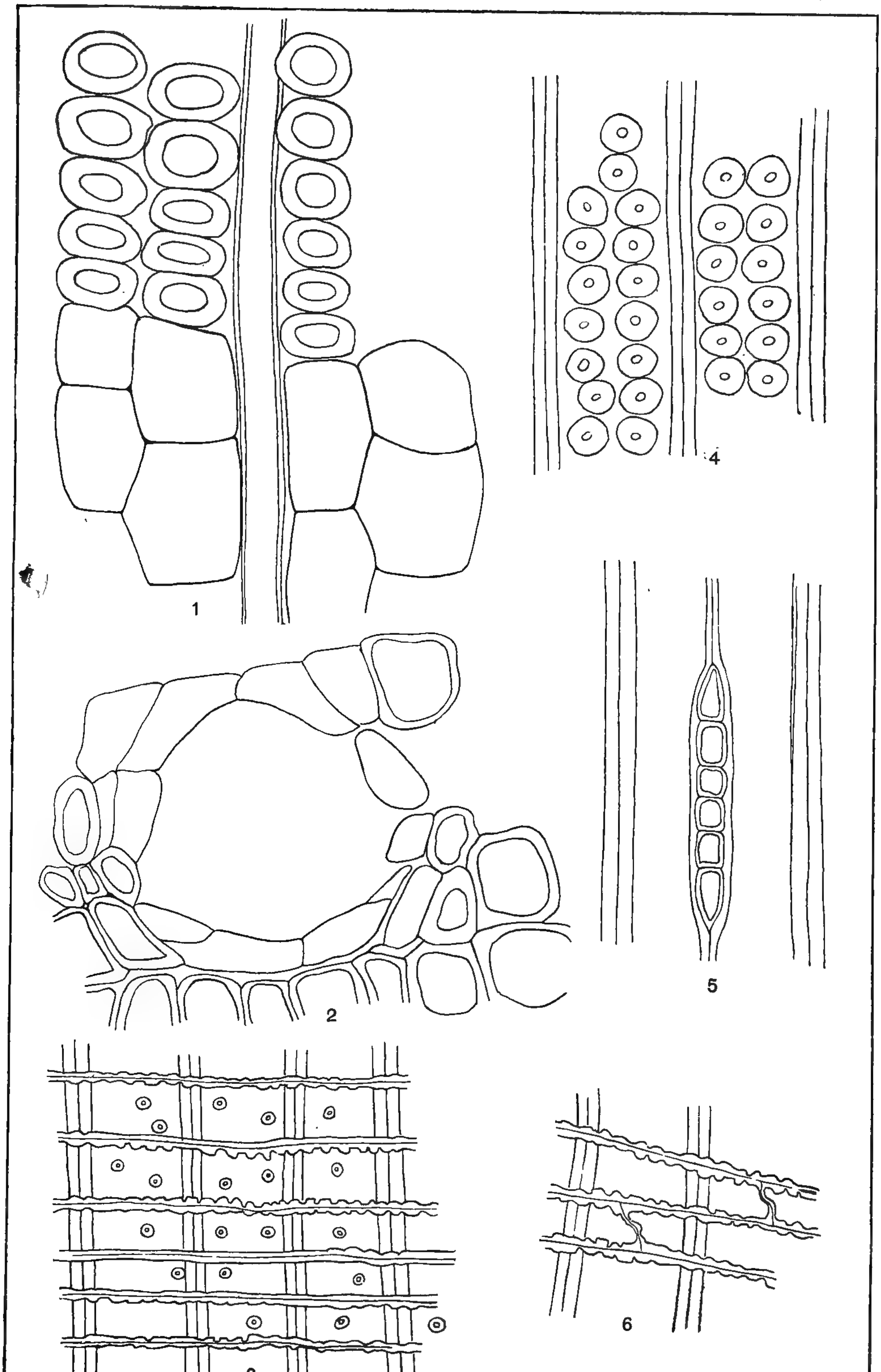
Fig. 2. Transverse section of resin passage in fall wood. × 320.

Fig. 3. Radial section, showing medullary rays with irregularly thickened walls and small bordered pits. × 320.

Fig. 4. Radial section, showing bordered pits on walls of spring wood. × 320.

Fig. 5. Tangential section, showing a single medullary ray. × 320.

Fig. 6. Radial section, showing manner in which the medullary rays are thickened and also the ends of the cells. × 320.




PINOXYLON DACOTENSE, FROM THE JURASSIC OF SOUTH DAKOTA