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135. Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for the year 1894, by Fred Boughton Weeks.

136. Volcanic Rocks of South Mountain, Pennsylvania, by Florence Bascom.

In preparation:

— The Moraines of the Missouri Coteau and their attendant deposits, by James Edward Todd.

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Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.

Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided,* That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey."

The money received from the sale of these publications is deposited in the Treasury, and the Secretary of that Department declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by POSTAL NOTE or MONEY ORDER, made payable to the Director of the United States Geological Survey, or in CURRENCY for the exact amount. Correspondence relating to the publications of the Survey should be addressed

To THE DIRECTOR OF THE
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *December, 1895*

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United States Geological Survey

VOLUME XXVI

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UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

THE FLORA OF THE AMBOY CLAYS

BY

JOHN STRONG NEWBERRY

A POSTHUMOUS WORK

EDITED BY ARTHUR HOLLICK

WASHINGTON
GOVERNMENT PRINTING OFFICE
1895

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF PALEONTOLOGY,
Washington, D. C., March 30, 1894.

SIR: I have the honor to transmit herewith the manuscript and drawings of a monograph of the flora of the Amboy Clays, by Dr. J. S. Newberry, edited by Dr. Arthur Hollick, and to request its publication.

Very respectfully, your obedient servant,

LESTER F. WARD,
Paleontologist.

THE DIRECTOR,
United States Geological Survey.

EDITOR'S PREFACE.

In submitting the accompanying monograph upon the flora of the Amboy Clays the editor appreciates fully the delicate nature of his task and takes advantage of this opportunity to offer a few words of explanation, in order that the credit due to the author may not suffer from any want of care on the part of the editor, and also to define the extent of the editor's responsibility.

The monograph as a whole is the work of Dr. J. S. Newberry. It was almost completed in the autumn of 1890,[1] but shortly afterwards Dr. Newberry became unable, on account of failing health, to put the finishing touches upon it, and nothing further was done in the matter until the spring of 1892, when it was turned over to me for completion. During that interval the manuscript and plates had become disarranged and in part lost, and the type specimens had suffered from lack of proper care and precaution in storing and handling. It was under such conditions that I undertook the responsibility of final revision and preparation for publication, and it is hoped that they may serve as sufficient excuse for some of the apparent lapses which may be noticed.

Few alterations have been made in the original text, it having been thought better to retain Dr. Newberry's conclusions, except where these had to be modified or omitted in the light of discoveries made or publications issued subsequent to the time when he ceased active work. Wherever it was found necessary to make additions or alterations the fact is indicated over the editor's initials in the form of a note. Numerous omissions it has been found impossible to fill out with the correct data. This is notably the case in regard to exact localities for some of the specimens, the records of

[1] *Fide* letter to Prof. Lester F. Ward, September 12, 1890.

which are lost or missing. In a number of instances manuscript descriptions were found for which there were no corresponding figures on the plates. Wherever such figures could be supplied from the named material in the collection this was done, but in case of the slightest doubt as to the identity the description was omitted entirely. Again, it was found that many of the figures were named but not described, and others were not even named. In the first instance descriptions were supplied, and in the second, wherever such a figure could be identified with its type specimen in the collection, the name attached to the specimen was adopted and a description added. In case no name or type specimen could be found for a figure an effort was made to identify it with some previously described species, and, failing in that, a description was written and an entirely new name adopted. The responsibility of the editor in all such cases is indicated by his initials; but in order to avoid any possible confusion in the future the authority for the new name is given in each instance after the name.

In conclusion, I wish to acknowledge my indebtedness to Prof. Lester F. Ward for assistance in verifying references, for corrections in terminology and nomenclature, and for bibliographic research, without which the completion of the work in its present shape would have been impossible.

After the foregoing was written Dr. Newberry died, and the present seems to be a proper time in which to give a brief review of his contributions to fossil botany. Accounts of his general scientific labors have been so faithfully given elsewhere by many friends and former associates, in various publications and in the records of scientific societies, that a repetition of them here would be superfluous. The editor will therefore confine himself solely to an account of Dr. Newberry's activity in the line of paleobotany.

JOHN STRONG NEWBERRY, M. D., LL. D.

CONTRIBUTIONS TO FOSSIL BOTANY.

Dr. Newberry was born in Windsor, Conn., December 22, 1822, and died in New Haven, Conn., December 7, 1892.

His earliest published scientific papers bear the date of 1851, and in 1853 the first of his contributions upon the subject of fossil botany was published. This bears the title "Fossil plants from the Ohio coal basin," and was published in the Annals of Science, Vol. 1, Nos. 8 and 9 (Cleveland, Ohio, 1853), pp. 95–97, 106–108. During the same year he read papers before the American Association for the Advancement of Science "On the structure and affinities of certain fossil plants of the Carboniferous era" and "On the Carboniferous flora of Ohio, with descriptions of fifty new species of fossil plants."

His next important investigations were in the fossil floras of the West, in connection with the Pacific Railroad report, in 1856; the Macomb exploring expedition, in 1859; the Ives expedition, in 1861; the Northwest Boundary Commission, from 1859 to 1863; and the Raynolds expedition, from 1859 to 1860. After this followed numerous investigations in the later extinct (Cretaceous and Tertiary) floras of North America, which finally resulted in the publication of "Notes on the later extinct floras of North America, with descriptions of some new species of fossil plants from the Cretaceous and Tertiary strata," in the Annals of the New York Lyceum of Natural History, April, 1868. These descriptions were not accompanied by figures, but the plates were subsequently prepared, and were issued in 1878 by the United States Geological and Geographical Survey of the Territories (F. V. Hayden in charge), under the title "Illustrations of Cretaceous and Tertiary Plants." Dr. Newberry's descriptions were not included, and the names to the figures were supplied by Prof. Leo Lesquereux. Dr. Newberry would never acknowledge any responsibility for this work.

In 1873 the volumes of the Ohio Geological Survey were published, containing the results of Dr. Newberry's previous investigations in the fossil flora of the Carboniferous formation in that State, and in 1878 the rich flora of the New Jersey Cretaceous clays attracted his attention, which finally resulted in the preparation of this monograph. During the progress of this investigation several contributions upon the subject were presented before the Torrey Botanical Club of New York, which were published in the Bulletin of the club. Two of the most important of these were "Description of a species of Bauhinia from the Cretaceous clays of New Jersey" and "The ancestors of the tulip tree," published in 1886 and 1887, respectively. His work upon the New Jersey Triassic fishes and plants appeared in 1888 as Vol. XIV of the Monographs of the United States Geological Survey, and the last of his works to reach the printer's hands was "The flora of the Great Falls coal field, Montana," published in the American Journal of Science in 1891.

Scattered through the volumes of this latter journal, the Transactions and Annals of the New York Academy of Sciences, Bulletin of the Torrey Botanical Club, Bulletin of the Geological Society of America, Proceedings of the American Association for the Advancement of Science, Proceedings of the United States National Museum, Smithsonian Contributions to Knowledge, Science, Nature, and other less-known publications, may be found his other contributions. He also contributed the article on Fossil Botany to the first edition of Johnson's Universal Cyclopædia in 1877, and left behind him several works and many notes in manuscript, which the editor hopes may some day be collected into proper shape for publication.

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Arthur Hollick,
Columbia College, New York.

THE FLORA OF THE AMBOY CLAYS.

By J. S. Newberry.

INTRODUCTION.

The so-called Amboy Clays take their name from Perth Amboy and South Amboy, places in New Jersey which are nearly in the center of an area dotted over with clay pits from which are taken potters' clay, fire clay, paper clays, etc. These clays constitute an important item in the mineral resources of the State. The formation which includes them is some 350 feet in thickness and forms the basal member of the Cretaceous group as it is developed in the State of New Jersey. The upper member of the Cretaceous series consists chiefly of sands and greensand marls, the latter being largely used as fertilizers. These sands and marls contain abundant marine fossils, many of which have been found in the Cretaceous rocks of the Old World, and they have been proved by the investigations of Morton, Meek, Whitfield, and others to be the equivalents in geological age of the White Chalk of England.

The Amboy Clays, to which our attention is now more particularly directed, outcrop in a belt extending diagonally across the State, forming the east bank of the Delaware River for a long distance above and below Philadelphia, leaving the Delaware at Trenton and stretching across the State at its narrowest point to Raritan Bay, and thence, passing over the southern portion of Staten Island, where, as in the State of New Jersey, they are largely worked for economic purposes. They are then interrupted by The Narrows and New York Harbor, as well as by the crystalline rocks which occupy New York Island and underlie the northern portion of Brooklyn and the adjacent shores of Hell Gate. Eastward of this the Amboy Clays are generally covered with drift, but they reappear at Glen Cove, Sea Cliff, and various other points on the north shore of Long Island, where it has been deeply cut into by glacial action and is now occupied by inlets from Long Island Sound. Possibly the whole length of Long Island is underlain by the Amboy Clays, as characteristic fossils have been found in the moraine on the extreme end of Montauk Point. Farther east, the clay series reappears on Marthas Vineyard and forms part of the noted cliff of Gay Head. Again interrupted by the waters of the ocean, it apparently reappears in the southern counties of Massachusetts, and it was described by Prof. Edward Hitchcock in the reports of the geological survey of Massachusetts, though its geological equivalents were not recognized.

The southern extension of the formation has not been definitely traced, but it apparently thins out southward, appearing as an insignificant element in the series in Cecil County, Md., where Professor Uhler has described it as the bed of "alternate sands and clays" which there rests on the Potomac and is overlain by the equivalents of the Cretaceous marl beds of New Jersey. South of this point it has not been recognized.

In New Jersey the Amboy Clay series is generally underlain by the Triassic red sandstones, which have been proved to be of the age of the Keuper or Upper Trias in Europe.

The Amboy Clays are for the most part an estuary deposit. This is indicated by the presence of brackish-water shells, Corbicula, Gnathodon, etc., described by Prof. R. P. Whitfield in his report on the Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey, which forms Vol. I of the Report of the Geological Survey of that State,[1] made under the direction of Prof. George H. Cook. Near the top of the series, however, marine shells occur in the vicinity of Keyport, N. J., such as Inoceramus, Pholadomya, etc., found in the greensands above.[2] This evidence shows that the New Jersey clays occupy a position

[1] This is a part of the edition of Vol. IX, Monographs of the U. S. Geol. Survey, Washington, 1885, issued by the Geological Survey of New Jersey, with a separate title page of later date (1886).

[2] Since this was written the occurrence of a marine molluscan fauna associated with the characteristic flora of the Amboy Clays, in drift material, has also been noted by me on Staten Island (Trans. N. Y. Acad. Sci., Vol. XI, pp. 96-104, February, 1892).—A. H.

lower than the European Chalk and higher than the upper member of the Trias. Such other evidence as can be gained in regard to their precise geological age must be derived from their abundant plant remains, among which are a number of species that are common to the Dakota sandstones of the interior of the continent, to the Atane and Patoot beds of Greenland—known to be Upper Cretaceous—to the Cretaceous clays of Aachen, Germany, and to the Upper Cretaceous rocks of Bohemia.

The relation of the Amboy Clays to the Potomac formation of Virginia is not easily demonstrated, as the line of junction has not been fully traced, but we may say that the Potomac is the more ancient formation, and that probably a somewhat long interval of time separated the epoch of the Potomac group from that of the Amboy Clays. This is indicated by the almost entire distinctness of the floras of the two formations, which shows that a great change took place during that interval in the character of the vegetation which clothed the eastern shore of North America. Professor Fontaine has described, from the Potomac group of Virginia and Maryland, 365 species of plants, of which not one is certainly found in the Amboy Clays; and the difference in the character of the vegetation is shown by the fact that in the long list furnished by Professor Fontaine there are but 75 angiosperms (about one-fifth of all), whereas in the New Jersey clays, throwing out fragmentary and doubtful remains, of 156 described species all but 10 are dicotyledonous plants.

The relation of the Amboy Clays to the Dakota group can be much more definitely determined, for the proportion between the angiosperms and lower plants in the Dakota group is about the same as in the Amboy Clays, showing a similar stage of progress in the development of plant[1] life. We have already obtained 12 species common to the two formations, a number that will undoubtedly be considerably augmented with the further exploitation of the Amboy flora. The Dakota group is known to occupy about the middle of the Cretaceous system. Until recently it was supposed to be the basal member of that system as developed on the North American continent, and it was believed that until about the middle of the

[1] This was written previous to the publication of Lesquereux's Flora of the Dakota Group, edited by F. H. Knowlton, and my discoveries in the Cretaceous of Staten Island and Long Island. We are now enabled to identify at least 40 species as common to the two formations.—A. H.

Cretaceous period our continent had remained above the ocean level; but it has been shown recently that considerable areas of North America are occupied by sediments deposited from the Cretaceous sea before the date of the Dakota formation, and that on the northwestern coast, on Queen Charlotte Island, and in the Shasta group in California we have accumulations of sediment that took place before the Dakota sandstones. Mr. R. T. Hill and Dr. C. A. White have demonstrated that a considerable portion of the State of Texas is underlain by rocks that are the equivalent of the Neocomian or Lower Cretaceous of the Old World. Very recently, too, Sir William Dawson has found in the fresh-water coal-bearing deposits of western Canada fossil plants identical with some from the Kome group or Lower Cretaceous of Greenland; and a much larger collection of fossil plants obtained by the writer from the coal basin of the Falls of the Missouri in Montana, collected by Mr. R. S. Williams, contains many Kootanie or Lower Cretaceous plants, and, what is of still greater interest, a number of species that have been described by Professor Fontaine from the Potomac group of Virginia. Thus the conclusions of Professor Fontaine as to the Wealden age of the Potomac are strikingly confirmed. His arguments in favor of this view were that the Potomac flora was most like that of the Wealden of Europe, a few of the species being apparently identical, while it had nothing in common with any other flora known. To this I ventured to add the suggestion that it could hardly be Jurassic, as claimed by some writers, since in no part of the world had angiosperm plants been found in the Jurassic, though in Europe the Jurassic rocks had yielded great numbers of plants and the flora had been carefully studied. Now the finding of species identical with those of the Potomac in the Great Falls basin, and with them plants found in the Kootanie of Canada and the Kome deposits of Greenland, seems to place the question beyond doubt.

CHARACTERISTICS OF THE FLORA.

It is evident that it is yet too early finally to review and discuss the botanical character and relations of the flora of the Amboy Clays. I have now before me as I write 156 species of plants that have been described;

and among the material that is suggestive rather than instructive—fragments and indications of other species not sufficiently well represented to be described in full—there are perhaps 30 other species, including seeds and fruits, of which the connection with the plants that bore them is conjectural. Most of the species enumerated in this list are represented by a large number of individuals, and the degree of preservation of the specimens is such that it is very satisfactory material for study as far as it goes; but it is evident that only a beginning has been made in gathering the fossil plants of the Amboy Clays, and probably for years to come considerable additions will be made annually to that flora, so that the present memoir can be properly regarded as only the commencement of a great work. The partial view of the subject here given will be recognized by all those who are interested in it, and not too much weight will be given to such portions of the memoir as consist in descriptions of unique specimens or fragmentary material.

Some special difficulties have stood in the way of making collections of the plants of the Amboy Clays. These clays have come to be a most important element in the resources of the State, and they are the basis of a great industry. The clay beds have been opened at a great number of points, and as the different layers are the products of changing physical conditions, and probably mark the lapse of considerable intervals of time, it is not strange that many differences should be noticeable in the fossil plants of the various beds.

The greater number of the fossil plants now described are from the middle bed in the series—the Woodbridge clay bed—while we have not a few of the plants characteristic of the lower or Raritan beds, opened at Sayreville, and of the upper or South Amboy beds. Not enough material has been obtained from the South Amboy and Sayreville beds, however, to enable us to form a clear idea of the phases of vegetation prevalent at the time when these different deposits were made. We have learned that there is certainly considerable difference in the grouping of the plants in the three beds, and it is also probable that there are species which are not only characteristic of but confined to each of the three great divisions of the clay series.

The Sayreville beds, if not the first opened, were those most largely worked in the early history of the clay industry, and our first collections were made from this deposit. Dr. N. L. Britton, then my assistant in the geological department of the School of Mines, took a special interest in the subject, and brought in from the banks of the Raritan River a large amount of material which at first view was particularly attractive and interesting. The fossil plants were represented by a considerable amount of carbonaceous matter that was of a jet-black color, and this contrasted well with the dove-colored background of the damp clay, so that the leaves as they were taken out resembled strong and handsome lithographs. Mr. Arthur Hollick, a graduate of the School of Mines and a skillful draftsman, was on hand at that time to make sketches of some of this material, and it was fortunate that this was possible, because these beautiful plant impressions proved to be in many cases evanescent and temporary. The sheet of carbonaceous matter which covered the area of a leaf, having been hermetically sealed in the plastic clays, had lost little of its substance and was a relatively thick sheet of lignite. This contained a large quantity of water, and when the specimen was dry the material shrank and season-cracked so that it could often be blown away with the breath, leaving only a faint impression that was nearly invisible. Efforts were made to preserve these specimens by various devices. They were varnished, coated with gum, saturated with paraffin, with glycerin, with water glass, all without success, and we had the mortification of repeating the experience of the merchant whose story is told in the Arabian Nights, who, receiving what seemed beautiful new coins from a necromancer, found on going to his money drawer the next day that all his bright coins had resolved themselves into dried and withered leaves.

The same thing had happened before, for the leaf impressions in the Amboy Clays had early attracted the attention of Professor Cook, at that time the head of the Geological Survey of the State, and he had caused many of them to be collected. When my attention was drawn to the subject and I went to New Brunswick to examine the material that had been gathered into the cabinet of Rutgers College, I found that nearly all the specimens had perished in the way I have described and were indeterminable.

This experience caused us great disappointment, and I became nearly hopeless of being able to accumulate such representatives of the Amboy Clay flora as would suffice for careful and deliberate study, and, what was of primary consequence, should remain as types and standards for future comparison. Nothing has contributed more to the confusion and uncertainty that has prevailed in the literature of natural history than the loss of type specimens, and no solid and substantial progress could be made in the study of this flora if the material were to perish in the using.

The truth of this statement is abundantly proved by the uncertainties that hang over the first efforts to investigate this flora. The fossil plants collected by Professor Cook were submitted to Mr. Leo Lesquereux, of Columbus, Ohio, the eminent paleobotanist, and his report upon them is given on page 27 of the Report on the Clay Deposits of New Jersey, which forms one of the reports of the Geological Survey of the State, issued in 1878. His report will be referred to in detail on another page. It begins as follows: "The specimens, very numerous, badly preserved, from Sayreville and other localities, have, * * * * so far as they are determinable, the characters of the flora of the Dakota group." He attempted, however, to determine the species, and reports a list which I shall give further on. The material submitted to him I had an opportunity of examining, and, as before stated, found it to be practically worthless.

At this stage of our experience, and when we were much discouraged in our efforts to gather and study the remains of the clay flora, Dr. Britton fortunately discovered at South Amboy a layer of the clays in which the leaf impressions carried very little carbonaceous matter—simply enough to color the area of the leaf with a coffee-brown tint. These impressions we found to be permanent, and since that time our efforts have been mainly directed to the discovery of such layers in this and other clay pits and the gathering of material of this kind. A similar layer was discovered by Mr. I. H. Woolson at Woodbridge, and this has furnished perhaps three-fourths of all the specimens which are figured and described in this memoir. From Sayreville we have as yet obtained no leaf impressions of this character, and the treasure which there lies entombed is for the most part intact, and we must discover some method by which the specimens from this locality and from similar beds in other clay pits can be preserved before they can be satisfactorily studied.

The circumstances detailed above have limited the accumulation of material for examination, and it should also be said that the limited appropriations at the command of Professor Cook made it impossible for him to pay for the thorough examination of all the hundreds of clay pits which have been opened in the clay belt. Thus it is that the study of the Amboy Clay flora has progressed slowly and the greater part of the work is yet to be done. As the clay pits in New Jersey are destined for hundreds of years to be an important source of wealth to the inhabitants of the State, it is certain that the work of excavation will go on for a long time to come, and should means be provided for making the necessary collections and for the publication of the results of their study, we may hope and expect that ultimately the Amboy Clay flora will be thoroughly investigated, and the results of such investigation be one of the most important and interesting contributions to the history of vegetation on the globe.

As the report of Mr. Lesquereux, referred to above, was the first contribution made to our knowledge of the Amboy Clay flora, it deserves some further notice. The list of plants which he gives is as follows:

1. Pettit's clay bank, near Washington, [South River].

Sterculia, undetermined species.	Proteoides daphnogenoides.
Rootlets of Equisetum.	Platanus Heerii Lesq.
Andromeda.	

2. Sayre & Fisher's clay bank, at Sayreville.

Glyptostrobus gracillimus Lesq.	Laurus species.
Sequoia condita Lesq.	Persea nebrascensis Lesq.
Sequoia Smithsiana Heer (sic).	Daphnophyllum?
Sequoia subulata Heer.	Salix proteaefolia Lesq.
Araliopsis, undeterminable.	Proteoides daphnogenoides Heer.
Magnolia alternans Heer.	Proteoides, undeterminable.
Magnolia Capellinii Heer.	Sterculia species.
Cinnamomum Heerii Lesq.	

3. J. K. Brick's clay bank, Burts Creek.

Sassafras (Araliopsis).	A Sequoia with thick leaves.
Seed of conifer.	Sequoia Reichenbachi.
Rootlets.	

4. Mrs. Allen's clay pit, South Amboy.

Quercus, dentate leaves.	Andromeda.
(Dryophyllum).	Cinnamomum Heerii Lesq.
Sterculia, same as above.	Sequoia rigida Heer.
Myrica, or Lomatia.	Sequoia Reichenbachi Heer.
Salix proteæfolia.	Leaves of a peculiar new kind of fern.

In looking over this list I find that only the following plants have been identified in our collections: *Magnolia alternans*, *Proteoides daphnogenoides*, *Salix proteæfolia*, *Andromeda Parlatorii*, *Sequoia Reichenbachi*, and *Glyptostrobus gracillimus* Lesq., the last, as shown on another page, not being a Glyptostrobus. The concluding note of Mr. Lesquereux's report is: "These specimens are few and poor, and therefore the determinations are not positively ascertained," much of the uncertainty being due, as before mentioned, to the very bad condition of the material. A number of species are mentioned in his list which we have never been able to recognize in any of our collections made from the New Jersey clays, though it is, of course, possible that in a flora so rich as this they may be discovered hereafter.

To refer to certain plants in the list which we have specially sought without finding, we may mention *Plantanus Heerii* Lesq. and *Sequoia condita* Lesq., both of which are plants of the Dakota group. "*S. Smithsiana* Heer" is undoubtedly intended for *S. Smittiana* from the Lower Cretaceous (Kome) beds of Greenland, which occurs in the Kootanie group, and is almost certainly not a member of the Amboy flora. The same may be said of *S. subulata* Heer and *Magnolia Capellinii*, which are likely enough to be found in the Amboy Clays, though we have not seen them. They are very widely distributed and ought to be here. *Cinnamomum Heerii* Lesq. is perhaps the species which we have called *C. intermedium*. In *C. Heerii* the leaf is broader, less wedge-shaped, and more prominently three-nerved. Sassafras is perhaps our species *S. progenitor* or *S. acutilobum* Lesq., both of which occur not rarely in these beds. *Sequoia rigida* Heer is not like any species we have seen, and as it occurs lower in the series it is doubtful if it has been found in New Jersey. *Sequoia Reichenbachi* is a species of great vertical and lateral range, occurring on Vancouver Island, in the Laramie group of the West, in the Cretaceous beds of Greenland, both lower and upper, and throughout the continent of Europe where the plants of the upper half of the Cretaceous system have been gathered.

BOTANICAL CHARACTER OF THE FLORA.

In the present memoir, including fruits and flowers, 156 species of plants are described. Of these, one is apparently a seaweed (*Chondrites flexuosus*). *Hausmannia* and *Czekanowskia* are of uncertain botanical affinities, and *Baiera*, of which, as of the others mentioned, we have one species, is probably a conifer. Leaving out these doubtful elements, we find that of ferns there are 8 species; of conifers, 17; of cycads, 5; and all the others are dicotyledonous angiosperms. Of these, as has been already mentioned, the botanical rank is high—as high, probably, as that of an indiscriminate selection from the same number of arborescent plants taken from the living flora of the State of New Jersey would be. Hereafter, when more material shall have been gathered and this more carefully and wisely studied, it is probable that some changes will be required in the botanical balance of this flora; but it is evident that no discoveries hereafter to be made will greatly change its aspects. Changes will be made in the genera enumerated, species will be united or broken up, and the addition of groups of plants from layers which have furnished us little or nothing will doubtless color the result; but we can hardly imagine that the conclusions here announced will be greatly modified.

As we look over the subjoined list of plants it will be seen that among them there are no palms. This is in accordance with all the observations hitherto made elsewhere upon the flora of the Lower and Middle Cretaceous. Mr. Lesquereux has doubtfully announced the discovery of a palm (*Flabellaria? minima*) in the Dakota group of the West (Cret. Flora, p. 56, Pl. XXX, fig. 12), but by reference to his figure and description it will be seen that no important conclusion can be based upon material so doubtful. We may say, therefore, that up to the present time no remains of palms have certainly been found in the Middle and Lower Cretaceous rocks. This is one of the many surprises we meet with in this connection, since palms are considerably lower in the botanical scale than the dicotyledonous plants, the remains of which are here so abundant, and it may perhaps be explained by the supposition that no Middle Cretaceous rocks have been opened in districts where tropical or subtropical climatic conditions prevailed. This, however, is unsatisfactory, for the Lower Cretaceous rocks have been opened in all quarters of the world and plants have been collected from them; and the Dakota flora gives evidence from all sources that it is that of a warm temperate climate, and that the climate was in the same localities afterwards warmer, since palms, which may be accepted as an evidence of a warmer climate, are so abundant in the Laramie and Tertiary beds.

From the conditions under which the Amboy Clays were deposited, that is, in estuaries of no great extent, surrounded by land covered with a dense vegetation, and from the nature of the deposits, largely fine clay which subsided in the quiet water, we should expect to find here the remains of herbaceous plants as well as arborescent, and yet so far they have been conspicuous by their absence.

Again, we should have anticipated the preservation of insects in large numbers—dragon flies, at least, which were so numerous in the Jurassic age as to leave multitudes of representatives in the Solenhofen slates—and yet, though we have searched for them most carefully, no definite remains of insects have yet been discovered. Flowers were there in abundance, and why the insects have not left any proof of their existence is a mystery. That insects existed in great numbers as early as this is proved by the fact that in the St. Étienne coal basin in central France, in rocks of the Carboniferous age, Mr. Charles Brongniart has obtained over 1,300 species of insects.

GEOGRAPHICAL DISTRIBUTION OF THE FLORA.

In this installment of fossil plants from the Amboy Clays, out of 156 described species, about 50, or one-third of the whole number, are described by Heer from the Cretaceous rocks of Greenland. In Velenovský's Flora der Böhmischen Kreideformation I find 6 that I regard as identical with those that we have from New Jersey. In the Dakota group, out of 460 described species, there are at least 40 which seem to occur in the Amboy Clays; and I have identified 3 positively, and several others presumably, of our New Jersey plants in the Cretaceous beds of Aachen. The flora of the Aachen clays has never been fully described. Debey and Ettingshausen began to illustrate it, and published two parts of a proposed monograph. These included Thallophytes and ferns, but the conifers, cycads, and angiosperms were left untouched; at least, though partially studied, they were not figured or described. To make the comparison which it was impossible to do through books, I at one time took occasion to go to Aachen, and had the privilege of examining a very considerable portion of the collections made by Dr. Debey. I found that the formation there resembles our Amboy Clays very much lithologically, and some of the strata are of economic importance and have been extensively worked. Unfortunately, the spread of the town has covered most of the pits where excavations were made, and hereafter it will be impossible to enjoy the opportunity possessed by Dr. Debey, who for twenty-five years was a practicing physician in Aachen and had in his pay the men employed in the clay pits, so that the collections he made were very large. These have since been made up into sets and sold.

In the few hours I spent in the examination of Dr. Debey's plants it was impossible for me to make the systematic comparison with the Amboy flora that is desirable, but that will doubtless be made in time, when someone takes up the work begun by Dr. Debey and gives a full description of the plants he found. I was greatly interested to see the general correspondence in the character of the floras, and to identify with certainty such plants as *Moriconia cyclotoxon*, *Cunninghamites elegans*, *Asplenium Foersteri*, etc. The number of identical species will undoubtedly be largely augmented, and there can be no mistake about the parallelism of the two formations.

Dr. Charles Horion, of Liege, has given a lucid explanation of the structure and relations of the Aachen beds in his Notice sur le Terrain Crétacé de la Belgique (Bulletin de la Société Géologique de France, 2^{me} Série, Vol. XVI, p. 635), and has shown that the formation of that region covers the upper half of the Cretaceous system, the upper member being the Maestricht beds, which is the summit of the system, while the beds at Aachen, though all mechanical—clay, sands, etc.—range down to about its middle, or form the equivalent of the Upper Greensand of England.

The mode of accumulation of the beds at Aachen seems to have been similar to that of the Amboy Clays and the Potomac group; that is, they are local estuarine beds resting upon Paleozoic rocks and composed of the wash of the neighboring land, in which were buried great numbers of leaves and trunks of the trees which grew upon that land. The trunks are now converted into lignite, and they are as conspicuous an element in the lithology of the group as in New Jersey. Dr. Debey supposed that his collection contained 300 to 400 species of angiosperm plants. This is perhaps an exaggeration, for he included in his list a great many doubtful fragments; but when the floras of the Aachen beds and those of the clays of New Jersey shall be fully studied and illustrated it will undoubtedly be found that the botanical aspects are the same, and that there are perhaps as many species identical in the two formations as in those of Greenland and New Jersey. Hence, we may fairly infer that the collections of plants from the New Jersey clays, the Dakota group, the Patoot and Atane beds of Greenland, the Aachen series of Germany, and the plant-bearing Cretaceous rocks of Bohemia fairly represent the vegetation of the world during the middle and latter portions of the Cretaceous age.

DESCRIPTION OF SPECIES.

CRYPTOGAMIA.

THALLOPHYTA.

Order CHONDRITEÆ.

CHONDRITES FLEXUOSUS Newb. n. sp.

Pl. I, figs. 1, 4.

In various localities the Amboy Clays are found penetrated in every direction by vegetable fibers which are imperfectly shown in the figures now given. These specimens are evidently the remains of fresh-water fucoids or sponges. They are apparently not the rootlets of aquatic plants, because they are not found connected with any stems, and they should apparently be classed with similar organisms which have in different formations been generally included in the genus Chondrites and have been supposed to be Thallophytes. No detailed description of these specimens is necessary, but they will be recognized wherever found by the figures now published.

In Debey and Ettingshausen's Die Urweltlichen Thallophyten von Aachen,[1] Pl. II, figs. 6 and 8, similar organisms are represented, to which our specimens are closely allied. They differ, however, in the long and flexuous tendrils, which are less distinctly connected with a parent stalk.

Localities: Sayreville, Woodbridge, etc.

[1] Denkschriften d. Akad. Wiss., Bd. XVI, Wien, 1859.

BRYOPHYTA.

Order HEPATICÆ.

HAUSMANNIA RIGIDA Newb. n. sp.

Pl. I, figs. 2, 3, 5.

Frond large, bipinnate or tripinnate, flat; central line of pinnæ and pinnules traversed by a strong continuous midrib, from which are given off many fine, flexuous, branching veins. Margins entire, pinnæ and pinnules mostly opposite, pinnules linear, subacute.

This interesting plant is not uncommon at South Amboy, and a single fragment of it has been found at Woodbridge. It is evident, however, that it belongs to the upper beds of the Amboy Clays, and was an inhabitant of the region around New York Harbor only in the last half of the Amboy epoch of the Middle Cretaceous period.

It closely resembles *Hausmannia dichotoma* of Dunker (Monographie der Norddeutschen Wealdenbildung, p. 12, Pl. V, fig. 1; Pl. VI, fig. 12), but is far more exact and regular in the divisions of the frond, and they are not dichotomous. In regard to the botanical affinities of this plant, our specimens do not solve the problem. In my judgment, it is a fern or hepatic, though no living fern comes very near to it.

From a resemblance which appeals rather to instinct than reason, I have been led to think it possible it was a higher kind of hepatic, a Marchantia, for example, lifted from its creeping condition into an independent and erect plant, trained and disciplined into symmetry by the occult influence which has given such grace and exactness to the foliage of ferns, lycopods, and some conifers.

Probably future collections will solve this problem, but until the fructification shall be found this will remain one of the most puzzling forms of extinct vegetation.

Among fossil plants Rachiopteris (formerly Schizopteris) seems to me to be most like Hausmannia, but no species of that genus shows anything like the regularity and symmetry of structure which are conspicuous characters in the plant before us.

Localities: Woodbridge, South Amboy.

PTERIDOPHYTA.

Order FILICINÆ.

GLEICHENIA GIESEKIANA Heer?.

Pl. IV, fig. 12.

Gleichenia Giesekiana Heer, Fl. Foss. Arct., Vol. I, p. 78, Pl. XLIII, figs. 1 a, b, c, 2 a, 3 a, b; Pl. XLIV, figs. 2, 2e, 3; Vol. III, Part II, p. 43, Pl. III, figs. 1d, 8; Pl. VII, fig. 1; Vol. VI, Abth. II, pp. 6, 35, Pl. II, figs. 9a, 9b; Pl. XIII, figs. 4, 4b.

Among the fragments of fronds of Gleichenia there are some which agree in all essential particulars with the species named above, but the material is too fragmentary and imperfect to justify any positive assertion of identity. The plant is much larger and stronger than that which I have referred to *G. Zippei*, the pinnæ having a length of 10^{cm} to 12^{cm} and the pinnules being from 8^{mm} to 12^{mm} in length. Better specimens will undoubtedly be obtained hereafter, and will permit a more satisfactory comparison with described species. All we can now say with certainty is that a relatively large species of Gleichenia was an element in the Cretaceous flora of the country surrounding the mouth of the Hudson, and in any catalogue of the plants constituting this flora this demands a place.

Locality: Woodbridge.

GLEICHENIA MICROMERA Heer?.

Pl. III, fig. 6.

Gleichenia micromera Heer, Fl. Foss. Arct., Vol. III, Part II, p. 55, Pl. X, figs. 14, 15.

We have obtained a few fragments of a fern which is more like the species to which Heer gave the above name than any other, living or fossil. The plant was very delicate, the fronds flexuous, the pinnæ narrow, linear, leaving the rachis at a right angle, the pinnules ovate or oblong, not more than 2^{mm} or 3^{mm} in length.

The material before us is too imperfect to suffice for satisfactory comparison, and yet we have here traces of a very beautiful and distinctly marked plant which deserves recognition as one of the minor but more attractive elements in the Amboy flora.

Locality: Sayreville.

Gleichenia Zippei Heer ?.

Pl III, fig. 5.

Gleichenia Zippei Heer, Fl. Foss. Arct., Vol. I, p. 79, Pl. XLIII, fig. 4; Vol. III, Part II, p. 44, Pl. IV, figs. 1–5; Pl. V, figs. 1–9; Pl. VI, figs. 1–3; Pl. VII, fig. 2.
Pecopteris Zippei Corda in Reuss, Versteinerungen d. Böhm. Kreidef., Abth. II, p. 95, Pl. XLIX, figs. 2, 3.
Gleichenia Rinkiana Heer, Fl. Foss. Arct., Vol. I, p. 80, Pl. XLIII, fig. 6.

We have occasionally found fragments of the fronds of a Gleichenia which I have been unable to distinguish from that so fully illustrated in Heer's Kreide Flora (Fl. Foss. Arct., Vol. III, Part II), and to which he gives the above name. The plant was evidently a delicate one, and it is much less perfectly preserved than the associated ferns which I have referred to the genus Anemia. The fronds being much broken up, it is impossible to say whether or not we have united under one name plants which belong to different species. It has been thought, however, that an error of synthesis would be less mischievous than one of analysis, and it has seemed a fruitless labor to attempt to define species sharply where the material is defective, and when it is certain that in future years the exploitation of the New Jersey clay beds will permit the accumulation of abundant material, and that in better state of preservation.

The genus Gleichenia was evidently widespread in the Cretaceous age, and there were many species of the genus in Europe and America. In the flora of the Amboy Clays other ferns are more numerously represented, if we can judge by the collections already made. It is true, however, that the distribution of species is somewhat local in the clay beds, and a treasury of specimens and perhaps species may at any time be discovered. The most abundant of the ferns which I have referred to Gleichenia is that which corresponds best with Heer's description and illustrations of *G. Zippei*. The frond would seem to have been more open than most of those figured by Heer, but this is proved by his illustrations to be a variable character. The fructification is present on some of the specimens found at Woodbridge, and this has altogether the character of that figured by Heer. The pinnules are set nearly at right angles to the rachis, are from 6^{mm} to 8^{mm} long, and when in fruit carry three or four sori on each side of the midrib.

Locality: Woodbridge.

ANEMIA STRICTA Newb. n. sp.

Pl. III, figs. 1, 2.

Frond of large size, ternate, subdivisions ovate or lanceolate, pinnæ lance-linear in outline, pinnules lanceolate, acute, decurrent, simple above, below toothed and finely pinnatifid; nervation fine, each pinnule having at base a central nerve which sends off, pinnately, straight, forked branches to the margins on all sides; fructification unknown.

Of this beautiful fern numerous specimens have been collected at Woodbridge, and from these a selection has been made for representation on Pl. III, of which the figures will serve for comparison with other living and fossil ferns. In general aspect and structure this plant closely resembles some species of Asplenium, and it might without impropriety be referred to that genus, but in the absence of fructification no positive statement can be made in reference to its generic relations. It evidently belongs to a group of ferns which was extensively developed in later Cretaceous times—a group which includes the two plants described in this memoir under the name of *Asplenium Foersteri* and *A. Dicksonianum*, as well as the widespread species of the Upper Cretaceous and Tertiary, *A. subcretacea*. Doubtless, at no distant day the fructification of these plants, as yet unknown, will be discovered in connection with these sterile fronds, and will set at rest the discussion which has been excited in reference to their botanical relations. So far as the vegetative organs are concerned, they might very well belong either to Asplenium or Anemia, the divisions of the frond and the nervation being very like those of the more dissected species of these genera. The Marquis Saporta has suggested that his *Asplenium subcretaceum* may be the type of an extinct generic group allied to Todea, but this must remain a suggestion or conjecture until the fructification shall be discovered.

In looking through Heer's illustrations of the Cretaceous flora of the Arctic regions we find a number of figures which may and probably do represent the plant before us. For example, in the Flora Fossilis Arctica, Vol. VI, Abth. II, Pl. XLIV, fig. 2, is a fragment of a fern to which the name *Dicksonia borealis* is given. This specimen consists of parts of four contiguous pinnæ, which afford a very imperfect view of the plant to which they belong. It is evident, however, that this was closely allied to the fern now under consideration, the only perceptible difference being that the pinnules of the Greenland plant are narrower and less acute. So also on Pl. XXXIV of the same volume—a plate devoted to *Aspidium Oerstedi*—in fig. 8 is represented a small portion of the upper part of a fern frond in which the pinnæ are narrow, the pinnules closely set at a very acute angle with the midrib, decurrent, entire-margined and acute, in all respects resembling some portions of the frond of *Anemia stricta* and almost certainly different from *Aspidium Oerstedi*.

Though not rare at Woodbridge in certain layers of the clay, *Anemia stricta* has up to the present time been found nowhere else. No traces of fructification have yet been detected on any of the specimens. As may be inferred from the figures, the sterile frond was ternate and the fruit was probably borne on a distinct stipe.

Locality: Woodbridge.

Asplenium Dicksonianum Heer.

Pl. I, figs. 6, 7; Pl. II, figs. 1–8; Pl. III, fig. 3.

Asplenium Dicksonianum Heer, Fl. Foss. Arct., Vol. III, Part II, p. 31, Pl. I, figs. 1–5; Vol. VI, Abth. II, p. 3, Pl. II, figs. 2, 2b; p. 33, Pl. XXXII, figs. 1–8.

In the Kreide-Flora der Arctischen Zone (Flora Fossilis Arctica, Vol. III, Part II, p. 31, Pl. I), Prof. Oswald Heer describes a fern which I am entirely unable to distinguish from one that occurs abundantly at Woodbridge. We have now collected many hundred specimens of this fern, and have learned that its fronds were of large size and differed much in the details of the different parts. Selections have been made from this large amount of material for the figures on Pls. I, II, III, and since all the different phases here presented are fossilized together and are connected by intermediate forms, it is impossible to resist the conviction that they all belong to one species. By reference to the numerous illustrations given by Heer, a satisfactory comparison may be made with the figures now published, and it will be seen that the closest correspondence exists in all particulars between the Greenland and New Jersey specimens. The geological importance of this identification is apparent, and is quite independent of the yet undecided question of the botanical relations of this plant. Professor Schimper (Paléontologie Végétale, Tome I, p. 660) refers this fern to Asplenium, like all those with which it is associated geologically and botanically, viz, *Asplenium Brongniarti* Deb. & Ett., *A. Foersteri* Deb. & Ett., *A. cænopteroides* Deb. & Ett., and *A. subcretaceum* Sap. Professor Heer adopts this view, and in his Flora Arctica, Vol. III, he changes the name of the fern under consideration from Sphenopteris to Asplenium. This harmony of opinion among the distinguished botanists whose names have been mentioned must carry with it great weight, but it is necessary to say that it is based on the general similarity of form and nervation, and that, the fructification of none of these ferns having been yet found, the question of their generic relationship can not be said to be decided. From the absence of fruit in all these plants, which he takes as evidence that the fertile and sterile fronds were borne on distinct stipes, as well as from the resemblance of the vegetative organs, Mr. J. Starkie Gardner, in his Monograph of the British Eocene Flora, decides to refer *Asplenium subcretaceum* Saporta to Anemia. This question is discussed at some length in my notes on the allied and associated species, *Asplenium Foersteri*, and it need not be further pursued here.

As in *A. Foersteri*, the fronds of this fern were evidently somewhat thick and coriaceous; the surface is polished, and the nervation is generally obscure; the stipes are fluted, a central ridge being bordered by a more or less distinct furrow on either side. From this ridge a nerve passes through the center of each pinna, and this midrib gives rise to a slender nerve fiber which traverses each pinnule to the apex. In a few specimens it may also be seen that delicate side nerves are given off by the midrib of each pinnule.

Locality: Woodbridge.

ASPLENIUM FOERSTERI Deb. & Ett.?

Pl. IV, figs. 1–11.

Asplenium Foersteri Debey and Ettingshausen, Die Urweltlichen Acrobryen (Denkschr. Wien. Akad., Vol. XVII, p. 193), p. 13, Pl. II, figs. 4–7, 11.

A number of fragments of a fern have been found which in some respects closely approaches that described by Debey and Ettingshausen under the above name (loc. cit.), although the specimens which they figure are too few and imperfect to render the identification certain. Heer has also described in his Flora Arctica, Vol. III, Part II, p. 93, Pl. XXVI, fig. 1, a similar if not identical fern from the Upper Cretaceous rocks of Greenland, but his material was also fragmentary and entirely inadequate for satisfactory description or comparison.

Debey and Ettingshausen refer their plant with confidence to Asplenium and compare it with the living species *Asplenium Adiantum-nigrum* and *A. furcatum;* but while the general aspect and mode of division of the small portions of the frond which they obtained correspond well with some species of Asplenium, the fructification, which alone would be decisive of this question, has not yet been found.

Heer and Saporta compare the specimens from Aachen and Greenland with the fern described by Saporta in his Flore de Sézanne under the name *Asplenium subcretaceum*, a plant of very wide distribution in the Upper Cretaceous and Tertiary rocks of Europe and America. There is certainly a marked resemblance between them, so that it may be fairly inferred that they belong to the same genus, but they are specifically distinct. The Marquis Saporta's plant is evidently larger and coarser in texture, with stronger nervation and more acute pinnules. Mr. J. Starkie Gardner, in his monograph of the British Eocene Flora, now in course of publication by the Palæontographical Society, has referred *Asplenium subcretaceum* to the genus Anemia, arguing that the absence of all traces of fructification among the great number of specimens of this fern found in Europe and America may be accepted as evidence that the sterile and fertile fronds were separated. This question, however, will be decided rather by time and observation than by discussion. When we know more of this group of ferns, so characteristic of the Upper Cretaceous and Eocene periods, we shall be better able to determine their botanical relations.

By comparison of the figures given on Pl. IV it will be seen that our specimens differ considerably from those figured by Debey and Ettingshausen. In our specimens the lower pinnæ are widely separated, opposite, strongly decurrent, and unsymmetrical, the nerve which traverses each one passing near to the upper border. Toward the extremity of the pinnæ, however, the pinnules are closer, and they finally coalesce and pass first into notched and then into simple lobes closely resembling those figured in the Kreide von Aachen, Pl. II, figs. 4, 5. I have therefore been inclined to suppose that if we could compare complete fronds we should find the American and European plants to be identical. It will be noticed, however, that the specimens now figured show some marked peculiarities not visible in those found in Europe, especially the want of symmetry in the lower pinnules of the pinnæ.

The texture of our plant was apparently coriaceous, the nervation fine and generally visible. In one or two specimens we can trace fine nerve branches given off from the main nerve of each pinnule, but they are delicate and apparently widely separated.

On comparing the fern under consideration with living plants, I find the strongest resemblance with *Microlepia cystopteroides* Presl. (Ettingshausen, Farnkräuter der Jetztwelt, p. 209, Pl. CXLIII, fig. 2; Pl. CXLIV, fig. 4). This is a peculiar fern and the resemblance to our plant is quite striking. It would be unwise, however, to attach much importance to this resemblance of the fronds and nervation unless it were confirmed by similarity in the fructification.

Localities: Woodbridge, South Amboy.

PHEGOPTERIS GROTHIANA Heer ?.

Pl. III, fig. 4.

Phegopteris Grothiana Heer, Fl. Foss. Arct., Vol. VII, p. 3, Pl. XLVIII, figs. 12, 13.

Fragments of a fern closely allied to, if not identical with, Heer's species occur rarely in the clays at Cutler Bank, Woodbridge. The specimens obtained are, however, too poor to afford any satisfactory comparison.

This fern is without doubt a species of the same genus as that figured and described by Heer (Flora Arctica, Vol. VII, Pl. XLVIII, figs. 12, 13). Whether that be a Phegopteris or not is not certain, but from the large number of plants common to the New Jersey and Greenland floras we may strongly suspect that the species is the same. Further collections will doubtless solve the question.

Locality: Woodbridge.

Ophioglossum granulatum Heer.

Pl. IX, figs. 11–13.

Ophioglossum granulatum Heer, Fl. Foss. Arct., Vol. VII, p. 8, Pl. LVII, figs. 8, 9.

Professor Heer has described and figured a peculiar fossil which he regards as the fertile stipe of a fern and compares with the fertile frond of *Ophioglossum vulgatum.* Of this organism numerous examples have been found in the Amboy Clays, two of which are now figured. There can be no mistake about the identity of the plant, but as to its true character there may be great differences of opinion. Most of the specimens show at the base of an ament-like fruit spike one or more slender linear leaves or bracts, which evidently spring from the same stem. These leaves are sometimes as long as the fruit spike or longer, and to me they seem like the male ament of a conifer rather than the fruit of a fern. The granules with which the axis of the fruit spike is invested are arranged spirally about it, and so far as has been observed there is nothing by which it can be decided whether they are sporangia or pollen cases. Doubtless more will be learned about these singular objects, but they are interesting as being the fruit of some of the plants which are common to the Amboy Clays and the Cretaceous beds of Atane, Greenland.

PHANEROGAMIA.

GYMNOSPERMÆ.

Order CYCADACEÆ.

PODOZAMITES ANGUSTIFOLIUS (Eichw.) Schimp.[1]

Pl. XIII, figs. 1–4.

Podozamites angustifolius Eichw.) Schimp. Schimper, Paléontologie Végétale, Vol. II, p. 160.

Zamites angustifolius Eichwald, Lethæa Rossica, Vol. II, p. 39, Pl. II, fig. 7.

Leaves long lanceolate, from 5^{cm} to 15^{cm} in length by 6^{mm} to 12^{mm} in width, base narrowed to the short petiole, summit pointed; nervation fine, parallel.

In general appearance these leaves are not unlike some of the many forms of *P. lanceolatus*, but are usually longer, narrower, and more flexuous in outline. Taken by themselves they might easily be mistaken for some of the leaves of Fontaine's *Nageiopsis longifolia* from the Potomac group, but the nerves are much finer and more crowded than in that plant.

Locality: Woodbridge.

PODOZAMITES MARGINATUS Heer?.

Pl. XIII, figs. 5, 6.

Podozamites marginatus Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 43, Pl. XVI, fig. 10.

Leaves 18^{cm} to 20^{cm} long by about 3^{cm} in width, lanceolate, obtusely pointed at the summit, narrowed to a thickened base.

This would seem to be the plant figured and described by Heer (loc. cit.) and obtained from the Upper Cretaceous rocks of Atane, Greenland, although the marginal border, on which he lays stress and from which he derives its name, is not visible. Unfortunately, the two specimens we have are very imperfect, and we must await the discovery of other material before we can satisfactorily make the comparison. We may at least say that the

[1] This species appears in Dr. Newberry's manuscript as *P. angustifolius*, n. sp., a specific designation which manifestly can not stand under the rules of priority. As it agrees in all essential particulars with *P. angustifolius* (Eichw.) Schimp., I have so designated it.—A. H.

species, if not identical, are exceedingly alike, and that the differences specified are not sufficient to separate them.

Locality: Woodbridge.

Podozamites acuminatus Hollick n. sp.

Pl. XIII, fig. 7.

The only specimen we have of this plant is too imperfect for a satisfactory description. It is a leaf of a species of Podozamites which had as characteristic features widely separated, open nervation and extremely long-drawn point. This will serve to distinguish it from any of the leaves of Podozamites with which it is associated and any other yet described.

Locality: Woodbridge.

Notes.—1. In Dr. Newberry's manuscript this species was named *Podozamites acutifolius.* As Professor Fontaine had already used this specific name for a species from the Potomac formation, it was necessary to change it, and it was thought that *acuminatus* would describe the leading character nearly as well.

2. In Dr. Newberry's paper on the Flora of the Amboy Clays, in the Bulletin of the Torrey Botanical Club for March, 1886 (Vol. XIII, p. 35), the author says that *Podozamites tenuinervis* Heer probably occurs in the flora, but I have failed to find any indication that he definitely identified any specimen with that species.—A. H.

Microzamia gibba (Reuss) Corda.

Pl. XII, figs. 6, 7.

Microzamia gibba (Reuss) Corda, in Reuss, Verstein. d. Böhm. Kreidef., Abth. II, p. 85, Pl. XLVI, figs. 1–10.

Conites gibbus Reuss, Geognostische Skizzen, p. 169.

We have found quite a large number of slender fruit spikes, twenty or more, sometimes as much as 15^{cm} in length by about 2^{cm} in diameter, composed of a central axis thickly set with capsules, of which the ends give a tessellated appearance to the surface when sufficiently well preserved to show it. These apparently represent the fruit spikes that were described with the above name by Corda, in Reuss (loc. cit.), and more fully noticed by Velenovský in Die Gymnospermen der Böhm. Kreideformation, p. 6, Pl. III, figs. 5–16; Pl. IV, fig. 6; Pl. V, fig. 8.

The number of these fruit spikes found in the Amboy Clays indicates that a cycad grew in the region where they were deposited in greater abundance than would be inferred from the comparatively small number of cycadaceous leaves we have found: but further explorations would probably bring to light more of the foliage.

These fossils form another connecting link between the flora of the Amboy Clays and that of the Upper Cretaceous rocks of Bohemia, so well illustrated by Velenovský.

Locality: Woodbridge.

Cycadinocarpus circularis Newb. n. sp.

Pl. XLVI, figs. 1–4.

Discoid seeds of a cycadaceous plant, from 6^{mm} to 12^{mm} in diameter, nearly circular in outline, though sometimes slightly heart-shaped, with a slight emargination at the point of attachment on one side; within the larger outline is a smaller circle which marks the seed itself, which is round, smooth, and flat, with a slight projection at the point of emargination and where a neck or stem penetrated the sarcocarp for attachment.

These fruits closely resemble some species of Cardiocarpus in the Coal Measures, such as *C. orbicularis*, *C. annulatus*, etc., which I have described in the Palæontology of Ohio, Vol. 1, p. 374, Pl. XLIII, figs. 8, 10.

We have collected perhaps fifty of these fruits, but as yet have not been able to connect them with any of the other plants found.

Locality: Woodbridge.

Order CONIFERÆ.

Dammara borealis Heer.

Pl. X, fig. 8.

Dammara borealis Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 54, Pl. XXXVII, fig. 5.

In his Flora Fossilis Arctica (loc. cit.) Professor Heer describes and figures the scales of a cone of a conifer which very much resemble those of *Dammara australis*, and yet there are some reasons for doubting the accuracy of his reference. It may also be said that the fruit scales which he calls *Eucalyptus Geinitzi* (ibid., p. 93, Pl. XLV, figs. 4–9; Pl. XLVI, fig. 12d) are without doubt generically the same. They have very little resemblance to any of the fruits of Eucalyptus, however, which are urn-like, with a conical cover. On the contrary, the fruits figured by Heer under the name of Eucalyptus are plainly scales, and are parts of an imbricated cone. I say this with confidence, because it has happened that in the Amboy Clays we have found numbers of them sometimes associated together, oftener scattered and showing both faces. A peculiarity of these scales is that they are striped longitudinally by clefts which are filled with an amber-like substance. This structure is plainly seen in those figured by Professor Heer on Pl. XLV. Similar scales are described in an article by Mr. David White on the fossil plants from Gay Head. (American Journal of Science, 3d series, Vol. XXXIX, p. 98, Pl. II, figs. 9, 10.)

The considerations which have led me to doubt whether these cone scales are those of Dammara are that we have found no Dammara-like leaves associated with them, whereas in one locality in New Jersey they occur in great numbers mingled with and sometimes apparently attached to the branchlets of an extremely delicate conifer much like Heer's *Juniperus macilenta* (Fl. Foss. Arct., Vol. VI, Abth. II, p. 47, Pl. XXXV, figs. 10, 11), but the leaves are more appressed. Almost no other plant except this conifer is found with the cone scales, and it is difficult to avoid the conclusion that they belong together. Another reason for doubting whether these are the scales of a species of Dammara is that in some of them traces of two seeds are apparently visible, while in Dammara there is but one seed under each scale.

On our plate (fig. 9) is a representation of *Dammara microlepis* Heer, taken from his work, Pl. XL, fig. 5, and also (fig. 10) one of *Eucalyptus Geinitzi* Heer, from the same volume, Pl. XLV, fig. 5, for purposes of comparison.

Pinus sp.?

Pl. IX, figs. 5–8. 17. 18.

Not infrequently fascicles of leaves, which seem to be those of a pine, have been found at South Amboy and elsewhere. They are in threes, 8^{cm} to 10^{cm} long, and very slender. No cones have been found with them which could certainly be attributed to the genus Pinus, but some which are considerably macerated and decayed, like figs. 7 and 8 on the same plate, may perhaps have been pine cones, or they may have belonged to some other conifer. Future collections will doubtless solve this problem. Fragmentary winged seeds, apparently referable to Pinus, are represented by figs. 17 and 18.

Cunninghamites elegans (Corda) Endl.

Pl. V, figs. 1–7.

Cunninghamites elegans (Corda) Endlicher, Synopsis Coniferarum, p. 270.

Cunninghamia elegans Corda, in Reuss, Verstein. Böhm. Kreidef., Abth. II, p. 93, Pl. XLIX, figs. 29–31.

Numerous and well-marked specimens of this widespread species were obtained by Rev S. Lockwood from the iron concretions in the upper Amboy Clays. Some of these are figured on Pl. V. Fig. 1 represents a branch with branchlets in which the leaves, diverging in all directions, have been largely broken away, but the scaled aspect of the immediate surface is well shown. The leaves are from 2^{cm} to 5^{cm} in length, with a single keel; the scales or leaf impressions about 6^{mm} in length, ovoid or rhomboidal, pointed, and keeled. Figs 2 and 3 represent terminal branchlets with long divergent leaves, while fig. 5 represents branches with short and closely appressed leaves, a diversity of foliage seen in many conifers.

The large specimen figured by Heer (Flora Fossilis Arctica, Vol. VII, Pl. LIII, fig. 1) is much like the long-leafed branches now represented. The shorter form of foliage he does not seem to have met with, or has not identified with this plant, but our specimens represented by figs. 1–6 are all from the same concretions and are so related that there can be no doubt that they belong to the same tree. Fig. 4 represents what may be a fruit-bearing twig, but it is too indistinct to be certainly identified as such.

Cunninghamites elegans seems to have been extensively diffused in the latter half of the Cretaceous age. It was first described from Moletein in Moravia and from Mseno in Bohemia. Subsequently Hosius and Von der Marck found it in the chalk of Westphalia. Heer obtained it from the Atane beds of Greenland, and now we have it from the Amboy Clays of New Jersey.

Locality: Near Keyport.

SEQUOIA HETEROPHYLLA Vel.

Pl. VI, figs. 1–13.

Sequoia heterophylla Velenovský, Gymnospermen d. Böhm. Kreidef., p. 22, Pl. XII, fig. 12; Pl. XIII, figs. 2–4, 6–9.

One of the most common conifers of the Amboy Clays seems to be identical with the one that has been described by Velenovský as *Sequoia heterophylla*, found in the Upper Cretaceous of Bohemia and described in Die Gymnospermen der Böhmischen Kreideformation (loc. cit.) A number of figures are given of it, and it may be noticed that they show distinctly the conspicuous feature of the plant, and that which has given it its name, viz, the two forms of foliage, often on the same twig; toward the base the leaves very short, appressed, almost scale-like; higher up, leaves much longer and dichotomously expanded.

NOTE.—Figs. 4, 4a, Pl. IX, represent cones of a Sequoia, according to Dr. Newberry's labels on the corresponding specimens, but he did not indicate the species to which he supposed them to belong.—A. H.

SEQUOIA REICHENBACHI (Gein.) Heer?.

Pl. IX, fig. 19.

Sequoia Reichenbachi (Gein.) Heer?, Fl. Foss. Arct., Vol. I, p. 83, Pl. XLIII. figs. 1d. 2b, 5a, d, dd, 8, 8b.

Araucarites Reichenbachi Geinitz, Charakteristik d. Schichten u. Petref. d. Sächsischen Kreidegebirges, p. 98, Pl. XXIV, fig. 4.

A few branches of a Sequoia with short and divergent leaves resembling those of *Sequoia Reichenbachi*, but more slender and delicate, are contained in our collections. I have thought it probable that they represent this world-wide species, but more material will be required before that question can be decided.

Locality: Woodbridge.

Sequoia gracillima (Lesq.) Newb.

Pl. IX, figs. 1, 2, 3,

Glyptostrobus gracillimus Lesq., Am. Jour. Sci., 2d series, Vol. XLVI, p. 92.

In the American Journal of Science (loc. cit.) and in his Cretaceous Flora, p. 52, Mr. Lesquereux has described a slender-branched conifer from the Dakota group near Sioux City, which he referred to the genus Glyptostrobus "on account of the form and mode of division of its branches, of the scale-like leaves without nerves, and of the form and position of the male catkins." At the latter date, however (Cretaceous Flora, p. 53), he was disposed to identify this plant with *Frenelites Reichii*, described by Ettingshausen in his Cretaceous Flora of Niederschoena. There is little doubt, however, that both references were erroneous, as the foliage is more like that of Sequoia than Glyptostrobus, and cones which I have from the same localities that furnished Lesquereux's specimens are distinctly those of Sequoia and very different from those of any species of Glyptostrobus known.

The specific name *gracillimus*, given by Lesquereux, was well deserved, since the branches are extremely slender and the only form of foliage seen is short and appressed. Beautiful cones of the same species occur in the Amboy Clays near Keyport, and a complete one of this kind may be seen on Pl. IX, fig. 1. They are cylindrical, 5^{cm} or more in length by 1^{cm} or more in breadth. Immature ones are depicted in figs. 2 and 3 of the same plate.

Apparently the same plant is described and figured by Heer in his Flora Fossilis Arctica, Vol. VII, p. 16, Pl. LI, fig. 13. The form of the cone is similar to that of the genus Geinitzia, but the foliage is widely different, and as the leaves and fruits are associated in my specimen, there can be no doubt that our plant is not a Geinitzia.

Professor Heer also figures, on Pl. LI, a slab containing branchlets and leaves of a conifer which closely resembles the one under consideration, and on the same specimen a cone is represented which has the cylindrical elongate form of ours; so I can not doubt that this plant, which he calls *Sequoia macrolepis*, is the same as that previously described by Lesquereux as *Glyptostrobus gracillimus*.

These specimens are interesting as showing another plant common to the Dakota of the West, the Amboy Clays of New Jersey, and the Patoot and Atane beds of Greenland.

That Mr. Lesquereux's Glyptostrobus is not identical with *Frenelites Reichii* will be seen by referring to Pl. VIII, which is occupied by this species under the name *Widdringtonites Reichii* (Ett.) Heer. It is rather abundant in the Amboy Clays, and occurs in Greenland and in the Cretaceous beds of Aachen and Niederschoena. The terminal branches are covered with minute appressed or divergent, acute, rigid leaves, but the larger and lower branches are generally denuded of foliage, and are articulated at frequent intervals in a way altogether foreign to Glyptostrobus.

Locality: Near Keyport.

GEINITZIA FORMOSA Heer?.

Pl. IX, fig. 9.

Geinitzia formosa Heer, Kreideflora von Quedlinburg, p. 6, Pl. I, fig. 9: Pl. II. figs. 1–6.

The single specimen here identified with the above species was found at Woodbridge. The specimen is named as above by Dr. Newberry, but no description accompanied it.—A. H.

BRACHYPHYLLUM CRASSUM Lesq.[1]

Pl. VII, figs. 1–7.

Brachyphyllum crassum Lesq., Fl. Dak. Group, p. 32, Pl. II, fig. 5.
Thuites crassus Lesq., Cret. and Tert. Fl., p. 32.

Trees of medium or large size, branches pinnately divided, covered with relatively large, rhomboidal, striated, scale-like leaves, spirally arranged. Fruit a cylindrical cone 15^{cm} to 20^{cm} in length by about 4^{cm} in diameter, covered with spatulate, overlapping scales.

In certain clay beds at South Amboy and elsewhere one of the most common plants is a scaled conifer, which, judging from the twigs and foliage, no one would hesitate to include in the genus Brachyphyllum. The

[1] Dr. Newberry's manuscript name for this species is *B. macrocarpum*, n. sp. It is evidently identical with *B. crassum* Lesq., as figured in Flor. Dak. Group. Pl. II, fig. 5.—A. H.

scale-like leaves which cover the branches are arranged in double spirals, are square or rhomboidal, 3^{cm} to 5^{cm} in diameter, with the upper point most prominent, and from this strong, sharp ridges radiate over the surface. Frequently there is a short keel beginning at the upper angle and running a little way down the surface. Good examples of this foliage may be seen in the Marquis Saporta's figures of *B. Papareli* Sap. and *B. Moreauanum* Brongn. (Paléontologie Française, Flore Jurassique, Vol. III, Pls. XXXIII and XXXVIII), but with this typical foliage of Brachyphyllum occur cones which are so different from those which have been ascribed to Brachyphyllum as to make us doubtful of the reference of our plant to that genus, or of the apparent connection between the cones and the branches. Unfortunately, none of the specimens establish beyond all doubt the connection between the cones and the branches, but some of the cones are borne on pedicels which are marked with scales essentially like those of the branches under consideration. When the specimens were first exhumed the scaling of the cone stems was well defined, and was such that I did not hesitate to connect the twigs bearing the rhomboidal scales with the cones, but containing so much woody matter that the lignite of which the cones and twigs are composed has cracked and broken away to such a degree that it can not now be asserted from the specimens. New material must be sought and treated with a better preservative than that which we have to demonstrate to all eyes that this, the most common conifer at South Amboy, bore this most common cone. The cone represented on Pl. VII, fig. 3, was quite entire when found, but has since suffered much by the cracking up of the lignite composing it. It was once covered with a series of scoop-shaped or spatulate scales, of which some specimens, fairly well preserved, are seen near the summit, and the outlines of others on the sides. In a general way the cone resembles that of some species of pine, but its mode of growth was different, as will be seen by an examination of the immature cones represented in figs. 4 and 6. It is certainly not the cone of a pine tree, and my conviction amounts almost to a certainty that it was borne on branches like those represented in figs. 1 and 5.

Some comparisons of these cones with others that have been described from rocks of about the age of the Amboy Clays will be interesting and instructive. Ettingshausen has described in his Kreideflora von Niederschoena two cones which may not be different from ours. Of these those represented on Pl. I, figs. 4–6, may be compared with our fig. 6 on Pl. VII, and are perhaps immature, while fig. 9 of the same plate, which was called *Cunninghamites oxycedrus* by Sternberg, is very much like our larger cones, and yet it is not known that a Brachyphyllum similar to that found in the Amboy Clays occurs in the Niederschoena beds. Another cone not unlike this is figured and described by Lesquereux in his Cretaceous Flora, p. 114, Pl. XXIV, fig. 1, with the name *Ptenostrobus nebrascensis.* Mr. Lesquereux does not attempt to connect this cone with any other plant, but points out its resemblance to *Cunninghamites oxycedrus.* Finally, I would call attention to the striking resemblance between the scale-leafed conifer now figured and that which Velenovský calls *Echinostrobus squamosus* (Gymnospermen der Böhmischen Kreideformation, p. 16, Pl. VI, figs. 3, 6, 7, 8).

Locality: South Amboy.

Thuya cretacea (Heer) Newb.

Pl. X, figs. 1, 1a.

Libocedrus cretacea Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 49, Pl. XXIX, figs. 1, 2; Pl. XLIII, fig. 1d.

Professor Heer (loc. cit.) has carefully figured and described what is apparently the plant of which we have found numerous twigs in the Amboy Clays and of which I have given a figure as indicated above, yet he considers the plant a species of Libocedrus, while to my mind it is much nearer to Thuya. In our living Libocedrus, as well as our fossil ones, the joints of the twigs, or rather the appressed leaves which cover the woody axis, are much longer and wider above, having a club-shaped outline; whereas in Thuya the four rows of appressed leaves, forming a joint or whorl, are of nearly equal height and breadth, so that the twigs are strap-shaped, the sides nearly parallel, just as in the fossil before us. I can detect no differences, however, between the specimens from New Jersey and Greenland.

Locality: South Amboy.

THUYITES MERIANI Heer.

Pl. X, fig. 5.

Thuyites Meriani Heer, Fl. Foss. Arct., Vol. III, Part II, p. 73, Pl. XVI, figs. 17, 18.

This species is represented by a single specimen, identified as above by Dr. Newberry, but not accompanied by any description or indication of locality.—A. H.

JUNIPERUS MACILENTA Heer.

Pl. X, fig. 7.

Juniperus macilenta Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 47, Pl. XXXV, figs. 10, 10b, 11.

At Keaseby's clay pit, on the Raritan River, near Perth Amboy, a conifer occurs in great abundance which closely resembles that described by Heer (loc. cit.) and called by him *Juniperus macilenta.* The branchlets are apparently more regularly and gracefully expanded, with a pinnate arrangement that indicates that they spread on the same plane, like those of Thuya, and the leaves are somewhat shorter and more appressed than those represented in Heer's figures. Still, the resemblance is striking, and it has seemed to me probable that the species is the same. This is further indicated by the fact that thickly scattered among the twigs there are cone scales and cones, though the latter are very badly preserved. The cone scales are evidently identical with those described by Heer under the name of *Dammara microlepis* (Fl. Foss. Arct., Vol. VI, Abth. II, p. 55, Pl. XL, fig. 5), and probably with those described by him as *Dammara borealis* (op. cit., p. 54, Pl. XXXVII, fig. 5). These scales terminate below in a comparatively long and narrow neck for attachment, expanding above to form an elliptical disk, the summit of which consists of a crescentic, smooth band, terminating above in a point. This was evidently the exposed portion of the scale. Below the summit the scales are thickened, striated, and longitudinally cracked, the cracks being filled with amber. In a few instances the scales are grouped together, and in one or two cases they compose cones, now much decayed, and yet showing that the form was ovoid and that the number of scales must have been twenty or more.

The great number of these scales mingled with the branches of the conifer in question indicates very strongly that we have here the fruit of the tree. If so, it is evident that this was not a Dammara, and equally evident that it was not a Juniperus. The form of the cones and the cone scales is sufficiently like that of Dammara, but the foliage is as far as possible removed from it. The Dammara-like scales have been found in a number of the clay pits of New Jersey, and branches have been collected at Cutler's bank, in Woodbridge; so that it is apparent that the tree was of frequent occurrence in the forests that surrounded the estuaries in which the Amboy Clays accumulated, and we may therefore hope that in the future material will be obtained that will enable us to reconstruct this tree and determine with accuracy its botanical relations.

Localities: Keaseby's clay pit, Woodbridge.

NOTE.—*Dammara borealis* Heer, from South Amboy, and *D. microlepis* Heer, as figured by Heer, are shown on Pl. X, figs. 8, 9, of this monograph, but no specimens of the scales mentioned by Dr. Newberry as occurring with the branches of *J. macilenta* were found in any of the collections.—A. H.

MORICONIA CYCLOTOXON Deb. & Ett.

Pl. X, figs. 11–21.

Moriconia cyclotoxon Debey & Ettingshausen. Urweltl. Acrobryen d. Kreidegeb. v. Aachen (Denkschr. Wien. Akad., Vol. XVII, p. 239), pp. 59, 64, Pl. VII, figs. 23–27.

This, the most beautiful of conifers, was first described by Debey and Ettingshausen in Die Urweltlichen Acrobryen von Aachen (loc. cit.), among "*Plantæ incertæ sedis filicibus affines,*" but as their specimens were very imperfectly preserved and the general outline of the leaf-bearing twigs is much like that of some ferns, it is not surprising that they were mistaken as to its affinities. Subsequently Professor Heer met with it among the fossil plants brought from Greenland and described it (Flora Fossilis Arctica, Vol. III, Part II, p. 97, Pl. XXVI, fig. 18) as *Pecopteris kudlisetensis.* Afterwards better specimens were brought to him from Greenland which revealed the true character of the plant, and these he describes and figures (op. cit., Vol. VI, Abth. II, p. 49, Pl. XXXIII, figs. 1–9) with the proper name. To make his identification sure he corresponded with Dr. Debey and received from him drawings which distinctly showed the twigs to be covered with closely pressed semicircular leaves. These convinced Heer of their coniferous character, but Dr. Debey refused to accept this conclusion. The numerous specimens figured by Professor Heer would seem, however, to leave no doubt upon this subject, and the many and beautiful specimens we have obtained from the Amboy Clays, some of which are now figured, fully confirm Heer's views.[1]

No fruit has yet been found with the remains of Moriconia, but this want will doubtless be supplied from the New Jersey clays and will permit its relationship with other conifers to be determined. Judging from the foliage alone, Professor Heer is inclined to place Moriconia among the Cupressineæ and near to Libocedrus.

When in Aachen in 1888 I had an opportunity of examining some of the specimens of Moriconia collected by Dr. Debey, and a few of them showed the outlines of the appressed leaves, but most of the specimens were very imperfectly preserved, the outlines of the twigs, colored brown, being all that remained of the plant. I was anxious to identify this conifer with that found in the Amboy Clays, for the ample illustration given of the species by Heer left no doubt that it is common to the Amboy Clays and the Atane group of Greenland, and this was the first of the somewhat long list of species common to Aachen, Greenland, and New Jersey which enabled me to fix with great certainty the geological horizon of the Amboy Clays.

Locality: South Amboy.

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[1] It is somewhat remarkable that Professor Heer, after figuring carefully and accurately a number of specimens of Moriconia which fully show the peculiar foliage on the plate cited above, should have figured on Pl. LIV (op. cit., Vol. VII) a much larger branch of a conifer and called it Moriconia, when it is apparent that it is a Brachyphyllum. Instead of being semicircular the leaves are rhomboidal, and it is also probable that the species is the same with *Brachyphyllum crassum*, p. 51, Pl. VII. of this monograph.—A. H.

WIDDRINGTONITES SUBTILIS Heer.

Pl. X, figs. 2–4.

Widdringtonites subtilis Heer, Fl. Foss. Arct., Vol. III, Part II, p. 101, Pl. XXVIII, figs. 1, 1b; Vol. VI, Abth. II, p. 51, Pl. VII, figs. 13, 14.

We have collected a large number of specimens of a peculiar and graceful conifer which is fairly represented in the figures given. Figs. 2 and 3 are from South Amboy; fig. 4, from Cutler's clay pit at Woodbridge. The branches of this conifer are numerous and slender and are completely invested by appressed, scale-like leaves. They closely resemble the plant described and figured by Heer (Fl. Foss. Arct., Vol. VI, Abth. II, p. 51, Pl. VII, fig. 13; Pl. XXVIII, fig. 4). On one of the specimens from South Amboy is a small cone, a centimeter or more in diameter, of which the structure is not plainly visible. This is apparently connected with the branches with which it is in contact, but that is not absolutely proven. More material will be needed before anything definite can be said in regard to the botanical relations of this plant, but as it is locally so abundant, there is little doubt that its fruit will ultimately be obtained in such a state of preservation as to permit of its analysis.

The number of specimens obtained by Professor Heer is small, but they give very good views of the foliage, which is precisely that of the plant before us.

Localities: Woodbridge, South Amboy.

WIDDRINGTONITES REICHII (Ett.) Heer.

Pl. VIII, figs. 1–5.

Widdringtonites Reichii (Ett.) Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 51, Pl. XXVIII, fig. 5; Vol. VII, p. 13, Pl. LII, figs. 4, 5.

Frenelites Reichii Ett., Kreideflora von Niederschoena, p. 246, Pl. I, figs. 10a–10c.

This is one of the most common conifers in the Amboy Clays, where slabs a foot square are obtainable, covered with the delicate tracery of its slender branches. Figs. 2 and 3 are portions of such slabs. They were drawn with some care when first obtained, but the wood being replaced by lignite that contained much water, thus shrinking and cracking, it has been found almost impossible to preserve them. Professor Heer considers this plant equivalent to that described by Lesquereux (Cretaceous Flora, p. 52, Pl. I, figs. 8, 11–11f) under the name of *Glyptostrobus gracillimus*, but the correctness of this reference I am inclined to doubt, as we find none of the characteristic cones of *Glyptostrobus gracillimus* with the branches and twigs of Widdringtonites. But we do find, as described elsewhere, cylindrical cones, 5^{cm} or more in length, associated with the twigs of a somewhat different plant, which, if twigs and cones go together, is a Sequoia. The cones and fruit of that plant are figured on Pl. IX, figs. 1–3, and we regard them as more closely allied to Heer's *Sequoia fastigiata*, as illustrated in his Flora Fossilis Arctica, Vol. VII, Pl. LI, fig. 12. In this figure a cone is represented which is referred by Heer to his *Geinitzia hyperborea;* but just such a cone we find associated with the branches of *Glyptostrobus gracillimus* (which is certainly not a Glyptostrobus) in both the Dakota sandstones and the Amboy Clays, and no certain evidence of the presence of Geinitzia has been found in either.

Hereafter, when more specimens of *Widdringtonites Reichii* shall be collected and better means of preserving them be discovered, we may hope from the abundance of the plant to obtain all desired information as to its structure and relations.

In fig. 3 on Pl. VIII it will be seen that two minute cones are borne on the end of one of the twigs. These are probably very young fertile cones, but they may be immature pollen-bearing organs.

Localities: South Amboy, Woodbridge, Sayreville.

Frenelopsis Hoheneggeri (Ett.) Schenk?.

Pl. XII, figs. 4, 5.

Frenelopsis Hoheneggeri (Ett.) Schenk, Die Fossilen Pflanzen der Wernsdorfer Schichten in den Nordkarpathen, Palaeontographica, Vol. XIX, Heft 1, p. 13, Pl. IV, figs. 5–7; Pl. V, figs. 1, 2; Pl. VI, figs. 1–6; Pl. VII, fig. 1.

Thuites Hoheneggeri Ettingshausen, Beitrag zur Flora der Wealdenperiode. Abhandl. d. k. k. geol. Reichsanstalt, Vol. I, Abth. III, No. 2, p. 26, Pl. I, figs. 6, 7.

Among the fragmentary remains figured, but not described, are two specimens from Woodbridge, labeled as above by Dr. Newberry.—A. H.

FRENELOPSIS GRACILIS Newb. n. sp.

Pl. XII, figs. 1–3a.

Branches numerous, long, slender, simple or remotely forked, set at distant intervals with small scale-like leaves spirally arranged.

I have referred this interesting plant to Frenelopsis with some hesitation, but it seems nearer to the living genus Frenela and its fossil ally Frenelopsis than to any other conifer with which it has been compared. The tree, when living, with its numerous slender, cylindrical branches, of which the leaves were invisible, must have had the general aspect of the broom, the tamarisk, *Canotia holocantha*, and most of all of the Ephedras.

Locality: Woodbridge.

Coniferæ of Uncertain Affinities.

THINNFELDIA LESQUEREUXIANA Heer.

Pl. XI, figs. 1–17.

Thinnfeldia Lesquereuxiana Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 37, Pl. XLIV, figs. 9, 10; Pl. XLVI, figs. 1–11, 12a, b.

In the Cretaceous Flora (p. 54, Pl. I, fig. 12) Mr. Lesquereux describes an "oval, oblong leaf, tapering from below the middle to a short, thick petiole, abruptly rounded, and undulate above." This he called *Phyllocladus subintegrifolius*. It was obtained from the Dakota sandstone near Decatur, Nebr., and in the Upper Cretaceous rocks of Greenland leaves were found in considerable numbers which are apparently identical with this. They have been so considered by Professor Heer, who has figured and described them (Fl. Foss. Arct., Vol. VI, Abth. II, p. 37, Pl. XLVI, figs. 1–11), and has given them the name of *Thinnfeldia Lesquereuxiana*, deciding that they can not be conifers, as supposed by Lesquereux. Now we have to report the discovery in the Amboy Clays of some hundreds of leaves which are apparently identical with those from Greenland, and presumably so with those from Nebraska.[1] A number of these are figured on Pl. XI,

[1] In the Flora of the Dakota Group, Pl. II, figs. 1, 2, 3, leaves are figured under the name *Phyllocladus subintegrifolius* Lesq. which are considered by Dr. Knowlton to be identical with *Thinnfeldia Lesquereuxiana* Heer. As the true relationships of the plant are yet problematic, it has seemed to be the wiser course to allow the name adopted by Dr. Newberry to stand for the specimens found in the Amboy Clays, which may eventually be determined to be distinct from those of the Dakota group.—A. H.

and out of this large number I have endeavored to select such as most fairly represent the prevailing characters. It will be seen that they differ very considerably in form, some being linear, some lanceolate, and others spatulate or long ovate. Sometimes, though rarely, the margins are entire; more generally they are undulate, and sometimes acutely toothed. So in their nervation they are variable, sometimes a midrib traversing the entire length of the leaf, while in other cases it vanishes about the middle. A few branches have been found with the leaves still attached. These show that the twigs were terminated by three leaves or leaflets springing from a common base, while below this there may be one or several pairs placed opposite.

The principal interest connected with this plant is its occurrence in Greenland and New Jersey, and it has a value, therefore, quite independent of its botanical relations. Whether it should be referred to the genus Thinnfeldia is doubtful, and even if it should belong there its botanical relations would not yet be ascertained. The genus was described by Ettingshausen, who considered it as nearly related to Phyllocladus, while Schenk considers it a cycad, and Schimper and Saporta regard it as a fern. No fruit or flowers have been found in connection with the Amboy leaves, but the aspect which they present is not quite that of any known ferns. The nervation is fine, regular, parallel, the side branches diverging from the midrib and generally running straight to the margins, but sometimes, as in fig. 16, passing to the upper end.

Baiera incurvata Heer?.

Pl. X, fig. 6.

Baiera incurvata Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 45, Pl. XIII, fig. 6.

In his Flora Fossilis Arctica (loc. cit.) Professor Heer describes and illustrates a species of Baiera with which we might readily identify the plant now figured, except that the curvature of the summit of the frond is not distinctly marked in that. This, however, seems to me more likely to be an accidental character, the result of violence, as among all the species of Baiera no other exhibits a tendency to such a flexure of the frond. As we have but a single specimen of our plant, and the one described by Heer seems to have been unique, satisfactory comparison can not yet be made. The resemblances are such, however, between the Greenland plant and our own that it has seemed better to consider them identical until such time as differences shall be discovered.

Locality: Woodbridge.

CZEKANOWSKIA CAPILLARIS Newb. n. sp.

Pl. IX, figs. 14, 15, 16.

With some hesitation I have referred to this genus a considerable number of specimens that have been taken from the Amboy Clays. They consist of bundles or masses of linear or capillary leaves, 8^{cm} to 10^{cm} in length, which are for the most part single, but sometimes dichotomously forked. They exhibit no structure, but apparently spring from a common root or origin, and have the aspect of the bundles of leaves which have been described by Heer under the name of *Czekanowskia dichotoma* (Fl. Foss. Arct., Vol. VI, Abth. II, p. 14, Pl. II, fig. 12b; Pl. III, fig. 1). As forming a distinct element in the Amboy Clay flora, it seems to me proper that they should be mentioned, that hereafter they may receive such attention as may determine their botanical relations. The leaves are thin and if matted and confused together might be taken for a Confervites, but they are straight or gently curved, single, and parallel, and have nothing of the filamentous, irregular character of the fibers of Conferva.

Locality: Woodbridge.

Coniferæ. Miscellaneous Notes.

1. In Dr. Newberry's Later Extinct Floras (Ann. Lyc. Nat. Hist., Vol. IX, 1868, p. 9), the name *Cupressites Cookii* occurs, credited to New Jersey. I do not find, however, that he elsewhere mentions this species, nor have I been able to discover any specimen so labeled in the collection.

2. On Pl. IX, fig. 10, of this monograph, may be seen a branch of a conifer with a cone attached. I could find no manuscript relating to it, the specimen had no label attached, and no satisfactory comparison could be made with any described species. Its affinities appear to be with the

Abietineæ, but beyond this I have not felt justified in proceeding, and have decided to admit it without further comment.—A. H.

ANGIOSPERMÆ.

DICOTYLEDONEÆ.

Order JUGLANDACEÆ.

JUGLANS ARCTICA Heer?.

Pl. XX, fig. 2.

Juglans arctica Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 71, Pl. XL, fig. 2; Pl. XLI, fig. 4c; Pl. XLII, figs. 1, 2a, b, 3; Pl. XLIII, fig. 3.

Among the fossil leaves collected, a single one, almost complete and beautifully preserved, seems to be different from anything else in the collection. I have given a figure of it and refer it provisionally to the above-named species. This will be found represented in a number of figures in Heer's Flora Fossilis Arctica (loc. cit.). These figures differ considerably among themselves, the first one especially representing the base of a much broader and more rigid leaf than the others; but Professor Heer doubtless had other material which guided him in his union of these specimens as one species. The figures given on Pl. XLII are very much more like our plant, and fig. 1, although imperfect at the summit, is nearly its counterpart. With this are the aments and a nut which seem to justify fully the reference of the leaves to Juglans.

Locality: Woodbridge.

Order MYRICACEÆ.

MYRICA EMARGINATA Heer?.

Pl. XLI, figs. 10, 11.

Myrica emarginata Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 66, Pl. XLI, fig. 2; Pl. XLVI, fig. 12e.

Although our specimens have not the exact obovate outline of Heer's species, as represented in Flora Fossilis Arctica, Vol. VI, Abth. II, Pl. XLI, fig. 2, the comparison seems to be sufficiently close to warrant a provisional reference to it. No indication of name or locality accompanied these figures or their corresponding specimens.—A. H.

Myrica parvula Heer.

Pl. XIX, fig. 6.

Myrica (Comptonia) parvula Heer, Fl. Foss. Arct., Vol. VII, p. 20, Pl. LV, figs. 1–3.

One complete leaf is the only specimen of the species contained in our collections. It resembles very closely, though exceeding somewhat in size, the leaves which are figured and described by Heer in his Flora Fossilis Arctica, Vol. VII, p. 20, Pl. LV, figs. 1–3, and it evidently belongs to a closely allied species of the same genus, if not to this one. Professor Heer describes on p. 77 of the same volume, and figures on Pl. LXXI, fig. 12, a fragment of a leaf to which he gives the name of *Myrica (Comptonia) parvifolia.* This is so similar to the last described that it is difficult to see why they should be separated. So fig. 9 on the same plate, named *Myrica borealis*, may very well have been a leaf from the same tree.

Locality: Sayreville.

Myrica Newberryana Hollick, n. sp.[1]

Pl. XLII, fig. 5.

Leaf about 3^{cm} in length by 1^{cm} or more wide, summit blunt-pointed, base unknown, margins undulate; nervation rather clear, but fine, midrib strong, side branches given off at a large angle, curving upward and inosculating near the margin.

Only two or three fragments of this species have been obtained, but, though allied in appearance to *M. fenestrata*, it differs from that in the fineness, curvature, and divisions of the lateral nerves.

Locality: South Amboy.

Myrica fenestrata Newb. n. sp.

Pl. XLII, fig. 32.

Leaf lanceolate, blunt-pointed, 4^{cm} long by 1^{cm} wide, margins undulate; nervation strong, lateral nerves given off from the midrib nearly at a

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[1] Dr. Newberry's manuscript name for this species was *Myrica undulata*, but as Schimper has transferred the *Dryandroides undulata* of Heer to the genus Myrica, the names become identical. No species of this genus having been hitherto named for Dr. Newberry, this one may be so designated.—A. H.

right angle and passing directly to or near the margin, thus dividing all the area of the leaf into quadrangular spaces.

Only one specimen of this peculiar little leaf has been found. It presents the general aspect of Myrica, but is distinct from any other species with which it has been compared. The specimen figured is defective, and may be but an imperfect representation of the species. It is, however, different from any other in the collection, and therefore it deserves to be mentioned.

Locality: Sayreville.

Myrica cinnamomifolia Newb. n. sp.

Pl. XXII, figs. 9–14.

Leaves long-petioled, oblong-lanceolate in outline, sometimes panduriform, abruptly narrowed to a point at base and summit, margins deeply lobed, lobes one, two, or three on a side, rounded, obtuse; nervation fine and regular, midrib straight, well-defined from base to summit; from this, at or near the base of the leaf, spring two strong lateral nerves which reach to or beyond the middle of the leaf or terminate in the lower main lobes; from the middle upward, secondary nerves are given off, which terminate in the lobes of the lateral margins and connect with each other by many inosculating branches.

Of these peculiar leaves quite a number are contained in the collection, but none is absolutely complete. Where nothing but the basal portion of the leaf is preserved, almost anyone would refer it to Cinnamomum, but all the cinnamons known have entire leaves, and yet there is an air about the plant that makes it difficult to believe that there is not some relationship between them. Some of the Myricas are not unlike these, and I would especially call attention to the resemblance between *Myrica parvula* Heer (Fl. Foss. Arct., Vol. VII, p. 20, Pl. LV, figs. 1–3) and the leaf referred to this species and represented in this monograph on Pl. XIX, fig. 6; yet the two basilar side nerves so characteristic of Cinnamomum are not, to my knowledge, found in any species of Myrica, and hence the reference to that genus is made with great mental reservation and is strictly provisional. In fig. 9 of Pl. XXII simply the base of the leaf is figured, and here the resemblance to Cinnamomum will strike any observer; fig. 12 represents the panduriform variety of the leaf, while fig. 11 shows a summit—the most complete of any found.

Localities: Woodbridge, South Amboy.

Myrica acuta Hollick n. sp.

Pl. XLII, fig. 35.

Leaf about 3^{cm} long by 1^{cm} wide, lanceolate, acute, sharply and irregularly denticulate in the upper part of the margin, lower part entire; secondaries leaving the midrib at a wide angle, bending upward sharply near the margin, anastomosing and connecting by cross veining.

This species is represented only by the upper two-thirds of a single leaf, so that the characters of the lower part have not been determined

No indication of locality or probable botanical affinities accompanied the figure or specimen.—A. H.

Myrica raritanensis Hollick n. sp.

Pl. XLII, fig. 34.

Leaf about 32^{mm} long by 12^{mm} or 13^{mm} wide, broadest in middle and tapering acutely to both ends, margins dentate in upper half of leaf, entire below; nervation obscure, sparse, and thin.

Dr. Newberry left no indication as to his ideas concerning its probable relationship or any information as to the exact locality where it was found.—A. H.

Order SALICACEÆ.

Populus? apiculata Newb. n. sp.

Pl. XV, figs. 3, 4.

Leaves round-ovoid or ovate; 8^{cm} to 12^{cm} in length by 6^{cm} or 7^{cm} in breadth, pointed or acuminate at summit, rounded or slightly wedge-shaped at base, petioled, margins entire; nervation delicate, midrib slender, slightly flexuous, lateral branches about six on a side, gently curved upward and uniting in a festoon near the margin.

These leaves have been placed in Populus with much hesitation. They are not three-nerved, as are most leaves of that genus, and the nervation is more flowing and simple, less contorted and tangled, than in any species of the genus Populus known to me. They closely resemble, however, those leaves found in the Upper Cretaceous of Greenland which have been called by Professor Heer *P. hyperborea* and *P. Berggreni* (Fl. Foss. Arct., Vol. VI, Abth. II, pp. 63, 64), and since no generic relationship that is more plausible suggests itself, perhaps it is well enough to leave them there for the time being.

Locality: Woodbridge.

SALIX PROTEÆFOLIA Lesq.

Pl. XVIII, figs. 3, 4.

Salix proteæfolia Lesq., Am. Jour. Sci., 2d series, Vol. XLVI, p. 94; Cret. Fl., p. 60, Pl. V, figs. 1–4.

In the figures cited above are represented two slabs of clay upon the surface of which are spread out twigs and leaves of a willow which I have been unable to distinguish from *Salix proteæfolia* Lesq. (Cret. Fl., p. 60, Pl. V, figs. 1–4), and yet, as the nervation is too imperfectly represented in both the impressions in the Dakota group and those from the Amboy Clays, it is impossible to insist upon the identification. It is manifest, however, that this species differs from *Salix membranacea* from the same beds in having the base wedge-shaped instead of rounded. Further comparisons will be necessary before the relations of these leaves to the genus Salix and to the species with which they have been compared can be satisfactorily determined.

Locality: Woodbridge.

SALIX MEMBRANACEA Newb.

Pl. XXIX, fig. 12.

Salix membranacea Newb., Later Extinct Floras, p. 19; Illustrations of Cretaceous and Tertiary Plants, Pl. II, figs. 8, 8a.[1]

Leaves petioled, smooth and thin, lanceolate, long-pointed, rounded or abruptly narrowed at the base, near which they are produced, margins

[1] The reference is to the plates of an unpublished work. Twenty-six of these plates were, indeed, published in 1878, under the title Illustrations of Cretaceous and Tertiary Plants, the figures having been independently identified by Professor Lesquereux. Dr. Newberry, however, did not accept all these identifications. For example, on the above-quoted Pl. II, figs. 5-8 were referred to this species, while Dr. Newberry refers figs. 5–7 to *S. cuneata* (see bibliography, p. 18).—A. H.

entire; medial nerve slender, often curved; secondary nerves remote, very regularly and uniformly arched from their bases, terminating in or produced along the margins until they anastomose; tertiary nerves given off at right angles, forming a uniform network of which the areoles are polygonal, often quadrate.

This is a well-marked leaf of what I had supposed to be a species of Salix. Without more material this can not be proven, but the form and nervation harmonize well with that of many species of the genus. Like the leaves of many of the willows, these are frequently unsymmetrical, one side being most developed and the midrib curved. The leaf is broadest next the base, and is thence narrowed to a long and acute point.

Localities: Sayreville, Woodbridge.

SALIX INÆQUALIS Newb. n. sp.

Pl. XVI, figs. 1, 4, 6; Pl. XVII, figs. 2–7.

Leaves lanceolate, long-pointed, generally broadest near base, sometimes in the middle, 8^{cm} to 12^{cm} in length by 4^{cm} to 5^{cm} wide, long-petioled to sessile, margins entire; midrib slender, generally flexuous, always or mostly eccentric, dividing the blade longitudinally into two unequal parts; secondary nerves slender, often invisible, curved upward and apparently connecting near the margins.

A large number of specimens of the leaves of this plant are contained in the collection. On Pl. XVII are given six figures illustrating the predominant forms. The eccentric position of the midrib is perhaps their most striking character, and this has thrown a little doubt upon the propriety of their reference to Salix and has suggested Sapindus, but the flexuous form of the leaves is much more like the willows than like Sapindus, in which the leaves are pinnately arranged, with a certain rigidity of structure. Hence, until further light is thrown upon the plant, I have thought it better to leave it in the genus Salix.

Locality: Woodbridge.

SALIX NEWBERRYANA Hollick n. sp.[1]

Pl. XIV, figs. 2–7.

Leaves 10^{cm} to 15^{cm} in length by 1^{cm} to 3^{cm} in width, lanceolate in outline, elongated at summit, wedge-shaped at base, petioled; finely and sharply serrate; nervation fine, invisible on the upper surface, sharply defined in the impression of the lower; medial nerve straight and strong; lateral nerves given off at an angle of about 45°, numerous, inosculating at their summits; intervals between them filled with a polygonal and relatively coarse network.

These leaves are referred to Salix with doubt, although they possess the outline, nervation, and margins of some of the willows of the present day. The general appearance is somewhat like that of *Celastrophyllum angustifolium*, described in this monograph, but in that species the margin is crenulate, while here it is finely and sharply denticulate. Professor Heer enumerates a number of species of Salix from Greenland, but they are from the Tertiary and none from the Cretaceous beds.

Localities: Woodbridge, Sayreville, South Amboy.

SALIX sp.?

Pl. XLII, figs. 6–8.

Leaf ovate-lanceolate in outline, 3^{cm} long by 1^{cm} or more broad, entire, tapering to a point above, rounded below, short petioled; nervation obscure.

These leaves have the general appearance of *Salix Ræana* Heer, as figured in Flora Fossilis Arctica, Vol. VII, Pl. LXIX, fig. 2, but the nervation in our specimens is too indistinct for definite comparison. They also closely resemble *Salix Hayei* Lesq., although considerably smaller, as figured at Pl. III, fig. 7, in the Flora of the Dakota Group. The affinity of this latter species with *S. Ræana* is noted by Professor Lesquereux, and I have thought it probable that all three species may have to be ultimately

[1] Dr. Newberry, in his manuscript, called this species *Salix denticulata*, a name which is preoccupied by a Miocene species of Switzerland described by Heer. It was therefore decided to name the Amboy species after Dr. Newberry.—A. H.

united under one specific name. Hence it has seemed the wisest course to leave this specific name for future determination, when more and better material may assist us in arriving at a definite conclusion.

The exact locality I have not been able to ascertain.—A. H.

Order FAGACEÆ.

QUERCUS JOHNSTRUPI Heer?.

Pl. XIX, fig. 7.

Quercus Johnstrupi Heer, Fl. Foss. Arct., Vol. VII, p. 24, Pl. LVI, figs. 7–10, 11, 11b, 12a.

This is a somewhat obscure impression of the summit or upper half of a notched leaf which, when complete, must have been very like some of the specimens of the species to which it is provisionally referred, and which is figured and described in Heer's Flora Fossilis Arctica (loc. cit.). Without more material it will be impossible to assert the identity of the New Jersey and Greenland plants, but they present no differences which would justify us in separating them.

Locality: Sayreville.

Order ULMACEÆ.

PLANERA KNOWLTONIANA Hollick n. sp.[1]

Pl. XLII, figs. 1–4.

Leaves 2.5^{cm} to 5^{cm} in length by 1^{cm} to 2^{cm} in breadth, ovate, pointed; margins coarsely serrate; nervation distinct, midrib flexuous, lateral nerves numerous, simple, parallel, given off at an acute angle and terminating in the serrations of the edges.

Of this little leaf quite a number of specimens are contained in the collection, but none in a very good state of preservation. They are quite elm-like in character, and closely resemble some of the species of Planera that have been described from the Upper Cretaceous and Tertiary rocks.

Locality: Woodbridge.

[1] Named for Dr. F. H. Knowlton on information from Prof. Lester F. Ward that the name *P. antiqua*, which Dr. Newberry had given to this leaf, was preoccupied.—A. H.

Order MORACEÆ.

Ficus Woolsoni Newb. n. sp.

Pl. XX, fig. 3; Pl. XXIII, figs. 1–6.

Leaves ovate or heart-shaped, 8^{cm} or 10^{cm} broad, 10^{cm} to 12^{cm} in length; summit pointed, base emarginate, rounded or slightly wedge-shaped; margins entire; essentially three-nerved, the middle nerve being the strongest, the basal lateral nerves reaching above the middle and giving off a series of branches which inosculate near the margins.

The form and nervation of these leaves are very like those of *Ficus latifolia* of the Laramie group, and they apparently represent a group of species of the genus Ficus which had great development in Cretaceous times, being represented in the Laramie by *F. speciosissima* Ward, *F. planicostata* Lesq., and *F. latifolia* Newb., and by *F. tiliæfolia* Heer and *F. sordida* Lesq. in the Tertiary. The species is dedicated to Mr. I. H. Woolson, of the Columbia College School of Mines, who collected this, with many of the other fossil plants described in this volume.

Localities: Woodbridge, Sayreville.

Ficus ovata Newb. n. sp.

Pl. XXIV, figs. 1–3.

Leaves ovate, 8^{cm} to 12^{cm} in length by 4^{cm} to 5^{cm} in width, petioled, rounded or slightly wedge-shaped at base, long-pointed above, margins entire; nervation that of *F. Woolsoni*, *F. speciosissima*, etc., that is, the leaves are three-nerved, the midrib being the strongest, the lateral nerves reaching above the middle of the leaf and giving off parallel secondary branches, which inosculate in a festoon near the margin, the space between the midrib and lateral nerves, as well as between the secondary branches, being filled with elongated areoles formed by generally simple branches which span the interval.

This species is evidently closely allied to *F. Woolsoni*, from which it differs chiefly in its ovate and long-pointed outline.

Fig. 1 represents a large leaf, nearly entire; fig. 2, a specimen below the middle size; fig. 3, a portion of the base, to show the petiole and the blade decurrent on it.

Locality: Woodbridge.

Ficus myricoides Hollick n. sp.

Pl. XXXII, fig. 18; Pl. XLI, figs. 8, 9.

Leaves narrowly lanceolate in outline, apparently about 10^{cm} long by a little more than 2^{cm} broad, blunt-tipped, entire; midrib straight, secondaries all of equal rank, straight, regular, parallel, and numerous, forming an angle of about 45° or greater with the midrib, connected by fine cross-veining near the margins, where they form polygonal areoles.

I have decided with some hesitation to unite under this name the figures above indicated, although the imperfect base of fig. 9 and the absence of a tip in fig. 18 render accurate comparison impossible.

No name or indication of locality accompanied either of the figures or their corresponding specimens.—A. H.

Order PROTEACEÆ.

Persoonia Lesquereuxii Knowlton.

Pl. XLII, fig. 16.

Persoonia Lesquereuxii Kn., Fl. Dak. Gr., p. 89, Pl. XX, figs. 10-12.

This is apparently a small leaf of the above species. Its identity with Persoonia is apparent, and it so closely resembles the species quoted that I have not thought it advisable to separate them.

No memorandum of either name or locality accompanied the figure or the specimen.—A. H.

Persoonia spatulata Hollick n. sp.

Pl. XLII, fig. 14.

Leaf about 35^{mm} long by 11^{mm} or 12^{mm} wide at broadest part, obovate-spatulate in outline, rounded at the apex and tapering into a long, narrow base, margin entire; nervation fine, lower nerves forming an acute angle with the midrib, upper ones more obtuse.

I have not seen another specimen exactly comparable to this, either in our collection or in any from other localities, and it is with some hesitation that I have placed it in the above genus.

No locality is given, and no indication appears as to Dr. Newberry's ideas in regard to its probable botanical relations.—A. H.

Proteoides daphnogenoides Heer.

Pl. XVII, figs. 8, 9; Pl. XXXII, figs. 11, 13, 14; Pl. XXXIII, fig. 3; Pl. XLI, fig. 15.

Proteoides daphnogenoides Heer, Phyllites Crétacées du Nebraska, Nouv. Mém. Soc. Helv. Sci. Nat., Vol. XXII, No. 1, 1867, p. 17, Pl. IV, figs. 9, 10.

Leaves lanceolate, 15^{cm} to 25^{cm} long by 2^{cm} to 3^{cm} wide, more or less abruptly narrowed to the base, gradually tapering upward to a long, acute, generally flexuous point; margins entire, surface smooth; medial nerve well marked toward base and thread-like at summit, lateral nerves slender, leaving the midrib at an acute angle, connected in a flowing festoon near the border; tertiary nerves forming many rounded or subquadrate areoles.

The leaves represented by the figures now given and many other specimens in our collections seem to be identical with those described by Heer in his Phyllites Crétacées du Nebraska (p. 17, Pl. IV, figs. 9, 10) and figured and described more in detail by Mr. Lesquereux in his Cretaceous Flora, p. 85, Pl. XV, figs. 1, 2. Such leaves are not at all uncommon in the Dakota group of the interior of the continent, and while the finer details of nervation are generally wanting, so far as observable they correspond to what we find in a rather common group of leaves in the Amboy Clays. The figures now given will serve for a comparison with those published by Heer and the still better ones given by Mr. Lesquereux. These leaves afford another point of identity between the flora of the Amboy Clays and that of the Dakota group at the West, still further strengthening the conclusion drawn from the other identical species that the geological level of the two formations is nearly the same.

Localities: Woodbridge, Sayreville, etc.

Order MAGNOLIACEÆ.

MAGNOLIA LACOEANA Lesq.[1]

Pl. XV, figs. 1, 2.

Leaves round-ovoid, 15^{cm} long by 10^{cm} wide, blunt-pointed at summit, slightly wedge-shaped at base; nervation regular and characteristic of the genus, midrib slightly flexuous, lateral nerves almost uniformly spaced, simple until they approach the margins, when they connect in a regular and graceful festoon.

We have too little material which we can consider as representing this species to insist upon its definition or classification. The two specimens represented in the figures now given are from the same locality and presumably represent the same species; but if so, we have no other representatives of that species, and if not, the two leaves belong to two species of which we have no other traces in the collection. Though in a somewhat different state of preservation, they agree well enough as regards their form and nervation, and it has seemed to me better to consider one the summit and the other the base of a leaf of a species of Magnolia which differs from any other in the collection by being much broader and rounder. In form and in nervation it strikingly resembles some leaves we might select of *Magnolia acuminata*.

Locality: Woodbridge.

MAGNOLIA ALTERNANS Heer?.

Pl. LV, figs. 1, 2, 4, 6.

Magnolia alternans Heer, Phyllites Crétacées du Nebraska, p. 20, Pl. III, figs. 2–4; Pl. IV, figs. 1, 2.

I have with some hesitation considered the plant represented in the figures now given as identical with Heer's species from the Dakota group of Nebraska, the chief difference being that in *M. alternans* the leaf is wedge-shaped at the base, while in our species from the Amboy Clays

[1] The original manuscript name by which Dr. Newberry designated this species is *Magnolia latifolia*, n. sp. It is, however, manifestly identical with *M. Lacoeana* Lesq. (Fl. Dak. Gr., p. 201, Pl. LX, fig. 1.)—A. H.

the base is sometimes rounded and sometimes wedge-shaped. I doubt if the latter character can be insisted upon as a characteristic feature of *M. alternans*. In other respects the leaves are essentially identical. The middle nerve is strong and persistent, lateral nerves fine, generally alternating and forming a continuous and marked festoon parallel with the margin.

Locality: Woodbridge.

Magnolia glaucoides Newb. n. sp.

Pl. LVII, figs. 1–4.

Leaves elliptical, 10^{cm} to 12^{cm} in length by 4^{cm} to 5^{cm} in width, long petioled, rounded at summit, slightly wedge-shaped at base, margins entire; nervation delicate or sunk in the integument of the leaf, midrib strong, lateral nerves numerous, fine, leaving the midrib at an acute angle, uniting to form a festoon near the margin.

It would be difficult for anyone to discover any marked difference between these leaves and those of the common *Magnolia virginiana* L. (*M. glauca*). The petiole is perhaps longer, but this is a variable character in the living species, and yet we should hardly be warranted in considering this as identical with the common plant of our Atlantic States. Possibly in the future the fruit and foliage may be found so fully represented that it may be possible to establish the identity; at present it seems better to indicate by the specific name the close resemblance between them.

Locality: Woodbridge.

Magnolia woodbridgensis Hollick n. sp.[1]

Pl. XXXVI, fig. 11; Pl. LVII, figs. 5–7.

Leaves 12^{cm} to 18^{cm} in length by 5^{cm} to 8^{cm} in greatest breadth, long-ovate in outline, broadest near base, rounded below, blunt-pointed at summit, margins entire; nervation delicate.

These leaves have somewhat the form of those of *M. longifolia*, but are much smaller, more wedge-shaped, broadest near the base, rapidly drawn into a narrow but obtuse summit.

[1] In Dr. Newberry's manuscript this species is named *Magnolia cuneata*, but as he had already given that name to a fossil plant from the Cretaceous of Orcas Island (Geol. Rept. of the Exploration of the Yellowstone and Missouri rivers, 1869, p. 163), it became necessary to change it, and it was accordingly named for the locality at which it was collected.—A. H.

The texture of the leaf would seem to have been thin, as the margins are generally somewhat warped and the surface undulate, as though yielding readily to local pressure.

Locality: Woodbridge.

MAGNOLIA AURICULATA Newb. n. sp.

Pl. XLI, fig. 13; Pl. LVIII, figs. 1–11.

Leaves ovate, 8^{cm} to 12^{cm} long, petioled, acute or blunt-pointed, base rounded, more often auriculate, margins entire; nervation that of the Magnolias, viz. lateral nerves given off at a large angle, widely separated, inosculating at the ends to form a festoon parallel with the margin.

I have included these leaves in the genus Magnolia with much hesitation. They are sharply defined, beautifully preserved, and exhibit some features unlike any others in the collection—that is, the base is generally somewhat truncated or eared, as in figs. 1, 4, 6, and 11 of Pl. LVIII, and sometimes the auriculation is peculiarly complete and exact, as in fig. 1, where the ears are symmetrical and helicoid. It is quite possible that ultimately facts will be brought to light which will require the reference of these leaves to a new genus, but since the nervation is similar to that prevailing among the Magnolias, and there is developed among them a marked tendency toward the auriculation of the base of the leaf, as is seen in *M. Fraseri* and *M. macrophylla*, it has seemed to me that our plant could not be far removed from this group. In studying these leaves, Aristolochia, Polygonum, and Maclura have suggested themselves. In Aristolochia we generally find a deeply cordate leaf which is sometimes almost auriculate, but the nervation is always different from that before us. In Polygonum it is common to find auriculate and hastate leaves, but the plant is herbaceous, with thin and delicate leaves, and with a nervation different from that under consideration. In Maclura the form, consistence, and nervation of the leaves are much like these, but there is apparently no tendency to the formation of the hastate or auriculate base. Hence the weight of probability seems to be in favor of Magnolia, and for the present we leave it there. In consistence the leaves seem to have had smooth surfaces and to have been rather thick.

Locality: Woodbridge.

MAGNOLIA LONGIPES Newb. n. sp.

Pl. LIV, figs. 1–3.

Leaves ovate-oblong, rounded or wedge-shaped at base, obtuse at summit, very long petioled; nervation open, midrib very strong, lateral nerves relatively remote and delicate, uniting above to form a festoon of large meshes parallel with the border.

The most striking feature in these leaves is the length of the petiole, which sometimes reaches 12^{cm} or 13^{cm}, whereas in *M. glaucoides* and *M. longifolia* it does not exceed 5^{cm} in length. Another distinguishing feature is the loose and open character of the secondary nervation.

Locality: Woodbridge.

MAGNOLIA LONGIFOLIA Newb. n. sp.

Pl. LV, figs. 3, 5; Pl. LVI, figs. 1–4.

Leaves oblong or long-ovoid, 30^{cm} or more in length by 10^{cm} in width at the broadest part, petioled, base narrowed or rounded, summit subacute or obtuse; nervation characteristic of the genus, midrib strong, lateral nerves nearly uniform in strength, running parallel toward the margin, there uniting in a festoon or rather large loops. Between the principal lateral nerves issue shorter secondary nerves which branch at the summit and are lost among the areoles of the tertiary nervation.

I include in this species a group of quite large Magnolia leaves, of which a fair idea can be obtained from the figures now given. These leaves are so large that we have never succeeded in taking out one of them entire; yet in fig. 1 on Pl. LVI we have what is approximately the full form of the leaf. The summit belonged to a different leaf from the base, but the portion represented corresponds very nearly to that which was broken away.

Locality: Woodbridge.

Genus LIRIODENDRON Linnæus.

The genus Liriodendron, as all botanists know, is represented in the living flora by a single species, "the tulip tree," which is confined to eastern America, and a doubtful variety, from eastern Asia, *L. tulipifera chinense*. It is a magnificent tree—on the whole, the finest in our forests. Its cylindrical trunk, sometimes 10 feet in diameter, carries it beyond all its associates in size, while the beauty of its glossy lyre-shaped leaves and tulip-like flowers is surpassed only by that of the flowers and foliage of its first cousin, *Magnolia grandiflora*. That a plant so splendid should stand quite alone in the vegetation of the present day excited the wonder of the earlier botanists, but the Sassafras, the sweet gum, and the great Sequoias of the far West afford similar examples of isolation, and the latter are still more striking illustrations of solitary grandeur.

Before the study of fossil plants threw its light upon the history of our living flora such cases admitted of no satisfactory explanation, but we now know that all the trees enumerated above, with our magnolias, button-ball, and deciduous cypress, are relics of the golden age of North American vegetation; of a time when a genial climate prevailed all the way to the Arctic Sea, and when a well-watered and fertile soil supported forests in which our now lonely giants lived surrounded by brothers, cousins, and more distant relatives as gigantic as themselves, and all combined to form the greatest forest growth the world has ever seen. But this glorious summer, which continued perhaps a million of years, and created or fostered all the noblest forms of forest life that have come down to us, and many perhaps nobler that have perished, was followed by a winter of corresponding severity and duration—the Ice age—in which snows and glaciers spread from Greenland and Alaska southward until two-thirds of the continent was under snow and ice. All the region north of New York and Cincinnati was then changed from a paradise to a howling wilderness, where not a trace remained of the luxuriant vegetation that before covered the surface, or of the varied fauna that was associated with it, except where leaves, trunks, and bones, relics of earlier generations, were buried in rock or soil too deep to be reached by the grinding glacier or the burrowing torrent. These relics we have disinterred on Greenland, Disco Island, on the McKenzie River, and in Alaska, as well as at many places farther south, as in the country bordering the Columbia, or the Missouri, and in New Jersey and Virginia. Seven quarto volumes filled with descriptions and plates of fossil plants constitute the contribution that Prof. Oswald Heer has made in his Flora Fossilis Arctica to our knowledge of the vegetation that covered the circumpolar lands before the Ice age, and an equal mass of material has been gathered by Lesquereux, Ward, Fontaine, and the writer, as a preparation for the work of illustrating the wonderfully rich Cretaceous and Tertiary flora of North America. Although but a beginning has yet been made, already the remains of at least a thousand distinct species of arborescent plants have been brought to light. The botanical relations of many, perhaps most of these, are yet to be accurately determined, but the general character of the vegetation which covered our continent in the later geological ages has certainly been ascertained, and much light has been thrown on the derivation and history of our present flora.

With the facts before us we are fully warranted in making the statement that our angiosperm flora began its existence on this continent in early Cretaceous times; that even then its present aspects were distinctly developed, and subsequent changes have been rather of degree than of kind. In the banishment of our Tertiary flora from the great area it once occupied, and its restriction to the narrow space at the south into which it was forced, many of its finest elements were destroyed; and when, with an amelioration of climate, the exiles returned to that portion of their former home again opened to them, they came as a handful representing a host, perhaps as solitary species, remnants of generic groups that had mostly perished by the way.

Among these survivors the Sequoias stand first in magnitude and interest, and their story has been admirably told by Dr Gray in his Sequoia and its History. Gingko and Platanus have been described by Prof. Lester F. Ward in several memoirs. The Liriodendron, the Magnolias, the Liquidambar, the Cypress, and the Sassafas will also, I hope, have their biographers, and to aid in the task of one of these I now give some of the facts which have come to my knowledge in regard to the history of our lyre-leaved tulip tree.

At least two species of Liriodendron are indicated by leaves found in the Amboy Clays—Middle Cretaceous—of New Jersey, and others have been obtained from the Dakota group, from the Upper Cretaceous strata of Greenland, and the Laramie of the West. Though differing considerably among themselves in size and form, all these have the deep sinus of the upper extremity so characteristic of the genus, and the nervation is also essentially the same. Hence we must conclude that the genus Liriodendron, now represented by a single species, was in the Cretaceous age much more largely developed, having many species, and those scattered throughout many lands. In the Tertiary age the genus continued to exist, but the species seem to have been reduced to one, which is hardly to be distinguished from that now living. In many parts of Europe leaves of the tulip tree have been found, and it extended as far south as Italy. Its presence there was first made known by Unger in his Synopsis (p. 232) and in his Genera et Species (p. 443), where he describes it under the name of *Liriodendron Procaccinii*. Later it was mentioned by Massalongo (Studii Fl. Foss. Senigall., p. 311) and Heer (Urwelt der Schweiz, p. 332), and it is enumerated and figured among the fossil plants of Iceland by Heer in his Flora Fossilis Arctica, Vol. I, p. 151, Pl. XXVI, fig. 7b; Pl. XXVII, figs. 5–8; and from the Tertiary of Greenland, Vol. VII, p. 121, Pl. LXXXIII. Leaves of similar form are described and figured in Heer's Flora Tertiaria Helvetiæ, Vol. III, p. 29, Pl. CVIII, fig. 6, with the name of *Liriodendron helveticum* Fisch.; also Ettingshausen, in his Flora v. Bilin., Part III, p. 9, Pl. XLI, fig. 10, describes a fragment which he names *L. Haueri*. All these are, however, so much like the living species that it is impossible to distinguish them, and they should probably be united with it. We here have a striking illustration of the wide distribution of a species which has retained its characters both of fruit and leaf quite unchanged throughout long migrations and an enormous lapse of time.

In Europe the tulip tree, like many of its American associates, seems to have been destroyed by the cold of the Ice age, the Mediterranean cutting off its retreat; but in America it migrated southward over the southern extension of the continent, and returned northward again with the amelioration of the climate.

Of the species of Liriodendron found in the Dakota group of Kansas, the leaves of one, *L. primævum* Newb. (Later Extinct Floras of North America, etc., Ann. N. Y. Lyc. Nat. Hist., Vol. IX, p. 12), are much like those of the living species, but considerably smaller. Another species (*L. Meekii* Heer) has small, fiddle-shaped leaves. Professor Heer considers this identical with *L. primævum*, but the form is quite different, and no connecting links have been found. Professor Heer also unites with *L. Meekii* some ovate emarginate leaves from the Dakota and Greenland strata, to which he formerly gave the names *Phyllites obcordatus* and *Leguminosites Marcouanus*; but it is by no means certain that they were borne by the same tree that carried the leaves called *Liriodendron Meekii*. Indeed, the probabilities are against it, since no intermediate forms have been found, and none of the panduriform leaves of *L. Meekii* have been obtained from Greenland, where obovate, entire, or emarginate leaves similar to those given the above names do occur, and also many of the emarginate, oblong-ovoid, or lanceolate leaves which I have called *Liriodendropsis simplex*.

Several additional species of Liriodendron are enumerated by Mr. Lesquereux among the fossil plants of the Dakota group, viz: *L. giganteum* Lesq., *L. intermedium* Lesq. (Cret. Fl., p. 93, Pl. XX, fig. 5; Pl. XXII, fig. 2), *L. acuminatum* Lesq., *L. cruciforme* Lesq., *L. semi-alatum* Lesq., *L. pinnatifidum* Lesq. (Bull. Mus. Comp. Zool., Vol. VII, No. 6, p. 227). As only the first two are figured, and these from fragments, and the others very briefly described, I am unable to make any satisfactory use of this important material in tracing the life history of the genus.

I have[1] elsewhere reported as a remarkable fact that among all the great collections of Laramie and Eocene plants made in Washington, Wyoming, and Colorado, and in the country bordering the upper Missouri, not a single leaf of Liriodendron had yet been identified. Since then a fragmentary specimen has been described from the Laramie strata, Point of Rocks, Wyo., by Prof. Lester F. Ward (Bull. 37, U. S. Geol. Survey, p. 102, Pl. XLVIII, fig. 2), and during the summer of 1889 numerous leaves of a marked species of this genus were obtained by Mr. R. C. Hills from the Lower Laramie at Walsenberg, Colo.[2] Thus another link in the chain has been supplied.

NOTE.—At the time when the above was written the Flora of the Dakota Group, as edited by Dr. Knowlton from Professor Lesquereux's manuscript, had not been published, and Dr. Newberry never saw the still further development of this genus as there depicted.—A. H.

[1] Bull. Torrey Bot. Club, Vol. XIV, p. 8.

[2] *L. alatum* Newb., Hollick in Bull. Torrey Bot. Club, Vol. XXI, p. 167, Pl. CCXX.—A. H.

Liriodendron quercifolium Newb.

Pl. LI, figs. 1–6.

Liriodendron quercifolium Newberry, Bull. Torrey Bot. Club, Vol. XIV, January, 1887, p. 6, Pl. LXII, fig. 1.

Leaves large, 15^{cm} long by 10^{cm} broad, long petioled, base horizontal or slightly cordate, summit deeply emarginate, sides bearing each three or four pointed, sometimes spatulate lobes, separated by narrow sinuses which reach nearly to the midrib; nervation regular, midrib straight or curved, terminating at the bottom of the sinus of the summit, strong side branches traversing each lobe and terminating in the point between these more delicate, generally simple branchlets.

The general form of these leaves is considerably like that of some of the oaks, *Quercus alba*, *Q. nigra*, etc., a character which has suggested the name. The strong terminal emargination and the nervation suffice, however, at once to separate them from Quercus and bring them into Liriodendron. As will be seen by the figures now given, there is considerable diversity in these leaves, some having broader lobes and shallower sinuses, approaching the form of those of *L. oblongifolium*, with which they are associated in the Amboy Clays. As a whole, they show a variation from the leaves of the living species in an opposite direction from those of *L. oblongifolium*, the latter being more simple in outline, oblong in form, with small points or lobes on the sides, whereas these are much more deeply lobed.

Locality: Woodbridge.

Liriodendron oblongifolium Newb.

Pl. LII, figs. 1–5.

Liriodendron oblongifolium Newberry, Bull. Torrey Bot. Club, Vol. XIV, January, 1887, p. 5, Pl. LXI, fig. 1.

Leaves 15^{cm} to 20^{cm} in length by 10^{cm} to 12^{cm} in breadth, oblong in outline, long petioled, base rounded, square, or slightly cordate, summit deeply emarginate, sides bearing three or more obtuse or acute points, separated by shallow sinuses; nervation distinct, moderately strong, midrib straight, terminating in the bottom of the sinus of the upper extremity, lateral nerves nearly straight, parallel, forming two series, the stronger ones separated by intervals from 6^{mm} to 12^{mm} broad, branching and inosculating at their extremities, and forming a series of loops near the margin; between these are shorter and more delicate nerve-branches, which are usually simple and equally divide the interspaces.

Unfortunately, but few of these leaves have been found, and none of them are quite perfect. Together, however, they are sufficient to determine the general form and nervation. Their resemblance to the leaves of the living species, *L. tulipifera*, is striking, but the form is more oblong. In the living species the lobes of the margin are quite variable; generally the basal pair are much developed, and above these a deep sinus on each side leads up to the terminal points. Not infrequently, however, we find two and sometimes three points on a side, and a much nearer approach to the form of the leaves before us. The leaves of the living species are, however, always shorter, and relatively broader, yet the resemblance on the whole is so close that it is impossible to avoid the conclusion that we have in these Cretaceous leaves relics of the progenitor of the living species, with all the more important characters of form and nervation already distinctly specialized.

Locality: Woodbridge.

Genus Liriodendropsis Newberry gen. nov.

Leaves ovate, oblong, or lanceolate, petiolate, base wedge-shaped or rounded, summits broadly emarginate, margins entire, sometimes undulate or slightly constricted to almost fiddle-shaped; nervation crowded and fine, but distinct, midrib slender, generally flexuous, terminating in the bottom of the apical sinus; secondary nerves leaving midrib at a large angle, uniting in festoons near the margins; tertiary nervation distinct, filling the space between the secondary nerve-branches with a rather fine network; meshes elongated near the midrib, rounded or polygonal near the margins.

I have thought it best to distinguish by a new generic name a group of leaves which are numerous in the Amboy Clays and the Atane beds of Greenland. They have been hitherto included in the genus Liriodendron by Professor Heer and myself, but while they are evidently related to the tulip tree, their simple ovate or lanceolate form, relatively small size, and strongly marked, reticulated nervation separate them into a group by themselves possessing characters which seem to have more than a specific value.

Liriodendropsis simplex Newb.

Pl. XIX, figs. 2, 3; Pl. LIII, figs. 1–4, 7.

Liriodendron simplex Newberry, in part, Bull. Torrey Bot. Club., Vol. XIV. 1887, p. 6, Pl. LXII, figs. 2, 3.

Leaves 8^{cm} to 10^{cm} in length, long petioled, ovate-lanceolate in outline, sometimes undulate to slightly fiddle-shaped or constricted, from 3^{cm} to 6^{cm} in width at the broadest part, summit emarginate, wedge-shaped; nervation fine but distinct, midrib strong, terminating abruptly in the sinus of the summit, lateral branches forming two sets, the first and larger being separated by intervals of about 6^{mm}, branching near their extremities, and anastomosing to form a coarse network along the border; the spaces between these divided unequally by one or several smaller, shorter, and generally simple nerve-branches which run parallel with the large ones, sometimes connecting with the exterior network; all the spaces between the lateral nerves occupied by a relatively coarse reticulation.

Although so different from the leaves described under the names of *Liriodendron oblongifolium* and *L. quercifolium*, these have in common with them the peculiar angular emargination so characteristic of the genus, and essentially the same nervation. The more elongate and lanceolate form represented on Pl. LIII, figs. 3, 4, occurs in considerable numbers, and apparently represents a distinct species, but others are broader and more ovate or irregular in outline, like those represented on Pl. XIX, figs. 2, 3; Pl. LIII, figs. 1, 2, 7.

Professor Heer, in his Flora Fossilis Arctica, Vol. VI, Abth. II, Pl. XXII, has represented a number of leaves which apparently belong to the same species with those now under consideration. All these he regards as varieties of *L Meekii*, first described by him from the Dakota sandstones, but it seems to me that they do not represent either of the two forms from the Dakota group, neither of which has yet been found in Greenland. Hence, until more material shall show the simple, ovate, or lanceolate forms to be connected by insensible gradations with others, I must regard them as specifically distinct.

Locality: Woodbridge.

LIRIODENDROPSIS ANGUSTIFOLIA Newb. n. sp.

Pl. LIII, fig. 8.

Liriodendron simplex Newberry, in part, Bull. Torrey Bot. Club, Vol. XIV, 1887, p. 6, Pl. LXII, fig. 4.

Among the elongated leaves that have been credited to Liriodendropsis a large number occur in the collection which are well represented by fig. 8. They may be surmised to be but varieties of *Liriodendropsis simplex*, but the outline is so different, so narrow and elongated, that it has seemed to me improbable that they belonged to the same tree. For the present at least, therefore, I have thought it best to consider them representatives of a distinct species. In some places the clay is literally packed with them, presenting essentially the same outlines, and there can be no doubt that if a new variety it was a permanent variety and such as deserves to be designated by a distinct name.

Order MENISPERMACEÆ.

MENISPERMITES BOREALIS Heer?.

Pl. L, figs. 1–6.

Menispermites borealis Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 91, Pl. XXXIX, fig. 2.

Many fragments of leaves have been found which I have been inclined to refer to this species. Unfortunately, Professor Heer's description was founded upon a single fragment of a large leaf, which failed to give to him a clear idea of its outline and structure. It was, however, apparently unsymmetrical, and, so far as we can judge from so little material, must have been similar in outline and nervation to the leaves figured on Pl. L. These are triangular in outline, with the midrib much nearer one side than the other, as though one-half of a large cordate leaf had been developed at the expense of the other side. Professor Heer's leaf would seem to have been very much of the same character; so provisionally I unite them. Fig. 3 gives nearly the entire outline of the leaf. It will be seen to have somewhat the shape of *Menispermites obtusiloba* Lesq. (Cret. Fl., p. 94, Pl. XXV, fig. 1; Pl. XXVI, fig. 3), with which Heer compares his plant; but our leaves are smaller, are more decidedly unsymmetrical, and have entire margins. Supposing Heer's figure to represent a normal leaf of his species, those we find in New Jersey are too closely allied to it to permit us, without more material, to separate them.

Locality: Woodbridge.

MENISPERMITES WARDIANUS Hollick n. sp.

Pl. XXIX, figs. 9, 11.

Leaves about 8^{cm} long by 4^{cm} broad at widest part, unsymmetrical in shape, the midrib being nearer to the concave side, strongly triple-nerved, and with a subsidiary nerve near the convex margin, giving the appearance of unequal quadruple nervation; margins entire, apex pointed, base cuneate.

In placing these specimens under the above genus I have followed Dr. Newberry's probable disposition of them as indicated by his comparison of other similar unsymmetrical leaves with this genus. (See Pl. L of this monograph.)

The specific name is given in honor of Prof. Lester F. Ward, of the United States Geological Survey.

Exact locality not recorded.—A. H.

Order LAURACEÆ.

LAURUS PLUTONIA Heer.

Pl. XVI, figs. 10, 11.

Laurus plutonia Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 75, Pl. XIX, figs. 1d, 2, 3, 4; Pl. XX, figs. 3a, 4–6; Pl. XXIV, fig. 6b; Pl. XXVIII, figs. 10, 11; Pl. XLII, fig. 4b; Vol. VII, p. 30, Pl. LVIII, fig. 2; Pl. LXII, fig. 1a.

The numerous figures given by Professor Heer of his species are so fragmentary that they leave much to desire in reference to the form and nervation of the leaves. Among our Amboy Clay fossils there are, however, a number of lanceolate leaves which resemble so closely those figured by Heer as to lead me to refer them to his species. As a general rule our leaves are broader in proportion to their length, but this is the only perceptible difference.

Laurophyllum minus Newb. n. sp.

Pl. XVI, figs. 7–9.

Leaves elongate, obtuse at summit, wedge-shaped at base; midrib very strong, lateral nervation invisible, indicating a thick and coriaceous leaf.

In general form and consistence these leaves approach those which have been described under this generic name, and which are so common in the Dakota sandstone. For the present I have thought best to associate them, although the generic affinities are yet doubtful.

Laurophyllum angustifolium Newb. n. sp.

Pl. XVII, figs. 10, 11.

Leaves 12^{cm} to 15^{cm} in length by 2^{cm} wide, long lanceolate, widest above, summit subacute, base wedge-shaped, short petioled, margins entire, straight, pronounced; secondary nervation delicate, often invisible; general surface smooth.

We have in our collections a group of very symmetrical, lance-linear leaves, of which the smooth surface, the coriaceous texture, the symmetrical outline, and strong midrib are features which ally them to Laurophyllum. I therefore provisionally place them in that genus, giving them a specific name indicating their narrowness.

Among the leaves figured by Heer in his Flora Fossilis Arctica some of those which he has called *Myrica longa* (Vol. VI, Abth. II, p. 65, Pl. XXIX, figs. 15–17; Vol. VII, p. 21, etc.) resemble in form those under consideration, but others are much broader and must belong to a different species from ours.

Locality: Woodbridge.

LAUROPHYLLUM LANCEOLATUM Newb. n. sp.

Pl. XVII, figs. 1, 12.

Leaves lanceolate, 10^{cm} to 15^{cm} in length by 2^{cm} to 3^{cm} in width, short petioled, margins entire, summit narrowed to an obtuse or rounded point, base wedge-shaped; medial nerve strong, lateral nerves fine, subequal, arched upward, and connecting near the margin; surfaces smooth, consistence apparently coriaceous.

Leaves similar to those represented in the figures cited are quite common in the New Jersey clays. They may be recognized by their smooth, shining surface, the nervation for the most part lost in the parenchyma, the strong midrib, the short but robust petiole, and the narrowed but obtuse apex. In general character they agree well with the somewhat larger leaves common in the Dakota sandstones, to which Mr. Lesquereux has given the name of *Laurophyllum reticulatum*, and which are rather inadequately represented in his Cretaceous Flora, p. 76, Pl. XV, figs. 4, 5. The leaves were evidently thick and leathery; hence the details of the secondary and tertiary nervation are rarely seen. Until the fruit is found in connection with these leaves, or at least until the nervation is well known, any attempt to determine their botanical relations must be unsatisfactory, but an indescribable something about them impresses the observer with the conviction that they belong to the laurel family.

Locality: Woodbridge.

SASSAFRAS ACUTILOBUM Lesq.

Pl. XXV, figs. 1–10; Pl. XXVI, figs. 2–6.

Sassafras acutilobum Lesq., Cret. Fl., p. 79, Pl. XIV, figs. 1, 2.

One of the most common of the trilobed, sassafras-like leaves of the Amboy Clays offers no character by which I can distinguish it from *S. acutilobum* of the Dakota sandstones of Nebraska. A number of figures are now given illustrating the variations in size and outline, but nearly all these forms could be duplicated at the West. Velenovský has found what seems to be this same species in the Upper Cretaceous rocks of Bohemia (Flora der Böhm. Kreidef., Part III, p. 2, Pl. II, fig. 1).

Locality: Woodbridge.

SASSAFRAS PROGENITOR Newb. n. sp.

Pl. XXVII, figs. 1–3.

Leaves trilobed, 8^{cm} to 20^{cm} long, lobes pointed or obtuse, central lobe somewhat spatulate, base somewhat wedge-shaped; nervation and outline that of normal leaves of *S. sassafras* (L.) Karst.

Among the trilobed leaves which form so striking a feature in the Cretaceous flora there are several that have so strong a resemblance to our living Sassafras that they have been provisionally referred to that genus. *S. cretaceum* Newb. of the Dakota group has been generally accepted as a Sassafras, while some authors, noting the tendency of these sassafras-like leaves to run into those more like the living palmate-leaved Aralias, have suggested that all should be placed in a provisional genus, Araliopsis. It is doubtless wise to avoid hasty generalization or positive assertion in regard to the botanical relations of plants which have left us only their foliary appendages, in better or worse state of preservation. There can be little doubt, however, that in the present case the assumption that we have here the remains of a species of Sassafras very closely allied to the living one is well founded. A glance at the outlines and nervation of the three figures which have been cited will show so close a resemblance to the living Sassafras as to make a generic separation of these two plants unwarranted. When it is remembered that our common Sassafras stands alone in our flora, it is evident that its history reaches far back into the past, and, as in the case of the tulip tree and sweet gum, we must look for its kindred in the remains of the forests of the Tertiary and Upper Cretaceous periods. Doubtless we shall sooner or later find the fruit connected with the leaves, and thus have all our doubts put at rest.

Locality: Woodbridge.

SASSAFRAS HASTATUM Newb. n. sp.

Pl. XXVII, figs. 4–6; Pl. XXVIII, figs. 1, 2; Pl. XL, fig. 4.

Leaves trilobed, lobes conical, entire, middle one largest, lateral lobes nearly horizontal, giving a hastate outline to the leaf.

Very considerable diversity is seen in the forms of the leaves which I have united in this species, and perhaps they should be separated into two or more groups. The normal form of the hastate leaf is seen in Pl. XXVII, fig. 6; Pl. XXVIII, figs. 1, 2; but occurring with these are forms like figs. 4 and 5, Pl. XXVII, in which the lateral lobes are turned up and there is a near approach to the form of *S. progenitor.* There is, however, so wide a difference between the prevailing forms of these halberd-shaped leaves and others with which they are associated that it seems necessary to regard them as forming a distinct species.

Locality: Woodbridge.

CINNAMOMUM INTERMEDIUM Newb. n. sp.

Pl. XXIX, figs. 1–8, 10.

Leaves symmetrically lance-oval or lentiform, petioled, 10^{cm} to 12^{cm} in length and 3^{cm} to 4^{cm} in width, blunt-pointed at summit, narrowed to the base; nervation strong, lateral nerves springing from the midrib either at the base or a little above and reaching almost to the summit, giving off lateral branches from the base up, which unite to form a festoon parallel with the edge. On the inside the branches from the midrib are delicate and inconspicuous until above the middle; three or four alternate pairs are then given off, which converge in a festoon to the summit.

The leaves of this species of Cinnamomum are intermediate in character between those of *C. mississippiense*, *C. Heerii*, and *C. affine*, all of Lesquereux, which have the base broad and rounded, and *C. sezannense* Wat. and *C. Scheuchzeri* Heer. They have more the form of *C. ellipsoideum* Sap. et Mar., Révision de la Flore Heersienne de Gelinden, p. 61, Pl. IX, figs. 7–9, but are larger, generally more wedge-shaped at the base, are longer petioled, and in cases have the lateral nerves brought much nearer the point. If, however, they had been found in the same country and beds of the same age, I should feel compelled to consider them as but forms of that species.

Localities: Woodbridge, Sayreville.

Order ROSACEÆ.

PRUNUS? ACUTIFOLIA Newb. n. sp.

Pl. XIV, fig. 1.

Leaf ovate, acute at summit, slightly wedge-shaped at base, margins serrate; nervation unknown; dimensions, about 4^{cm} long by 2^{cm} to 3^{cm} wide.

The name given above is applied to a unique and imperfect leaf, and one which presents all the ordinary characters of Prunus, and yet it is far from being conclusive evidence of the presence of this genus in the Amboy flora. Doubtless other leaves of the kind will be hereafter found which will throw some light upon the question of its botanical relations.

Locality: Woodbridge.

Order LEGUMINOSÆ.

HYMENÆA DAKOTANA Lesq.

Pl. XLI, fig. 14.

Hymenæa dakotana Lesquerenx, Fl. Dak. Gr., p. 145, Pl. LV, figs. 2, 3; Pl. LVI, figs. 1, 2; Pl. LXII, fig. 2.

This species is represented by the single specimen as above indicated. I am unable to separate it from the species described and figured under this name by Lesquereux in Flora of the Dakota Group, p. 145, Pl. LV, figs. 2, 3.

Dr. Newberry left no memorandum of any description concerning this specimen —A. H.

DALBERGIA APICULATA Newb. n. sp.

Pl. XLII, figs. 17–19.

Leaves 2^{cm} to 5^{cm} in length, quite unsymmetrical, narrowed to the base, which is sessile or short petioled, expanded and rounded above, with a peculiar point at the summit.

Among the numerous smaller leaves contained in the collection there are a few which have the general character attributed to Dalbergia by Heer. These are represented on Pl. XLII, figs. 17, 18, and perhaps 19. As they are quite distinct from any other leaves in the collection, I have thought best to designate them by the above name.

Locality: Woodbridge.

BAUHINIA CRETACEA Newb.

Pl. XLIII, figs. 1–4; Pl. XLIV, figs. 1–3.

Bauhinia cretacea Newberry, Bull. Torrey Bot. Club, Vol. XIII, New York, May, 1886, p. 77, Pl. LVI, fig. 5.

Leaves large, from 10^{cm} to 18^{cm} in diameter, general outline circular, deeply two-lobed, sinus reaching below the middle, margin entire, base rounded, lobes oblong or broadly spatulate; nervation strong, radiate or bilateral, midrib slender, from 1^{cm} to 4^{cm} in length, running to bottom of medial sinus, there forking equally, each slender branch running parallel with the margin of the sinus; lateral nerves strong, usually two, rarely one on each side, springing from a common base, the interior lateral nerve strongest, forking several times and giving off fine branches, which inosculate to form a graceful festoon near the upper margin; the exterior lateral nerves throwing off numerous branches which anastomose in loops near the margin, producing a camptodrome nervation. In those which have but a single lateral nerve the lobes are narrower, and each is covered with the ramifications of the branches, which spring chiefly from the outer side of the single main nerve.

The form and nervation of these leaves are so precisely those of some of the Bauhinias of the present flora that there can be no reasonable doubt that we here have the remains of a well-marked species of this genus, which grew near the mouth of the Hudson River in the middle of the Cretaceous age, and was the associate of the Magnolias, tulip trees, Aralias, etc., which composed the angiosperm forest of eastern North America. In size some of these leaves exceed those of any living Bauhinia, and the outline and nervation indicate that the genus was as perfectly defined and highly specialized in the Cretaceous age as now.

The living Bauhinias inhabit the tropical and subtropical regions of the Old and New Worlds, India, Mauritius, Surinam, Cuba, Mexico, etc. The genus is closely related to Cercis, and most of the species have a similar habit. In a few the leaves are orbicular or slightly emarginate, but they are generally bilobed, the sinus reaching the middle of the leaf, sometimes extending to the base, as is the case with the only species inhabiting the United States, *B. lunarioides* Gray of Texas and Mexico.

In most of the East India species the nervation is more crowded than in the fossil leaves before us, each nerve having three and sometimes four lateral nerves, the medial nerve, however, being quite the same. In several oriental species, and all those of the New World, the nervation is simpler and especially like that of the fossil. In the Texan species the leaves are generally divided to the base, and the medial nerve is therefore obsolete; the lateral nervation is, however, precisely that of our fossil. As the depth of the sinus is a variable character, differing greatly in the leaves of the same tree, it is quite possible that *Bauhinia lunarioides* is only a dwarfed and slightly modified descendant of the Cretaceous species.

Prof. Oswald Heer, in his Flora Fossilis Arctica, Vol. VII, p. 45, Pl. LX, fig. 4a, describes and figures, under the name *Diphyllites membranaceus*, a bilobed leaf which in general form is much like those I have called *Bauhinia cretacea*, but the nervation as given by Heer is quite different. The leaf is divided to within an inch of the base, and a slender nerve, which would be the midrib in an ovate or lanceolate leaf, reaches nearly to the sinus, there forking symmetrically, the branches running near the margins of the sinus on either side. So far we have the nervation of Bauhinia, but in Heer's Diphyllites the lobes of the leaf are traversed by a number of lateral nerves that spring from the base. Only one specimen seems to have been seen, but I strongly suspect that when others shall be obtained in a better state of preservation the nervation will be found to be different from that figured by Heer, and that his bilobed leaf will prove to be generically if not specifically identical with those which we have in the Amboy Clays.

Velenovský has described, in the Flora der Böhmischen Kreideformation, Part IV, Vol. V, p. 12, a bilobed leaf which is almost certainly a species of Bauhinia. The specimen figured by Velenovský, like Heer's Diphyllites, seems to be as yet unique, and it is also evidently malformed. One of the lobes is nearly complete, and in form and nervation practically identical with that of some species of Bauhinia, e. g., *B. tomentosa*, now living in India. The other lobe is not much more than half as long, is truncated, and in all probability abnormal. When other specimens are found I shall be surprised if they are not symmetrical and so much like the leaves of Bauhinia that it will be impossible to separate them from this genus. It will, however, prove to be, if generically identical with our bilobed Amboy leaves, specifically different, for the sinus extends almost to the base of the leaf. Some of the living species of Bauhinia are almost completely divided in the same way, and this is the case with *Bauhinia lunarioides*, as has been mentioned.

Locality: Woodbridge.

BAUHINIA? GIGANTEA Newb. n. sp.

Pl. XX, fig. 1.

Leaves large, a single lobe or leaflet, 20^{cm} long by 7^{cm} or 8^{cm} wide, unsymmetrically spatulate in outline, inner margin nearly straight and entire, outer margin strongly arched and undulate; nervation distinct, consisting of one strong primary nerve springing from the inner margin at the base, gradually diverging from this until it becomes central in the rounded summit; lateral nerves spring from this as follows: one of medium strength at the base which follows for a time parallel with, finally approaching, the outer margin, and having a length of perhaps 5^{cm}; above this a strong lateral nerve is given off 2^{cm} or 3^{cm} above the base; this arches gently upward and reaches the outer margin considerably above the middle of the leaf; still higher smaller lateral nerves are given off to supply those portions of the leaf which lie on both sides of the primary nerve.

Unfortunately, but two specimens of this interesting leaf have yet been found, only one of which is complete. This is conspicuously unsymmetrical and was probably one of a pair which combined to form a leaf not unlike those of *Bauhinia cretacea*, but much more deeply cut. It is not certain, indeed, that the lobes were not separated quite to the base, as in the living *Bauhinia lunarioides*. The nervation is nearest that of *Bauhinia cretacea*, but shows this marked difference, that the principal nerve is much nearer the inner margin. It is also much like that of some species of Hymenæa, and it is quite possible that future discoveries will show that it should be referred to that genus. One species of Hymenæa (*H. primigenia* Sap.) has been found in the Upper Cretaceous rocks of Europe and is there associated with Aralias and Hederas, as are our Bauhinias from the Amboy Clays, so that it is probable the genus was represented in the forests of New Jersey during the Cretaceous age.

Locality: Woodbridge.

Cæsalpinia Cookiana Hollick n. sp.

Pl. XLII. figs. 49, 50.

Leaves orbicular in outline, entire, 12^{mm} or 14^{mm} long by 5^{mm} broad; midrib slender, secondaries few, forming a large angle with the midrib and anastomosing in wide loops.

I have not been able to determine satisfactorily the affinities of these small, delicate leaves, and have placed them with some hesitation in the above genus. They appear to be leaflets belonging to some compound leaf, such as we find in many of the Leguminosæ.

The specific name is given in honor of the late Prof. George H. Cook, State geologist of New Jersey.

No indication of the exact locality where they were found or any speculations as to their probable botanical relations were left by Dr. Newberry.—A. H.

Genus Fontainea Newberry gen. nov.

Shrubby or arborescent plants with opposite or alternate leaves, below unsymmetrically lanceolate, above forming one or two pairs which are united in a common petiole that is unsymmetrically winged by the decurrent blade of each leaf. Apparently related to Hymenæa, to the extinct genus Sapindopsis described by Fontaine from the Potomac group of Virginia, and perhaps to *Aralia elegans* Vel. (Fl. der Böhm. Kreidef., Part III, p. 13, Pl. IV, fig. 1.)

In Sternberg's Flora der Vorwelt, Vol. II, p. 34, Pl. XXIV, fig. 7, are given a description and figure of a plant from the greensand at Schoena, near Freiberg, Saxony. This was discovered by Reich and described in manuscript under the name *Fucoides dichotomus*. For this name Sternberg substituted *Haliserites Reichii*, because, as he thought, it had so much affinity with *Haliseris polypodoides* Ag., a well-known alga (*Fucus membranaceus* Stackh.).

On Pl. XLV, fig. 5, is given a copy of Sternberg's figure, and it will be necessary only to compare this with the other figures on the plate, even hastily, to detect a resemblance that can scarcely mean anything else than generic identity. Reich's plant is much smaller than ours and undoubtedly belongs to a different species, and yet, as far as we can judge from the imperfect material before us, their botanical affinities bring them within generic limits. It is impossible that our plant should be a seaweed, and hence I have ventured to give it a new generic name, since that chosen by Sternberg, if retained, would perpetuate a misconception.

In Professor Fontaine's monograph of the Flora of the Potomac Formation he describes several species of a genus which he calls Sapindopsis (see Pls. CLIV and CLV). All the species are peculiar and, it seems to me, have little in common with Sapindus; but what he calls *Sapindopsis variabilis* (Pl. CLIV, figs. 2–4; Pl. CLV, figs. 2–5) is in some respects so like the plant before us that I am inclined to regard them as botanically related. With more material we may establish a closer union between the plant now under consideration and Fontaine's Sapindopsis, but I do not now feel justified in uniting them. I have concluded, therefore, to designate the plant figured by Sternberg and that which we have recently discovered in the Amboy Clays by a new generic name; and supposing the type may be brought into intimate relationship with Fontaine's Sapindopsis, I venture to dedicate the new genus to him as a slight tribute of esteem for one who has proved himself among the most important contributors to the science of fossil botany.

The foliage of the plant figured by Sternberg is considered by him as a "dichotomous, bipinnate frond, almost pedate," and a not dissimilar structure is visible in the leaf or leaves of Velenovský's *Aralia elegans*, but it is difficult to see how such a structure could prevail in the strong and woody plant which is the type of the genus under discussion; and yet I can not but feel that all these plants are closely related, and that their nearest living allies are Hymenaea and Bauhinia.

NOTE.—In connection with the discussion concerning the probable botanical affinities of Fontainea, I have concluded to append the following, kindly communicated to me by Prof. Lester F. Ward.—A. H.

"In discussing the genus Fontainea Dr. Newberry mentions Sternberg's figure of *Haliserites Reichii* and reproduces it on Pl. XLV, fig. 5. This figure is much smaller than any of the forms of Fontainea, but in Bronn's Lethaea Geognostica, Pl. XXVIII, fig. 1, is represented a form much more like those of the Amboy Clays and nearly as large, this figure being only half the natural size. Bronn regarded it as a Chiropteris, but Schimper (Pal. Vég., p. 185) says that this plant more nearly resembles Halymenites, although on p. 178 of the same volume he refers it to Delesseria. I am inclined to believe that the form figured by Bronn, at least, is a dicotyledon."

FONTAINEA GRANDIFOLIA Newb. n. sp.

Pl. XLV, figs. 1–4.

Leaves in part simple, unsymmetrical, lanceolate, petioled, partly in pairs united on a common petiole, winged by the decurrent blades; nervation fine, pinnate, apparently camptodrome.

I have here represented all we have yet found of this remarkable and interesting plant. It will be seen that the specimens drawn are but fragments, and yet they reveal enough of the foliage to show that it is highly specialized and apparently distinct generically from any hitherto described. In each of the figures given we have represented the base of a pair of leaves which spring from a common petiole, and of which the outside web descends to form a broad wing to that petiole. Apparently lower down on the branches which bear these double leaves are single ones which are unsymmetrically lanceolate in form, as shown in fig. 4, and it is possible that these leaves also formed pairs like the upper ones, but more distinctly separated.

In the preceding generic description all has been said in regard to the botanical relations of this plant warranted by our present knowledge. Doubtless in the future more material will permit more positive statements on this subject.

Locality: Woodbridge.

Colutea primordialis Heer.

Pl. XIX, figs. 4, 5.

Colutea primordialis Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 99, Pl. XXVII, figs. 7–11; Pl. XLIII, figs. 7, 8.

In the figures now given are represented two leaves of a species of Colutea which, though presenting some minor differences, are so like Heer's species that I have not felt justified in considering them as distinct species.

Locality: Woodbridge.

Leguminosites omphalobioides Lesq.

Pl. XLII, fig. 39.

Leguminosites omphalobioides Lesquereux, Fl. Dak. Gr., p. 149, Pl. XXXVIII, fig. 4.

I am unable to separate our specimen from the species described and figured under the above name by Lesquereux.

No memorandum of any kind by Dr. Newberry was found in connection with our figure or specimen.—A. H.

Leguminosites atanensis Heer.

Pl. XLII, fig. 40.

Leguminosites atanensis Heer, Fl. Foss. Arct., Vol. III, Abth. II, p. 119, Pl. XXXIV, fig. 6.

This species is represented by the one specimen here indicated, of the identity of which there can be but little doubt, the only difference being that Heer's figure represents a specimen somewhat larger than ours.

Dr. Newberry left no memorandum whatever in connection with the figure or specimen.—A. H.

Leguminosites coronilloides Heer.

Pl. XLII, fig. 48.

Leguminosites coronilloides Heer, Fl. Foss. Arct., Vol. III, p. 119, Pl. XXXIV, fig. 14.

This somewhat imperfect leaf appears to be so nearly like Heer's species that I have decided to consider them as identical.

I have no memoranda which would guide me in knowing what Dr. Newberry's impressions were regarding the specimen, nor is any locality indicated.—A. H.

Order AQUIFOLIACEÆ.

Ilex? elongata Newb. n. sp.

Pl. XVIII, figs. 1, 5.

Leaf lanceolate, 10^{cm} long by 3^{cm} wide, margins set with remote spiny teeth.

Only two specimens of this plant have yet been obtained, and they are in an imperfect state of preservation. They show enough, however, to prove that they are distinct from any other leaf in the collection, and are remarkable for the series of spiny teeth with which the margins are defended. In this respect they closely resemble several species of Ilex, and we may assign them a provisional place in that genus.

Locality: Sayreville.

Ilex? ovata Newb. n. sp.

Pl. XVIII, fig. 2.

Leaves small, lanceolate in outline, blunt-pointed above, narrowed below, margins set with numerous small and large subacute teeth.

We have but a single leaf of this species in the collection. It is, however, distinct from any others and therefore deserves enumeration. Its reference to the genus Ilex is only provisional, and its true botanical relations can be determined only by the discovery of more material.

Locality: Sayreville.

Order CELASTRACEÆ.

Celastrus arctica Heer.

Pl. XIII, figs. 8–18.

Celastrus arctica Heer, Fl. Foss. Arct., Vol. VII, p. 40, Pl. LXI, figs. 5d, 5e.

Professor Heer in his Flora Fossilis Arctica, Vol. VII, Pl. LXI, fig. 5d, represents a small lanceolate leaf with remotely toothed margins, which he compares with the Tertiary *Celastrus Ettingshauseni* and calls *Celastrus* *arctica.* Of leaves which are plainly identical with this we find many in the upper layers of the Amboy Clays. On Pl. XIII a sufficient number of these are represented to show the prevailing forms and the details of the nervation. They are generally much larger than the specimen figured by Heer, and the plant which bore them would seem to have been much more common in New Jersey than in Greenland. Ettingshausen, who first described the Tertiary species referred to, called it *C. acuminatus* (Tert. Fl. von Häring, p. 71, Pl. XXIV, fig. 16), but this name had been anticipated and it was therefore changed by Heer. That species, though evidently distinct, is much like the one before us, and they both resemble so closely some living species of Celastrus now growing in Australia and the East Indies (*C. ramulosus*, for example)[1] that it is highly probable that Heer is right in referring them to the genus Celastrus. The oval leaves now figured and named Celastrophyllum are, however, quite as closely allied in form, nervation, and margins with the living species of Celastrus, such as *C. scandens*, and it would be equally proper to refer these to that genus. Doubtless the fruit will some time decide the question, and it is probable that they will prove the broad and rounded leaves, rather than the narrow ones, to belong to Celastrus, so that it would have been perhaps wiser to place them all provisionally in the genus Celastrophyllum.

Locality: South Amboy.

Celastrophyllum crenatum Heer.

Pl. XLVIII, figs. 1–19.

Celastrophyllum crenatum Heer, Fl. Foss. Arct., Vol. VII, p. 41, Pl. LXII, fig. 21.

Leaves ovate or elliptical, 2^{cm} to 8^{cm} in length by 1^{cm} to 5^{cm} in breadth; summit rounded, rarely pointed, not infrequently slightly emarginate, with a prominent scallop in the center; base wedge-shaped; margins closely crenulate or crenulate-dentate, except near the base, where they are entire.

With some hesitation I have adopted for these leaves the name given by Professor Heer to one which he has figured and described (loc .cit.) from

[1] The name *Celastrus ramulosus* occurs in Ettingshausen's Blattskelette, p. 153, Pl. LVIII, fig. 6; Pl. LXIII, fig. 8; but I have been unable to find it listed in any work on Australian or East Indian floras to which I have access.—A. H.

the Patoot beds of the Upper Cretaceous in Greenland. Unfortunately, he has given but a single figure, and that represents a leaf more pointed than is often seen in the group with which I have compared it, and of which numerous figures are now given. In size, form, and nervation Professor Heer's leaf is more like those of the smaller and more abundant species which I have described in this monograph under the name of *Celastrophyllum denticulatum* [= *C. Newberryanum* Hollick; see below], but in that species the margin is always denticulate, if not spinulate. As will be seen from the figures now given, our leaves are generally much larger and more coarsely crenulate than that from Greenland, but some may be found in the collection which approach it so closely in all important characters that I do not feel justified in considering them distinct.

Localities: South Amboy, Sayreville.

CELASTROPHYLLUM CRETACEUM Lesq.

Pl. XLII, fig. 13.

Celastrophyllum cretaceum Lesquereux, Fl. Dak. Gr., p. 173, Pl. XXXVIII, figs. 12–14.

The single leaf here represented appears to be so closely allied to the species figured by Lesquereux in his Flora of the Dakota Group, Pl. XXXVIII, fig. 14, that it seems needless to separate them, although it may be noticed that our specimen is somewhat more obovate or spatulate in outline. The differences between Lesquereux's figs. 12 and 14, however, are far greater than are those between his fig. 12 and our specimen, and under the circumstance it does not seem advisable that they should be separated.

Exact locality not known.—A. H.

CELASTROPHYLLUM ANGUSTIFOLIUM Newb. n. sp.[1]

Pl. XIV, figs. 8–17.

Leaves lanceolate, pointed above and more or less wedge-shaped below, 6^{cm} to 15^{cm} in length by about 1.5^{cm} to 2.5^{cm} in width; nervation fine and delicate, very numerous lateral nerves springing from the midrib, simple at

[1] This species is manifestly very close to *C. decurrens* Lesq. (Fl. Dak. Gr., p. 172, Pl. XXXVI, fig. 1), but differs slightly in the crenate rather than serrate dentation and the somewhat more polygonal areolation. I am inclined to think that more complete material from the West may prove them to be identical.—A. H.

base, but branching above and forming an intricate network along the margins, which are finely and uniformly crenate-dentate.

In his Kreideflora von Niederschoena (pp. 257, 260, Pl. III, figs. 1, 3, 9, and 11) Ettingshausen describes some lanceolate leaves with serrated borders, which he calls respectively *Dryandroides Zenkeri* and *Celastrophyllum lanceolatum*; and Velenovský, in Die Flora der Böhmischen Kreideformation (Part II, p. 13 [38], Pl. III, figs. 1–9), describes a series of similar leaves, all of which he regards as of the same species, and calls them *Myrica Zenkeri*. So also he claims *Celastrophyllum ensifolium* Lesq. (Cret. Fl., pp. 108, 109, Pl. XXI) and Heer's *Proteoides ilicoides* (Kreideflora von Quedlinburg, p. 13, Pl. III, figs. 7, 8) as only forms of *Myrica Zenkeri*. Doubtless the leaves which we now figure and name *Celastrophyllum angustifolium* would be thought by him also to belong to the same species; but there is one distinguishing mark which separates them, and that is that all of our leaves are beautifully crenate, while those described by Ettingshausen and Velenovský are dentate, and so I am led to believe that, though perhaps generically identical—but rather as Celastrophyllum than Myrica—specifically our leaves are distinct. The relationship of these leaves to the still more common ones by which they are accompanied, *C. grandifolium*, is intimate and interesting. There can hardly be a doubt that they are members of the same genus, and that genus, it seems to me, is Celastrophyllum.

Locality: Woodbridge.

Celastrophyllum Newberryanum Hollick n. sp.[1]

Pl. XLIX, figs. 1–27.

Leaves small, 2.5^{cm} to 6^{cm} long by 1^{cm} to 2.5^{cm} wide, generally ovate, often obovate, in outline, somewhat narrowed and wedge-shaped at the base; margins usually set with sharp, appressed, spiny denticles, but sometimes entire; summit generally acute, sometimes apiculate, but not infrequently evenly rounded; nervation distinct, camptodrome, and very closely resembling that of *Celastrus scandens* L.

[1] The original manuscript name by Dr. Newberry is *C. denticulatum* n. sp., but this name was previously used by Professor Fontaine in his Potomac or Younger Mesozoic Flora, p. 306 (1889). This specific name is therefore preoccupied, and in its place I have associated Dr. Newberry's name with the species.—A. H.

In size, general form, and nervation these leaves, of which we have compared some hundreds, are closely allied to that figured by Heer (Fl. Foss. Arct., Vol. VII, p. 41, Pl. LXII, fig. 21), but differ from that in having the margins sharply denticulate instead of crenate. There can be no doubt that they belong to the same genus, however, and to a closely allied species, and both are as much like the leaves of *Celastrus scandens* as they are like each other.

This is one of the most common leaves found at South Amboy, and a sufficient number have been drawn to give a good idea of their general characters. It will be necessary to have the fruit before any positive statement can be made in regard to their generic relations, but the form, margins, and nervation are so entirely like those of the leaves of some species of Celastrus that they will probably be brought very near to, if not united with that genus.

Although plentiful at South Amboy and Sayreville, not a single leaf of this species has been found at Woodbridge. The South Amboy beds are very near the top of the clay series, and those of Woodbridge near the bottom. Hence this plant formed a conspicuous element in the later phase of the Cretaceous vegetation in New Jersey.

Localities: South Amboy, Sayreville.

Celastrophyllum undulatum Newb. n. sp.

Pl. XXXVIII, figs. 1–3.

Leaves oblong or ovoid, 10^{cm} to 15^{cm} in length by 4^{cm} to 8^{cm} in width, narrowed to base, obtuse or blunt-pointed at summit, margins undulate or coarsely crenate; nervation consisting of a strong midrib, giving off at a large angle frequent secondary nerves which run simply or branched to the margin; generally they unite in a festoon which follows the outline of the undulations.

This large species resembles *Celastrophyllum crenatum* Heer, in the character of its marginal ornamentation, but the leaves are much longer and larger and more oblong. They differ, too, markedly from the leaves of *C. grandifolium*, which are lanceolate and have margins that are finely denticulate or undulate.

From *C. ensifolium* Lesq. (Cret. Fl., p. 108, Pl. XXI. figs. 2, 3) these leaves differ in being generally broader and more ovate, and especially in the coarse crenulation of the margins, in contrast with the comparatively fine denticulation of the borders in *C. ensifolium*.

Velenovský intimates that the latter species is identical with his *Myrica Zenkeri*, but a comparison of specimens would show him that they are evidently different.

Localities: Woodbridge, Sayreville.

Celastrophyllum spatulatum Newb. n. sp.

Pl. XLII. figs. 43–45.

Leaves 4^{cm} long by 1.5^{cm} wide at broadest part, spatulate in outline; midrib slightly curved, giving the leaves an unsymmetrical appearance; margin dentate above, entire below, tapering into a narrow base; secondaries leaving the midrib at an acute angle, curving upward, anastomosing and uniting by fine cross-veining.

The above name, without any description or other memoranda, was given to these specimens by Dr. Newberry, but no locality was indicated.—A. H.

Celastrophyllum robustum Newb. n. sp.

Pl. XLII. figs. 41, 42.

This may perhaps be an extreme form of *C. spatulatum* Newb., from which it differs mainly in the much broader upper part. No memoranda were left by Dr. Newberry, but the specimens were plainly labeled with the name here adopted, and it was his evident intention to maintain them as a distinct species.[1]—A. H.

[1] Figs. 24 and 25 on Pl. XLII were apparently introduced by Dr. Newberry for comparison with other leaves on this plate. They evidently represent living species in the Celastraceæ, and I have endeavored to compare them with *Myginda integrifolia* Lam. and other species of the order, but without entirely satisfactory results. I am satisfied, however, that they are not meant to represent any of the fossil species from the Amboy Clays. They may be compared with this species.—A. H.

CELASTROPHYLLUM GRANDIFOLIUM Newb. n. sp.

Pl. XIX, fig. 8; Pl. XXI, figs. 1–4.

Leaves large, 15^{cm} to 25^{cm} long, petiolate, lanceolate in outline, rounded or subacute at summit, rounded or rarely wedge-shaped at base; margins above the base undulate or closely serrate, entire near the base; nervation regular, midrib strong, secondary nerves numerous, emerging at an angle of 45°, anastomosing and forming a network near the margin; tertiary nerve branches leaving the secondary nerves generally at a right angle, dividing the intervening spaces into a coarse quadrangular reticulation.

The normal appearance of these leaves is well shown on Pl. XXI, but of the large number which have been collected some are rounded at base and summit, and the margins are almost entire, being slightly undulate in some parts. Such leaves resemble those of some species of Juglans, and one of these is shown on Pl. XIX, fig. 8, but they shade into the normal form in such a way that they can not be separated.

These leaves are much like those described by Lesquereux under the name of *Celastrophyllum ensifolium* (Cret Fl., p. 108, Pl. XXI, figs. 2, 3), which were found in the Dakota group of Kansas, and it is quite possible they are specifically identical; but they are represented as being more coriaceous in texture, having a much stronger nervation, and a base abruptly narrowed, with a concave curve; the summit truncated or "broadly deltoid-pointed." If these characters should be found to be constant in the Kansas leaves they would plainly separate the species, for in those under consideration the summit is always gradually narrowed and broadly or narrowly rounded; the texture also seems to have been much lighter.

Among the foreign Cretaceous species of Celastrophyllum, this may be compared with *C. lanceolatum* Ett. (Kreideflora von Niederschoena, p. 260, Pl. III, fig. 9). But the single figure given by Ettingshausen shows the margins to be set with coarse, acute serrations, such as are only very exceptionally seen on the margins of our leaves. In other respects the resemblance is close, and with more material we may find that the species should be united.

Heer, in his Flora Fossilis Arctica (Vol. VII, p. 40, Pl. LXIV, fig. 9a; Pl. LXV, figs. 7, 8), gives figures of three imperfect leaves which he refers to

C. lanceolatum. These show only the basal portions, and are scarcely sufficient for accurate determination. Two of these have the margins coarsely serrate; in the third they are represented as entire. Under the circumstances we are scarcely justified in considering our leaves specifically identical with either Heer's or Ettingshausen's, but they are very closely allied. Another leaf figured by Heer (op. cit., Pl. LXV, fig. 6) he calls *Celastrophyllum serratum* Sap. et Mar., but in this the long wedge-shaped base is coarsely serrated nearly to the petiole, a character which we have never found in our leaves. Saporta and Marion obtained the leaves upon which the description was based from the Upper Cretaceous strata at Gelinden, and it is an interesting fact that leaves so closely allied, if not identical, occur in strata approximately of the same age at these so widely separated localities.

Celastrophyllum minus Hollick n. sp.

Pl. XLII, figs. 51, 52.

Leaves broadly spatulate in outline, 12^{mm} or 13^{mm} long by 8^{mm} broad, entire or somewhat undulate-crenate near the apex, narrowed to the base; nervation obscure or obsolete.

These are the smallest leaves which I have referred to this genus The absence of nervation makes it almost impossible to know where to look for their affinities, but the spatulate outline and crenate margin give a general impression of the genus.

No memoranda in regard to name or locality were found in connection with them.—A. H.

Celastrophyllum Brittonianum Hollick n. sp.

Pl. XLII, figs. 37, 38, 46, 47.

Leaves lanceolate or slightly lanceolate-spatulate in outline, finely denticulate above, entire below, tapering to the petiole; secondary nervation fine, but clearly defined, anastomosed in irregular loops, and connected by numerous reticulations.

The several leaves included under this name differ from *C. spatulatum* chiefly in having a nearly symmetrical lanceolate outline and finer dentation. That they are generically related there can be but little question, and it may be that they and *C. robustum* Newb. should all be considered as varieties of one species. It was, however, the evident intention of Dr. Newberry to keep them separated, and hence they are so retained.

Dr. Newberry left no memoranda in connection with these specimens, and I have named the species in honor of Dr. N. L. Britton, of Columbia College.—A. H.

Order ACERACEÆ.

Acer amboyense Newb. n. sp.

Pl. XLVI, figs. 5–8.

Leaves unknown; samaræ 15^{mm} to 25^{mm} in length and 8^{mm} to 10^{mm} in width; the wing is broad, rounded, membranous, and veined.

These seeds of a species of maple are quite unmistakable, and a number of them have been found in the Amboy Clays; but up to the present time we have no leaves that in any way correspond to those of Acer or Negundo. The samaræ are about the form and size of those of the red maple (*Acer rubrum*), but the wing is rather broader.

We find in the collection a few samaræ which are different from the usual form. One of these is represented by fig. 5, in which the wing is nearly straight. This, I have fancied, might very well be the winged seed of a pine, the presence of which genus in the Amboy flora is proven by fascicles of leaves.

Localities: Woodbridge, South Amboy.

Order RHAMNACEÆ.

Rhamnites minor Hollick n. sp.

Pl. XLII, fig. 36.

Leaf small, about 19^{mm} or 20^{mm} long by 22^{mm} or 23^{mm} broad at middle, slightly decurrent at the wedge-shaped base, rounded at apex; nervation fine, camptodrome, lower secondaries leaving the midrib at an acute angle, upper ones less so.

It is not unlike *R. apiculatus* Lesq. (Fl. Dak. Gr., p. 171, Pl. XXXVII, figs. 8–13), but is considerably smaller and is not mucronate.

Dr. Newberry left no indication of name or locality in connection with either figure or specimen.—A. H.

Paliurus ovalis Dn.

Pl. XXIII, figs. 8, 9.

Paliurus ovalis Dawson, Mesozoic Floras of Rocky Mountain Region. Trans. Roy. Soc. Canada, Vol. III, sec. 4, 1885, p. 14, Pl. IV, figs. 4, 8.

The leaves now figured are rather smaller than, but otherwise indistinguishable from, those figured by Sir William Dawson, which he collected at Mill Creek, Canada, from about the middle of the Cretaceous series Lesquereux describes a somewhat similar leaf, *P. membranaceus*, from the Dakota group (Cret. Fl., p. 108, Pl. XX. fig. 6), but it differs manifestly in this, that the lateral nerves are relatively finer and do not reach to or near to the summit, as they do in the leaves figured by Dawson and myself. There is little doubt in my mind that our leaves should be set off in a new genus, as they are almost equally three-nerved, and the lateral nerves are drawn in to join the midrib at the summit, as in Smilax. Sir William Dawson suggests that there are scarcely any good characters by which these leaves can be distinguished from those of Ceanothus, but while this is true of the Cretaceous and Tertiary species, such as *P. membranaceus* Lesq., from the Dakota group, *P. ovoideus* Heer, from the Tertiary of Œningen, and of a part of the leaves described by Heer under the name of *P. Colombi*, the leaves now under consideration—those described by Sir William Dawson (loc. cit.) and that figured by Heer (Fl. Foss. Arct., Vol. VII, Pl. LXIX, fig. 9), with entire margins, ovate elliptical outlines, and three nerves which come together at the summit—present characters so unlike those of the serrated or crenulated leaves called Paliurus that they should be placed in a distinct genus.

Order VITACEÆ.

Cissites formosus Heer.

Pl. XLVII, figs. 1–8.

Cissites formosus Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 85, Pl. XXI, figs. 5–8.

Quite a number of leaves are here represented which I have referred to the above species. Unfortunately, most of the specimens are in a bad state of preservation, owing to the fact that at the locality where they were found the leaves are all coated with a thick sheet of lignite, which, containing much water, cracked and fell to pieces on exposure. When first obtained the leaves were perfect and beautiful, but before they could be drawn they had suffered irreparable harm. Possibly more than one species is represented in these figures, as those represented by figs. 1, 4, and 5 seem to have been trilobed, while in the others the lobes were subdivided so that they might be called five-lobed. Doubtless in the future more perfect specimens will be obtained, which will permit a more thorough comparison among themselves and with the Greenland plant. It seems to me, however, that we can not doubt that among these lobed leaves from the Amboy Clays we have a number that are identical with those found in the Atane beds of Greenland.

Among the leaves figured on Pl. XLVII those represented by figs. 1, 3, and 6 are from beds in which the coating of the leaf was thin, amounting in some cases to a mere coffee-colored stain. These have been perfectly preserved, and in beds where the leaf impressions are of this character others no doubt will be found in the future that will present the complete outlines and the range of variation of these leaves. Those shown at figs. 4, 5, 7, and 8 are, however, from the clays where the sheet of carbonaceous matter over the leaf impressions was less oxidized and thicker, and which failed to be preserved by any method adopted. Colodion, glue, mucilage, paraffin, water glass, all were ineffectually tried. Possibly a solution of shellac in alcohol, in which the leaf impressions had been dipped or sprayed, would have been more successful. We have here an illustration of the great difficulty which has attended the collection and study of the fossil plants of the New Jersey clays.

Localities: Sayreville, South Amboy, Woodbridge.

Cissites crispus Vel.?

Pl. XLII, figs. 20–23.

Cissites crispus Velenovský, Fl. Böhm. Kreidef., Part IV, p. 12, Pl. IV, fig. 6.

We have figured here a number of small leaves with deeply toothed or incised margins. Among all fossil plants which have come under my observation that figured and described by Velenovský with the above name comes nearest to these, and while without much more material it will be impossible to assert the identity of our leaves with those found in the Upper Cretaceous of Bohemia, still the resemblance is so close that it seems extremely probable that they are related, if not identical.

Locality: Woodbridge.

Order TILIACEÆ.

TILLÆPHYLLUM DUBIUM Newb. n. sp.

Pl. XV, fig. 5.

Leaf 9^{cm} wide by 10^{cm} long, ovate, cordate, pointed at the summit, margins uniformly and strongly dentate; nervation delicate, but well defined; midrib slightly arched upward, two basal nerves strong, throwing off branches to the margin on either side, above these the side branches and branchlets terminate in the margins, but near the summit are apparently camptodrome.

But a single leaf of this species is contained in the collection. It is in a rather bad state of preservation, but is very distinct from any other plant yet found in the Amboy Clays, and therefore deserves notice. By the general plan of its nervation, by its dentate margin, and by its want of symmetry it resembles some leaves of our basswood, such as could be collected in almost any forest. The texture of the leaf would seem to have been thin and the surface not polished. Doubtless collections made in the future at the locality where this specimen was found will yield material for a more complete description.

Locality: Fish House.

Order PASSIFLORACEÆ.

PASSIFLORA ANTIQUA Newb. n. sp.

Pl. XXIII, fig. 7.

Leaves medium size, petiolate, margins entire, two-lobed, lobes widely divergent, rounded at summit; primary nerves, three, all diverging from the base of the leaf, the central one running directly to the bottom of the broad sinus, the others passing from the base to the point of the lobes, in which they are lateral below, central above; secondary nerves very fine, alternate branches given off from each of the primary nerves, but lost before reaching the margin.

The leaves of this species are smaller than those of *Bauhinia cretacea*, with which they are associated, and may be distinguished at a glance by the different nervation and the very much broader sinus, the lobes being divergent at an angle of 45°.

Locality: Very rare at Woodbridge.

Order MYRTACEÆ.

Eucalyptus Geinitzi Heer.

Pl. XXXII, figs. 2, 12, 15, 16.[1]

Eucalyptus Geinitzi Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 93, Pl. XLVI, figs. 12c, 13.

Leaves lanceolate, pointed above and below, 10^{cm} to 15^{cm} long by 15^{mm} to 25^{mm} wide, margins entire; nervation open and flexuous, lateral nerves numerous, arched upward, connecting above to form a festoon parallel with the margin, united by tertiary branches which divide the spaces between them into square or oblong areoles.

A considerable number of leaves answering to the description given above occur in the Amboy Clays, and so nearly coincide with those figured by Heer under the name of *Eucalyptus Geinitzi* that I have been compelled to consider them the same. The plan of nervation is essentially the same as that of the other leaves I have grouped in the same genus, but the nervation is more open and the leaves are broader and larger.

One of the supposed fruits of this species as figured by Heer is represented on Pl. X, fig. 10, of this monograph. (See supra, p. 46.)

Localities: Woodbridge, Sayreville, etc.

[1] I doubt very much that fig. 16 represents a specimen of this species, or even genus. It is unquestionably so included, however, in Dr. Newberry's manuscript.—A. H.

EUCALYPTUS? ATTENUATA Newb. n. sp.

Pl. XVI, figs. 2, 3, 5.

Leaf 10^{cm} to 15^{cm} in length, narrowed or rounded at the base, pointed or attenuated at the summit, margin entire; nervation strongly reticulate.

Numerous leaves of this species occur, generally in an imperfect state of preservation. The nervation, however, is nearest that of Eucalyptus, or at least of the leaves so designated by Heer from the Atane beds of Greenland.

More material will be required before the generic affinities can be positively asserted.

Locality: South Amboy.

EUCALYPTUS? ANGUSTIFOLIA Newb. n. sp.

Pl. XXXII, figs. 1, 6, 7.

Leaves long linear, pointed above, attenuated or rounded below, from 10^{cm} to 15^{cm} long, 8^{mm} to 12^{mm} wide, margins entire; nervation rather crowded, midrib slender, side branches numerous, leaving the midrib at an acute angle and forming a festoon close along the margin.

These leaves apparently belong to the same genus as those that have been called Eucalyptus by Heer in his Flora Fossilis Arctica, Vol. VI, Abth. II, pp. 93, 94, Pl. XLVI, figs. 12–14. The general form of the leaf is similar, and the peculiar nervation—that is, numerous lateral nerves uniting to form a continuous festoon closely parallel with the margin—is essentially that of Eucalyptus. Professor Heer feels strengthened in his reference of leaves having this nervation to Eucalyptus by finding in company with them what he regards as the fruit of Eucalyptus; but in my judgment the examples he gives of this fruit (op. cit., loc. cit., and Pl. XLV) are rather detached scales of the cone of some conifer, and probably generically identical with the cone scales which he has called *Dammara borealis* (op. cit., pp. 54, 55, Pl. XXXVII, fig. 5). The fruit of Eucalyptus is a pyxis or urn, circular in section, and with a lid; but in the large number of specimens of organisms which I have found in the Amboy Clays and have considered identical with Heer's so-called Dammara I have looked in vain for any evidences of a separation between the summit and base, and have regarded them as the exposed and buried portions of cone scales. (See supra, pp. 54-55.)

The leaves now under consideration differ from those I have considered as identical with Heer's *Eucalyptus Geinitzi* in this, that they are much longer and narrower and more attenuated at base and summit.

Locality: South Amboy.

NOTE.—For representatives of fruit of *Dammara microlepis* Heer and *Eucalyptus Geinitzi* Heer, from Fl. Foss. Arct., see Pl. X, figs. 9, 10, of this monograph.—A. H.

EUCALYPTUS? NERVOSA Newb. n. sp.

Pl. XXXII, figs. 3, 4, 5, 8.

Leaves long-linear, rounded or subacute at summit, narrowed and wedge-shaped at base, 15^{cm} in length by 1^{cm} in width, margins entire; nervation strong, crowded, midrib continuous from base to summit, lateral nerves very numerous, generally parallel and uniting to form a continuous nerve-thread near to and parallel with the margin.

The general aspect of these leaves is peculiar. The style of nervation is similar to that of all the elongated, lanceolate, or linear leaves which I have grouped provisionally in the genus Eucalyptus, but in this species the nervation is much more crowded, and the union of the summits of the lateral nerves forms a more straight and continuous nerve-thread.

Locality: South Amboy.

EUCALYPTUS? PARVIFOLIA Newb. n. sp.

Pl. XXXII, figs. 9, 10.

Leaves small, about 5^{cm} to 6^{cm} in length by 12^{mm} to 15^{mm} wide in the middle, strictly lanceolate in form, pointed above and below, margins entire; nervation rather delicate and open, lateral nerves more or less numerous united in a festoon somewhat removed from the margin.

The leaves described above may be but one of the varieties of *E. Geinitzi*, but they are so decidedly lanceolate in outline, so much broader in proportion to their length, and so much smaller, that I have felt constrained to consider them distinct. The characters of the form and nervation exhibited by these leaves are well shown in the figures now given.

Locality: South Amboy.

Order ARALIACEÆ.

Hedera primordialis Sap.

Pl. XIX, figs. 1, 9; Pl. XXXVII, figs. 1–7.

Hedera primordialis Saporta, Le Monde des Plantes, p. 200, fig. 29.

Normal leaves kidney-shaped or cordate, with a deep sinus at the base, 8^{cm} to 15^{cm} in diameter, long petioled, margins entire, sometimes waved; nervation radiate, from five to seven nerves springing from a common point at the base of the leaf, diverging toward the margin, branching above, inosculating and forming a network of large meshes which are filled with areoles of various sizes and dimensions.

Leaves which I can not distinguish by any constant characters from *Hedera primordialis* of Saporta are rather common at Woodbridge. A number of figures on Pl. XXXVII are given to show the variation in form and for the purpose of identifying a characteristic plant of the formation, and one which possesses the additional interest of being common to the Amboy Clays, the Atane beds of Greenland, and the Cenomanian of Bohemia. It will be seen that there is considerable diversity in the size and form of the leaves, but the predominant and normal character is shown by figs. 1, 2, 4, and 6 of Pl. XXXVII.

Locality: Woodbridge.

Hedera obliqua Newb. n. sp.

Pl. XXXVII, fig. 8; Pl. XXXVIII, fig. 5.

Leaves large, 10^{cm} to 15^{cm} in length and 8^{cm} or 10^{cm} in width, unsymmetrical, elliptical in outline, margins somewhat waved; nervation radiate from the top of the petiole, which is an inch or more in length; that one of the nerve branches strongest which passes to the portion of the margin most remote from the base; the other branches, three or four in number, inosculate with this and with one another to form an irregular and open network.

These leaves have much in common with the much more numerous ones that are associated with them and which I have considered as identical with Saporta's *Hedera primordialis*, and it may prove that they are but phases of the same foliage. It will be seen, however, that the leaves of *H. primordialis* are symmetrically heartshaped, with more or less deep sinuses, and with a midrib and corresponding branches radiating from the base on either side. In the leaves now under consideration, however, the want of symmetry is most marked. The leaves attain a larger size, are not cordate, and are generally transversely or obliquely elliptical, though sometimes nearly round. Of *H. primordialis* we have thirty or forty fairly well preserved leaves; of *H. obliqua*, only three or four, so that it would seem that this species or variety was much less common than the other.

Locality: Woodbridge.

Aralia Wellingtoniana Lesq.[1]

Pl. XXVI, fig. 1.

Aralia Wellingtoniana Lesquereux, Fl. Dak. Gr., p. 131, Pl. XXI, fig. 1; Pl. XXII, figs. 2, 3.

Leaves medium size, 15^{cm} long by 12^{cm} or 13^{cm} broad, petiolate, symmetrically three-lobed, lobes lanceolate, acute, sharply but remotely serrate, basal margin entire; base long wedge-shaped; nervation strong, primary nerves three, which meet before reaching the point of the base, secondary nerves diverging at an angle of about 45°, parallel, gently curved, terminating in the teeth of the border.

This very elegant leaf resembles those of *A. Saportana* Lesq. of the Dakota group as far as regards the shape of the lobes and their denticulated edges, but it may be at once distinguished from that species by its having only three lobes instead of five. *Aralia decurrens* Vel. (Die Flora

[1] Dr. Newberry's original manuscript name for this species is *A. concinna*, n. sp. It is, however, manifestly identical with the three-lobed form of *A. Wellingtoniana* Lesq. as described and figured in the Flora of the Dakota Group.—A. H.

der Böhm. Kreidef, Vol. IV, Part III, p. 11, Pl. IV, figs. 5–7) is somewhat like *A. Wellingtoniana* in its three-lobed and denticulate margins, but in Velenovský's species the lobes are relatively longer and narrower, the denticulation is coarser, and the sinuses extend to the base of the leaf.

From the other species of Aralia with which this is associated in the Amboy Clays this differs in having the margins of the lobes denticulate, since they all have entire margins. A similar trilobate species of Aralia (*A. Looziana* Sap. et Mar.) occurs in the Paleocene beds of Gelinden, but the leaves are smaller, less deeply cut, and the denticulation is coarser.

A trilobate Aralia (*A. formosa* Heer) also occurs in the Upper Cretaceous strata of Moletein, and Lesquereux figures (Cret. and Tert. Fl., p. 60, Pl. XI, figs. 3, 4) what he considers leaves of the same species from the Dakota sandstones of Morrison, Colo., but these differ from those now before us in the much coarser dentation of the margins. It may even be said that in the Colorado species the margins are crenate, being set with closely approximated obtuse teeth or scallops, while in the leaves of *A. Wellingtoniana* the margins of the lobes—not the base—are set with remote, acute, awn-like teeth, as in *A. macrophylla* of the Green River Tertiary.

Locality: Woodbridge.

ARALIA QUINQUEPARTITA Lesq.

Pl. XL, figs. 1, 2.

Aralia quinquepartita Lesquereux, Cret. Fl., p. 90. Pl. XV, fig. 6.

Two specimens contained in our collections, those now figured, I have been unable to distinguish from Lesquereux's species from the Dakota group mentioned above. They also approach near to *A. Ravniana* Heer (Fl. Foss. Arct., Vol. VI, Abth. II, p. 84, Pl. XXXVIII, figs. 1, 2), but have the central lobe much narrower. Perhaps more material will bring out differences between our plant and that described by Lesquereux, but this seems improbable. Doubtless this should be added to the considerable number of species of fossil plants common to the Amboy Clays and the Dakota sandstones.

Locality: Woodbridge.

Aralia grönlandica Heer.

Pl. XXVIII, fig. 4.

Aralia grönlandica Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 84, Pl. XXXVIII, fig. 3; Pl. XXXIX, fig. 1; Pl. XLVI, figs. 16, 17.

Among the great number of trilobate leaves which we have collected from the Amboy Clays there is one variety which has considerable resemblance to that named by Heer *A. grönlandica* (loc. cit.). In these leaves the lobes are subequal, the lateral nerves leaving the midrib at an angle of about 45°. The leaf now figured is smaller and the lobes narrower than those represented by Heer; and in one of his figures, on the under side of the lateral lobes, there is a small sublobe; so that Professor Heer's figures, which he has included under one name, differ more among themselves than they do from this, which I have supposed might be our representative of the species. It will be seen by looking over the figures of the different leaves of Aralia given in this monograph that there were evidently a number of species in the Amboy flora, and also that, like the leaves of most trees, there was considerable variation within the limits of a single species; so that it is possible all the figures credited to *A. grönlandica* by Professor Heer may represent one species; but it seems to me more probable that the broad, entire lobed leaf represented on Pl. XXXVIII, fig. 3, of the Flora Fossilis Arctica, should be regarded as distinct from that represented on Pl. XXXIX, fig. 1. It is certain also that the fragmentary leaves represented in figs. 16, 17, on Pl. XLVI, do not belong to the same species, fig. 16 being perhaps identical with the type of *A. grönlandica*, while the second was a many-lobed leaf and probably belonged to Heer's species, *A. Ravniana* (op. cit., p. 84, Pl. XXXVIII, figs. 1, 2).

Locality: Woodbridge.

Aralia formosa Heer?.

Pl. XXII, fig. 8.

Aralia formosa Heer, Kreideflora von Moletein, p. 18, Pl. VIII, fig. 3.

A single and very imperfect specimen of what seems to have been a trilobed Aralia with undulate margins has been found. The lobes of the leaf must have been longer, more acute, and less strongly crenulate on the margins than the type of Professor Heer's description in his Kreideflora von Moletein; but Velenovský, in his Flora der Böhmischen Kreideformation, Part I, Pls. VI and VII, gives figures of several specimens of what he calls *Aralia formosa*, in which the sinuses are deeper, the lobes narrower, and the marginal teeth smaller than in the type, in these respects approaching very closely to our specimen; hence, since that is different from any other yet obtained from the New Jersey clays and approaches so closely to Velenovský's figures, I venture to call it provisionally by the same name.

Locality: South Amboy.

ARALIA PALMATA Newb. n. sp.

Pl. XXXIX, figs. 6, 7; Pl. XL, fig. 3.

Leaves palmate, five-lobed, lobes short, the upper three much larger, than the lower, margins entire; secondary nervation either delicate or sunk in the parenchyma of the leaf, often invisible.

In general aspect this species somewhat resembles *Aralia Whitneyi* Lesq. (Flora Auriferous Gravels, p. 20, Pl. V, fig. 1), but the leaf is smaller, the number of the marginal lobes is less, and in that species they are acute.

Locality: Woodbridge.

ARALIA PATENS Newb. n. sp.

Pl. XXVIII, fig. 3.

Leaves petioled, 18^{cm} to 20^{cm} in lateral diameter, palmately three-lobed, lobes subequal, lance-linear in outline, subacute, lateral lobes broadly divergent, with deep sinuses between them and the middle lobe, margins entire.

The above description is based on the leaf figured and what seems to be a lateral lobe of another of still larger size. Both may be but forms of *A. grönlandica* Heer, but the divergence of the lateral lobes is much greater and the sinuses are much deeper than in any of the many leaves I have supposed to represent Heer's species in our collections.

The angle of divergence of the lateral lobes is about as great as in *Sassafras hastatum*, but in that species the lateral lobes are shorter and broader, being triangular in outline.

Locality: Woodbridge.

ARALIA POLYMORPHA Newb. n. sp.

Pl. XXXIX, figs. 1–5.

Leaves extremely variable in form, three- to five-lobed, frequently unsymmetrical, the middle and larger lobe turned to one side, margins entire; nervation delicate, often invisible; lobes obtuse; petiole short or wanting.

By reference to the figures now given it will be seen that this is a protean species, fig. 2 being quite symmetrical, having the outline of so many Aralias; that is, primarily three-lobed, but with a subordinate basal lobe on either side. Figs. 1 and 3 represent the distorted form to which allusion has been made in the description. Figs. 4 and 5 represent small and abnormal forms which may or may not represent this species.

Locality: Woodbridge.

ARALIA ROTUNDILOBA Newb. n. sp.

Pl. XXVIII, fig. 5; Pl. XXXVI, fig. 9.

Leaves five-lobed, 10^{cm} wide by 7^{cm} or 8^{cm} high; lobes all rounded and comparatively short; margins entire; nervation delicate, camptodrome.

Only two specimens of the leaf of this plant have been obtained. The most striking peculiarity is the rounded outline of each of the lobes. I have seen some specimens of *Liquidambar integrifolium* Lesq. in which the lobes are obtuse and somewhat rounded, giving the leaf very much the aspect of those before us. More material will be necessary, however, before the identity of the two forms can be asserted.

Locality: Woodbridge.

CHONDROPHYLLUM OBOVATUM Newb. n. sp.

Pl. XLII, figs. 26, 27.

Leaves obovate to orbicular, 15^{mm} to 25^{mm} in length by 10^{mm} to 20^{mm} wide, margins entire, base more or less wedge-shaped, summit rounded and sometimes emarginate; nervation conspicuous and yet delicate, consisting of a midrib which vanishes near the summit of the leaf and gives off branches that unite to form festoons relatively remote from the margins, while all the intervals between the secondary nerves and between the festoon and the margin are filled in with large polygonal areoles.

These leaves resemble those described by Professor Heer (Fl. Foss. Arct., Vol. III, Part II, pp. 114–115, Pl. XXXII, figs. 11–13). In outline they seem intermediate between the two forms which he calls *Chondrophyllum Nordenskiöldi* and *C. orbiculatum*, the outline being somewhat more like the former, the nervation like the latter. I have therefore thought it better to give to our leaves a distinct name.

The genus Chondrophyllum is ill defined, and more material will be needed before anything definite can be said in regard to its limitations or its relations to living plants. Professor Heer puts the species referred to above into the family of the Ampelideæ, states that fruits which he considers those of the Panax were found with them, and suggests that they belonged to this genus or some related araliaceous plant.

Locality: Woodbridge.

CHONDROPHYLLUM RETICULATUM Hollick n. sp.

Pl. XLI, figs. 6, 7.

Leaves orbicular (?) in outline, abruptly narrowed at the base, entire; midrib and secondaries fine, about equal in thickness, all gradually losing themselves in the parenchyma of the leaf or merging into the delicate reticulated nervation of the blade.

The two imperfect specimens represented are apparently referable to this genus and have much in common with *C. orbiculatum* Heer. The imperfect upper part of both of our specimens leaves us in doubt as to the exact character of the apex, which may have been emarginate.

No memorandum in regard to either name or locality accompanied either the specimens or the figures.—A. H.

Order CORNACEÆ.

CORNOPHYLLUM VETUSTUM Newb. n. sp.

Pl. XIX, fig. 10.

Leaves elliptical, 7^{cm} or 8^{cm} long by about 4^{cm} wide, points subacute, base slightly wedge-shaped, short petioled, margins entire; nervation delicate, midrib straight, lateral nerves opposite or alternate, about seven pairs, parallel, strongly arched upward, especially toward the summit, where they connect in a simple festoon.

The form and structure of these leaves is altogether that of Cornus, yet the nervation is more delicate than is known in that genus. The lateral nerves running out parallel, strongly arched upward, curving near the margins to connect with those above, and drawn in at the summit, precisely as in many species of Cornus, tempt us to include it in that genus; but a certain want of rigidity and exactness in the nervation suggests that the relationship should be indicated rather than asserted. This is a rare form in our collections, and more material will be needed for its exact classification

Locality: Woodbridge.

Order ERICACEÆ.

ANDROMEDA PARLATORII Heer.

Pl. XXXI, figs. 1–7; Pl. XXXIII, figs. 1, 2, 4, 5.

Andromeda Parlatorii Heer, Phyllites Crétacées du Nebraska, p. 18, Pl. I, fig. 5.
Prunus (?) *Parlatorii* Lesquereux, Am. Jour. Sci., 2d ser., Vol. XLVI (1868), p. 102.

One of the most common leaves found in the New Jersey clays is indistinguishable from that described by Heer (op. cit.) from the Dakota of Nebraska, and as it is so characteristic a plant of the formation and one found at nearly every locality opened, I have felt justified in giving a number of figures of it. There seems to be little evidence that this really represents the genus Andromeda, but aside from its botanical relations the plant is an important one as showing the relation between the Amboy Clays and the Dakota group of the West.

ANDROMEDA LATIFOLIA Newb. n. sp.

Pl. XXXIII, figs. 6–10; Pl. XXXIV, figs. 6–11; Pl. XXXVI, fig. 10.

Leaves varying greatly in size and shape; 4^{cm} to 20^{cm} in length by 1.5^{cm} to 7^{cm} in width, lanceolate or spatulate in outline, generally acute, sometimes rounded at summit, wedge-shaped below; nervation strong and simple, midrib very strong, lateral branches relatively few, slender, and flexuous, leaving the midrib at an acute angle and inosculating to form an open festoon near the margin; substance of the leaf coriaceous; surfaces smooth.

With the leaves of *A. Parlatorii* occur others which are larger, broader, and less regular in outline. They have the same leathery consistence, which frequently results in the peeling off and breaking away of the residual substance of the leaf.

Localities: Woodbridge, Sayreville, etc.

ANDROMEDA FLEXUOSA Newb. n. sp.

Pl. XXXIV, figs. 1–5.

Leaves linear or lanceolate, 6^{cm} to 12^{cm} in length by 1.5^{cm} to 3^{cm} wide, pointed above, wedge-shaped below, margins entire; nervation relatively strong and simple, midrib flexuous, giving off at the salient curves side branches which are arched upward and inosculate very near the margin; tertiary nervation mostly consisting of simple, sometimes forked nervelets which connect the secondary branches dividing the interval into oblong areoles.

The general aspect of these leaves is similar to that of those which I have noted as *A. Parlatorii* and *A. latifolia*, and while their relation to the living genus, the name of which was given them by Heer, is doubtful, they seem to be inseparably connected together and form a group which is a marked feature of the flora of the Amboy Clays. As in the other species, the leaves of *A. flexuosa* were thick and leathery, though to a less degree. Its most marked feature is the flexuous course of the midrib.

Localities: Woodbridge, Sayreville, etc.

ANDROMEDA NOVÆ-CÆSAREÆ Hollick n. sp.

Pl. XLII, figs. 9–12, 28–31.

Leaves lanceolate in outline, about equally acuminate at both ends, entire, tapering to the petiole; secondaries more or less obscure, numerous, leaving the midrib at an acute angle, subparallel, gradually nearing each other at their extremities, where they are connected by fine cross-veining.

These leaves have somewhat the appearance of small specimens of

A. Pfaffiana Heer, and are not unlike the specimen described and figured by Professor Lesquereux (Fl. Dak. Gr., p. 118, Pl. LII, fig. 5) under the name *A. linifolia*; but our specimens are not so long-acuminate, and are too broad in proportion to their length, more nearly resembling *A. Snowii* Lesq. (Fl. Dak. Gr., p. 117, Pl. XVII, fig. 16), but apparently sufficiently distinct to be regarded as a separate species.

Locality not known.—A. H.

Order MYRSINACEÆ.

Myrsine borealis Heer.

Pl. XXIV, figs. 4-6.

Myrsine borealis Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 81, Pl. XXIV, figs. 7b, 8; Pl. XXVII, fig. 1b; Pl. XLIV, fig. 5a; Pl. XLVI, figs. 19, 20.

Among the most common leaves in the Amboy Clays at all the localities where plants are found there is one which is small, sharply defined, oval or oblong in outline, 2.5^{cm} to 4^{cm} in length, and of thick and leathery consistence. The nervation is generally lost in the parenchyma of the leaf, but where seen it corresponds with the plant figured by Heer, which also seems to have been common in the Patoot and Atane beds of Greenland.

Myrsine elongata Newb. n. sp.

Pl. XXII, figs. 1-3.

Leaves lanceolate, obtuse, entire, petioled, tapering to a wedge-shaped base, about 6.5^{cm} to 7^{cm} long, including the petiole, by 2^{cm} wide at broadest part; nervation that of Myrsine.

No description accompanied these figures, but the above name appears upon the specimen labels in Dr. Newberry's handwriting.

Locality: South Amboy.—A. H.

Myrsine oblongata Hollick n. sp.

Pl. XLII, fig. 15.

A single leaf with oblong outline and entire margin, 25^{mm} long by 12^{mm} or 13^{mm} wide, blunt at both ends, is placed under the above name

No memorandum in regard to locality or supposed botanical relationship was found in connection with either the figure or the specimen.—A. H.

Order SAPOTACEÆ.

Sapotacites retusus Heer.

Pl. LIII, figs. 5, 6.

Sapotacites retusus Heer, Fl. Foss. Arct., Vol. VII, p. 32, Pl. LXI, fig. 10.

In the Amboy Clays, as in the Atane beds in Greenland, numerous emarginate leaves are found which correspond to several of those figured by Heer in his Flora Fossilis Arctica as either forms of *Liriodendron Meekii* (Vol. VI, Abth. II, Pl. XXII) or regarded by him as species of Colutea, Sapotacites, or Leguminosites. Among others is a long-ovate leaf, of which a figure is now given, that corresponds closely with the one figured by Heer as *Sapotacites retusus*. In some cases the emargination is much deeper than in others, and such leaves would probably be referred by Heer to his *Liriodendron Meekii*, but we have reason to believe that this leaf is not a Liriodendron. We have several species of that genus represented in the Amboy Clays, some of which have been already described in the Bulletin of the Torrey Botanical Club; and while one of these, which I have included among the varieties of *Liriodendropsis simplex*, has the long-ovoid and lanceolate form of the leaves under consideration, it always has the margination angular and the lateral points acute.

I should also say that the forms figured on Heer's Pl. XXIII of Vol. VI, formerly described by him as *Leguminosites Marcouanus* and *Sapotacites obcordatus*, but later considered by him as forms of *Liriodendron Meekii*, have not been found in the Amboy Clays, and so far as known at present they are confined to the Dakota sandstones of the West, and they should not, in my judgment, be regarded as varieties of any species of Liriodendron.

Locality: Woodbridge.

Order EBENACEÆ.

DIOSPYROS PRIMÆVA Heer.

Pl. XXX, figs. 1–5.

Diospyros primæva Heer, Phyll. Crét. du Neb., p. 19, Pl. I, figs. 6, 7.

A number of leaves have been found which so closely resemble those described by Heer, first in the Phyllites Crétacées du Nebraska, and afterwards in Vols. VI and VII of the Flora Fossilis Arctica, that I am compelled to consider them the same. The form is ovoid, elliptical, the base wedge-shaped, the summit obtuse or subacute, the margins entire, the nervation very distinct and open, the midrid strong, the lateral branches forming a coarse festoon parallel with the margins, and all the included areas filled with polygonal and relatively large areoles. This prominence of the tertiary nervation is a marked feature of these leaves, as it is of those obtained by Heer from the Upper Cretaceous of Greenland, as will be seen in Vol. VII, Pl. LXI, fig. 5b.

Locality: South Amboy.

Order ASCLEPIADACEÆ.

ACERATES sp.?

Pl. XXXII, fig. 17; Pl. XLI, figs. 4, 5.

In regard to the specimen figured on Pl. XXXII, fig. 17, there can be little doubt that it belongs to the genus *Acerates*. *A. arctica* Heer is described and figured in Flora Fossilis Arctica, Vol. VI, Abth. II, p. 82, Pl. XXX, figs. 19, 20, but our specimens seem to compare better with *A. longipes* as described and figured in Contributions à la Flore Fossile du Portugal, pp. 31–32, Pl. XXIV, figs. 1b, 1c, 3a, 4, 5, 6, etc.

The specimens represented on Pl. XLI, figs. 4, 5, while probably the same, are destitute of any visible veining, and hence could be assigned only provisionally to the same species. It would therefore seem safer to place all three specimens under the same generic name, leaving the specific status to be determined in the future in the light of more and better material.

Locality: South Amboy.—A. H.

Order CAPRIFOLIACEÆ.

VIBURNUM INTEGRIFOLIUM Newb. n. sp.[1]

Pl. XLI, fig. 1.

Leaves circular or nearly so, somewhat longer than broad, 7^{cm} or 8^{cm} in diameter, margins entire; nervation strong, regular, craspedodrome.

One imperfect leaf of this plant is contained in the collection. The general structure of the leaf is that of Viburnum, and, except that the margins are entire, it fairly represents one of the larger and orbicular leaves of *Viburnum lantanoides*. The base is probably heart-shaped, but both summit and base in the specimen are defective. With so little material, of course the reference to Viburnum is entirely problematical, but this deserves to be enumerated as another of the extinct species of dicotyledonous leaves in the Amboy flora.

Locality: Woodbridge.

GENERA AND SPECIES OF UNCERTAIN AFFINITIES.

PALÆANTHUS (WILLIAMSONIA) PROBLEMATICUS Newb. n. sp.

Pl. XXXV, figs. 1–9.

Flowers, when fully expanded, discoid, 7^{cm} or 8^{cm} in diameter, composed of twenty or more narrow, strap-like floral envelopes set around the edge of a discoid receptacle, which is conical in form, flat above, pointed below, where it is continuous with the stem.

These remarkable objects have produced the greatest surprise, perhaps, which has been met with in the disinterment of the representatives we have collected of the flora of the Amboy Clays. Their general aspect is altogether that of a helianthoid flower; so much so that when drawings of them were sent to Dr. Gray, the leading authority on the Compositæ, he did not hesitate to say that they were composite flowers. Indeed, it would be impossible to reproduce in a fossil state, at least embedded in clay, anything more perfectly representative, in general and detail, of a composite

[1] The identity of this specimen with the genus Viburnum appears to be exceedingly doubtful, and yet there can be no doubt of Dr. Newberry's views in the matter; hence the original name remains unaltered.—A. H.

flower with twenty or more ray-florets. It is evident, however, that the material composing these florets of the ray was more substantial and persistent than that of most helianthoid flowers, but it is well known that many of the Compositæ, like Gnaphalium, Heliochrysum, etc., have the ray-florets scarious or woody, and large flowers of the latter genus buried up in mud and then baked would present practically the same aspect and exhibit apparently the same structure as these.

But it is well known that the Compositæ are among the most specialized and, as we say, the highest, of the flowering plants, and it would require some modification of the generally prevalent ideas of the progress of plant life on the globe to suppose that plants as highly organized as any at the present time were not only present but abundant in the flora that dates back to the middle of the Cretaceous age. And yet our exploration of the Cretaceous flora has been full of surprises like this. That the forests of North America at the date of the deposition of the Dakota sandstones and the Amboy Clays were largely composed of trees which in size, beauty, and botanical rank would compare favorably with the constituents of our forests at the present day is indisputable. Magnolias and Liriodendrons, the ornaments of our present forests, were there in abundance and apparently in their greatest development, because they were represented by a larger number of species than are found living at the present time. The Liriodendrons were not only more numerous but more varied and specialized, and it is evident that they were then in the golden age of their existence. So the Sassafras, the sweet gum, and the Aralias, and all the other conspicuous elements in this flora are of relatively high botanical rank. Hence, in such a flora, flowers of the Compositæ would not be out of place, and we should not hesitate to accept the obvious inference that these were such if it were not that a group of flower-like organs—I mean the flowers called Williamsonia—had been found in the Mesozoic rocks, possibly as low as the Trias, which are not without resemblance to, and perhaps not without botanical affinity with, these, and which have been proved to be the florescence of cycads. The flowers of Williamsonia have given rise to much discussion and have been regarded by botanists as representative of very different botanical groups. For example, Professor

Williamson[1] considered the first discovered species as the flower of *Zamia gigas*, an opinion concurred in by Carruthers,[2] who named the genus; Heer considered Williamsonia as a parasite allied to Rafflesia, while Saporta considered the plant which bore these flowers as monocotyledonous and allied to Pandanus.[3]

There is, however, this marked difference between Palæanthus and any of the species of Williamsonia known, such as *W. gigas* Carr., *W. Leckenbyi* Nath., *W. Blanfordi* Feistm., *W. virginiensis* Font., that these all consist of a series of floral envelopes of a tenacious and permanent character, surrounding an internal, urn-like, pear-shaped, or cylindrical spadix, the whole florescence sessile or short-peduncled; whereas in Palæanthus the ray-florets surround a tessellated disk, closely resembling the achenia-bearing receptacle of composite flowers, and are surrounded by a scaled involucre and supported by a well-defined stem.

Williamsonia Smockii Newb. n. sp.

Pl. XXXVI, figs. 1–8.

The flower cup-shaped or cylindrical, open above, with a simple margin, which is generally expanded slightly, sometimes contracted; below it rests upon a conical receptacle which reaches evenly downward, but narrows to a comparatively slender stem.

The dimensions vary considerably, from 2.5^{cm} to more than 3^{cm} in breadth, and from 2.5^{cm} to nearly 4^{cm} in height. The base of the flower and the stem seem to be covered with scales or bracts. Perhaps fifty of these flowers have been found in the Amboy Clays, and yet nowhere has any connection with any other plant been detected. There is great similarity between these flowers and those which I have called Palæanthus, but in the latter the flower consists of a large number of distinct and separable scarious spiral envelopes, which are sometimes radiately expanded,

[1] Williamson: Linn. Trans. Vol. XXVI, p. 663–674, Pls. LII, LIII.

[2] Carruthers: Linn. Trans. Vol. XXVI, pp. 680, 691.

[3] The following further references may be found of assistance in this connection:
Phillips: Geol. Yorksh., 3d ed., pp. 224, 225, Pl. XXIV.
Feistmantel: Flora of Kach (Palæontologia Indica), p. 52, Pl. XII, figs. 5–7.
Nathorst: Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1880, p. 33; 1888, p. 359.
Fontaine: Potomac Flora, p. 273, Pl. CXXXIII, figs. 5–7; Pl. CLXV, fig. 5.

sometimes contracted to form an outline not unlike the flowers under consideration. These, however, seem to consist of a continuous sheet of what, to have been preserved, must have been coriaceous material. This is striated longitudinally and is divided into distinct organs. The receptacle upon which each form of flower rests is essentially the same. It is a cone, of which the point below connects with the stem and the flattened base formed the floor of the flower. The resemblance of our fossils to those which have been called by Heer *Williamsonia cretacea* is so close that there can be no doubt of their generic identity. Professor Heer's fossils are described in Flora Fossilis Arctica, Vol. VI, p. 59, and figured on Pls. XII and XIII. The form of the flower cup in Professor Heer's species is much the same as that of ours, except that it is more swollen, less cylindrical and regular, and at the same time has a crenulated margin and is striated longitudinally, as though composed of compacted petals, while in our fossil the surface is essentially smooth. The pedicel, however, of Professor Heer's species is very different from ours: it is no broader at the top, but contracts much less rapidly, and descends to a thick, fleshy, scaled stem.

Professor Heer discusses at considerable length the relations of his fossils, recognizing their resemblance to several species of Williamsonia that have been described, and indicating their connection by taking the generic name; yet he does not accept the conclusion of Professor Williamson and others that it is the florescence of a cycad, but accepts the suggestion of Dr. Nathorst that it should be regarded rather as a parasite belonging to the order Balanophoreæ. But the recent discovery by Dr. Nathorst of a species of Williamsonia on the same stem with the leaves of Anomozamites places the subject in a new light and will probably compel us to return to the original suggestion of Williamson.

PROTOPHYLLUM OBOVATUM Newb. n. sp.

Pl. XXXVIII, fig. 4.

Leaf oval in outline, 10^{cm} to 12^{cm} in length by 7^{cm} or 8^{cm} broad, contracted at the base, the blade surrounding the petiole in a margin about 12^{mm} in width, margins entire; nerves delicate, pinnately arranged above, radiate at base, camptodrome.

Only one specimen of this interesting plant has yet been found in the Amboy Clays. It differs from the species described by Lesquereux from the Dakota group of the West (*Protophyllum Sternbergii*, *P. multinerve*, *P. rugosum*, etc.) in the simplicity of its outlines—as all the other species have undulate or dentate margins—and in its obovate form. The character of the base is, however, such as distinctly to bring it within the genus, and it indicates that this feature, so striking in the flora of the Dakota, was not wanting on the eastern shore of the continent during the deposition of the Amboy Clays.

The relations of Protophyllum to the flora of the present day have never been satisfactorily determined, but I would suggest that the leaves of some species of Coccoloba are very closely allied, both in form and structure, to those of Protophyllum.

Locality: Woodbridge.

Dewalquea grönlandica Heer?.

Pl. XLI, figs. 2, 3, 12.

Dewalquea grönlandica Heer, Fl. Foss. Arct., Vol. VI, Abth. II, p. 87, Pl. XXIX, figs. 18, 19; Pl. XLII, figs. 5, 6; Pl. XLIV, fig. 11; Vol. VII, p. 37, Pl. LXII, figs. 5, 6.

By comparison of our specimens with the figures represented by Heer in Flora Fossilis Arctica, Vol. VII, Pl. LXII, figs. 5, 6, under the above name, there seems to be but little doubt that the two are identical and that we are warranted in provisionally referring them to the same species.

No indication was given by Dr. Newberry as to his ideas concerning the probable affinities of these leaves, nor was there any memorandum in regard to locality.—A. H.

Dewalquea trifoliata Newb. n. sp.[1]

Pl. XXII, figs. 4–7.

Leaves in threes, springing from the same base, lance-linear, wedge-shaped at base, margins entire, summits unknown.

[1] The two-leaved form shown at fig. 7 was not named by Dr. Newberry, although grouped with the other figures. I am unable to determine whether he intended to regard it as a distinct species, and have included it provisionally with the others.—A. H.

Several of these trifoliate groups are contained in the collection, but none in which the entire form of the leaflets is shown. This material is too meager to determine with accuracy their generic relations, but no other has suggested itself than that with Dewalquea, a genus so frequently represented in rocks of Upper Cretaceous age.

Locality: Woodbridge.

Phyllites orbicularis Newb. n. sp.

Pl. XXIV, figs. 7, 8.

Leaves nearly orbicular, short petioled, about 4^{cm} in diameter, slightly emarginate at the summit and wedge-shaped at the base, margins entire; nervation fine, but distinct, regular; midrib slightly arched, side branches nearly equally spaced, simple below, connecting in a festoon above.

Only two specimens of this leaf are contained in the collection, and they present no characters by which they can be confidenrly referred to their botanical position. They are not unlike some of the forms of *Populus hyperborea* of Heer, but in my judgment they do not belong to the genus Populus. Hereafter more material will doubtless permit the generic relations to be satisfactorily determined.

Locality: Sayreville.

Phyllites ellipticus Newb. n. sp.

Pl. XXIV, fig. 9.

Leaf elliptical or long-ovoid, rounded at base, obtuse at summit, margins entire, slightly undulate; nervation fine, midrib somewhat curved, side branches delicate, set with considerable regularity, parallel, curved upward.

Only a single specimen of this species has been obtained from the Amboy Clays, and this does not suffice to determine its botanical relations. It is, however, distinct from any other leaf contained in the collection, and so it seems proper to call attention to it.

Locality: Woodbridge.

Phyllites undulatus Newb. n. sp.

Pl. XXIV, fig. 10.

Leaf nearly circular, about 6^{cm} in diameter; margins broadly undulate; nervation distinct, but delicate, midrib thin and flexuous, side branches remote, curved upward, and connecting in a festoon along the margin.

Only a single incomplete specimen of this leaf has been collected, and this is shown in the above figure. The general aspect is that of a leaf of Hamamelis, but the nervation is different, inasmuch as it is camptodrome, while in Hamamelis it is craspedodrome. We must wait for the collection of more material before attempting to determine its botanical affinities.

Locality: Woodbridge.

Phyllites obscura Hollick n. sp.

Pl. XLII, fig. 33.

This single leaf appears like a distorted or abnormal specimen. Inasmuch as Dr. Newberry left no indication of his ideas regarding it, and no memorandum of locality or collector, I have thought it best to designate it by the above name.—A. H.

Calycites parvus Newb. n. sp.

Pl. XLVI, figs. 28, 29.

Small calyx-like organisms, with (normally) five blunt sepals arranged around a circular disk or center. Entire organism not more than 6^{mm} or 7^{mm} in diameter.

The name here adopted is that given by Dr. Newberry on the labels attached to the specimens. No manuscript relating to them was found, and I am unable to state whether or not he had formed any opinion in regard to their probable botanical affinities.

Locality: Woodbridge.—A. H.

CALYCITES DIOSPYRIFORMIS Newb. n. sp.

Pl. XLVI, figs. 39–41.

Organism about 12^{mm} in diameter, calyx-like, consisting of a center, around and connected with which are five blunt or slightly pointed lobes. It resembles somewhat the dried calyx of Diospyros, for which reason I presume the above name was adopted by Dr. Newberry. No memoranda concerning the specimens were found except the labels which were attached to them.

Locality: Woodbridge.—A. H.

TRICALYCITES PAPYRACEUS Newb. n. sp.

Pl. XLVI, figs. 30–38.

Organism consisting of a very small nucleus to which is attached a deeply triple-lobed or winged appendage; lobes broadly linear, obovate or irregularly ovate, blunt, delicately veined or striated longitudinally.

The substance of the lobes is well preserved, and may be removed from the surface of the clay like thin tissue paper. The lobes vary in size, but the middle one is apparently always the longest, varying from 12^{mm} to 25^{mm} in length and from 6^{mm} to 10^{mm} in width. The name here adopted is the one which Dr. Newberry gave to the specimens, without any accompanying description.

Locality: Woodbridge.—A. H.

TRICARPELLITES STRIATUS Newb. n. sp.

Pl. XLVI, figs. 9–13.

Among the most abundant fruits collected in the Woodbridge clays are those to which Dr. Newberry gave the above name. They are nut-like in appearance, irregularly ovoid in shape, inclosed in a longitudinally striated husk or shell, 25^{mm} to 40^{mm} long and 20^{mm} or more wide, terminated with a sharp apex, rounded at the base, striated laterally, and normally grouped in threes at the summit of a stem.

No indication of their probable botanical affinities was given by Dr. Newberry, and it seems best to leave them, without comment, under the name with which he labeled them.

Locality: Woodbridge.—A. H.

CARPOLITHUS WOODBRIDGENSIS Newb. n. sp.

Pl. XLVI, fig. 22.

A few subellipsoidal longitudinally striated fruits, 9^{mm} or 10^{mm} long by 3^{mm} or 4^{mm} broad, were found, to which the above name was attached by Dr. Newberry. Their probable botanical affinities were not indicated.

Locality: Woodbridge.—A. H.

CARPOLITHUS PRUNIFORMIS Newb. n. sp.

Pl. XLVI, fig. 42.

Somewhat irregular in shape, ovoid, pointed at both ends, striated longitudinally, single, or connected at their ends in pairs, 15^{mm} or 16^{mm} long by 6^{mm} or 8^{mm} wide.

These organisms are more or less abundant in the Woodbridge clays. They were named as above by Dr. Newberry, but without any indication of his opinion as to their botanical affinities.—A. H.

CARPOLITHUS FLORIBUNDUS Newb. n. sp.

Pl. XLVI, figs. 17–21.

These organisms are apparently small seed pods, somewhat longer than broad, 3^{mm} or 4^{mm} to 6^{mm} or 7^{mm} in diameter, with an opening at the apex surrounded by sharp teeth. The opening is often closed, in which event the pod merely appears to have an acute apex, due to the coalescing of the sharp teeth. They occur singly or in pairs (fig. 18) on slender branches, and one specimen (fig. 19) shows an apparently dichotomous arrangement of the branches.

The name adopted is the one by which Dr. Newberry designated the specimens from which the drawings were made. No indication of probable botanical affinities was given.

Locality: Woodbridge.—A. H.

Carpolithus ovæformis Newb. n. sp.

Pl. XLVI, figs. 15, 16.

Ovate or, when young (?), slightly obovate in outline, 12^{mm} to 20^{mm} long by 6^{mm} to 10^{mm} broad; apex pointed; base rounded. Apparently a several-chambered pod or capsule.

The name was given by Dr. Newberry without any description or discussion of probable botanical affinities.

Locality: Woodbridge.—A. H.

Carpolithus hirsutus Newb. n. sp.

Pl. XLVI, figs. 14, 14a.

Obovate in outline, about 1^{cm} long by 6^{mm} broad at widest part, apparently consisting of two carpels, surrounded by a fringe of hair or bristles.

The above name is the one attached to the specimens by Dr. Newberry, without any accompanying memoranda.

Locality: Woodbridge.—A. H.

Staminate aments?

Pl. XLVI, figs. 23–27.

Among the most common objects collected in the clays at certain places are fruiting spikes or aments whose botanical affinities we have not as yet determined. They vary from short, close, bud-like spikes, as shown in figs. 23, 25, to a more elongated, ament-like structure, as shown in figs. 24, 26, 27.

Dr. Newberry labeled the specimens "Staminate aments," without describing them in any way. Under the circumstances, I have thought it best to include them without further comment.

Locality: South Amboy.—A. H.

TABLE OF DISTRIBUTION

List of species, showing distribution in New Jersey.

Page of this work.	Species.	Keyport.	Woodbridge.	South Amboy.	Perth Amboy.	Sayreville.	Fish House.	Not stated.
34	Chondrites flexuosus Newb. n. sp		+			+		
35	Hausmannia rigida Newb. n. sp		+	+				
36	Gleichenia Giesekiana Heer?		+					
36	Gleichenia micromera Heer?					+		
37	Gleichenia Zippei Heer?		+					
38	Anemia stricta Newb. n. sp		+					
39	Asplenium Dicksonianum Heer		+					
41	Asplenium Foersteri Deb. & Ett.?		+	+				
42	Phegopteris Grothiana Heer?		+					
43	Ophioglossum granulatum Heer?							+
44	Podozamites angustifolius (Eichw.) Schimp		+					
44	Podozamites marginatus Heer?		+					
45	Podozamites acuminatus Hollick n. sp		+					
45	Microzamia gibba (Reuss) Corda		+					
46	Cycadinocarpus circularis Newb. n. sp		+					
46	Dammara borealis Heer							+
47	Pinus sp.?			+				
48	Cunninghamites elegans (Corda) Endl	+		+				
49	Sequoia heterophylla Vel							+
49	Sequoia Reichenbachi (Gein.) Heer		+					
50	Sequoia gracillima (Lesq.) Newb	+						
51	Geinitzia formosa Heer?		+					
51	Brachyphyllum crassum Lesq			+				
53	Thuya cretacea (Heer) Newb			+				
54	Thuyites Meriani Heer					+		
54	Juniperus macilenta Heer		+		+			
55	Moriconia cyclotoxon Deb. & Ett			+				
57	Widdringtonites subtilis Heer		+	+				
57	Widdringtonites Reichii (Ett.) Heer		+	+		+		
58	Frenelopsis Hoheneggeri (Ett.) Schenk?		+					
59	Frenelopsis gracilis Newb. n. sp		+					
59	Thinnfeldia Lesquereuxiana Heer							+
60	Baiera incurvata Heer?		+					
61	Czekanowskia capillaris Newb. n. sp		+					
62	Juglans arctica Heer?		+					
62	Myrica emarginata Heer?							+
63	Myrica parvula Heer					+		
63	Myrica Newberryana Hollick n. sp			+				
63	Myrica fenestrata Newb. n. sp					+		
64	Myrica cinnamomifolia Newb. n. sp		+	+				
65	Myrica acuta Hollick n. sp							+
65	Myrica raritanensis Hollick n. sp							+
65	Populus ? apiculata Newb. n. sp		+					
66	Salix proteæfolia Lesq		+					
66	Salix membranacea Newb		+			+		

List of species, showing distribution in New Jersey.

Page of this work.	Species.	Keyport.	Woodbridge.	South Amboy.	Perth Amboy.	Sayerville.	Fish House.	Not stated.
67	Salix inæqualis Newb. n. sp	----	+	----	----	----	----	----
68	Salix Newberryana Hollick n. sp	----	+	+	----	+	----	----
68	Salix sp.?	----	----	----	----	----	----	+
69	Quercus Johnstrupi Heer?	----	----	----	----	+	----	----
69	Planera Knowltoniana Hollick n. sp	----	+	----	----	----	----	----
70	Ficus Woolsoni Newb. n. sp	----	+	----	----	+	----	----
70	Ficus ovata Newb. n. sp	----	+	----	----	----	----	----
71	Ficus myricoides Hollick n. sp	----	----	----	----	----	----	+
71	Persoonia Lesquereuxii Knowlton	----	----	----	----	----	----	+
71	Persoonia spatulata Hollick n. sp	----	----	----	----	----	----	+
72	Proteoides daphnogenoides Heer	----	+	----	----	+	----	----
73	Magnolia Lacoeana Lesq	----	+	----	----	----	----	----
73	Magnolia alternans Heer?	----	+	----	----	----	----	----
74	Magnolia glaucoides Newb. n. sp	----	+	----	----	----	----	----
74	Magnolia woodbridgensis Hollick n. sp	----	+	----	----	----	----	----
75	Magnolia auriculata Newb. n. sp	----	+	----	----	----	----	----
76	Magnolia longipes Newb. n. sp	----	+	----	----	----	----	----
76	Magnolia longifolia Newb. n. sp	----	+	----	----	----	----	----
81	Liriodendron quercifolium Newb	----	+	----	----	----	----	----
81	Liriodendron oblongifolium Newb	----	+	----	----	----	----	----
83	Liriodendropsis simplex Newb	----	+	----	----	----	----	----
84	Liriodendropsis angustifolia Newb. n. sp.	----	----	----	----	----	----	+
84	Menispermites borealis Heer?	----	+	----	----	----	----	----
85	Menispermites Wardianus Hollick n. sp	----	----	----	----	----	----	+
85	Laurus plutonia Heer	----	----	----	----	----	----	+
86	Laurophyllum minus Newb. n. sp	----	----	----	----	----	----	+
86	Laurophyllum angustifolium Newb. n. sp	----	+	----	----	----	----	----
87	Laurophyllum lanceolatum Newb. n. sp	----	+	----	----	----	----	----
87	Sassafras acutilobum Lesq	----	+	----	----	----	----	----
88	Sassafras progenitor Newb. n. sp	----	+	----	----	----	----	----
88	Sassafras hastatum Newb. n. sp	----	+	----	----	----	----	----
89	Cinnamomum intermedium Newb. n. sp	----	+	----	----	+	----	----
90	Prunus? acutifolia Newb. n. sp	----	+	----	----	----	----	----
90	Hymenæa Dakotana Lesq	----	----	----	----	----	----	+
90	Dalbergia apiculata Newb. n. sp	----	+	----	----	----	----	----
91	Bauhinia cretacea Newb	----	+	----	----	----	----	----
93	Bauhinia? gigantea Newb. n. sp	----	+	----	----	----	----	----
94	Cæsalpinia Cookiana Hollick n. sp	----	----	----	----	----	----	+
96	Fontainea grandifolia Newb. n. sp	----	+	----	----	----	----	----
97	Colutea primordialis Heer	----	+	----	----	----	----	----
97	Leguminosites omphalobioides Lesq	----	----	----	----	----	----	+
97	Leguminosites atenensis Heer	----	----	----	----	----	----	+
97	Leguminosites coronilloides Heer	----	----	----	----	----	----	+
98	Ilex? elongata Newb. n. sp	----	----	----	----	+	----	----
98	Ilex? ovata Newb. n. sp	----	----	----	----	+	----	----
98	Celastrus arctica Heer	----	----	+	----	----	----	----
99	Celastrophyllum crenatum Heer	----	----	+	----	+	----	----
100	Celastrophyllum cretaceum Lesq	----	----	----	----	----	----	+
100	Celastrophyllum angustifolium Newb. n. sp.	----	+	----	----	----	----	----
101	Celastrophyllum Newberryanum Hollick n. sp.	----	----	+	----	+	----	----
102	Celastrophyllum undulatum Newb. n. sp	----	+	----	----	+	----	----
103	Celastrophyllum spatulatum Newb. n. sp	----	----	----	----	----	----	+
103	Celastrophyllum robustum Newb n. sp	----	----	----	----	----	----	+
104	Celastrophyllum grandifolium Newb. n. sp	----	----	----	----	----	----	+
105	Celastrophyllum minus Hollick n. sp	----	----	----	----	----	----	+
105	Celastrophyllum Brittonianum Hollick n. sp	----	----	----	----	----	----	+
106	Acer amboyense Newb. n. sp	----	+	+	----	----	----	----
106	Rhamnites minor Hollick n. sp	----	----	----	----	----	----	+
107	Paliurus ovalis Dn	----	----	----	----	----	----	+

List of species, showing distribution in New Jersey.

Page of this work.	Species.	Keyport.	Woodbridge.	South Amboy.	Perth Amboy.	Sayerville.	Fish House.	Not stated.
107	Cissites formosus Heer		+	+		+		
108	Cissites crispus Vel.?		+					
109	Tiliæphyllum dubium Newb. n. sp						+	
109	Passiflora antiqua Newb. n. sp		+					
110	Eucalyptus Geinitzi Heer		+			+		
111	Eucalyptus? attenuata Newb. n. sp			+				
111	Eucalyptus? angustifolia Newb. n. sp			+				
112	Eucalyptus? nervosa Newb. n. sp			+				
112	Eucalyptus? parvifolia Newb. n. sp			+				
113	Hedera primordialis Sap		+					
113	Hedera obliqua Newb. n. sp		+					
114	Aralia Wellingtoniana Lesq		+					
115	Aralia quinquepartita Lesq		+					
116	Aralia grönlandica Heer		+					
116	Aralia formosa Heer			+				
117	Aralia palmata Newb. n. sp		+					
117	Aralia patens Newb. n. sp		+					
118	Aralia polymorpha Newb. n. sp		+					
118	Aralia rotundiloba Newb. n. sp		+					
118	Chondrophyllum obovatum Newb. n. sp		+					
119	Chondrophyllum reticulatum Hollick n. sp							+
119	Cornophyllum vetustum Newb. n. sp		+					
120	Andromeda Parlatorii Heer							+
120	Andromeda latifolia Newb. n. sp		+			+		
121	Andromeda flexuosa Newb. n. sp		+			+		
121	Andromeda novæ-cæsareæ Hollick n. sp							+
122	Myrsine borealis Heer							+
122	Myrsine elongata Newb. n. sp			+				
122	Myrsine oblongata Hollick n. sp							+
123	Sapotacites retusus Heer		+					
124	Diospyros primæva Heer			+				
122	Acerates sp.?			+				
125	Viburnum integrifolium Newb. n. sp		+					
125	Palæanthus (Williamsonia) problematicus Newb. n. sp							+
127	Williamsonia Smockii Newb. n. sp							+
128	Protophyllum obovatum Newb. n. sp		+					
129	Dewalquea grönlandica Heer?							+
129	Dewalquea trifoliata Newb. n. sp		+					
130	Phyllites orbicularis Newb. n. sp					+		
130	Phyllites ellipticus Newb. n. sp		+					
131	Phyllites undulatus Newb. n. sp		+					
131	Phyllites obscura Hollick n. sp							+
131	Calycites parvus Newb. n. sp		+					
132	Calycites diospyriformis Newb. n. sp		+					
132	Tricalycites papyraceus Newb. n. sp		+					
132	Tricarpellites striatus Newb. n. sp		+					
133	Carpolithus woodbridgensis Newb. n. sp		+					
133	Carpolithus pruniformis Newb. n. sp		+					
133	Carpolithus floribundus Newb. n. sp		+					
134	Carpolithus ovæformis Newb. n. sp		+					
134	Carpolithus hirsutus Newb. n. sp		+					
134	Stammate aments?			+				

PLATES.

PLATE I.

PLATE I.

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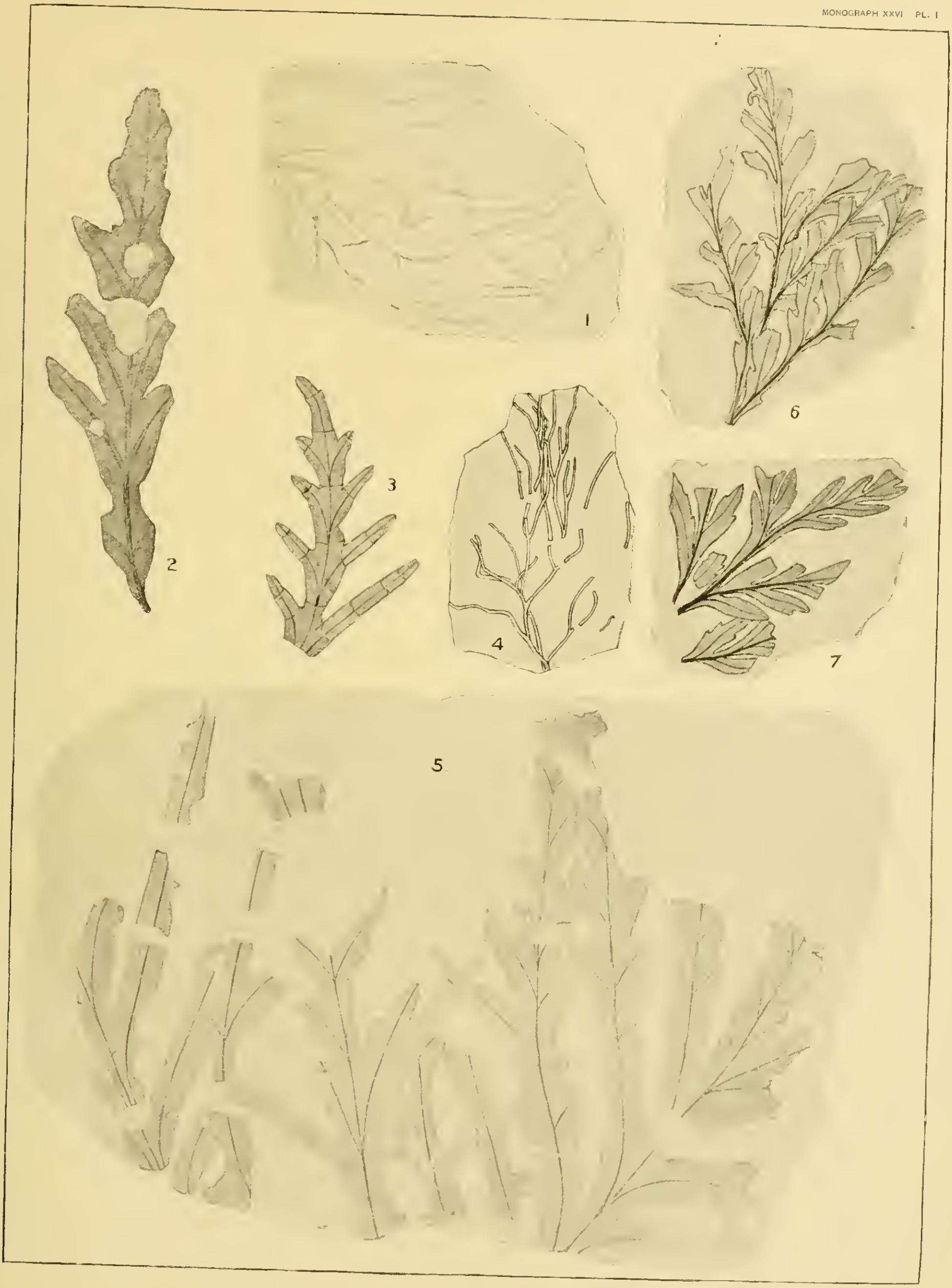
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PLATE II.

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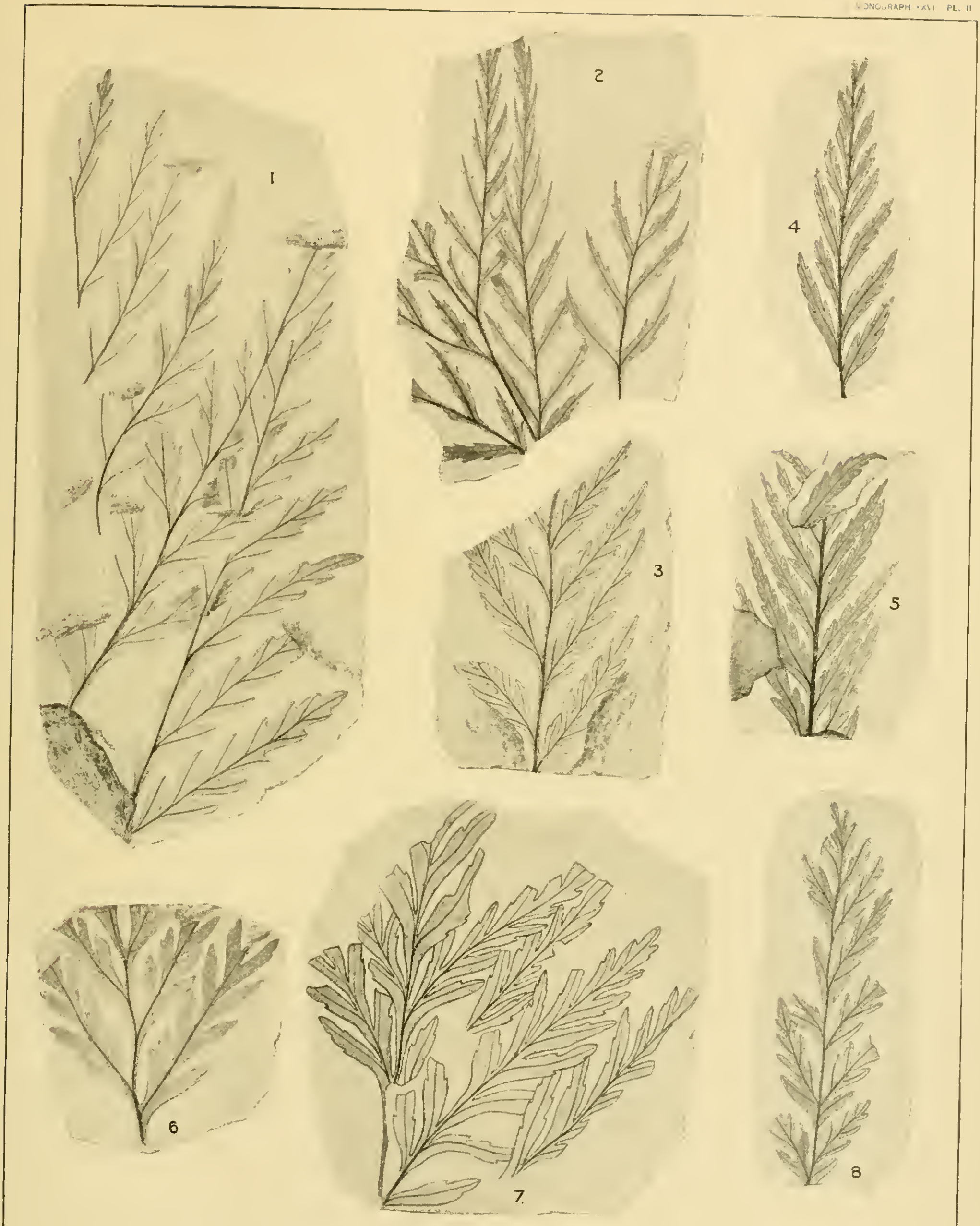
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PLATE III.

PLATE III.


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PLATE IV.

PLATE IV.

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PLATE VI.

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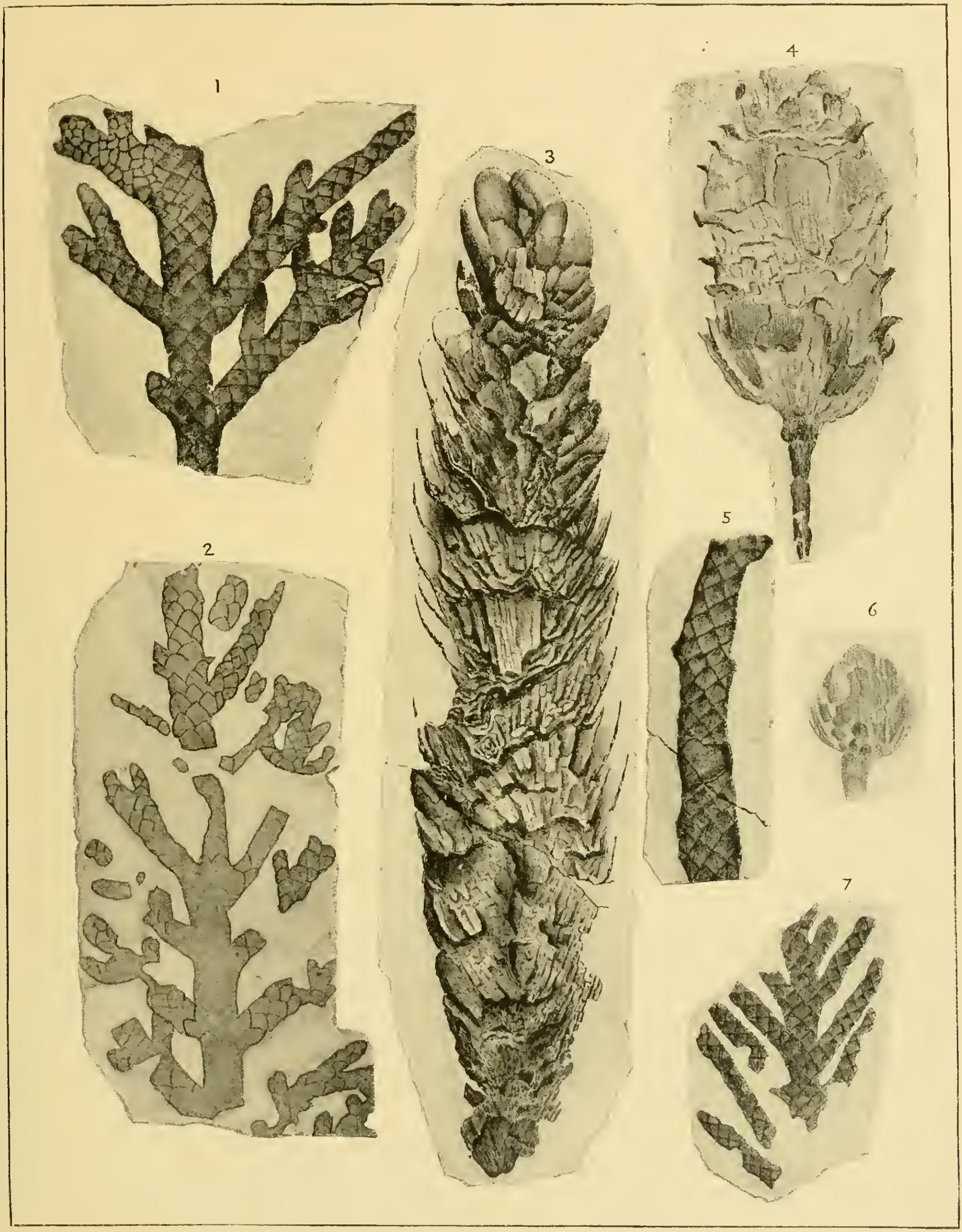
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PLATE VIII.

PLATE VIII.

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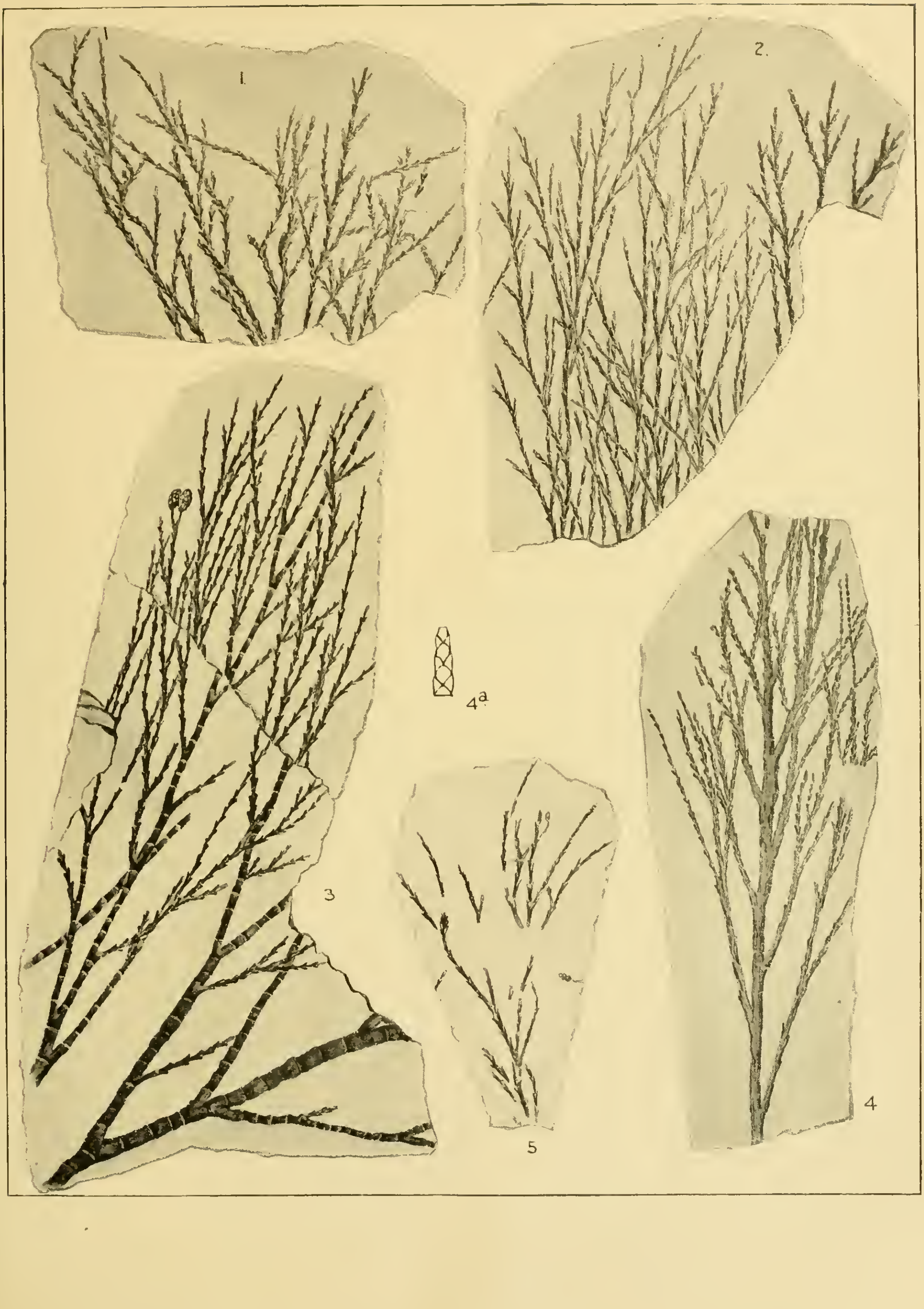
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PLATE IX.

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PLATE X.

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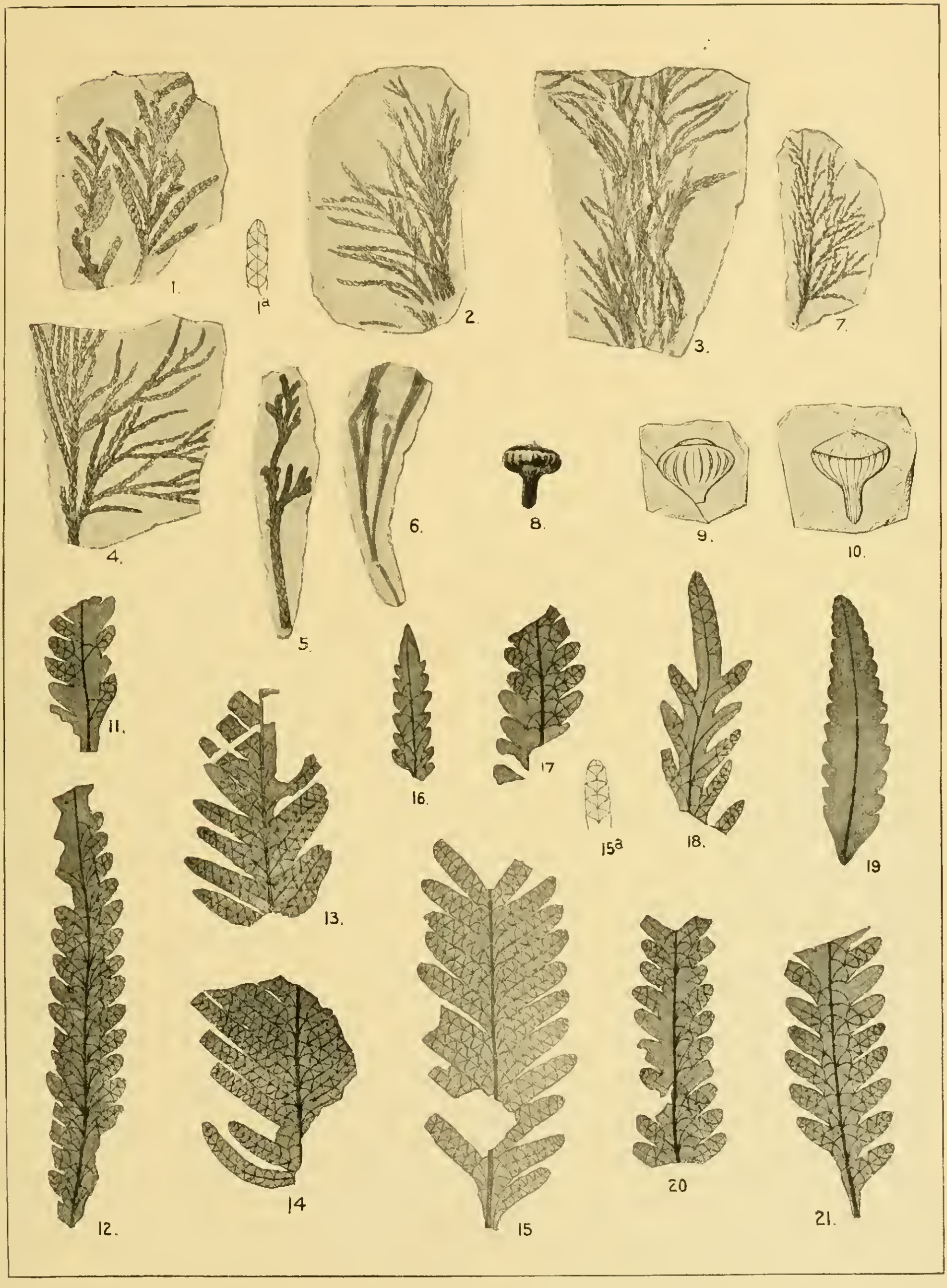

PLATE XI.

PLATE XI.

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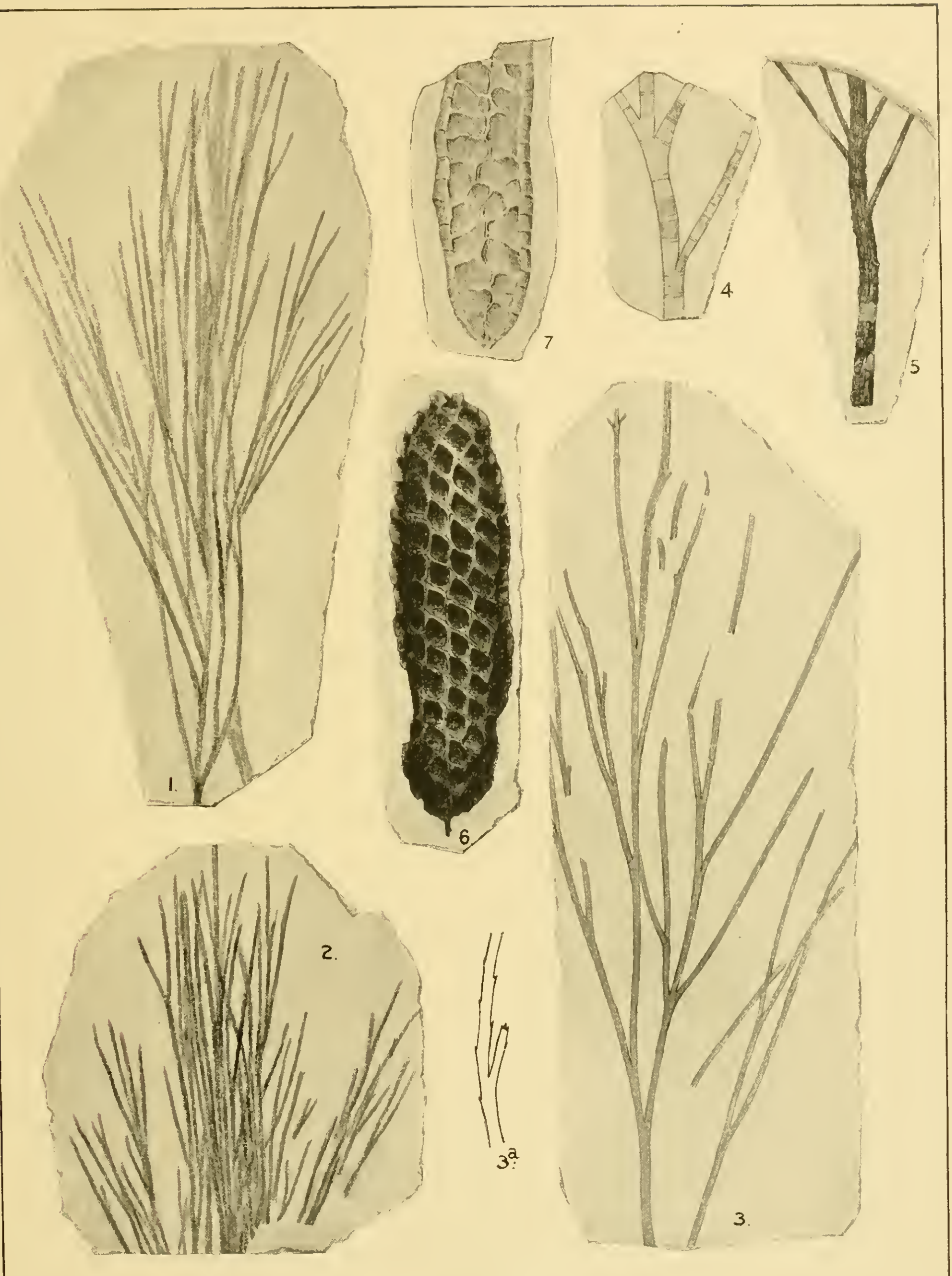
PLATE XII.

PLATE XII.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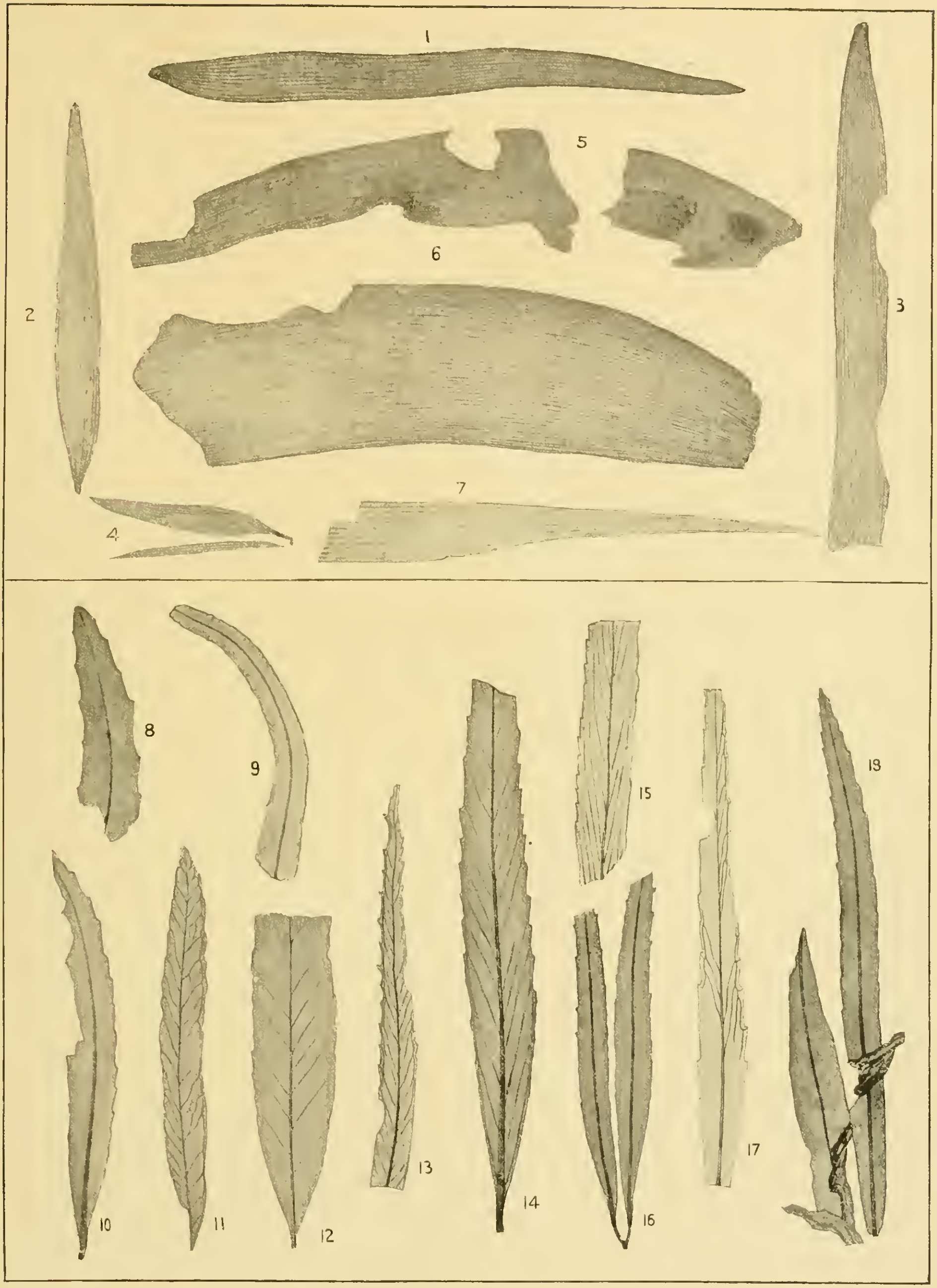
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PLATE XIV.

PLATE XIV.

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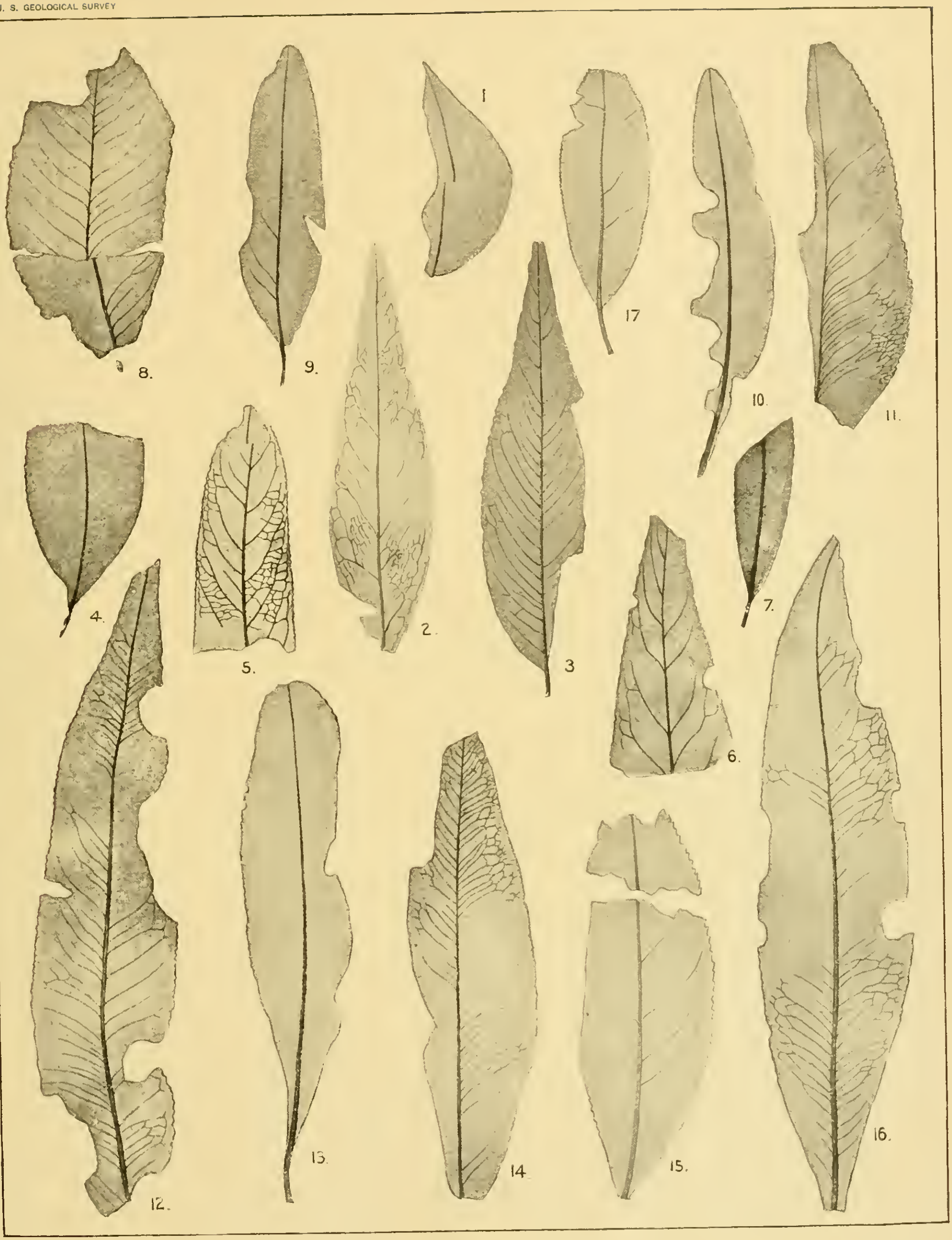
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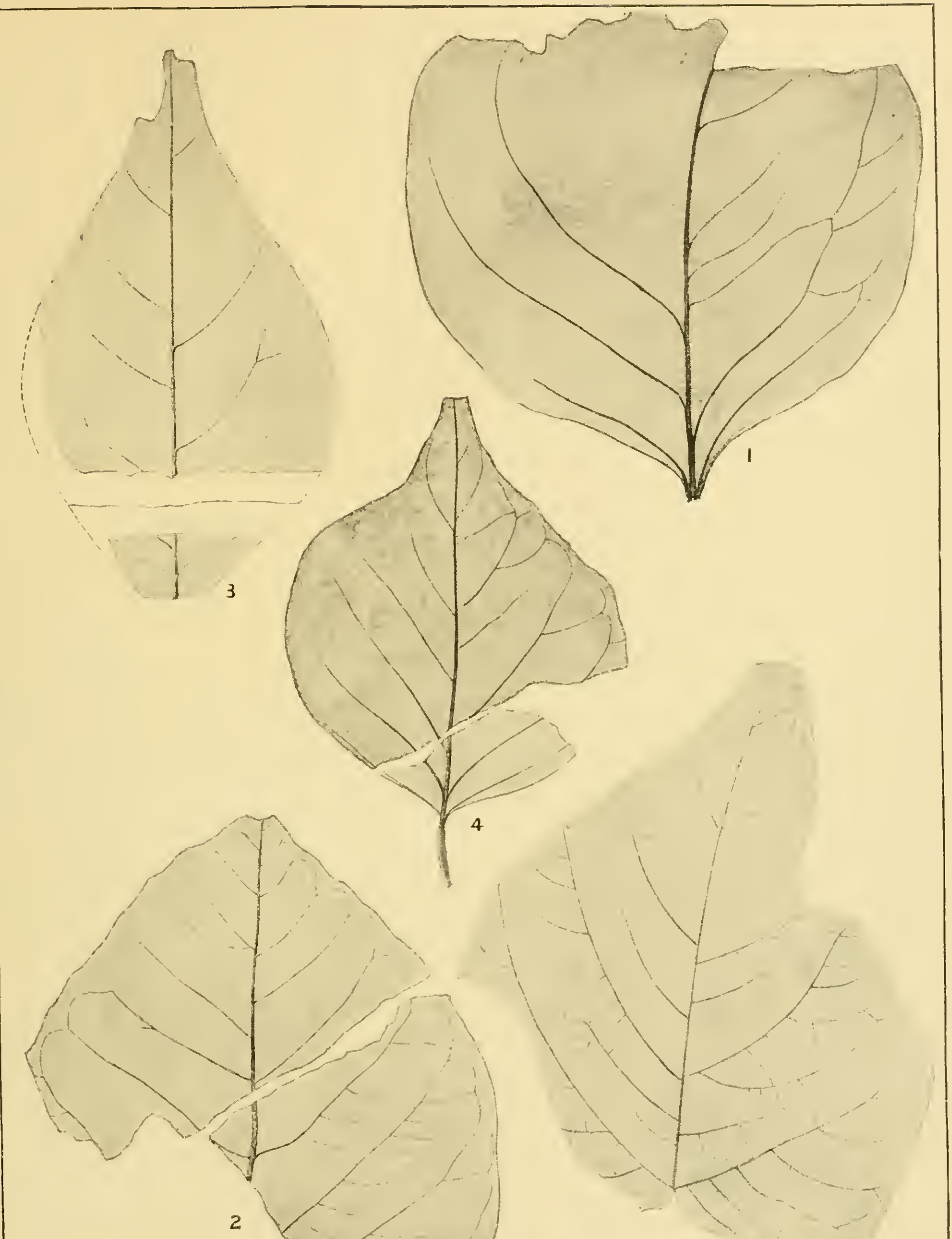
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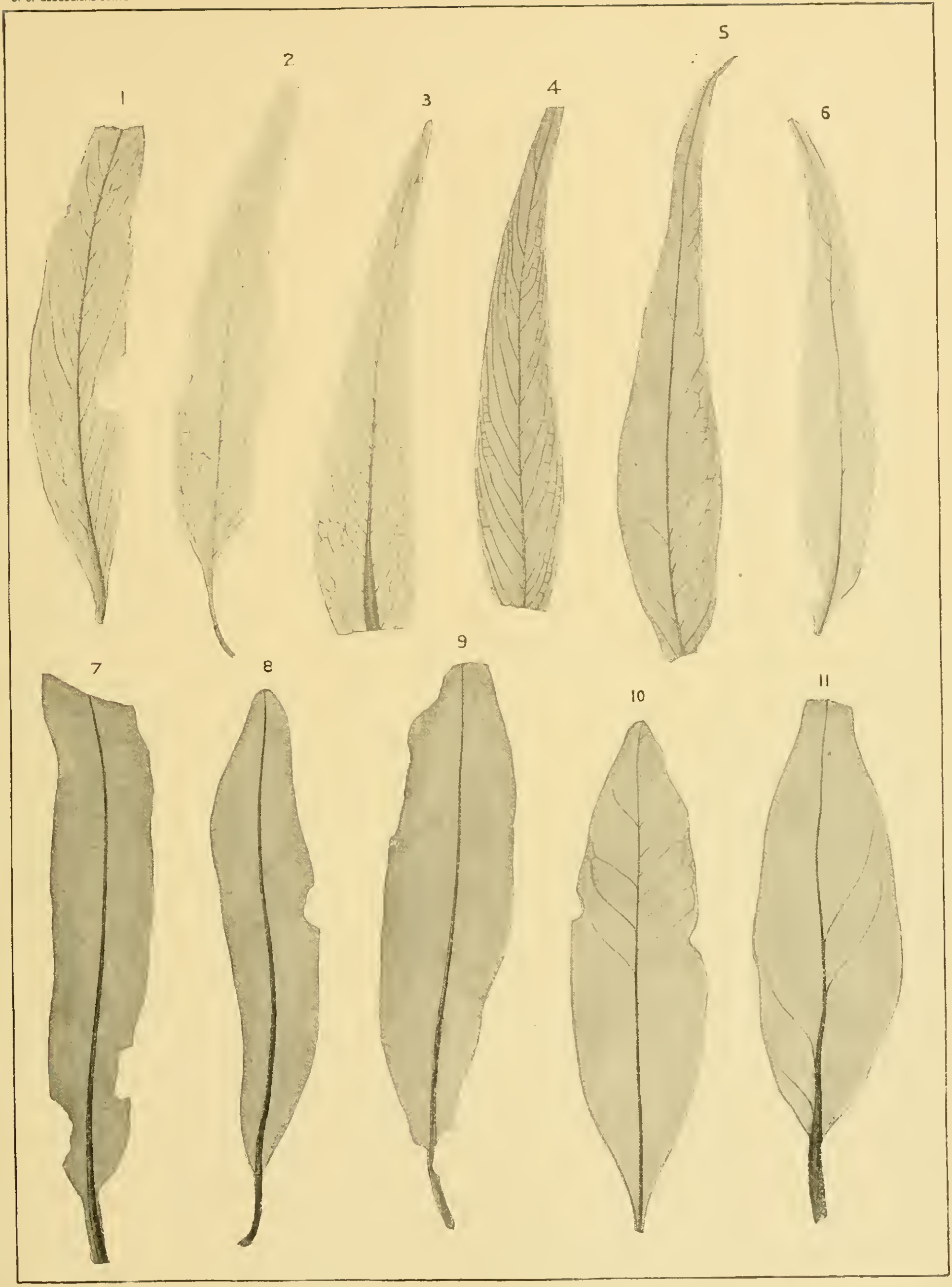
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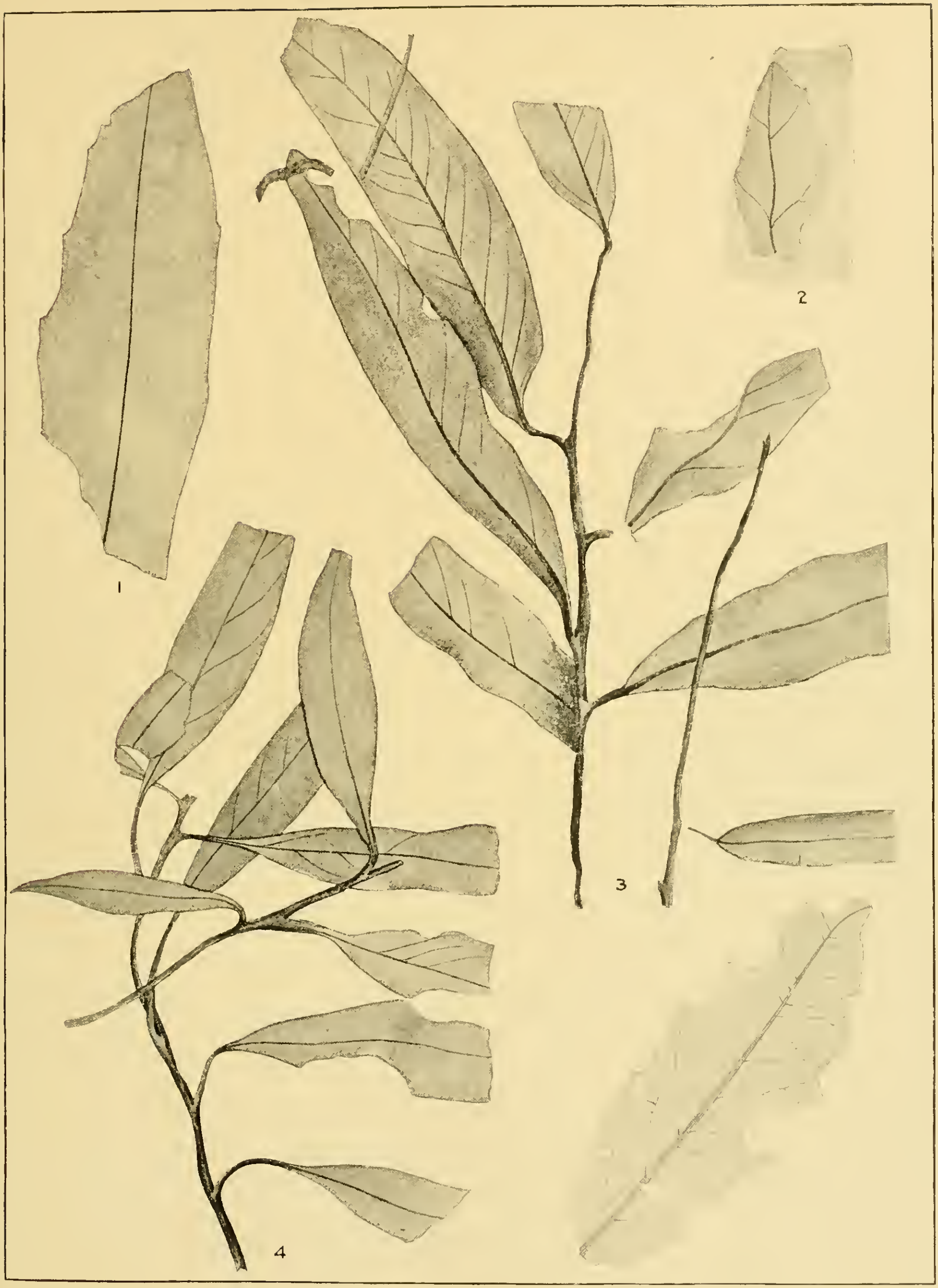
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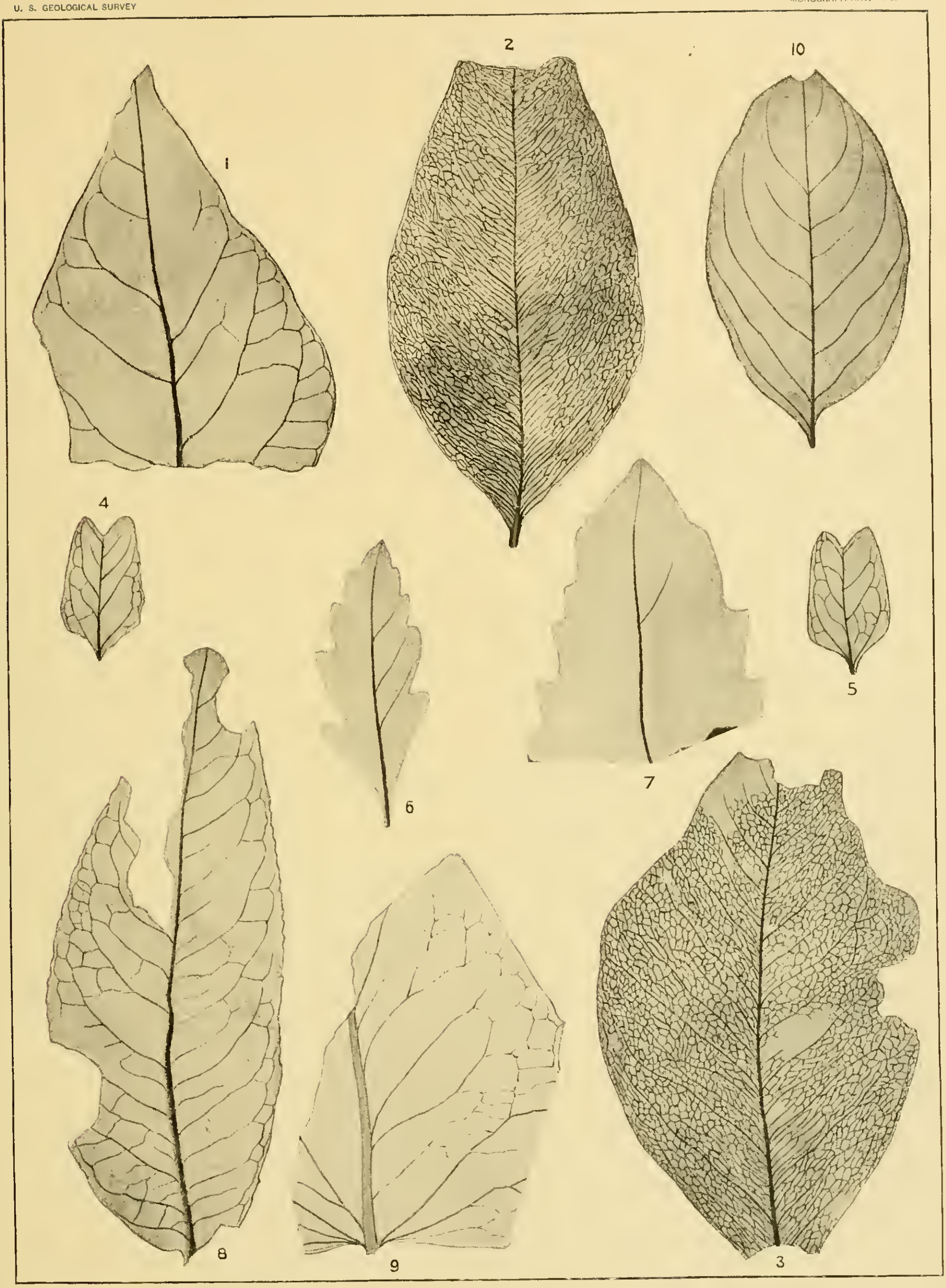
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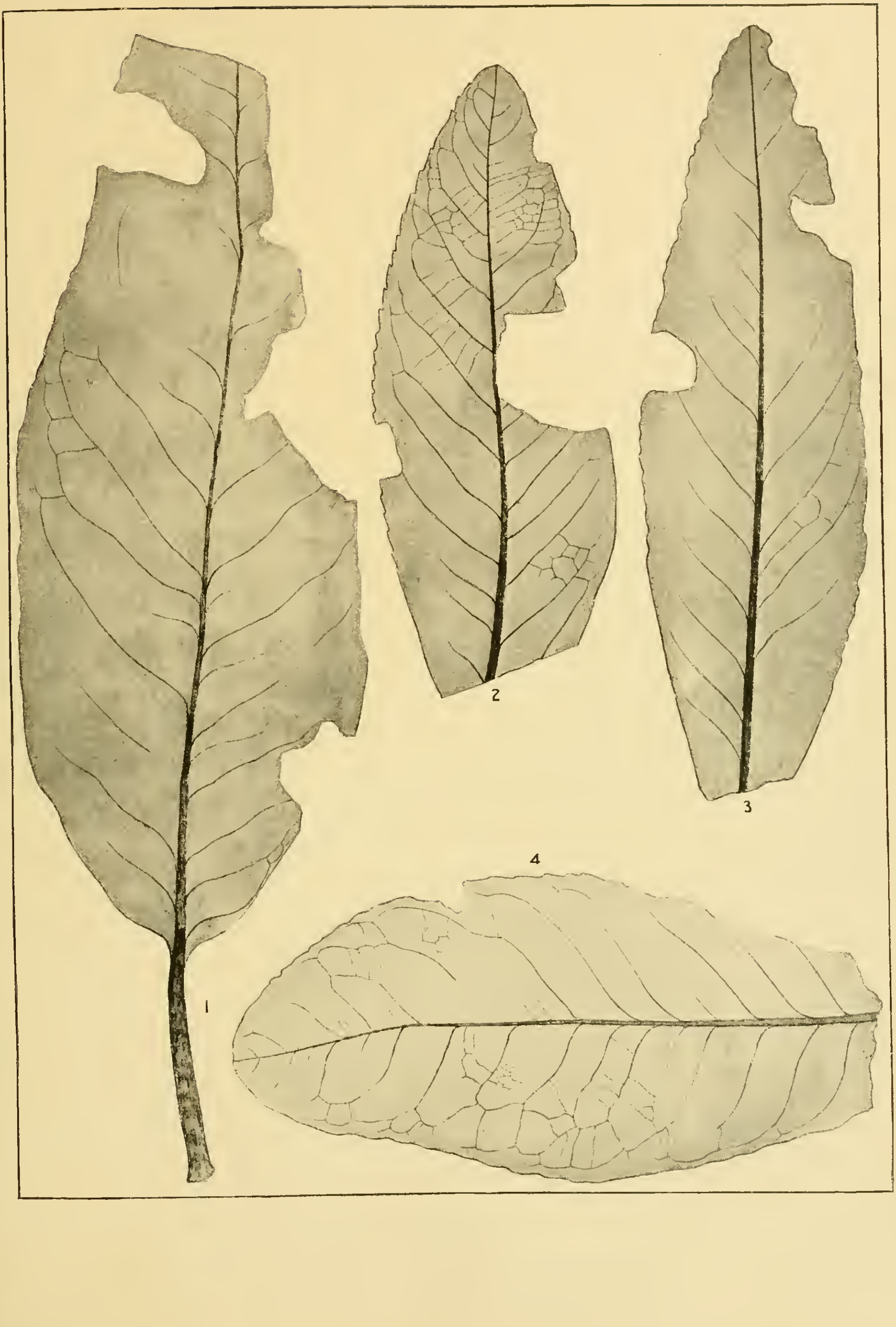
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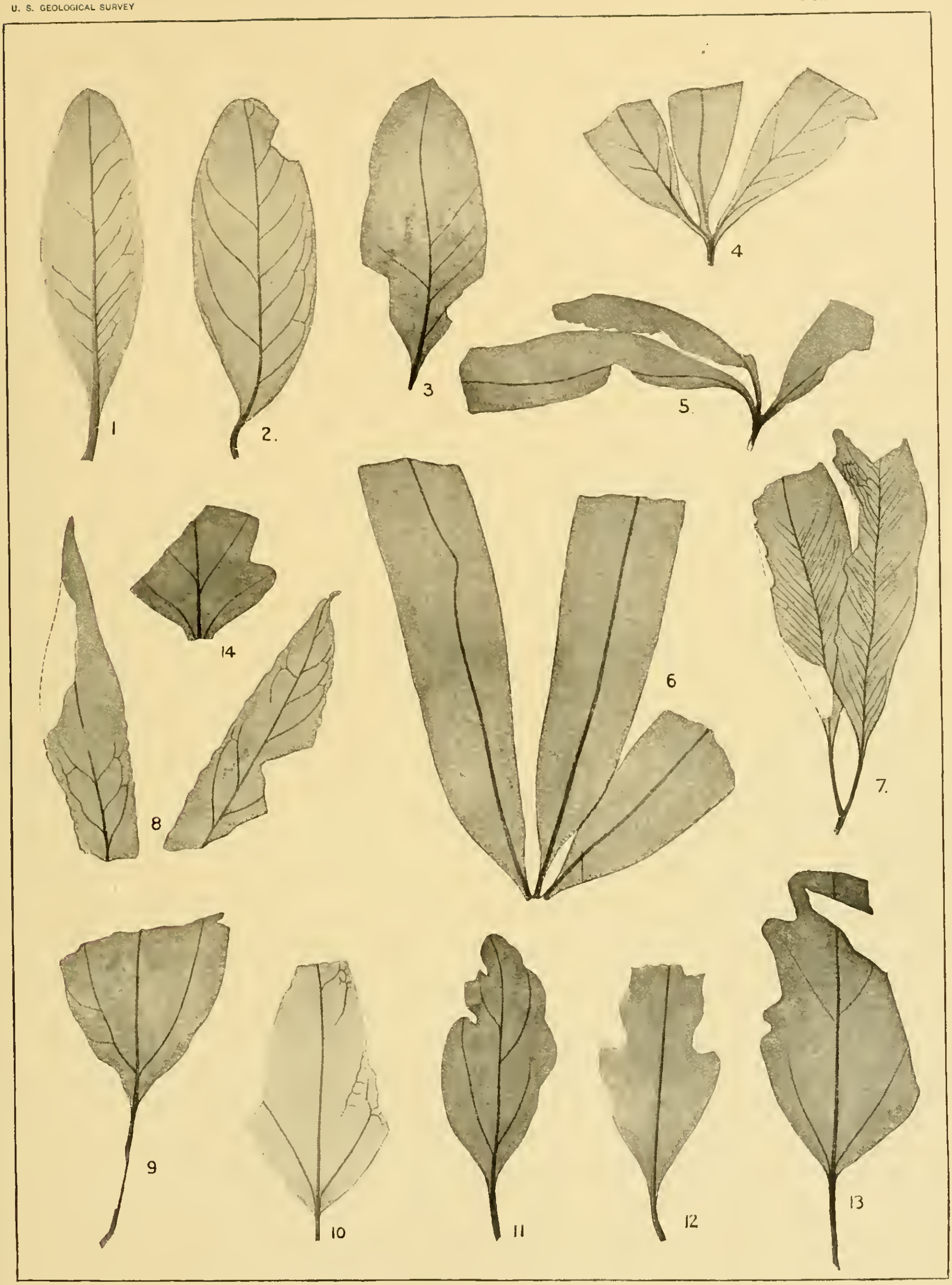
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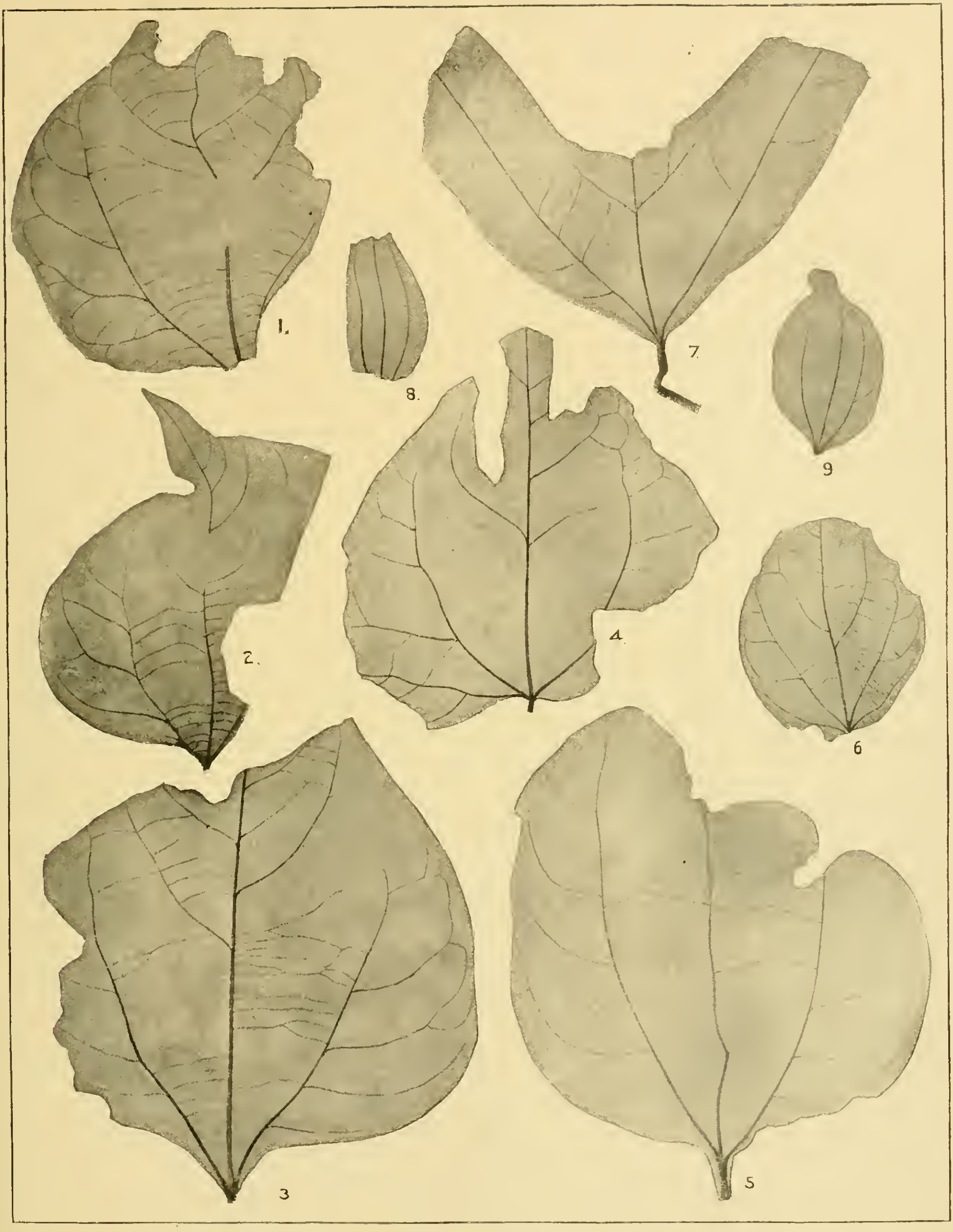
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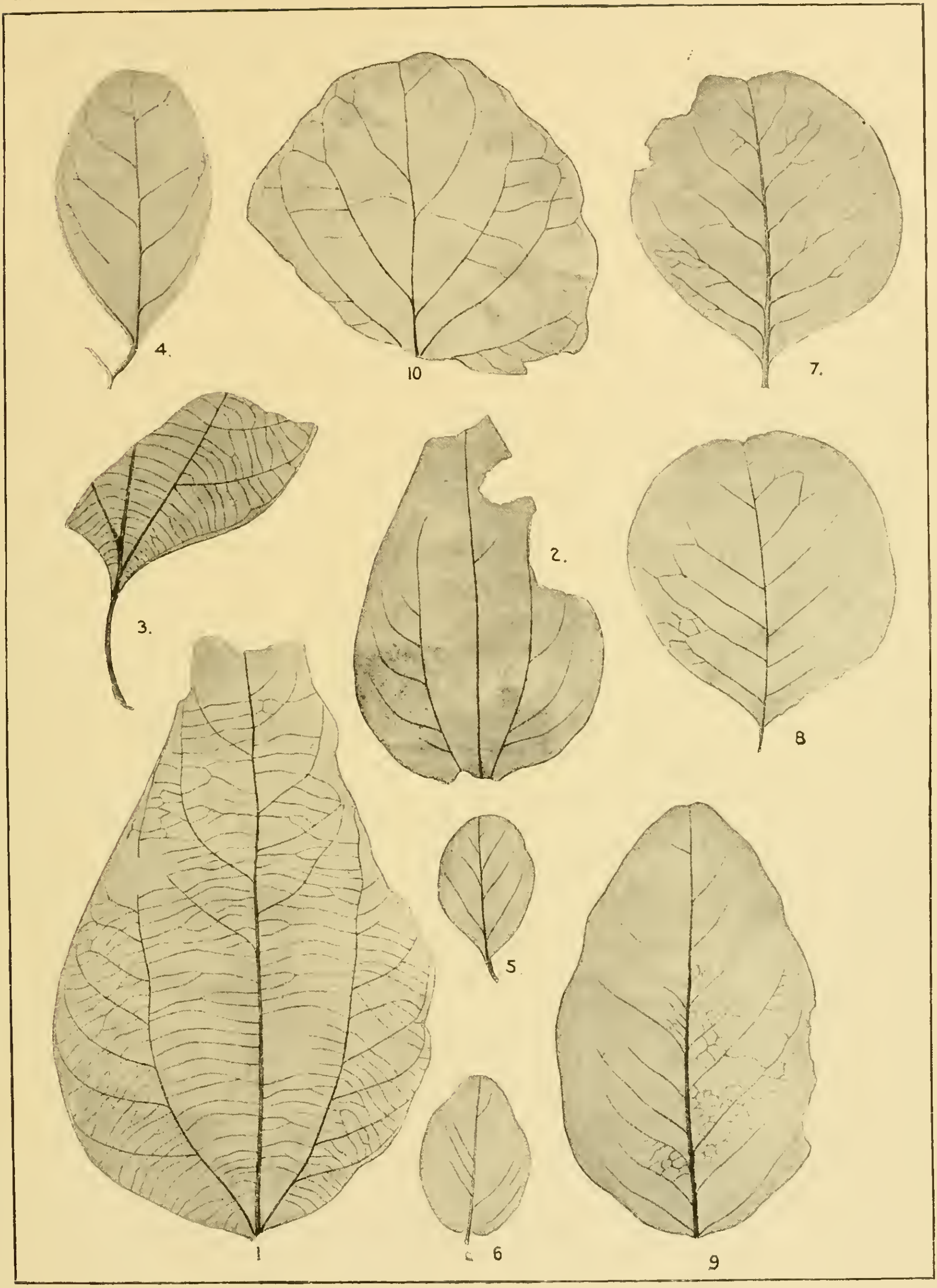
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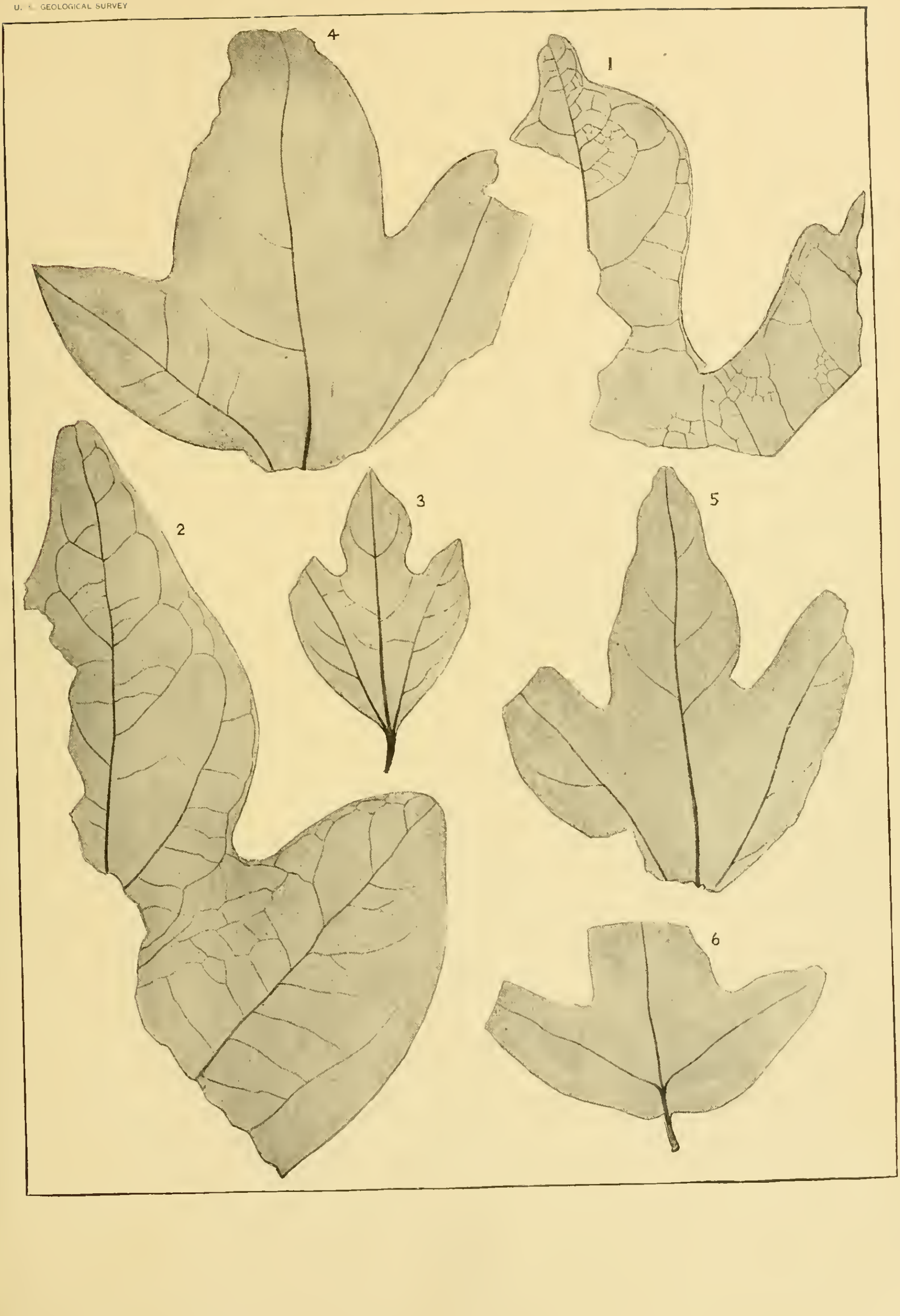
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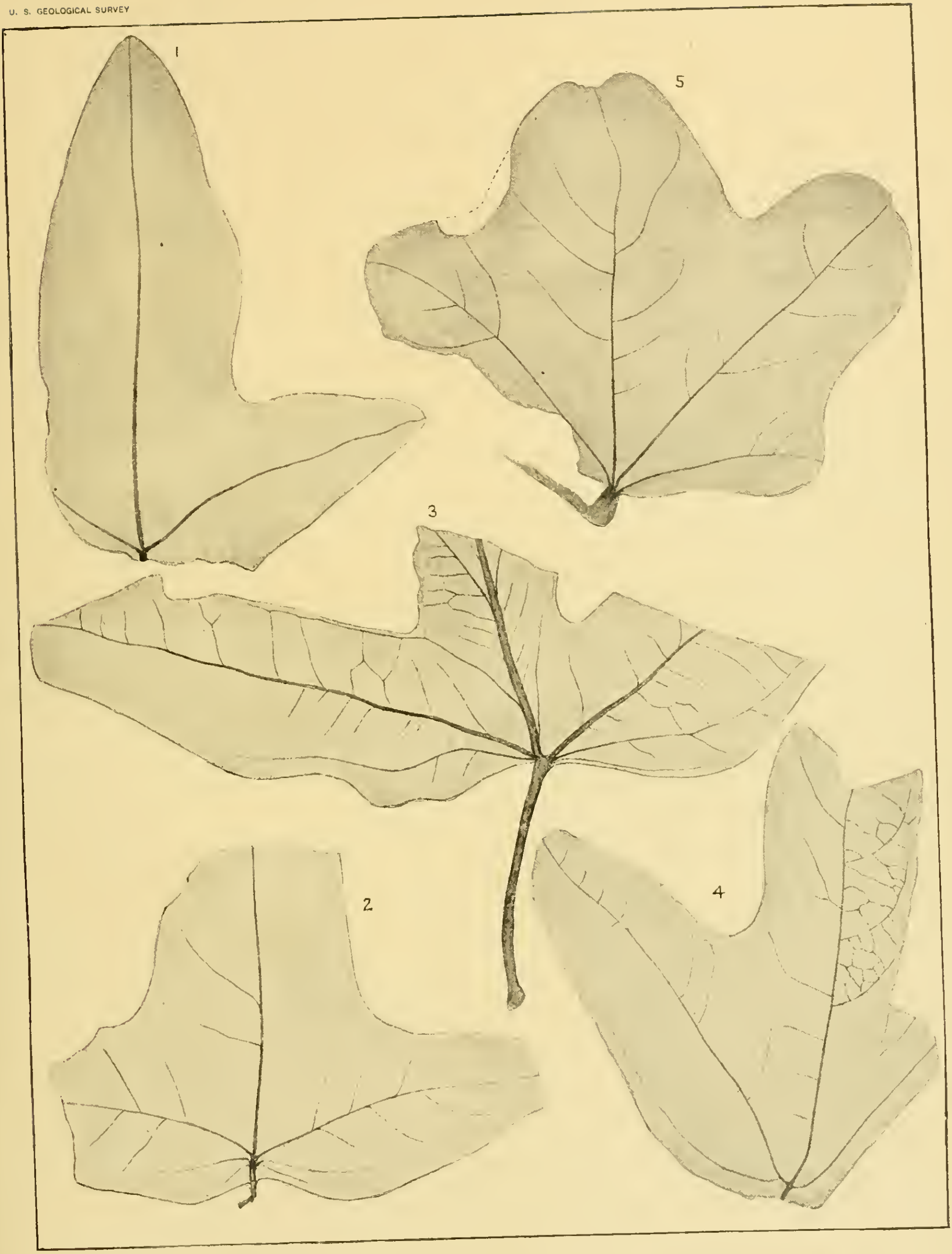
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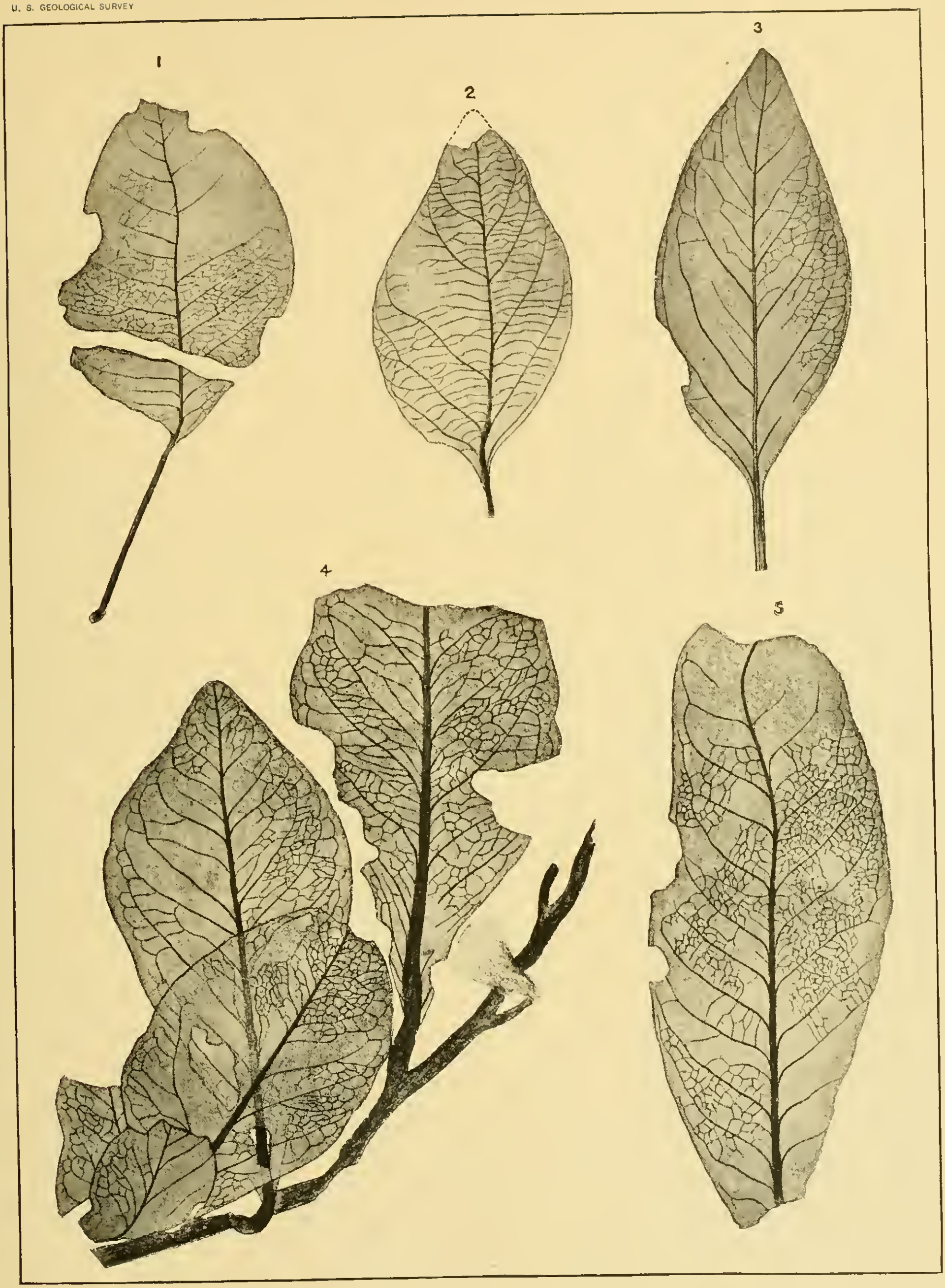
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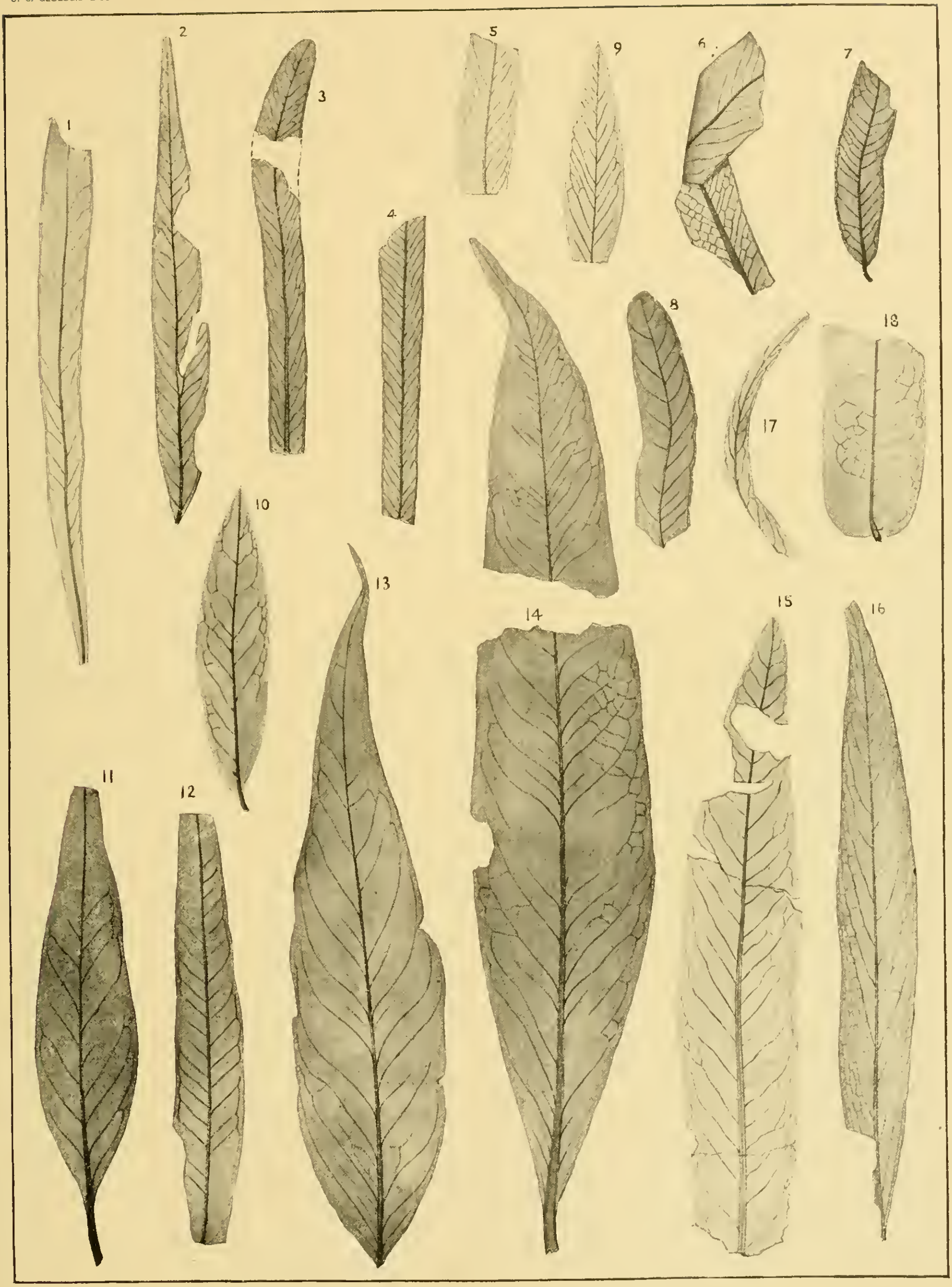
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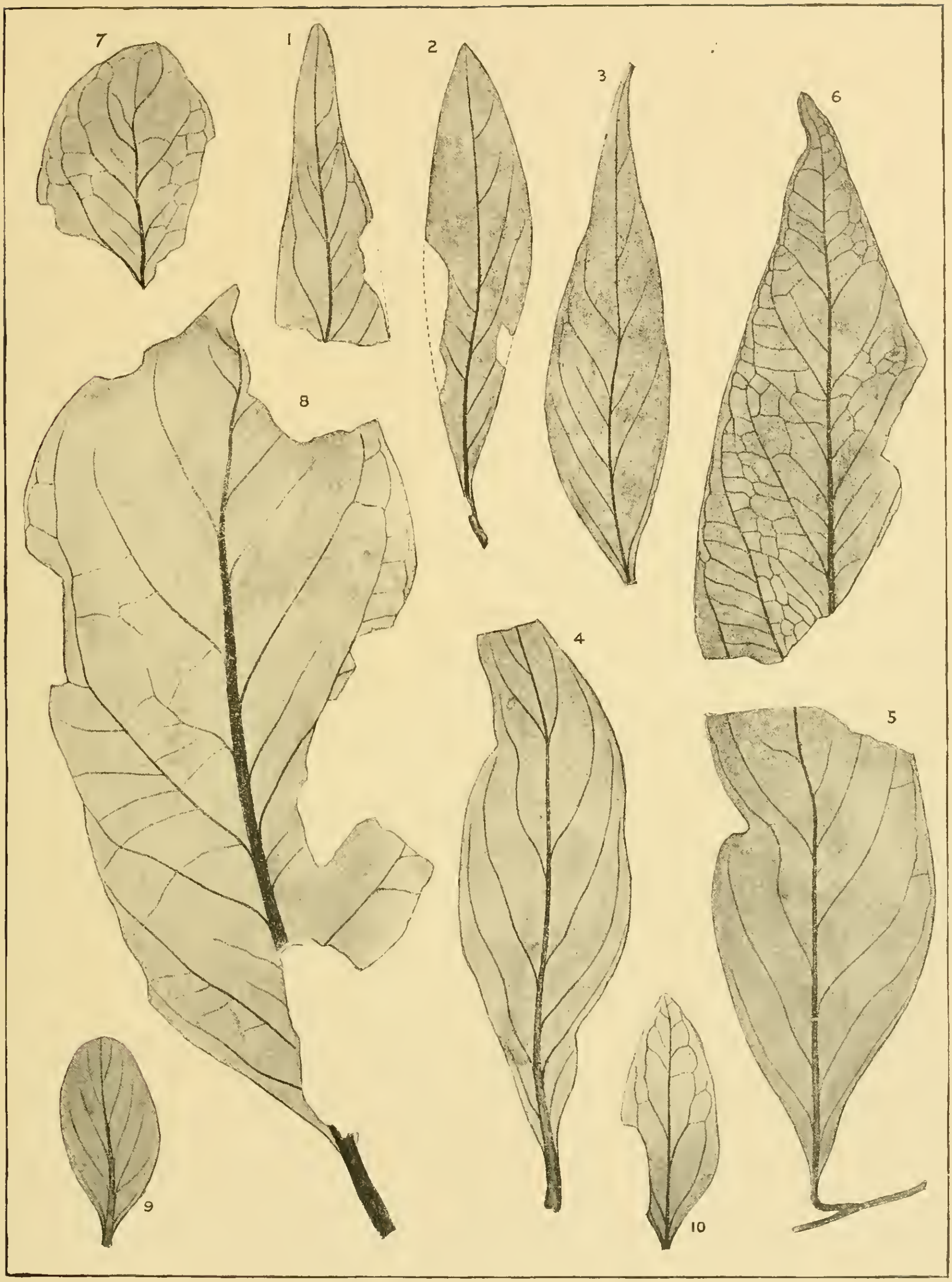
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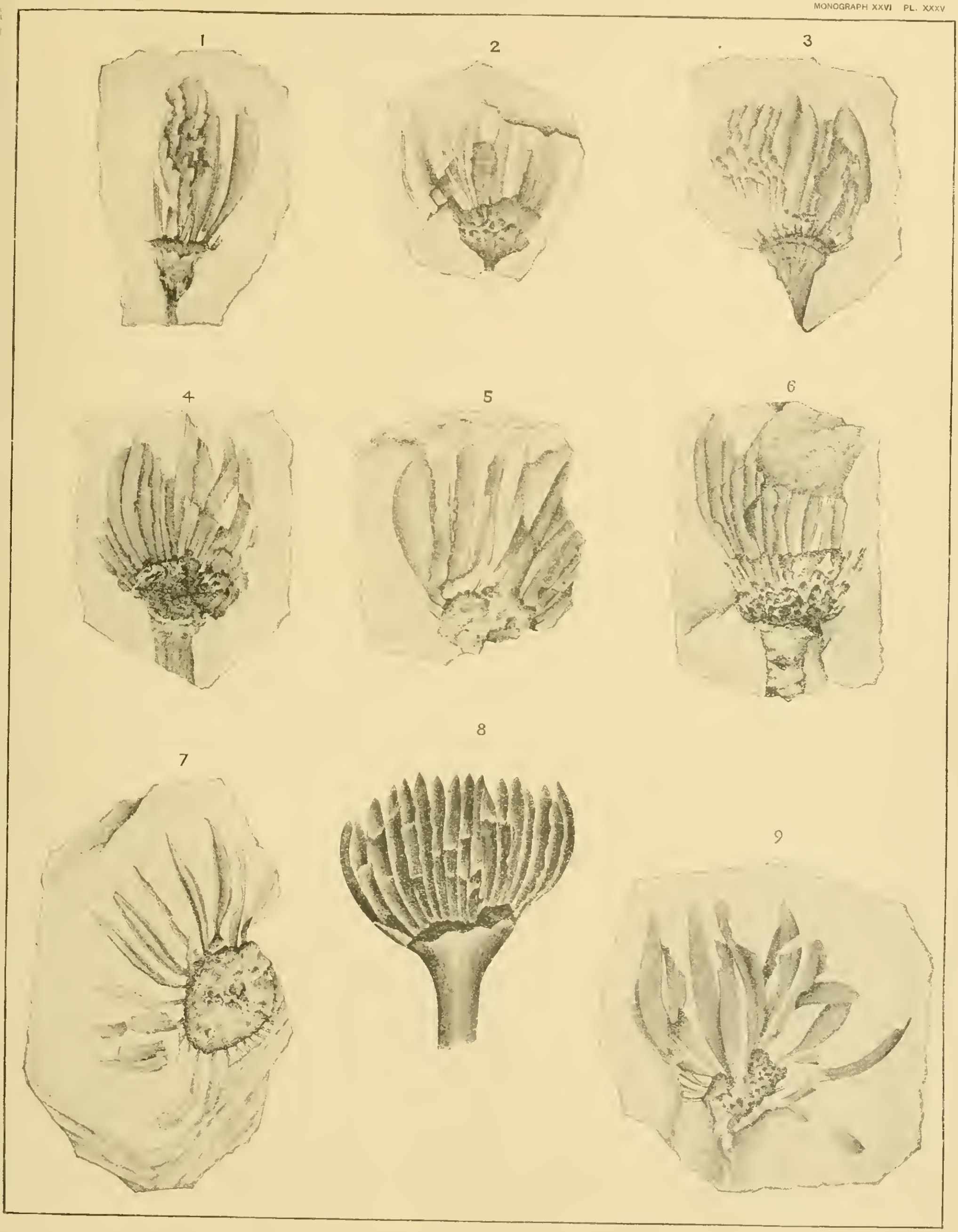
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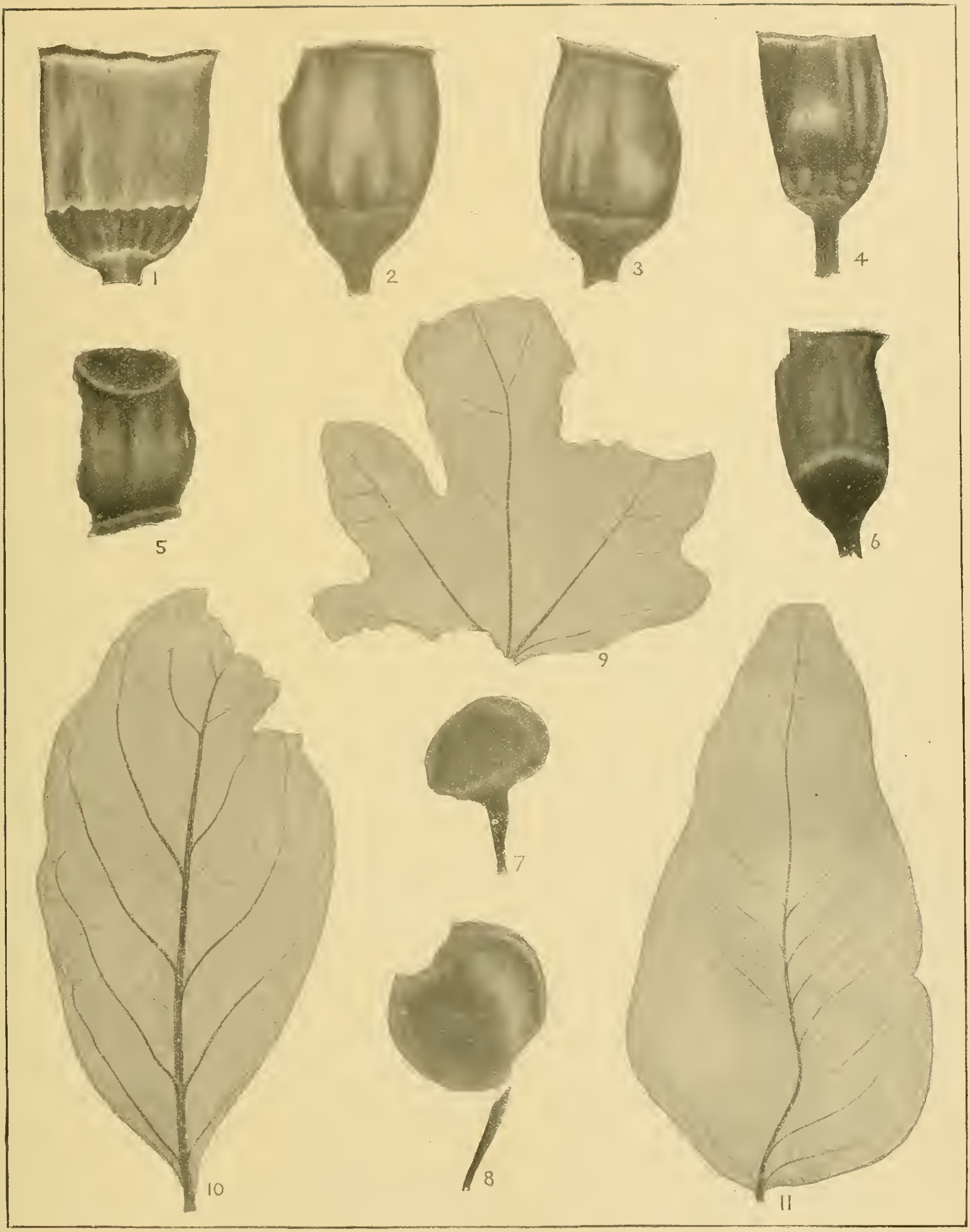
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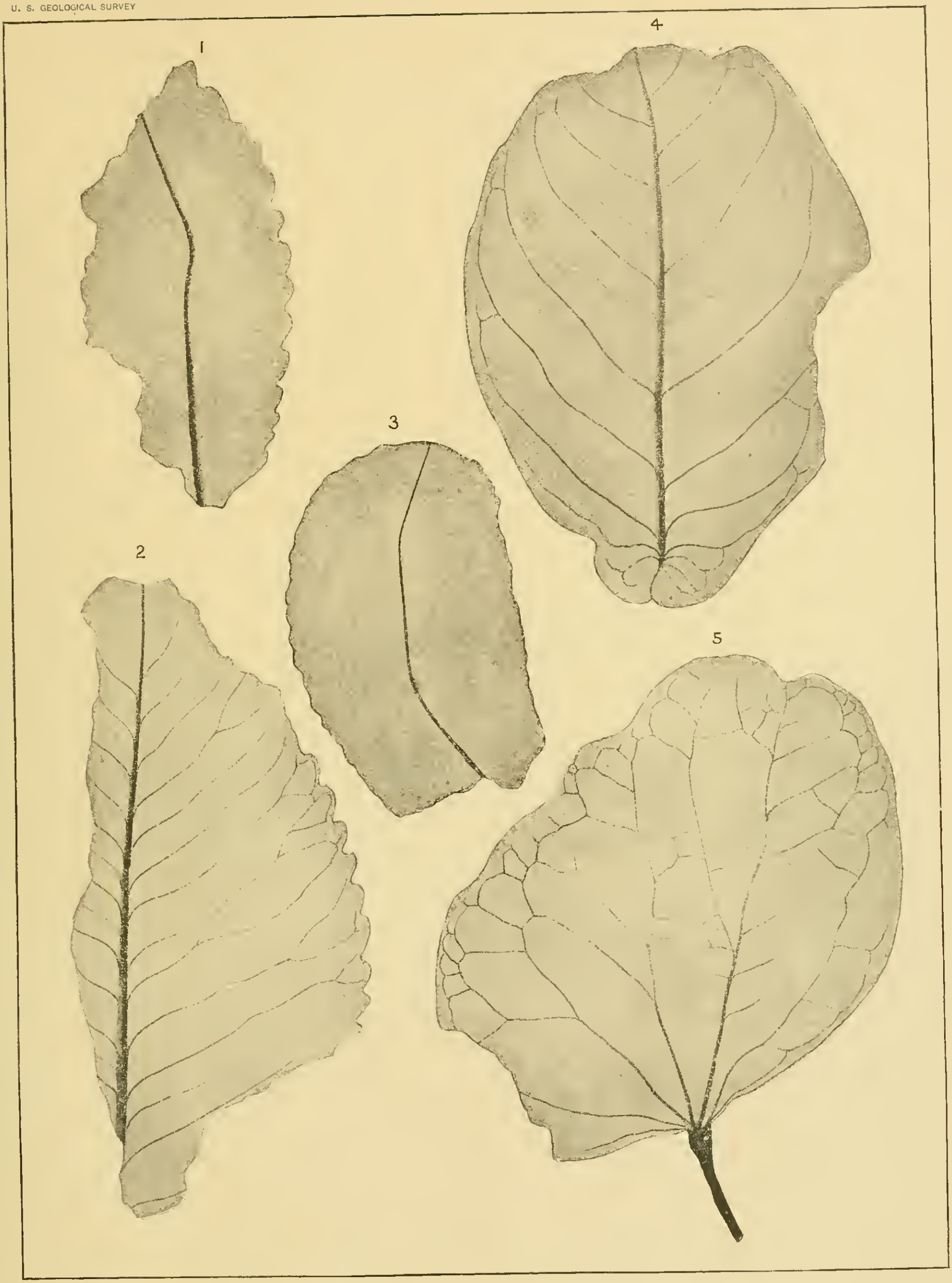
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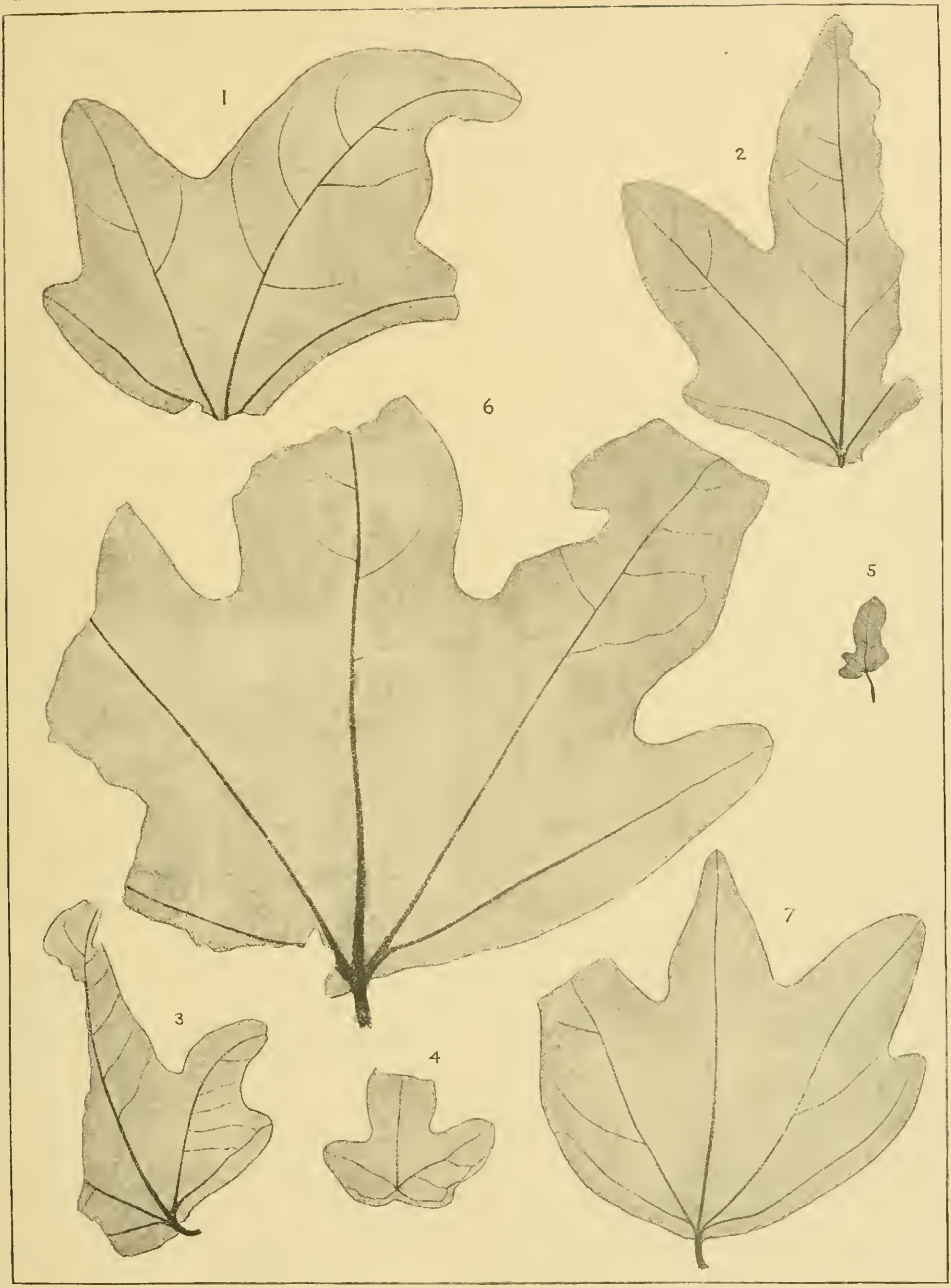

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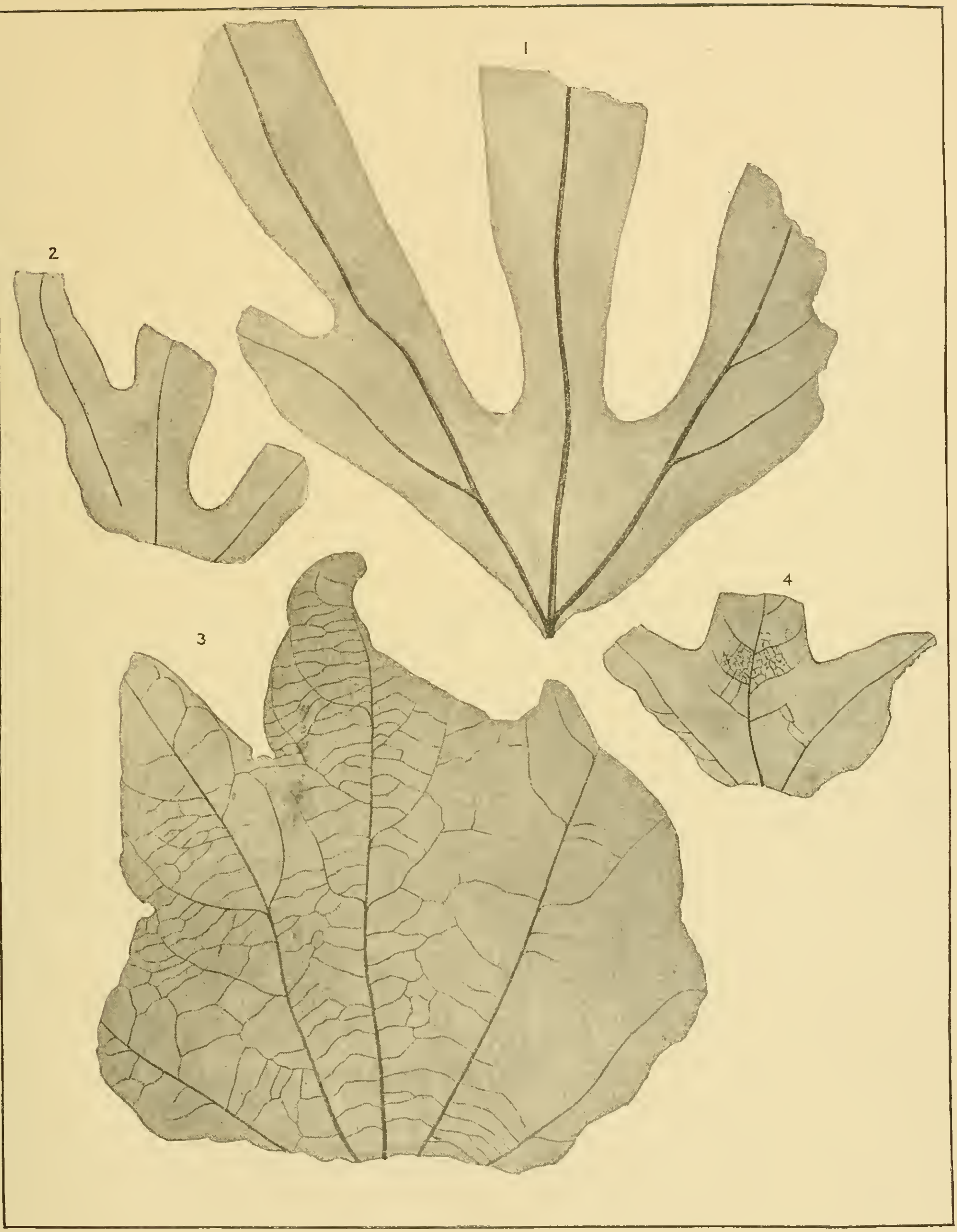
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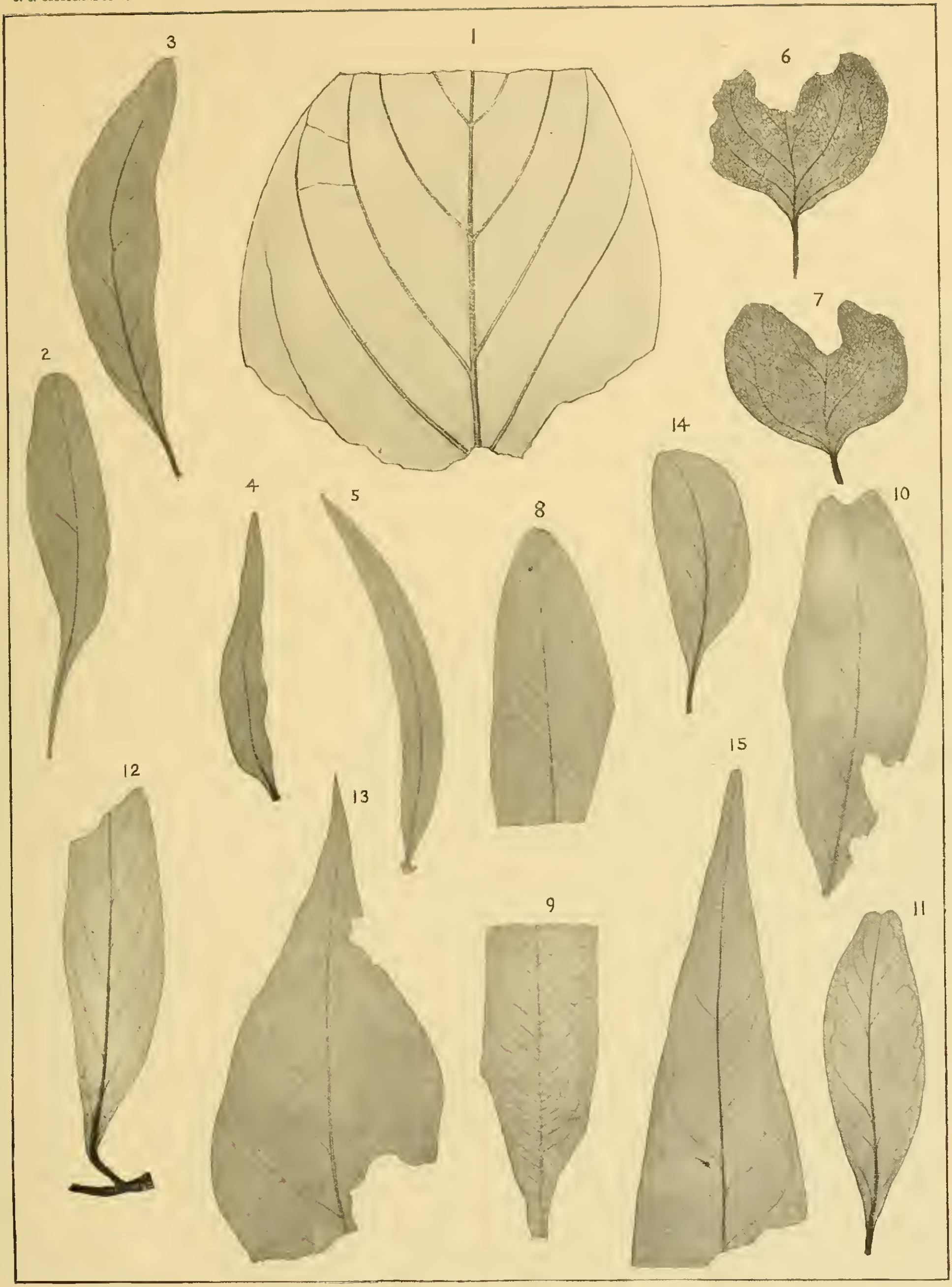
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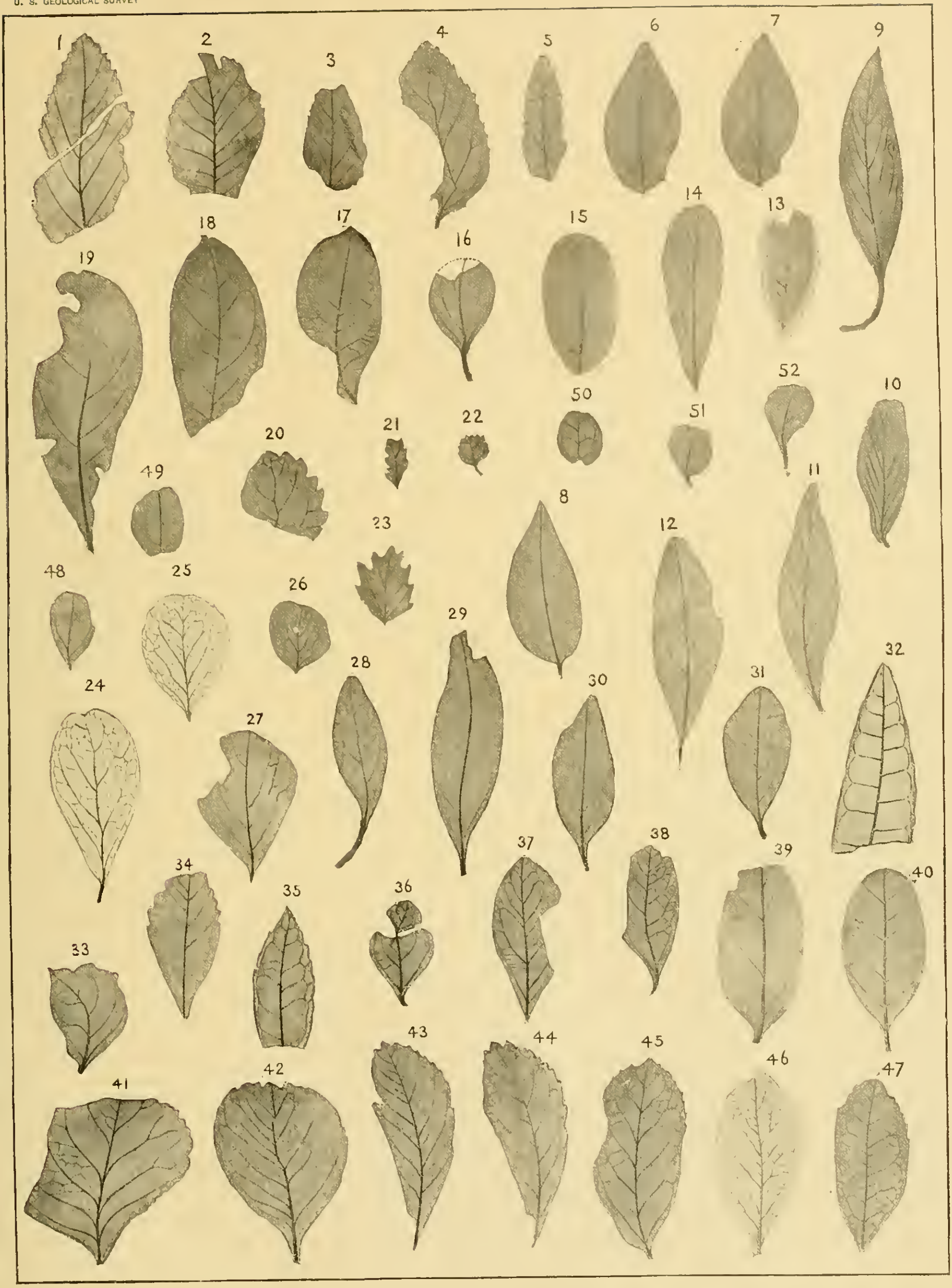
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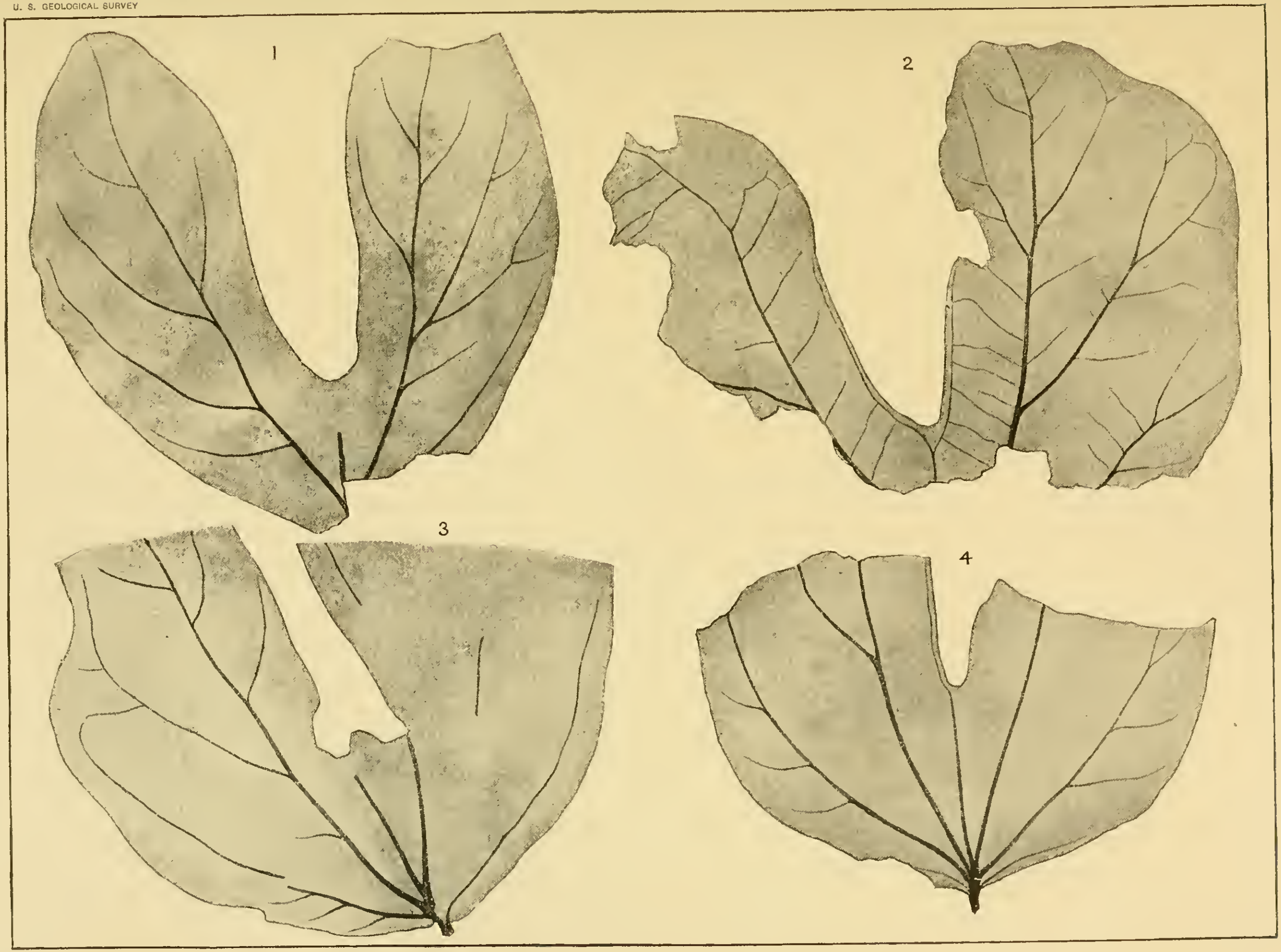
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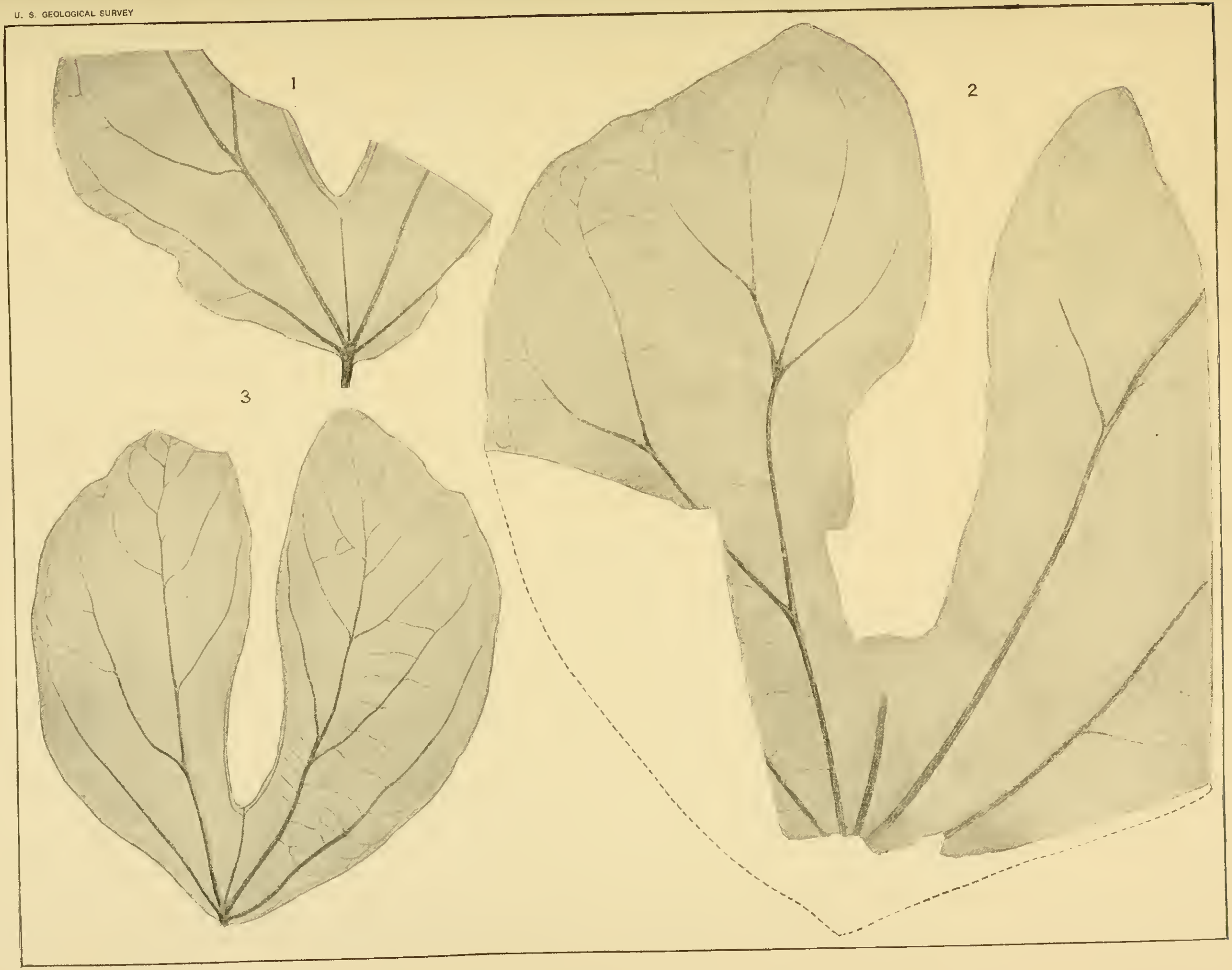
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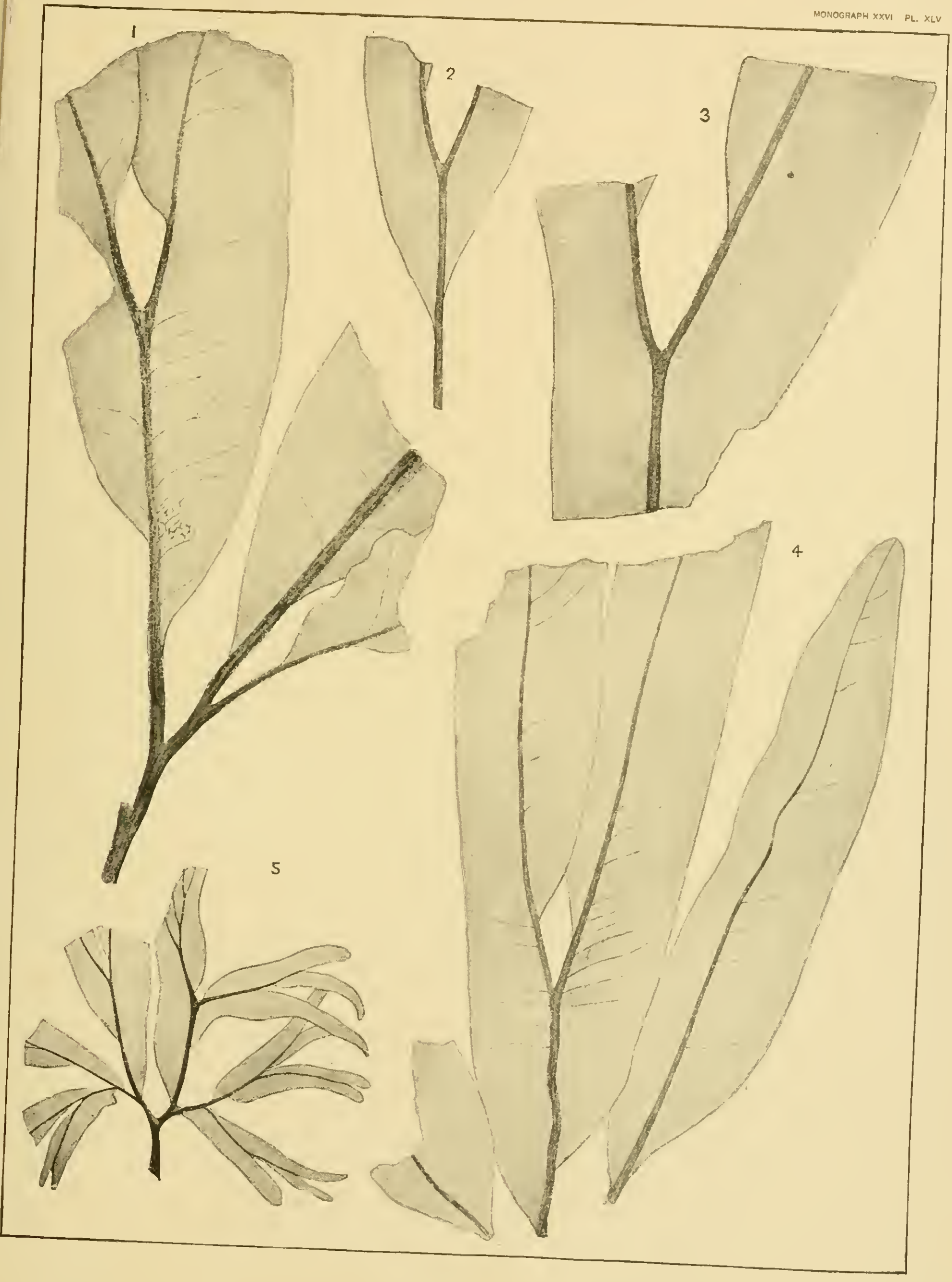
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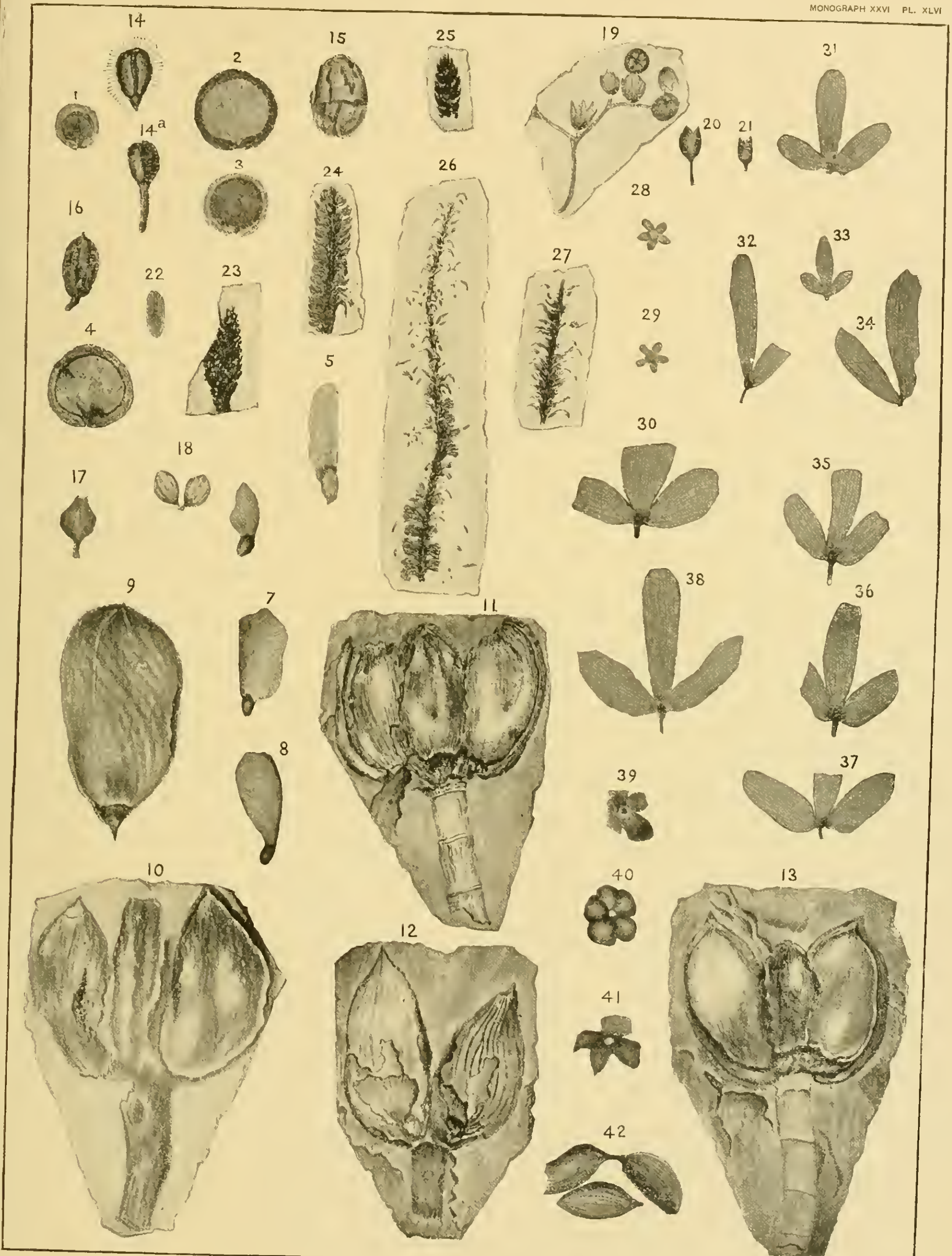
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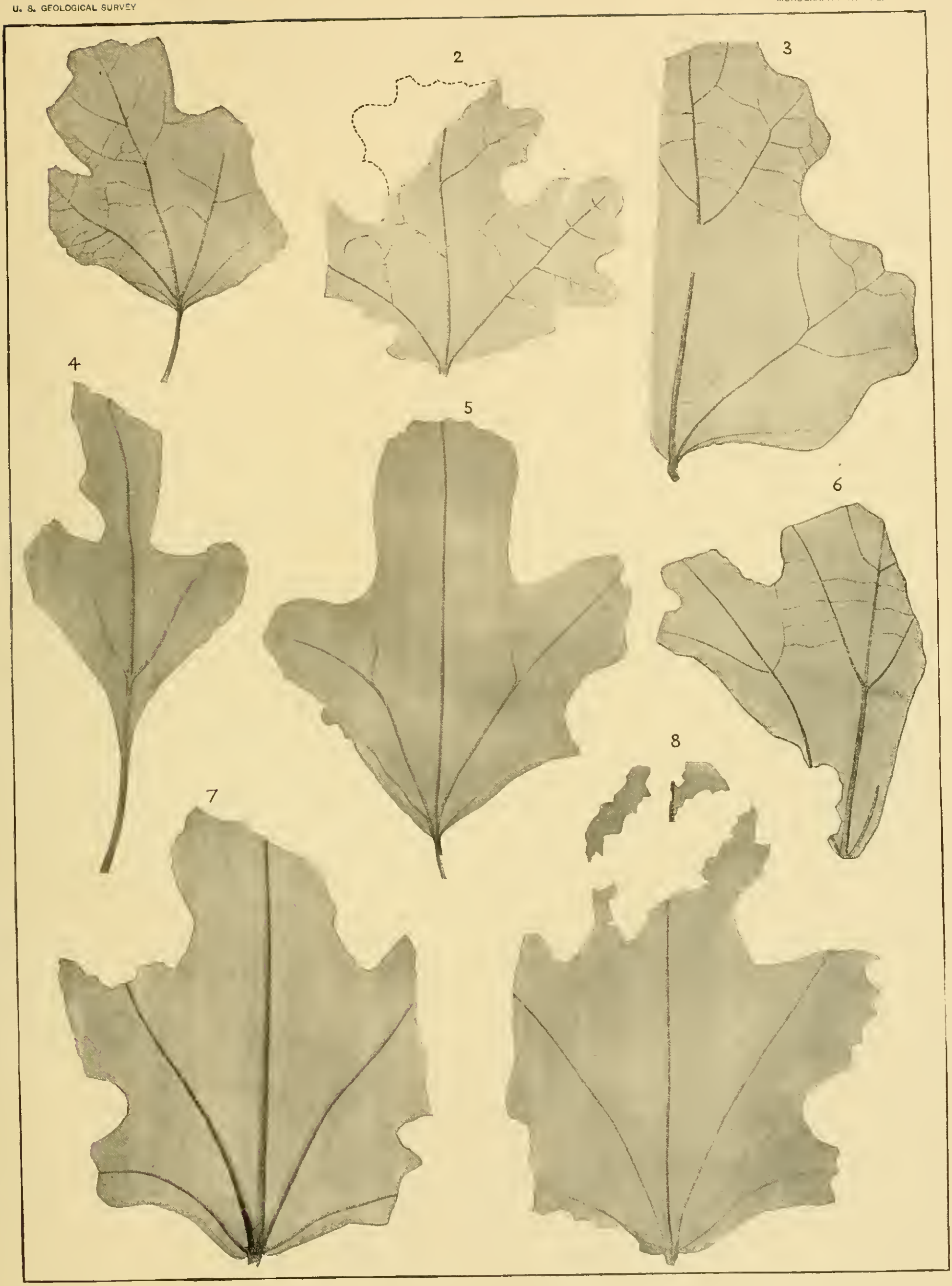
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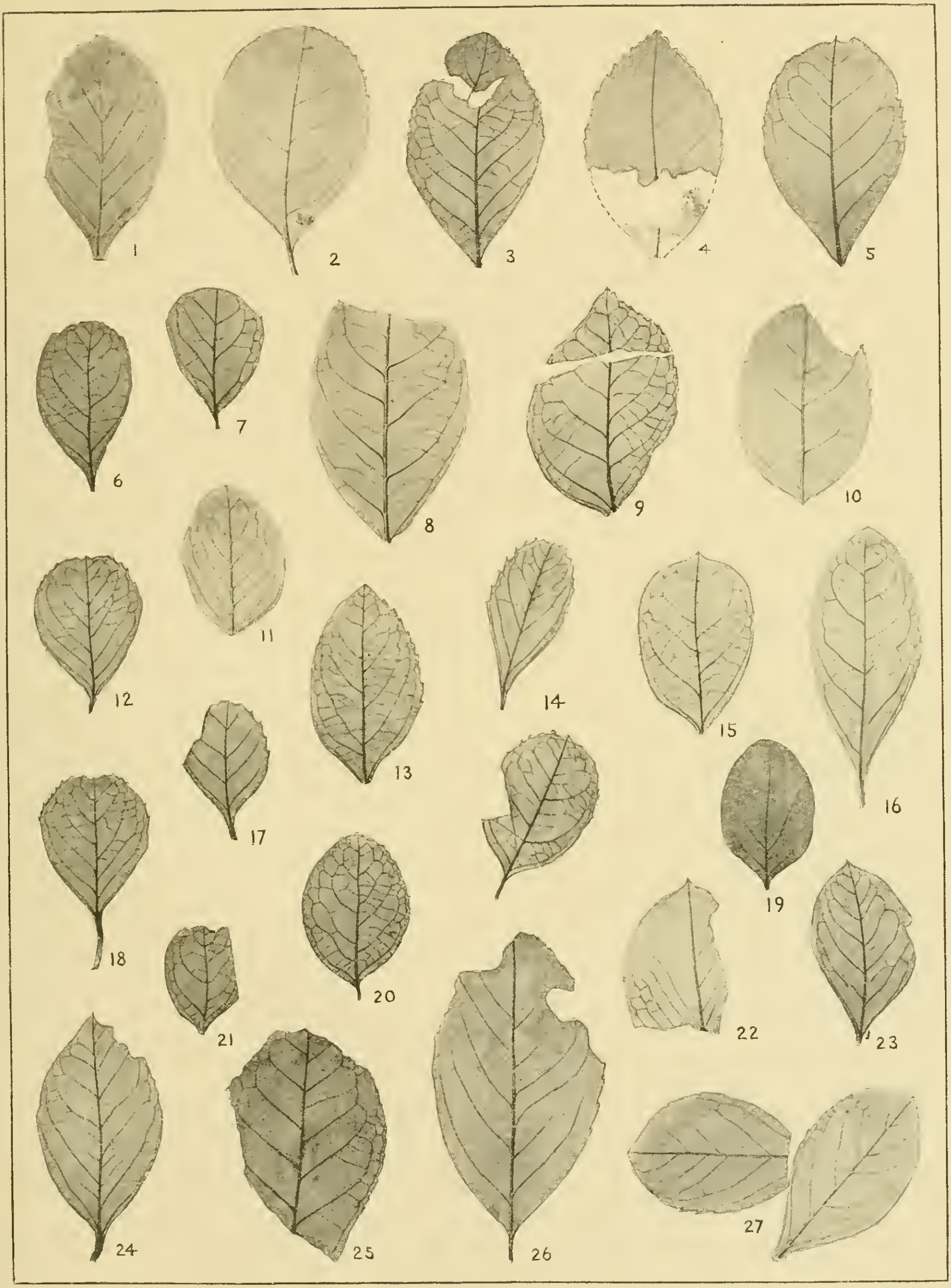
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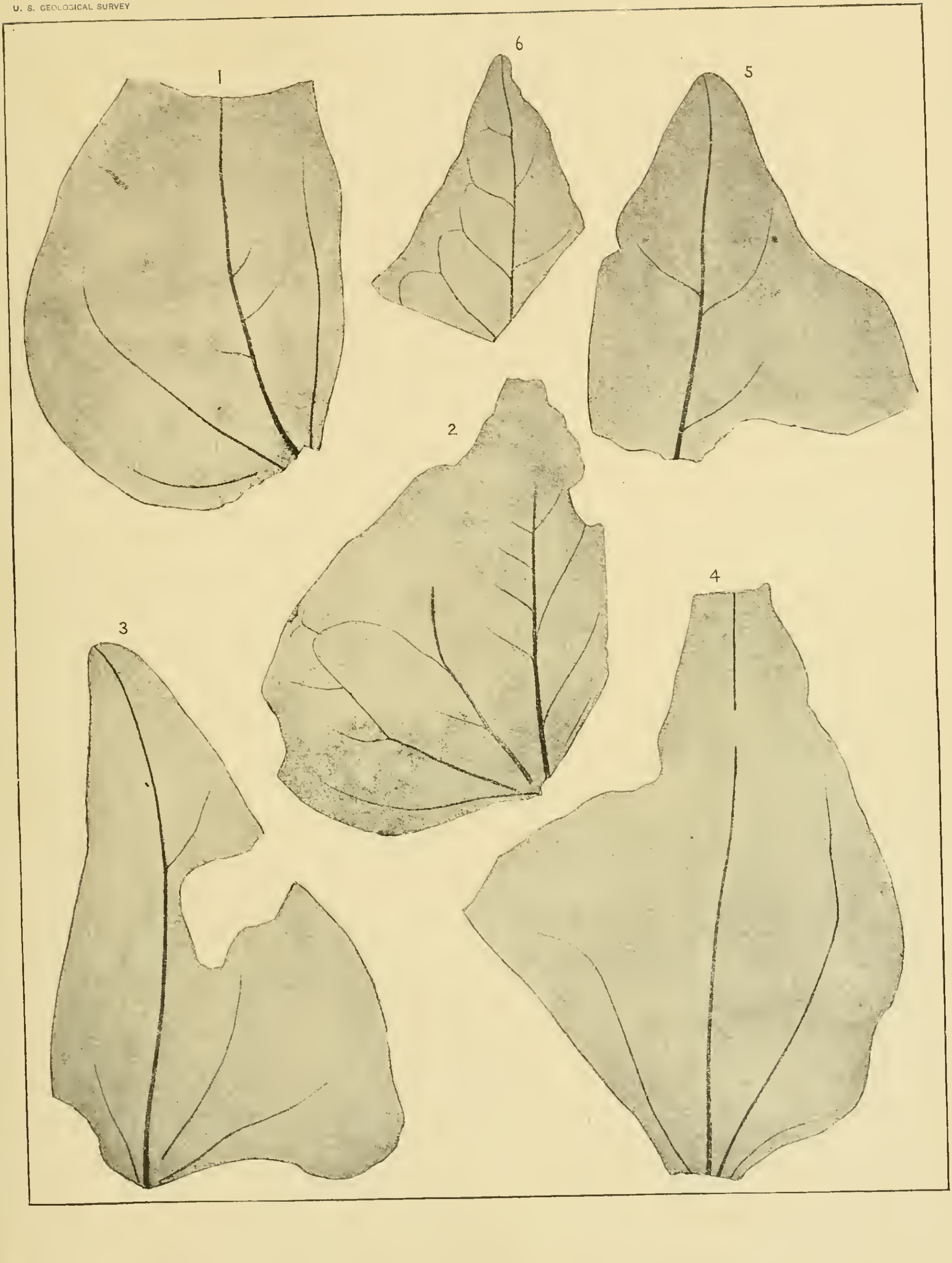
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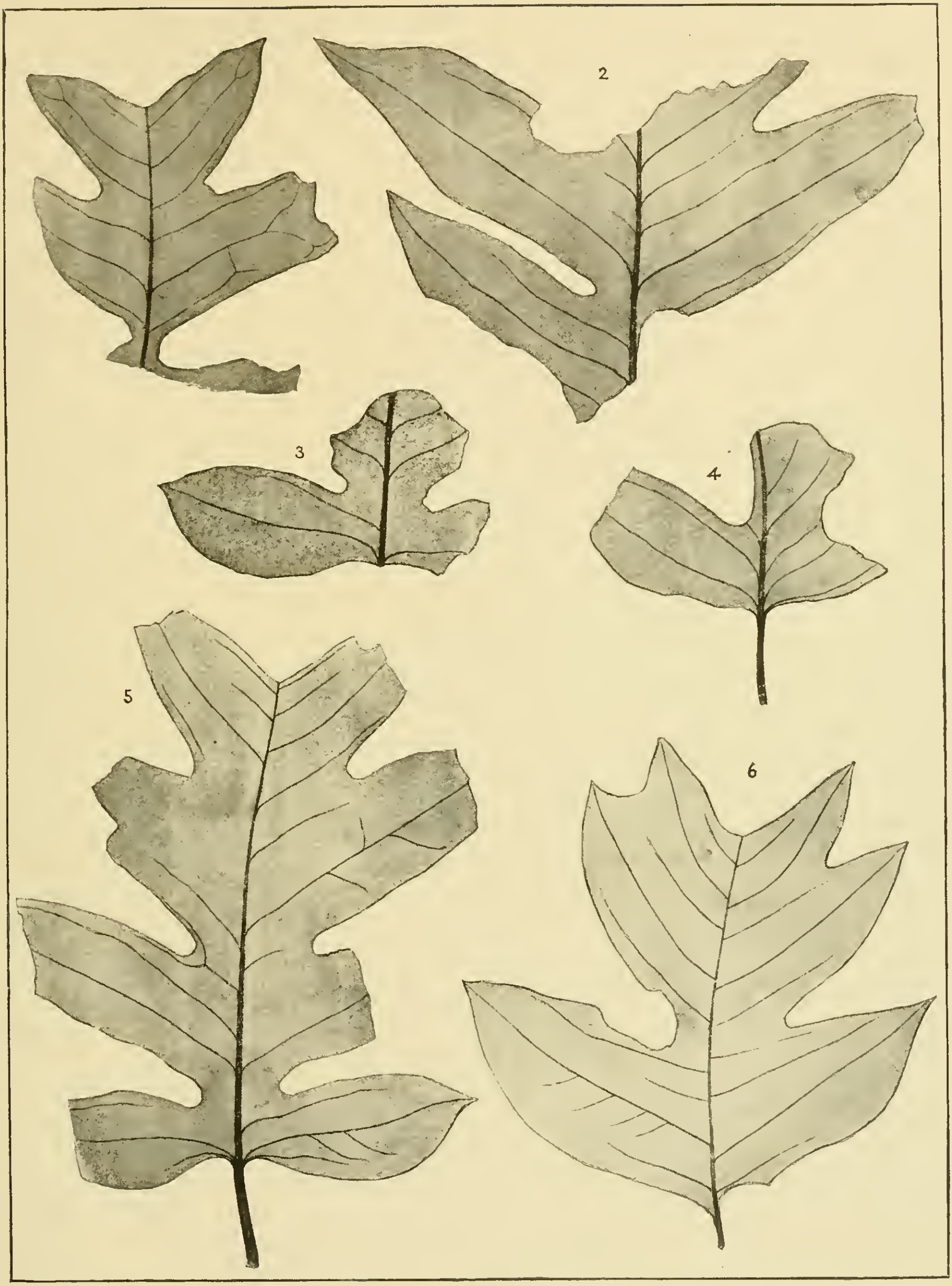
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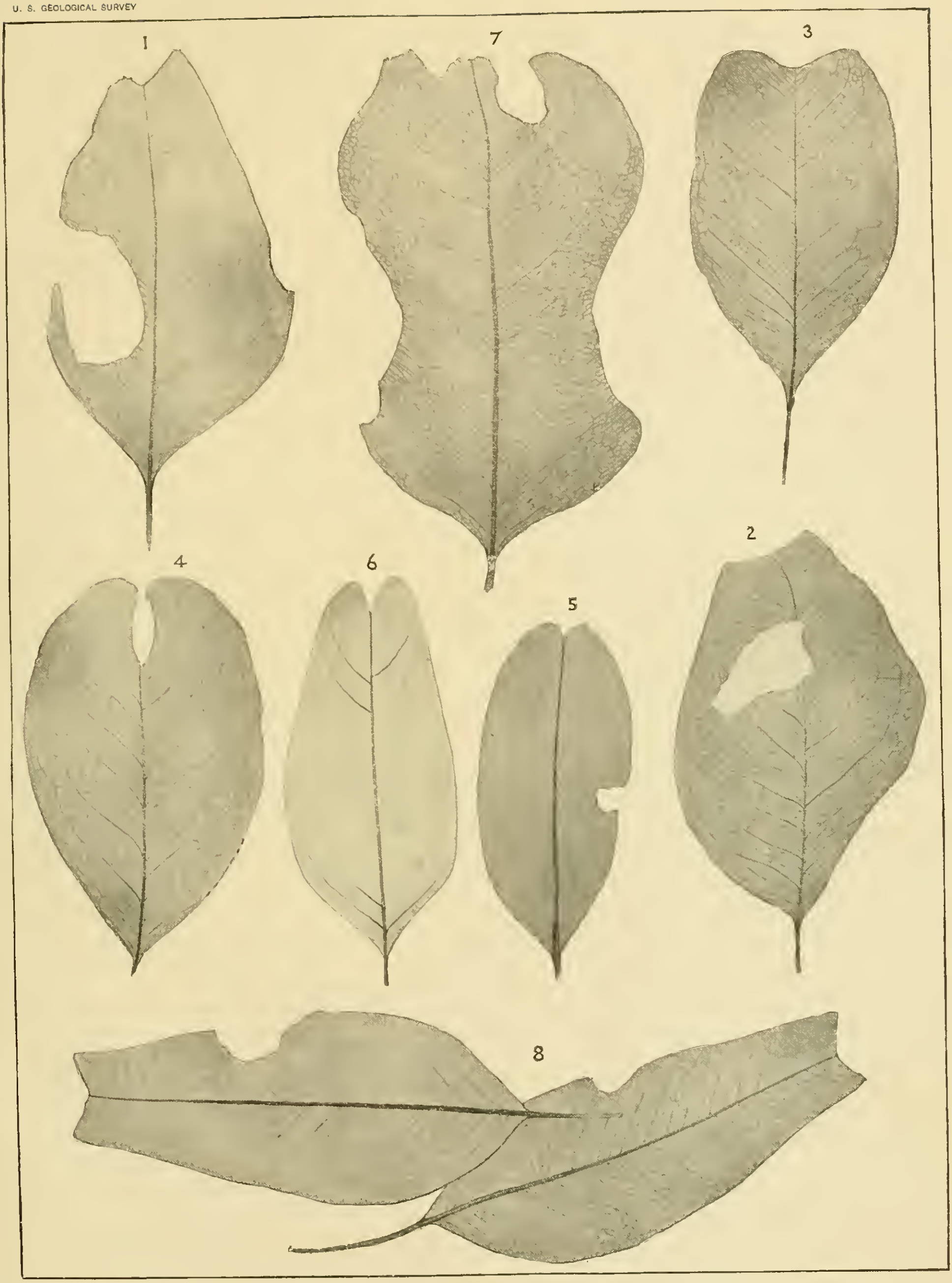

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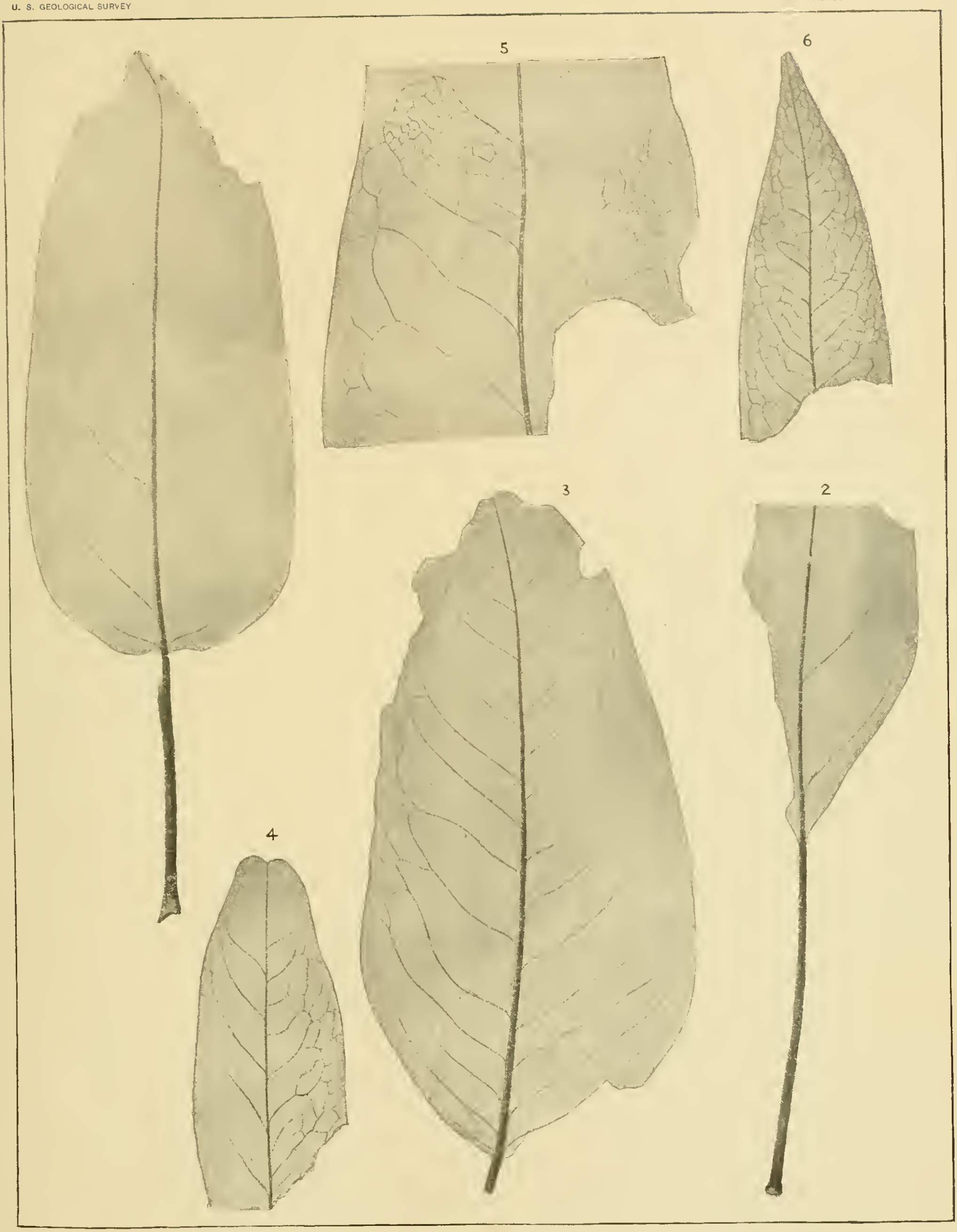
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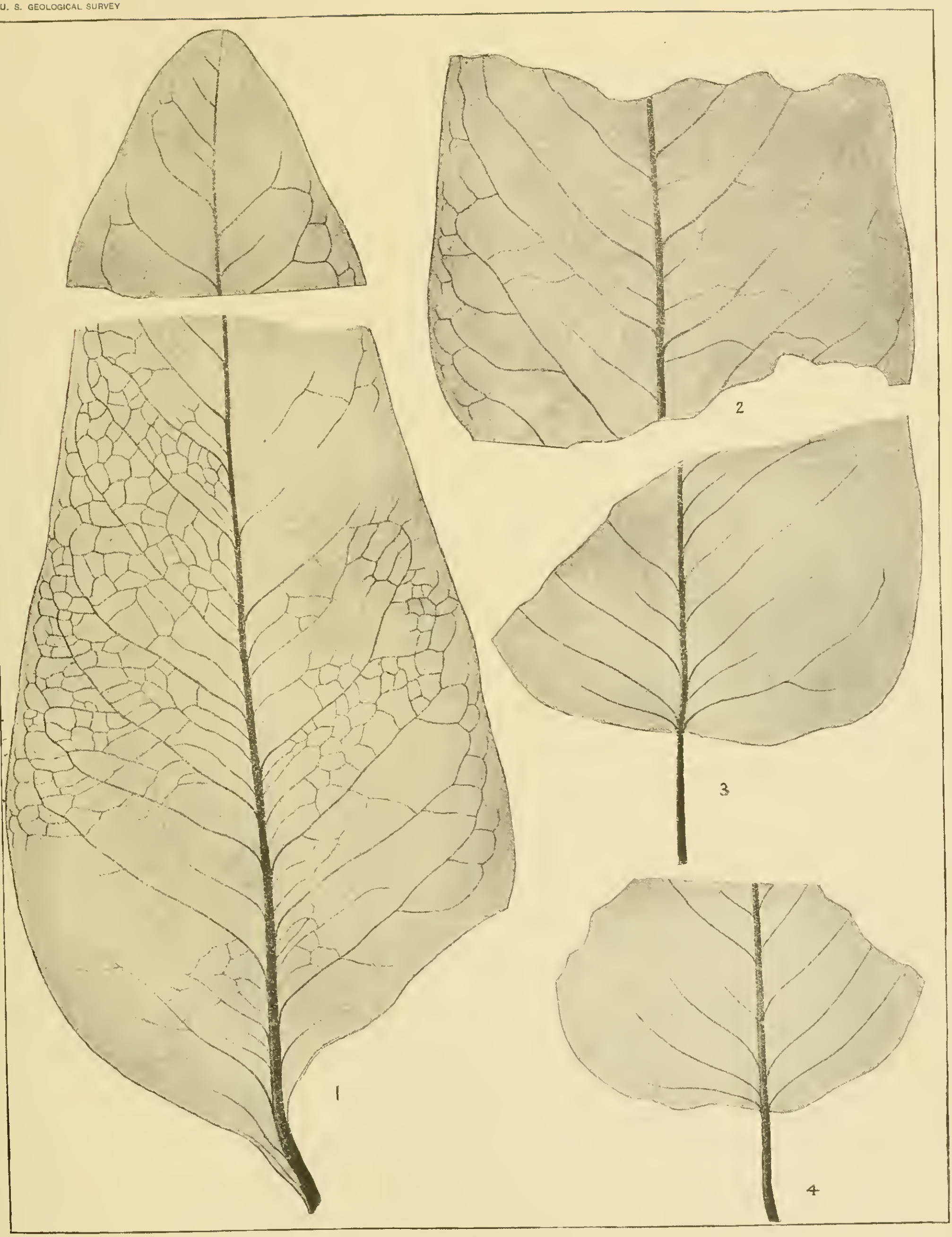

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[Genera and all higher groups are printed in SMALL CAPITALS; synonyms in *italics*. Heavy faced figures refer to pages on which descriptions are given, or to pages on which the species appear in their proper systematic position.

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