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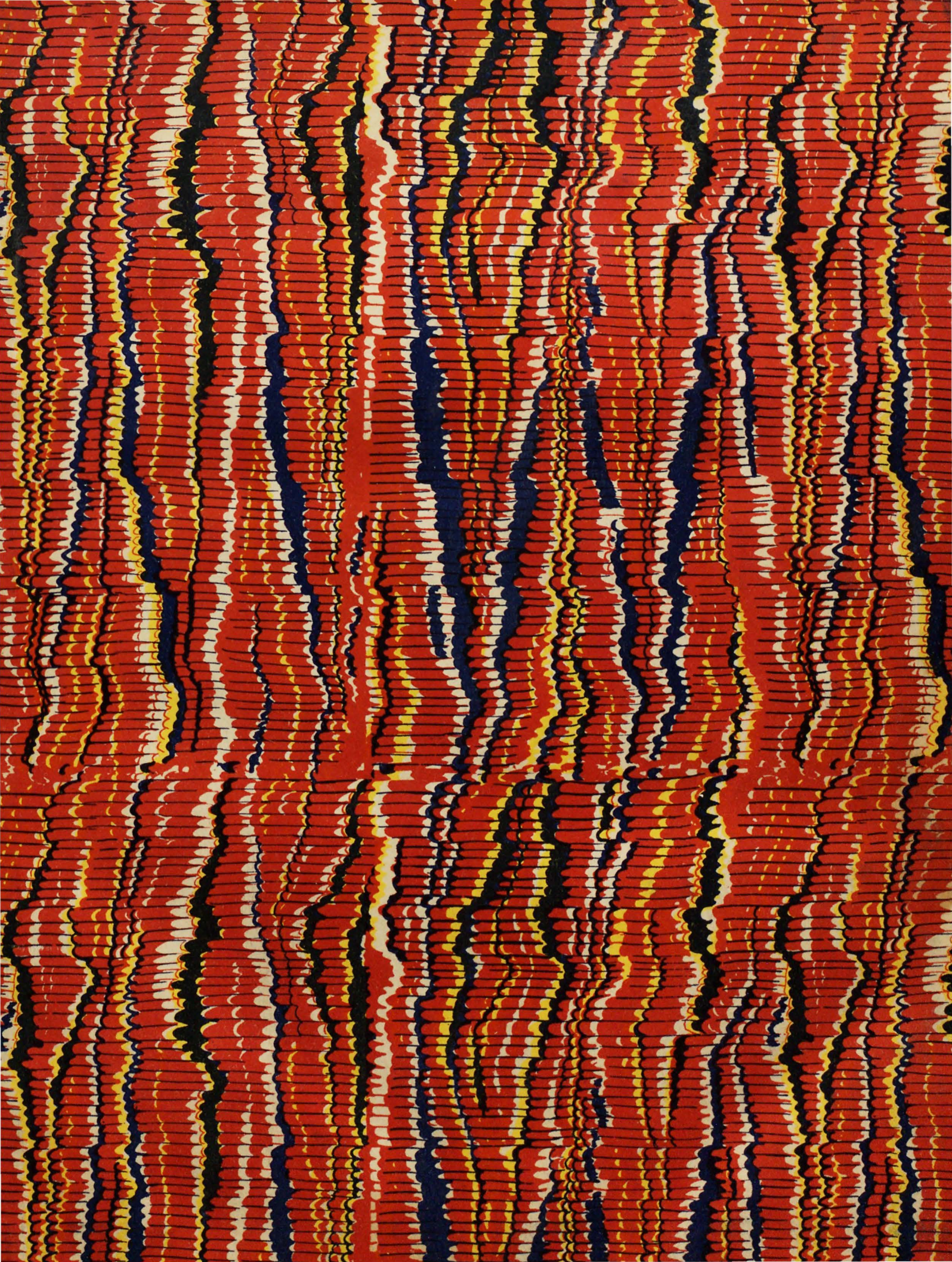

DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

OF

THE TERRITORIES.

F. V. HAYDEN,

UNITED STATES GEOLOGIST-IN-CHARGE.

VOLUME VI.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1874.

LETTER TO THE SECRETARY.

OFFICE U. S. GEOLOGICAL SURVEY OF THE TERRITORIES,
Washington, D. C., March 1, 1874.

SIR: I have the honor to transmit for publication the very valuable report of Prof. Leo Lesquereux on the Fossil Flora of the Cretaceous Dakota Group. This division, lying at the base of the Cretaceous series, forms a most important link in the physical history of the western portion of the continent, containing as it does the first proofs of the introduction on the earth of a vegetation allied to our fruit and forest trees. The formation also has a vast geographical extension, being exposed along the flanks of the various mountain-ranges, from a point far north of our northern boundary, and extending far south to Mexico. Nearly all the fossil forms, however, vegetable or animal, that it has yielded up to this time, have been found on the plains in the eastern portions of Kansas and Nebraska.

This elaborate memoir of Professor Lesquereux will be indispensable to every student of the geology of the West, and will reflect great credit on the survey at home and abroad, and its immediate publication is earnestly requested.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

HON. C. DELANO,
Secretary of the Interior.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

CONTRIBUTIONS

TO

THE FOSSIL FLORA

OF THE

WESTERN TERRITORIES.

PART I.

THE CRETACEOUS FLORA.

By LEO LESQUEREUX.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1874.

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ERRATA.

Page 31, line 20, for Cryptogamiæ read Cryptogamæ.
Page 31, line 30, for Phanerogamiæ read Phanerogamæ.
Page 32, line 3, for Phyllodadus read Phyllocladus.
Page 32, line 14, for 2 read 1.
Page 32, line 16, for 4 read 3.
Page 33, line 12, for Diospiros read Diospyros.
Page 39, line 32, for 30° read 35°.
Page 46, line 22, for XXX, Fig. 12[b], read XXIX, Figs. 5, 5[b].
Page 48, line 37, for Pl. IV and V read Pl. IV.
Page 49, line 13, for 97 read 91.
Page 49, line 25, for p. 139 read I, p. 139.
Page 51, line 29, for p. 8 read p. 7.
Page 55, line 11, for (p. 62, Pl. XXIII, Figs. 2, 3,) read (I, p. 62, Pl. XXIII, Figs. 8, 9, 11.)
Page 57, line 2, for p. 442 read 422.
Page 59, line 5, for p. 704, read II, p. 704.
Page 62, line 7, for Kanseana read Kansaseana.
Page 65, line 17, for Ellsworthianus read Ellsworthiana.
Page 69, line 19, for read 98.
Page 79, line 8, for former read following.
Page 91, line 19, for darted read parted.

COLUMBUS, OHIO, *February* 12, 1874.

DEAR SIR: I send you herewith my report on the fossil flora of the Cretaceous Dakota group.

Allow me to gratefully acknowledge the assistance received from you in the preparation of this memoir. The opportunity offered to me of exploring the more interesting localities where the materials for this work have been obtained was especially of great advantage. It enabled me to become acquainted with the geological distribution of the formation; to study the vegetable remains, and to compare their various forms in places where they were more abundant; to recognize their local disposition, and thus to solve many questions which, without this advantage, would have been left indefinite.

Very respectfully, yours,

L. LESQUEREUX.

Prof. F. V. HAYDEN,
United States Geologist, Washington, D. C.

ON THE FOSSIL PLANTS OF THE CRETACEOUS DAKOTA GROUP OF THE UNITED STATES.

§ 1.—The discovery of the fossil plants.

From the beginning of his explorations for the Geological Survey of the Western Territories, Dr. F. V. Hayden had remarked a formation of reddish and yellow sandstone, with variously colored clays, seams of impure lignite, and remains of fossil plants, the whole group holding a position at the base of the Cretaceous series of the Northwest. Already in 1853 he had obtained a number of specimens of leaves of exogenous and dicotyledonous plants, referable, according to his statements of that time, *if not to species, at least to genera still represented in our flora*, or, as he said,[1] *closely resembling those of some of the higher types among our existing dicotyledonous forest-trees.* In 1856 and 1857 the same geologist, then assisted by Professor Meek, found new specimens of these fossil plants in Nebraska; and later in their explorations of Kansas, undertaken in common for the purpose of studying the same formation which some geologist had referred to the Trias,[2] they still discovered in that State a number of leaves of the same kind. They moreover ascertained that the Kansas formations are in exact correlation, in all their geological characters, with No. 1 of their Nebraska section, now bearing the name of the *Dakota Group.* From a number of specimens these dicotyledonous leaves of Kansas were recognized as identical with some which had been formerly seen in abundance in strata of this Dakota group at the mouth of the Big Sioux River and at the Blackbird Hills, on the Missouri River, in Nebraska. Among these leaves especially were specimens of a trilobate leaf, mentioned by Mr. Hawes, as found in the measures which he referred to the Trias of Kansas, and which had been exhibited at the Baltimore meeting of the Association for the Advancement of Science. In the discussion on the age of the formation where these fossil plants had been recognized, the discoverers, Messrs. Meek and Hayden, remark, in the same paper, that these

[1] American Journal of Science and Arts, vol. xxvii, No. 79, 1859, p. 32.

[2] Trias of Kansas, by F. Hawn, Trans. Saint Louis Academy of Science, vol. I, p. 171.

leaves certainly belong to a higher and more modern type of dicotyledonous trees than has yet been found even in Jurassic rocks, and that therefore the formation could not be of Triassic age. And though they recognized it in immediate superposition to Upper Carboniferous or Permian rocks, they persisted in the former opinion of Doctor Hayden, that the red sandstones of the Dakota group were of Cretaceous age. Some sketches of these plants had been sent to Prof. O. Heer, of Switzerland, and in the meanwhile the whole collection of the leaves had been subjected to the examination of Doctor Newberry, who wrote, "that they did include so many highly organized plants, that were there not among them several genera exclusively Cretaceous, he should be disposed to refer them to a more recent era." After remarking that these plants did not represent any vegetable type older than Cretaceous ones, he says that the species, though probably all new, are closely allied to the Cretaceous species of the Old World. He refers them to the following genera: *Sphenopteris*, *Abietites*, *Acer*, *Fagus*, *Populus*, *Cornus*, *Liriodendron*, *Pyrus*, *Alnus*, *Salix*, *Magnolia*, *Credneria*, and *Ettingshausenia;* this last represented by that peculiar trilobate leaf mentioned above, which from better and more numerous specimens has been since admitted as referable to the genus *Sassafras.*

The discussion on the age of the Dakota group, which was then considered as Triassic by Messrs. Swallow and Hawn, and as Jurassic by Professor Marcou, was then complicated by the opinion of Professor Heer, who, answering Doctor Hayden's letter after the examination of the sketches sent to him, stated: That although one of the outlines resembles a Cretaceous genus, (*Credneria,*) the nervation being obscure, and the others more like Tertiary forms than anything known in the Cretaceous of the Old World, he was inclined to the opinion that they represent Tertiary species. From what is now known of the characters of the flora of the Dakota group, it is clear that, judging from mere sketches, the celebrated professor of Switzerland could scarcely come to a different conclusion. But this has nothing to do with the discovery of the fossil plants of the Dakota group, and with the history of the Cretaceous flora as we know it now. The above remarks merely tend to prove that the first discovery of the vegetable Cretaceous remains of this western section is due to Dr. F. V. Hayden, who first by himself, and afterward in connection with Professor Meek, studied the formations where these remains have been discovered, first in Nebraska and afterward in

Kansas; marking exactly the limits and the characters of this group, now generally admitted as the lower member of the American Cretaceous formation.

Vegetable palæontology has been too often considered as of little importance in regard to the determination of the age of geological divisions. In this case at least we have an evident proof of its value as a guide; for, indeed, without the fossil leaves of Nebraska, the relation of the Dakota group either to the Trias, the Jurassic, or the Cretaceous, would be still uncertain and subject to dispute; especially for the reason that the few animal remains recognized in the red sandstones of this group have been, as yet, too scant and of too little distinct characters to afford sufficient evidence on this point. This proves the importance of the first collection of fossil plants of Prof. Hayden. For now, as a result of his care in collecting them; in publishing geological facts marking the exact relative position of the Dakota group to the Permian rocks which underly it, and to the Cretaceous strata above it, and at the same time forcing the examination and comparative study of these fossil plants, which most of the geologists of the time would have passed as unworthy of regard; new researches have been induced; specimens have been obtained, more numerous, more perfect; and we have not only full geological evidence in regard to the lithology and geological distribution of the strata, but the first pages of what may be called a new chapter of our geological history. To it have been added the records furnished by the materials afterward brought up in abundance from various points.

The first contribution to these materials appears to have been furnished by Doctor Newberry. In reporting his opinion on the general character of the leaves submitted to his examination by Messrs. Meek and Hayden, he adds this paragraph:[1] "I may say in confirmation of the assertion that your fossil plants are Cretaceous, that I found near the base of the yellow sandstone series in New Mexico, a very similar flora to that represented by your specimens, one species at least being identical with yours, associated with *Gryphæa*, *Inoceramus*, and *Ammonites* of Lower Cretaceous species." And in his report on Doctor Hayden's fossil plants, he also remarks:[2] "That he subsequently went himself to the region where the vegetable remains had been obtained, and that he spent some years in the study of the geology of the interior of the Continent, exploring a large area occupied by Cretaceous

[1] American Journal of Science and Arts, vol. xxvii, No. 79, p. 33.
[2] Notes on the later extinct floras of North America, p. 3.

rocks in Kansas, Colorado, Arizona, New Mexico, and Utah. That during these explorations he obtained from the Cretaceous strata, at a great number of localities, angiosperm-leaves, consisting of some of the species obtained by Doctor Hayden, with many others, all of which are described in the report of the San Juan expedition, not yet published."

Unhappily for paleontological science, nothing is known as yet of these vegetable remains but what is said above, and they cannot be taken into consideration now as truly representing Cretaceous species. For the reason, especially, that except from the Cretaceous strata of Nebraska, Kansas, and Minnesota, we do not know as yet any fossil plants positively referable to a Cretaceous formation from the western territories named above, and traversed by Doctor Newberry in his survey. All our plants from these countries are referable to the Tertiary, like those of Colorado, Wyoming, and of California.

In 1856, being on a tour of exploration on the southwestern limits of the State of Minnesota, I remarked, above the mouth of the Big Waraju, or Cotton-wood, which enters the Minnesota River, near the present town of New Ulm, some exposures of a yellow-reddish sandstone bearing a few vegetable impressions, apparently representing leaves of willow. By reason of the generic identity of these leaves, I considered the rocks as of Tertiary age. I was the more disposed to admit this conclusion, as I found near by, in the bottom of the river, pieces of lignitic coal, evidently Tertiary, which I supposed to have been taken out by the water, from beds underlying the sandstone, somewhere in the vicinity; for I was not then aware that in the Big Waraju, as in the Smoky Hill River and many affluents of the Missouri and the Minnesota, these pieces of lignite coal are carried by the current from the upper part of the rivers, where they cross the Tertiary formation, hundreds of miles above.[1] As I did not have then any instrument with me, not even a hammer, and no means of transportation, I was unable to get specimens of these fossil plants, and regretted many times thereafter the impossibility of comparing these Minnesota leaves with those of Doctor Hayden, and especially with some referable to *Salix*, which I have since obtained in abundance from Nebraska and Kansas. In 1867, at the meeting of the National Academy at Northampton, Prof. Jas. Hall, who had just returned from a geological exploration in Western Minnesota, exhibited, among a number of

[1] These lignites are different from the shaly, friable, carbonaceous matter seen in the bluffs of the same river. They correspond by general aspect and chemical compound with the Tertiary lignite found, too, in the bed of the Blue Earth River above Saint Peter, in the Missouri, the Smoky Hill River, &c.

other specimens, some fossil leaves taken from a red sandstone at about the same locality which I had formerly visited. From my impression in regard to the geological distribution of the rocks which I had seen in place, and from the presence of two species of leaves recognizable among these specimens—one *Salix*, one *Laurus*, with apparently a *Cornus*, I then considered them as pertaining to a Tertiary formation. By the kindness of Professor Hall I have now these specimens for examination, and, comparing them with those of the Dakota group of Nebraska, recognize them easily as from the same Cretaceous formation. Some of the species are identical with those of the Blackbird Hills, and the compound of the stone is of exactly the same kind. It is coarser, however, forming a rough-grained sandstone, which renders somewhat difficult the study of the specimens, on account of the obliteration of the veins. Some of these leaves are described and figured in this paper.

In 1863 another geological exploration in the same field of research had also contributed new and interesting materials for the study of our Cretaceous flora. As has been stated already, the reference of the Nebraska fossil leaves to a Cretaceous formation caused a difference of opinion between some American and European geologists concerning the true age of the Dakota group. The details of the discussion on this subject are given at length in Dr. Newberry's Extinct Floras, (*loc. cit.*) Professors Marcou and Capellini, two European geologists of celebrity, wishing to obtain for themselves full evidence on the conclusions of Doctor Hayden, undertook an exploration in Nebraska to visit the localities where the fossil plants had been discovered and to review the stratigraphical records on which these conclusions had been based. They obtained in their tour, especially in the vicinity of Tekamah, as also from the Indian reservation in the Blackbird Hills, a number of specimens, which were delivered to Professor Heer for examination. From these materials the *Phyllites du Nebraska* were prepared and published—a very interesting paper, 22 pages quarto, describing seventeen species, all new ones, with four plates of illustrations. This memoir gives us the first authentic and reliable record of our North American Cretaceous fossil plants, and is the more valuable on account of the high scientific attainments of the author, of the accuracy of his descriptions of the leaves, and of the figures by which they are exemplified.[1] Of course the explora-

[1] Three leaves from the Dakota group are figured in Journal of Sciences and Arts, vol. xxvii, No. 80, pp. 222 and 223, 1869. They are, however, without description. The first has been considered a leaf of *Liriodendron*, the second a *Credneria*, the third a *Sassafras*.

tions of Messrs. Marcou and Capellini could but corroborate the facts already known from the reports of Dr. Hayden. They recognized the accuracy of the statements concerning the stratigraphical distribution of the members of the Dakota group, as also the conclusions advanced on its age. They even acknowledge that after ascertaining that the American geologists were right, they had been unable to pursue their explorations to as successful a result as had been done by Dr. Hayden, having failed to discover the line of superposition of the Benton group with its animal fossils to the red-sandstone bearing plants.

In the mean while the interest awakened by the discussions in regard to these plants and to their positive relation to the age of Nebraska sandstones had incited new researches, and the result was the discovery of a large number of better specimens, representing some species already known, and many new ones, too. In the same year (1863) Prof. F. B. Mudge, of Manhattan College, Kansas, collected, as State geologist, some splendid specimens of Cretaceous fossil plants, which were sent to Prof. F. B. Meek and to the Smithsonian Institution. In 1867 Dr. John Leconte, while connected with the survey of the Union Pacific Railway, obtained also a number of fine specimens of fossil leaves from the same red shales of the Dakota group, near Fort Harker; and about the same time, Mr. Charles Sternberg, who was domiciled in that vicinity, discovered some localities rich in remains of fossil plants, and sent many specimens of them to the Smithsonian Institution and to Dr. Newberry. From the examination of specimens furnished to me by Dr. Hayden, Dr. Leconte, and Professor Mudge, I prepared a paper entitled *On Some Cretaceous Fossil Plants from Nebraska*, the first paper published in America describing fossil plants of the Dakota group. This memoir[1] gives an account of fifty-three species, eight of which were known already from the *Phyllites du Nebraska*, by Professor Heer, three referable with doubt to others already published, and the balance, forty-one species, considered as new. Soon after, a second paper, partly on the same subject, was published by Doctor Newberry and distributed in pamphlet form.[2] This very interesting memoir,

[1] American Journal of Sciences and Arts, vol. xlvi, No. 136, pp. 91–104.

[2] Though I do not attach any importance whatever to the right of priority of authorship for species of fossil plants, known from mere descriptions, I take this opportunity of fixing dates in order to show that my paper had precedence in distribution, if not of publication, to that of Dr. Newberry, and that therefore if a few identical species are described in both memoirs, under different names, I am in no way accountable for it. My own report, as seen from its datum, was delivered to Dr. Hayden 19th March, 1868, and published in the Journal (*loc. cit.*) July, 1868. Dr. Newberry's paper is marked by him as read the

The Late Extinct Floras of North America, describes, besides Tertiary plants, twenty-one species of fossil plants from the same Dakota group.

Later still, in Dr. F. V. Hayden's annual report for 1871, eight new species are described by the writer, with mention of two already known, all from specimens furnished by Dr. B. F. Mudge. And from my own explorations of 1872 over the Dakota group of Kansas I obtained a large number of fine specimens, serving to better illustrate some species already described from insufficient materials, and adding to our list of Cretaceous species twelve new ones for the American flora, three of which, however, were known from Europe and European publications.

All these species, already briefly described by myself either in the Journal of Sciences and Arts, or in the annual reports of Dr. Hayden, together with the new ones recognized from specimens collected in a tour of field explorations in Kansas and Nebraska, (1873,) constitute the materials from which the present memoir is made. I must remark, also, that in order to complete, as far as it was in my power, the history of the flora of the Dakota group, I have added to the materials mentioned above, the description and figures of five species which I had published, as an appendix to the Tertiary plants of the Mississippi, in the Transactions of the American Philosophical Society, vol. xiii, and also of a few new species recognized in the specimens kindly lent to me by Prof. Jas. Hall, which are described and figured with his approval.[1] I do this especially in order to have all together the materials pertaining to our Cretaceous flora. With Professor Newberry's Report on the Ancient Floras, which is to have also descriptions and figures of all his species of Cretaceous plants, we have nearly the whole of what is known as yet of this interesting group of fossil plants. The only species which have been described by Professor Heer and have not been published out of the *Phyllites du Nebraska* are: *Salix nervillosa*, *Ficus primordialis*, *Magnolia capellini*, and *Cissites insignis*. These, however, are remarked upon in the text of this memoir.

22d of April, 1867, and reprinted from the Lyceum of Natural History of New York, vol. ix, April, 1868. It was mentioned in the Journal of Sciences and Arts November, 1868, and distributed at the same time in pamphlets, the copy sent me being received 7th November, 1868. As far as I am informed, no copies of this paper had been distributed at an earlier date.

[1] By the kindness of the industrious and untiring investigator of the Cretaceous measures of Kansas Prof. B. F. Mudge, I have recently received, after the preparation of this paper, a new contribution of specimens, which has enabled me to add two new plates to the flora of the Dakota group, representing, among others, ten species not described before.

§ 2.—Surface distribution of the Dakota group.

In order to illustrate the geological relation of the species of fossil plants described in this memoir, it is convenient to make some remarks on the distribution of the group wherein they have been discovered. In doing this it will be advisable to record facts already published by geologists who have formerly explored this formation—by Dr. Hayden especially, by Professors Meek, Mudge, Conrad, Marcou, Capellini, Hall, &c. These records and quotations are rendered necessary by the scattering of the materials referring to this group in scientific journals which are rarely accessible to paleontologists.

The eastern limits of the surface area of the Dakota group are marked in the Geological Report of Iowa, by Prof. C. A. White, who recognizes the most easterly deposits of this formation, which he calls the *Nishnabotany sandstone*, in the southeast part of Guthrie County, and as far south as the southern part of Montgomery County. To the north it passes under the *Woodbury sandstone*, overlaid by the Inoceramus, or chalky beds. The northwestern counties of Iowa have not been yet surveyed in detail, and owing especially to the few exposures of the rocks underlying the drift, and the prairies which cover this region, the exact limits of the group are not here distinctly recognized. The direction, however, is, in Iowa, from near Council Bluffs north and somewhat east to the point where the Des Moines River leaves Minnesota, and hence due north to the mouth of the Big Cottonwood River, near New Ulm, where the red sandstone is exposed in the bank of the river. From this locality Professor Hall has recognized it one hundred and thirty miles farther north. From Council Bluffs, or from above the mouth of the Platte, in Nebraska, the border of the belt passes in the same direction, south a little westward, across the western part of Cass and Otoe Counties; thence to the middle of Gage County, near Beatrice; then through Marshall County, entering Kansas in the eastern corner of Clay. It descends farther south to the mouth of Solomon River, and reaches the Arkansas River west of the line of the Atchison, Topeka and Santa Fé Railroad, near the mouth of Cow Creek.

I can find no data marking the borders of the belt, nor even recording its appearance in the Indian Territory, between Kansas and Texas. But subsequent geological investigations cannot fail to recognize it in that country, as its connection cannot be broken in that, as yet unexplored, region alone. The records of the geological surveys of Texas and of Arkansas indicate it

in those States, in the same direction which it is following in Kansas, or nearly due south. In a note in the proceedings of the Academy of Science of Saint Louis, Professor Shumard, after remarking,[1] "that they had not before succeeded in finding dicotyledonous leaves in the Lower Cretaceous marls and sandstone of Texas, as had been done by Meek and Hayden in Nebraska and Kansas, and that they supposed they would probably be found in this position," adds: "I have now the pleasure to inform you that further explorations in Lamar County, near Red River, have resulted in the discovery, by Dr. G. G. Shumard, of numerous impressions of leaves in alternations of yellowish sandstone and bluish shales which are believed to occupy a position below the marly clay, or Red River group of my section, and which we regard as being on a parallel with the lower beds of No. 1 of the Nebraska section. The collection made by Dr. G. G. Shumard contains several species of dicotyledonous leaves which appear to belong to the genera *Salix*, *Ilex*, *Laurus*, &c."

At the time of the discovery of these fossil plants, I corresponded with Doctor Shumard, desiring that they should be sent to me for examination, and I was promised communication of them. To my regret the promise was not fulfilled, owing especially to modifications in the corps of the geological survey of Texas. There can be no doubt, however, from the description of the position of the strata, of their compound, and also of the generic relation of the leaves, that they are referable to species of the flora of the Dakota group, or that this Cretaceous group is represented in the northern counties of Texas. The chalk-beds of the Cretaceous equivalent of the Benton group are predominant not only in Texas, but also in the southwestern corner of Arkansas, and have been recognized in the whole extent of Sevier, Pike, and Hempstead Counties, &c. According to Dr. D. Dale Owen's report on the geological survey of Arkansas, this chalk limestone is seen in these counties, almost everywhere near the bottom of the creeks, under the loam. On account of its lower station, of course the red sandstone of the Dakota group was not observed, the beds of the river being nowhere deep enough to expose it to view. From North Texas, the Cretaceous formation passes to the south, under wide prairies mostly of loam and Tertiary deposits. It is not positively ascertained if it reaches the Gulf of Mexico, but it is

[1] Vol. ii, No. 1, (1863,) p. 140.

more than probable, as Hayden and Hall suppose, that it extends further south to the sea.

In tracing the eastern borders of the Dakota group, the length of its area from north to south is recognized from the northern limits of the State of Minnesota to North Texas, on about 20° of latitude. That this group extends farther north into British America maybe hypothetically admitted; and as the fossil leaves received from Greenland by Professor Heer, and considered by this author as Upper Cretaceous, represent some genera and, perhaps, some species too, identical with those of the Dakota group, it would seem that this formation has been continuous from the Gulf of Mexico to the Arctic lands, Greenland, Melville, &c., over 35° of latitude.

As far as it is known, in the States of Iowa, Kansas, and Nebraska, the average width of the belt occupied by the Dakota group from east to west, varies from sixty to one hundred miles. It has been seen that the red sandstone of this formation is exposed in the southeast part of Guthrie County, in Iowa, which is already ninety to one hundred miles east of De Soto, on the Missouri River. In following up this river, the same formation is still exposed to thirty miles above the mouth of the Big Sioux, where it passes under the bed of the river.[1] This, in a direct line, is at least one hundred and thirty miles. In Nebraska State, the width of the belt is, according to Doctor Hayden, from sixty to eighty miles.[2] In Kansas I have followed this formation along the Kansas Pacific Railroad, from the mouth of Solomon River, for seventy-five miles to the west. Professor Mudge has collected specimens of its fossil plants around Fort Larned, and recognized the sandstone of the Dakota group, up the Arkansas River, to the limits of the State. He says that the average breadth of this sandstone formation in the northern half of the State is about forty miles, (northwest and southeast,) or about sixty miles in a diagonal line running due east and west. But when it reaches the bluffs of the Arkansas Valley the strike is westerly, and instead of a westerly extension of sixty miles, it covers the whole country from thirty miles east of Pawnee Rock to the western line of the State, a distance of about two hundred miles.[3] It may be that it enlarges still farther southwestward, for, according to Dr. Newberry's statement, it reaches

[1] F. V. Hayden's remarks on the Cretaceous rocks of the West. American Journal Science and Arts, vol. xliii, p. 172.

[2] Report United States Geological Survey, (1867,) 2d edition, p. 52.

[3] Transactions Kansas State Board of Agriculture, (1872,) p. 408.

New Mexico and the Rocky Mountains. I have not been able to find any trace of it in that country, however, and as all the specimens of fossil plants either found by myself south of Colorado or sent to me for examination from the Rocky Mountains or their eastern slopes, are species representative of the Tertiary formations, as remarked already, I am still uncertain if the Dakota group is really extended farther west than Kansas. The western strata bearing plants which are now recognized as of Eocene age, were formerly considered as Cretaceous, and the leaves found in great abundance in connection with the Tertiary formation, though of a different character, may have been inadvertently referred to species of the Dakota group. However it may be, this Cretaceous group has not been positively recognized by Dr. Hayden in his explorations to and along the Rocky Mountains, and from the nature of its compounds, which, as it will be seen hereafter, induces me to consider it as a beach formation, I doubt whether it is of a much wider extent westward, as it has been reported, or whether it is to be found west of the borders of Kansas.

§ 3.—Stratigraphical distribution of the Dakota group.

The section of the Cretaceous rock of the West, published in Dr. Hayden's Report of the Geological Survey of the Territories, 1870, p. 87, gives the best possible illustration of the relation of the groups of the American Cretaceous from its base, in connection with the Permian, to its top, over which the Eocene sandstone is superposed. It is here copied in full as a necessary exemplification of the details which are given in this chapter:

General section of the Cretaceous rocks of the Northwest.

		Divisions and subdivisions.	Localities.	Estimated thickness.	
				Feet.	
Upper series.	Fox Hills beds. Formation No. 5.	Gray, ferruginous, and yellowish sandstone, and arenaceous clays, containing *Belemnitella bulbosa, Nautilus dekayi, Ammonites placenta, A. lobatus, Scaphites conradi, S. nicolletti, Baculites grandis, Busycon bairdi, Fusus culbertson, F. newberryi, Aporrhais americana, Pseudo-buccinum, nebrascensis, Mactra warrenana, Cardium subquadratum,* and a great number of other molluscous fossils, together with bones of *Mosasaurus missouriensis, &c.*	Fox Hills, near Moreau River, near Long Lake, above Fort Pierre, along base Big Horn Mountains, and on North and South Platte Rivers.	500	*Senonien*, D'Orbigny.
	Fort Pierre group. Formation No. 4.	Dark-gray and bluish plastic clays, containing, near the upper part, *Nautilus dekayi, Ammonites placenta, Baculites ovatus, B. compressus, Scaphites nodosus, Dentalium gracile, Crassatella evansi, Cucullœa nebrascensis, Inoceramus sagensis, I. nebrascensis, I. vanuxemi,* bones of *mosasaurus missouriensis, &c.*	Sage Creek, Cheyenne River, and on White River, above the Mauvaise Terres.	700	Upper or white chalk and Maestricht beds.
		Middle zone nearly barren of fossils.....	Fort Pierre and out to Bad Lands, down the Missouri, on the high country, to Great Bend.		
		Lower Fossiliferous zone, containing *Ammonites complexus, Baculites ovatus, B. compressus, Helioceras mortoni, H. tortum, H. umbilicatum, H. cochleatum, Ptychoceras mortoni, Fusus vinculum, Anisomyon borealis, Amauropsis paludiniformis, Inoceramus sublœvis, I. tenui-lineatus,* bones of *Mosasaurus missouriensis, &c.*	Great Bend of the Missouri, below Fort Pierre.		
		Dark bed of very fine unctuous clay, containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret iron, and numerous small scales, fishes, local, filling depressions in the bed below.	Near Bijou Hill, on the Missouri.		
	Niobrara division. Formation No. 3.	Lead-gray calcareous marl, weathering to a yellowish or whitish chalky appearance above, containing large scales and other remains of fishes, and numerous species of *Ostrea congesta* attached to fragments of *Inoceramus.* Passing down into light yellowish and whitish limestone, containing great numbers of *Inoceramus problematicus, I. pseudo-mytiloides, I. aviculoides,* and *Ostra congesta,* fish scales, &c.	Bluffs along the Missouri, below the Great Bend, to the vicinity of Big Sioux River; also below there on the tops of the hills.	200	
Lower series.	Fort Benton group. Formation No. 2.	Dark-gray laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light-colored limestone, *Inoceramus problematicus, I. tenuirostratus, I. latus, I. fragilis, Ostrea congesta, Venila mortoni, Pholadomya papyracea, Ammonites mullani, A. percarinatus, A. vespertinus, Scaphites warreni, S. lævæformis, S. ventricosus, S. vermiformis, Nautilus elegans, (?) &c.*	Extensively developed near Fort Benton, on the Upper Missouri; also along the latter from ten miles above James River to Big Sioux River, and along the eastern slope of the Rocky Mountains as well as at the Black Hills.	800	Eq. lower or gray chalk (and upper gray sandstone) of British geologists. *Turonien* and *Cenomanien (?)* of D'Orbigny.
	Dakota group. Formation No. 1.	Yellowish, reddish, and occasionally white sandstone, with, at places, alternations of various colored clays and beds and seams of impure lignite; also silicified wood and great numbers of leaves of the higher types of dicotyledonous trees with casts of *Pharella (?) dakotensis, Axinæa siouxensis, Cyprina arenaria.*	Hills back of the town of Dakota; also extensively developed in the surrounding country, in Dakota County, below the mouth of Big Sioux River, thence extending southward into Northeastern Kansas and beyond.	400	

It is now generally admitted that the upper strata of the limestone (mostly magnesian) underlying the Cretaceous, west of the Missouri River, belongs to the Lower Permian, though a large number of species of mollusks of the Carboniferous formations are still mixed in these strata, with predominant and characteristic species of the Permian, in such a way that this limestone is often called by the name of *Permo-carboniferous*. Until recently, I had never been able to see any trace of vegetable remains from this formation, and thus to know what the fossil plants might indicate in relation to the evidence furnished by animal paleontology. In the explorations of Dr. Hayden of 1873, however, Dr. A. C. Peale discovered, in strata referred by him either to the Carboniferous or the Permian, a number of well-preserved branches or stems of *Calamites*, whose identification proves for the formation whence they are derived the same intermixture of characters referable to both the Permian and the Carboniferous. A large number of these specimens represent *Calamites approximatus*, Brgt., a species which as yet has been considered as belonging exclusively to the Carboniferous, and which in this case is distinctly characterized by its very thick bark. The outer coating, which is generally a compound of carbonaceous layers, is in these specimens petrified like the internal woody cylinder, but destroyed in some parts of the stems, and in that way the different characters of both the internal cylinder and the bark are exposed to view. The other specimens are well-preserved fragments of *Calamites gigas*, Brgt., which has been formerly considered by Brongniart and Unger as an Upper Carboniferous species, but which now is admitted as characteristic of the Lower Permian. After indicating its *habitat* in the red sandstone of Alsatia, of Wettaravia, with specimens of *Walchia* in the Permian of Russia, &c., Schimper, in his Vegetable Paleontology, (1869,) adds that this species has never been found in a productive Carboniferous formation, &c. These specimens were all obtained from the same locality, Eagle River, near Holy-Cross Mountain, Colorado, together with many fragments of undeterminable *Stigmaria* and one of an *Asterophyllites*. This coincidence in the data furnished by animal and vegetable paleontology proves that the end of the Paleozoic times in our American geology is marked, from the Mississippi River to the Rocky Mountains, by the Upper Carboniferous, already modified by the first traces of Permian life.

The formation of the Dakota group, corresponding to the Upper Cretaceous of Europe, is now recognized to be in immediate superposition to this

Upper Carboniferous.[1] On this subject Dr. Hayden remarks[2] that "It is very difficult to find rocks of this Dakota group resting immediately upon the beds below, from the fact that in almost all cases a grassy slope intervenes;" that "it became a matter of much importance to find the junction of the two great formations or to ascertain what beds come between." For my explorations of 1873 over part of the area of the same group, I was therefore directed by Dr. Hayden to carefully look to exposures where the strata positively referable to the Dakota group could be seen in immediate connection with those of the underlying or overlying formations. Before exposing the result of my researches on this point, I will record here again the only case of immediate superposition discovered by Dr. Hayden, and published a long time ago.[3] The observation was made near the old Otoe Village, about eight miles above the mouth of the Platte River. "The section, in descending order, is as follow:

"1. Gray, compact, siliceous rock, passing down into a coarse conglomerate, an aggregation of water-worn pebbles cemented with angular grains of quartz; then a coarse-grained micaceous sandstone, 25 feet.

"2. Yellow and light-gray limestone of the coal measures, containing numerous fossils—*Spirifer cameratus*, *Athyris subtilita*, *Fusulina cylindrica*, with abundant fragments of coral and crinoid remains, 20 to 50 feet. A, quartz rock; B, conglomerate; C, coarse micaceous sandstone; D, Carboniferous limestone."

With the clay beds generally at the base of the Dakota group the series marked by letters resume, as will be seen, the essential lithological character of the strata of the group.

Having recognized the connection, as marked above, along the Platte, I found in Gage County, near Beatrice, about eighty miles more southward, along the banks of the Big Blue River, some exposures of the same kind, where the strata of the limestone, with those of the Cretaceous sandstone above, could be seen either in close or in immediate conjunction.[4] The variety in the nature of the lowest strata is at first seen at many places. Near the base of the group, beds of fine soft plastic clay, either white or, more

[1] The question of the relation of the Dakota group to European groups of the Cretaceous, as considered from analogy of vegetable remains, is discussed after the description of the species.

[2] Report of 1867, p. 42.

[3] Transactions of the American Philosophical Society, 1862.

[4] Dr. Hayden had previously visited the same country, and recorded about the same observations.

generally, speckled or veined with red, are seen either alternating with or underlying banks of coarse, dark yellowish, easily disintegrating sandstone. At one place, near a small branch of the Blue, such a bank of sandstone, 22 feet high, and perpendicular, has its sides hidden by thick strata of that soft clay, forming on both sides gentle slopes to the creek. The preponderance of this clay, which either covers the underlying strata and hides them, easily invaded as it is by vegetation, or which, removed by water erosions, is replaced by materials of transportation, renders more or less obscure or ill-defined the line of superposition of the two formations. Generally, too, the upper magnesian limestone is shaly, easily disintegrated, and therefore prepared, like the clay beds, for the formation of grassy slopes. All around Beatrice, even in the town, as, for example, behind the mill, the shaly Permian limestone may be seen exposed in banks overlaid by humus and trees, when at a short distance, and nearly at the same level, the sandstone of the Cretaceous is exposed in a reverse condition, or with its base concealed by detritus or by vegetation. In descending the river for five or six miles from the same place, quarries are seen opened into an inferior member of the magnesian limestone, which is there generally very hard and compact, without any fossil remains, only mixed with concretions of clay and pyrites. This bed has a thickness of 4 to 10 feet, and passes above into irregular layers of shaly, fossiliferous Permian limestone, ascending in some places to 30 feet high. In exploring around, up the branches, the superposition of variegated clay or of sandstone upon the limestone is constantly recognized, though generally, as said above, somewhat indistinct, sometimes a few feet only passing from view or being covered up between the two formations. I carefully observed a number of sections of the same kind in order to ascertain if, in cases of recognized and recorded immediate superposition of strata of the two formations, the succession of these strata is always in the same order, and if any traces of materials representing an intermediate formation could be discovered anywhere. As far as the researches have been made until now, either by other geologists or by myself, nothing has been seen under the Dakota group but the Permian limestone, with which its lower members are always in contact. A section of a continuous series of the Permian and Cretaceous rocks is exposed a few miles south of Beatrice, in a small branch, where a new quarry has been opened for flag-stones, of poor quality. The stone is a magnesian, fossiliferous, shaly limestone, worked down to about 6 feet, where it passes to

a more compact limestone of the same kind as that which is quarried in solid blocks six miles farther down the river. The section is as follows in ascending:

1. Fossiliferous, shaly, or flaggy Permian limestone, 6 feet.
2. White soft clay, passing upward to reddish sand, 4 feet.
3. Conglomerate and concretionary sandstone, 2 feet.
4. Yellowish, coarse sandstone, 20 feet.
5. Red, hard, ferruginous sandstone, with plants, 45 feet.

The stratum No. 2, 4 feet thick, is the line of transition or of superposition. In its lower part, and in contact with Permian limestone, it is Permian. In its upper part, the reddish sand is Cretaceous. The hills around are still higher by 20 to 40 feet, and all, from base to top, at least from what is seen by exposures, are composed of the same hard red sandstone, which is more or less flaggy, and whose fragments are heaped in mounds by the farmers and used for building or for wells. In all this country, with the exception of clay-beds, which are irregularly distributed in regard to the horizon of the strata, the whole compound of the group is sandstone, rarely mixed in horizontal streaks with small pebbles, occasionally yellow and crumbling, but most generally hard, ferruginous, either compact or cavernous, like all the ferruginous sandstones. Its appearance is so little varied that it is everywhere easily recognized without the evidence of its leaves. No formation could show a more striking contrast than it does with that of the underlying limestones of the Permian. In ascending upward through the higher strata of the Dakota group, or in following the exposures of this formation along the rivers to the west, the same uniformity is constantly remarked to the highest point, where the upper beds of sandstone pass under the second or upper group of the Cretaceous. For example, in Kansas, from the mouth of Salina River to Fort Harker, I have all the time traveled along the banks of this red sandstone. It is sometimes interstratified with beds of soft clay, Carbonaceous matter, or streaks of coarse materials forming bands of conglomerate sandstone, but the areas occupied by them are not of wide extent. They appear here and there without apparent continuity, and are irregularly distributed in the whole thickness. When near the surface, the clay-beds have been generally decomposed and mostly destroyed under atmospheric action, forming hollows or depressions, which in some localities mold the surface of the prairies into groups of small domes or hillocks, like a miniature of what is seen in such a grand scale in the Tertiary clay formations of the *Mauvaises Terres*. The

deepest hollows are, however, scarcely 20 feet lower than the tops of the hillocks. Generally these changes of consistence of the strata are marked by mere undulating prairies. A few cases of the interstratifications of materials apparently differing in composition, are mentioned in remarking upon the localities where they have been observed. The general character of the group may therefore be described as a succession of more or less coarse, sandy materials, regularly stratified, more or less impregnated with oxide of iron, and, according to the prevalence of this mineral, either hard, compact, dark red, or yellowish, composed of sandy grains more loosely cemented and more easily disintegrated; the whole mass being interlaid by deposits of fine potter's clay, yellowish, white, or red spotted, or black, rarely mixed with carbonaceous matter, distributed more generally near the base and the top of the formations in areas of small extent.

The thickness of the Dakota group has not been as yet, and could scarcely be, exactly ascertained without borings made at many distant localities. In the land of prairies where it prevails, the rivers are bordered by banks whose elevations are from 30 to 60 feet, rarely reaching an altitude of more than 100 feet. In South Nebraska, around Beatrice, the section made by Dr. Hayden in his report, (1867, p. 27,) estimates the whole thickness of the group at 150 feet. It is the same measure which I marked in ascending from the quarries on the Big Blue, counting it from the upper exposure of the Permian, the shaly fossiliferous limestone, to the top of the highest hill above, composed of red shale in its whole thickness. But at a short distance to the south there is still a succession of hills of the same formation which are at least 40 feet higher. On the banks of the Missouri River, near the Indian reservation, the bluffs of sandstone, as exposed above the alluvial deposits which cover their base, measure from 70 to 100 feet, generally perpendicular. I have seen, probably about at the same localities where Dr. Hayden made the section recorded in the report of 1867,[1] the sandstone exposed 120 feet from its base, where it is apparently covered by 20 to 25 feet of detritus and alluvial matter, and from the top, in ascending along a quarry road, I dug here and there from the surface loose pieces of the same sandstone, to 70 feet higher. According to Meek and Hayden, the dip of the strata of the whole series, which rests conformably upon the Permian limestone, is to the northwest.[2] This dip is of

[1] Geological Survey of the Territories, p. 46.

[2] American Journal of Sciences and Arts, vol. xxvii, 1859, p. 35.

slight degree, indeed; but considering only the slope of the area covered by the formation in its width from east to west, there is in sixty miles only, as from Papillion Station to Schuyler, on the Union Pacific Railroad, a difference of 375 feet of altitude. These figures, representing the thickness of the strata, should be still increased by the amount of the dip. It appears, therefore, that the estimate of Professor Swallow of a thickness of about 400 feet for this formation is not overrated. I take this estimate from the report on the geological survey of Kansas,[1] adding to it the three upper members of the fourth section, marked Triassic, overlaying the buff magnesian limestone. The group is described as a compound of brown, ferruginous yellow and buff sandstones, which, says the author, "are generally classed as Cretaceous, though I saw no proof of its age." The same thickness is already marked in Hayden's Report on the Exploration of the Yellowstone and the Missouri Rivers, 1859–'60, published in 1869, where, in the section of the Cretaceous rocks of Nebraska, the Dakota group is estimated 400 feet thick, as in the section recorded in the beginning of this chapter. The thickest continuous series of the sandstones which have been measured and recognized as bearing leaves, from the base to the highest point, is that mentioned by Prof. B. F. Mudge, of Manhattan College, in the Kansas Agricultural Report of 1872, where, in Clay County, near Roverdale, Kansas, the fossil leaves were found at the bottom of a well 35 feet deep, as low as the bed of the Republican River, and on the top of the adjoining hills, 200 feet high. The thickness of the strata is related, of course, to the depth of the local erosions into the formation which they cover. As indicated from the homogeneity of the compounds, however. it is apparently generally the same, only increasing somewhat toward the west,

Having positively recognized the point of superposition of the Dakota group to the Permian limestone, and the permanence in the characters of the strata which come in juxtaposition at the base of this group, it is important also, to look for the same kind of evidence in the succession and modification of its upper strata in the line of union with a higher member of the Cretaceous. For this we have still to receive our more precise informations from the records of the explorations of Dr. Hayden, who has so carefully studied and so admirably described the Dakota Group, in fixing its limits, and marking its characters, that he has scarcely left anything to discover to those who have followed him in the same field of researches. He has seen at two

[1] Preliminary Report of the Geological Survey of Kansas, 1866, p. 9.

different localities the upper limits of the lower group, and its connection with No. 2 of the Cretaceous. First, near the mouth of Iowa Creek, on the eastern side of the Missouri River, where the river cuts the bluffs, and where the rocks are seen all in their order.[1]

4. Yellow marl, a recent deposit.

3. Niobrara group, layers of white and yellow chalky lime, passing down into gray marly rock.

2. Black plastic clay with hard layers, containing *Inoceramus*, a species of *Ostrea*, like *O. congesta*, remains of fishes, crystals of sulphuret of iron, selenite, &c.

1. Dakota group, sulphuret of iron, fragments of wood, impressions of leaves, willow, laurel, &c.

The second case of superposition of both formations is marked by Dr. Hayden six miles above the mouth of the Big Sioux River, where the strata are reported in the same order as in the former:

3. Shaly limestone, gradually passing into the bed below, with an abundance of *Inoceramus problematicus* and of fish-remains.

2. Dark plastic clay, with ferruginous concretions.

1. *a*, Yellow friable sand; *b*, earthy lignite, six inches; *c*, variegated sandstone and clays, with dicotyledonous leaves.

In following the bluffs of the Missouri River, about eight miles east of the Winnebago village of the Indian reservation of the Blackbird Hills, I obtained another well-exposed section of the Upper Dakota group and of the Cretaceous formations above it, as follows:

3. Impure limestone, formed of an agglomeration of large shells, *Inoceramus*, *Ostrea*, &c., with sandy yellowish clay; worked for lime from the surface to the bed below, eight feet.

2. Dark laminated clay, with shells and fish-remains, 7 feet.

1. Yellow sandstone, easily disaggregated, with streaks of hard red sandstone or ferruginous clay, passing down to compact red sandstone, 50 feet.

At this place, about two miles north of Warner's Quarry, I did not find any leaves in the formation which from its top represents the Dakota group. But in following the bluffs down to that new-opened quarry, I found an abundance of remains of fossil plants to the highest point, or in the yellow friable sandstone immediately topped by the strata of No. 2, the Benton

[1] Geological Survey of the Territories, 1867, p. 48.

group of the Cretaceous. At this quarry, which has been recently opened for the purpose of obtaining good building-materials, which are hauled to the Winnebago village, I saw for the first time that intercalled quartzite bank which is mentioned in the same report of Dr. Hayden, page 46. He describes it "as a very compact quartzite, the hardest and most durable rock in the State, found all along the hills opposite Sioux City." At this quarry the stone is of a dark grayish color, generally in two banks, one 4 feet thick, the other, above, 2 to 3 feet, with an interlaying of a few inches of hard clay. The lower is the more compact, hard as flint, giving fire by percussion, and therefore difficult to break. It contains fragments of leaves, some entire and well preserved, with distinct nervation; all, at least all those which I have seen, extended flat in the plane of stratification. This bank is underlaid immediately and without transitional modification of the materials in contact by soft-grained sandstone, easily cut with the knife, marked at different localities by rough Indian sculptures of animals, &c., which, as remarked by Dr. Hayden, (*loc. cit.*,) appear *doubtless portions of the hieroglyphical history of the Indian.* This lower sandstone is more or less exposed in proportion to the amount of detritus and alluvial covering its base. The best exposition of it is from 20 to 25 feet. Above the quartzite the sandstone is more ferruginous, darker, and hard. It has generally rare impressions of leaves; but just above Warner Quarry, under the thin coating of humus which covers the top of the hill with vegetation, the remains of plants are in greater quantity than I had seen them anywhere else in the vicinity. This place is little more than one mile from the locality where No. 2 is exposed at the same level, and therefore it appears that the fossil leaves do not become less abundant in the upper part of the Dakota group. The whole section of the Warner Quarry is 60 feet. Quite near Iowa City, the upper strata of the same group are intermixed with beds of impure lignite, a matter without any value as combustible, and the sandstone underlying them is blackened by an immense mass of roots and rootlets of fluvial plants. This appearance is most like that of the clay strata underlying beds of Tertiary lignite, or of the true coal of the Carboniferous epoch. In this last case the remains in the under clay-beds are leaves of *Stigmaria;* in those of the Tertiary coal-beds, they are evidently roots and rootlets of water-plants, recognized especially by the tubercles and rhyzomas of the *Equisetum.* At Sioux City the roots in the clay-beds are mostly undeterminable. They are mixed with fragments of

branches and leaves of conifers heaped in a confused mass, and deformed by a too advanced stage of decomposition. These shales are immediately below the under layers of the upper group, No. 2, which they resemble by their color and the presence of scales of fishes. However, they still have the essential characters of the Dakota group, viz, dicotyledonous leaves. Among others, I found there an entire leaf of the same species of *Laurus*, which is common from Minnesota to Kansas, in the whole thickness of the formation, and the only species seen in the bed of quartzite in the Blackbird Hills. From this we may conclude that the whole group bears, with scarcely any change in the nature and compound of its strata, the same essential character, or its peculiar vegetable remains, from the lowest strata to the line of conjunction with the Fort Benton group above it.

For a time, as remarked before, the clay-beds, which had been observed mostly at the base of the Dakota group, were considered, without paleontological evidence however, as representing either the Jurassic or the Triassic formation. This supposition was derived from the idea of a sequence of the geological formations, as they are generally admitted, and, of course, it seemed at first incredible that formations like the Triassic and the Jurassic, which have immense development in Europe, should be without any trace of representatives over the coal-measures of the West. The subject has been satisfactorily discussed, and little evidence can be added to what has been published already. There was still, however, some uncertainty in regard to the geological reference of the clay-beds at the base of the Dakota group, which, overlying the Permian, are locally of a tolerable thickness, and where, as yet, no fossil remains, either animal or vegetable, had been found. This lowest member is marked by Professor Swallow as especially predominant in the vicinity of Smoky Hill River, Cottonwood, and Fancy Creek, where it is composed of brown, drab, and reddish marls and shale 32 feet thick. I had an opportunity to see these clay-beds exposed at many places along the Smoky Hill River, and unexpectedly found in them a peculiar kind of remains which give positive evidence of their Cretaceous age. The essential exposure where the discovery was made is at the bottom of a small branch of the river, about fifteen miles southeast of Fort Harker, where a layer of coal, or rather of carbonaceous matter, 1 to 2 inches thick, crops out, interlaid into a bank of soft, black, laminated shale. The traces of coal in the creek have stimulated a searching for some thick bed of the same matter in that locality, and one shaft has been

sunk near the creek to 15 feet through the bank of soft black shale there overlaid by white plastic clay. I believe that the bottom of the shaft is not far from the Permian limestone, if it does not reach it; but this could not be ascertained, the bed of the creek being in a deep depression, as low nearly as the bed of Smoky Hill River. The materials taken out of the shaft had been decomposed by atmospheric action; the small fragments of shale did not show trace of organic remains; but having dug out from the bed of the black shale in the creek some large pieces, in order to get specimens of the coal, I was surprised to see them, in their contact with the carbonaceous layer, covered by a prodigious quantity of fragments of a plant which has been recently discovered in the Neocomian of Switzerland, and has been seen as yet in this Cretaceous formation only. These remains have been described under the generic name of *Gyrophyllites*. Professor Heer, in his *Urwelt der Schweitz*, page 190, has figured and briefly described four different forms, which he considers as species of vegetable. These remains are in whorls of six to ten linear, slightly oblanceolate divisions, attached to a common center, like the spokes of a wheel, and, where I found them, superposed and heaped in immense numbers one upon another in such a way that the impressions of the whorls and their divisions were perfectly distinct, but the stems and branches could not be seen. The relation of form of these small plants is with the *Annularia* of the coal measures, which are also often seen in accumulated whorls without distinct impressions of their stems or branches. In the form observed in Kansas, the divisions are short, measuring scarcely more than one-fourth of an inch, gradually widening from the base to the angular point. Their impressions into the shale are deep and angular or with a deep medial line, as if they had been made by three-faced or prismatic abruptly-pointed crystals of selenite. Indeed, most of them were exactly filled like molds by those crystals, and it is the reason why, after a protracted examination, I was left uncertain of the true nature of these remarkable impressions. The whole mass was, moreover, so fragile that it was difficult to separate any portion of it in the horizontal plane of their marks, and I could not carry away and preserve any specimens for drawing and descriptions. I have, however, seen at Fort Harker, in a small cabinet of fossils from the vicinity, one piece of red sandstone found at the same locality with dicotyledonous leaves, which bears whorls of the impressions of those *Gyrophyllites*, with apparently traces of branches or stems. Unhappily, I could not obtain the specimen on account of the absence of the owner.

Professor Heer, considering these organisms, remarks that their systematic relation is very uncertain. They are, by the disposition of their divisions, distantly comparable to the *Characeæ*, but that is all. As they have been found in Switzerland, only in connection with deep animal marine remains and fucoids, they should have lived in the seas, if they did represent vegetable, while from their association in this country with dicotyledonous leaves the contrary assertion would be authorized. They may be, after all, the marks of a peculiar kind of crystallization, and it is to be hoped that somebody may procure from our Cretaceous measures specimens in such a state of preservation that the true relation and nature of these fossils may be ascertained. In any case their presence in the lower beds of clay of the Dakota group should be recorded as an indication of their geological relation with the European Cretaceous. And of course these fossils, though without any relation recognized as yet, are positive evidence of the continuity of the series of the Dakota group from the point of contact of the clays with the Permian beds of limestone. No trace of an intermediate formation can be admitted between them. This opinion has been from the first admitted by Dr. Hayden, and the further the explorations are pursued the more generally accepted it becomes. Professor Mudge, in the Agricultural Report of Kansas, already quoted, says "Observations made the past year (1871) confirm my statement read before a former meeting of the association, viz, that there is in Kansas no geological representation of the formations found in other countries between the upper Carboniferous or Permian, and the Cretaceous. Careful research has been made for fossils of Jurassic and Triassic periods along the western borders of the Permian, and none have been found, while dicotyledonous leaves and Cretaceous fossils have been procured lately nearer the line of the Permian than during our first collection." In a letter of October, 1873, the same geologist writes that: "Since writing the above article I have become settled in the idea that the Dakota group rests directly on the Permian, as I have found leaves of the Cretaceous and shells of the Permian within three miles of each other, at about the same horizon and without traces of any intermediate formation."

§ 4.—The Dakota group considered as a marine formation.

Dr. F. V. Hayden, in a paper in the American Journal Sciences and Arts, vol. xliii, March, 1867, p. 178, remarks: "Both Mr. Marcou and Pro-

fessor Capellini agree in regarding this sandstone in which the dicotyledonous leaves are found as a fresh-water formation. I would simply say that I have always regarded it as marine, and I am sure this has been the opinion of my friend Mr. Meek. At any rate, we have found mingled with the leaves at Sioux City quite well preserved casts of *Pharella dakotensis*, *Axinea siouxensis*, and *Cyprina arenacea*, shells peculiar to marine deposits." Since that time a number of species of marine mollusks have been found in the strata of this group, and Dr. Mudge, in his paper quoted above from Transactions Kansas Agricultural Report, p. 396, gives a list of species determined by Prof. B. F. Meek, all referable to marine mollusks: *Crassatellina oblonga*, *Arca parallela*, *Yoldia microdonta*, *Cardium kansasensis*, *C. salinens*, *Cyrena* (*Corbicula*) *nucalis*, *C. subtrigonalis*, *Tellina subscitula*, *T. mactroides*, *Leptosolen conradi*, *Turritella kansasensis*, *Turbo mudgeanus*. Professor Mudge remarks on these shells that: "They are in the same strata and in the vicinity of several deposits with the dicotyledonous leaves, and together with the plants, identify this portion of the sandstone as belonging to the Dakota group of the Cretaceous, as described by Messrs. Meek and Hayden, in their first report."

The opinion that this group of the Cretaceous may be a fresh-water formation is, moreover, contradicted by its extent and by the homogeneousness of its compounds. It has been seen that at some places it covers an area of more than sixty miles in width, and that its length along the borders of the Carboniferous or Permian measures is recognized as continuous from Texas to the northern limits of Minnesota, thus passing through fourteen degrees of latitude, even probably across the English portion of North America to Greenland. It is not possible to suppose a fresh-water formation of such extent, especially when we consider, as stated above, the homogeneity of the materials composing it. For, indeed, with the exception of thin local strata of carbonaceous shale and soft clay, especially observed near its base, the compound is essentially the same in the whole thickness and in the whole extent, varying only in degree of hardness, compactness, and red coloring, resulting from the different proportion of oxid of iron with which it is impregnated. This formation, by the character of its ferruginous arenaceous shale, even by its color, and also by the special character of its flora, has the greatest analogy with the red sandstones so widely formed at the end of the Devonian epoch, between the Chemung and the Carboniferous, either as the Catskill group, or as the

Subcarboniferous (Umbral, &c., of Roger,) underlying the anthracite basin of Pennsylvania, and extending southward to North Carolina, and also with the New Red Sandstones of the Lower Permian. Of course, in this comparison the difference of the epochs has to be taken into account. But in all these formations we remark a peculiar compound without relation to past and sequent formations; a great uniformity of these compounds which are much alike at the different epochs; a nearly total absence of animal remains, and a flora, exclusive in its characters and without marked relation to the floras of corresponding times. The origin of these groups of red sandstone is the same, to my belief, at least. They are beach formations, like those in progress at the present time along the shore of the North Sea, in Holland and Belgium, where the widely extended muddy shores are formed of a soft substance of the same red color. As I have had opportunity to observe it, it is a mixture of small grains of sand, brought from the sea, with the mud deposits, carried by rivers of long course, after traversing flat countries. By slow deposition, it constitutes low shores, successively washed by the tides, which, of course, recede or advance farther in proportion to the slow upheaval or to the depression of the land. Marine animals, the shells especially, are very rare in a formation of this kind. It has only a few species mostly of small size; also the prints of the tracks of Saurian, of birds, &c., the ripple-marks, the cracks or the preforation caused by atmospheric influences, dryness, heavy rain or hail. But it is shunned by every kind of land animals, and it has, therefore, no other remains imbedded into its compound but Saurians, and rarely fishes.[1] Its flora is for the same reason of a peculiar character. It has no remains of marine plants, for these do not grow on the mud or upon soft ground; the vegetation of high dry land, and also that of the bogs or of the peat, are excluded from it; the first on account of the humidity and softness of the ground, the other from its constant alternance from a dry to a submerged surface.

The character of the leaves found in the Dakota group, and their analogy with species of our time, seem at first to refer them to a dry-land flora; it is, however, not positively the case. The most abundant representative of this Cretaceous flora, the Sassafras, is remarkably similar to the present *Sassafras officinale*, which inhabits every kind of ground and station, from the dry hills of Ohio to the low swamps of Arkansas. The numerous leaves of *Laurus*, too, are comparable to those of *Laurus caroliniana*, a shore plant, as are also

[1] In Holland the ditches across the flats, where water is permanent, are mostly inhabited by eels in prodigious quantity.

the *Magnolias*, *Platanus*, *Populus*, *Salix*, and *Menispermites*, the essential types of the vegetation of the Dakota group being, therefore, those of low islands or of low shores, rather than of hills and dry land.

§5.—Distribution of the leaves in the compounds of the Dakota group.

Professor Capellini remarks, in his introduction to the pamphlet on the *Phyllites du Nebraska*: "Although the Tekamah molasse is distinctly stratified, the vegetable impressions are not arranged in the plane of stratification; a proof that the water wherein were deposited the materials which entombed the leaves, and which were brought by alluvion, was not quiet enough. The deposit was not made quietly enough to allow the leaves to be flattened as well as those which are found in the deposits of Oeningen and of Senigallia." The fact stated by the European professor is not generally observed. The leaves, indeed, are found sometimes rolled or crumbled as may have been dry leaves when falling upon a muddy surface where they may have been imbedded in that condition, and often, too, penetrating the mud edgewise, either vertically or in various degrees of inclination to the plane of the mud deposits; at some places they have been also probably rolled by the waves. But these deviations of the horizontal plane are far from frequent. In most cases the leaves are flattened upon the shales, often found covering each side of a piece of shale of moderate thickness, and also when in abundance they are generally superposed and flattened upon another. This deviation of the horizontal plane is nowhere more marked for the fossil plants of the Dakota group than for those of our Carboniferous or of our Tertiary formation, and it appears rather ascribable to wind or to tidal action than to any current or alluvial movement. These remarks already tend to indicate that the Cretaceous fossil leaves have been derived from trees or groups of trees growing in the vicinity of the muddy bottoms where they have been buried and fossilized. Other facts confirm this assertion.

The leaves are regularly disseminated in the shale of this formation, and thus found here and there over wide areas. They are often very abundant at one locality, occupying a surface of small extent, and then they disappear entirely from the same horizon and are not seen anywhere around for miles. The locality near Salina, from which a large number of fine specimens have been obtained, covers scarcely three acres of ground. In following the bluffs to the station for a distance of about eight miles, although the exposures of the

red shale are frequent and of the same horizon, no trace of any fossil vegetable remains could be found by a party of three who were actively searching for them in every direction. South of Fort Harker, on the Smoky Hill River, a locality discovered by Mr. Ch. Sternberg, who lives near by, is a small hollow where the red shales are full of leaves in a thickness of 8 to 10 feet; while out of this none have been found for a great distance. This hollow would not cover, I think, half an acre of ground. The same remark has been made by Prof. B. F. Mudge, of Manhattan College, who has for many years, as State geologist of Kansas, explored the Dakota group, studying its geological distribution and its paleontology with the greatest care. Some of the finest specimens of its fossil flora have been discovered by him. In the Transactions of the Kansas State Board of Agriculture, the professor remarks:[1] "The fossil plants are found at certain intervals of territory. In searching for them we have frequently examined every visible outcrop for fifteen or twenty miles without finding a specimen; then, perhaps, a single square mile would furnish several good localities. Our cabinet is represented by specimens collected from twenty-five or thirty places from Washington County to Fort Larned, near the Arkansas, a distance of one hundred and seventy-five miles. The fossil plants are usually obtained from thin layers or strata, extending in a horizontal position along a ravine or around a hill. They may occur at several places in the same vicinity, but usually without any connection. Thus, in Clay County, near Riverdale, they were found at the bottom of a well as low as the bed of the Republican, and on the top of an adjoining hill 200 feet high, with numerous strata between, in which none could be seen. The deposits appear to have been local, dependent upon circumstances. There must have been, necessarily, an arm of the sea with soft, sandy mud, bordered by an adjoining dry land covered with a forest. The characteristic of the local deposits indicate that the forests were on small islands scattered over the Cretaceous ocean."

The leaves, moreover, are not variously mixed, as they should be if they had been carried from any distance by currents or any other kind of motive-power; but are generally found in groups of representatives of same or analogous species. For example: all the specimens of *Juglans*(?) *debeyana* sent to me for determination are marked from two localities only; from Decatur, Nebraska, twenty-nine specimens; and from three miles northeast of Fort

[1] P. 395.

Harker, Kansas, six specimens. I have also found specimens of the same species at these two localities; on one hill near Decatur, I found no other kind of leaves with them. Near Fort Harker, the leaves of this species are mixed with those of *Laurus*. All the specimens of *Platanus obtusiloba*, twenty-two in number, come from near Beatrice, Southern Nebraska. Representatives of this species have not as yet been found elsewhere. The specification of the various forms of leaves of *Sassafras*, as may be seen in the descriptive part, is confirmed by local distribution. *Sassafras mirabile*, *S. cretaceum*, *S. harkerianum* are from Fort Harker; *Sassafras mudgii* and *S. obtusum* from Salina. Most of the *Pterospermites*, too, have been found at Fort Harker. The Salina locality is along the bluffs of the river formed by a succession of low hills, whose faces are more or less abruptly cut and exposed by erosion. Two of these hills are separated by a narrow depression formed by a spring, and the top of both is on the same level, as can be seen by the exposure of the upper strata of red shale. One of them is strewn with fragments bearing specimens of *Menispermites obtusilobus*, a species which I have as yet not seen from any other locality, though it is there in abundance; the other has only specimens of *Sassafras*. A distribution of this kind can result only from the proximity of the trees from which the leaves have been derived, and confirms the opinion that the formation of the Dakota group is the result of muddy flats whose surface, raised perhaps in hillocks above water-limits, and already solid ground, was cut like an immense swamp, here and there interspersed by rare groups of trees and bushes. Of course the main portion of this surface was subject to continuous changes in the successive modifications resulting from the heaping and displacement of matter by water, and thus the leaves were distributed either at the same places but at different levels, or at the same level but at different localities.

The only objection to this supposition is the absence of roots or of fossil trunks, which as yet have been rarely observed in the shale of the Dakota group.[1] If we consider that the low islands bearing trees were rare, and especially if we think how great is the disproportion in quantity between trunks of trees with their roots, and the leaves which they bear and disseminate annually for a series of years, we may easily account for this apparent anomaly of leaves found petrified without accompanying trunks

[1] Fossil silicified wood has been found, however, in Nebraska, in the lowest strata of the Dakota group, and also at the upper part of the same formation. Near Sioux City, the shales are blackened by the heaping of rootlets, as they are generally in the clay-beds preparing for the formation of peat.

and roots. It is, moreover, probable that the activity of life continued for procuring sustenance to the trees, has preserved the substance of the roots against the process of fossilization which acted upon the leaves; for, indeed, these leaves are not truly fossil; they are merely printed on the shales, but nothing of their substance has been left. The process of fossilization depends on local circumstances, and an indication of the incapacity for this process, or of the absence of fossil petrifying elements in the shales of the Dakota group, is the soft state of some fragments of wood in the deposits of roots and rootlets of Sioux City. These fragments have the consistence of decayed wood, and crumble in powder under the pressure of the finger.

§6.—Generic characters of the flora of the Dakota group.

These characters are the more easily and clearly exposed in a table marking the groups and genera to which the species are referable. The table comprises the genera admitted by Professor Heer, for the description of the species in *Phyllites du Nebraska;* those of Doctor Newberry, for the leaves described in notes on extinct floras, &c., and those which I have admitted for the description of species in this paper. The number marked after the generic name indicates approximately the number of species referred to each genus:

CRYPTOGAMIÆ.

Order *Thallophytes.*

Zonarites, Brgt	1

Order *Filices.*

Lygodium, Swartz	1
Hymenophyllum, Sm	1
Sphenopteris, Brgt	1
Pecopteris, Brgt	1
Gleichenia, Sm	1
Todea, Willd	1

PHANEROGAMIÆ, GYMNOSPERMÆ.

Order *Zamiæ.*

Pterophyllum, Brgt	1

Order *Coniferæ.*

Sequoia, Endl	2
Araucaria, Juss	1

Abietites, Auct.	2
Glyptostrobus, Endl	1
Phyllodadus, Rich	1
Geinitzia, Heer	1

MONOCOTYLEDONÆ.

Order *Glumaceæ.*

Arundo, L.	1

Order *Artorhizæ.*

Dioscorea, Plum	1

Order *Palmæ.*

Flabellaria, Sternb.	1

DICOTYLEDONÆ, APETALEÆ.

Order *Iteoideæ.*

Liquidambar, L.	2
Populus, Tourn.	5
Populites, Lsqx.	4
Salix, Tourn.	6

Order *Amentaceæ.*

Myrica, L.	2
Betula, Tourn.	1
Betulites, Heer	1
Alnus, Tourn.	1
Quercus, Ung.	8
Fagus, Ung.	2
Platanus, L.	6

Order *Urticeæ.*

Celtis, Tourn.	1
Ficus, L.	1

Order *Thymeleæ.*

Nyssa, Gron.	1

Order *Laurineæ.*

Laurus, L.	2
Laurophyllum, Heer	1
Persea, Gartn.	2
Sassafras, Nees	1

Sassafras, (Araliopsis)	6
Cinnamomum, Burm	2
Oreodaphne, Nees	1

Order *Proteineæ.*

Proteoides, Heer	3
Embothrium, Forst	1
Aristolochites, Heer	1

GAMOPETALEÆ.

Order *Bicornes.*

Andromeda, L	1

Order *Styracinæ.*

Diospiros, Dal	2
Sapotacities, Ung	1
Bumelia, Swartz	1

POLYPETALÆ.

Order *Umbelliflorœ.*

Aralia, L	1
Hedera, L	1
Cissites, Heer	1

Order *Polycarpicæ.*

Magnolia, L	5
Lyriodendron, L	3
Menispermites, Lsqx	4

Order *Columniferæ.*

Protophyllum, Lsqx	8

Order *Aceraceæ.*

Acerites, Newby	1
Negundoides, Lsqx	1
Greviopsis, Sap	1
Anisophyllum, Lsqx	1

Order *Frangulaceæ.*

Paliurus, Tourn	1
Celastrophyllum, Ett	1
Rhamnus, Juss	1

Order *Terebinthinæ.*

Juglans, L	1
Rhus, L	1

Order *Calophytæ.*

Pyrus, Lindl	1
Prunus, L	1

Order *Leguminosæ.*

Leguminosites, Heer	1

Incertæ sedis.

Eremophyllum, Lsqx	1
Phyllites, Auct	5
Ptenostrobus, Lsqx	1
Caulinites, Heer	1
Carpolithes, Sternb	2

The table indicates one hundred and thirty species, distributed according to descriptions in seventy-two genera, or about two species to each genus. From this it would seem right to suppose, for the determination of the Cretaceous fossil leaves, a certain degree of reliable positiveness which could not be expected of a flora with more numerous specific divisions. For, of course, the species of the geological times were more numerous, perhaps, than those of our own epoch, generally more contiguous, more or less illimitable; subject, therefore, to personal criticism or opinions. The descriptions of the species of the Dakota group force a contrary conclusion. If some of the genera are clearly characterized and their relation positively ascertained, some others may be considered as groups of analogous forms, which point to the derivation of different types, and which therefore cannot be considered as homogenous or identical, though it may be difficult to divide them and to limit the divisions by positive characters. Moreover, a number of those ancient leaves are not referable to any of the types of our present vegetation. They represent apparently extinct vegetable groups, or their typical characters have been modified in such a way that by successive deviations from the primitive forms the relation of the offsprings cannot be recognized. This necessitates the admission of peculiar names in the description of these groups of leaves, (*Populites, Menispermites, Phyllites,* &c.,) whose affinity is merely supposed. The relation may be recognized hereafter, either

by the discovery of intermediate forms, or by the study of larger collections of living plants than those which I have at my disposal. It will be the task, a pleasant one I hope, of other paleontologists to go further into the acquaintance with that most interesting Cretaceous flora of ours; to recognize its affinities better than I am able to do, and to correct errors of determination which are an unavoidable result of deficiency of materials for comparison.

§ 7.—Disconnection of the flora of the Dakota group from antecedent types.

The remarkable disproportion between the number of genera compared to species in the Dakota group seems at first to corroborate the system so generally admitted now, of a successive development of vegetable forms according to a supposed rule of progression of more complex forms constantly originating by the multiplication or subdivision of simple organs of inferior types. For, according to this rule, the more we recede in our researches from the present floras toward the more ancient ones, the nearer we come to plants resuming, in organs of the simplest types, all the multiple characters which they are prepared to represent in a continuous series of divisions. In that way the old floras should be represented by simple generic forms and by only a few specific divisions slightly different from the generic characters. The uniformity or sameness of the facies of the Cretaceous flora, with its leaves mostly entire, coarsely veined and coriaceous; the difficulty of separating into distinct groups, by fixed characters, the numerous forms of leaves which, seen separately, represent different species or even genera, and which, considered in series or in groups, appear undividable into sections, and therefore as referable to a same genus, can be, also, admitted as a confirmation of the same hypothesis.

As long as we remain in the domain of suppositions, it is easy to go along in that way, and to ascend from one or more primitive forms for the building up of a progressive scale of vegetables, by mere deviations or multiplications of organs. But until we know more we have to consider the facts. And the conclusion evidently forced, at least in considering the flora of the Dakota group, is, that its disconnection from ancient types is so wide that even the supposition of intermediate, unknown, extinct vegetable types fails to account for the origination of its peculiar characters.

The limestone formations overlying the coal-measures in Eastern Kan-

sas and Nebraska are referable, for their upper part, at least, to the Permian, by their fossil remains of animals; but as yet no fossil plants have been obtained from them. The highest coal-beds in Kansas, those of Brownsville, for example, have still in their shale species of ferns of the Carboniferous measures, not only the omnipresent species as *Neuropteris loschii*, *N. hirsuta*, &c., but also *Alethopteris serlii* and *Neuropteris rarinervis*. In Franklin County, of the same State, the coal also in the upper part of the Carboniferous measures is overlaid by an arenaceous shale, which has *Asterophyllites equisetiformis*, *Pecopteris serrata*, *Lepidodendron*, and other true Carboniferous plants. Here is, for the western geological formations, the end of the flora of the Paleozoic times. Except the two species of *Calamites* recorded from the Permian of the Rocky Mountains, no fossil vegetable remains have been found referable to a formation between the Carboniferous and the Cretaceous Dakota group. This remark could apply to the whole North American Continent, but for the few fossil plants known from the coal-measures of Richmond and South Carolina, which by their characters are referable to the Triassic. They mostly represent species of ferns with some large *Equisetaceæ*, *Cycadeæ*, and *Conifers*. And from what is known in Europe of the flora of the formations between the Permian and the Cretaceous, the essential types which have marked the character of the vegetation, by the predominance of their remains, belong to the same families of plants. No trace of a leaf referable to a dicotyledonous species has been recognized anywhere before the Cretaceous. And even until the discovery of the vegetable remains of the Dakota group, it was generally admitted that the first dicotyledon had appeared in the middle or the Upper Cretaceous measures.

A glance over the table of genera named above, as representing the essential types of the flora of the Dakota group, is enough to show the prodigious difference which separates this flora from those of any former epoch, even considering the antecedent vegetation of the Jurassic, known as it is from European specimens and European publications. The Ferns, Conifers, and Cycadeæ, with a few species of Equisetaceæ, which constitute the whole flora of that epoch, are all of peculiar types, without relation to any of the species of the same families recognized as yet in the flora of the American Cretaceous. Of Ferns, this flora has an *Hymenophyllum* and *Sphenopteris*, whose affinity is with *Hpmenophyllites furcatus* of the Carboniferous, and still more with a number of species of *Hymenophyllum* of our own time. Another

species of the same family, a *Gleichenia*, is allied to species recognized in the middle Cretaceous of Europe, but far distant from either of the two species of this genus described from the Olithe. Of the *Cycadeæ* one species from Nebraska is allied to a *Pterophyllum*, described and figured also from the Quader-sandstein of Germany, but this last species, like ours, has no known relation to any fossil or living plant of this genus, and therefore is not positively referable to this family. In the Conifers the Cretaceous flora of Nebraska has representatives of *Sequoia*, *Glyptostrobus* and *Cunninghamites?* perhaps. The first two have not been seen anywhere before the Cretaceous, and the last only in the Miocene. The fragments considered by Dr. Newberry as representing an *Araucaria* are closely related to a species of Conifer described formerly by Dunker, under the name of *Abietites curvifolius* from the Quader-sandstein of Blankenbourg. The relation of this form is rather with *Abies* than with *Araucaria*. Admitting it, however, in the section *Araucariæ*, which after being recognized in the fossil wood of the Devonian, disappears entirely as far up as the Jurassic, where it is represented by four species, it is still impossible to find even a distant affinity between the supposed Cretaceous *Araucaria* of ours and any of the forms of older formations. The relation of the genus *Phyllocadus* is with that of *Salisburia* in the section *Taxaceæ*. It is represented in the flora of the Dakota group by one species, and has not been seen before in a fossil state. All the *Salisburia* fossil species are as yet from the Miocene of Europe, and from the Eocene of this continent. So far, this is all that can be said of the relation of the flora of the Dakota group with any of the vegetable remains recognized from precedent epochs, and it is indeed very little. It is possible, of course, to suppose an intermediate and unknown land formation, where, in an immense space of time, the plants of a lower grade have developed those primitive types and multiplied them to the Cretaceous epoch. But the Cretaceous flora does not preserve any traces of ancient forms known of old; of the ferns, large *Calamites*, *Cycadeæ*, &c., not even a predominance of ferns and Conifers, which were remarked in the Jurassic as it is known until now. Among its 130 species, the Dakota group flora has only five species of ferns or Cryptogamous plants; one single species very doubtfully referable to the *Cycadeæ;* six species of Conifers, two Monocotyledons; all the others represent Phœnogamous plants, distributable not in a single one, but in all the essential groups of vegetables living at our time. Of the Apetalous plants it has the *Itoideæ*, *Amentaceæ*, *Myricaceæ*, *Plataneæ*,

Salicineæ; groups represented, indeed, in a large proportion, but not larger than in the vegetation of the present time. Of the Gamopetalous, it has the *Bicornes, Ebenaceæ*, &c. Of the Polypetalous, the *Magnoliæ, Menispermaceæ, Sapindaceæ*, &c., and therefore it has representatives of all the classes of plants without disproportion in one degree or the other, as compared to what is considered the scale of the vegetable kingdom. This seems to prove a collateral development of different primitive types, and therefore the appearance at certain epochs of those original forms which, at each geological period, have changed the character of the vegetable world, and which do not have any connection with antecedent types. On this point of view, it is evident that the flora of the Dakota group is as widely disconnected from that of the Jurassic, even of the Lower Cretaceous, or as distincly original, as are the flora of the Carboniferous compared to that of the Devonian, or the Permian types compared to those of the Cretaceous.

§ 8.—The flora of the Dakota group in relation to climate.

The specimens from which this flora has been studied until now have been obtained in different localities over the whole extent of the area covered by the formation, from the 39° to the 47° of north latitude. In this space of 18° the general facies of the vegetation has been apparently preserved without marked changes in relation to latitude. At least the evidence of a variation indicating atmospheric differences in the distribution of what might be called northern and southern types, is not positive enough to be considered as in correlation with the vegetable distribution of our present time. The specimens obtained from Minnesota by Prof. Jas. Hall represent a greater proportion of crushed fragments of conifers, stems, and cones especially, of which a few seeds only, doubtfully referable to the genus *Cunninghamites*, Presl., are recognizable. With these they have fragmentary leaves of *Laurus*, of *Lyriodendron, Sapotacites, Ficus, Andromeda*, referable to the species published from the specimens of the Blackbird Hills of Nebraska, by Doctor Newberry and Professor Heer. These same paleontologists have also described, from North Nebraska, species of *Platanus, Populus, Diospiros, Rhamnus, Quercus, Fagus, Sassafras, Proteoides, Magnolia, Lyriodendron*, and *Acer* or *Acerites*. All these genera are also represented in the specimens of Doctor Hayden, from Decatur, and some of them also by the leaves which the same geologist has collected in South Nebraska, Lancaster and Gage

Counties. These represent more especially species of *Populites*, *Platanus*, *Quercus*, and *Betula*. The same genera are all recognized in the specimens from Kansas, with the exception of *Populus*, *Salix*, *Rhamnus*, *Betula*, *Fagus*, while Kansas has exclusively as yet representatives of the genera *Liquidambar*, *Credneria*, *Dombeyopsis*, *Pterospermites*, and *Aralia*. The distribution, according to species, is also somewhat different in Kansas and Nebraska. The north has very few leaves of *Sassafras*, and these represent one species only; while in Kansas, especially near its southern limits, a large portion of the fossil-leaves belong to five species of this genus. Per contra, the leaves referable to *Laurus* are more and more numerous toward the north in Nebraska and Minnesota, where also are found in larger proportion the leaves referable to *Quercus*, which there represents five species, while one only is described from Kansas specimens. In considering these differences in the distribution of typical forms, and the general facies imprimed to the flora by this distribution, one might suppose that the flora of the Dakota group indicates in Kansas, by its character, a higher degree of temperature. This supposition receives some authority from the luxuriance of the vegetation, marked in Kansas by *Crednaria*, *Pterospermites*, and *Dombeyopsis*, genera represented as yet in this State only, and all with leaves of large size; and by the difference in the proportion of the leaves of species of some genera common to both States. The species of *Platanus*, for example, *P. newberrii*, *P. obtusiloba*, recognized in Nebraska, have smaller leaves than *Platanus heerii*, of Kansas. The two species of *Liriodendron*, of Nebraska, are of a very diminutive type compared with that of *L. giganteum*, of Kansas. *Sassafras mirabile*, of Kansas, has leaves measuring more than one foot in diameter, while *S. creteceum*, of Nebraska, is represented by small leaves. These differences may be ascribable to local circumstances, to more or less favorable exposition, to a more fecund composition of the ground, &c., rather than to a general atmospheric deviation. This seems to be proved by observations of a more general character.

Considered as a whole, most of the types of the Dakota group, related to those of our present flora, represent a moderate climate, like the one prevailing now between the 30° and 45° of latitude north. The vegetable types more distinctly characterized by their leaves, and which are recognized by all the paleontologists, *Salix*, *Fagus*, *Platanus*, *Sassafras*, *Aralia*, *Magnolia*, *Liriodendron*, *Menispermum*, *Paliurus*, *Rhus*, &c., are all co-ordinate to identical climatic circumstances, or to the same average temperature which

governs at our time the vegetation of the latitude indicated above. All these types are, therefore, present in the North American flora, some of them with scarcely any alteration of forms.

Professor Heer has the same opinion in regard to the climate of the upper Cretaceous epoch of Greenland as indicated by its flora. He is just now publishing two memoirs, which, besides their great scientific importance, and merely considering the question of the relation of the floras to temperature, are of high general interest. The first describes a group of fossil plants from the lower Cretaceous of Greenland, representing thirty-eight Fucoids, one lycopodiaceous species, three Equisetaceæ, nine Cycadeæ, seventeen Conifers, five monocotyledonous, and one dicotyledonous species. These vegetable remains, according to the author, represent types of a tropical or subtropical flora, and this under the 70° of north latitude. There is evidently no relation whatever between this low Cretaceous flora and that of the Dakota group. But in a second memoir, the author describes an upper Cretaceous flora of the same country, which, in its essential types, appears identical with that of the Dakota group. It has 28 species of the genera *Populus*, *Myrica*, *Ficus*, *Sassafras*, *Proteoides*, *Credneria*, *Andromeda*, *Dermatophyllites*, *Diospiros*, *Panax*, *Chondrophyllum*, *Magnolia*, *Myrtophyllum*, *Sapindus*, *Rhus*, *Leguminosites*,[1] genera, which, with few exceptions, are represented in the Cretaceous North American flora. What a difference in the types of these two groups of plants from the same locality and of the same formation, one with 74 species, 42 of which are cryptogamous plants, 26 phenogamous gymnosperms, among which are nine Cycadeæ, indicating tropical climate, and only one dicotyledon; while the other represents only 28 species distributed in 16 genera, all dicotyledonous and of types analogous to those of the present North American flora. The distribution of such a small number of species in so many genera of distant affinity is, by itself, a fact of great weight in considering the succession of types in their relation to geological periods, and confirms the remarks at the close of the former chapter,[2] But it is still more remark-

[1] Heer in letters.

[2] New and important information comes just now in confirmation of this remark. From a letter of Count Saporta, the most ancient flora of the Cretaceous of Bohemia, whose position is similar to that of the Dakota group, or at the base of what the German geologists call the quadersandstein, here immediately overlying the primitive formation, is composed mostly of dicotyledonous leaves whose forms are remarkably analogous to those of the Dakota group flora. The celebrated paleontologist of France remarks that with the dicotyledonous leaves the specimens represent only one species of Conifers; that the dicotyledonous leaves are large and of varied forms, all apparently representing new types whose exact determination will be the more difficult that they evidently represent synthetic types, resuming, perhaps, each one, the character of a whole family, and appearing as intermediate links between many groups of our present order of vegetation, &c.

able to see, at two horizons of the same formations, the respective floras denoting so great a difference in the atmospherical circumstances which have governed the distribution of each.

It seems evident, from what has been formerly said of the grouping of leaves of the same kind upon separate and limited areas of the Dakota group, as also of their generally flat position in the sandstone or upon the shale, that the trees from which the fossil remains are derived have grown in the same localities where the fossil leaves are found. These leaves cannot have been carried down torrents and rivers from mountains whose altitude could account for the climatic differences. They do not either represent a kind of transportation by floating islands, like those which are carried down the Amazon River and sunk near its mouth; they are true representatives of the climate of that epoch. In regard to the Cretaceous floras of Greenland, and to the atmospheric modifications indicated by their characters, we can as yet say very little. The facts and their causes will have to be discussed by the celebrated author who has had under examination the specimens representing the two groups of plants. And we may be certain that the question will be fully considered by him. I shall be permitted, however, to present these few remarks: 1st. Admitting the relation of the flora of the Dakota group with that of the upper Cretaceous of Greenland, a relation which, though recognized as yet by generic affinity only, appears sufficiently close to authorize the conclusion that both have been affected by identical conditions of temperature, supposing, also, a contemporaneity of the formations, we might easily account for this relation by the well-known fact that the isothermal zones are wider in proportion to the age of the formations, a fact resulting mostly from a greater proportion of atmospheric humidity. The same reason has been surmised already for explaining the identity of a number of species of the Western Tertiary, especially of the lignitic measures of Carbon and Evanston, with those of the Miocene of Greenland.[1] 2d. The cause of the modifications of climate, either slow and continuous during a period of time, or remarked from different formations of the same epoch, result from the changes of land surface which modify in a corresponding degree the intensity or direction of the elements which enter into the composition of the atmosphere. A case serving to illustrate this, is remarked in passing upward from the flora of the Dakota group to that of the Eocene of the Rocky Mount-

[1] Dr. F. V. Hayden's Report, 1871, p. 312.

ains. The Dakota group, resting upon Permian land, or deposited upon its shores, was under the influence of a land climate at the end of a stationary period of long duration. Its climate was accordingly dry, and proportionally cold. A long period of subsidence covered it, to the west at least, by a succession of deep marine formations recorded in the different stages of the Cretaceous strata. At the opening of the new epoch, the Eocene sandstone, full of fucoidal remains, is brought up to the surface of the sea. The first land that covers it is still, like the low land, under an atmosphere of vapors. The climate is proportionally warm, or at least the mean temperature is higher, and the vegetation appears in exact relation to these atmospheric circumstances. It is a time for a luxuriant vegetation of ferns, of palms, of the boggy plants which favors the growth of peat, and the heaping of vegetable matter in a succession of beds which have afterward been decomposed into coal. That this vegetation has no relation whatever with that of the Dakota group is a matter of course, as it is born or established under totally different influences and circumstances. The difference between the flora of the Dakota group and that of the formation which I call Eocene is, therefore, attributable to a change of climatic influences, rather than to difference of age, a conclusion admittable for all the changes indicated by geological floras. But on this assertion, and especially in regard to its application to the floras of the Tertiary groups of the West, nothing more can be said until the fossil plants of these formations are published, a work prepared for another volume. I reserve for that time also, the discussion on this new hypothesis: that groups of identical fossils, especially vegetable ones, do not prove or indicate contemporaneity of the formations which they characterize, when these formations are observed at great distances or under different degrees of latitude.

§ 9.—DESCRIPTION OF SPECIES.

It is not possible to attach any importance to the priority of nomenclature of so-called species of fossil plants, as long as they are known from mere descriptions. The analogy, not to say the specification, of fossil leaves is uncertain enough when the descriptions are illustrated with carefully made drawings or figures which clearly define the essential characters, the outline or general forms, with the nervation of the leaves. In the written records of vegetable fragments, even of whole and well-preserved leaves, the descriptions, though exact they may be, are always subjected to erroneous representations of the mind. For the same reason, I consider not only as a right,

but as a duty, to modify names and descriptions of fossil species which I may have published formerly, whenever this change is demanded either by the discovery of more perfect specimens, which may show under another light the relations of a plant, or by the recognition of different characters which were not observed in a preliminary examination. The first specimens furnished me were comparatively few, mostly incomplete, and I was requested to make an examination of them and to describe them, at least in a precursory way, in a very short time. They were the materials from which was written and published in the American Journal of Science and Arts, vol. xlvi, July, 1868, the paper on some Cretaceous fossil plants from Nebraska. Since that time I have not only received a large number of specimens from the Dakota group, but at two different times I have been over the field for the purpose of studying the distribution of the fossil plants, their relation to localities, &c., and have had opportunities of collecting a number of specimens in a better state of preservation, and, what is still more advantageous for the exactitude of the determination of fossil plants, to compare in place different forms related to the same species. Of course these prolonged studies and the increasing amount of materials may already account for, and render excusable, some difference in the specifications and the synonymy remarked in the following descriptions.

Moreover, at the time when the first descriptions of these fossil plants were made, there was nothing as yet known of the dicotyledonous leaves of the Cretaceous, either of Europe or America, except the little which had been published in the Paleontographica, by Stiehler, Zenker, and Dunker, and in the *Phyllites crétacées du Nebraska* by Heer. As remarked by this author, Debey, who has a large collection of leaves of the Cretaceous of Aix-la-Chapelle in Belgium, had admitted that our fossil leaves of the Dakota group had no relation whatever with those of Belgium, and that therefore no comparison could be made between them. Since that time, Professor Ettinghausen has published, on the Cretaceous flora of Niedershœna of Saxony, what he calls a *Contribution to the acquaintance of the oldest dicotyledonous plants of our earth*, and Heer, also, has given on the Cretaceous flora of Moletin, in Moravia, and on that of Quedlinburg, two very fine quarto memoirs, affording, like that of Ettinghausen, a few points of comparison for the present study of the flora of the Dakota group. Notwithstanding this supplement of mate-

rials, it is certain that this flora is still very imperfectly known in its essential characters and its diversified forms.

A valuable assistance has been given me in the revision of this memoir, and since the engraving of the plates, by Count Saporta, of Aix. An examination of the first proofs of the plates suggested to him, on the relation of some leaves, important remarks which have been used for the distribution of the groups and the limitation of some genera. The thankful acknowledgment of this cordial assistance is as pleasant to me as has been the exchange of views and the intercourse with a paleontologist of so high a standing and so justly celebrated.

CRYPTOGAMOUS PLANTS.

Thallophytes.

ZONARITES DIGITATUS, Brgt., Pl. i, Fig. 1.

Frond flat, membranaceous, dichotomous, branching in an acute angle of divergence; divisions as broad or broader than the main axis, linear, entire, obtuse, slightly enlarging upward.

Fucoides digitatus, Brgt., Hist. d. Veg. foss. p. 69, Pl. ix, Fig. 1.—*Zonarites digitatus*, Geinitz, Dyas., Pl. xxvi.—Lesqx. in Hayden's Report, 1872, p. 421.

Our specimen is less complete than the one figured by Brongniart. It is broken on one side, and merely represents two of the divisions of the plant. These, one cent. broad, slightly enlarging upwards, diverging under an angle of 20°, are apparently of thin membranaceous texture, merely marked by the irregularities of the surface of the calcareous clay over which the plant is preserved. No difference is observable between this and the European form, except in the slightly broader size of the divisions. The main axis has the same character as the branches, slightly enlarging from the base upwards.

The relation of these remains has not yet been positively ascertained. Schenk, in Paleont. xi, p. 301, compares it to *Cyclopteris digitata*, Brgt., a fern of the Oolithe. Schimper, Pal. Veget., p. 186, rejects this opinion from anomaly of characters, and would consider it as referable to the genus *Jean-Paulia*, Ung., which, too, represents species of uncertain affinity related to ferns. The association of these fossil remains with those of animals of deep marine water, large *Ammonites*, *Baculites*, *Inocerami*, is a sufficient indication of their submarine origin, and if they represent a plant it is truly a

Fucoid. It may be, however, a kind of sponge, as it resembles some tubulose species of this class by its punctate or perforated-like surface, an appearance which, as remarked above, may be due to the porous compound of the matrix.

Habitat.—Niobrara group of the Cretaceous, about 100 feet above the top of the Dakota group, six miles north of Fort Harker; on the highest point of the divide between Saline Fork and Smoky Hill River. It is there mixed with a prodigious quantity of fossil shells. It is the only species described in this paper from out of the Dakota group. In Europe it has been recognized in the Dyas or Permian.

Filices.

LYGODIUM TRICHOMANOIDES, sp. nov., Pl. i, Fig. 2.

Pinna linear from the truncate base to the middle, enlarged and lobed upwards from the forking of the medial nerve; veins broadly oblique, distinct, simple or branching from the base.

Lygodium (?) species, Lesqx., American Journal of Science and Arts, vol. xlvi, p. 91.

This fragment of a fern, too small for exact determination, was doubtfully referred at first to a *Lygodium*, though I do not know of any species of this genus to which it may be related. Of all the ferns which I have been able to compare, none appears to have any marked analogy with it but *Trichomanes pinnatum*, Schwartz, and this only by the characters of its lowest pinnæ. The frond of this species, which inhabits the northern tropical regions from Mexico to Brazil, is lanceolate in outline, simply pinnate, with linear pinnæ in the fertile state and oval lanceolate ones in the sterile fronds. In these, the lowest leaflet is often enlarged and lobed from the middle upward, by the forking of the medial nerve, exactly as in the fossil fragment. The analogy is rendered more marked by the disposition of the veins, which in the living species are fine, very close, distinct, simple, or branching, going out in an open angle from the thick costa, with exactly the same degree of divergence as seen in the fossil species. The fossil fragment, however, is of a coriaceous texture, while *Trichomanes* species are more generally thin and membranaceous. The degree of relation cannot, therefore, be positively ascertained without better specimens.

Habitat.—Fort Harker, Kansas, *Leconte.*

HYMENOPHYLLUM CRETACEUM, Lesqx., Pl. i, Figs. 3 and 4; Pl. xxix, Fig. 6.

Frond membranaceous or subcoriaceous; pinnæ linear oblong, pinnately divided into oblanceolate or cuneiform alternate oblique pinnules, decurring to the convex slightly winged rachis, more or less deeply bi-trilobate; lobes obtuse, simple nerved.

Hymenophyllum cretaceum, Lesqx., Hayden's Report, 1872, p. 421.

As seen from the figures, we have three specimens of this species. The one, Fig. 3, represents a narrow linear lanceolate pinna with alternate pinnules more closely approached towards the point; the second, Fig. 4, represents an upper or terminal lobe of an apparently larger pinna. The third is of the same character, with longer narrower lobes. These fragments indicate a species variable in its modes of division and in the size of the pinnules, which, however, have the same general form and the same nervation. The texture of this fern appears thickish, subcoriaceous; the nerves and their dichotomous simple branches are well marked, and ascend to the upper borders of each pinnule, which they sometimes mark by depression into a small notch. No species related to this has been described, though it may be compared to *Sphenopteris Johnstrupi*, Heer, of the Cretaceous flora of North Greenland, Arc. Fl., p. 78; Pl. xliii, Fig. 7. Its analogy is rather with species of the section of the *Sphenopteris hymenophylloides*, mostly represented in the Carboniferous measures, and still more with a number of species of *Hymenophyllum* of Cuba, or of the north tropical region of this continent.

Dr. Newberry, in *Notes on the extinct floras*, &c., p. 10, has described as *Sphenopteris corrugata*, a species which, from the description, at least, seems related to this one.

Habitat.—Eight miles south of Fort Harker, Kansas.

PECOPTERIS NEBRASKANA (?) Heer, Pl. ~~xxx, Fig. 12b~~. 29, figs. 5, 5a.

Pinna coriaceous, linear lanceolate obtuse, alternately equally lobed; lobes more or less disjointed, turned outside, obtuse; medial vein thin, undulating; divisions alternate and alternately branching in simple veinlets, ascending to the borders.

The small branch, a pinna, represented by the specimen is 2 centimeters long, 8 millimeters broad, near the abruptly attenuated base, 4 millimeters near the obtuse point; cut in obtuse lobes, the four inferior ones disjointed to below the middle, enlarging upwards to a very obtuse point and turned outside, the upper ones connected nearly to the borders, which are slightly crenate, by the impression of the veins or the wrinkled surface of the pinna; secondary veins alternate, decurring to the middle one, which they join in a very acute angle, alternately pinnately and simply branching twice on each side, rarely thrice, the branches ascending to the borders.

I find this species figured, not described, in *Flore fossile de Sezane*, by Saporta, p. 332, with the remark that it is still inedited. The fragment from which

our figure and description is made is much like that figured by Saporta. There is, however, some difference in the more deeply disconnected lobes; in the slightly crenulate borders, a character which may be caused by the wrinkled surface of the leaflets; especially in the disposition of the tertiary vinelets more evidently alternate, and of the secondary ones more decurrent than marked by the enlarged figure of the author. Our fragment has also as evident a degree of likeness by the form of the leaflet to *Raphaëlia neuropteroides*, Deb. et Ett., as figured in the *Acrobyren* of the Cretaceous of Belgium, Pl. v, Fig. 20, and by its nervation to the same species as figured enlarged, Pl. iv, Fig. 25. Indeed, it seems that the American form is not specifically distinct from the Belgian one, which by its different fragments indicates a fern with a polypinnate frond and variable divisions.

Habitat.—Kansas, *Prof. B. F. Mudge.*

3. Gleichenia kurriana, Heer, Pl. i, Figs. 5, 5^{b}, 5^{c}.

Frond pinnately divided; pinnæ long, linear, pinnately equally lobed; lobes nearly at right angles to the rachis, separated to near the base; medial nerve thick, pinnately branching; veins forking at the middle.

Gleichenia kurriana, Heer, Flora v. Moletin, p. 6, Pl. ii, Figs. 1–4.—*G. kurriana*(?), Lesqx., Hayden's Report, 1872, p. 421.

Though the branch of fern described here much resembles the species described by Heer, by the form of its pinnules disjoined to below the middle by a narrow obtuse sinus, identity of both these forms is, however, doubtful. The difference in the characters is more marked between the American specimen and those of Moletin, than with a small fragment of a pinna published also by Heer from the Cretaceous formations of Quedlinburg, and which the author refers with doubt to the same species: *Quedl. Flora*, p. 5, Pl. 1, Fig. 3–4. The specimens from Moletin, however, are fructified while these last are sterile, and this may account for the difference of the facies. From the Moletin specimens the American form essentially differs by proportionally shorter, broader, more obtuse pinnules, more open too, or nearly at a right angle to the rachis, and from both the European specimens, by the forked secondary veins, which are marked simple in the descriptions and figures of the author. By this character our American species or variety would be more closely related to *Didymososorus comptoniifolius*, Deb. et Etting., a species from the Cretaceous of Aix-la-Chapelle, which, with a somewhat like form of pinnules, has its veins also forked. The facies of this last fossil fern

represented in Kreide flora von Aachen, Pl. i, Fig 1–5, is, however, different, the lobes being shorter, less distinctly divided, and rather turned upward than horizontal. As Heer separates his species from the Belgian one, especially on account of the veins being simple in the Moletin specimens, while they are sometimes forked in those of Belgium, (for the figure *a* represents them simple, except the two lower pairs of two of the leaflets,) and as in the American form all the veins are forked, while it has the same facies as the Quedlinburg specimens, I believe that all these Cretaceous fragments represent the same species. For this reason I do not wish to increase the number of species from characters of little importance and rarely permanent in the ferns of this group.

Habitat.—In a ravine, three miles east of Fort Harker.

TODEA (?) SAPORTANEA, *sp. nov.*, Pl. xxix, Figs. 1–4.

Frond large, coriaceous, bi-tripinnately divided; pinnæ linear or enlarged in the middle, pinnately, alternately divided in lanceolate, pointed, entire, open, erect pinnules, disjointed to the decurring base, which forms a narrow wing along the narrow rachis or medial nerve; nervation pinnate; secondary veins simple, alternate, parallel, turning upwards in ascending to the borders, which they follow in a series of curves.

This beautiful species is represented by a number of specimens, the largest of which, Fig. 1, shows the point of three apparently parallel pinnæ $3\frac{1}{2}$ centimeters wide, cut down nearly to the rachis into erect patent, simple, linear lanceolate, entire, sharply-pointed segments, decurring by their base and forming a narrow border along the rachis to the point of union with a lower segment. These lobes, mostly equal in length upon the same pinnæ, are from 2 to 5 centimeters long, and from 3 to 8 millimeters broad. The nervation is remarkably similar to that of some dicotyledonous leaves; the lateral or secondary simple veinlets in an acute angle to the middle nerve, (40°) are close to each other, 2 to 3 millimeters distant, parallel, ascending in curving upward to the borders, which they follow and join the upper veins, forming successive bows or festoons. The veins are generally simple, separated often by Tertiary shorter vinelets which disappear toward the middle of the principal areas into large areolæ, by dividing on both sides. The relation of this fern to *Todea*, a genus of the section of the *Osmundceæ*, is indicated merely by the form and mode of division of the pinnæ; but the neuration is different from that of any of the living species of this genus, even from any species of ferns of our time. It is comparable to *Monheimia aquisgranensis*, Dev. and Ett., *Acrobryen*, p. 31, Pl. iv and v, Fig. 6. Of course the exact relation of

this fern cannot be positively known as long as its fructification has not been discovered.

Habitat.—Kansas. Recently discovered and communicated by *Professor Mudge.*

PHAENOGAMOUS PLANTS.

Cycadeæ.

1. PTEROPHYLLUM? HAYDENII, Lesqx., Pl. i, Figs. 6 and 6^{b}.

Frond linear, simply pinnate; rachis rugose, half an inch broad or more, marked by circular dots in vertical rows and regularly placed about half a centimeter distant, apparently scars of the points of attachment of the pinnæ; pinnæ entire, oblong, oval-obtuse, slightly arched on the lower side, flat, attenuated at the round point of connection to the rachis, regularly and narrowly striated lengthwise.

Pterophyllum haydenii, Lesqx. in part, American Journal of Science and Arts, *loc. cit.*, p. 91.

In the paper above referred to, I considered the fragments here described, together with a cone, as referable to the genus *Pterophyllum* from their likeness to vegetable organs of the same kind described and figured by Stiehler, in *Palæont.*, vol. v, p. 76, Pl. xv, Figs. *a* and *d*, under the name of *Pterophyllum ernestinæ*. I have seen nothing since, in the publications of recent authors, which might give any clue to the true relation of this vegetable. Its parts as represented, Figs. 6 and 6^{b}, are evidently related by their form and characters to Stiehler's species, and referable at least to the same genus, the frond merely differing by the pinnæ attenuated at the base and not sessile in their whole width; by the smaller size of these pinnæ and the slender close striæ with which they are marked. In considering Stiehler's species, Schimper only remarks, in Pal. Veget., p. 139, that probably this vegetable should be separated from the genus *Pterophyllum*, on account of the thickness of the rachis. But the plant is left by him with species of uncertain affinity. The cone, too, by its likeness to that of Stiehler's, Fig. *d*, was for the same reason referred to the same kind of vegetable. I have followed Professor Heer's advice in separating it as rather referable to Conifers

Habitat.—Near Decatur, Nebraska, *Hayden.*

Coniferæ.

ABIETITES ERNESTINÆ, Lesqx., Pl. i, Fig. 7.

Cone oblong, abruptly narrowed to a short pedicel, scales broad, truncate, appressed and imbricated in spiral.

Pterophyllum haydenii, Lesqx. in part, American Journal of Science and Arts, *loc. cit.*, p. 91.

This cone, as remarked above, was at first referred to *Pterophyllum haydenii*, from its likeness to that which is described by Stiehler, *Paleont.*, vol. v, p. 76, Pl. xv, Fig. *d*, under the name of *P. ernestinæ*. With us, as in Germany, the fragment of the cone was found in the same locality as the specimens of the fronds and leaves; but not in close connection. These casual circumstances do not afford sufficient authority to consider as identical with a branch of Cycadeæ a strobile referable by its characters to the pine family. Stems and leaves of *Abies* or of *Araucaria* have also been found in the Cretaceous of the Hartz Mountains, the quadersandstein of Blankenburg, as also in the Dakota group. Dunker, in Paleont., vol. iv, p. 180, describes, under the name of *Abietites*, three species, two of which, *A. curvifolius* et *A. hartigi*, Pl. xxxiii, Fig. 1–2, bear leaves more or less curved inward and enlarging upward to an obtuse point. Dr. Newberry, in *Notes on extinct floras*, p. 10, describes from Sage Creek, Nebraska, fragments of branches bearing *broadly spatulate obtuse leaves* under the name of *Araucaria spathulata*, which appear related to Dunker's species. In considering, therefore, the relation of habitat, we have the same authority for referring this cone of Cretaceous age to Conifers as to Cycadeæ. The description cannot add much to what may be seen on the figure. None of the scales seem to have been preserved entire; they are broadly oval or rounded smooth, truncate at the top, an appearance due probably to the erosion or destruction of part of the scales. As the stone wherein the fragment is imbedded is very hard, it was not possible to see anything of the seeds, if there are any, covered by these scales.

Habitat.—Near Decatur, Nebraska, *Hayden.*

SEQUOIA FORMOSA, Lesqx., Pl. i, Figs. 9 and 9^b.

Cone spindle-shaped, tapering upward and downward about in the same degree; scales closely appressed, rhomboidal.

Sequoia formosa, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 92.

The cone is $4\frac{1}{2}$ centimeters long, $1\frac{1}{2}$ centimeters broad in its widest part, below the middle, tapering upward to a point and downward to a short slender peduncle. The scales, as seen Fig. 9^b enlarged, are rounded in the upper part,

narrowed downward to an obtuse point, surrounded by an inflated margin or thick border, and marked in the central space by wrinkles diverging from a small round point under the upper border. The width of these scales is about 4 millimeters each way, being, however, especially in the upper part of the cone, a little more expanded on the sides and broader than long.

The reference of this fine cone to the genus *Sequoia* is not positively ascertained. By the position and the form of its scales, it resembles the cones described in Sternb., *Flora der Vorwelt*, (vol. ii, p. 184, Pl. xlix, Figs. 2[a] and 3,) under the name of *Bergera minuta*, a species which is represented by better specimens under the name of *Cunninghamites sternbergii* by Ettinghausen, in his *Kride Flora Von Nieders.*, (p. 12, Pl. i, Figs. 4–6.) The cones of this species, however, are proportionally shorter and broader, more obtuse, sometimes nearly round, and the scales, more enlarged in the middle, do not appear marked by an inflated border. In my description, *loc. cit.*, I compared this cone to *Araucarites sternbergi*, Gopp., as figured in Heer's Urwelt der Schweitz, p. 310. This species is a synonym of *Steinhauera minuta*, Sternb. (*loc. cit.*, vol ii, p. 202, Pl. lvii, Figs. 7–15.) The relation, however, is disproved by the same degree of difference as with the former species, the scales being in Sternberg's species more enlarged on the sides, without a border, and the cones still more obtuse and proportionally broader. No fossil cone described as yet, to my knowledge at least, has such a tapering conical form as ours, except the *Lipidanthium microrhombeum*, Schp., figured in Schenk. Foss. Flora, d. Grenzsch, (Pl. xxxii, Fig. 8,) which is considered as the inflorescence of some Cycadeæ.

Habitat.—Near Decatur, Nebraska, *Hayden.*

SEQUOIA REICHENBACHI, Heer, Pl. i, Fig. 10–10[b].

Cone small, oblong-oval; receptacles oval-pointed at both ends; foliaceous scales crumpled, deeply imbedded in the stone, seeds small, oval-oblong.

Sequoia reichenbachi, Heer, Molet. Flor., p. 8, Pl. i, Fig. 2–3.

The cone is cut vertically, and its axis, like the receptacles of the seeds and their follicles, is exposed to view. It is narrowly oval, narrowed to the slender peduncle, a little more than 1½ centimeters long and 1 centimeter wide. The receptacles are empty, but distinctly cut into the stone as in Fig. 10[b] somewhat enlarged; the scales and follicles are vertically and deeply imbedded, and their shape undistinguishable The axis is marked with deep perforations indicating the points of attachment of the receptacles.

I should have been disposed to separate this cone, as representing a distinct species, on account of its slender axis, slender branches, and shorter, more open, and close receptacles; but these characters are not of positive specific importance, and as we do not know the leaves of this Conifer, nor the form of the scales of the strobile, they do not authorize a multiplication of nomenclature, especially in this case, where Heer's species has been already described in its different forms under six generic or specific names. There is also a probability of identity of species in this fact, that *S. reichenbachi* has been described from the Upper Cretaceous of Greenland, whose flora, from recent discoveries, seems to be closely related to that of the Dakota group. It should be remarked, however, that Heer refers to his species *Cunninghamites sternbergii*, Etting., to which I have compared the former species, recognizing positive difference. Now, this broken cone of our Cretaceous bears in its general form and size the same relation to *S. reichenbachi* as that of *Sequoia formosa* bears to the cones described by Ettinghausen. If, therefore, the European forms belong to the same species, *S. reichenbachi*, the cone of ours, Fig. 10, is different and may represent a crushed dry cone of *S. formosa*. The relation of these strobiles cannot be positively recognized as long as the leaves and scales are unknown.

Habitat.—Nine miles south of Fort Harker, Kansas.

GLYPTOSTROBUS GRACILLIMUS, Lesqx., Pl. i, Figs. 8, 11–11*f*.

Branches fastigiate, very slender, thread-like, much divided; leaves imbricate, appressed, embracing at the base, linear lanceolate, more or less abruptly pointed; cone narrow, cylindrical.

Glyptostrobus gracillimus, Lesqx., American Journal of Science and Arts, vol. xlvi, p. 92.—*Frenelites reichii* (?), Ettinghs., Kreide flora von Nieders., p. 12, Pl. i, Fig. 10.—*Lycopodites insignis*, Reich. Bronn, Lethæa geogn., 1846, p. 577, Pl. xxviii, Fig. 13.

The specimens where this small species of Conifer is preserved are irregularly covered or perforated in various directions by the deep impressions of thread-like branches, scarcely 1 millimeter thick, round and knotty by the base of the leaves, which appear as placed in whorls or by four. The branches are irregular in their divisions, either alternate or opposite, or one-sided, of various length, erect, crowded, with leaves closely appressed, imbricated and biform, either linear, lanceolate, sharply pointed, or shorter, more abruptly pointed and slightly obtuse, without trace of a medial nerve. As seen in the figures 11*d* to *f*, much enlarged, the lower part of the leaves

seems slightly narrowed from the middle downward, an appearance resulting from their concavity in the embracing of the stems toward the base. The top of some of the branches is enlarged by an agglomeration of small scales, whose form, as far as it can be recognized, is figured 11*c* enlarged. These are apparently male catkins of the plant. One of the numerous specimens covered with branches of this little Conifer is traversed by a small narrow cone which appears cylindrical, but of which only a few scales are visible. These are rhomboidal in outline, pointed at the corners, marked in the middle by an oval dot with thin, linear close striæ, diverging to the borders: Fig. 8 enlarged.

I have referred this species to the genus *Glyptostrobus* on account of the form and mode of divisions of its branches, of the scale-like leaves without nerves, and of the form and position of the male catkins. But since the publication of my paper on the Cretaceous plants of Nebraska, (*loc. cit.*,) I have received, by the kindness of the author, the Cretaceous flora of Niederschœna, containing description and figures of *Frenelites reichii*, which so well agree with the characters of this species that I scarcely doubt their identity. The only appreciable difference is in the leaves, which, as figured 10*b* by the European author, are shorter and marked by a costa. The leaves, however, are not figured separately, and may not have been distinct enough to ascertain their exact form. The genus *Frenelia*, Mirb., is represented by a number of species now inhabiting only New Holland, Tasmania, and New Caledonia. From the description of the genus, the branches are terete and the branchlets alternately triquetrous, rarely tetraquetrous, and closely articulated; the leaves are verticillate by three, rarely by four, adnate, but free in their whole length at the summit, and in the inferior branches only joined to the stem by their base, somewhat open and linear. This agrees well enough with the description and figures of our fossil species, and even the few scales, recognized from a cone, do not appear to differ from those of a *Frenelia*, which in old strobiles are woody, connate at their base only, smooth, rugose or tuberculate on the back, with a bract, mucronate or mucronulate at the top. I have, however, been unable as yet to obtain for comparison a branch bearing an old cone of a *Frenelia*, and I am, therefore, still in doubt about the true reference of this Cretaceous species. It would not be strange to have in these remains the representative of another type of Australian Conifers, or of a flora to which some leaves of the Dakota group seem to be related.

Habitat.—Near Sioux City; mouth of Iowa Creek, *Hayden.*

GEINITZIA, Heer, species(?).

In the grayish bituminous clays of the upper Dakota group near Sioux City, which, as remarked formerly, are filled with undeterminable fragments, especially of rootlets and branches of Conifers, I have found some rhomboidal scales, 2 centimeters wide each way, broadly rounded at the upper border, obtuse on the sides, narrowed downward to the spur of the scales, which at its base is obtuse and 2 millimeters wide. The whole surface is marked by prominent small ribs, curving along the borders and descending into the spur of the scale, becoming of course less curved toward the middle of the scale. These costæ, transformed into bitumen or amber, are thread-like or cylindrical, leaving a groove upon the stone when dug out of it. Their appearance is like the ribbed surface of the scales of *Geinitzia formosa*, Heer, a new genus and species, admirably illustrated by the author in *Kreide flora v. Quedlinburg*, (p. 6, Pl. ii, Figs. 4, 6.) As I could obtain but a single scale, preserved well enough to recognize its form, I can only remark on its characters, in order to direct the researches to better determined organs of a form which probably represents some new and remarkable kind of Conifers.

PHYLLOCLADUS SUBINTEGRIFOLIUS, Lesqx., Pl. i, Fig. 12.

Leaf oval, oblong, tapering from below the middle to a short thick petiole, abruptly rounded and undulate above, coriaceous; medial nerve narrow, scarcely distinct; lateral veins very close and thin, simple, a few more prominent or thicker, all running to the borders.

Phyllocladus subintegrifolius, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 92.

The leaf is $3\frac{3}{4}$ centimeters long from the end of the petiole, which measures $\frac{1}{2}$ centimeter, 11 millimeters broad at the middle, and abruptly obtusely pointed; the lateral veins are very close, more or less indistinct, apparently simple, very thin but irregular in thickness, passing to the borders by a slight downward curve in an acute angle of 30°. The borders of the leaf are entire, only undulate near the top, and in this differ from the species of *Phyllocladus* or *Salisburia* now known, which are all more or less lobate and denticulate. From all the species of *Podocarpus*, which this leaf resembles by its outline, it differs by its nervation, which is evidently of the *Phyllocladus* type. The lateral veins are apparently rendered indistinct by the coriaceous texture and the somewhat wrinkled surface of the leaves, as is generally the case in species of this genus.

Habitat.—Near Decatur, Nebraska, *Hayden*; a single specimen.

Glumaceæ.

PHRAGMITES CRETACEUS, Lesqx., Pl. i, Fig. 13, 14; Pl. xxix, Fig. 7.

Arundo cretaceus, Lesqx., American Journal Science and Arts, *loc. cit.*, p. 92.

The species was described from two small imperfect specimens, one representing a small fragment of a leaf, Fig. 14, the other a knot of a branch or a root similar to organs of this kind, as they would appear when separated from the stem of an *Arundo* or a *Phragmites*. This last specimen is a circular, button-like convex scar, 2 centimeters broad, marked at the border or outside of the convex center by two parallel rows of verrucose, irregular, mostly round, convex papillæ; the largest 1½ millimeters wide. It is comparable to the scars of *Arundo göpperti*, Heer, as represented in Flora Tert. Helvet., (p. 62, Pl. xxiii, Figs. 2, 3,) and especially Pl. xxii, Fig. 3^{b}, being, however, twice as large. Scars of the same form, but not quite as distinct, are also seen as branch scars of *Phragmites œningensis* in the same work, (Pl. xxiv, Figs. 1, 2.) The generic relation of those small fragments was contestable. Recently, Prof. B. F. Mudge has discovered in concretions of the Dakota group of Kansas a fine specimen, which, representing the same species relates it more evidently to *Phragmites* than to *Arundo*. It represents, as seen Pl. xxix, Fig. 7, the upper part of a linear lanceolate leaf, 12 centimeters long, about 3 centimeters wide at the base of the preserved fragment, gradually tapering to an obtuse point, with equidistant, parallel, distinct primary nerves, and three or four intermediate thin vinelets. The consistence of the leaf is thickish or coriaceous, and the vinelets distinguishable only where the epidermis has been destroyed. This leaf is, in its characters, similar to the fragments of leaves represented by Heer, (*loc. cit.*, Figs. 1, 5, 8, of the same Pl., xxv,) where the characters of *Phragmites œningensis* are so finely illustrated. This leaf of ours shows the same form in its upper part, also same kind of nervation, differing only by the narrower space between the primary nerves. As this space varies in leaves of the Tertiary species according to their width, and as it is also seen diminishing on the Cretaceous leaf in ascending to the point, the difference is unimportant. Specifically this new species of *Phragmites* is separated from the Tertiary one by its coriaceous consistence, rendering the vinelets discernible only under the thick epidermis, and by the large size of the verrucose knots.

Habitat.—Near Fort Harker, *Leconte;* Western Kansas, *Mudge.*

Dioscoreæ.

DIOSCOREA (?) CRETACEA, sp. nov., Pl. xxviii, Fig. 10.

Leaf coriaceous, entire, nearly round, slightly emarginate at the point, broader than long, round or truncate at base; veins apparently all from near the base, the outside ones curving parallel to the borders, and somewhat branching; the others parallel to each other, simple, curving in the same way in ascending, connected in the upper part by arched nervilles, the inner ones acrodrome.

The leaf is lacerated in the middle through, from top to base, and therefore the nervation is not satisfactorily ascertained. The upper lateral veins appear as branching from the destroyed middle nerve. According to the remark of Saporta, this leaf is referable to both the present genera *Dioscorea* and *Pitsia*.

Habitat.—Western Kansas; found in concretions, *Mudge*.

Palmæ.

FLABELLARIA (?) MINIMA, sp. nov., Pl. xxx, Fig. 12.

Rays narrow, splitting in laciniæ; veins prominent, parallel; intermediate space concave, marked with indistinct veinlets, parallel to the primary veins.

The fragment shows four rays or laciniæ, diverging upwards as if out of the same central point, splitting in ascending, in the same manner as the rays of palm leaves in the upper part, and thus enlarging fan-like. The lines or nerves marking these divisions in their length are parallel, narrow ridges, separated by concave grooves, having the appearance of the folds or rays of Sabal leaves reduced to a very narrow proportion, Fig. 12^b enlarged. If these fragments represent a species of palm, it is a very diminutive one. They cannot be compared to gramen leaves on account of their fan-like division. The substance is, if not thick, at least hard, firm, the surface polished and shining like culms of straw. This small fragment seems to indicate the first traces of palms in our Cretaceous measures.

Habitat.—Western Kansas; found in concretions, *Mudge*.

DICOTYLEDONEÆ APETALEÆ.

Iteoideæ.

LIQUIDAMBAR INTEGRIFOLIUM, Lesqx., Pl. ii, Fig. 1–3; Pl. xxiv, Fig. 2; Pl. xxix, Fig. 8.

Leaves of medium size, coriaceous, deeply five-palmately lobed; divisions ovate-lanceolate obtuse, entire, separated by obtuse sinuses.

Liquidambar integrifolium, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 93 ; Hayden's Rept., 1872, p. 442.

The first description was made from a single leaf. Since then I have found a number of specimens of the same kind, all representing leaves of a smaller size. They vary from 10 to 16 centimeters broad, from the points of the lowest lobes, from 8 to 15 centimeters long, without the petiole. The lobes, cut to nearly the middle of the leaves, are equally diverging, the lowest horizontally or at right angle to the middle nerve, and the intermediate at about the same angle between the lowest and the middle lobe. The lobes are perfectly entire, slightly enlarged in the middle, and ovate-lanceolate, obtusely pointed, or, in the smaller leaves, oblong-obtuse. The palmately divided primary thick nerves are united a little above the basilar border of the leaves, either all at the same point, or the lateral ones parting from the middle nerve a little above its base, and, as seen in Plate iii, Fig. 2, the lowest are branching too at a distance from the base of the lateral nerve. The characters of the areolation and the divisions of the veins are the same as in our present *Liquidambar styraciflŭum*, L., and but for its entire borders and the somewhat broader and shorter divisions of the fossil leaves, those of Pl. ii, at least, would be referred as identical to our present species. Even the petiole, at the point of union with the leaves, appear bordered like the living species by a foliaceous appendage, Pl. ii, Fig. 1. The two small leaves, however, represented in Pl. xxiv and xxix, seem by their smooth surface and round obtuse point referable to a variety of this species or related to a different type, that of the *Acerineæ* (?) Of the four species of *Liquidambar* known in our present flora all have the divisions of their leaves serrate ; of the fossil species, one, *Liquidambar goepperti*, Wat., Pl. foss. du bass. de Paris, (p. 166, tab. xlvii, Fig. 4,) has the borders entire, but the leaf merely trilobate ; a second, *L. Scarabellianum*, Massal., Flor. foss. Senegal, (p. 239, Pl. xv, xvi, Figs. 7, 11 ; Pl. xx, Fig. 1, and Pl. xxxviii, Fig. 7,) has leaves with acute lobes and sinuses, without analogy with the forms of ours. A third species, *Platanus sirii*, Ung., Flora v. Sotzka, (p. 36, Pl. xxxvi, Fig. 1,) is more closely related to the Cretaceous leaves by its general form, but is more deeply lobed, its lobes proportionately narrower. It is, however, of the same type, and, considering its generic affinity, the author is uncertain if the leaf should be referred to *Liquidambar* or to *Acer*. It is also related to *L. gracile* of the second Tertiary group. In this leaf the secondary nervation is apparently totally obsolete. In

ours it is distinct and evidently of the *Liquidambar* type. Corda in Reuss. Verstein, Pl. li, Fig. 4–5, represents from the Planer Sandstein of Trziblitz equivalent to the lower Quadersandstein of Bohemia, under the name of *Phyllites sp.*, two fragments of leaves of the same type as ours, or even perhaps of the same species.

Habitat.—Eight miles above Salina Station, Kansas. The first described specimen, Pl. ii, Fig. 1, was probably discovered by Professor Mudge at the same locality. It has been communicated by the Smithsonian Institution.

Populites, Mass., emend.

Leaves round, oval, obtuse, entire, palmately or subpinnately nerved; nervation craspedodrome.

To this genus I refer leaves related by form and nervation to the genus *Populus*, from which, however, they differ by the generally entire, obtuse leaves, narrowed to the petiole, abruptly curving to it from a truncate or cordate base, or passing to it by a longer slightly decurring base; and especially by the more distinctly craspedodrome nervation; the lateral nerves and their essential divisions evidently running to the borders. They represent altogether some of the characters pertaining to the genera *Populus*, *Fagus*, *Platanus*, and even *Acer*. Their relation to *Populus* is so indefinite that Schimper, (Pal. Veget.,) places *P. lancastriensis* and *P. cyclophylla* in his doubtful species, while he admits *Populites elegans* as a true *Populus*. It is therefore advisable to consider all these forms under a peculiar generic name, until further researches and perhaps the discovery of the fruits may point out their positive relation. Some forms admitted at first into this division are now separated from it on account of a more marked relation with other genera. The name *Populites* has been already used by Massalongo in Flor. Senig. for the description of a leaf, *P. gasparini*, which by its form is indeed comparable to some of our Cretaceous species, but whose nervation is different, the lateral veins and their divisions curving along the borders or evidently camptodrome.

(Lesqx)

Populites lancastriensis, Lesqx., Pl. iii, Fig. 5

Leaf large, broadly cordate, pointed (?) with entire, slightly undulate borders; primary nerves in five, subpalmately divided.

Populus lancastriensis, Lesqx., American Journal Science and Arts, *loc. cit.*, p. 93.

A large leaf, 12 centimeters broad, 10 centimeters long without the petiole broken 1 centimeter from the base; broadly cordate, apparently pointed, with

entire slightly undulate borders; lowest primary nerves thin, following the borders, the lateral oblique, (50°) parallel, branching; divisions running to the borders; nervilles in a right angle to the nerves and their divisions, distant and distinct, nearly continuous. The areolation of this species is of the *Platanus* or *Dombeyopsis* type. Schimper (Pal. Veget., p. 704) considers it as related to this last genus.

Habitat.—Near Lancaster, South Nebraska, *Hayden.*

POPULITES ELEGANS, Lesqx., Pl. iii, Fig. 8.

Leaves broadly oval or nearly round, narrowed by an abrupt curve to a long slender petiole; borders entire, undulate; nervation pinnate, the lowest secondary veins from above the border of the leaf.

Populites elegans, Lesqx., Journal of Science and Arts, *loc. cit.*, p. 94.

A well-preserved entire leaf of the same thickish, but not coriaceous, substance as the former, 8 centimeters broad, 10 centimeters long, exclusive of the petiole 2½ centimeters, round in outline, more enlarged below the middle, very obtuse, pinnately nerved; angle of divergence of the veins 40°; areolation and divisions of the veins of the same type as in the former species. This leaf has not the basilar primary nerves remarked in the former, and the lowest pair branches opposite from above the base of the middle nerve. These differences, and the form of the leaf, separate it evidently.

Habitat.—Decatur, Nebraska, *Hayden.*

POPULITES CYCLOPHYLLA, Heer (?) Pl. iv, Fig. 5, and Pl. xxiv, Fig. 4.

Leaves round, entire or slightly undulate, rounded or truncate to the petiole; texture rather thin; nervation pinnate from the base; lateral veins straight, simple, or the lowest only branching, craspedodrome.

Populus cyclophylla, Heer (?), Proceedings of the Academy of Natural Sciences, Philadelphia, 1858, p. 266.—Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 93.

From the short diagnosis given of his species by Professor Heer, I considered this as identical to it. From the observations of the author, however, it is probable that I am mistaken in this supposition. The leaves represented by many specimens are all nearly round, 6 to 7 centimeters wide each way, either abruptly rounded to the petiole or truncate at base, the border slightly inclining downward at the point of contact with the petiole. The nervation is pinnate from the base of the leaves, the lateral veins, five pairs, at equal distance, parallel, all simple except the lowest, passing up from the medial nerve at an angle of divergence of 40° and reaching the borders without

scarcely any diminution in their thickness; they are joined by perpendicular distant subcontinuous nervilles forming large areas, with a close, nearly square areolation. I have referred to the same species the leaf of Pl. xxiv, Fig. 4, with some doubt. The form is the same, as also its thin substance; but it bears under the lowest pair of lateral veins a distinct marginal one, and the lateral veins are more divided than in the normal form. These differences do not appear marked enough for authorizing a separation.

Habitat.—Lancaster County; Decatur, Nebraska, *Hayden.* The specimen of Pl. iii comes from this last locality, where I found it with other fragments of the same species.

SALIX PROTEÆFOLIA, Lesqx., Pl. v, Fig. 1–4.

Leaves lanceolate, taper-pointed, largest at or more generally below the middle, coriaceous; surface polished.

Salix proteæfolia, Lesqx., American Journal of Science and Arts, *loc cit.*, p. 94.

The size of these leaves is very variable, from 5 to 12 centimeters long and 1 to 2 centimeters broad, generally lanceolate and gradually tapering to the point from a little above the base where they are the largest, and descend by a more or less tapering outward curve to a short petiole; some of the leaves, however, as seen in Fig. 2 and 4 are wider in the middle, and judging from the last figured leaf, the smallest, the form is sometimes oblong oval and the point blunt. The species is represented by a number of leaves, some crowded upon the same specimens and indentifiable, though fragmentary they may be, by their thickish texture and polished surface. For this reason I have considered them all representing a single species, though different the outlines and size of the leaves may be. From their form, and especially their nervation, which is marked Fig. 3 as distinct as it could be seen, these leaves are truly referable to *Salix*, and merely considering these characters, they could not be separated from *Salix tenera*, A. Br., as figured and described by Heer, Flor. Tert. Helv., (p. 32, Pl. lxviii, Fig. 7–13.) The variety in the form of the leaves enlarged in the middle or above the base; in their size, even in the nervation, is exactly the same.

The remark of Schimper, (in Pal. Veget., vol. ii, p. 663,) that *if the relation of some saliciform leaves of the Cretaceous formation is rightly ascertained we have here one of the oldest forms of the Angiosperm dicotyledonous*, is, with its restriction, applicable to every kind of fossil vegetable remains

whose relation cannot be positively affirmed if the seeds or other essential characteristic organs are not discovered. The number of leaves, however, which have to be referred to the same order of the vegetable scale tends to confirm the relation of these leaves as it is indicated. The leaves referred to the *Proteineæ* or to an Australian type are mostly, if not all, without nervation, and therefore of a far more doubtful relation. With us, at least, the Eocene formation has scarcely any well recognized species of willows; none as yet whose characters are as evident as in the Cretaceous leaves. They become, however, more predominant in the Carbon and Evanston groups of the Tertiary, and especially in the Pliocene.

Habitat.—Near Decatur, *Hayden*. Not found elsewhere; ten specimens.

Amentaceæ.

BETULA BEATRICIANA, Lesqx., Pl. v, Fig. 5, Pl. xxx, Fig. 4.

Leaves small, rhombic-obovate in outline, cuneiform from the middle downward to the petiole, rapidly tapering from above the middle to a point, unequally simply toothed in its upper part, undulate entire to the base; nervation pinnate, craspedodrome.

Betula beatriciana, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 95.

The species was at first represented by one leaf in three fragmentary specimens. Leaf 6 centimeters long and 3 centimeters broad, rhomboidal, cuneiform from the middle to the base, marked above by a small pointed lobe or tooth on each side, and hence contracted upwards and tapering to a slightly obtuse point; irregularly and simply toothed or undulate lobed in the upper part; secondary veins irregularly distant, but parallel, at an acute angle of divergence (40°), six to seven pairs, branching near the point, nervilles strong, more or less continuous and at a right angle to the veins. Another leaf discovered lately has the same essential characters as the other, being, however, smaller with equally distant closer secondary veins. The lowest veins in this leaf also are thinner, marginal or parallel to the borders, and join the middle nerve above its base.

This species is, by the form of its leaves and its nervation, comparable to some of the numerous varieties of *Betula nigra*, L. The only evident difference is in the simply dentate border of the fossil leaves, which are doubly serrate in the present species. In the *Phyllites du Nebraska*, Professor Heer has described under the name of *Betulites denticulata*, p. 15, Pl. iv, Figs. 5 and

6, two fragments of leaves which have not any relation to this species, and appear, by the enlarged base, to belong to a type related to our *Betula lutea*, Michx. The specimens however are fragmentary, and the affinity of these leaves is uncertain.

Habitat.—Near Beatrice, South Nebraska, *Hayden.* All the specimens are from the same place.

ALNUS KANSEANA, sp. nov., Pl. xxx, Fig. 8.

Leaf thickish, round-oval, rounded and narrowed to the slightly attenuated subcordate base, and above to an obtuse point, entire or marked by a few obscure teeth in the upper part; lateral veins parallel and mostly opposite, the lowest camptodrome, the upper ones entering the teeth; nervilles thick, in right angle to the veins.

The leaf is 4 centimeters long, $3\frac{1}{4}$ centimeters broad in the middle, its widest part; round-oval, with borders undulate from above the middle downwards, slightly obtusely dentate toward the obtuse point, with seven to eight pairs of thick lateral veins, mostly opposite, passing up from the middle nerve under a broad angle of divergence of 60°, the lower veins curving along the borders, the superior ones entering the teeth by their point or their divisions. The veins are all at equal distance and parallel, except the lowest pair attached to the medial nerve a little above the base of the leaf, and somewhat more open than the others. The nervilles, at right angle to the veins, are strongly inflated at their point of connection to the veins, forming by subdivision at right angle, a rough quadrate areolation. By its outline, this leaf resembles the small forms of *Alnus viridis*, differing however by the borders mostly entire, and by the nervation. By this last character it has some affinity to *Alnus gracilis*, Ung., which has sometimes, as in Fig. 4, Pl. xv of Bil. Flora, the borders entire from the middle downwards, and the lowest pair of veins camptodrome.

Habitat.—Kansas; found in concretions, by *Professor Mudge.*

Alnites quadrangularis, Lesqx., Pl., iv, Fig. 1.

Leaf subcoriaceous, small, broadly rhomboidal in outline, with obtuse angles; borders undulate entire, rounded to a thick, short (broken) petiole; nervation pinnate; veins craspedodrome.

Populites quadrangularis, Lesqx., American Journal of Science and Arts, *loc cit.*, p. 94.

The leaf is 38 millimeters long and about as broad; the secondary veins, seven pairs, at an open angle of divergence 50°, are thick, at least toward the base, parallel, alternate, going nearly straight to the borders, mostly simple.

The lower pair follows the border as slightly thinner marginal vinelets. I do not know of any leaf to which this is comparable; by its nervation it seems to have a distant relation to the former; its consistence is as thick, but the surface is smooth or polished.

MYRICA OBTUSA, sp. nov., Pl. xxix, Fig. 10.

Leaf thick, coriaceous, shining, linear, obtuse, entire; medial nerve thick; secondary veins thin, nearly at a right angle to the medial nerve, curving near and along the borders in marginal festoons, anastomosing from the middle or above with intermediate shorter veinlets.

The fragment shows the upper part, 5½ centimeters long, of a narrow linear obtuse leaf, only 12 millimeters wide. The secondary veins about at right angle, not quite parallel, and also variable in distance, are extremely thin, undulating, in passing up to the border which they follow in successive curves, anatomosing with the divisions of intermixed shorter vinelets, which come out of the medial nerve under a different angle of divergence, and forming a mixed small quadrate or polygonal areolation. The leaf, by its form and nervation too, is somewhat similar to *Andromeda venulosa*, Sap., Ets., Part ii, p. 3, Pl. iv, Fig. 15, whose details of nervation are admirably figured 15[b]. The direction of the secondary veins to and along the borders, the mode of branching with intermediate shorter veins of a more open angle, the very small irregular quadrate or polygonal areolæ are still more related to the same characters of some species of Myrica, as M. major, Thun. of Japan especially. The leaf is as thick as that of M. venezuelana, Rich of Cuba.

Habitat.—Kansas, *Mudge.*

MYRICÆ? SEMINA, Pl. xxvii, Fig. 4 and 4[a].

The specimen figured represents a hollow stem 2 centimeters wide, cylindrical, irregularly costate rugose on the outside, marked inside with points or small perforations; walls of the tube 3 millimeters thick. This hollow stem is comparable to a branch of *Sambucus* deprived of its pith. The same specimen is furrowed by the impressions of branches crossing at right angles with a number of seeds, which, as seen in Fig. 4 enlarged, are oval-pointed and surrounded by a narrow border. These seeds are similar to those figured as seeds of *Myrica* in Heer Kride Fl. v. Qued., Pl. iii, Figs. 15–18, which are found in the same clay beds with leaves of *Myrica schenkiana*, Heer, (*loc. cit.*, p. 11, Pl. iii, Fig. 1.)

The leaf of Myrica recently discovered in the Cretaceous of Kansas

gives some weight to the reference of the seeds to the genus. The figured specimen, moreover, bears upon its surface fragments of striated scales which compare well with those of a catkin of *Myrica*. The agglomeration of seeds imbedded into the stone, either flat or oblique or perpendicular, seems by itself to indicate their origin as from a crushed catkin.

Habitat.—Near Decatur, Nebraska.

QUERCUS PRIMORDIALIS, Lesqx., Pl. v, Fig. 7.

Leaf subcoriaceous, narrowly oval, equally gradually tapering upward to a point and downward to a short petiole, sharply equally dentate; nervation pinnate, simple, craspedodrome.

Quercus primordialis, Lesqx., American Journal of Science and Arts, (?), xlvi, 1868, p. 95.

A well-preserved leaf, narrowly oval lanceolate, broader in the middle, nearly $2\frac{1}{2}$ centimeters, gradually tapering upward to a point and narrowing downward in the same degree to a short petiole, altogether 11 centimeters long; borders equally sharply distantly dentate, with the teeth turned upward, lateral veins close, 14 pairs, deeply marked, parallel, all simple, nearly straight to the point of each tooth under an angle of divergence of 40°; nervilles about in right angle to the veins, undulate; areolation obsolete.

By its form and its nervation this leaf has its relation marked with some variety of leaves of *Quercus prinoides*, Michx., and perhaps still more with those of *Castanea*. This type is represented by a number of species in the Tertiary, for example, in Unger's Flora v. Kumi, as *Quercus lonchitis*, Figs. 4 and 6 of Pl. v, which have the more likeness to our leaf; in Massal. Flora. Senig., as *Castanea ombonii*, as illustrated Pl. xlii, Fig. 8, &c. All these forms and a number of other fossil leaves of the same character show always by comparison some difference from this Cretaceous species. Debey, in the study of the Cretaceous leaves of Belgium, has established a new genus, *Dryophyllum*, containing leaves related to this *Prinoid* section of *Quercus*, as also to *Castanea* and *Castaneopsis*. The nervation is described in Schimper's Pal. Veget., II, p. 613, as *subcamptodrome, the veins forking near the borders*, a character which is not remarked in this leaf. *Phyllites geinitzianus*, Gopp. from the quader sandstein of Silesia, is closely allied to the Nebraska species,

Habitat.—Near Decatur, Nebraska, *Hayden*. It is represented by four specimens, all fragmentary except the one figured as above.

QUERCUS HEXAGONA, Lesqx., Pl. v, Fig. 8.

Leaf rhomboidal-ovate, tapering to a point from above the middle, narrowed downward, irregularly dentate above; nervation pinnate, simple, craspedodrome.

Quercus hexagona, Lesqx., American Journal of Science and Arts, (?) xlvi, 1868, p. 95.

A mere fragment of a coriaceous or thickish leaf, whose form, as indicated by the preserved part, is rhomboidal or hexagonal, with the sides parallel in the middle, obliquely tapering to a point, and narrowed to the base. The borders, undulate and entire from the middle downward, are cut above and to the point by irregular teeth more or less distant; the secondary or lateral veins, 7 pairs, are alternate, diverging only 30°, all simple and simply craspedodrome, running to the point of the teeth. No details of areolation are recognizable. This leaf is in appearance, for the form at least, like that, Fig. 5 of the same plate, which is referred to a *Betula*. There is, however, a marked difference in the consistence of the leaves, in the lateral veins thicker and simpler in this species, a character not in concordance with the nervation of *Betula*. The relation, however, of this fragment to *Quercus* is not positive.

Habitat.—Cass County, Platte River, Nebraska, *Hayden*. The fragment figured is the only specimen found.

QUERCUS (?) ELLSWORTHIANUS, Lesqx., Pl. vi, Fig. 7.

Leaf subcoriaceous, oblong-oval, pointed (?), rounded and narrowed to the base; borders undulate; nervation pinnate, camptodrome.

Quercus ellsworthianus, Lesqx., American Journal of Science and Arts, (?) xlvi, 1868, p. 96.

A fragment only of an oblong oval leaf of medium size, 4 centimeters broad, 9 centimeters long, narrowed by an outward curve to the base, (point broken,) with borders deeply undulate, and a pinnate nervation; lateral veins numerous, simple or forking near their point, slightly turning downward to the medial nerve, which they join in a broad angle of 50 to 60°. I have compared this leaf to some forms of *Quercus lyelli*, Heer, (Flora of Bovey-Tracey, p. 1058.) It is, indeed, like the fragment of leaves figured, Pl. lxiii, Figs. 5–6 of this work, not in the form and size of the leaves merely, but also in the nervation; in Fig. 5 some of the veins fork in the same way, and in Fig. 6 the angle of divergence is the same. This affinity has forced the reference of this Cretaceous fragment to *Quercus*. Some of the lateral veins are shorter, or abruptly disappearing, and this, too, is remarked upon the specimens of *Q. lyelli*, figured by Heer.

Habitat.—Near Decatur, Nebraska, *Hayden*. A single specimen.

QUERCUS PORANOIDES, sp. nov., Pl. xxx, Fig. 9.

Leaf broadly oval or nearly round, undulate, obtuse at the top and the base; medial nerve thick, lateral veins thin, mostly opposite, open, curved in passing up to the borders, camptodrome.

The surface of this leaf is polished; its substance rather membranaceous than coriaceous; it is 4 centimeters long and just as large, apparently round or truncate at the point, and rounded to the base in the same way. It is marked by 6 pairs of thin opposite secondary veins, emerging at an angle of 70° to 80°, the two lowest pairs more open still, curving and branching near the borders, with intermediate thinner and shorter veinlets. The upper part of the leaf is somewhat erased, and the details of areolation undiscernible. The relation, therefore, of this species to *Quercus* is not more definite than that of the former.

Habitat.—Kansas, found in concretions, *Mudge.*

CELTIS (?) OVATA, Lesqx., Pl. iv, Figs. 2–3.

Leaves ovate, obtuse or truncate at the point, enlarging toward the base, truncate or abruptly curved to a long petiole; borders more or less undulate; nervation palmate from the base, in three craspedodrome divisions.

Populites ovata, Lesqx., American Journal of Science and Arts, (2), xlvi, p. 94.

This species has some affinity with this genus in the form of the leaves and the palmate nervation. In this last character especially, it resembles the American *C. mississippiensis*, and *C. tourneforti* by the form of the leaves, which, however, are crenate in this last species. In Fig. 2, the primary nerves, three only, join the top of the petiole, and ascend, branching more or less, and under angles of divergence of 30°, to the borders. In the second leaf, Fig. 3, the division of the primary veins is more irregular, the branch on the left side being as thick as the medial nerve, and under an angle of divergence of 30°, while the branch of the right side is thin, nearly in a right angle to the medial nerve, appearing like a marginal veinlet, while another branch above it has the normal direction of the primary lateral nerve, but is as thin as the lowest marginal vein. This abnormal division of the nerves, as also the multiplication of the lateral veins, is apparently casual, and cannot indicate a distinction of species for these leaves. Their substance is the same—thickish, membranaceous—and also the areolation, which, in its ultimate divisions, is small, polygonal, derived from large, square continuous areas like that of *Platanus*, as marked in the enlarged part. The border of the leaves, at least, as seen in this same specimen, cut or rounded at the base to near the petiole, turn abruptly down, and are slightly decurrent.

Habitat.—Decatur, Nebraska, *Hayden.*

FAGUS POLYCLADA, Lesqx., Pl. v, Fig. 6.

Leaf ovate-oblong, cuneate to the base, short-petioled; borders entire and undulate; medial nerve straight; secondary veins close, numerous, simple, parallel, craspedodrome.

Fagus polyclada, Lesqx., American Journal of Science and Arts, (?), xlvi, 1868, p. 95.—*F. cretacea*, Newby.(?) Extinct Floras, p. 23.

Leaf membranaceous, about 8 centimeters long, (the point is broken,) including a short petiole 4 millimeters long, ovate-oblong, apparently obtuse, with borders entire and regularly wavy, especially in the upper part; medial nerve straight and narrow; secondary veins oblique, in an angle of divergence of 40° close to each other, 12 pairs in a length of 6½ centimeters, very thin, exactly parallel, running to the borders without marking them with any denticulation. This last character appears to be the only essential difference between this leaf and the one described by Dr. Newberry as *F. cretacea*, which, as he remarks, *has the termini of the nerves most prominent, and the intervals between them forming shallow sinuses.* In our leaf, the secondary veins are, on the contrary, effaced to the borders, and they indifferently end either at the convex or the concave part of the undulations.

The relation of this leaf to the genus *Fagus* is undeniable. In comparing it with some leaves of *Fagus sylvatica*, L., of Europe, it is scarcely possible to point out any difference, except, perhaps, in the more numerous secondary veins, and the more acutely wedge-shaped base. The living species also has, in its leaves, the two characters which mark the difference between both the Cretaceous leaves described; one with entire wavy borders, the other with the borders denticulate by the short protraction of the point of the veins beyond the borders of the limb. This last character is more distinct in our *Fagus ferruginea*, Ait., considered for a long time as a mere variety of *F. sylvatica.* We have, therefore, in these two leaves exact representatives of the only species of beech now living in the northern regions, of both the American and the European continents. Counting eight doubtful species, Schimper describes, in his Pal. Veget., twenty-three species of *Fagus*, all Tertiary except the two mentioned here from the Dakota group, and one unsatisfactorily known, from arenaceous concretions of Austria and Hungary. The Tertiary species are without relation to our Cretaceous leaves; they have dentate or serrate borders, except *Fagus dubia*, Wat., represented by a fragment which does not even appear to belong to a species of *Fagus*, and *F. macrophylla*, Ung., whose leaves are very large, 18 centi-

meters long, represented by an analogous form in the Miocene of Greenland. Gaudin, in his Contributions, (I, p. 31, Pl. vi, Figs. 6–7,) describes *Fagus sylvatica* from the Miocene of Tuscany. His species is represented by two leaves, one of which (Fig. 6) would seem a counterpart of ours but for the more distant and less numerous secondary veins. The Tertiary leaf has only eight veins when perfect, while, if the point was added to the Cretaceous one described here, it would have no less than fifteen.

The presence of a *Fagus* in the formation of the Dakota group should be taken into account as an indication of the temperature of that epoch, especially in searching for relative species of our time.

Habitat.—Decatur, Nebraska, *Hayden.* A single specimen. The locality of the leaf described by Dr. Newberry is marked Smoky Hills, Kansas.

FICUS (?) HALLIANA, sp. nov., Pl. xxviii, Figs. 3, 9.

Leaves hard, subcoriaceous, very entire, petioled, oblong-lanceolate, pointed, more or less obtusely cuneate to the petiole; nervation pinnate; lateral veins close, straight, parallel, numerous.

The leaves, broader below the middle or a little above the base, are more or less abruptly narrowed to the petiole, and gradually tapering to the point; the secondary veins, at an angle of divergence of 40°, are straight, numerous, all equidistant and parallel, except the lowest pair, which is more oblique and parallel to the base; the reticulation is formed by intermediate or tertiary veins, which anastomose with nervilles at right angles to the secondary veins, forming loose, irregular, quadrate, or pentagonal meshes; medial nerve narrow; secondary veins thin.

It is at first difficult to admit that both these leaves are referable to the same species. But in the fossil descriptions and representations of Tertiary pinnately-nerved species of *Ficus*, the secondary veins are often, even upon the same leaf, as in *Ficus lanceolata*, Heer, variable in distance, or close on one side and distant on the other. The same difference is recognizable in the Cretaceous leaves of *Ficus geinitzii*, Ett., (Flora v. Niedeeshoena, p. 16, Pl. ii, Figs. 7, 9–11,) whose forms and nervation have great analogy with those of the Nebraska leaves. Fig. 11 has the secondary veins of the same type as those of our Fig. 3, while the broader leaf of Figs. 9 and 9^b enlarged, has a more open nervation, with close veins, and an areolation of the same character as seen in our Fig. 9. There is, however, especially between the fragments represented (Fig. 9) and some species of *Rhus*—*R. metopium*, L., for

example—as great an affinity in form and nervation as exists between the Minnesota leaves and those of Niedershoena, and, therefore, their relation to *Ficus* is uncertain.

Habitat.—Cretaceous, (Dakota group,) of Minnesota. Collected in numerous fragments by Prof. *James Hall.*

PLATANUS OBTUSILOBA, Lesqx., Pl. vii, Figs. 3–4.

Leaves small, thin, palmately irregularly trilobate; lobes obtuse, short; borders undulate; nervation 3–5 palmate from above the base of the long petioled leaf.

Platanus obtusiloba, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 97.

Leaves 6 to 8 centimeters broad in their widest part, not quite as long, round or reniform in outline, enlarged on the side by the diverging obtuse lobes, abruptly narrowed or undulately truncate at the base, which reaches the petiole by a short downward curve; nervation 3-5 peltate; the lateral veins at a distance from the basilar border of the leaves, branching; medial nerve pinnately divided in its upper part; nervation crespadodrome; nervilles irregular, deeply marked, some of them simple and continuous.

In the form of its leaves, and the general character of its nervation, this species is closely related to *Anisophyllum semi-alatum,* described p. 98. I was even at first inclined to consider all these leaves as representing only one species. There is, however, a marked difference: in the texture of these leaves, which is much thinner in this species; in their finer, more delicate nervation; in their equal divisions in obtuse undulate lobes, &c. The platanoidal character of these leaves is marked in the branching of the primary veins at a distance above the borders, and, therefore, they are not referable to *Acer,* some species of which have leaves of an analogous form.

Habitat.—Beatrice, Gage County, Nebraska, *Hayden.* Represented by a number of specimens. It may be remarked that all these specimens were found at the same locality as those of *Anisophyllum.* Considering the great affinity of characters, this coincidence tends to indicate identity of species, or at least a community of *habitat* for closely allied, perhaps transient or derived forms.

PLATANUS PRIMÆVA, Lesqx., Pl. vii, Fig. 2; Pl. xxvi, Fig. 2.

Leaf large, palmately trilobate, with short, scarcely distinct lateral lobes, broadly deltoid, deeply distantly dentate to the point, truncate undulate to the base; nervation three-palmate, platanoidal.

Platanus aceroides (?), Gopp., var. *latior*, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 97.

A large subcoriaceous leaf, 11 centimeters broad, 9 to 10 centimeters long, without the petiole, obscurely palmately trilobate, distantly dentate; teeth large, sharp-pointed, turned outside; lateral veins at equal distance, parallel.

Though the lobes of this leaf are less marked than in the common form of *P. aceroides*, Gopp., being merely slightly longer than the teeth and of the same form, I am still unable to find any positive character by which this species may be satisfactorily separated from that of Goppert. The border base is undulate, more broadly truncate, not descending as far down along the petiole. But in comparing our figure with that of Heer, (Flor. Tert. Helv., Pl. lxxxviii, Fig. 11,) one sees for the base of the leaves and the distribution of the nervation a perfect similarity. This identity of characters is still more marked between the Cretaceous leaf and *P. guillelmæ*, Gopp., (in Schoss. Fl., Pl. xi, Fig. 1,) and as *P. guillelmæ*, has been for a long time considered by Heer as a variety of *P. aceroides*—an opinion still sustained by D. Ettinghausen—I do not see the possibility of considering as reason for separation the shortness of lateral lobes, which is so generally remarked in *P. guillelmæ*, and even in recognized varieties of *P. aceroides*. I have, however, changed the name, to follow Heer's opinion, and substituted one which indicates this species as the original form of a type, which has passed through the Tertiary, and which is scarcely modified in our living *P. occidentalis*.

The fragment represented Pl. xxvi, Fig. 2 is evidently of the same species. It is, however, different in its basilar nervation, or rather in the lowest branches of the lateral primary nerves, which are not mere marginal veinlets, but well-developed divisions, regularly branching. The two figures, 3 and 4, of Heer's Pl. lxxxvii, *loc. cit.*, show the same differences; the largest leaf, Fig. 3, having the lowest secondary veins simple, while in Fig. 4 the corresponding veins of the same order are thicker and divided.

Habitat.—Lancaster County, Nebraska, *Hayden*. In four specimens; the last remarked one is from Salina River, Kansas.

PLATANUS HEERII, Lesqx., Pl. viii, Fig. 4; Pl. ix, Figs. 1–2.

Leaves round or broadly rhomboidal in outline, palmately three-lobed; lobes short, obtuse; borders entire or undulate, oblique or wedge-form toward the petiole, and more or less abruptly decurring along it; petiole short.

Platanus heerii, Lesqx., Hayden's Report, 1871, p. 303.

Leaves large, 10 to 14 centimeters long and about as wide, coriaceous, smooth, palmately three-lobed; lobes short and obtuse; borders undulately broadly deltoid from the lateral lobes upward, broadly cuneate to the base, turning to the petiole, and descending along it about one and a half centimeters lower than the primary divisions of the nerves; lateral primary nerves more or less oblique, branching; inferior lateral veins either thin, marginal, simple, or, as in Fig. 2, thicker, and anastomosing by branches and nervilles, with a marginal undulate vein underneath. This last character is not abnormal; it is marked in leaves of our *P. occidentalis*, when the borders of the leaves are entire at the base, and when the lowest basilar veins follow the borders in curving and in anastomosing with divisions of an upper branch; it is seen also in *P. aceroides* and still more in *P. guillelmæ*.—The leaf (Pl. viii, Fig. 4) has a somewhat different facies from the two figured, (Pl. ix.) Its surface is more polished, though its substance is of the same thickness, and the secondary veins are less distant from the primary ones. This, however, is a difference of little moment, for a species whose nervation is so variable, as indicated by the two last quoted figures, the one of which (Fig. 1) has a thick secondary vein in an abnormal position, under a thick vein of the same order, and the other (Fig. 2) has two thick inferior veins under the fork of the primary ones.

Habitat.—Bluffs on the Salina River, eight miles above its mouth.

PLATANUS AFFINIS, Lesqx., Pl. iv, Fig. 4.

Leaf subcoriaceous, round-hexagonal in outline, rounded to the petiole, narrowed in a broad angle to a short point; borders undulate, distantly dentate; nervation pinnate, craspedodrome.

Populites affinis, Lesqx., Hayden's Report, 1872, p. 423.

The leaf is 9 centimeters broad, and a little longer, round, somewhat hexagonal; the upper borders joining in a broad angle to a short point; the sides nearly parallel; and the lower part rounded to the petiole. By its form and nervation, the leaf is related to that of *Platanus heerii*, (Pl. viii, Fig. 4,) and also in some degree at least to the leaf described as *Sassafras harkerianum*, (Pl. xi, Fig. 3.) In some points, indeed, the leaves described in these genera are like transitional forms, referable as well to one as to the other.

Habitat.—Salina Valley, eight miles above the station.

PLATANUS RECURVATA, Lesqx., Pl. x, Figs. 3, 4, 5.

Leaves 3-5 palmately lobed; lobes nearly equal; borders undulate; lateral nerves curved outside, forking near the base.

Sassafras recurvatum, Lesqx., Hayden's Report, 1872, p. 424.

This is a remarkable form, of which I have found very few specimens. The more complete ones are figured here. Leaves subcoriaceous, nearly flabelliform or broadly wedge-form in outline, deeply divided in three or five (?) nearly equal lobes, rounded downward, and narrowed by a deep inward curve to the petiole; borders entire or undulate; primary veins in three, from above the base, the lateral ones divided by one or two secondary branches as thick as the primary nerves, which either curve inward and follow the borders, branching and joining the secondary veins above, or curve outside toward the point of one or two other lateral lobes of the leaf. The primary veins are equally branched on both sides, but the branches vary in number and distance, according to the divisions of the leaves. The specimen (Fig. 4) is fragmentary, but the expansion of the limb of the leaf and its division in one or perhaps two lower lobes, in accordance with the direction of the thick branches of the primary nerves, is clearly seen on the left side of the leaf. In comparing the leaf, Figs. 4, 5, of Pl. x, with Fig. 4, of Pl. viii, the generic relation of the forms which they represent is easily seen; but Fig. 3, of Pl. x, seems to be a deviation from the platanoid type, passing to that of *Sassafras*, (*Araliopsis*,) and, therefore, may not represent the same species. The polished surface of these membranaceous or subcoriaceous leaves and their presence at the same locality induced me to consider them as identical, they are related about in the same degree to *Platanus* or to *Sassafras*.

Habitat.—Smoky Hill River, eight miles south of Fort Harker, Kansas.

PLATANUS NEWBERRYANA, Heer, Pl. viii, Figs. 2–3; Pl. ix, Fig. 3.

Leaves of medium size, thickish, palmately three-lobed, either tapering to a point from the lateral lobes upward or without lobes, and ovate taper-pointed, broadly cuneate to the base, equally dentate; secondary veins close, numerous.

Platanus (?) *newberryana*, Heer, Phyl. du Nebr., p. 16, Pl. 1, Fig. 4.—*Platanus newberrii*, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 97.

The description of Heer was made from an imperfect specimen, better, however, than the one copied in Pl. ix, Fig. 2, for it shows under the lateral lobes the peculiar kind of dentation which marks the borders to the point. Two better specimens have been obtained since; one (Pl. viii, Fig. 3) represents a palmately three-lobed leaf 12 centimeters long without the petiole, 10 centimeters wide between the top of the lobes, which are short-pointed,

denticulate, placed a little below the middle of the leaf, with three primary nerves from a little above the base, and 7 to 8 pairs of secondary veins, parallel, close, at an angle of divergence scarcely more than 30°, straight to the borders where they enter the teeth with their divisions. The other leaf (Pl. ix, Fig. 3) is much smaller, not lobate, and has the same kind of nervation, except that the primary lateral veins are slightly alternate, not quite as thick as the secondary veins above. This, like the other leaf, has its border denticulate, with that peculiar kind of short outward-turned teeth, separated by equal obtuse sinuses, remarked in *Greviopsis haydenii; Protophyllum mudgii*, &c. The nervation of these leaves, and also the decurrent prolongation of their base below the division of the primary nerves, refer them to *Platanus*. The leaves of young branches of *P. occidentalis* are often also without lateral lobes, or have scarcely distinct lobes, and in that case their nervation appears rather pinnate than palmate.

Habitat.—Beatrice, Gage County, *Hayden*. Blackbird Hills, *Marcou, Capellini*. I found it, too, near Decatur, Nebraska.

PLATANUS DIMINUTIVA, Lesqx., Pl. viii, Fig. 5.

Leaf small, thick, enlarged above the base, rounded downward, narrowed to an obtuse point; nervation 3-palmate.

Platanus diminutivus, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 98.

This small leaf, a little more than 2 centimeters long and nearly as large, may be a diminutive form of *P. primæva* or of *P. heerii*, and even may be referable to another genus. It looks like a leaf stunted by parasitical excrescences. It is round from the middle to the base, and broadly deltoid, obtusely pointed, undulate or nearly entire. The impression of its surface is deeply furrowed by the two thick primary lateral nerves, which are slightly alternate, and both like the medial nerve, and the secondary veins are thickened here and there by irregular bolsters or expansions. The primary veins alone are branching; the nervilles are thick, continuous, perpendicular to the veins; the base appears broken, and, therefore, it is not clear if the leaf is prolonged downward along the petiole.

Habitat.—Dakota group. The specimen had no label. It is mixed with specimens from Lancaster County, Nebraska, and the stone is of the same color and consistence.

Laurineæ.

LAURUS NEBRASCENSIS, Lesqx., Pl. x, Fig. 1; Pl. xxviii, Fig. 14.

Leaves thick, coriaceous, elliptical oblong or narrowly lanceolate, obtusely pointed, tapering downward to a short thick petiole; medial nerve thick, half-round; secondary veins alternate, at an acute angle of divergence, camptodrome.

Laurus nebrascensis, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 98.

Persea nebrascensis, Lesqx., Transactions of the American Philosophical Society, vol. xiii, p. 431, Pl. xxiii, Figs. 9, 10.

The leaves referred to this species are represented by a number of specimens which mark transitional forms between the large elliptical leaf of Pl. x, Fig. 1, and the linear lanceolate one of Pl. xxviii, Fig. 14. In the memoirs of the Transactions, (*loc. cit.*,) I had figured, in apposition with this last fragment, the base and petiole of another leaf exactly similar to any of the two figures of this report, by its thick vein, thick, short petiole, and secondary nervation, but intermediate to both in form and size. These leaves are thick, coriaceous, perfectly entire, the largest 12 centimeters long, including the petiole 2 centimeters; widest in the middle $2\frac{1}{2}$ to 4 centimeters broad, gradually and equally tapering in a curve up to a slightly obtuse point and downward to the thick petiole; the secondary veins alternate, at an acute angle of divergence of 30° to 35°, curve near and along the borders, being unequally distant but parallel from the base; the details of areolation, obsolete even in the best preserved specimens, are doubtfully indicated by a kind of papillose marking of the surface, which, however, may result from the coarseness of the matrix of the specimens.

If the relation of these leaves to those of some species of *Laurus* is well marked, as, for example, with *Persea speciosa*, Heer, of the Miocene of Europe, it is not the less evident with some Cretaceous species of Magnolia like *M. speciosa*, Heer, (Mol. Fl., Pl. 10, Fig. 2.) The narrow leaves of our species are comparable also to *Myrtophyllum geinitzii* of the same, Mol. Fl., Pl. xi, Figs. 3–4, for their form at least. The presence of a fruit referable to a species of *Laurus* seems to point out the reference to the same genus of the leaves described above.

Habitat.—Near Decatur, *Hayden.* Leaves and fruit near Fort Harker, Leconte.

LAURUS MACROCARPA, Lesqx., Pl. x, Fig. 2.

Fruit round oval; nut surrounded by a thick pericarp; pedicel club-shaped.

Laurus macrocarpa, Lesqx., American Journal of Science and Arts, (2), xlvi, 1868, p. 98.

The fruit represents an oval nutlet a little more than 1 centimeter long, 8 millimeters broad, surrounded apparently by a pericarp 1½ millimeters thick, which seems to have been of a fibrous texture. The nut is marked in its length by thin, equidistant, scarcely discernible lines or ribs, and undulately wrinkled across; the pericarp being split all around nearly at equal distance in fissures enlarged to the point of contact with the nut, and corresponding with the wrinkles marked upon its surface. The pedicel, which was easily detached from, or scarcely adherent to the fruit, is club-shaped, and marked upon its horizontal surface, or upon the face in contact with the fruit, by four round, small perforations, which appear like scars of vascular dots. This fruit is comparable to that of a number of species of *Laurineæ: Laurus canariensis*, Web., as figured by Heer in his Tertiary Flora; *Phœbe triplinervis*, Gr., a species of our time, inhabiting Cuba; especially *Sassafras officinalis*, Nees., and a number of fossil fruits referred to the genus *Cinnamomum*.

Habitat.—Near Decatur, Nebraska, *Hayden*.

PERSEA LECONTEANA, Lesqx., Pl. xxviii, Fig. 1.

Leaf large, oblong-ovate, lanceolate-pointed; borders entire, undulate; nervation pinnate; lower secondary veins distant, curving near and along the borders, and ascending to the middle of the leaf; upper veins more open and shorter.

Sassafras(?) *leconteanum*, Lesqx., Transactions of the American Philosophical Society, vol. xiii, p. 431, Pl. xxiii, Fig. 1.

The texture of this leaf is not very thick; the figured fragment is 14 centimeters long, (the point and the base of the leaf broken,) 5½ centimeters broad, of an oblong oval form, apparently pointed and gradually narrowed to its base; lower secondary veins thinner than the upper ones, following the borders, or on a more acute angle of divergence; all camptodrome, more or less undulate; medial nerve of medium thickness.

On the description and figure of this leaf in Trans., (*loc. cit.*,) from which our figure is copied, Schimper remarks, (Pal. Veget., vol. 2, p. 836,) *that this leaf is, indeed, referable to the Lauraceæ, but that it is doubtful if it belongs to a Sassafras.* The relation by the direction of the veins and the form of the leaf is with fossil species of *Benzoin*, described from the Tertiary of Europe, and with species of *Nectandra* and *Lindera* of our time. Heer, in his remarks (in litter.) on the same leaf, is disposed to refer it to *Magnolia*. The leaf

described as *Magnolia tenuifolia* (Pl. xxi, Fig. 1) has a corresponding outline with this one, but the substance of the leaf is thinner, and the secondary veins at a more open angle of divergence. What is said of the relation of this form to *Quercus benzoin*, Lesqx., of Nanaimo, in Trans., (*loc. cit.*,) is in the same degree of uncertainty as before, for the reason that the specimens could not be compared.

Habitat.—Near Fort Harker, *Leconte.*

PERSEA STERNBERGII, Lesqx., Pl. vii, Fig. 1.

Leaf large, thick, coreaceous, entire, broadly oblong, oval or obovate, obtusely pointed (?) (point broken,) tapering by a curve to the base; nervation pinnate, coarse, very distinct, camptodrome.

Ficus sternbergii, Lesqx., Hayden's Report, 1872, p. 423.

Judging from the preserved part of this fine leaf, its length is 15 to 16 centimeters, 10 centimeters wide above the middle; it is of an obovate form, perfectly entire, pinnately nerved, with secondary veins thick, alternate, distant, separated by some shorter veins in a broader angle of emergence and not as thick, which anastomose with nervilles or branches of the principal secondary divisions; these are parallel at an angle of 50° to the medial nerve, curving near and along the borders, branching in the upper part by oblique divisions, or marked in their whole length like the medial nerve by very strong nervilles, nearly as thick as the tertiary veins, which, by joining the opposite ones and anastomosing, form a large loose reticulation composed of square or rectangular meshes.

According to the remarks of Saporta, this leaf compares still better to species of *Persea*, as, for example, *P. gratisima*, Gartn., especially the var. *vulgaris*, with obovate leaves, a form extensively represented in the southern parts of the North American continent from Cuba to Brazil.

Habitat.—Near Fort Harker, eight miles south of the station.

LAUROPHYLLUM RETICULATUM, Lesqx., Pl. xv, Figs. 4–5.

Leaves coriaceous, oblong, linear lanceolate, entire, gradually tapering to the base, and decurrent to a thick costa; nervation pinnate; secondary veins open; areolation loosely distinctly reticulate.

Laurophyllum reticulatum, Lesqx., Hayden's Report, 1872, p. 425.

Leaves of a thick consistence, from 10 to at least 16 centimeters long, and from 2 to 4 centimeters wide, entire, linear-lanceolate, tapering from the middle upward to a point, and gradually narrowing to the base, where it follows the medial nerve, forming a narrow border before joining the thick short

petiole; secondary veins numerous, parallel from the base, open, at an angle of divergence of 60°, with shorter intermediate veins, which they join from the base by curved branches or nervilles, forming a continuous irregular polygonous areolation to the borders, where they curve in festoons. This kind of areolation is related to that of *Ficus geinitzii*, Ett., (Flora v. Nieders, Pl. ii, Figs. 7, 9–11,) but the facies of these leaves, their consistence, &c., appear to refer them rather to the *Laurineæ*. The numerous fragments of these leaves, though having a common form, may be referable to more than one species, some of the leaves being without any traces of veins on their upper surface.

Habitat.—Over the whole of the Dakota group from Minnesota to Southern Kansas, mostly found as yet in fragments.

SASSAFRAS, Bauh.

Leaves 3-palmately, more or less deeply lobed, lobes entire or obscurely dentate; primary nerves forking at a distance above the prolonged subdecurrent base of the leaves.

To this genus pertain some leaves formerly referred to *Ettinghausenia*. Some of the forms here described have characters in accordance with those of the leaves of *Sassafras officinale*, Nees., so widely distributed in the western slope of North America, and the only species left of his genus. It is especially the case for *S. mudgii*. An objection, however, has been made by Count Saporta against the admitted relation of most of these leaves to the genus *Sassafras*, especially on account of the dentate borders and craspedodrome nervation of some of them. The eminent paleontologist of France considers them as more evidently related to some *Araliaceæ* of Central America of the genus *Oreopanax* especially. I have been, as yet, unable to obtain any specimens of these living plants for comparison, and, though admitting the relation as ascertained, I find in comparing between themselves the fossil leaves of the Dakota group which have been referred to *Sassafras* such an intimate coincidence of form and of nervation that, admitting one as representative of the genus *Sassafras*, I am not able to find any distinct character to separate the others.

As said before, *Sassafras mudgii* (Pl. xiv, Figs. 3–4) is the form more evidently representing the characters of the leaves of this genus, not only in comparison with leaves of the living species, but also in regard to the forms represented fossil in the Tertiary. The leaf which has been figured especially for this comparison (Pl. xxx, Fig. 7) is in its form and nervation intermediate between this *S. mudgii* and the leaves which have been separated from

this species under the name of *S. acutilobum*, (Figs. 1–2 of the same plate.) In passing from this form to *S. cretaceum*, Newby., of Pl. xii, Fig. 2, no other difference is remarked but that of the shorter medial lobe. There is no difference whatever in the nervation, as seen from the comparison of numerous specimens. The two leaves of Pl. xi, Figs. 1–2, which I have referred to the same species, *S. cretaceum*, differ by the denticulation of the outside borders, but by this only, and a number of specimens of intermediate character have this denticulation either obsolete or distinct, or merely on one side of a leaf, while the other border is entire, or, so to say, with intermittent teeth, as marked upon Fig. 3, Pl. xi, whose upper secondary nerves are either camptodrome curving along undulate or entire borders, or craspedodrome going out to the borders and forming or entering a tooth. Figs. 1–2 of this same plate show the same anomaly. The outside borders of Fig. 1 are positively dentate, while the middle lobe is entire. In Fig. 2 this middle lobe is marked by two teeth. And when we come to the leaves which I have called *S. mirabile*, we have a nervation mostly craspedodrome, and teeth all around the borders except the lower veins, which are still camptodrome. Differences of this kind are remarked in the more or less deep divisions of the leaves; in the basilar borders decurrent more or less along the petiole, which they join, sometimes ta a distance, sometimes quite near the point of union of the primary nerves, as seen in Pl. xi, Figs. 3–4, and Pl. xxvii, Fig. 2. The specimens which represent these vegetable forms are very numerous, and it is only after long comparison of them and a revision of their characters that I have preserved the name of *Sassafras* for the description of these leaves, admitting, however, as possible in the future the subdivision of *Araliopsis* for all the species except that of *mudgii*. The same observation may be made for these leaves as for other types of the Cretaceous. They may be, and have been considered by authors as complex in their simplicity, as uniting some definite characters with some others still in an embryonic state, already slightly apparent, but not yet distinct enough to allow a clear line of separation between the original and the derived typical forms.

SASSAFRAS MUDGEI, Lesqx., Pl. xiv, Figs. 3–4; Pl. xxx, Fig. 7.

Leaves proportionally long; lateral primary nerves narrow, at an acute angle of divergence; medial lobe twice as long as the lateral ones; surface of the leaves polished.

SASSAFRAS MUDGEI, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 99.

This species is distinct from the others and their numerous varieties by

the comparatively longer and narrower leaves, the prolongation of the middle lobe twice as long as the lateral ones, the less oblique direction of the narrow lateral lobes, and accordingly of the lateral nerves, the acute wedge-form of the base of the leaves decurring along the petiole by a narrow border, and, too, by the polished upper surface of the coriaceous leaves. The borders are always entire, more or less irregulary undulate; all the secondary veins camptodrome. The areolation of this species is also less uniformly rectangular than in the former ones, and the divisions of the primary veins at a greater distance above the base of the leaf. By this character this form is more intimately related with the species of *Sassafras* described from the Miocene of Europe, like *S. ferettianum*, Mass., which, in some of its leaves, has the medial lobe narrowed toward the base in the same way as seen in our Fig. 4. In Fig. 7, of Pl. xxx, however, the base of the leaf is more enlarged, less decurrent to the petiole; the lobes more oblique, a deviation of type which seems as a transitional form between this and the following species.

Habitat.—Hills along Salina River, Kansas. The first specimen seen of this species, which is copied in our Fig. 3, was sent from the collections of the Smithsonian Institution, labeled "*Presented by Prof. Mudge.*" From the directions of the professor, I visited the locality, and found a number of less perfect impressions of leaves of the same kind. This and the following species are rarely represented in the collections.

SASSAFRAS ACUTILOBUM, sp. nov., Pl. xiv, Figs. 1–2.

Leaves subcoricaceous, of the same consistence as the former species; lateral lobes lanceolate-pointed, diverging nearly at a right angle from the medial nerve; primary nerves more or less disjointed at the base.

I considered at first this species as a variety of the former. It is, however, so far different in all its parts, essentially in its general outline, its sharply acute, more diverging lobes, its thin secondary veins uniformly curving along the borders, that it has the same right to be considered as a species as the other forms described in this paper. As in *S. mudgei*, the primary nerves are comparatively thin; and both surfaces of the leaves, though distinctly marked by the nervation, are not as rough as in the other species, or more generally smooth.

Habitat.—With the former.

SASSAFRAS (ARALIOPSIS) CRETACEUM, Newby., Pl. xi, Figs. 1–2; Pl. xii, Fig. 2.

Leaves of medium size, with diverging, slightly obtuse or acutely-pointed lobes, enlarged toward the broad sinuses, broadly wedge-shaped toward the base, decurring to the long petiole; borders entire or obscurely dentate.

Sassafras cretaceum, Newby., Extinct Floras, p. 14.

This species, the most commonly represented in the red shale of the Dakota group, is always easily recognized by the deep, sharply-cut impressions of its leaves, and of the nervation of its under surface. The leaves are generally smaller; the lobes sharply-pointed or acuminate, either entire or obscurely dentate; the secondary veins thicker, passing outside to short teeth or curving along the borders, being often craspedodrome and camptodrome in the same leaf. As it is evident from the examination of transitional forms, the leaf, (Pl. xii, Fig. 2,) with its entire borders and slightly obtuse lobes, belongs to the same species.

Habitat.—Blackbird Hills, Nebraska; Smoky Hill Fork, Kansas, *Hayden.* Fort Harker, &c.

SASSAFRAS (ARALIOPSIS) CRETACEUM var. OBTUSUM, Lesqx., Pl. xii, Fig. 3; Pl. xiii, Fig. 1.

This form is recognized from the former by its shorter, especially more obtuse lobes and its very coarse nervation; the primary and secondary veins are proportionally much thicker, these especially so from the middle downward; the medial nerve, from the forking of the lateral veins to the petiole, is twice as thick as in the normal form.

Habitat.—Mostly on the bluffs of Salina Valley.

SASSAFRAS (ARALIOPSIS) MIRABILE, Lesqx., Pl. xii, Fig. 1.

Leaves coriaceous, very variable in size; lobes broad, deep, obtusely dentate on the borders; secondary veins mostly craspedodrome.

Sassafras mirabile, Lesqx., Hayden's Report, 1872, p. 424.

The thick leaves of this species vary in size from 8 to 23 centimeters broad between the points of the lobes, and from 9 to 16 centimeters long without the petiole, which, as seen upon one of our specimens, is from 6 to 7 centimeters in length. The three primary nerves separate at a comparatively short distance above the decurrent base of the leaves, the lateral ones bearing outside in the lower part one or two thin marginal veinlets, which follow the borders in successive bows, joining the point of the lowest secondary veins;

these are all simple, entering the points of obtuse teeth, which mark the borders of the lobes from their base to the point.

This form differs from all the other species by its large size, its broad, obtusely-dentate borders, and the direction of the secondary veins, all craspedodrome. Its *facies* is like that of a *Platanus*, or of a group referable, perhaps, to *Araliaceæ*, like *P. nobilis*, Newby., *P. jatropæfolia*, *P. hercules*, Ung., &c., which have representatives in the Miocene of Europe and of America.[1]

Habitat.—South of Fort Harker, Kansas.

SASSAFRAS HARKERIANUM, Lesqx., Pl. xi, Figs. 3–4; Pl. xxvii, Fig. 2.

Leaves coriaceous, very thick, broadly round, quadrangular in outline, abruptly narrowed or broadly cuneate to the petiole, and scarcely decurring at the base; obscurely three-lobed, undulate dentate between the acute or obtuse lobes.

Sassafras harkerianum, Lesqx., Hayden's Report, 1872, p. 425.

This form is like a transient one, and may be considered as in close affinity with *S. cretaceum* var. *obtusum* and *S. obtusum*. From this, however, it differs evidently by the thick smooth coriaceous substance of its leaves; from the former by its scarcely-marked lobes. It is short-petioled, with short obtuse lobes separated by large undulate sinuses, as in Fig. 4, or with scarcely any definite lobes; the lateral primary nerves and the lower secondary veins, too, pass up to short teeth, while the upper secondary veins curve near the borders, which then are entire or merely undulate, as it is easily seen at the upper border of the right side of the leaf, (Fig. 3.) The nervation of this last leaf is coarser than that of Fig. 4; the secondary veins, also, are at a greater distance; but the substance of the leaves and their general outline are the same; both, too, have been found at the same locality. Fig. 2 of Pl. xxvii is copied from a specimen sent to me lately (1873) by Dr. Mudge, and found south of Fort Harker, or near Fort Larned. The leaf, though much smaller, has the characters of this species. The disjunction of the primary nerves is well marked.

Habitat.—South of Fort Harker, Smoky Hill Forks.

SASSAFRAS OBTUSUM, Lesqx., Pl. xiii, Figs. 2–4.

Leaves thin, flabelliform, long-petioled, three-obtusely lobed, entire or undulate along the lobes, broadly cuneate or narrowed, and scarcely decurring to the petiole; primary nerves forking at a short distance above the border-base of the leaves.

Sassafras obtusum, Lesqx., Hayden's Report, 1872, p. 424.

[1] *Platanus nobilis* seems to have the peculiar character, remarked in *Sassafras* leaves, with craspedodrome secondary veins and dentate borders, or with camptodrome veins and borders entire.

Populites salisburiæfolia, Lesqx., American Journal of Science and Arts, *loc. cit.*, p 94.

Leaves of small size, three-lobate, with very obtuse, half-round lobes, either perfectly entire or rarely undulately-dentate, narrowed in a broad angle of divergence to the petiole, which is slender and very long; secondary veins thin, subcraspedodrome, areolation formed of large, irregular quadrate meshes.

The reference of these leaves to *Sassafras* is very uncertain. Their appearance is quite different, rather resembling leaves of some of those *Ampelideæ*, *Cissus*, &c., which have a number of representatives in the Eocene of the Rocky Mountains, though of a far different type, and to which Heer refers one of his leaves of the Cretaceous of Moletin, under the generic name of *Chondrophyllum*. These leaves are of a thin texture; the form and nervation, though analogous, differ also, especially by the apparently craspedodrome character of the secondary veins, which, though the borders are perfectly entire, do not seem to curve as in *Sassafras;* the slender petiole is also comparatively longer than in any of the leaves of this genus. The leaf (Fig. 2) was doubtfully referred to the genus *Populites* on account of the craspedodrome character of the secondary nerves, and also of the thinness of the leaves. It was at the time the only leaf of this type. I have since found many specimens representing the same forms as in Figs. 3–4. They are apparently all referable to the same species, the essential difference being only in the narrow sinuses separating the more undulate lobes of the leaf in Fig. 2. The curving of the broken petiole is evidently casual. The last specimen comes, however, from a different locality, and the identity of these leaves may be ascertained only by the discovery of intermediate forms.

Habitat.—Lancaster County, Nebraska, *Hayden*, the specimen, Fig. 2; all the other specimens from Salina Valley.

SASSAFRAS (?) SUBINTEGRIFOLIUM, Lesqx, Pl. iii, Fig. 5.

Leaf thickish, broadly obovate, emarginate at the rounded top, narrowed to a thick petiole, anormally tri-palmately nerved; lateral veins at a distance above the borders, disjointed.

Sassafras subintegrifolium, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 99

By its general appearance, its thick, primary nerves, the narrowing of the border to the base, this leaf seems referable to this genus. Even in considering the primary nervation, we may recognize in the two lowest lateral

veins, though disjointed and distant as they are at the base, two primary nerves forcing the distribution of the limb in two broad, round lobes, apparently folded upon another along the upper part of the middle nerve. The secondary nervation is comparable to that of *Sassafras æsculapi*, Heer, (Flor. Tert., ii, p. 82, Pl. xc, Fig. 13.) The lateral nerves are irregularly branching outside, and their divisions, in the direction of the borders, are effaced in the reticulation before reaching them; the reticulation is composed of very small, nearly round or polygonal meshes like those of a *Benzoin*. This leaf, therefore, though positively referable to some *Laurineæ*, is doubtfully so to *Sassafras*. The distance between the base of the primary nerves, which, normally placed, should be opposite, is observable not only in species of *Sassafras*, as in our Fig. 2 of Pl. xxvii, but in *Cinnamomum*, &c. Unger, in his Fossil Flora of Sotzka, (Pl. xvi, Figs. 5, 7,) has two leaves of *C. lanceolatum* with the same disjunction.

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Habitat.—Fort ~~Harker,~~ specimen No. ~~6434,~~ in the cabinet of the Smithsonian Institution.

CINNAMOMUM SCHEUCHZERI, Heer, Pl. xxx, Figs. 2–3.

Leaves thick, coriaceous, polished on the upper surface, elliptical or oblong-lanceolate, pointed, narrowed by a curve to the short petiole, entire and slightly undulate, triple-nerved; medial nerve thick; lateral veins opposite, a little above the base, ascending along the borders as high up as the lower secondary veins, which they join by ramifications.

Cinnamomum scheuchzeri, Heer, Flor. Tert. Helv., II, p. 85, Pl. xci, Figs. 4–22; Pls. xcii–xciii, Figs. 1, 5.

The species is represented by two specimens, one (Fig. 2) representing a leaf narrowly elliptical, acuminate or lanceolate pointed, narrowed by a curve to the base, (petiole broken,) 5 centimeters long, 17 millimeters broad, with a thick medial nerve, and the lateral veins branching and forming along the borders a series of festoons, as in Heer, (*loc. cit.*, Pl. xci, Figs. 12, 18.) This leaf shows its upper surface and its distinct areolation in small, round areolæ, as exemplified in this last, (Fig. 18.) The second leaf (Fig. 3) is broken from above the middle, but represents the same characters as the former. It is merely broader, with the lateral veins descending lower and nearer to the base; comparable for its form to Heer, (*loc. cit.*, Pl. xcii, Fig. 5*a*.) I am unable to find any character by which these two leaves could be separated from the Miocene species, and consider them as identical.

Habitat.—Western Kansas, found in concretions, *Mudge*.

CINNAMOMUM HEERII, Lesqx., Pl. xxviii, Fig. 11.

Leaf thickish, subcoriaceous, entire, ovate, taper-pointed, rounded downward, three-nerved from the base; lateral veins ascending to above the middle, branching outside.

Cinnamomum heerii, Lesqx., Transactions of the American Philosophical Society, vol. xiii, p. 431, Pl. xxiii, Fig. 12.

Our figure is a copy of this last, for, to my regret, and though I carefully searched for specimens representing a leaf like this, I found nothing in the Dakota group comparable to it. I have, therefore, nothing to add to my former remarks. It is not possible to know, on account of the deformation of the specimen by grinding it round from the middle to the base, if the borders are rounded or narrowed, and if, as in the *Cinnamomum* leaves, they descend lower than the base of the primary nerves. If it is the case, the species would be related very closely indeed to *C. mississipiense*, Lesqx., of the same paper, (p. 418, Pl. xix, Fig. 2,) a species abundantly found in the Eocene of the Rocky Mountains and of the Mississippi. The same uncertainty concerning its relation exists for the leaf of Vancouver, from which the present species was named, (American Journal of Science and Arts, vol. xxvii, p. 361.) The identity of both leaves is, therefore, uncertain.

Habitat.—Fort Harker, *Dr. Leconte.*

OREODAPHNE CRETACEA, sp. nov., Pl. xxx, Fig. 5.

Leaf elliptical, gradually curving to an obtuse point, narrowed in about the same degree to its base, entire; medial nerve thick, secondary veins opposite.

This leaf preserved entire, except the petiole, is a little more than $4\frac{1}{2}$ centimeters long, $1\frac{1}{2}$ centimeters broad, narrowly ovate-pointed, with four pairs of opposite lateral veins on an acute angle of divergence 30° to 40°, branching in the upper part, camptodrome, united together by thick nervilles. The lower pair joins the middle nerve a little above the base of the leaf, and follows up nearly parallel to the borders, anastomosing by its ramifications with those of the veins above. The substance is thickish or subcoriaceous; the surface rough by the coarse nervation.

This form is comparable to *Oreodaphne heerii*, Gaud., (Contributions, &c., 1st Mem., p. 35, Pl. x, Figs. 4–9, and Pl. xi, Figs. 1–7.) The leaf is much smaller, but except this there is not great difference of form and nervation. Even the small inflation, like bulbs, seen in the axils of the veins of the Miocene species, are also apparent, though not very distinct, in the Cretaceous leaf.

Habitat.—Western Kansas, concretions, *Mudge.*

Proteoides, Heer.

In the description of the first species referred to this genus in *Phyllites du Nebraska*, the celebrated author remarks, "I have united, under the name of *Proteoides*, some leaves from Big Sioux River, near Sioux City, which I consider as referable to the family of the *Proteaceæ*, but which are in such a poor state of preservation that their precise determination is not possible. They are of great interest as the only representatives, but not as yet perfectly recognized, of a family represented in abundance in the Upper Cretaceous of Aix-la-Chapelle." As far, at least, as a comparison can be made with the incomplete fragments figured by Heer, our leaves, representing the species described in the Phyllites and far better preserved, seems to confirm the statement of the celebrated author. The relation, however, is still uncertain, based, as it is, merely on the comparison of the forms of leaves, whose nervation is mostly undiscernible.

Proteoides daphnogenoides, Heer, Pl. xv, Figs. 1–2.

Leaves ovate-lanceolate near the base, gradually tapering upward to a long, acute, scythe-shaped point, entire, smooth, and coriaceous; medial nerve narrow; secondary veins obsolete, few, ascending under a very acute angle from the medial nerve and following the borders.

Proteoides daphnogenoides, Heer, Phyllites du Nebraska, p. 17, Pl. iv, Figs. 9, 10; Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 99.

The best preserved specimen shows an entire leaf, measuring nearly twenty centimeters in length, and three centimeters broad in its widest part, a little above the base; the other leaf, also preserved nearly entire, is about thirteen centimeters long and proportionally broad, enlarged like the other above the base, tapering downward by a curve to a short petiole, and more gradually tapering upward to a long point. The secondary veins, which are extremely thin, are not at all marked in the large leaf, and are distinguished upon the smaller leaf with some difficulty. Heer describes his species as leaves coriaceous, narrowed to the base, entire, with a strong medial nerve, and acrodrome secondary veins nearly parallel to the borders. The medial nerve of these leaves is deeply impressed into the stone but not thick; and though the secondary veins ascend nearly parallel to the borders, they do not appear acrodrome. Though the figures of this species in the *Phyllites* show a larger leaf than the fragments of the two others, these fragments are too incomplete for positively ascertaining identity.

Habitat.—Decatur, *Hayden*, five specimens.

PROTEOIDES ACUTA, Heer, Pl. xv, Fig. 3; Pl. xxviii, Fig. 13.

Leaves coriaceous, linear-lanceolate, narrowed to the base, and gradually tapering upward to a slightly scythe-shaped point; borders undulate; medial nerve broader; secondary veins invisible.

Proteoides acuta, Heer, Phyllites, p. 17, Pl. iv, Figs. 7–8; Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 99; Transactions of the American Philosophical Society, vol. xiii, p. 431, Pl. xxiii, Figs. 5–7.

The fragments figured by the author indicate much smaller leaves than ours; they do not show the undulation of the borders, as remarked upon the numerous specimens which I have examined; the only character which indicates the identity of these leaves with those of Heer is the total absence of secondary veins. These leaves appear about of the same size as those of the former species, but somewhat narrower toward the base; their surface is not polished; the medial nerve is thicker, and the borders undulate. The lower part of the leaf (Fig. 5 in Transactions) is somewhat decurrent to the enlarged base of the medial nerve, as it is generally in a sessile leaf; the same character is remarked in our Pl. xv, Fig. 3; the fragment, (Fig. 13 of Pl. xxviii,) like that represented, (Fig. 7 of the Proceedings,) indicates the size of the leaves of this species as being as large as in the former, or from two to three and a half centimeters wide.

Habitat.—Fort Harker, *Leconte;* near Decatur, *Hayden.*

PROTEOIDES GREVILLEÆFORMIS, Heer, Pl. xxviii, Fig. 12.

Leaf coriaceous, small, enlarged above the base, linear-lanceolate, flexuous; borders entire; medial nerve thick; secondary veins alternate, thin, acrodrome, ascending nearly parallel to the borders, and curving slightly inward.

Proteoides grevilleæformis, Heer, Phillites, p. 17, Pl. iv, Fig. 11; Lesqx., Transactions of the American Philosophical Society, *loc. cit.*, p. 432, Pl. xxiii, Fig. 8.

The same uncertainty exists in regard to the identity of the species described here with that of Heer, on account of the too fragmentary specimen represented in his Fig. 11. Our leaf is enlarged above the base still more proportionally to the size than the leaves of *P. acuta;* the nervation, however, is as indicated by Heer. From the former species, it differs by its very entire, not undulate border, and by the secondary veins more distinct than in its two congeners. The point of the specimen is broken; the upper part of the leaf, however, appears very gradually narrowing upward in the same way as in *P. acuta*, first curved to one side and then to the other, or

doubly scythe-shaped; the medial nerve is as thick as in the former species, a character which also separates it from *P. acuta*.

Habitat.—Near Decatur, Nebraska, *Hayden*, a single specimen.

EMBOTHRIUM (?) DAPHNEOIDES, sp. nov., Pl. XXX, Fig. 10.

Leaf coriaceous, oblong, narrow, gradually tapering downward, and decurrent to the broad, medial nerve; borders slightly reflexed; nervation pinnate; lateral veins close, at an acute angle of divergence.

The specimen represents only the lower half of a thick, coriaceous, smooth, entire, linear-lanceolate or narrowly-oblong leaf, which is gradually narrowed downward, the borders slightly decurring along the enlarged medial nerve. The preserved part is about 4 centimeters long and 1½ centimeters wide; the medial nerve at base, with a narrow wing, is 3 millimeters broad; the lateral veins, three pairs, in an angle of divergence of 20°, ascend to and along the borders, and appear to curve inward and join the upper ones by thin ramifications.

The fragment represents, apparently, the lower surface of the leaf, which is smooth, and does not expose any details of areolation; the leaf is bordered by a narrow linear groove, as if the borders were slightly reflexed. The leaves of some *Proteineæ*, however, have a marginal groove of this kind marked upon the upper surface along the borders.

The relation of this leaf is uncertain. By its form and nervation, it is comparable to the leaf of *Embothrium salignum*, represented in Heer's Flor. Tert. Helv., (Pl. xcvii, Fig. 35.) In the fossil leaves, the veins are closer and more numerous. This fragment also resembles *Andromeda Parlatorii*, Heer, Phyll., p. 18, Pl. i, Fig. 5, differing especially by more oblique and more numerous secondary veins.

Habitat.—Western Kansas, *Mudge*.

ARISTOLOCHITES DENTATA, Heer, Pl. XXX, Fig. 6.

Aristolochites dentata, Heer, Phill., *loc, cit.*, p. 18, Pl. ii, Figs. 1–2.

Professor Heer, in the Phyllites, has described, as indicated above, two fragments of a *peltate, triple-nerved leaf, with borders crenate-dentate*, of which I have seen one specimen only, which is figured in this report by the permission of the Museum of Comparative Zoology of Cambridge, to which it belongs, from the collection of Prof. Marcou. This specimen agrees fully with the description and figures of the author. The leaf is smaller, however, 4 centimeters long, from the point of attachment of the petiole, which is marked by a cavity enlarged on both sides, and placed 1 centimeter above the border-base of

the leaf; this is nearly as wide as it is long, 5 centimeters broad, nearly round; obtusely-dentate, or equally crenate all around; the nervation is rather 5-nerved than triple-nerved, two somewhat smaller nerves emerging from the corner of the point of attachment of the petiole, and diverging at right angle to the middle nerve. One only of these lateral nerves is marked in Heer's Fig. 1, probably on account of the laceration of the leaf on one side.

Though I have closely examined the locality where Messrs. Marcou and Capellini have found their specimens, I have been unable to discover any trace of this species, as also of the fragment of leaf described by Heer (Fig. 3 of the same plate) under the name of *Cissites insignis*. Both are from Tekamah, Nebraska.

GAMOPETALEÆ.

Bicornes.

ANDROMEDA PARLATORII, Heer, Pl. xxiii, Figs. 6–7; Pl. xxviii, Fig. 15.

Leaf lanceolate, narrowed to the base and decurring along the petiole by a narrow border, entire; medial nerve thick; secondary veins at an acute angle of divergence, parallel, camptodrome.

Andromeda parlatorii, Heer, Phill., p. 18, Pl. i, Fig. 5; Lesqx., Transactions of the American Philosophical Society, vol. xiii, p. 432, Pl. xxiii, Fig. 11.

Prunus (?) *parlatori*, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 102.

The specimen referred to this species in the Transactions is somewhat more complete than the one figured by Heer; it has the base of the leaf, apparently an enlarged petiole, to which the leaf is decurring in a narrow border. This leaf appears thickish or subcoriaceous; the upper end of the secondary veins are not distinct, though in the lower part they are thicker than figured by Heer; its areolation is undistinguishable.

I refer to this species, from the revision of the specimens, the two leaves, (Pl. xxiii, Figs. 6–7,) which I have described in the Journal, as marked above, under the name of *Prunus* (*Andromeda*?) *parlatori*. The reference of these leaves, one of which is whole, oblong, gradually tapering upward to an obtuse point, was doubtfully indicated by the presence, in the shale, of two nutlets, resembling the fruit of *Prunus*. The nervation of these leaves as marked (Fig. 6) is more positively that of some species of *Andromeda*. I have, however, preserved the name of *Prunus* for the description of the fruits.

Habitat.—Fort Harker, *Leconte*; Tekamah, *Marcou*.

DIOSPYROS ANCEPS, Lesqx., Pl. vi, Fig. 6.

Leaf coriaceous, narrowly oval, obtusely acuminate; borders entire; nervation pinnate, camptodrome.

Quercus anceps, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 96.

Leaf of medium size, 3½ centimeters wide, about 9 centimeters long, narrowly oval, contracted to a short, obtuse acumen; borders perfectly entire; lateral veins deeply marked, curving to and along the borders, simple; surface smooth, marked by continuous nervilles, perpendicular to, and anastomosing in the upper part with the veins.

The reference of this leaf to *Quercus* was indicated by its specific name as very doubtful. Its form is much like that of *Diospyros lancifolia*, Lesqx., as figured by Heer in his Vancouver Flora, (Pl. i, Figs. 10–12, and Pl. ii, Figs. 1–2.) This leaf is, however, obtusely acuminate; its substance is thicker, and the veins are at a more equal and greater distance, curving nearer to the borders. *Diospyros primæva*, Heer, (Phyll. du Neb., p. 19, Pl. i, Figs. 6–7,) differs essentially from this leaf by its undulate, secondary thinner veins, separated by shorter tertiary veins, which divide the nervilles. The type is different. The reference of our leaf is still uncertain; it may represent a kind of *Laurus* (?).

Habitat.—Ten miles below Lancaster, Salt Creek, Nebraska, *Hayden;* two fragments.

DIOSPYROS ROTUNDIFOLIA, sp. nov., Pl. xxx, Fig. 1.

Leaf subcoriaceous, entire, nearly round, pinnately-veined; secondary veins parallel, camptodrome.

The species is represented by a fragment of a leaf of which the lower part is destroyed. It is about 7½ centimeters long, 7 centimeters wide, with a narrow middle nerve and six to seven pairs of lateral veins, on an angle of divergence of 50° to 60°, branching and curving at a distance from the borders, and forming, by their divisions, a double festoon along them. The veins are joined by coarse or thick fibrillæ nearly at a right angle to them, but disconnected, and forming, by divisions and subdivisions, a netting of very small square or polygonal areolæ. The secondary veins and the nervilles also are deep, and mark the surface of the leaf with wrinkles and undulations. This fine leaf has some relation of form and nervation with *Diospyros styracifolia*, Sap., a leaf of the Lower Eocene of Montpellier, a sketch of which has been obligingly communicated to me by the author. I do not know of any other fossil species to which this leaf could be compared but, by its form, to the leaf of *Juglans* (?) *debeyana*, (Pl. xxiii, Fig. 2, of this

report;) far different, however, by its nervation. In regard to living species, its affinity is with *D. coccolobæfolia,* Mart., of Brazil.

Habitat.—Western Kansas, found in concretions by *Professor Mudge.* These concretions appear rich in leaves, which have not been preserved, or, at least, have not been found yet in the arenaceous shale of the group.

BUMELIA MARCOUANA, (Heer,) Lesqx., Pl. xxviii, Fig. 2.

Leaf membranaceous, broadly oval, entire, emarginate, rounded downward to a long, slender petiole, penninerve.

Leguminosites marcouanus, Heer, Dana's Manual of Geology, Ed. II, p. 459, Fig. 827.

Leaf 5 centimeters long from the top of the slender 2½-centimeter-long petiole, more than 4½ centimeters broad, very entire; with seven pairs of secondary veins, parallel, on a broad angle of divergence of 60° to 70°, passing up to near the borders, where a few of them branch once, and all become effaced. These veins are mostly opposite, the lower pair joining the middle nerve a little above the borders; this, with the second and third pairs, are closer to each other, 4 millimeters in distance, while the upper pairs are more distant, 6 to 9 millimeters, all straight or slightly curved. The notch is marked by two straight lines, which, however, are smooth like a continuation of the borders, and not as resulting from erosion. The leaf is so very similar in form, size, and nervation, also, to those of our present *Rhus cotinus,* which also are sometimes notched, that a relation to this last genus could be supposed. The absence of any trace of areolation prevents a close comparison. The notch is, however, deeper and more marked than in any of the leaves of *R. cotinus.* This leaf is evidently identical to that figured in Dana's Manual, (*loc. cit.*) The long, slender petiole of this leaf prevents its reference to *Leguminosites.*

Habitat.—Minnesota, *James Hall;* two fragments, one with the petiole; Nebraska, *Marcou;* a fragment without petiole.

POLYPETALÆ.

Umbelliflorœ.

ARALIA QUINQUEPARTITA, Lesqx., Pl. xv, Fig. 6.

Leaves membranaceous, three-nerved from above the base, five-lobed by the forking of the primary nerves; lobes oblong, somewhat narrowed downward, entire or undulate; base of the leaf cuneiform.

Aralia quinquepartita, Lesqx., Hayden's Report, 1871, p. 302.

This leaf is represented by a single specimen, representing a leaf of a thick-

ish, subcoriaceous texture, narrowed cuneiform at base, apparently petioled, palmately three-nerved and three-lobed; primary lobes deep to near the point of union of the nerves; lateral ones cut in two much shorter divisions, or bilobate by the forking of the lateral primary nerves, which branch at a short distance above their base; sinuses narrow, but obtuse. The upper part of the lobes is destroyed. As far as can be seen from the specimen figured, the leaf is five-lobed, with lobes diverging, like the nerves and their divisions, at an acute angle of 30° to 35°. The lobes appear all entire. There is only a trace of undulation on the upper part of the right lateral lobe, just near the broken line of the leaf. Prof. Heer, in Keide Flora v. Moletin, (p. 18, Pl. viii, Fig. 3,) has described *Aralia formosa*, a three-lobate leaf with crenate lobes, which is closely related to our species. It differs merely by having three divisions only, and the borders obtusely crenate in the upper part of the lobes. The Kansas leaf has, however, the upper half of the lobes destroyed; and, from a kind of undulation marked along the upper part of the outside borders, it would seem as if the lobes, too, had been undulate dentate in their upper part. This leaf, also, is much larger than that of Heer; and it may be that, as it is the case in some species of *Aralia*, the smaller leaves are merely trilobate, and the large ones darted in five or more lobes by subdivision. As identical between the European species and ours, we have the following characters: tripalmate basilar nervation; subcoriaceous substance of the leaves; the same wedge-form base of the leaves; and the borders entire toward the base.

Habitat.—South of Fort Harker, Kansas, *Mudge.*

HEDERA OVALIS, sp. nov., Pl. xxv, Fig. 3, and Pl. xxvi, Fig. 4.

Leaves coriaceous, entire, oval, broadly obtuse, narrowed to the base, pinnately nerved; medial nerve thick; secondary veins alternate, irregular in distance, more or less numerous; nervation mixed.

In comparing the nervation and areolation of these leaves with our living *Hedera helix*, L., their reference to this genus is obvious. The smaller leaves show apparently the upper side; the other, (of Pl. xxv,) the lower, with the veins and their divisions more marked, and the medial nerve increasing in thickness toward the base by the connection of the secondary veins. The leaves, whose petiole is broken, are thick, from $4\frac{1}{2}$ to $6\frac{1}{2}$ centimeters long, $3\frac{1}{2}$ to $4\frac{1}{2}$ centimeters wide, oval, round-obtuse, narrowed by a curve a little more on one side than on the other, or slightly unequilateral. The secondary veins are either curved near and along the borders or passing up and entering them; the areolation is in large, irregular meshes, by nervilles anastomosing with divisions of the secondary veins, in various angles of divergence.

The angle of divergence of the secondary veins is also variable. Leaves of *H. helix*, L., the European ivy, have been found fossil in the Tertiary of Italy. Gaudin (in Contributions, etc., III, p. 17, Pl. i, Figs. 21–24) describes, under this name, leaves closely related by form and nervation to those of the Dakota group.

Habitat.—Near Decatur, Nebraska. The specimen of Pl. xxiv, Fig. 4, is from Kansas, *Mudge*.

POLYCARPICÆ.

MAGNOLIA TENUIFOLIA, Lesqx., Pl. xxi, Fig. 1.

Leaf large, oblong, rounded upward to an obtuse point(?), (broken,) narrowed in a curve to a short, slender petiole; medial nerve straight, narrow; lateral veins alternate, on a broad angle of divergence, slender, undulate, deflexed near their point of insertion to the medial nerve.

Magnolia tenuifolia, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 100.

The upper part of this leaf is destroyed; it is a large leaf of thin texture, about 17 centimeters long, 7 centimeters broad, oblong oval, entire or undulate on the borders, apparently rounded upward to an obtuse point, gradually curving to the petiole, which, like the medial nerve, is rather slender, at least for a leaf of this size. The secondary veins mostly opposite, irregular in distance, or obliterate here and there, are very thin, on a broad angle of divergence of 60°, undulating to the borders, where they curve, and which they appear to follow.

The relation of this leaf with that referred to *Persea leconteana* has been remarked upon in describing this last species.

Habitat.—Decatur, Nebraska; represented by four specimens.

MAGNOLIA ALTERNANS, Heer, Pl. xviii, Fig. 4.

Leaves coriaceous, ovate-oblong or elliptical, entire, tapering to the petiole; secondary veins numerous, parallel, camptodrome, at an acute angle of divergence.

Magnolia alternans, Heer, Phyllites, p. 20, Pl. iii, Figs. 2–4; Pl. iv, Figs. 1–2.—Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 100.

The leaf figured in this memoir is not as perfect as those which Professor Heer had for his description of this species. Our figure is comparable in size, form, and nervation to that of Pl. iii, Fig. 3, of the Phyllites, which has the base of a leaf with a short, slender petiole, while the upper part and the base of ours is broken. In both these leaves, as also in the fragment represented, (Pl. iv, Fig. 1, of the same memoir,) the secondary veins appear intermixed with shorter tertiary ones. This character, like the form of the

leaf, identifies ours with Heer's species. I have very rarely recognized it among the specimens received for examination.

Habitat.—Fort Harker, Kansas; a single specimen, No. 6433, from the collections of the Smithsonian Institution.

LIRIODENDRON MEEKII, Heer, Phyllites, p. 21, Pl. iv, Figs. 3–4.

These leaves are figured from drawings communicated to Professor Heer by Dr. Hayden. They are small, 4½ centimeters long, truncate or scarcely emarginate at the top, with round, very obtuse terminal lobes, and slightly less obtuse basilar ones. The nervation is of the type of *Liriodendron.* I have seen some fragments referable to this species in Dr. Hayden's and Professor Hall's specimens; but I have not been able to discover any myself. All these fragments come from north Nebraska and from Minnesota.

Habitat.—Near mouth of Big Sioux, *Hayden.*

Dr. Newberry has in his Extinct Flora a species, *Liriodendron primævum,* which, according to the description, is distinct from this one by its large size and the lobes more broadly rounded. It is described from specimens found in Blackbird Hill, North Nebraska, by *Hayden.*

LIRIODENDRON INTERMEDIUM, Lesqx., Pl. xx, Fig. 5.

Leaf large, three-lobate; upper lobe elongated, deeply emarginate-lobed; secondary veins thin, parallel.

Liriodendron intermedium, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 99.

Though the specimen represents a fragment, the upper part of a leaf, it is sufficient to show the relation of this leaf to the genus *Liriodendron.* The leaf in its integrity is at least 14 centimeters long; the basilar lobes appear to have been much enlarged, and abruptly so, and the leaf contracted or narrowed between the lower and upper lobes, which are obovate-obtuse, 4 centimeters long, and separated by a deep, slightly obtuse sinus. This fragment shows a thickish, somewhat coriaceous leaf.

Habitat.—South Nebraska, *Hayden.*

LIRIODENDRON GIGANTEUM, Lesqx., Pl. xxii, Fig. 2.

A mere fragment, still more incomplete than the former, representing the half of the upper lobe of a species of this genus. From the preserved part, the whole upper lobe measured 17 centimeters wide, while that of the former species measures only 7½ centimeters. The secondary veins of this magnificent leaf are very thick, at least comparatively to those of the former species, but not thicker than they are in large leaves of our *L. tulipifera,* L.,

a species from which all our Cretaceous forms differ by their round-obtuse lobes. The same characters separate them from the Tertiary species of Europe, *L. procacini* and its numerous varieties, which all are more or less acutely-lobed.

Habitat.—Near Fort Harker, Kansas; No. ~~6432~~ 7093a of the collection of the Smithsonian Institution.

Menispermites, Lesqx.

Leaves large, coriaceous or subcoriaceous, broadly deltoid, more or less distinctly three-lobed, with obtuse divisions, and borders entire or undulate; nervation palmately 3–5 nerved, from a peltate or subpeltate, truncate or subcordate base; primary veins craspedodrome, their points joining the borders of the lobes, but their divisions following along them by a series of curves upon each others, or of multiple festoons, as seen in the leaves of the present *Menispermum canadense* especially. The divergence from this last type is marked in one species only, whose nervation agrees with that of *Menispermum* (*Cocculus*) *carolinum*, &c. The leaves referred to this genus have been described formerly as *Acer* or *Acerites*, *Dombeyopsis*, even *Populites*. Their essential characters seem to refer them all to this section.

Menispermites obtusiloba, sp. nov., Pl. xxv, Figs. 1–2; Pl. xxvi, Fig. 3.

Leaves large, coriaceous, broadly deltoid or nearly round, obtuse in outline, peltate, 3–5-nerved, deeply undulate.

These leaves are thick, variable in size, the largest 20 centimeters long, 15 centimeters wide, reniform-deltoid in outline, obtuse, peltate, enlarged, and truncate at base, obscurely three-lobate, with borders deeply undulate; five-nerved; primary nerves under various degrees of divergence, much branched, subcraspedodrome, their points reaching the borders with camptodrome divisions anastomosing in bows along the borders and along the veins, with two to four veinlets under the primary veins, around the point of attachment of the petiole. The leaf (Pl. xxv, Fig. 1) is the better preserved one of this species. I have, however, seen fragments indicating leaves of a larger size. In this the three-lobate form is more marked than in the other figured specimens. It is evident that the leaf (Pl. xxvi, Fig. 3) belongs to the same species. In Pl. xxv, Fig. 2, the base of the leaf is destroyed; but the union of the primary nerves and of the basilar veins is clearly seen as being above the borders. The middle nerve is not branching; at least, no trace of secondary veins could be seen on the spec-

imens. It will be remarked, however, that the first lateral vein of the left side has no divisions whatever, while that of the other side has three strong branches. The absence of the medial secondary veins may, therefore, be casual, or the veins may have been erased from the impression of the leaves. As it is seen from the divisions of the primary nerves, and of their branches, in Pl. xxvi, Fig. 3, the direction of the nerves and their ramifications are very irregular.

Habitat.—Bluffs of Salina River, eight miles above its mouth.

MENISPERMITES OBTUSILOBA var. (?), Pl. xxii, Fig. 1.

Dombeyopsis obtusiloba, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 100.

The specific relation of this fine leaf with those described for the former species is not positive. The general outline of the leaf is the same, as, also, the five-palmate nervation, with two lower marginal veins. The first pair of nerves, however, is turned upward on a more acute angle of divergence, and the leaf does not appear peltate. In comparing, however, the primary nervation with that of the small leaf of Pl. xxv, Fig. 2, it will be seen that in this last specimen the inner lateral pair of nerves has in both the same direction, and that, too, at the base of each leaf, which in both is destroyed by erosion, there is a small marginal border, which looks as if originally joined under the point of union of the nerves. Except these differences, the relation is evident by the form, three obtusely-lobed, of the leaf, its round truncate base, the direction of the nervilles, the thick substance, &c.

Habitat.—The same place as the normal form. This splendid specimen is in the cabinet of the Smithsonian Institution, presented by *Prof. B. F. Mudge.*

MENISPERMITES SALINENSIS, Lesqx., Pl. xx, Figs. 1, 4.

Leaves thickish, membranaceous or subcoriaceous, triangular in outline, obtusely palmately five-lobed, or deeply undulately lobed, palmately five-nerved from the enlarged truncate base.

Acer obtusilobum (?), Ung., Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 100.

Populites salinæ, Lesqx., Hayden's Report, 1872, p. 423.

The study of these leaves, made on the place where I found a large number of more or less fragmentary specimens, near Salina, afforded means of comparison between their forms and nervation; and, from the intermediate and transitional characters, I had to admit them as representing a single

species—perhaps even as a mere variety of the former-described ones. These leaves are generally smaller, from 6 to 10 centimeters long, more enlarged on the sides, from 8 to 12 centimeters broad, broadly triangular, obscurely five-lobed or deeply undulately lobed, palmately five-nerved from the base of the leaf, (not peltate,) with the lateral nerves much divided, their ultimate divisions curving along the upper end of the veins and anastomosing in successive bows, all the divisions dissolved or effaced before reaching the borders. In the leaves referable to this species, the veins and the areolation, though thin, are more distinct than in the former species; the divisions of the primary nerves are from the base of the leaves; the middle nerve is comparatively thicker; and the surface of the leaves is smooth. Fig. 4 has the general aspect of a *Populus* of the coriaceous-leaved section, with somewhat different borders, while Fig. 1 is, by its form, related to the leaf described as *Acer obtusilobum* in Unger's Chloris Prot., (p. 134, Pl. xliii, Fig. 12.)

Habitat.—Salina River, same hill as the former.

MENISPERMITES ACERIFOLIA, Lesqx., Pl. xx, Figs. 2–3.

Leaves small, triangular or rhomboidal in outline, 3–5 obtusely lobate, wedge-form or abruptly narrowed to the base.

Acerites menispermifolia, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101.

These leaves are of a thinner substance than those of the former species, small, 3 centimeters long and about as wide, 3–5 lobate, with lobes diverging from near the middle of the leaves, all obtuse, the middle only slightly acuminate, 3–5 palmately nerved from the broad, nearly truncate, or more gradually attenuated cuneiform base. In Fig. 2 the lateral primary nerves, only two, are apparently without branches, and pass up to two lateral lobes. The leaf (Fig. 3) is five-nerved and five-lobed, with the form somewhat like Fig. 1 of the former species; the first pair of lateral nerves is divided above the middle in two branches, one passing outside toward the borders, the other ascending and curving inside toward the base of the first secondary vein above. This kind of nervation, and the form of the leaves, too, are so similar to those of the leaves of *Cocculus* (*Menispermum*) *carolinus*, D. C., that I can but consider them as referable to this genus. The living plant has only a longer and more pointed middle lobe of its leaves. The nervation, also, is the same as that of the leaf described by Unger (*loc. cit.*) as *Acer obtusilobum*.

Habitat.—Near Decatur, Nebraska, *Hayden.*

NEGUNDOIDES ACUTIFOLIA, Lesqx., Pl. xxi, Fig. 5.

Leaves divided; leaflets thin, lanceolate-pointed or enlarged lobate, with acute lobes; veins pinnate, camptodrome.

Negundoides acutifolia, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101.

Of this species, described from a mere fragment, I have been unable to see any other specimen but that which is figured. The fragment represents two leaflets, apparently attached to a common, pinnately-divided pedicel; the lower one deeply bilobate by the forking of the middle nerve, with a broad, dentate sinus, and lobes entire and sharply pointed; the upper leaflets, (if it is not the lacerated part of the other,) appear simple, lanceolate-pointed, entire; secondary nervation simply pinnate in both fragments of leaves, but compound in the inner part of the lobate leaflet, as it is generally the case for a compound leaf. Professor Unger, in his Chloris, has described, (p. 135, Pl. xliv, Figs. 3–6,) as *Acer pegasinum*, two lanceolate-dentate opposite leaflets, upon a common rachis, and which, therefore, appear to belong to a compound leaf like a *Negundo*. In our *N. aceroides*, and especially in *N. californicum*, the terminal and one of the lateral leaflets become sometimes united into a compound leaf, with some likeness to this fossil fragment.

Habitat.—Ten miles below Lancaster, Southern Nebraska, *Hayden*.

GREVIOPSIS HAYDENII, sp. nov., Pl. iii, Figs. 2, 4; Pl. xxiv, Fig. 3.

Leaves large, oval, tapering upward to a point, and more abruptly narrowed downward to the base; borders equally denticulate from below the middle; nervation abnormally five-palmate, craspedodrome.

Populites fagifolia, Lesqx., Hayden's Report, 1872, p. 422.

The description of this species was made out and its name admitted from the examination of the first specimen, (Pl. iii, Fig. 2,) a small leaf, with borders indistinct, which did not show the details of conformation well enough. The large leaf, obtained since and represented in Pl. xxiv, Fig. 3, has its borders and its areolation more distinctly marked. The leaves are of a thick, subcoriaceous texture, 11 centimeters long, without the petiole, from 8 to 11 centimeters broad in the middle, tapering upward, or more or less broadly lanceolate to a point, and narrowed, too, more or less abruptly to the base; borders equally cut by shallow half-round sinuses, the short teeth all turned outside; nervation rather pinnate or abnormally five-palmate, as in some species of *Populus;* lateral veins at equal distances, ten pairs, oblique, diverging about 45°, nearly straight, the lowest branching, the upper ones simple, all running to the borders, like their divisions; nervilles in right

angle to the veins, subcontinuous; areolation platanoidal. There is an apparent difference between the leaves representing this species. The small leaf (Pl. iii, Fig. 2,) is more acutely pointed and more acutely tapering to the base, where the borders turn to the medial nerve, and follow it, in decurring, to the petiole, which is broken in both leaves; the borders appear mostly entire, and the nervation more indistinctly palmate. But in comparing both leaves carefully, these differences are recognized as merely resulting from the development of each leaf. In the small leaf there is harmony of conformation in the more elongated point and base; the denticulation, in its peculiar form, is visible near the point; and at the base the distribution of the lateral nerves compares with that of the larger leaf by the two inferior veins of the right side, which are narrower, and by the exact coincidence of the two inferior veins of the left side; the lowest, thin, marginal, and simple; the other thick and much divided. The leaf of Pl. iii, Fig. 4, is apparently, too, referable to the same species. It was described under the name of *Populites flabellata* in the American Journal of Science and Arts, *loc. cit.*, p. 94; but in comparing it to Fig. 3, it seems to be a mere deformed leaf of a same kind, turned to one side by compression, and with the point broken or recurved inward. It has about the same number of lateral veins, the lower appearing more divided, and giving thus a different *facies* to the leaf; but the same character is recognized in the large leaf of Pl. xxiv, Fig. 3.

I owe to Count Saporta the indication of the relation of this species to *Greviopsis*, a new genus established by him in the family of the *Tiliaceæ* for some leaves from the Lower Eocene of Sezane. The Cretaceous species is comparable by some of its characters, especially the nervation and the denticulation, to *G. credneriæformis*, Sap.

Habitat.—South of Fort Harker, Kansas, *Leconte, Mudge*, &c.

Incertæ sedis.

Anisophyllum, Lesqx.

Leaves thick, coarsely-veined, ovate or obovate in outline, either abruptly narrowed, subtruncate, and subcordate to the petiole, or rounded, wedge-form to the base, irregularly lobate on one side, deeply undulate on the borders; nervation irregularly 3-5-palmate from above the base of the leaves; primary veins much divided.

Anisophyllum semi-alatum, Lesqx., Pl. vi, Figs. 1–5.

Quercus semi-alata, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 96.

These leaves, all marked with a coarse nervation and of a thick texture,

present the most variable forms and greatest differences in their nervation. As seen in Fig. 1, the general outline is ovate, obtuse, with the borders entire or merely undulate on one side, while the other side is deeply lobed by the prolongation of a basilar secondary nerve nearly as thick as the medial one, branching outside with the divisions subcamptodrome. In this leaf the nervation is evidently irregularly pinnate from the base of the leaf, which appears rounded to the petiole; the lateral veins are parallel on one side, though at unequal distance, while on the other side the angle of divergence is variable, and all the divisions are camptodrome, or rather subcamptodrome, as the point of the veins passes to the borders, while some of the divisions follow the borders in successive curves. Though the leaf of Fig. 2 is broken on one side, it evidently shows, however, a disposition to a division by lobe on the left side, where the lateral veins are less numerous, but thicker and more branched than on the right. The division of the nervation appears here to be three-palmate; two thick opposite lateral primary nerves branching at a distance above the basilar borders of the leaf, rounded on one side, broadly cuneate on the other, with two thinner lower veinlets on the left side only. This division is platanoidal on one side, and of the *Credneria* type on the other. In Fig. 3 the same kind of one-sided division is still evident by the disposition and thickness of the lateral primary veins, which are here by five, high above the border of the truncate base of the leaf, and with inferior lateral thinner veinlets nearly at a right angle to the thick medial nerve. Fig. 4 is, too, of the same type by the one-sided division; a lobe being indicated by the lateral nerve of the right side, while on the other the division and the thinning of the nerve show that it ends without entering a prolongation of a lobe. In this leaf the borders are cuneate to the base; the lower lateral veins under the primary ones go out of the medial nerve in the same angle of divergence; and as in the other leaves, the divisions of the lateral veins are mostly camptodrome, while the secondary veins are mostly craspedodrome. In Fig. 5, the three-palmate nervation is still more marked, and the extension of the leaf on one side evident by the extraordinary thickness of the basilar nerve on the left side. I have figured this fragment, though incomplete it is, because it is the only one which shows the whole base of the leaf with a petiole. The junction of the borders to the petiole is equally abnormal; the leaf being on one side round cordate, and on the other round wedge-form.

These leaves are not referable to *Platanus* or to *Credneria*, on account

of the discordance of their characters. A similar kind of variability is remarked only, I think, in species of *Quercus*. Some leaves of oaks have the double nervation camptodrome and craspedodrome upon the same leaf; some others show a disposition to an unequal expansion of the limb on one side or on the other, in relation to the unequal division of the veins; even a nervation somewhat analogous to that of these leaves is remarked in some fossil species, as in *Quercus desloësi*, Heer, *Q. charpentieri*, H., *Q. agnostifolia*, H., &c. But this relation is too far; the type is evidently original, and for this reason it had to be separated as of uncertain affinity.

Habitat.—Near Beatrice, Gage County, Nebraska, *Hayden*.

Protophyllum, Lesqx.

Leaves generally of large size, thick, coriaceous, broadly oval or round-pointed, subpeltate; borders entire or undulate; nervation palmato-pinnate; lower primary lateral veins at a distance from the border-base, with more or less numerous veinlets underneath, either in right angle to the middle nerve or diverging downward; upper lateral veins at equal distance from the lower pair and parallel, all craspedodrome.

In my examination of the numerous leaves described in this division, and which I have previously referred either to *Credneria* or to *Pterospermites*, I have never been able to recognize characters which might satisfactorily account for this reference. If some of the leaves, like that of Pl. xvi, of Pl. xvii, Fig. 1, or of Pl. xviii, Fig. 2, are referable to *Credneria* on account of their size, their form, and the lower horizontal veins at the base of the leaves under the primary divisions, they do not show the characters indicated by Zenker in the diagnosis of this genus in Paleont., V. II, p. 63, viz: *Caulis polygonearum, folia obovata, basi subcordata, longe-petiolata, nervi primarii suberecti, etc.* In regard to the nervation, all the *Credneria* leaves figured in the same work with entire borders have a camptodrome nervation; those with craspedodrome secondary nerves are dentate or lobed. In the beautiful leaf described by Heer in Molet. Fl., (p. 16, Pl. iv,) as *Credneria macrophylla*, which, judging from our fragmentary specimen of *Credneria leconteana*, (Pl. xvii, Fig. 4,) is related by its form to the American species, the camptodrome nervation is positively marked.

Now, besides this difference between the European *Credneriæ* and all the Cretaceous leaves, with borders entire, which I have referred, until now, to this genus, these still differ from the characters of *Credneria* by the overlapping of the border-base upon the petiole. These leaves are generally

subpeltate, and therefore they should be referable to *Pterospermites*. The analogy of some of these leaves to those of the living *Pterospermum acerifolium*, Wild., is indeed evident. In this, however, the essential nerves, three or five, end into the point of a lobe, while all their branches and the intermediate nerves are camptodrome. And though the base of the leaves is overlapping and covering, by its broad auricules, the upper part of the petioles, all the lower veins come out from the top of the petiole, and there is no trace of the horizontal vinelets, which are remarked, without exception, in all the species which I describe in this new genus. I do not know of any leaves of *Pterospermites* but those which are described by Heer from Greenland. In Fl. Arct., (p. 480, Pl. xliii, Fig. 15^b, Pl. liii, Figs. 1–4, and Pl. liv, Fig. 3,) the author has described two species, *Pterospermites spectabilis* and *P. alternans*, whose nervation and cordate base are of the same character as in the species of *Credneria*, the only difference being in the size of these leaves, which appear smaller. Of these fragments, Fig. 15^b is comparable, by its basilar nervation, to the Cretaceous leaf of this memoir, (Pl. xvii, Fig. 3,) which, however, differs from the Greenland species by its craspedodrome nervation. In the same work, Heer has (p. 122, Pl. ix, Fig. 14a) *Pterospermites integrifolius* without any horizontal basilar nerves, the medial nerve passing under the border-base of the leaf or peltate, and (p. 138, Pl. xxi, Fig. 17^b, and Pl. xxiii, Figs. 6, 7,) he represents *Pterospermites dentatus* with a peltate leaf and basilar veins running down from the base of the medial nerve, or with secondary veins at right angle to it. It is, therefore, difficult to know by what characters the genus *Credneria* may be positively separated from *Pterospermites*, besides that of larger-sized leaves for the former genus, and of more or less peltate ones for the second. Some of our peltate leaves, however, referable to *Pterospermites* by the nervation, have leaves, as remarked already, as large as those of *Credneria*. Having, therefore, to describe a number of forms which, though related to the yet undefined genera *Credneria* and *Pterospermites*, are forcibly removed from them by some important characters, I have united them all in this new division.

PROTOPHYLLUM STERNBERGII, Lesqx., Pl. xvi; Pl. xviii, Fig. 2.

Leaves large, coriaceous, entire, round or cordate at the base, narrowed upward into a slightly obtuse point; basilar nerves one or two pairs.

Pterospermites sternbergii, Lesqx., Hayden's Report, 1872, p. 425.

Pl. xvi represents a splendid leaf, of which only one-half is preserved.

Its size, form, and nervation are, however, definite. It is at least 20 centimeters long, 19 centimeters broad in its widest part above the base, where it is rounded downward to the petiole; tapering upward, or narrowed in undulating entire borders, to a slightly obtuse point; medial nerve half-round, comparatively narrow; secondary veins mostly opposite, branching once, rarely twice, all craspedodrome; basilar veins two pairs, the upper one in a right angle to the medial nerve, forking; the lower simple, thin, somewhat deflected downward. This last character is marked by the end of one of the basilar veins, distinctly seen near the border-base on the left side; and it is still more defined in the smaller leaf, (Pl. xviii, Fig. 2,) which is subpeltate by the border-base of the leaf covering the petiole.

In the eight figures of leaves of *Credneria* which Stiehler (in Paleont., *loc. cit.*) has published, the basilar veins are thinner than in our large leaf, but not more so than in the small one; and in all the European leaves referred to *Credneria*, the second pair of lateral veins is at a greater distance from the lower pair than from those above, even in the leaves with entire borders. They have, therefore, a general appearance more resembling that of species of *Platanus*. In the American leaves, this difference does not exist; on the contrary, the secondary veins are at about the same distance, except near the base, where the lower pair, which may be considered as a marginal one, though still of the same thickness, is nearer to the pair above. These secondary veins are also more numerous. In this species there are nine to ten pairs running straight to the borders, which they enter as craspedodrome, while the European leaves have only four to six pairs, all the veins curving up in ascending to the borders, with mostly camptodrome divisions. These differences are somewhat less marked, but evident, however, in the fine leaf which Heer has described in the Cretaceous Moletin Flora as *Credneria macrophylla*, (Pl. iv, p. 16,) and which, besides, widely differs from ours by its very thick medial nerve and its camptodrome secondary veins. It is of the same size and of the same form, however. Heer rightly remarks, in describing this species, "that the systematical relation of the genus *Credneria* is still very uncertain." The same can be said of the species in relation to this genus, or of the relation of the leaves referred to it.

Habitat.—South of Fort Harker, in a locality discovered by *Chs. Sternberg;* both leaves.

PROTOPHYLLUM LECONTEANUM, Lesqx., Pl. xvii, Fig. 4; Pl. xxvi, Fig. 1.

Leaves coriaceous, round, more enlarged in the middle, entire; medial nerve thick; lowest secondary veins much divided; basilar veins in right angle to the medial nerve, proportionally thick.

Credneria leconteana, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 98.

This species is represented by two fragmentary leaves, with the lower part destroyed in both. The nervation is of the same type as in the former species, differing, however, by the greater thickness of the medial nerve and by the more numerous divisions of the lateral veins. In both species the divergence of these veins is the same, (40° to 70°,) gradually increasing in width from the top to the base, and in both, also, the veins and their divisions run to the borders, where they become more or less effaced by the anastomosis of the nervilles, which are coarsely marked, in a right angle to all the divisions of the veins, and more or less continuous. Besides the difference marked in the character of the nervation, this species is still further separated from the former by its round outline and broadly obtuse point.

Habitat.—Brooksville, Kansas, *Leconte;* the small specimen from south of Fort Harker. The localities where the specimens of Dr. Leconte were obtained (three miles northeast of Fort Harker and near Brooksville) are eight to ten miles north of the one where I mostly collected my own, which are marked in this report as near Fort Harker.

PROTOPHYLLUM NEBRASCENSE, sp. nov., Pl. xxvii, Fig. 3.

Leaf small, subcoriaceous, oval-oblong, broadly cuneate to the petiole; borders entire; medial nerve, thin; secondary veins close, parallel, all under the same angle of divergence.

This leaf differs in its characters from those described from Kansas. It is comparatively very small; its surface somewhat rough, though its substance is not as thick; the form is oval-oblong, the borders in the middle being apparently parallel, and its base is rounded broadly-conical to the petiole; the secondary veins, all under the same angle of divergence of 40° to 50°, are thin, parallel, camptodrome, straight, with a single thin marginal veinlet on each side from below the lowest pair of the secondary veins. This vein follows the borders, anastomosing with nervilles of the divisions of the lower veins which are camptodrome, while the primary divisions are craspedodrome. The leaf is not peltate, the narrow primary nerve being prolonged into a short, apparently broken petiole. It may be compared to *Credneria integerrima*, Zenker, as represented in Paleont., (Vol. V, Pl. ix, Fig. 2,) which has

about the same basilar form, and also on each side one single basilar veinlet, anastomosing in following the borders with the divisions of the vein above. But the difference is great indeed, especially in the narrow medial nerve of the American leaf, in its straight, craspedodrome, secondary nerves, and its form.

Habitat.—Hills near Decatur, Nebraska; the only leaf as yet referable to *Protophyllum* from that State.

PROTOPHYLLUM QUADRATUM, Lesqx., Pl. xix, Fig. 1.

Leaf thickish, round-square in outline, truncate at base, subpeltate, deeply undulate, obtuse; nervation thick, craspedodrome.

Pterospermites quadratus, Lesqx., Hayden's Report, 1871, p. 301.

Leaf large, 13 centimeters both ways, coriaceous, deeply undulate, subpeltate; secondary veins thick, moderately branching, at an open angle of divergence, parallel; basilar veins open, the lower pair at right angle to the the medial nerve, even curving downward, with two thin veinlets under them, decurring down the border-base which covers the petiole, either continuous or auricled. This leaf is not comparable to any published until now from the Cretaceous flora of Europe.

Habitat.—South of Fort Harker, where I found it in numerous specimens, none, however, as perfect as the one figured here, which was communicated by *Professor Mudge.*

PROTOPHYLLUM MINUS, sp. nov., Pl. xix, Fig. 2; Pl. xxvii, Fig. 1.

Leaves coriaceous, small, ovate, largest near the base, truncate or abruptly rounded, entire or slightly undulate on the border, subpeltate.

This species is, perhaps, a variety of the former. The leaves are smaller and less deeply undulate, but the general *facies* is the same. The secondary veins are more numerous or less distant, but straight to the borders in both species, and the disposition of the marginal veins at the base, like the subpeltate basilar borders, are also of the same character. In Fig. 2 of Pl. xix, the secondary veins, though running to the borders, do not mark them with undulations or small, slightly-protruding lobes. The borders of this leaf are, however, apparently somewhat reflexed and imbedded into the stone in such a way that the outside margin cannot be distinctly seen. It is separated from the former species by the differences indicated. Perhaps intermediate forms may be found hereafter.

Habitat.—Salina River, hills eight miles above its mouth. The small specimen (Pl. xxvii, Fig. 1) was communicated by *Professor Mudge* from Fort Larned, Kansas.

PROTOPHYLLUM MULTINERVE, Lesqx., Pl. xviii, Fig. 1.

Leaf of medium size, coriaceous, oval-oblong, round-truncate at the base, peltate; medial nerve thick; lateral veins close, parallel, numerous; borders entire or undulate.

Pterospermites multinervis, Lesqx., Hayden's Report, 1871, p. 302.

The figured fragment is the most perfect among many others referable to the same species. It is 12 centimeters long, (its upper part is broken,) 11 centimeters wide a little above its base, where it is slightly enlarged and then rounded downward and truncate; its borders are nearly parallel, slightly undulate; its medial nerve is comparatively thick, like the numerous, opposite, nearly parallel secondary veins, whose angle of divergence is more and more open toward the base, the lower veins running down from the point of attachment of the peltate leaf in various degrees of inclination, across the broad border-base, which is at least one centimeter wide. This impression of the leaf is apparently that of the lower side, and the petiole has been broken just at the base of the medial nerve. The distinction between the secondary veins and the marginal ones is not clear on account of the similarity of the veins in their thickness and of the slow degree of change in their angle of divergence. Counting from the lowest, thick, branching lateral veins to the upper part where the leaf is broken, there are ten pairs of secondary veins in a space of $9\frac{1}{2}$ centimeters, and under them four or five deflexed smaller veins on each side of the middle nerve near and at its base.

Habitat.—South Kansas, near Salina River.

PROTOPHYLLUM RUGOSUM, Lesqx., Pl. xvii, Figs. 1–2; Pl. xix, Fig. 3.

Leaves deltoid-ovate, rounded at the subpeltate base; borders entire; nervation coarse; secondary veins irregular in distance and direction.

Pterospermites rugosus, Lesqx., Hayden's Report, 1872, p. 426.

The leaves, of a thick coriaceous substance, have a rough surface, deeply furrowed and wrinkled by the veins and the nervilles; they vary in size from six to twelve centimeters long and from five to nine centimeters wide. They are broadest below the middle, rounded truncate at base, the borders tapering to a deltoid point. The middle nerve is not as thick as in the former species, becoming thicker, however, toward its base. The secondary veins are placed

at irregular distances, curving in various directions, less parallel than in the other species, with only two or three marginal veinlets at right angles to the medial nerve, but none descending into the narrow border below the point of attachment of the petiole.

Fig. 3, Pl. xix, is a fragment of a smaller leaf, which has the same rough surface as the others of this species. It has, too, the same irregularity in the distance of its secondary veins, but the base of the middle nerve is not thickened, and is more prolonged downward, forcing a deflection of the borders, and thus a less truncate or more wedge-form base.

Habitat.—South of Fort Harker, Kansas; not rare.

PROTOPHYLLUM HAYDENII, Lesqx., Pl. xvii, Fig. 3.

Leaves small, coriaceous, smooth, ovate-oblong, pointed, deeply and irregularly undulate-lobed, abruptly rounded to the base; secondary veins parallel; basilar veins thin, undulate, two or three on each side of the medial nerve, at a right angle to it.

Pterospermites haydenii, Lesqx., Hayden's Report, 1871, p. 302.

Besides other more fragmentary specimens, the species is represented by a leaf 9 centimeters long, 5 to 6 centimeters wide, oblong, broadly lanceolate-pointed, deeply undulate all around or irregularly marked on the borders and in the middle by short, obtuse, irregular lobes; strongly pinnately-veined to the base, with lateral veins thick, parallel, all under the same angle of divergence of 50°, and thin, simple basilar veins at a distance of the lateral ones and near the base of the leaf, diverging at a right angle from the medial nerve, flexuous, three on one side and two on the other. The secondary veins are less branched than in any of the former species. I have compared this species, in report *loc. cit.*, to *P. spectabilis*, Heer, (Fl. Arct., p. 480, Pl. xliii, Fig. 15^b.) The leaf has, indeed, some likeness to it by its general outline; but the direction of the more numerous and craspedodrome lateral veins in the Cretaceous leaf is far different.

Habitat.—South of Fort Harker, *Mudge.*

PROTOPHYLLUM (?) MUDGEI, Lesqx., Pl. xviii, Fig. 3.

Leaf coriaceous, ovate, obtuse, enlarged and truncate at the base, equally denticulate; medial nerve very thick; secondary veins alternate, thick, more or less branching, craspedodrome.

Quercus mudgei, Lesqx., Hayden's Report, 1871, p. 302.

Leaf ovate, apparently tapering to an obtuse point, (the upper part is broken,) 6 centimeters broad near the base, where the leaf is the largest,

truncate; nervation very coarse and deeply marked; secondary veins more or less branching, entering each, with their divisions, the point of a tooth.

The denticulation of the borders of this leaf is of the same character as that remarked in *Greviopsis haydenii*, viz, shallow teeth pointed outward, separated by equal, obtuse sinuses; the lateral veins nearly parallel, join the medial nerve under a broad angle of divergence of 50° to 60°. Dunker in the Paleont., (vol. iv, p. 181, Pl. xxxiv, Fig. 1,) has described, from the Quadersandstein of Blankenburg, a leaf or a fragment under the name of *Castanea hausmanni*, which is somewhat related to our species. The denticulation is, however, unequal; the tertiary veins stronger; the base of the leaf round. I refer this leaf with doubt to this section.

Habitat.—Kansas, *Professor Mudge.*

EREMOPHYLLUM FIMBRIATUM, Lesqx., Pl. viii, Fig. 1.

Leaf peltate, kidney-shaped, with an entire broadly-truncate base; borders dentate by equal hastate or auricled teeth; nervation seven-palmate.

Ficus (?) *fimbriata*, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 96.

The leaf is peltate from the union of the borders a little lower than the point of attachment to the petiole; its form is nearly round, enlarged on the sides or kidney-shaped, entire and truncate at the enlarged base, equally dentate from its lower part, with equal short teeth, appendaged with obtuse auricles, and separated by deep half-round sinuses; petiole thick, attached above the borders, which are joined under it in a very obtuse angle; nervation seven-palmate; veins diverging at equal distance, of the same thickness, except the middle nerve, which is slightly stronger, forking once or twice from above the middle, with the divisions turned toward, but not entering, the teeth; areolation small, round, polygonal.

The relation of this leaf is still more uncertain than that of the former species. By the round form of the leaf, it is comparable to *Ficus crenata* Ung., (Sillog., p. 14, Pl. vi, Fig. 3,) a round, subpeltate leaf, with a seven-palmate nervation, or to *Ficus asarifolia*, Ett., (Bilin. Flor., p. 80, Pl. xxv, Fig. 3;) also a subpeltate, nearly round leaf. The relation is, however, distant. I have not been able to find, either in living plants or in the descriptions and figures of fossil ones, anything analogous to the kind of denticulate appendages which surround this Cretaceous leaf, and have therefore sepa-

rated it under a new genus, whose characters are those of the species. The substance of the leaf is membranaceous, its surface smooth, the veins distinct, and the areolation recognizable near the middle part, where it is mrkaed as it is seen with the glass. The enlarged figure of the borders underneath show the foliaceous appendages of the teeth; some of them are curved downward, and appear obtuse and truncate.

Habitat.—Near Decatur, Nebraska, a single specimen, *Hayden.*

Frangulaceæ.

PALIURUS MEMBRANACEUS, Lesqx., Pl. xx, Fig. 6.

Leaf small, membranaceous, oval-obtuse, entire, palmately three-nerved from the base; lateral nerves thin; nervilles distinct, perpendicular to the nerves and joining them.

Paliurus membranaceus, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101.

The only leaf by which this species is represented is of a thickish membranaceous substance, with a polished surface; oval, very obtuse, rounded to the base by a less obtuse curve, with a comparatively thick medial nerve ascending to the upper border of the leaf, and two thin lateral veins going up from the base to two-thirds of the leaf in an acute angle of divergence of 20°. The middle nerve is branching in its upper part; the lateral ones are also branching outside; all the subdivisions are simple, slender, on a broad angle of divergence, most resembling the nervilles, which, from the middle of the leaf downward, join the middle nerve to the secondary ones. The leaf ($4\frac{1}{2}$ centimeters long and 3 centimeters wide) is apparently petioled, its base curving down as slightly decurring to a broken petiole.

From the numerous Tertiary species of *Paliurus*, to which this one is comparable by its nervation, it differs especially by its very obtuse leaf. *Zizyphus protolotus*, (Ung., in Heer, Fl. Tert. Helv., III, p. 74, Pl. cliv, Fig. 32,) represents, however, a still more round-obtuse leaf, but different in the type of its nervation.

Habitat.—Near Decatur, Nebraska, *Hayden.*

CELASTROPHYLLUM ENSIFOLIUM, Lesqx., Pl. xxi, Figs. 2, 3.

Leaves coriaceous, very thick, linear, abruptly narrowed to the base by a round curve, broadly deltoid-pointed; medial nerve very thick; secondary veins thin, close, parallel, open, camptodrome.

Magnolia ensifolia, Lesqx., Hayden's Report, 1871, p. 302.

The species is represented by two leaves, one 12 centimeters long and 6 centimeters wide, and the other only $8\frac{1}{2}$ centimeters long and $3\frac{1}{4}$ centime-

ters broad, both having the same form: linear, abruptly rounded to the petiole, and curving or deflexed to it, nearly truncate or broadly deltoid at the point. Both leaves, also, have a comparatively thick medial nerve, and thin, more or less obsolete secondary veins, emerging at a broad angle of 50° to 60°, undulating in passing to the borders, and anastomosing with branches of the veins above, camptodrome.

There is apparently a great difference between these two leaves, especially in the borders, which in Fig. 3 are merely undulate, while in the large leaf they appear undulate-crenate, a character which, to my knowledge, is not recognized in any living species of the *Magnoliaceæ* nor of the *Anonaceæ*, some of which have a nervation and areolation somewhat similar to that of this leaf. This denticulation of the borders, however, may not be normal. In the upper part of the large leaf, especially on the right side of the figure, the denticulation is more marked than seen upon the specimens, whose borders are somewhat obscurely marked or as reflexed, and not more deeply undulate than as they are seen on the left side.

I have referred these leaves, as advised by Saporta, to the genus *Celastrophyllum*, Ett., one species of which is described in the Cretaceous Flora v. Niedershœna, (p. 26, Pl. iii, Fig. 9,) under the specific name of *C. lanceolatum*. The reference of our leaves to this genus is not, however, positive; but their relation is still less marked with *Magnolia crassifolia*, Gopp., of the Tertiary of Silesia, to which I compared them formerly. The areolation is represented in Fig. 3 as distinctly as it can be seen. Though the end of the veins is effaced near the borders, they appear really camptodrome. This nervation has its analogy in species of *Oxandra*, as *O. laurifolia*, Rich., of Cuba, of which some of the leaves, at least, are abruptly pointed or obtusely acuminate.

Habitat.—South Kansas, *Mudge;* also six miles south of Fort Harker.

RHAMNUS TENAX, Lesqx, Pl. xxi, Fig. 4.

Leaf entire, lanceolate-pointed, narrowed by a curve to a short petiole; lateral veins close, numerous, thin, parallel.

Rhamnus tenax, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101

A fine leaf, attached to a branch by a short petiole. Its substance is not thick; its form lanceolate, tapering upward to a slightly obtuse point, and more abruptly downward from below the middle to the petiole. It is 9 centimeters long, with the petiole, which is about one centimeter and a little more than two centimeters wide in its broadest part. The thin lateral veins are

parallel, except the basilar one, which, following the curve of the borders, is on a slightly more acute angle, numerous, fifteen to sixteen pairs, under a general angle of divergence of 50°; they slightly curve in ascending toward the borders, where they bend, and which they follow, to anastomose with the vein above; the nervilles are numerous, obsolete, parallel to the veins. By its form, its short, slightly enlarged petiole, and its nervation, this leaf appears, indeed, referable to *Rhamnus*, and has its analogies in a number of species of the American Tertiary like *Rhamnus salicifolius*, Lesqx., *R. cleburni*, &c., which all, however, have much thicker secondary veins.

Habitat.—Same locality as the former, *Hayden.*

Terebinthineæ.

JUGLANS (?) DEBEYANA, Heer, Pl. xxiii, Figs. 1–5.

Leaves coriaceous, entire, broadly ovate, obtuse, or with a short obtuse point, rounded-subcordate at the base or narrowed downward by a curve, and slightly decurring to the petiole; medial nerve thick; secondary veins numerous, open, camptodrome.

Populus (?) *debeyana*, Heer, Phyllites, p. 14, Pl. i, Fig. 1.

Juglans debeyana, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101.

From a single specimen submitted to his examination, Professor Heer referred the leaf with doubt to *Populus.* A large number of good specimens of leaves of the same species have been procured later, and some of the more diverse forms figured in this memoir. These leaves vary from a broadly ovate-obtuse to an elliptical form, the borders being always entire, rarely slightly undulate, as in Fig. 1. The base is either slightly decurring to the petiole or round-cordate; and though the borders are generally equilateral, they sometimes are more enlarged on one side, and the leaves, or rather leaflets, are curved on one side, as in Figs. 4 and 5. This deviation, and also the difference in the direction of the borders, as seen in comparing Figs. 1 and 3 to Fig. 2, indicates a compound leaf: Fig. 2 representing a principal or top leaflet, the others representing lateral ones. The nervation is rough and very distinct upon the impressions of the lower side of the leaves, as in Figs. 2, 4, and 5. The secondary veins are numerous, twelve to fourteen pairs, (in the leaf Fig. 2, which is 8 centimeters long,) on an open angle of divergence averaging 60°, thick, variable in distance, more or less parallel, separated by tertiary shorter veins forming, by anastomose with the nervilles, a net of irregular, large, mostly quadrangular

meshes; the veins and their divisions curve along the borders in a succession of short flexures. This nervation is somewhat like that of some leaves of *Juglans* of the European Tertiary: for example, *Juglans latifolia*, Heer, (Flor. Tert. Helv., III, p. 88,) especially as marked in Pl. cxxix, Figs. 3, 6, and 9. However, the reference of these leaves to *Juglans* is far from positive, the nervilles being more irregular and the veinlets more irregularly divided than in any species of *Juglans*. A more analogous nervation to that of this species is remarked in some species of *Rhus*, as in *R. metopium*, which has coriaceous leaves, slightly cordate, and of forms somewhat resembling those of the fossil leaves.

Habitat.—Decatur, Nebraska, *Hayden;* a large number of specimens.

PHYLLITES RHOIFOLIUS, Lesqx., Pl. xxii, Figs. 5, 6.

Leaves coriaceous, lanceolate, penninerve, irregularly obtusely crenate; medial nerve thick; secondary veins parallel, camptodrome.

Phyllites rhoifolius, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 101.

The two fragments of leaves, represented in the figure, are of very uncertain relation. As seen in Fig. 6, the leaves of this species appear to have been enlarged on one side and somewhat lobate at the base, or of an irregular form. As in our *Rhus toxicodendron*, the secondary veins are thick, on a broad angle of divergence, curving along the borders, where they unite with oblique obscure nervilles. I compared it, for the nervation, (in the journal quoted above, 2, xlvi, 1868,) to *R. cotinoides*, one of the numerous varieties of the poison-ivy.

Habitat.—Lancaster County, Nebraska, *Hayden.*

PRUNUS CRETACEUS, Lesqx., Pl. xxiii, Figs. 8, 9.

Drupe ovate, obtusely pointed, smooth, grooved on one side to the middle, notched at the enlarged obtuse base.

Prunus cretaceus, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 102.

The form of this small, hard fruit is like that of the drupe of a plum, or of a large cherry. Another nutlet of about the same form, but compressed and flattened, is imbedded in the stone, its back and part of the sides only being visible, as seen in Fig. 9.

Habitat.—Same locality as the former.

Leaves and fruits of uncertain affinity.

PHYLLITES BETULÆFOLIUS, Lesqx., Pl. xxviii, Figs. 4–7.

Leaves small, mostly in fragments, round-ovate, truncate at the top, narrowed to the base by a round curve; borders dentate; nervation pinnate, irregular, craspedodrome.

Phyllites betulæfolius, Lesqx., Transactions of the American Philosophical Society, vol. xiii, p. 430, Pl. xxiii, Figs. 2–4.

These fragments, though far different in form and size, appear to belong to the same species. All the leaves are marked on the borders by short teeth, turned outside; the secondary veins, at various distances, are more or less open, mostly branching, entering the teeth by their points or those of their divisions, and joined by strong flexuous nervilles, perpendicular to the veins and undulate. The consistence of the leaves is thickish. They appear to have been petioled, at least from the narrowing of the base of the leaves in Figs. 5, 7, above the line of disruption.

Habitat.—Fort Harker, *Dr. Leconte;* the fragment of Fig. 4 is from Nebraska, *Prof. James Hall.*

PHYLLITES RHOMBOIDEUS, Lesqx., Pl. vi, Fig. 8.

Leaf rhomboidal, broadly cuneate to the base, more obtusely narrowed and undulate from the middle to an obtuse short point; nervation five-palmate from the base, the two inner lateral veins curving up at a very acute angle of divergence and acrodrome, or nearly reaching the point of the leaf, branching outside, the external veins following the borders up to the middle of the leaf, where they anastomose with branches of the first pair.

Ficus (?) *rhomboidea*, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 96.

A remarkable leaf, which, by its form and nervation, somewhat resembles the leaf of a *Smilax*, a *Paliurus*, or a *Populus*, and which, by its thick consistence and thick nervation, is different from any species of these genera. Its form is nearly exactly rhomboidal, being, however, more acutely cuneate and entire from the enlarged part, the middle, to the base than to its obtuse point, where it passes by undulations. Its five-palmate nervation is from a slightly enlarged base, apparently the top of a broken petiole. The general form of the leaf is like that of *Populus arctica*, Heer, as represented in Flora Arctica, (1, Pl. v, Fig. 3;)—even the direction of the five primary veins is about the same; but the veins are thicker, as is also the texture of the leaves, and these veins are less branching. Moreover, the base of the leaves in the Arctic species is always more enlarged, generally round or truncate. The

same analogies and differences are remarked between this leaf and that of *Populus leuce*, described by Unger, (Flora v. Sotzka, p. 37, Pl. xv, Fig. 6.) From its nervation, our leaf seems to have also some relation to species of *Ficus* of the palmate-nerved section, like *Ficus asarifolia*, Ett., *Ficus crenata*, Unger, and *Ficus grœnlandica*, Heer, (Flora Arctica, p. 111, Pl. xiii, Fig. 6.)

Habitat.—Near Decatur, Nebraska, *Hayden.*

PHYLLITES VANONÆ, Heer, Pl. xx, Fig. 7; Pl. xxviii, Fig. 8.

Leaves small, ovate-lanceolate, pointed, cuneiform to the base; borders entire; medial nerve thin; secondary veins few, scattered, camptodrome.

Phyllites vanonæ, Heer, Phyllites du Nebraska, p. 22, Pl. i, Fig. 8.—Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 102.

The form of the leaf of Pl. xxviii, Fig. 8, as far, at least, as regards its cuneate base, and the rare, lateral scattered veins, are the only characters which mark the identity of the two leaves figured as above. The substance of these leaves is rather membranaceous or thickish.

Habitat.—Near Decatur, Nebraska, *Hayden;* Minnesota, *Hall.*

PHYLLITES UMBONATUS, Lesqx., Pl. xix, Fig. 4.

American Journal of Science and Arts, *loc. cit.*, p. 102.

Apparently a deformed leaf, quadrate in outline, truncate at the base, deeply notched at the top by the splitting of the thick medial nerve, irregularly broadly undulate-lobate on the borders; secondary veins few, at irregular distance, nearly at right angle to the medial nerve, curving in passing to the borders, craspedodrome.

The border-base is destroyed.

Habitat.—Near Beatrice, South Nebraska, *Hayden.*

PHYLLITES AMORPHUS, Lesqx., Pl. xxii, Figs. 3, 4.

Two fragments of coriaceous, obovate, entire leaves, gradually narrowed to the base, (broken;) medial nerve deep and narrow; secondary veins either in right angle to the medial nerve or curved downward or going up in an acute angle of divergence, branching and anastomosing in various abnormal ways.

Phyllites amorphus, Lesqx., American Journal of Science and Arts, *loc. cit.*, p. 102.

I know nothing more about these fragments but what is described above. They are comparable to some species of *Quercus* by their nervation, at least.

Habitat.—Decatur, Nebraska, *Hayden.*

PTENOSTROBUS, Lesqx.

Cone oblong or cylindrical, bearing small oval seeds, attached to oval-oblong wings or scales.

This name is admitted for the description of a strobile, whose relation is as yet uncertain, as may be seen from the description of the species.

PTENOSTROBUS NEBRASCENSIS, sp. nov., Pl. xxiv, Fig. 1.

The figure represents, as far as it is distinguishable, a cone two to three centimeters wide, oblong, crushed, or, rather, cut in its length and by the middle, exposing numerous small, oblong-oval seeds, convex or lenticular-obtuse at one end, pointed downward, regularly striated lengthwise. These seeds are apparently crushed, and their relative position is undiscernible, except for a few which appear imbricated in an oblique row along the borders. They are attached to salient wings, oblique to the axis of the cone, and joined to the seeds, as marked in the enlarged figure. It is, however, possible that the dark ring, marked as the base of the scale at its point of union to the seeds, is only formed by a fragment of the coating of coaly matter which envelops the seeds, as seen in the figure, which shows a seed with part of the coating destroyed, and, therefore, that the scale is not superposed to the top of the seeds, but passes to the base behind it or invelops it, as in some species of conifers. In this case, the cone would present an appearance somewhat similar to that of *Cunninghamites oxycedrus*, as figured in Ett. Cret. Flor. v. Nieders., (Pl. i, Fig. 9,) supposing, however, that the scales of this cone, which appear broken, should have been longer and oval-lanceolate. In the Nebraska strobile, these scales are striate in the length as in those of the cone of Niedershœna. I am not able to find any other point of comparison for this fossil.

When I broke open the stone, the vegetable impressions were very distinct; the scales or wings, like the seeds, being sharply defined and painted black upon the yellowish sandstone. By exposure to the atmosphere, the coloring has become less distinct, and the specimen now presents the appearance as seen in the figure.

Habitat.—Warner's quarry, eight miles northeast of Winnebago Village, bluffs of the Missouri River.

CARPOLITHES (?), Pl. xxvii, Fig. 5; Pl. xxx, Fig. 11.

This specimen (Fig. 5) may be referable to some fruit of unknown

affinity. I was at first disposed to regard it as a mere sandstone concretion, and, therefore, as inorganic; but I found at the same locality, Blackbird Hills, two other specimens, which, though somewhat different in form and size seem to indicate their origin as vegetable. The one figured (Pl. xxvii) is oval, pointed at both ends, costate, apparently marked at the lower end by a small hollow, surrounded by round small bolsters, as seen at the end of the costæ. The second is oblong-oval, smooth or without ribs, more abruptly rounded at one end, and truncate at the other, with a distinct round excavation in the middle, like the scar of a detached pedicel. The third is smaller, but about of the same form as the first, and costate. These fruits (?) could be compared to some nuts of palms, or to fruits related to the *Nipadites* of Bowerbank, from the Eocene of England, but the analogy is questionable. In some exposures of the sandstone of this formation, as, for example, near Brooksville, Kansas, and between Tekamah and Decatur, there is an abundance of round, smooth, perfectly regular concretions, generally called nuts by the farmers, and considered as petrified walnuts or fruits of palm, &c. From the examination of a large number of them, they are positively recognized as mere ferruginous concretions. The so-called *Carpolithes*, described above, may be of the same kind. An exactly round form and a same size for a number of specimens of concretions is, however, more easily explained than a kind of relation by characters, which, like the hollow for a pedicel at one end, or an equal disposition of ribs, &c., are not generally the result of mere inorganic agglomerations.

CAULINITES SPINOSA, Lesqx., Hayden's Report, 1872, p. 422.

Stem or branch cylindrical, 1½ centimeters in diameter, with its surface rough, marked by irregular, close dots or small cavities resembling the impressions of scales. The stem apparently bears strong spines at a right angle; their hollow, cylindrical scars are seen perforating the stone. These small stems or branches resemble, by the rough surface, the fragments described by Ettinghausen as *Caulinites stigmarioides*, (Flora v. Nieders., p. 14, Pl. ii, Fig. 1;) the dots, however, being closer in our stem, and about round, or not so much transversely enlarged. The fragments, mostly imbedded and visible only at their ends, could not be figured.

Habitat.—Near Fort Harker, Kansas.

§ 10.—On the general characters and the relation of the flora of the Dakota group.

Though the formation of the Dakota group is in immediate superposition to the Permian or the Upper Carboniferous measures, we cannot, of course, look for any remains of Permian vegetable types in this American cretaceous. We should, perhaps, expect to find there some representatives of the preceding formation, the Jurassic, whose flora is a compound of *Ferns*, few *Equisetaceæ*, some *Conifers*, and especially a prodigious abundance of *Cycadeæ*. Three-fourths of all the fossil *Zamiæ*, and half of the *Cycadeæ*, known from all the geological formations, belong to the Jurassic. In the Lower Cretaceous of Greenland, Heer finds still a marked proportion of species of this family, there being nine *Cycadeæ* in a group of thirty-six species of land-plants, a proportion of 35 per cent. of the land-flora of that epoch as far as it is known. In the Dakota group, the only trace of a vegetable possibly referable to the *Cycadeæ* is the *Pterophyllum*(?) *haydenii*, which, as it is remarked in the description, is considered by Schimper as of doubtful affinity. Professor Heer, too, finds in the Upper Cretaceous of Greenland a flora of twenty-eight species, mostly of dicotyledonous plants, without any remains of *Cycadeæ*.

This absence of a predominant antecedent vegetable type in the Dakota formation is not more remarkable than that of other vegetable groups, especially the palms, which constitute an extraordinary large proportion of the flora of the Lower Tertiary strata, just above the deep marineformation overlying or following that of the Dakota group. The section of the Cretaceous strata, as copied from Hayden's Report, page 14, indicates at its base the sandstone and clay strata bearing plants, four hundred feet thick, and in ascending, some beds, mostly of clay, of a thickness of seventeen hundred feet, overlaid by five hundred feet of Cretaceous sandstone. Over this formation appears the Lower Tertiary sandstone with fucoidal remains, mixed in its upper part with fragments of land-plants, followed by the lignitic formation, with its peculiar flora, especially its abundance of palms. The series of strata between the Dakota group and the lignitic Eocene has been uninterrupted, as far as can be judged from the nature of the compound and the affinity of fossil animal remains. It does not indicate a period of long duration, at least comparatively to other more complex geological groups; and, nevertheless, the flora of the Dakota formation has not a single species which might be referable to, or is recognized as identical with, any of the

land-plants of the Eocene, especially none of its essential representatives, the Palms. The proportion of Palms, especially of *Sabal* species is marked in the lignitic at Golden, Black Butte, &c., not only by the remains of leaves, which in places fill thick strata of sandy clay, but also by fossil wood of the same class of plants, or by their trunks transformed into coal and identified by the characters of their internal structure. In ascending from the lower lignitic measures, where the essential types of the Cretaceous flora have no representatives, we see these Cretaceous types re-appearing, a few in the Upper Eocene of Evanston, more of them in the Carbon group above, still more in the Upper Tertiary, following thus an increasing degree of predominance, culminating, it seems, at the present time, in the flora of the eastern slope of the North American continent. The disconnection of types of the flora of the Dakota group appears, therefore, as a kind of break in the vegetable scale, accountable perhaps to modifications of climatic circumstances.

The essential and more numerous vegetable remains in the Dakota group are leaves of Dicotyledonous, representing the three divisions of this class, and, what is more remarkable, the genera to which belong most of the living arborescent plants of this country and of our present climate. If what may be called positive characters of the genera—the flowers and the fruits—are not ascertainable from fossil remains, it is at least impossible to deny the intimate relation of most of the leaves of the Dakota group to the genera to which they have been referred in their descriptions.

Beginning by the *Apetalous*, we have, first, *Liquidambar* leaves, so similar to those of our sweet-gum tree (*L. styraciflуum*) by form and nervation, that, in comparing the fossil leaves with those of our living species, no other difference can be remarked but the entire borders of the fossil ones. They are more or less serrate-crenulate in the living species, as also in *L. europeum* of the Miocene of Europe. But some species of the same formation, considered by authors as referable to this genus, have leaves with entire borders, as seen in the descriptions. Even Gaudin, in his first *Memoire* on the Fossil Leaves of Tuscany, figures as *L. europeum*, three leaves, one of which, with entire borders, (Pl. v, Fig. 3,) is remarkably similar to our Fig. 1 of Pl. ii; the lateral nerves being marked as branches of the second pair of nerves, just as it is in our Cretaceous leaves, and not emerging from the top of the petiole as in the leaves figured by Heer under the same name. Gaudin accounts for the entire borders of this leaf by the supposition that the

denticulation cannot be remarked on account of the coarseness of the stone imbedding the leaves. We could give the same reason or admit such a supposition, but the form of the leaves of this genus is so peculiar that the difference in the more or less serrate borders cannot prevent a generic identification. The leaves of the Cretaceous species are, especially by their truncate base and their general outline, rather related to those of our *L. styraciflŭum* than to those of the Asiatic form, *L. orientale*. These are the two only living species of *Liquidambar* with palmately-lobed leaves.

The history of this genus, its origin, and the present distribution of its species, offer, with that of *Platanus*, a coincidence worth remarking. Both appear first in the Dakota group; both pass through the Tertiary formations of Europe in different modifications; and both have each for essential representatives of the present flora an oriental and an occidental form: in Asia, *Liquidambar orientale* and *Platanus orientalis;* in our country, *L. styraciflŭum* and *P. occidentalis*, of which the Mexican and the Californian forms are mere derivations. No species of *Liquidambar* has been as yet recognized in our North American Tertiary formations. Two species widely distributed are described with numerous varieties from the Tertiary of Europe.

The leaves referred in this memoir to the genus *Populites* are not comparable to any of the North American species of *Populus* of our time. They especially differ by the entire borders, which in all our species are more or less serrate or dentate. By this character, as well as by their coriaceous substance, the relation of the Cretaceous species of *Populites* is with a peculiar group of poplars, the *Coriaceæ*, represented in the Upper Miocene of Europe, and with us at Evanston and Carbon, by *Populus mutabilis* and *P. gaudini*, Heer, and at this time by *P. euphratica*, Oliv., an oriental species, whose leaves, however, are dentate, and *P. pruinosa*, Schr., of Siberia, whose leaves are nearly round, with borders entire. This last one only may be said to have a marked relation to the *Populites* of the Dakota group.

The relation, however, of *Salix* and *Fagus* with present species of our flora is positively marked. Our *Salix candida*, Wild., as widely distributed as a shrub as the beech is as a tree, is the living willow most intimately related to the Cretaceous form. Its type is also represented in the Upper Tertiary, or the Pliocene of California especially. The species of *Fagus* of the Cretaceous is, by its entire, undulate leaves, rather referable to the present *F. sylvática* of Europe than to our *F. ferruginea*. Both these species, how-

ever, are so similar that they were formerly considered by botanists as mere varieties, and are still admitted as such by some. They have on both continents the same wide and general distribution, being essential constituents of the forests of our present time. *Per contra*, most of the species described as yet from the Tertiary more or less widely differ from the European or the North American types. *F. pristina* is distantly related to our *F. ferruginea*. *F. antipofi*, from the Miocene of Alaska, is related to the same by the slightly dentate borders, but differs, indeed, by the larger size of the more taper-pointed leaves. *F. macrophylla*, of the same formation and country, has the leaves entire, like the European species, but still of a far larger size, the specimen figured by Heer representing a leaf sixteen to eighteen centimeters long and ten centimeters wide. *F. deucalionis*, *F. feroniæ*, and *F. horrida* have borders of leaves more or less dentate, and therefore more like the North American type. The beech has now representatives in far distant countries, but its types are local, and all the exotic ones differ from that of our fossil species. Japan has one species, with leaves cordate at base and borders obtusely crenate, the secondary nerves tending to the sinuses. Chili has five, with leaves obtuse, truncate at the base, and borders mostly doubly serrate. South Central America has one of very wide distribution; it has small, coriaceous dentate leaves. New Zealand has four, all with doubly serrate leaves, and the lower surface white, tomentose; and Tasmania has for its share two species of a still more distant type, with obtuse, truncate, and dentate leaves. It is only when out of the geographical limits of the north occidental flora or in the Grecian Archipelago that we find a fossil species of *Fagus* related to an exotic form with doubly dentate small leaves, *F. dentata*, from Eubea, a species which Unger compares to the Chilian *F. obliqua*.

After this we find described, from our Cretaceous flora, *Betula beatriciana*, comparable, by the form of its leaves and its nervation, to our *B. nigra*, widely distributed from the northern shores of Lake Superior to Florida; leaves and seeds of *Myrica;* at least these which we have figured under this name are undistinguishable from Heer's seeds of *Myrica*, described from the Cretaceous flora of Quedlinburg, but, indeed, more flattened than the seeds of any of our present species; then two leaves which Saporta considers as representatives of the genus *Celtis*, of which we have still two species in our flora; then leaves of oaks, *Quercus primordialis*, of the type of the so widely distrib-

uted and variable *Q. prinus*, the chestnut-oak; and *Q. ellsworthianus*, type of our *Q. phellos* and *Q. imbricaria*, species with entire borders of leaves.

It would be hazardous to pursue a typical comparison of the Cretaceous species of oaks on account of the few materials found as representatives of this genus in the shales of the Dakota group. The few specimens referred to this genus, however, represent well typified leaves, from which, at least, we know that the oaks were already present in the Cretaceous flora of our continent. They appear few, in a modest way, though already of two distinct types; but soon the forms become more numerous, and the genus takes an important place in the arborescent vegetation of the world. In the Eocene flora of the Rocky Mountains, six species have been discovered already, among which one representing the third essential type of our oaks, marked with deeply pinnately-lobed leaves, as in the numerous species of the section of the North American black oaks. The Spring-Cañon specimens, which seem to represent two horizons of the Tertiary, have eight species; the Washakie group and Carbon have six; and in the Pliocene of California the representatives of this genus are still more numerous, and their types still more intimately related to those of the living species. The flora of the California chalk bluffs has six species of oaks under only thirty-four dicotyledonous species.

The three last genera of the *Apetaleæ* represented in the flora of the Dakota group are *Platanus*, *Laurus*, and *Sassafras*.

Though no fruit of *Platanus* has been found till now with the leaves, these are, by their form and nervation, positively typified as representatives of this genus. Heer had already recognized *P. newberrii* in his *Phyllites du Nebraska*. To this I have added *P. heerii*, far different from the former, as seen in the description, and *P. primæva*, which, from its likeness to *P. aceroides*, I was formerly induced to consider as a mere variety. Though, from the form of its more entire leaves, the Cretaceous species is apparently distinct, the analogy or similarity, as indicated by the characters of the leaves, is not the less remarkable. It is the type of the species later represented by acutely lobed and dentate leaves, which we recognize in the Eocene of the Rocky Mountains as *P. haydenii;* in the Miocene of the same country and of Europe as *P. aceroides;* in the Pliocene of California as *P. dissectus*, and especially now as *P. occidentalis*. *P. aceroides* was already considered by European authors as the ancestor of our *P. occidentalis* before the Cretaceous species

had been discovered. Now we have to refer the origin of our noble tree to a more ancient epoch.

Like that of *Fagus* and *Liquidambar*, the Cretaceous type of *Platanus* has not widely varied and multiplied; neither does it appear to have changed its habitat in a marked degree, at least not in latitude. One species only, *P. aceroides*, and its variety, *P. guillelmæ*, is abundantly distributed in the Miocene of Europe, from Greenland as far south as North Italy, over an area of about twenty-six degrees of latitude, while the range of *P. occidentalis* is from the great lakes to the Gulf of Mexico, passing still farther south into Mexico by its analogous *P. mexicana*. From Europe it has passed eastward as *P. orientalis* in the same way as it has gone west from our country as represented by *P. racemosa* of California.

In the *Laurineæ* we have leaves referable, by their form and nervation, to the genus *Laurus* or *Persea*, and a well-preserved fruit, *Laurus macrocarpa*, which, comparable, also, to the fruits of *Cinnamomum* and *Sassafras*, is, from its association in the same localities with leaves of *Laurus*, admitted as belonging to this genus. It seems a southern type in comparing it to the other species of the Dakota group, but it is rather, I think, a shore-type. Our *Laurus* (*Persea*) *caroliniana* extends in following the shores from Virginia to Louisiana and farther west in Texas. It is a meager remnant of a number of species of the same genus which inhabited our North American continent and that of Europe during the Tertiary period. We find some of them already in our Eocene, especially in Mississippi. Eight species of *Laurus* and two of *Persea* have been described from the Miocene of Europe. The genus enters by three species into the Miocene flora of the Baltic, but it has as yet no representative farther north. None has been described from the arctic regions.

Sassafras belongs to the same family. The leaves of *Sassafras* are found in such great proportion in the southern area of the Dakota group, especially in Kansas, that the genus seems to have represented there a large part of the land-vegetation. Our present *S. officinale* is, by its leaves, scarcely distinguishable from some of the varieties or forms of the leaves of the Cretaceous species, which, like the present one, seems to have had a remarkable disposition to variability. I have explained with the description of the fossil leaves what reasons have induced me to separate as species some of the more peculiar forms, and to refer all these forms to the same genus. I must say, however,

that, considering merely the outlines of the leaves of our present *Sassafras*, it would be as convenient, if they were found distributed in groups and in a fossil state, to separate as species as large a number of them as it has been done for the *Sassafras* leaves of the Dakota group.

One species of *Sassafras* has been recognized in the more recent geological formations of this continent, the miocene. Three species are described from the Tertiary of Europe, one of which, *S. ferretianum*, is in the Miocene of Greenland, as also in the same formation of Italy. The wide range of distribution of *S. officinale*, the only living species, also limited to this continent, is well known. It extends from Canada to Florida, and, over the same latitude, from the borders of the Atlantic to the Western prairies, even as far west as the region of the Dakota group, along the banks of the Missouri River near Omaha. The distribution of this beautiful, odorant, and sanative shrub, which in good situations becomes a tree of moderate size, is as remarkable as its exclusive affection for the land of its origin.[1]

The division of the *Gamopetaleæ* is not as positively and evidently represented in this Cretaceous flora as the former. Heer, however, has *described in the Phyllites du Nebraska* one species of *Andromeda*, figured in this memoir from better preserved specimens, and one species of *Diospiros*, to which two others have been added from more recent discoveries. The references of leaves of the Dakota group to these genera is therefore reliable. There is in the Tertiary of Europe and of this continent a number of species of the same genera. No less than twenty-four *Diospiros* species are described from the Miocene; among them, two from Alaska and Vancouver Island. Of nearly one hundred species known of this genus in the flora of our time, *D. virginiana*, the Persimmon, is the only one which has been left in the temperate regions of the North American continent. None belongs to Europe. Of the two species more intimately allied to the North American, one, *D. lotus*, a native of China, is often cultivated in the south of Europe; the other, *D. kaki*, is from Japan; both have eatable fruits.

Proceeding further and coming to the division of the *Apetalæ*, we find among the fossil leaves of the Dakota group an *Aralia* leaf, similar in its essential characters to one described by Heer from the Cretaceous of Europe. There is a slight difference, which may be considered as specific, but generic

[1] Like that of our *Cornus florida*, the acclimatization of this species has not succeeded in foreign countries.

identity is undoubtful; a *Hedera*, whose affinity is marked by the outline of its coriaceous leaves, and still more by the nervation; three species of *Magnolia*, represented by a large number of leaves and recognized already in the *Phyllites* by Heer; and four species of *Liriodendron*, the tulip-tree, whose form of leaves, like that of the *Sassafras*, sufficiently proves the generic reference.

Considering these genera separately in regard to their relations and to their present and past distribution, we find *Aralia* still represented in our flora by six species, all of different characters of leaves; for, indeed, the relation of the fossil form is rather to an old section of the *Aralia*, with compound palmate leaves, now referred to the *Hedera*, like *H. xalapensis* of the mountains of Mexico. This type is still represented by large leaves in the Pliocene flora of California. *H. helix*, the ivy to which our Cretaceous species *H. ovalis* is closely allied, is indigenous of Europe, where its origin is confirmed by paleontology, the species having been recognized in the Pliocene of Italy. It is, however, of so easy acclimation with us that it looks like an old wanderer returned home after a long absence. In the temperate zone of the United States, it invades walls and stone-dwellings as it covers the ruins of the European castles of old. The genus *Aralia* is not represented as yet in the fossil Tertiary flora of Europe.

But evidently these two most admirable genera of trees, *Magnolia* and *Liriodendron*, belong to North America by origin, succession, and presence. Of the eight species of true *Magnolia* (*Magnoliastrum*) now known to botanists, seven belong to the western slope of the temperate zone of North America, and the other, *M. mexicana*, is either a variety of *M. glauca* or *M. grandiflora*, or even is referable to a different genus. We have seen that already two species of *Magnolia* have been recognized by Heer in the Dakota group. I have added one species to the number. In our Tertiary, we have still seven species; five of them in the Mississippi Eocene, one at Carbon, and one at Black Butte. Of the Mississippi species, two have been found in the Raton Mountains, New Mexico, marking thus the genus with the same climatic distribution as it has now, or with wandering representatives far from the limits of its area of general distribution. Thus, one of the species, *M. inglefeldi*, found at Black Butte, is described by Heer from the flora of Greenland, just as we find now groups of *M. glauca* and *M. umbrella* isolated in deep gorges in New York, Pennsylvania, etc., far out of the mean range of habitat of the genus. In the Pliocene of California, the genus has two species. In the Tertiary for-

mations of Europe, it has none. As remarked above, however, one species is described from Greenland and two from the Cretaceous formation of Moletin, these of a type different from that of the Dakota-group species.

Liriodendron, the tulip-tree, has in its characters, its distribution, and its life a great degree of affinity with *Magnolia*. The American species is the only one known now in the vegetable world, and its habitat is strictly limited to this country. It does not ascend higher than the fortieth degree of latitude, except, perhaps, casually, like *Magnolia* under the protection of favorable local circumstances. The genus does not appear to have any disposition to modifications of its type and to migrations. We have as yet scarcely any fossil remains of it in our Tertiary formations. In that of Europe, it is represented from Greenland to Italy by one species only. The leaves of different forms, described from the Dakota group as four species, may perhaps be referable to a single one, as the characters, especially the size, of the leaves may be local, and result from climatic circumstances. It has thus passed a solitary life. Even now, by the singular and exclusive form of its pale-green glossy leaves; by its large cup-shaped yellow flowers, from which it has received its specific name; by its smooth, exactly cylindrical stem, gracefully bearing an oblong pyramidal head of branches, grouped with perfect symmetry, it stands widely apart from the other denizens of our forests as a beautiful stranger, or rather as a memorial monument of another vegetable world. Either considered in its whole or in its separate characters, the Tulip-tree is a universal and constant subject of admiration and wonder. It could be named, not the king, it is not strong enough for that, but the queen of our forests, if the *Magnolia* was not there with it to dispute the prize of perfection by the still grander majesty of its stature, the larger size of its foliage, the elegance and the perfume of its flowers. Our sense of admiration for these noble trees is heightened still by the dignity of their ancient origin.

I have referred to the family of the *Menispermaceæ*, under the generic name of *Menispermites*, a large number of leaves related, by their form and nervation, to those of the American species of *Menispermum*, *M. canadense*, and *M. carolinum*. The relation appears to me as positive as it can be established from a single kind of vegetable organs, the leaves. This relation may be searched for in plants of a far distant country and of a different climate, and there, perhaps, found as evident with another class of vegetables. But I cannot admit that we have to look to foreign types for analogy of a vegetation

whose essential characters are recognized in the species of this country *M. canadense* is now the consort of our *Platanus*, *Magnolia*, *Tulip-tree*, &c. It grows under the same climatic circumstances, and has the same habitat. As the leaves of the Dakota group, compared to this species, are like it—peltate, round or cordate, obtusely angular, of the same nervation and consistence—there is reason, indeed, to refer it to this genus rather than to any other having no representatives among us.

No species of *Menispermum* or *Menispermites* has been recognized from the geological formations, except the species of the Dakota group. One leaf, however, is described by Unger as *Acer obtusilobum*, which appears to me a true *Menispermites*. It has the secondary nervation of *Menispermum*, (*Cocculus*) *carolinum*, and the basilar veins come out from the borders of a round, notched base, as in a peltate leaf. Unger doubtfully considered this leaf as a species of *Acer*. Till now, we have not seen any appearance of organs of this last genus, either leaves or seeds, in the Dakota group, as we have none also in the Eocene. The maple seems to be of more recent origin, as it is remarked hereafter. However, one Cretaceous leaf, or the fragments of a double leaf are referred with doubt to the genus *Negundo*. As the leaf is not complete, its outline indefinite, it is useless to argue upon its possible affinity; and for this, as for some others, we have to wait for the discovery of more perfect materials.

The relation of other leaves of the Dakota group to the genera *Paliurus* *Rhamnus*, *Juglans* or *Rhus*, and even *Prunus*, appears sustained by sufficient evidence. The characters of the leaves of *Paliurus* and *Rhamnus* are not likely to be mistaken. Both these genera have identifiable remains in the Tertiary of the Rocky Mountains; one *Paliurus* is found in the Eocene of Golden and Black Butte, and another in the Miocene of Carbon and Washakie. This last is an arctic species, also recognized by Heer in the Miocene of Greenland and Spitzbergen. *Rhamnus* is especially well represented in our Lower Tertiary. Eight species are described from Golden, Black Butte, and the Raton Mountains, four of which are in the Miocene of Europe, where the genus has fourteen species. It is, therefore, an old type, well established at the beginning of our Tertiary period;[1] and it is not surprising to find it already in the Upper Cretaceous flora. Its present distribution is mixed. The genus preserves its predominance in Europe by the number of its species; it has there more than a dozen, while in North America it has only four or five.

[1] The leaf described under the name of *Rhamnus tenax*, is considered by Count Saporta as a *Salix*.

It is remarkable that the next closely allied genus, *Ceanothus*, has not yet been recognized in the Dakota group, though now an exceptional American type. It has one species in the Eocene of Golden, another, very fine, in the same formation of the Mississippi, and many more in the Upper Tertiary of the Rocky Mountains, and especially in the Pliocene of California. The ten living species of true *Ceanothus*, described in De Candolle's Prodromus, belong to the United States, especially to the southern zone, and a number of them are added to the list by the as yet unpublished flora of California. The absence of the type in the Cretaceous of the West is in accordance with the fact remarked upon, in describing the general character of the leaves of the Dakota group, viz, the absence in this group of any kind of serrate leaves.

It is uncertain whether the compound leaves, of which a number of separate leaflets have been figured in this memoir as *Juglans* (?) *debeyana*, represent a species of *Juglans* or of *Rhus*. I should be inclined to refer them to this last genus, especially on account of the nervation more analogous to that of the present *Rhus metopium* of Florida,[1] whose leaves also resemble somewhat the fossil ones; but there is as yet no sufficient evidence on this account. In considering the distribution of the species of both *Rhus* and *Juglans* in the subsequent formations, we do not find any difference pointing to a predominance of one of these types at any time. From the Dakota group, two other kinds of leaves are referable to *Rhus*. In the Upper Tertiary of the Rocky Mountains we have six; and it is well known now that the relation of our vegetable Cretaceous types is not with Eocene species, but rather with those of the Upper Tertiary and of the present flora. On another side, *Juglans acuminata* and *J. rugosa*, which, by their somewhat coriaceous, entire leaves, are distantly related to the Cretaceous species, have been recognized at most of the localities where Tertiary fossil plants have been found; they are at Carbon and also in the Eocene at Golden, the Raton, Black Butte, &c., and thus seem to indicate, by their general distribution, the origin of *Juglans* in the Cretaceous group as evidently as that of *Rhus*. From the Miocene of Europe, about twelve species of this last genus have been described, two from the arctic regions; and from the same formation, as many species of *Juglans*, with six species of *Carya*. At our time, *J. regia*, so generally known and cultivated for its large fruit, is of Asiatic origin, while of the other four species

[1] The species is indigenous in Cuba. I have specimens from South Florida, but it may be there cultivated.

known, three belong to the middle zone of the United States, which has also for its share all the living species of *Carya*. Of the living species of *Rhus*, Austral Europe has two, one of which, *R. cotinus*, has been compared, by the form of its leaves, to *Bumelia emarginata* of the Dakota group. We have in the United States, beside *Rhus metopium*, which is rather a tropical form, six species of the section of the pinnately-divided leaves, with the trifoliate *R. toxicodendron* and *R. aromatica*, both extremely variable, all types already represented in the Pliocene of California.

Except an *Amelanchier*, described by Dr. Newberry in his Notes on Extinct Floras, &c., from the Tertiary beds of the Yellowstone, we do not know as yet any fossil species of *Rosaceæ* from the western Tertiary measures This is not a reason why *Prunus* should be excluded from the list of the genera of the Dakota group. By their present distribution, our *P. serotina* and *P. virginiana* indicate an extreme power of life, or of resistance to climatic changes, both being the only arborescent species of this continent having a range of distribution of thirty to thirty-five degrees in latitude, and both, too, being found everywhere, on every kind of ground; the one as a shrub along the banks of streams, the other as a fine tree in our woods. And, also, we have in our *P. caroliniana*, a shore-tree of the South, a species whose coriaceous, entire leaves recall the essential characters of those of the Dakota group. Three species of this genus are described from the Tertiary of Europe, and none as yet from ours; but it is probable that fossil remains referable to it will be found hereafter, as it has in our present flora a larger number of species than in that of Europe, or of any other part of the world. Of the species described by De Candolle, fourteen are North American, five European, four species belong to Japan, &c.

Resuming, in a few sentences, the above remarks, we find that the dicotyledonous flora of the Dakota group represents species referable to the genera *Liquidambar*, *Populus*, *Salix*, *Betula*, *Myrica*, *Celtis*, *Quercus*, (in two of its principal types,) *Ficus*, *Platanus*, *Laurus*, *Sassafras*, *Cinnamomum*, *Diospiros*, *Aralia*, *Magnolia*, *Liriodendron*, *Menispermum*, *Negundo* or *Acer* (?), *Paliurus*, *Rhus* or *Juglans* (?), and *Prunus* (?); or, merely considering the affinities to our present flora, of twenty-one genera, seventeen of which are those to which belong the species of our trees and shrubs which have the more general and the widest range of distribution. Indeed, all our essential arborescent types are there, except those which are marked by serrate or doubly serrate leaves:

Tilia, *Æsculus;* all the serrate *Rosaceæ; Hamamelis*, *Fraxinus;* the *Urticineæ*, *Planera*, *Ulmus*, *Morus;* and of the *Amentaceæ*, the serrate *Betula*, *Alnus*, *Ostyra*, *Carpinus*, *Corylus*, *Carya*, &c.

This enumeration exposes the general *facies* of the leaves or of the flora of the Dakota group, viz, integrity of the borders and coriaceous consistence of the leaves. The borders, if not perfectly entire, are merely undulate or obtusely lobed. There is only one exception to this in that peculiar short denticulation with outside turned teeth, which is marked, exactly of the same kind, in *Greviopsis haydenii*, *Platanus newberrii*, *Protophyllum mudgei*, and the fragments described as *Phyllites betulæfolius*. This mode of division of the borders of leaves is very rare in species of our present times, except, perhaps, in some leaves of poplars.[1] One species only of the Dakota group, *Quercus primordialis*, has its leaves with borders distantly serrate, or marked by teeth turned upward. There is, also, in the flora of the Eocene of the Rocky Mountains a marked preponderance of leaves with entire borders. The serrate leaves appear in the Miocene with *Acer*, *Alnus*, *Corylus*, and become predominant in the Pliocene of California, where *Ulmus*, *Planera*, *Celtis*, and *Carya* abound, though these genera are not recognized till now in the flora of the Pacific slope.

But of the detailed correlation of the flora of the Dakota group with that of the subsequent geological epochs of this continent, I will say nothing more until the materials on hand are definitely described and figured for comparison.

There is as yet little to say on the relation of the Dakota group flora with that of any of the Cretaceous groups of Europe, especially on account of deficiency of materials for comparison. Of the ferns, *Gleicheinia kurriana*, represented in the Cretaceous of Kansas, is found also in that of Moletin, of Quedlinburg, and even of Belgium, if, as I believe it, *Didymososaurus comptoniifolius* is identical with it. *Pecopteris nebrascensis*, Heer, is closely related to *Raphaëlia neuropteroides*, and *Todea* (?) *saportanea* to *Monheimia equisgranensis*, both of the same Belgian formation. In the cycadeæ (?) and conifers, *Pterophyllum haydenii* has been compared to *P. ernestinæ* of the Quadersandstein of Blankenburg; *Sequoia reichenbachi* is in the Upper Cretaceous of Greenland; and *Glyptostrobus gracillimus* may be identical with *Frenelites reichii* of

[1] It is, however, remarkably predominant in the leaves of the Lower Eocene of Sezane, as also the serrate divisions, as seen in the splendid work of Saporta on the *Flore fossile* of this formation.

Niedershœna. Among the dicotyledonous vegetable remains, we find seeds of *Myrica* of the same form as those described by Heer from Quedlinburg; leaves of *Quercus primordialis* related to *Phyllites Geinitzianus* of the Quadersandstein of Silesia; an *Aralia* and a *Protophyllum*, represented by analogous forms in the flora of Moletin; and, in relation to the Cretaceous flora of Niedershœna, there is still to record, *Ficus halliana* compared to *F. Geinitzi*, and *Celastrophyllum ensifolium* distantly related to *C. lanceolatum*.

This is sufficient to prove, relatively to our present knowledge, at least, the truth of the assertion that the flora of the Dakota group, without affinity with any preceding vegetable types, without relation to the flora of the Lower Tertiary of our country, and with scarcely any forms referable to species known from coeval formations of Europe, presents in its whole a remarkable, and as yet unexplained case of isolation.

§ 11.—Conclusion.

After the printing of the last pages of this memoir, I have received, by the kind liberality of the authors, the third and last volume of W. P. Schimper's great work on vegetable paleontology,* and a very important memoir on the fossil plants of Gelinden, (Belgium,) by Count Saporta and Dr. Marion. Both these volumes expose documents of importance in regard to the Cretaceous floras of Europe, and, by correlation, to that of the Dakota group.

The geological station of the clay-beds bearing plants of Gelinden is referred by the Belgian geologist, Dewalque, to an inferior member of a group of strata intermediate to the Cretaceous and the Tertiary, or forming the lowest division of the Tertiary, under the name of Period Paleocene.† This geologist divides this group into the following stages: at the base, the Limestone (*calcaire*) of Mons; above it, the Heersien system; then, in ascending, the Landanien, (inferior and superior;) the Ypresien, (inferior and superior;) and the Paniselien. The lowest stage, the Limestone of Mons, is generally considered as the lowest Tertiary of Europe. Till now, no remains of fossil plants have been discovered in it. The Ypresien corresponds to the London clay; the clay-beds of Gelinden are placed in the Heersien system, by the authors of the flora.‡

* Traité de paléontologie végétale ou la flore du monde primitif, &c.

† In Schimper's work the Tertiary is divided into five periods: 1st, Paleocene; 2d, Eocene; 3d, Oligocene; 4th, Miocene; 5th, Pliocene.

‡ Essai sur l'état de la végétation à l'époque de marnes heersiennes de Gelinden, by Count Saporta and Dr. A. F. Marion, pp. 8–11.

The most abundant vegetable remains of these Lower Tertiary clay-beds represent leaves of *Dryophyllum*. It has been remarked, in the description of *Quercus primordialis* of Nebraska, that this species is referable to the same genus *Dryophyllum* established by Devey, in the description of a number of leaves from the Upper Cretaceous of Belgium. These leaves are considered by the author as prototypes of some species of *Quercus* of the *Chamidobalanus* section, of *Castaneopsis*, &c., whose representatives, all tropical, inhabit at our time South Asia and the adjoining islands, Borneo, Sumatra, &c. In the description of *Quercus primordialis* I have compared its leaves to those of some varieties of the chestnut-oak, which they closely resemble by their form, their denticulation, and their nervation. This relation seemed to me the more admittable from the association of the remains of this Cretaceous species with those of others like *Fagus*, *Platanus*, *Magnolia*, *Liriodendron*, *Salix*, *Menispermum*, &c., which are evidently types correlative of a moderate climate. Now, on considering still the great variability of that ancient *Dryophyllum*, I find in this fact another reason in favor of the relation of its species to oaks of the *Lepidobalanus* section, to which belongs our chestnut-oak. This division has a very large number of species; among others, all the species of Europe and of North America, some of which are endowed with a prodigious power of variability; and, also, it is represented in the Lignitic of the Rocky Mountains by other species, which, though of different types, as, for example, *Quercus angustiloba*, are positively referable to this same section, mostly represented in the temperate zone.

To the genus *Dryophyllum*, or to the same type, is also referable *Phyllites Geinitzianus*, Göpp., from the *Quadersandstein*. In the flora of Gelinden, the French authors describe four new species of *Dryophyllum*, and also figure two species of Watelet from the Lower Eocene of the Paris basin, and one species, *D. cretaceum*, Dev., from the Upper Cretaceous beds of Aix. Four other species have also been described from Sezane by Saporta. In comparing *Quercus primordialis* to these fossil leaves, its intimate relation is recognized especially with *Dryophyllum Saportæ*, Wat., and *D. Dewalquei*, Sap. & Mar. It differs essentially from both, however, by its shorter and comparatively more enlarged size and by the absence of cartilaginous or inflated borders and teeth. From the remark of the authors of the Flora of Gelinden, the same type re-appears, slightly modified, in *Quercus furcinervis*, Rossm., which,

recognized already in the London clay, ascends to the Lower Miocene of Germany and Italy. In North America, the same species of *Quercus* has been found, in numerous and finely-preserved specimens of leaves, by Prof. Jos. Le Conte, under the lava-beds of the Cascade Mountains of Oregon; by Prof. J. D. Whitney, in clay-beds of the Spanish Mountains of California; and by myself, in more fragmentary leaves in the Lignitic of Golden. Thus we have a series of closely-allied forms of oaks recognized, in the Quader sandstein of Bohemia as *Phyllites Geinitzianus;* in the Upper Cretaceous of Belgium as *Dryophyllum cretaceum;* in the Nebraska Cretaceous as *Quercus primordialis;* in the Lower Eocene, or Paleocene of France and Belgium in numerous species of the same *Dryophyllum;* in the Eocene of Europe and in the Lignitic of the United States as *Quercus furcinervis*. Analogous forms of the same type are traced farther up in the Miocene of Europe and of America, in the Pliocene of California, and at a later epoch in a large number of our present species of oaks.

What conclusions can be derived from these facts? In regard to the flora of the Dakota group, the re-appearance in a subsequent period in the European Tertiary of one of its types does not modify in the least the remark on the disconnection of this flora from the antecedent and next succeeding vegetable groups as far as they are known. This genus, *Dryophyllum*, seems to have had, since its origin, a large number of representatives, and to have been widely, if not universally, distributed. Its presence, therefore, in successive formations, as in different local groups of floras of synchronous stages of the Cretaceous, merely denotes an omnipresent, and, at the same time, a persistent type, which, like those of *Salix*, *Sassafras*, *Platanus*, &c., has passed through all the geological floras to that of our time with more or less definite modifications.

Nevertheless, the flora of Sezane, like that of Gelinden, of the Gyps of Aix, represent, from the Upper Cretaceous to the Upper Eocene, a series of land-formations with vegetable groups, which are absent in the American geology. This fact may furnish an argument against the assertion of the as yet unexplainable disconnection between the Cretaceous flora of Kansas and Nebraska and that of the Lignitic of the Rocky Mountains; for, in the long period of time manifested by these successive and already diversified groups of plants of the Lower European Eocene, the characters of the floras must have been considerably changed, either by introduction of new species or by modifications of

types under climatic or any other influence. This is certainly an apparently logical conclusion. But the same groups of floras mentioned above, viz, those of the Paleocene of Europe, contradict by their characters a supposition of this kind. With the flora of Gelinden that of the Dakota group is related only by that species of *Quercus primordialis*, or of *Dryophyllum*, a type present, as we have seen, in all the vegetable series of the Upper Cretaceous and of the Lower Tertiary, and, with that of Sezane, it has scarcely any other relation but that of the same *Dryophyllum* and of a *Sassafras*. Considering the general characters of the floras, that of the Dakota group appears still more different from that of Sezane than from that of the American Lignitic; for the phænogamous species of Sezane are mostly represented by dentate or serrate leaves of *Betula*, *Alnus*, *Myrica*, *Ulmus*, *Protoficus*, *Populus*, *Salix*, *Juglandites*, &c., genera either absent in the flora of the Dakota group or represented in it by leaves with entire borders, as it has been explained already.

The European authors have remarked upon the little cohesion of the constitutive elements of the Cretaceous groups of vegetables, which, even when apparently synchronous, are so diversified that they appear as brought together at random, and not to have belonged to the same epoch and the same country. "Never has the contrast been as great as at that moment, either between the floras of next succeeding stages or between those of separate localities, even in synchronism, when compared to each other. To quote only the localities which have been more carefully studied: what point of analytical connection can be established between Niedershœna, in Saxony; Moletin, in Moravia; Quedlinburg and Blankenburg, in the Hartz; Halden, in Westphalia; the sands of Aix; the Senonien of Bausset; the Santonien of Fuveau, in France; and the North American Cretaceous of Nebraska."*

This remark of Messrs. Saporta and Marion, true as it is and to the point in regard to the vegetable groups of the Cretaceous, might be farther extended, as applicable to the succeeding Lower Tertiary floras, which as yet do not present any marked degree of homogeneity as far up as the Lower Miocene. Though it may be, it confirms our remarks on the disconnection of the vegetable types of the Dakota group, and also explains the fact, as far as it can be, by generalizing it as a correlative phenomenon observed in other countries. The same remark amplifies in a degree the probability of truth of

* Fossil Plants of Gelinden, p. 74.

this hypothetical observation, that the first vegetable types, or at least the dicotyledonous ones, have appeared, at the same or at different times, not only at different places but with different original characters, constituting here and there distinct groups without homogeneity or relation of forms. Considering what is known of the succession of these groups, it seems as if some of the original types had persisted more or less indefinitely in the series, being modified perhaps by casual circumstances; and as if other original forms or prototypes had appeared here and there and multiplied the characters of the vegetable groups. Indeed, this second supposition is a mere corollary of the former.

But this touches the question of the origin of species, which cannot be considered now, especially because the materials for the basis of a discussion of this kind are as yet too scant. Schimper, in his great work, (*Palèontologie végétale*,) describes, indeed, nearly six thousand species, distributed under eight hundred and fifty genera of plants, known from fossil remains of all the geological formations. But what is this compared to what is known of the flora of this epoch, of which many hundreds of thousands of species are described under more than fourteen thousand genera? Of the old floras, especially of those of this continent, we know scarcely a diminutive fraction. The task of the paleontologist is, therefore, and must be for a long time to come, that of a mere recorder of facts. It is in this point of view that this monography of the plants of the Dakota group has been prepared, and may be considered of some advantage to science.

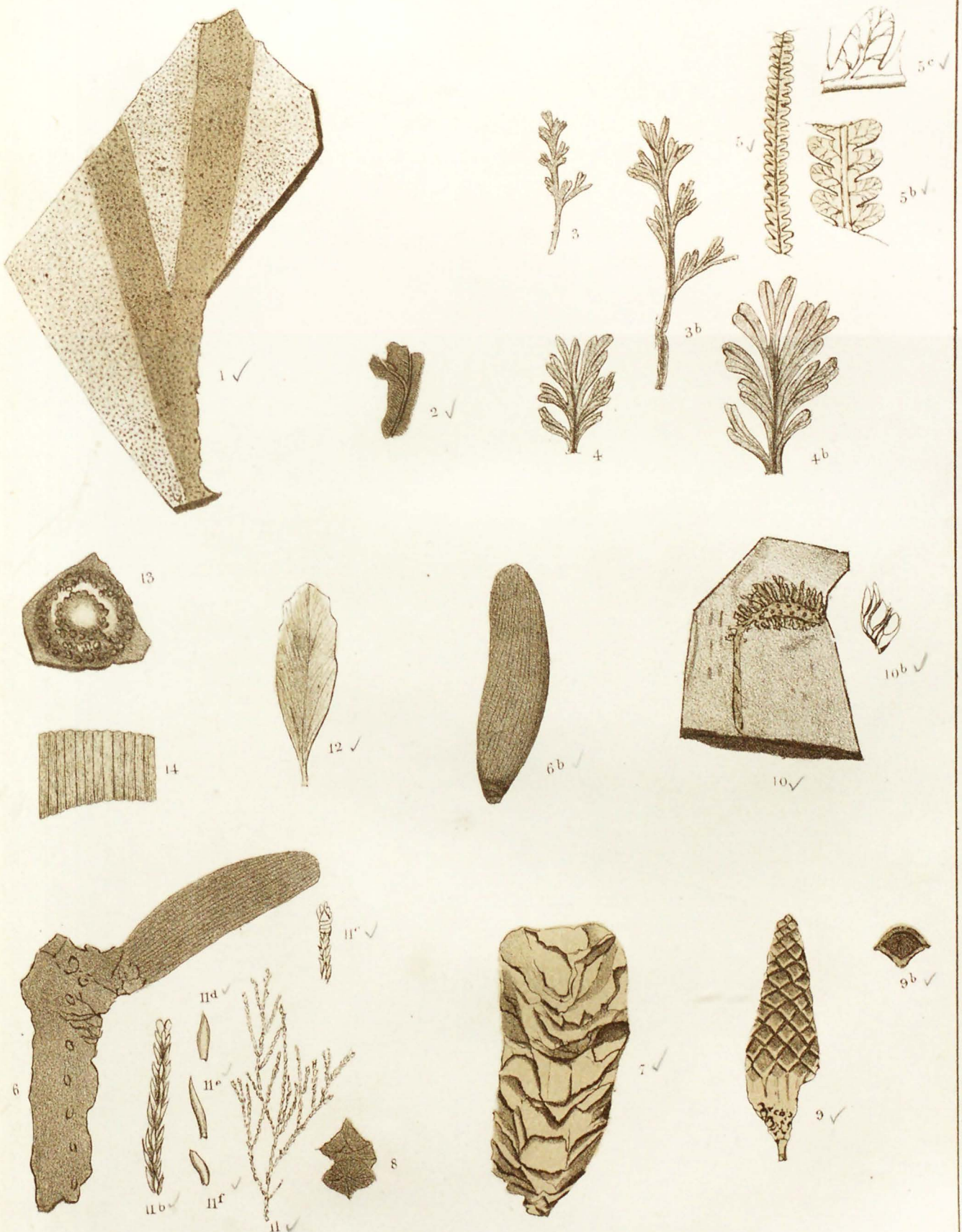
INDEX OF NAMES OF SPECIES AND THEIR SYNONYMS.

Page 89, line 1, for DIOSPYROS ANCEPS, read D. AMBIGUA.
Explanation of Pl. VI, Fig. 6, Diospyros ambigua.

The reader is also requested to make the following corrections on the *plates:*

On Pl. III (as corrected) for Fig. 1 read Fig. 3.
On Pl. III (as corrected) for Fig. 3 read Fig. 5.
On Pl. III (as corrected) for Fig. 5 read Fig. 1.
On Pl. VII (as corrected) for Fig. 1 read Fig. 2.
On Pl. VII (as corrected) for Fig. 2 read Fig. 4.
On Pl. VII (as corrected) for Fig. 4 read Fig. 1.
On Pl. VIII (as corrected) for Fig. 1 read Fig. 4.
On Pl. VIII (as corrected) for Fig. 4 read Fig. 5.
On Pl. VIII (as corrected) for Fig. 5 read Fig. 1.

EXPLANATION OF PLATE I.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EXPLANATION OF PLATE II

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J.Bien.Lith.

EXPLANATION OF PLATE IV.

J.Bien.Lith.

EXPLANATION OF PLATE V.

J.Bien,Lith.

EXPLANATION OF PLATE VI.

J. Rice, Lith.

EXPLANATION OF PLATE VII.

J.Bien.lith.

EXPLANATION OF PLATE VIII.

J. Bien, Lith.

EXPLANATION OF PLATE IX.

J.Bien,Lith.

EXPLANATION OF PLATE X.

J. Bien, lith.

EXPLANATION OF PLATE XI.

J.Bien.lith.

EXPLANATION OF PLATE XII.

J. Bien, Lith.

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J. Bien, lith.

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J.Bien.Lith.

EXPLANATION OF PLATE XV.

J.Bien,Lith.

EXPLANATION OF PLATE XVI.

J. Bien, lith.

EXPLANATION OF PLATE XVII.


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EXPLANATION OF PLATE XVIII.


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EXPLANATION OF PLATE XIX.

J. Bien, Lith.

EXPLANATION OF PLATE XX.


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EXPLANATION OF PLATE XXI.


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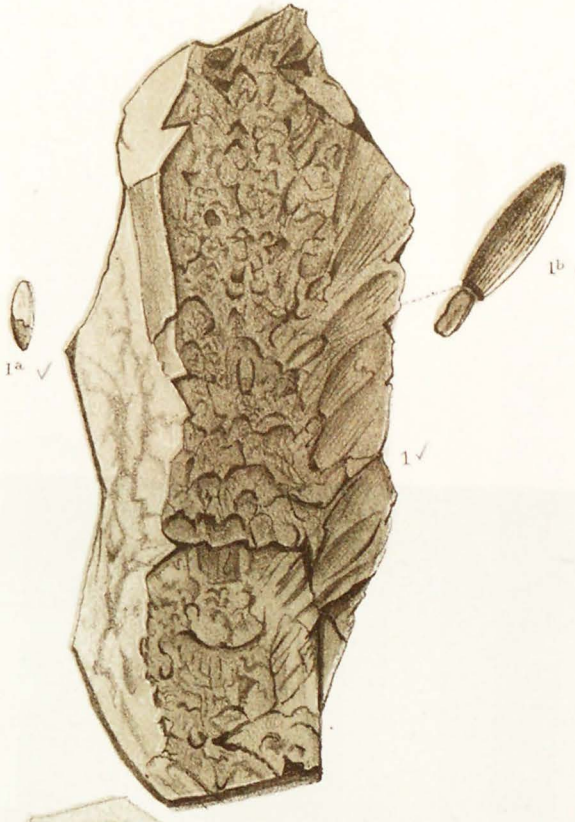
EXPLANATION OF PLATE XXII.

J. Bien, Lith.

EXPLANATION OF PLATE XXIII.

J.Bien,Lith.

EXPLANATION OF PLATE XXIV.



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EXPLANATION OF PLATE XXV.


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EXPLANATION OF PLATE XXVI.

Pl. XXVI.

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J. Bien, Lith.

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J. Bien, Lith.

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J. Bien, Lith.

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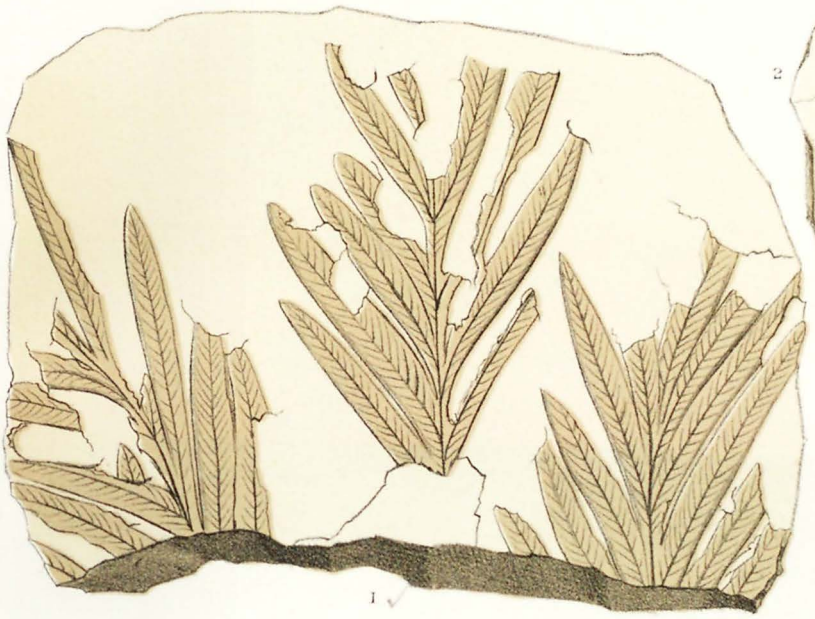
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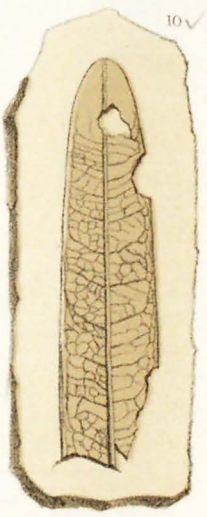
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T. Sinclair & Son. lith.

EXPLANATION OF PLATE XXX.

T. Sinclair & Son, lith.