DESCRIPTION OF A COLLECTION OF KOOTANIE PLANTS FROM THE GREAT FALLS COAL FIELD OF MONTANA[1]

By F. H. KNOWLTON

The present paper is based on a small collection of fossil plants obtained during the season of 1906 by Mr. Cassius A. Fisher, of the U. S. Geological Survey, while engaged in economic work on the coals of the Great Falls coal field and adjacent areas in north-central Montana. While not of great extent, this collection contains a number of very interesting things, among them a species of the genus *Protorhipis,* which has not previously been found in this country. There are also a number of species not before noted in the Kootanie of the United States, although present in the Canadian beds of this age, as well as several believed to be new to science.

Before passing to an enumeration of the plants, a brief review of previous collections of Kootanie plants may be of interest. The name Kootanie Series, so given from a tribe of Indians who formerly hunted in the country in which it occurs, was proposed in 1885 by Dr. George M. Dawson for a series of sandstones interbedded with shales and shaly sandstones, including occasional beds of conglomerate and a zone containing coal seams. The original area, which was about 140 miles in length and 40 miles in extreme breadth, is in the Rocky Mountain region of Alberta north of the forty-ninth parallel and south of the Bow River. The plants collected in these beds were reported on by Sir William Dawson,[2] who enumerated twenty-two forms with new species in the genera *Asplenium, Zamites, Ginkgo,* and *Taonurus.*

In the course of an examination of the Great Falls coal field, the late Dr. J. S. Newberry obtained fossil-plant data which, in 1887, enabled him to announce[3] that "these plants prove beyond question that the Great Falls coal basin is of the same age as those that have been described north of the boundary line by Dr. George M. Dawson, in what he has designated as the Kootanie series."

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[1] Published by permission of the Chief Geologist of the United States Geological Survey.

[2] Trans. Roy. Soc. Canada, vol. 4, 1885, sec. IV, pp. 5–10, pls. I, II.

[3] School of Mines Quarterly, vol. 8, July, 1887, p. 329.

Incident to the construction of the railroad from Helena to Great Falls, a considerable collection of plants was made in the cuttings near the latter town, which were reported on by Dr. Newberry in 1891.[1] In addition to eight species described as new and belonging to the genera *Chiropteris, Zamites, Baiera, Cladophlebis, Sequoia, Podozamites,* and *Oleandra,* Dr. Newberry listed thirteen species as common to the Great Falls field and the lower Potomac of Virginia, three as common to this locality and the Kootanie of Canada, and six as common to the Kome (Urgonian) beds of Greenland.

In 1890 Dr. A. C. Peale and the writer made a small collection of Kootanie plants from the vicinity of Great Falls and above the mouth of the Sun River, and the following year Mr. W. H. Weed made an additional small collection from the same place, which were studied by Prof. Wm. M. Fontaine, his report appearing in 1892.[2] He enumerated fifteen species and varieties, of which number six in the genera *Aspidium, Pecopteris, Cladophlebis,* and *Zamites* were regarded as new.

Also, in 1891, Dr. H. M. Ami and Dr. Hayden made a considerable collection of plants from the Kootanie of the Cascade coal basin of the Canadian Rockies, which were reported on by Sir William Dawson, whose report appeared in 1892.[3] This paper recorded twenty-one forms, of which two were new to science (*Pinus* and *Angiopteridium*) and eight not named specifically.

The final publication which it remains to notice was based on collections made during the years 1894 and 1895, the first by Mr. W. H. Weed and the last by Prof. Lester F. Ward, from a number of localities in Cascade County, Montana, largely in the vicinity of the stage station of Geyser and about forty miles southeast of Great Falls. These were turned over to Professor Fontaine for elaboration, and his report is published in Ward's second paper on the "Status of the Mesozoic Floras of the United States."[4] It includes sixteen species, of which five were described as new, the latter belonging to the genera *Dicksonia, Lycopodites, Cycadospermum, Nagiopsis,* and *Laricopsis.*

On compiling a list of all the plants heretofore reported from the Kootanie beds of Canada and the United States, we have a grand total of ninety forms. It is more than probable, however, that if all

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[1] Am. Jour. Sci., 3d ser., vol. 61, 1891, pp. 191–201, pl. XIV.

[2] Proc. U. S. Nat. Mus., vol. XV, 1892, pp. 487–495, pl. LXXXII–LXXXIV.

[3] Trans. Roy. Soc. Canada, vol. 10, sec. IV, 1892, pp. 79–93, figs. (in text) 1–16.

[4] Monog. U. S. Geol. Survey, No. 48, 1905, pp. 284–315, pls. LXXI–LXXIII.

these scattered collections could be assembled and carefully compared, a number of forms now held to be different would be found identical. Thus, specimens from Geyser doubtfully identified by Fontaine as his *Cephalotaxopsis ramosa* prove to be a fern which I have described as *Oleandra graminæfolia,* and from merely inspecting the figures of what Dawson has determined as Heer's *Pinus (Cyclopitus) nordenskiöldi,* from Anthracite, British Columbia, I suspect it may also be referable to this fern; so, also, Newberry's *Baiera brevifolia* is apparently identical with what I have called *Ginkgo sibirica.*

The geological age of the Kootanie formation has never been much in question. In the first publication in which the formation received its name and where we are afforded the first view of its floral contents, Sir William Dawson says: "The Kootanie series should probably be placed at the base of the table as a representative of the Urgonian or Neocomian, or, at the very least, should be held as not newer than the Shasta group of the United States geologists and the Lower Sandstones and Shales of the Queen Charlotte Islands. It would seem to correspond in the character of its fossil plants with the oldest Cretaceous floras recognized in Europe and Asia, and with that of the Kome formation in Greenland, as described by Heer." In his latest pronouncement on the subject he placed it with little qualification in the Neocomian, while later Newberry and Fontaine inclined to correlate it with the Wealden, the latter stating that he regarded it as "being essentially of the same age as the Lower Potomac of Virginia," which he placed in the Wealden. The flora of the Kootanie contains species occurring in the uppermost Jurassic, the Wealden of England, the Kome of Greenland, and the Lower Potomac of Virginia, but from the fact that no traces of angiospermous plants have thus far been detected in the Kootanie, though occurring in the Lower Potomac, I should incline to agree with Newberry in regarding the Kootanie as slightly older than the Lower Potomac, though undoubtedly both are essentially in the position of the Wealden.

Following is a complete list of the localities whence came the material included in the following report:

(1.) First railroad cut west of smelter on high line track, north side of Missouri River, Great Falls, Montana. Collected by Prof. O. C. Mortson.

(2.) Same as last, but slightly different bed.

(3.) Flood siding 5 miles southwest of Great Falls, Montana. Collected by C. A. Fisher.

(4.) East side of Spanish Coulée (T. 17 N., R. 3 E.), 12 miles east of Cascade, Cascade County, Montana. Collected by C. A. Fisher and H. M. Eakin.

(5.) Brown sandy shale 2 feet above main coal bed at Smauch's mine, on east side of Belt Creek, at Belt, Cascade County, Montana. Collected by C. A. Fisher and H. M. Eakin.

(6.) Meridith mine, east side of coulée, about 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana. Collected by C. A. Fisher and M. R. Campbell.

(7.) Cañon on west side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana. Collected by C. A. Fisher and D. E. Winchester.

ORDER FILICINÆ

CLADOPHLEBIS HETEROPHYLLA Fontaine

Cladophlebis heterophylla FONTAINE, Proc. U. S. Nat. Mus., vol. 15, 1892, p. 493, pl. LXXXIV, fig. 2; Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 294, pl. LXXI, figs. 21–25.

Locality.—Cañon north side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana; cut on Hazlett Creek 3 miles south of Bauer sheep ranch; Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

CLADOPHLEBIS BROWNIANA (Dunker) Seward

PLATE XI, FIGS. 1, 1A

Cladophlebis browniana (DUNKER) SEWARD, Cat. Mesoz. Pl. Brit. Mus., Wealden Fl., pt. 1, 1894, p. 99, pl. VII, fig. 4.

The material from Skull Butte, eastern Fergus County, Montana, contains a number of fragments of pinnæ that appear to belong to this species. From the portions preserved it appears that the pinnæ must have been long and narrowly linear, with the pinnules contiguous and not cut quite to the rachis. The nervation is strong and well marked, consisting of a fairly strong midvein and some 8 or 9 pairs of rather close forking veins.

With such limited material at hand, it is hard to determine this fern with complete satisfaction. It is apparently of exactly the same type as *Cladophlebis heterophylla* Fontaine [1]—in fact, it seems hardly

[1] In Ward, Monog. U. S. Geol. Survey, No. 49, 1905 [1906], pl. LXXI, fig. 24.

more than a "large edition" of that species. As Seward has pointed[1] out, this species has a strong resemblance to *Gleichenia zippei* Heer[2] from the Lower Cretaceous of Greenland. In the absence of conclusive evidence, however, it seems best to keep it under the present name.

Locality.—Cañon north side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana.

CLADOPHLEBIS CONSTRICTA Fontaine

Cladophlebis constricta FONTAINE, Monog. U. S. Geol. Survey, No. 15, 1889, p. 68, pl. II, figs. 11, 11*a*, 11*b*; pl. III, fig. 2; pl. VI, figs. 5, 5*a*, 6, 6*a*, 8–14; pl. XXI, figs. 9, 13; pl. CLXIX, figs. 2, 2*a*; Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 297, pl. LXXI, fig. 26.

A single characteristic and well preserved example.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

CLADOPHLEBIS FISHERI n. sp.

PLATE XI, FIGS. 2, 2A

Outline of frond unknown, pinnæ linear, evidently long, the rachis very strong, with two or three minute ridges on the upper side; pinnæ cut nearly to the rachis into relatively large opposite or subopposite, triangular, subfalcate rather obtuse pinnules, with entire or slightly undulate margins; nervation very strong, consisting of a thick midvein, which is zigzag and passes to the apex or forks once or twice into nearly equal branches in the upper portion, with four or five pairs of alternate, strong, remote veins on either side, each of which forks once or twice in passing to the margin; surface between the veins showing minute pits or areolations.

The example figured is the only one found in the collection, and it is with some hesitation that I have decided to describe it as new on such scanty material. It appears to approach most closely to *Cladophlebis virginiensis* Font.,[3] from the Lower Potomac of Virginia, from which it differs in having the pinnules shorter, much broader and more obtuse, and the nervation apparently stronger. It is possible that a larger series of specimens might show that these differences break down, in which case it can be referred to the Virginia species.

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[1] Op. cit., p. 100.

[2] Fl. Foss. Arct., vol. 3, 1874, pls. V, VI, etc.

[3] Monog. U. S. Geol. Survey, No. 15, 1889, p. 70, pl. IV, figs. 1, 3–6.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

THYRSOPTERIS ELLIPTICA Fontaine

Thyrsopteris elliptica FONTAINE, Monog. U. S. Geol. Survey, No. 15, 1889, p. 133, pl. XXIV, fig. 3; pl. XLVI, fig. 1; pl. I, figs. 6, 9; pl. LI, figs. 4, 6*a*, 6*b*; pl. LIV, fig. 6; pl. LV, fig. 4; pl. LVI, figs. 6, 7; pl. LVII, fig. 6; pl. LVIII, figs. 2, 2*a*; Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 290, pl. LXXI, figs. 12, 13.

Locality.—Spanish Coulée, 12 miles east of Cascade, Cascade County, Montana; Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County; cut on Hazlett Creek 3 miles south of Bauer sheep ranch.

ACROSTICHOPTERIS FIMBRIATA n. sp.

PLATE XI, FIGS. 3, 3A

Size and outline of whole frond unknown; pinnæ probably long, linear, rachis exceedingly strong though possibly fleshy; pinnules alternate, rather remote, very broadly triangular or ovate in general outline, decurrent down the rachis nearly or quite to the one next below, exceedingly thin and delicate in texture; pinnules (at least lower ones) deeply cut into about four cuneate-flabellate lobes, each of which is provided with two or three strong, sharp teeth; nervation sparse, consisting of a short, strong midvein which almost immediately splits into three or four veins which with one or two forks pass to the points of the sharp teeth; upper pinnules apparently not lobed, but strongly and sharply toothed.

This species is represented only by the single specimen figured, and except for the fact that it is so strongly marked it would be unwise to characterize a species on such scanty material. It is quite unlike anything that has been previously reported from these beds.

As may be seen from the figure, this is a very peculiar fern. The thickness of the portion of the rachis preserved would imply that the pinnæ were of considerable length, whereas the pinnules are obviously very thin and delicate. Their most marked character, however, is the degree of lobation, the two or three lower pinnules being deeply cut into three or four long wedge-shaped lobes which are again cut into two or three strong, sharp teeth. The nervation is very plain, though sparse, consisting of a thickened midvein which extends but a short distance in the lower pinnules, where it breaks up into three or four branches, each of which is usually once or

twice forked before their termination in the apex of the lobes or teeth.

There can be little doubt that this plant is correctly referred to the *Acrostichopteris* of Fontaine, thus proving another strong bond of affinity between the Kootanie and the Lower Potomac of Virginia. It is, for example, certainly generically similar to *Acrostochopteris parvifolia* Font.,[1] though it is much larger and has the teeth of the lobes larger and sharper. It is also strongly suggestive of *A. Ruffordi* Seward[2] from the Wealden of England; indeed, with a larger series of specimens for comparison, it is not at all impossible that they might be shown to be identical. As it is, the present species appears to differ in being slightly larger, not so much cut, and the lobes with stronger, sharper teeth.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

DRYOPTERIS MONTANENSIS (Fontaine) Knowlton

Dryopteris montanensis (Fontaine) Knowlton, Bull. U. S. Geol. Survey, No. 152, 1898, p. 92.

Aspidium montanense Fontaine, Proc. U. S. Nat. Mus., vol. 15, 1892, p. 490, pl. lxxxii, figs. 1–3; pl. lxxxiii, figs. 2, 3, 3*a*.

Locality.—First railroad cut west of smelter on high line track, north side of Missouri River at Great Falls; same locality, but slightly different bed; Flood siding 5 miles southwest of Great Falls, Montana [at or near type locality].

DRYOPTERIS? KOOTANIENSIS n. sp.

Plate XI, Figs. 4, 4a

Outline of frond unknown; pinnæ slender, linear; pinnules small, very remote, apparently alternate, oblique, strongly auricled on both upper and lower side, otherwise linear, obtuse at apex, attached at the slightly heart-shaped base; midrib slender; veins slender, rather remote, apparently once forked.

This species is represented by the single fragment figured, which shows a slender rachis with only about five pinnules. These, it will be observed, are very remote, and are remarkable in that they have a pronounced enlargement at the base on either side, though the point of attachment is apparently in a slightly heart-shaped base.

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[1] Monog. U. S. Geol. Survey, No. 15, 1889, pl. clxxi, figs. 3, 4.

[2] Cat. Mesoz. Pl. Brit. Mus., Wealden Fl., pt. 1, 1894, p. 61, pl. vi, fig. 3.

There is so little of this specimen available for examination that it is impossible to make out its real form or its position on the frond. It is possible that it is only an extremely auricled form of, for instance, *Cladophlebis constricta* Font.,[1] though in *Cladophlebis* the pinnules are supposed to be attached by their whole bases, whereas in the one under consideration the attachment is probably by only a minute portion of the base. As this species cannot be referred to *Cladophlebis,* I have placed it tentatively under *Dryopteris,* but we must await fuller material before it can be definitely placed.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

ADIANTUM MONTANENSE n. sp.

PLATE XII, FIGS. 1, 2

Outline of frond unknown; pinnules apparently opposite or subalternate, relatively large, short-petioled, reniform, margin cut into numerous large rounded lobes; primary nerves numerous (a dozen or more), equal, radiating, several times dichotomous.

This form is represented by a few fragments only, the best being figured. In the one shown in figure 1 there is seen to be a rather slender rachis with one pinnule attached by a very short petiole and another some distance above and on the same side which is not attached, but is possibly in nearly its original position. The other, shown in figure 2, exhibits two pinnules on opposite sides of the slender rachis, only one of which, however, shows the petiole attached. The outlines and nervation are very well shown in the figure.

This species is undoubtedly very closely allied to *Adiantum formosum* Heer,[2] from the Lower Cretaceous (Kome) of Greenland, though Heer supposed his species to be simple—that is, he found no evidence to show that the pinnules (or fronds) were ever attached to a rachis—whereas in the Kootanie form the frond was clearly compound, having the pinnules attached by a short petiole to a slender rachis. In size, shape, degree of marginal lobation, and nervation they are certainly very similar, and a well preserved suite of specimens might show even closer agreement. Neither Heer's species nor the one under consideration shows any trace of fruit, and hence the reference to *Adiantum* is based entirely on form and

[1] In Ward, Monog. U. S. Geol. Survey, No. 48, pl. LXXI, fig. 26.

[2] Fl. Foss. Arct., vol. 3, 1874, p. 35, pl. III, figs. 1, 2.

nervation, but this does not impair its stratigraphic value, since it can be readily recognized in future.

It may be noted in passing that Heer's *Adiantum formosum* is antedated by *A. formosum* R. Brown [Prod. Fl. N. Holland], 1810, p. 155], a living species of Australia and New Zealand.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

OLEANDRA GRAMINÆFOLIA n. sp.

PLATE XI, FIGS. 5, 5A, 6, 6A

Cephalotaxopsis ramosa FONTAINE? in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 311, pl. LXXIII, fig. 8.

?Pinus (Cyclopitus) nordenskiöldi HEER. Dawson, Trans. Roy. Soc. Canada, vol. 10, 1892, sec. IV, p. 88, fig. (in text) 9.

Fronds detached, narrowly linear and grass-like, long acuminate at apex; [base not seen]; midrib relatively very strong; nerves fine, close parallel, at right angles to the midrib, forking once, usually just at the base; [fructification not seen].

This species is represented by a large number of detached fronds which are scattered over and matted together on and in the matrix. There are no complete fronds, nor any evidences of the manner in which they were attached, though quite a number show the apex, which is seen to be narrowly acuminate. The length was more than 4 cm., for there are fragments this long, though most of them are shorter, while the width is from 2 to 3 mm. The nervation is very difficult to make out, but where it can be observed it is found to consist of a very thick midrib and numerous close parallel veins which fork near their point of origin in the midrib; no fruit was observed.

To the casual observer these little detached and more or less matted fronds appear like the tangled leaves of grasses or the detached leaves of conifers (like *Pinus*), and it is only by the most careful scrutiny that their real nature can be made out. At first it was supposed that they must represent a small, very narrow-leaved *Tæniopteris,* but the forking of the veins close to the midrib seem to place them nearest the genus *Oleandra.* The fronds, however, are much smaller and narrower than in any living or fossil species known to me.

In working up the material from Geyser, Professor Fontaine noted the presence of a number of "detached leaflets," which he referred somewhat doubtfully to his *Cephalotaxopsis ramosa* of the Lower Potomac beds of Virginia. Fortunately this material is preserved

in the U. S. National Museum (No. 31,711), and on looking at it critically it is found to be undoubtedly the same as the material in hand. It is indeed difficult to see how Professor Fontaine could have overlooked the fact that many of these supposed leaves of *Cephalotaxopsis* are at least twice the length of even the largest leaves of the Virginia species.

In his report on the Kootanie plants from Anthracite and Canmore, British Columbia, Dawson[1] has figured a mat of long, narrow leaves which he refers to Heer's *Pinus* (*Cyclopitus*) *nordenskiöldi*. I have not seen this material, but, judging from the drawing alone, I am decidedly of the opinion that it should be referred to *Oleandra*.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

CHIROPTERIS SPATULATA Newberry

Chiropteris spatulata NEWBERRY, Am. Jour. Sci., 3d ser., vol. 61, 1891, p. 199, pl. XIV, figs. 1, 2.

Locality.—Spanish Coulée, 12 miles east of Cascade, Cascade County, Montana.

PROTORHIPIS FISHERI n. sp.

PLATE XII, FIGS. 3, 4

Leaves of small size and thick leathery texture; orbicular or perhaps nearly circular in outline, very deeply heart-shaped at base, the lobes broad and rounded; (margin unknown, possibly entire, but at most probably not more than dentate); petiole very thick and strong, forking or splitting at the very base of the lamina into two approximately equal branches, which turn abruptly nearly at right angles and apparently there forming for a short distance the basal margin of the lamina, and thence continuing apparently to the lateral margin of the leaf; each main branch forks almost immediately, the branches passing up to supply the middle line of the blade, forking two or three times before reaching the apparent margin; from both sides of the main branches are several forks, the resulting branches supplying the rounded broad lobes and the lateral areas; the finer nervation consists of cross-nervilles approximately at right angles to the primary nerves, enclosing large areas which are filled with nearly as strong approximately quadrangular areolation; in one of

[1] Trans. Roy. Soc. Canada, vol. 10, 1892, sec. IV, p. 88.

the specimens the spaces between the veins are filled with the minute areolation, with little or no evidence of the slightly stronger cross-veinlets.

This species is represented at present by only two specimens, neither of which, unfortunately, is sufficiently well preserved to permit its complete description. So far as can be made out, these leaves were approximately circular or possibly broadly reniform in outline. In the larger example the length from the top of the petiole to the upper margin is about 2 cm., while the greatest apparent width is about 3.5 cm., but as it is very deeply heart-shaped, the general outline becomes approximately circular. The same dimensions in the smaller example are 1.75 cm. and about 2.5 cm., though again the deeply cordate base about restores the circular outline. The very thick petiole is nearly 1 cm. in length and is probably not fully preserved. The margin is not certainly preserved except for a short distance on the base of the basal lobes. It is impossible to determine the character of the margin on the lateral and apical portions, though if not entire it could hardly have been more than strongly dentate.

The nervation, as pointed out under the diagnosis, is very peculiar, all, including the ultimate ramifications, being very deeply impressed, thus showing the leaf to have been thick in texture. The primary nervation is always clearly and distinctly forked, the petiole being first forked at the point of entrance into the lamina, and from each of these branches arise the several (6 or 8) thick branches which may be observed at the base of the blade, these spreading and again forking two or three times before reaching the margin, the whole filling fairly evenly the area of the leaf. The character of the ultimate nervation is well shown in the figures.

As this is the first time the presence of *Protorhipis* has been noted in this country, at least as such, and as the affinities and interrelationships are still somewhat an open question, it may be worth while to pass briefly in review the distribution and history of the genus. *Protorhipis* was established by Andrae in 1853,[1] the type specimen (*P. buchii*) being from the Jurassic (Lias) of Steierdorf, in Banat, Hungary. It was a large leaf, some 10 or 12 cm. in width, semi-orbicular in shape, with a strongly sinuate-toothed margin. The base of the leaf was not preserved, but the primary nervation consists of strong, palmately disposed forked ribs or veins, the area between the veins being filled with a coarse quadrangular areolation.

[1] Fossile fl. Siebenbürgens u. d. Banates. Abl. k. k. geol. Reichs., vol. 2, abth. 3, No. 4, 1853, p. 35, pl. VIII, fig. 1.

This form was placed by its author among the ferns and compared especially with the living *Platycerium*.

The next species in point of time is *Protorhipis asarifolia,* described in 1865 by Zigno,[1] from the Jurassic (Oölite) of Italy. It is very much smaller than the type species, being only about 3 cm. in diameter. It is nearly circular in outline, deeply kidney-shaped at base, and has the margins perfectly entire; it was also placed among the ferns.

In 1878 Nathorst[2] described two small forms from the Jurassic (Rhetic) of Bjuf, Sweden. At first he inclined to refer one to *P. buchii* of Andrae, but later described both as new, under the names *P. crenata* and *P. integrifolia.* They are much smaller than the type species, and were also regarded as belonging among the ferns.

Two years later Heer[3] described his *P. reniformis* from the Oölite of Siberia, this being a small reniform, entire-margined species strikingly similar to Zigno's *P. asarifolia.* In 1882 the same author described another species, under the name of *P. cordata,*[4] from the Kome beds (Urgonian) of Kome, Greenland. It also belongs to the same group with *P. reniformis* and *P. asarifolia.*

In his final paper on the Mesozoic floras of Portugal, published in 1894, Saporta gave complete descriptions and figures of his curious and in some ways anomalous *Protorhipis choffati,*[5] which comes from the Urgonian of Cercal. It is very different from the forms previously referred to *Protorhipis,* and, as he suggests, has a rather striking resemblance to certain bracts, stipules, or involucral expansions of some angiosperms, as well as to certain ferns, such as *Platycerium.* Its nature and position can hardly be considered as settled. In the same paper[6] Saporta took occasion to describe and figure a very fragmentary specimen from Bjuf, Sweden, submitted to him by Nathorst, under the name of *Protorhipis nathorstii.* It is too imperfect to admit of very careful diagnosis and may very probably belong to some of the forms of this or the related genus, *Hausmannia,* already described from those beds.

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[1] Fl. Foss. Form. Oolithcæ, vol. 1, 1865, p. 180, pl. IX, figs. 2, 2*a*.

[2] Fl. v. Bjuf, pt. 1, p. 42; pt. II, p. 57, pl. XI, figs. 2, 4.

[3] Mem. Acad. Imp. d. St. Petersbourg (7 ser.), vol. 27 (Fl. Foss. Arct., vol. 6, Abth. 1, pt. 1), 1880, p. 8, pl. 1, fig. 4*a*.

[4] Fl. Foss. Arct., vol. 6, Abth. 2, p. 10, pl. III, fig. 11.

[5] Fl. Foss. Portugal, 1894, p. 144, pl. XXII, figs. 9–11; pl. XXVI, figs. 17, 18; pl. XXVII, figs. 1–5.

[6] Op. cit., p. 143, pl. XXII, figs. 14, 14*a*.

The genus *Hausmannia,* instituted by Dunker,[1] in 1846, from an imperfect leaf from the Wealden of North Germany, is also involved in the present complication. The type species, and apparently the latest species to be referred to *Protorhipis,* is *Dictyophyllum roemeri* Schenk, which is recorded by Seward[2] from the Wealden of Bernissart, Belgium, under the name *P. roemeri.* It is a mere fragment and can have no value one way or the other.

H. dichotoma is very different in appearance from *Protorhipis buchii,* the type of the former genus being palmate and deeply divided into lobed linear segments, which are traversed by forked main veins from which anastomosing branchlets are given off. A number of species were subsequently described under this generic name and which conform to the original generic diagnosis, but in 1892 Bartholin described from Bornholm, as *Hausmannia forchhammeri,* a number of specimens that were obviously the same as *Protorhipis buchii.* In commenting on this paper, Zeiller[3] took occasion to state that he had received additional material from the type locality of *Protorhipis buchii* Andrae, which he identified with that species; this material he illustrated by a number of good photographs. He states, and the figures certainly bear him out, that this new material shows the species to be deeply bilobed or cut quite after the manner of living *Dipteris* fronds, to which they are certainly most closely related; and, further, that while apparently differing markedly from Andrae's type specimens, it simply proves that species to be polymorphous, some leaves agreeing with the type and others showing more or less lobing or cutting. If this be true, there is obviously no ground for maintaining the genus *Protorhipis,* as *Hausmannia* has priority, and this is the view adopted by Möller,[4] who has recently worked over the Bornholm flora. He describes and figures at length the *Hausmannia forchhammeri* of Bertholin, and specially a new form of it which he denominates subspecies *dentata.* The latter is evidently similar to the *type* of *Protorhipis buchii,* while the other forms referred to *H. forchhammeri* exhibit to a greater or less extent the lobing supposed to be characteristic of *Hausmannia.* It may be that we really have here a highly polymorphous aggregate, as indeed Saporta suggested, one portion of the plant, or one stage in its growth, showing rounded, unlobed, and at most dentate-margined

[1] Monog. Norddeutschen Wealdenfl., 1846, p. 12, pl. v, fig. 1.
[2] Mem. Mus. Hist. Nat. Belgique, vol. 1, 1900, p. 18, pl. III, fig. 34.
[3] Rev. Gén. d. Botanique, vol. 9, 1897, p. 51 (reprint), pl. XXI, figs. 1–5.
[4] Kongl. Fysiogr. Sällsk Handl., vol. 13, 1902, p. 48.

leaves, and at another more or less profoundly lobed and cut leaves. There is of course abundant precedent for this condition among living ferns and dicotyledons, but I am free to confess that the evidence thus far presented does not seem to my mind sufficiently conclusive to warrant this sweeping contention, and I prefer to hold with Seward, that "it is convenient to retain the name *Protorhipis* for certain species of Wealden and Jurassic ferns," especially for some of the smaller entire or dentate-margined forms, which do not appear to have been cut or lobed after the manner of normal *Dipteris* fronds. With imperfect or fragmentary material, it may sometimes be difficult to distinguish between *Protorhipis* and *Hausmannia*, and the possibility that the generic distinctness does not exist is admitted; but with good material it should not be so. Although the nervation seems the same in both Andrae's and Zeiller's specimens from Steierdorf, judging from the figures given by both authors, it does not seem to me that it has been established beyond all doubt that they come from the same plant.

The question now comes as to the position of what I have here called *Protorhipis fisheri*. In size and shape it approaches most closely to *P. asarifolia* Zigno, *P. reniformis* Heer, and *P. cordata* Heer, but it seems to be extremely doubtful if either of these species has anything to do with *Protorhipis* as founded by Andrae, as Möller, Nathorst, and others have suggested. Indeed, Nathorst thinks it probable that Heer's *P. reniformis* is a scale, possibly of some species of *Zamiostrobus*, and the same may apparently be said of the others. The nervation in the three forms above mentioned, when it can be made out, is quite unlike that of typical *P. buchii*. The nervation of *P. fisheri*, on the other hand, is of the same character as that shown in the type of *P. buchii*, the main veins being several times forked and the intermediate areas filled with a strong quadrangular areolation. Unfortunately it is impossible to determine the character of the margin in *P. fisheri*, but it could hardly have been more than dentate, and there is certainly no evidence to show that it could be a portion of a deeply bilobed or cut leaf. It may be necessary to establish a new genus for the leaves under consideration, in the event that the typical forms of *Protorhipis* are incontestably proved to be indistinguishable from *Hausmannia*.

It further remains to consider the systematic position of the leaves here called *Protorhipis*. As already indicated, *Protorhipis buchii* was placed by Andrae among the ferns, on the ground of its resemblance to certain forms of the younger fronds of the living *Platycerium*. When the striking resemblance between this species and

subsequently described forms of *Protorhipis* and the living *Dipteris* was noted, the grounds for referring it to the ferns were strengthened, and when, later, Bartholin found evidences of sori arranged as in *Dipteris,* as apparently did Zeiller, the matter came to be practically settled. However, when Saporta, in 1894, presented his final paper on the fossil flora of Portugal, he took occasion to pass in review the several species of typical *Protorhipis,* added a new one (*P. choffati*), and decided that while they of coure resembled the ferns, they might possibly be archetypal dicotyledons, and so placed them with some caution in his group of Proangiosperms. Professor Ward, in a subsequent paper on "Some Analogies in the Lower Cretaceous of Europe and America,"[1] not only accepted Saporta's view, but abandoned his caution and boldly referred the entire genus *Protorhipis* to the dicotyledons. As already noted, such species as *P. reniformis, P. cordata,* and *P. asarifolia* can hardly have any legitimate connection with typical *Protorhipis,* and their wholesale reference to the dicotyledons is certainly without warrant. When we take into account the undoubted close relationship between *Protorhipis* and *Hausmannia* and the demonstrated affinity between the latter and the living *Dipteris,* it is seen that the grounds for regarding any of these fossil forms as primitive dicotyledons are very slight indeed. Even Saporta's *P. choffati,* which he compared to numerous living forms, is thought by Seward to be a fern, since it resembles especially the "bracket leaves" of *Platycerium.* It certainly does not belong to the genus *Protorhipis* as gauged by the type species.

Inasmuch as the flora of the Kootanie shows a strong affinity with that of the older Potomac of the Eastern States, it may be well to compare the species under discussion with certain supposed primitive dicotyledons described and figured by Fontaine,[2] such, for instance, as his *Proteæphyllum reniforme, P. orbiculare,* and *Populophyllum reniforme,* but it needs but a glance to show that they are not at all related to *Protorhipis fisheri.* While they agree fairly well in size and shape, the primary nervation is entirely different, being in the Virginia forms not only much more abundant, but distinctly reticulated, which in the former it never is.

I therefore reach the conclusion that the form here described as *Protorhipis fisheri* is to be placed among the ferns, and it is regarded as generically similar to *Protorhipis buchii.* It is named in honor

[1] Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 1, 1896, p. 535.

[2] Monog. U. S. Geol. Survey, No. 15, 1889.

of the collector, Mr. Cassius A. Fisher, of the U. S. Geological Survey.

Locality.—Cañon north side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana.

ORDER EQUISETACEÆ

EQUISETUM PHILLIPSII (Dunker) Brongniart

Equisetum phillipsii (Dunker) Brongniart, *cf.* Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905[1906], p. 298, pl. LXXII, figs. 1–11.

The only trace of this species noted on the collection is a small detached diaphragm such as that figured by Fontaine (loc. cit.), pl. LXXII, figure 4.

Locality.—In excavation of B. & M. smelter, Great Falls, Montana, below red shale.

ORDER CYCADACEÆ

PODOZAMITES LANCEOLATUS (L. & H.) Schimper

Plate XIV, Fig. 4

Podozamites lanceolatus (L. & H.) Schimper, Pal. Vég., vol. 2, 1870, p. 160.

This species has been noted by Dawson in the Kootanie of British Columbia, but not before detected in beds of this age in the United States.

Locality.—Meridith mine, about 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

PODOZAMITES NERVOSA? Newberry

Podozamites nervosa Newberry, Am. Jour. Sci., 3d.ser., vol. 61, 1891, p. 200, pl. XIV, fig. 6.

Newberry's species was founded on a single leaflet which was four inches in length, being "broadest toward the base, subacute at the summit, with the nerves parallel, distant, strong." The collection in hand contains a single fragment, evidently from near the base of a very large leaflet, that can hardly be referred to anything but the present species. It of course adds nothing to our knowledge, and I have even thought it best to question the determination.

Locality.—Flood siding 5 miles southwest of Great Falls, Montana [at or near type locality].

ZAMITES ARCTICUS Göppert

Zamites arcticus GÖPPERT, Neues Jahr. f. Min., etc., 1866, p. 134, pl. II, figs. 9, 10; Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 306, pl. LXXIII, figs. 1–6.

The status of this species in the Kootanie areas of the United States has been completely set forth by Professor Fontaine (loc. cit.), and it is unnecessary to go over the ground here. It is an abundant species in the present collection, in some instances being the only form present at certain localities.

Locality.—Brown sandy shale 2 feet above main coal at Smauch's mine, Belt Creek, Belt, Cascade County, Montana (only species present); Meridith mine, 3 miles southeast of Nollar's ranch [base of main coal]; cut on Hazlett Creek 3 miles south of Bauer's sheep ranch [43 feet below main coal].

ZAMITES APERTUS Newberry

PLATE XIII, FIG. 5

Zamites apertus NEWBERRY, Am. Jour. Sci., 3d ser., vol. 61, 1891, p. 199, pl. XIV, figs. 4, 5.

In seeking to identify the numerous specimens of *Zamites* in this collection I have been confronted with apparently the same difficulty that Professor Fontaine encountered, namely, a considerable number of so-called species to choose from and the difficulty of locating them definitely under either. Thus from the Canadian Kootanie Dawson reported *Z. acutipennis* Heer, *Z. montana* Dawson, and a form not specifically named, but which Fontaine[1] has placed under *Z. arcticus* Heer. In addition to these we have Newberry's *Z. apertus,* from the Great Falls area. As Fontaine very well says, it is more than probable that all of these (with the possible exception of *Z. apertus*) should be referred to *Z. arcticus* Heer; for, while it is possible to note minor differences, they are obviously of little value in considering a group in which there is known to be such variation as in cycad leaves. But with *Z. apertus* it is a little different, for while Newberry compared his species to *Z. arcticus,* he stated that it was "much more open in structure, the pinnules being separated by spaces sometimes as wide as themelves." I have not seen anywhere figures referred to *Z. arcticus* in which the leaflets are so widely separated, and for this confessedly doubtfully sufficient rea-

[1] In Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 306.

son I have decided to recognize Newberry's species. A larger series would be quite likely to show that this supposed distinction is not valid.

Dr. Newberry was not able to note the nervation in the leaflets, as the nerves were "sunk in the parenchyma," but in one of the specimens before me which is exceptionally well preserved, it appears that there are always four strong nerves, between which are a large number of very fine faint nerves.

In some cases the specimens are so well preserved that the actual epidermal substance of the leaflet is retained as a thin, delicate, carbonaceous film, which can often be pulled off almost entire.

At my request Dr. Albert Mann, of the U. S. Department of Agriculture, who is especially skilled in all branches of microscopic technique, has kindly undertaken to prepare microscopical slides of these carbonaceous films, and the result has been entirely satisfactory, the epidermal structure being plainly revealed. In the irregularity of the cell outline, character and disposition of stomata, etc., they agree very closely with similar structures described in various fossil cycads,[1] but Dr. Mann has called my attention to the fact that the structure differs entirely from that of certain living species to which the plants are supposed to be related. The subject is therefore deferred to a subsequent paper, in which it is hoped to present the evidence in full.

Locality.—Spanish Coulée, 12 miles east of Cascade, Cascade County, Montana?

In addition to the above, there are two or three fragmentary specimens doubtfully referred to this species from cut on Hazlett Creek 3 miles south of the Bauer sheep ranch.

PTEROPHYLLUM MONTANENSE (Fontaine) n. comb.

PLATE XIV, FIG. 3

Zamites montanensis FONTAINE, Proc. U. S. Nat. Mus., vol. 15, 1892, p. 494, pl. LXXXIV, fig. 4.

Professor Fontaine based his species on a drawing of a single imprint, and as this was preserved with the lower side of the leaf uppermost, the insertion of the leaflets was concealed by the thick midrib. It was therefore impossible to decide whether the species should be referred to *Zamites* or *Pterophyllum;* but as it appeared

[1] *cf.* Schenk, Palæontographica, vol. 19, 1871, p. 233 [31], pl. XXXV [XV].

to agree best with certain species of *Zamites,* it was referred provisionally to this genus.

According to Heer, Saporta, and others, the leaflets in *Zamites* are inserted on the upper surface of the rachis and are more or less contracted or inequilateral at base. In *Pterophyllum* the narrow leaflets are attached, usually at a right angle, by their entire bases to the edge of the rachis and are free throughout.

The present collection contains two well preserved specimens, one of which fortunately shows the upper surface of the leaf, and from this it is ascertained that the leaflets are attached by their bases to the edge of the rachis, thus throwing the species into *Pterophyllum,* to which I have accordingly transferred it. The two specimens here mentioned are preserved in small nodules, which when broken open exhibit nearly the complete leaf in an admirable state of preservation.

There are also several examples preserved in a soft shale that seem to belong here. They have, as may be seen from the figure, slightly narrower and rather more acuminate leaves, but the difference is probably too slight to warrant separating them. As a matter of fact, they do resemble Heer's *Zamites speciosus*[1] about as closely as the present species, but there is no evidence to show that the leaflets are not attached along the side of the rachis, and, moreover, the nervation, said by Heer to be obsolete in his *Z. speciosus,* is the same as in *Pterophyllum montanense.*

Locality.—Flood siding 6 miles southwest of Great Falls, Montana [at or near type locality]. Collected by Prof. O. C. Mortson, Spanish Coulée, 12 miles east of Cascade, Montana.

NILSONIA SCHAUMBURGENSIS (Dunker) Nathorst

Nilsonia schaumburgensis (Dunker) Nathorst, Anzeiger d. k. Akad. d. Wiss. in Wien, Jahrg. 26, 1889, p. 237; Fontaine in Ward, Monog. U. S. Geol. Survey, No. 48, 1905 [1906], p. 303, pl. LXXII, figs. 17–21.

The specimens obtained at Geyser are discussed at length by Professor Fontaine, and the present specimens add nothing of interest.

Locality.—Meridith mine, 3 miles southeast of Nollar's ranch and 6 miles southwest of Geyser, Cascade County, Montana.

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[1] Fl. Foss. Arct., vol. 3, 1874, p. 64, pl. XIV, figs. 1–12; pl. XVI, fig. 4.

ORDER GINKGOACEÆ

GINKGO SIBIRICA Heer

PLATE XIII, FIGS. 1–4; PLATE XIV, FIGS. 1, 2

Ginkgo sibirica HEER, Fl. Foss. Arct., vol. 4, 1878, Abth. II, p. 61, pl. VII, fig. 6; pl. IX, fig. 5*f*; pl. XI.

Baiera brevifolia NEWBERRY, Am. Jour. Sci., 3d ser., vol. 61, 1891, p. 199, pl. XIV, fig. 3.

The present collection contains such a bewildering array of excellently preserved *Ginkgo* leaves that I am almost at a loss to know how best to dispose of them. Individual specimens can be so satisfactorily matched with various described forms that it would be little trouble to recognize perhaps as many as four or five so-called "species"; but no one who has examined a good series of leaves from a tree of the living species (*G. biloba*) can fail to recognize the danger in this genus of basing species too closely on size, shape, or the degree of lobation. In fact, it has been said that every described fossil species of *Ginkgo* can be very closely approximated by leaves from the living tree, and from evidence that has been accumulating of late there is every reason to believe that the extreme variation now exhibited has been a character of *Ginkgo* since its establishment. It is of course true that a few dominant forms of types can be recognized, and these may be—probably correctly—accepted until we have secured collections of a sufficient magnitude to permit the working out of the limits of legitimate specific variation.

It is with some hesitation that I have decided to refer these leaves to *Ginkgo sibirica* of Heer. The types of the species described from the Jurassic of eastern Siberia are rather more deeply lobed than the Kootanie specimens in hand, though they agree very well with leaves that have been subsequently referred to it, such, for instance, as the leaf figured by Saporta[1] from the Jurassic of France, and it is certainly the same as the leaf from the Canadian Kootanie figured by Dawson[2] under this name. In the same publication Dawson has also noted the presence of *Ginkgo lepida, G. nana*, and *Baiera longifolia;* but, judging from the figures alone, it is very doubtful if these can be maintained; certainly the specimens referred to *Ginkgo lepida* and *Baiera longifolia* must be identical, while his *G. nana* is probably the same, though it is too fragmentary to be positive one way or the other.

[1] Pal. Française, Pl. Jurass., vol. 3, pl. XXXII, fig. 6.

[2] Trans. Roy. Soc. Canada, vol. 4, sec. IV, 1885, p. 8, pl. II, fig. 1.

Certain of the specimens from Montana agree also with some of the forms that have been referred to *Ginkgo digitata* (Brongn.) Heer, and with fewer specimens there would probably be no hesitation in so referring them, but they grade one into the other to such an extent as to make any line unsatisfactory.

There are a number of small specimens (*cf.* plate XIV, figs. 1, 2) that are absolutely indistinguishable from *Ginkgo polaris* Nathorst[1] except in possessing a long, strong petiole. As Nathorst has suggested, his species can be especially compared with *G. sibirica* Heer and *G. flabellata* Heer; so that, as he naïvely adds, "there is the temptation of classing some fragments with one species, some with the other." As the more perfect examples appeared to differ from either in the petiole being neither so long nor strong, he decided to give it a separate name. As the specimens under consideration are otherwise indistinguishable, their having a relatively long and very strong petiole may properly exclude them from *G. polaris*.

In his first paper on the Great Falls coal field, Newberry described a deeply lobed leaf as *Baiera brevifolia*, comparing it especially with *B. pluripartita* Schimper, from the Wealden of North Germany. I have not seen this specimen, and the figure of it is so poor that nothing of the nervation can be made out, but I can see no reason to suppose it is other than a small leaf of *Ginkgo*, especially as it can be matched satisfactorily by specimens before me. I have therefore referred it tentatively to *G. sibirica*.

Finally, I may add that I have given on the plate a number of figures showing the normal and extremes exhibited, and while it must be confessed some of them are very unlike what has usually been referred to *Ginkgo sibirica*, there are so many intermediate forms that it is quite impossible to draw any satisfactory line between them. They must either be regarded as belonging to one polymorphous species or to half a dozen poorly defined forms.

Locality.—Shale below main coal seam, 3 miles southeast of Nollar's ranch, at Meridith mine, and about 6 miles southwest of Geyser, Cascade County, Montana. Mr. Fisher also noted, but did not collect, this species opposite the smelter, on the south bank of the Missouri River at Great Falls.

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[1] Norwegian North Polar Exped., 1893–1896, Foss. Pl. from Franz Josef Land, p. 4, pl. 1, fig. 8.

ORDER CONIFERÆ.

SEQUOIA GRACILIS Heer

Sequoia gracilis HEER, Fl. Foss. Arct., vol. 3, 1873, Abth. II, p. 80, pl. XVIII, fig. 1; pl. XXII, figs. 1–10.

This species, described originally from the Kome (Urgonian) beds of Greenland, was first detected in the Kootanie at Great Falls by Newberry. The present collections contain it from these localities, some of the specimens being especially well preserved and agreeing perfectly with the figures from the Greenland beds.

Locality.—Flood siding 5 miles southwest of Great Falls; north side of cut on high-line railroad west of smelter at Great Falls; Spanish Coulée, 12 miles east of Cascade, Cascade County, Montana.

SEQUOIA AMBIGUA Heer

Sequoia ambigua HEER, Fl. Foss. Arct., vol. 3, 1874, Abth II, p. 78, pl. XXI, figs. 1–11.

Locality.—Railroad cut west of smelter, north side of Missouri River at Great Falls, Montana.

SEQUOIA REICHENBACHI (Geinitz) Heer

PLATE XII, FIGS. 7, 8

Sequoia reichenbachi (GEINITZ) HEER, Fl. Foss, Arct., vol. 1, 1868, p. 83, pl. XLIII, figs. 1*d*, 2*b*, 5*a*.

The collection made at Skull Butte, eastern Fergus County, contains a considerable number of rather fragmentary branchlets that appear to belong to this species, though the leaves are rather more spreading than is usual in *S. reichenbachi*. It is not, however, greatly different from certain of the forms referred to it by Heer from the Lower Cretaceous of Greenland.[1] There is also with these branchlets a very fragmentary cone that may belong with them; it is too much broken to figure.

Locality.—Cañon on north side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana.

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[1] *cf.* Fl. Foss. Arct., vol. 3, 1874, pl. XX.

CONIFEROUS LEAVES?

PLATE XII, FIGS. 5, 6

The material from Skull Butte, eastern Fergus County, Montana, contains a number of isolated but fairly well preserved leaves that appear to have belonged to some conifer. They are about 13 or 14 mm. in length and slightly over 2 mm. in width, the basal portion being truncate or slightly rounded and the apical end rather obtusely acuminate. They are provided with a single quite prominent median rib. I have not attempted to place them more definitely than indicated above, as they are too uncertain.

Locality.—Cañon north side of Skull Butte, 6 miles southeast of Stanford, Fergus County, Montana.

EXPLANATION OF PLATES

PLATE XI

FIG. 1. *Cladophlebis browniana* (Dunker) Seward.
1*a*. Enlarged pinnule of same, × 2.
2. *Cladophlebis fisheri* n. sp.
3. *Acrostichopteris fimbriata* n. sp.
3*a*. Enlarged pinnule of same, × 2.
4. *Dryopteris?* *kootaniensis* n. sp.
4*a*. Enlarged pinnule of same, × 2.
5. *Oleandra graminæfolia* n. sp.
5*a*. Enlarged portion of same, × 2.
6. *Oleandra graminæfolia* n. sp.
6*a*. Enlarged portion of same, × 2.

PLATE XII

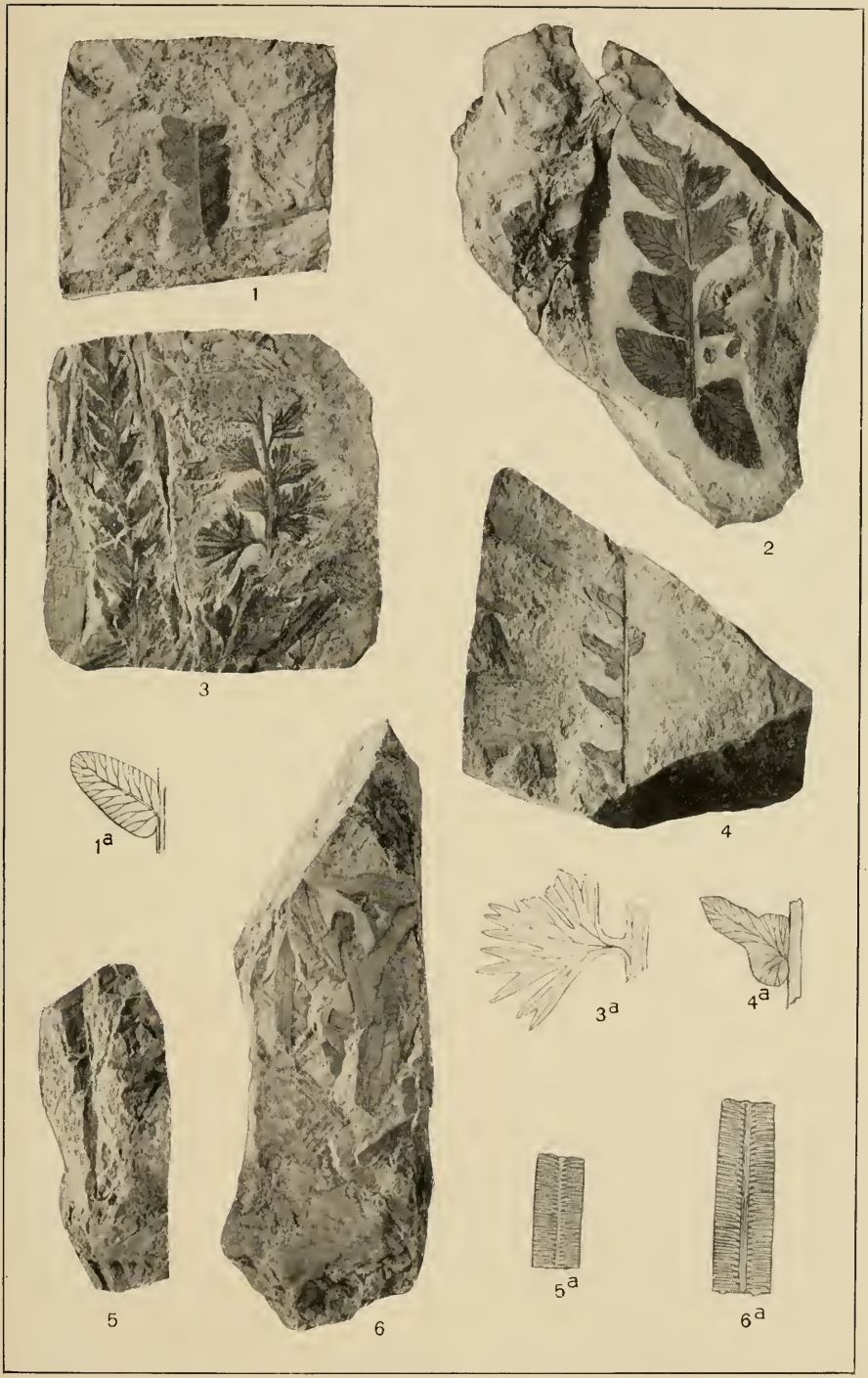
FIGS. 1, 2. *Adiantum montanense* n. sp.
3, 4. *Protorhipis fisheri* n. sp.
5, 6. Coniferous leaves.
7, 8. *Sequoia reichenbachi* (Geinitz) Heer

PLATE XIII

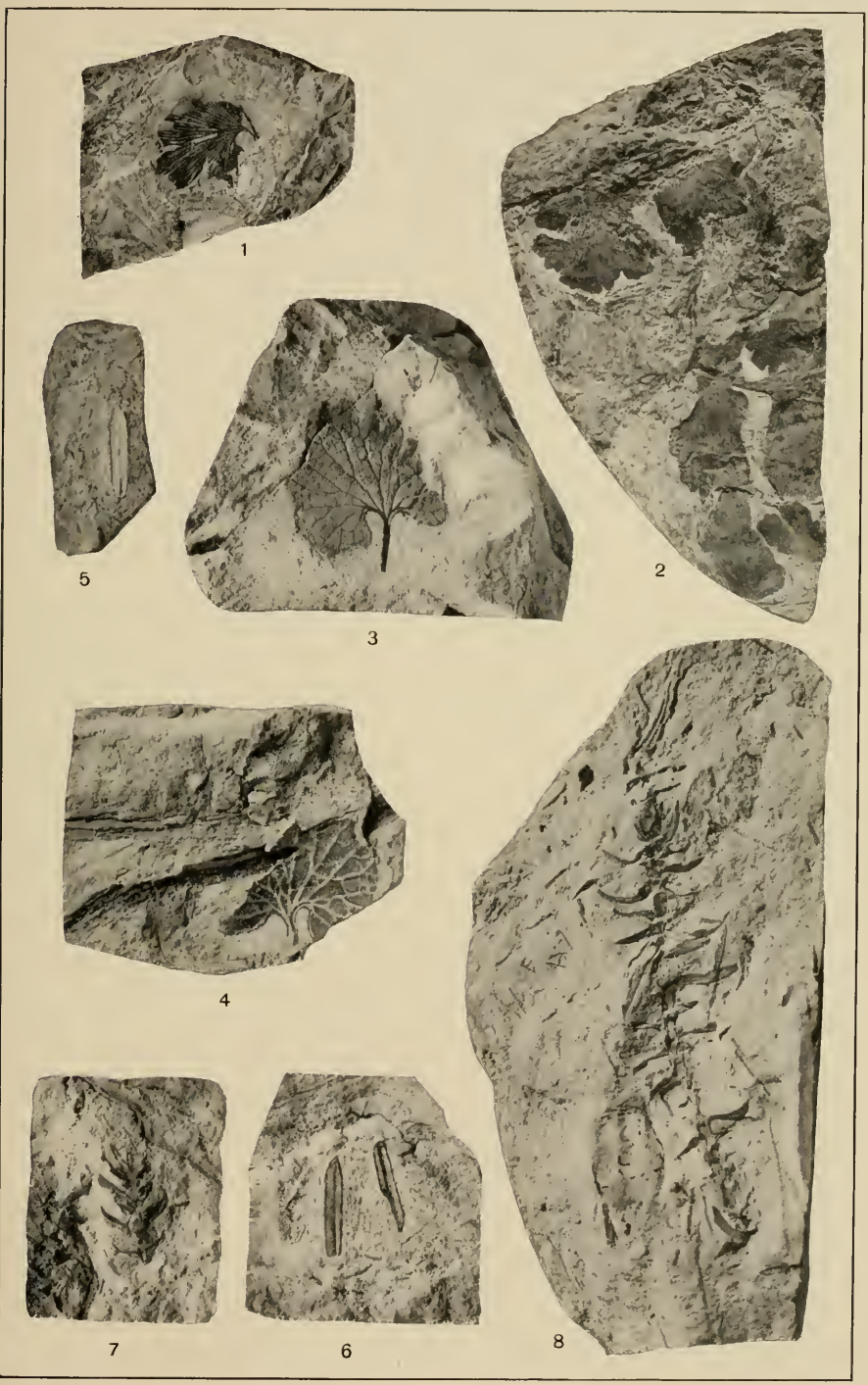
FIGS. 1–4. *Ginkgo siberica* Heer.
5. *Zamites apertus* Newberry.

PLATE XIV

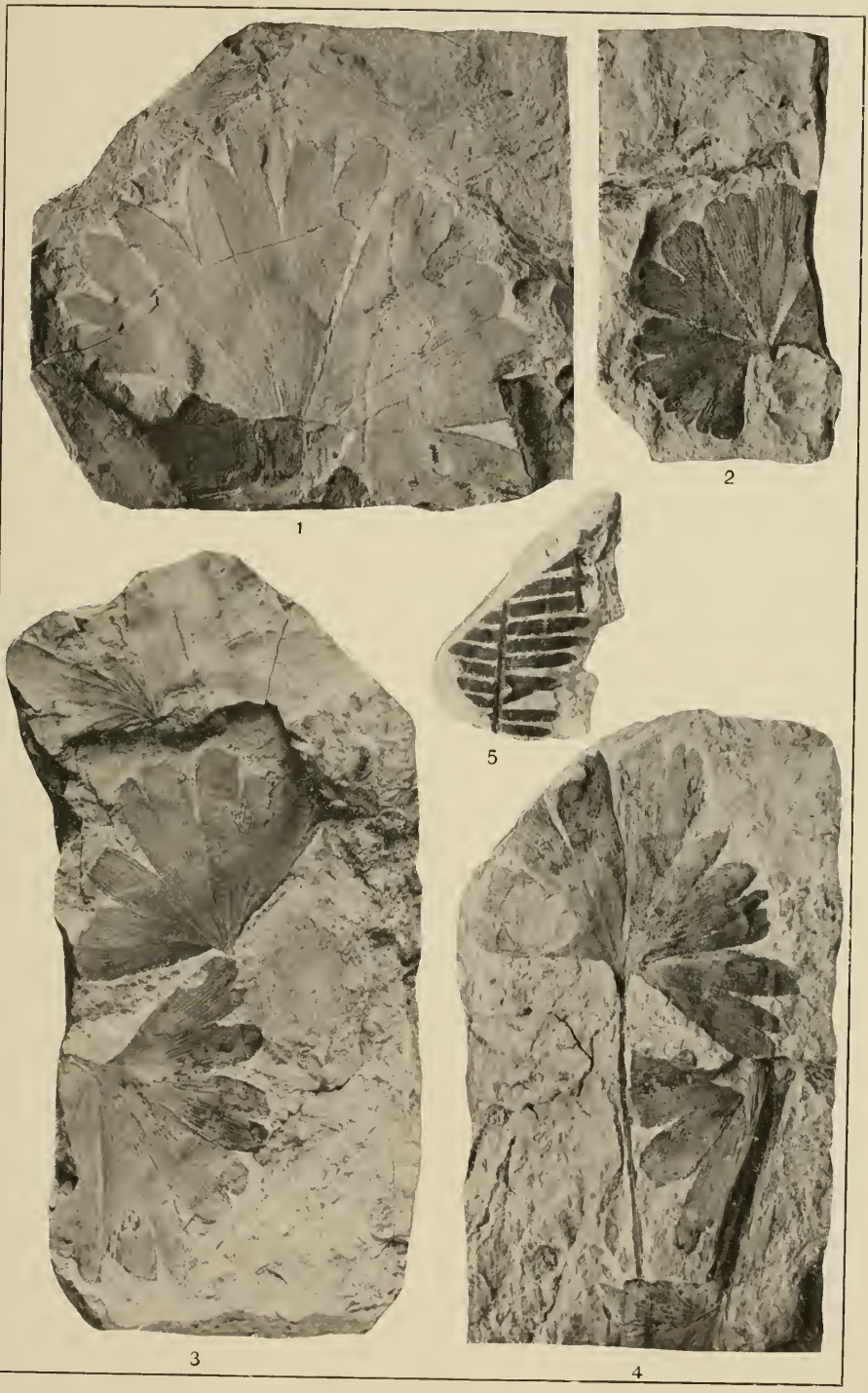
FIGS. 1, 2. *Ginkgo siberica* Heer.
FIG. 3. *Pterophyllum montanense* (Fontaine).
4. *Podozamites lanceolatus* (L. & H.) Nathorst.



KOOTANIE PLANTS FROM THE GREAT FALLS COAL FIELD OF MONTANA



KOOTANIE PLANTS FROM THE GREAT FALLS COAL FIELD OF MONTANA



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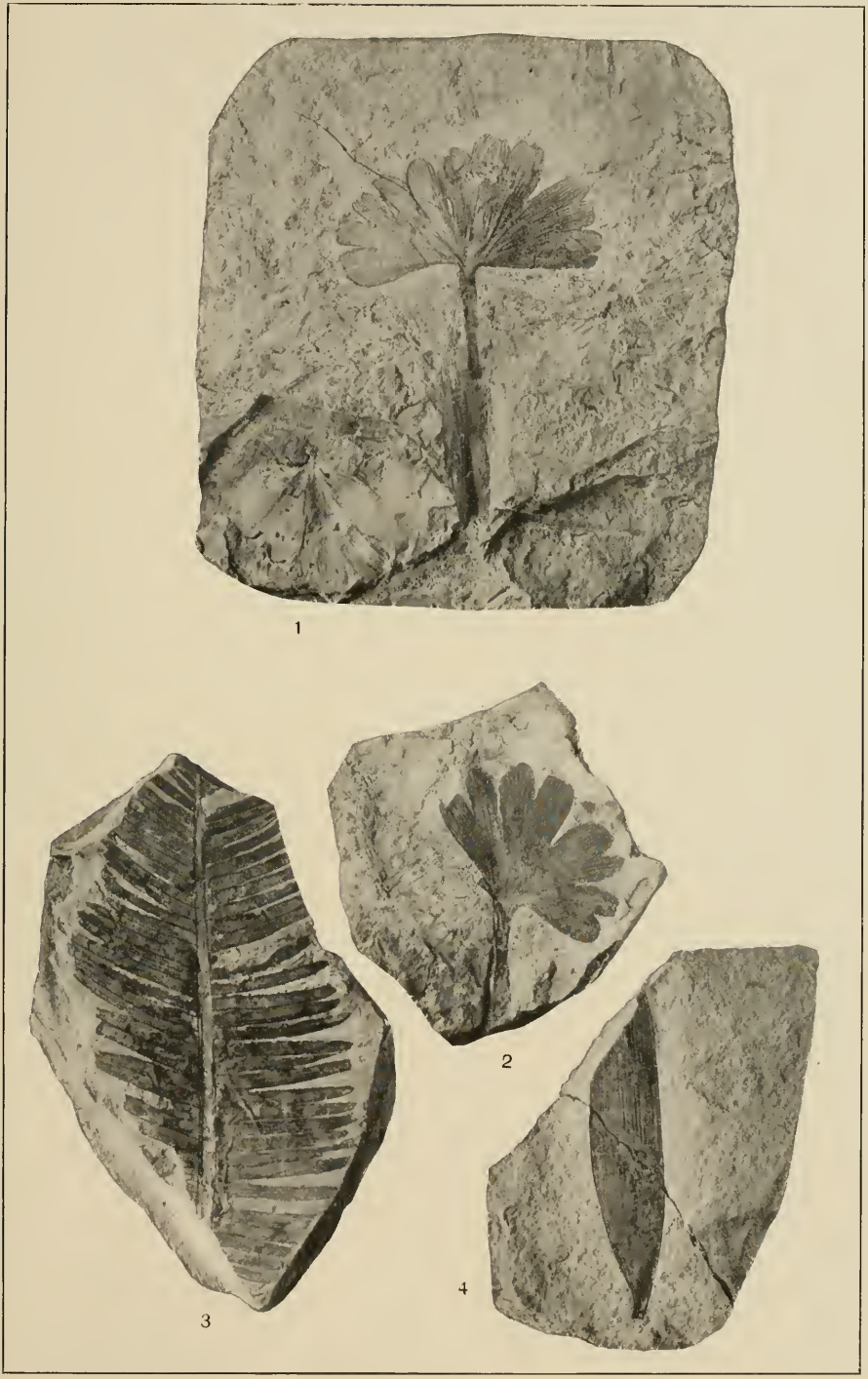

KOOTANIE PLANTS FROM THE GREAT FALLS COAL FIELD OF MONTANA