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THE FLORA OF THE FRONTIER FORMATION

BY

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THE FLORA OF THE FRONTIER FORMATION

By EDWARD WILBER BERRY

INTRODUCTION

In 1917 the late F. H. Knowlton described a flora from the Frontier formation of southwestern Wyoming.[1] This description was based upon collections made in the vicinity of Cumberland, in Lincoln County, by John C. Frémont in 1843, by A. C. Veatch in 1906, by T. W. Stanton and F. H. Knowlton in 1908, by A. C. Peale in 1909, and by T. W. Stanton in 1913. Knowlton enumerated 25 species, representing 7 ferns, 1 equisetum, 1 monocotyledon, and 16 dicotyledons.

In the last few years N. H. Brown, of Lander, Wyo., has sent in several small collections of plants from the Frontier formation of the Wind River Basin, in Fremont County, Wyo. These collections were obtained within a 6-mile radius of Lander and have resulted in the addition of nine species to this flora, several of which are of especial interest and serve to give a much clearer evaluation of it in terms of chronology and environment than was before possible. The present contribution is devoted to a description of these additional species in the northeasterly extension of the formation and to a discussion of the age and environmental conditions indicated by the flora as a whole. I am much indebted to Mr. Brown for his sustained interest in this and other problems of western Wyoming.

The Frontier formation in its wider extent is a thick series of sandstone beds with a few conglomeratic lenses, with shale and coal beds, and containing, above the middle, beds of long, slender oysters (*Ostrea soleniscus*) and a small but characteristic marine fauna of Benton age. The plants from Lincoln County came from a thin whitish clay in a 30-foot light-colored clay shale of considerable lateral extent about 1,200 feet below the top of the Oyster Ridge sandstone member, which underlies the Kemmerer coal. This fine-grained matrix accounts for the excellent preservation of the plants described by Knowlton. The plant-bearing exposures of the Frontier formation in the Wind River Basin are the normal coarse basal sandstones, and, except for the coriaceous forms such as the *Nilsonia* and *Protophyllocladus*, the plants are poorly preserved.

[1] Knowlton, F. H., A fossil flora from the Frontier formation of southwestern Wyoming: U. S. Geol. Survey Prof. Paper 108, pp. 73–107, pls. 27–39, 1917.

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It would seem that the Frontier formation as a whole and in a general way records a transition from continental swamp and river deposits through littoral deposits to shallow marine deposits. The beds near Lander from which the present collections were made form the basal sandstone of the Frontier as there identified and appear to me to be of continental origin and partly wind-laid, either in the lower part of a stream valley or in depressions of a beach ridge. I would not expect this phase to have been necessarily of any great extent or to have resulted in any unit thickness, but the predominance of coriaceous forms, the attitudes in which they were buried, and to a considerable extent the botanical character of the species identified all point in this direction.

CORRELATION OF FREMONT COUNTY WITH LINCOLN COUNTY FRONTIER

Although the more delicate species recorded from Lincoln County have not been found in Fremont County, especially most of the ferns, there can be no very great difference in the age of the plants from the two areas. This is proved by the presence in Fremont County of the following forms described by Knowlton as occurring in Lincoln County and not known from any other horizons:

Anemia fremonti Knowlton.
Cinnamomum? sp. Knowlton.
Dryophyllum lanceolatum (Knowlton) Berry.
Ficus fremonti Knowlton.
Ficus? sp. Knowlton.

The fact that the plants found in the Frontier of Lincoln County are associated with representatives of Benton invertebrates, whereas in Fremont County the plants were found in the basal sandstone and the larger part of the Frontier above the plant horizon contains Niobrara invertebrates,[2] suggests that the Fremont County plants may be slightly younger than those from Lincoln County, although the range of the plants in the two areas rather points to just the opposite conclusion.

The matrix of the plant material of the Frontier formation in Fremont County varies in its lithology from a coarse friable massive grayish sandstone to a

[2] Stanton, T. W., personal communication.

finer more or less brownish or yellowish sandstone with a considerable intermixture of mudstone. In the finer material the leaf laminae are not parallel with one another nor usually flat but are more or less contorted—a condition usually ascribed to eolian sedimentation. The forms here described were associated with some fragments of fishbones, which are not precluded from occurrence in wind-blown deposits, because piscivorous birds can be relied upon to drop the bones on land surfaces near their fishing resorts or nesting places.

AGE INDICATED BY THE FLORA

In Knowlton's discussion of the age of the flora from Lincoln County he pointed out that, although all the plants were peculiar to the horizon and localities at which they were collected, their affinities seemed to be with post-Colorado forms. A part of his statement [3] is worth quoting in the present connection:

> The spleenwort (*Asplenium occidentale*) belongs to the same group as and is pretty closely related to an unpublished species from the Farmington sandstone member of the Kirtland shale (Montana group) of San Juan County, N. Mex. The shield fern (*Dryopteris coloradensis*) is strongly suggestive of an unpublished species from the Vermejo formation of the Raton Mesa region of Colorado and New Mexico. The *Anemia* is very closely related to and perhaps identical with a species common in the Eocene of Europe but also reported from the Montana at Point of Rocks, Wyo. Among the dicotyledons, *Cinnamomum hesperium* is hardly distinguishable, except in size, from *Cinnamomum wardii*, from the upper part of the Adaville formation at Hodges Pass, a few miles north of the Cumberland localities. *Dewalquea pulchella* and *Dryandroides lanceolata* are so close to *Dewalquea insignis* and *Dryandroides quercinea*, respectively, from the upper Senonian of Westphalia, that it is perhaps doubtful if they should be maintained as distinct. *Quercus stantoni* is very similar to *Quercus formosa*, also from the Senonian of Westphalia. *Ficus fremonti* agrees in shape with *Ficus proteoides* Lesquereux and in shape, size, and nervation with *Ficus lanceolata acuminata* Ettingshausen, as figured by Lesquereux, from the Dakota sandstone. This is the only species that appears to show any special likeness to forms from beds whose position is lower than that assigned to the plant beds at Cumberland.

The only one of the nine additional Frontier species discovered in the Wind River Basin that falls in with the preceding statement is the *Sequoia*, which is most like the Judith River remains referred to *Sequoia reichenbachi*. Of the remaining eight species the *Sabalites* indicates nothing with respect to age, and the other seven represent a distinctly pre-Colorado element which survived into Colorado time. The *Nilsonia* represents a type which had its origin in the Triassic, reached its maximum in the Jurassic, and died out during the Upper Cretaceous. No species as large or as characteristic as the Frontier form has been found in rocks as young as these.

The other six species were all described originally from the Dakota sandstone or recorded from it by Lesquereux, and the *Sterculia* is abundant in the eolian sandstones of the still earlier Cheyenne sandstone of southern Kansas. It is true that several of these species have been found to have a considerable time range and are not confined to pre-Colorado horizons. For example, the *Protophyllocladus* is found outside the Western Interior in beds as young as the Montana group, but its type occurrence was in the Dakota sandstone, which was its latest known occurrence in the West prior to its discovery in the Frontier. The *Phyllites crassipes* and *Ficus inaequalis* were similarly confined to the Dakota sandstone in the West but ranged to higher horizons in the Atlantic Coastal Plain and Greenland. If the indications of age furnished by these additions to the Frontier flora are integrated with the age indications, as quoted above, of the plants from Lincoln County, the result agrees perfectly both with the age indications of the Frontier invertebrates and also with our expectations of what a Colorado flora would be like. That is to say, it shows a facies of its own but consists in part of forms derived from the Dakota and others praenuncial of later Upper Cretaceous floras. This same statement is true with respect to floras of Colorado age from western Canada which I have studied: *Anemia fremonti* of the Frontier is also found in the Sukunka formation of British Columbia.

COMPOSITION OF THE FLORA

The flora from the Frontier formation now numbers 34 species, representing 24 genera in 16 families and 15 orders, as listed below.

Arthrophyta:
- Equisetales:
  - Equisetaceae:
    - Equisetum sp. Knowlton.

Pteridophyta:
- Polypodiales:
  - Polypodiaceae:
    - Tapeinidium? undulatum (Hall) Knowlton.
    - Microtaenia variabilis Knowlton.
    - Microtaenia paucifolia (Hall) Knowlton.
    - Dennstaedtia? fremonti (Hall) Knowlton.
    - Dryopteris coloradensis Knowlton.
    - Asplenium occidentale Knowlton.
    - Anemia fremonti Knowlton.

Cycadophyta:
- Williamsoniales:
  - Nilsonia mehli Berry, n. sp.

Coniferophyta:
- Sequoia reichenbachi (Geinitz) Heer.
- Protophyllocladus subintegrifolius (Lesquereux) Berry.

Angiospermophyta:
- Monocotyledonae:
  - Arecales:
    - Arecaceae:
      - Sabalites sp.
  - Liliales?:
    - Smilacaceae?:
      - Smilax? coloradensis Knowlton.

[3] Knowlton, F. H., op. cit., p. 77.

Angiospermophyta—Continued.
Dicotyledonae:
Myricales:
Myricaceae:
Myrica nervosa Knowlton.
Salicales:
Salicaceae:
Salix cumberlandensis Knowlton.
Salix frontierensis Knowlton.
Fagales:
Fagaceae:
Quercus stantoni Knowlton.
Dryophyllum lanceolatum (Knowlton) Berry.
Urticales:
Moraceae:
Ficus fremonti Knowlton.
Ficus inaequalis Lesquereux.
Ficus? sp., Knowlton.
Ficus?, sp., Knowlton.
Sapindales:
Staphyleaceae:
Staphylea? fremonti Knowlton.
Malvales:
Sterculiaceae:
Sterculia towneri (Lesquereux) Berry.
Laurales:
Lauraceae:
Cinnamomum hesperium Knowlton.
Cinnamomum? sp., Knowlton.
Umbellales:
Araliaceae:
Aralia veatchii Knowlton.
Position uncertain:
Dewalquea pulchella Knowlton.
Phyllites ficifolius Knowlton.
Phyllites grandifolius-cretaceus (Lesquereux) Berry.
Phyllites cretaceus (Ettinghausen) Berry.
Phyllites crassipes (Heer) Berry.
Phyllites dentata Knowlton.
Phyllites sp. Knowlton.

The Arthrophyta are represented by a single rather indifferently preserved species of *Equisetum*. The ferns furnish seven species in six genera, and all except the *Anemia* are confined to the region around Cumberland, in Lincoln County. These ferns are perhaps the most interesting element in this flora; the *Tapeinidium* is closely related to existing Malaysian and Polynesian forms; the two species of *Microtaenia* are unique and without any close relatives among existing davallioid ferns; the *Dennstaedtia* is not certainly determined, as the material is fragmentary. The genus is only sparingly represented in the geologic record and was not previously known from horizons earlier than the Fort Union. The *Dryopteris*, *Asplenium*, and *Anemia* are to be expected anywhere in the Upper Cretaceous and require no comment.

The cycads are represented by the remarkable species of *Nilsonia*, which has already been referred to. Coniferophytes constitute a very minor element in the flora, being represented by only a very few twigs of *Sequoia* and the more abundant phylloclads of the more or less problematic *Protophyllocladus*. Upper Cretaceous floras in general contain a relatively great variety of conifers, and of the two reasons that may be advanced for their seeming rarity in the Frontier—namely, unfavorable environmental conditions or lack of discovery—experience indicates that the latter is probably the true explanation and that we may look forward to finding eventually a much better representation of this class of plants.

The angiosperms comprise two monocotyledons and twenty-two dicotyledons. One of the monocotyledons is of uncertain affinities. The form which I have referred tentatively to *Sabalites* is certainly a palm, but the form which Knowlton referred tentatively to *Smilax* is not a *Smilax*, in my opinion, and there is some doubt even of its being monocotyledonous.

The dicotyledons are in no way remarkable but represent such genera as *Myrica*, *Salix*, *Dryophyllum*, *Ficus*, *Sterculia*, *Aralia*, *Phyllites*, and *Dewalquea*, which are common elements in most Upper Cretaceous floras, commencing with those of Cenomanian age. Several of the dicotyledons recorded from the Frontier formation are of rather doubtful value, notably the forms which Knowlton described as *Ficus?* sp., *Cinnamomum?* sp., and *Phyllites*.

ENVIRONMENTAL CONDITIONS INDICATED

The occurrence of numerous thick and widespread beds of coal in the Frontier formation is a conclusive indication of a humid climate at the time of their formation, and the known flora points in the same direction, especially that facies found in the clays in the vicinity of Cumberland. The plants found in Fremont County, although they do not indicate any aridity of climate, seem to me in part to indicate less humid conditions, which I would interpret as due not to a lessened rainfall but to their having grown on beaches or between dunes along a coast where insolation was high, winds were rather constant, and the sandy surface was apt to afford a less constant water table or one insufficient to keep pace with the increased evaporation due to insolation and wind. I regard the *Nilsonia*, *Protophyllocladus*, *Dryophyllum*, and *Sterculia* as being especially indicative of such an environment. Their coriaceous nature points in the same direction, and both *Dryophyllum* and *Sterculia* occur frequently as fossils in exactly this environment—*Dryophyllum* in beach and dune deposits in the sands of Aix-la-Chapelle, along the shores of the lower Eocene Paris Basin, and in the Mississippi Gulf embayment, and *Sterculia* in the Cheyenne and Dakota sandstones.

Knowlton concluded that the climate of Frontier time was tropical or subtropical, basing his conclusion on the indeterminate growth of *Tapeinidium* and the other davallioid ferns present and the occurrence of *Ficus* and *Cinnamomum*. As I have frequently

pointed out, the universal tendency among paleobotanists is to demand tropical climates. If we consider the latitudinal range of the commoner Upper Cretaceous genera we either, like Knowlton, who followed Manson, accept a wholly impossible climatic control, or else, like Koppen and Wegener, we predicate a wandering pole. The number of plants as yet known from the Frontier formation is entirely too small to warrant any attempt to put forward an elaborate climatic discussion, but a few remarks are not inappropriate. In the first place, most discussions of climate that have been based on fossil organisms fail to differentiate between the geographic occurrence of the most closely related existing forms and the actual climate in which they live. Every country in the tropical zone is assumed to have a tropical climate, whereas, as a matter of fact, the altitudinal climatic zones in the Tropics may run up to those of Arctic conditions, as they do in all the Andean countries of South America. The plants most commonly thought of as tropical—these Frontier davallioid ferns, for example, or tree ferns in general—find their optimum modern conditions in temperate rain forests, not in tropical lowlands. We can only infer the climatic requirements of such wholly extinct Frontier genera as *Nilsonia* and *Protophyllocladus*, but of the Frontier genera that are represented in existing floras—namely, *Equisetum*, *Sequoia*, *Myrica*, *Salix*, *Quercus*, *Dryophyllum*, *Ficus*, *Staphylea*, *Sterculia*, *Cinnamomum*, and *Aralia*—some are decidedly temperate types, *Equisetum* and *Salix* extending into the Arctic zone, and none are out of place in a warm temperate climate.

As already stated, the Frontier plants are too few to afford the basis for a more conclusive analysis, but my inference would be that they indicate a warm temperate and not a subtropical or tropical climate.

SYSTEMATIC DESCRIPTIONS

Phylum CYCADOPHYTA

Order WILLIAMSONIALES

Genus NILSONIA Brongniart

Nilsonia mehli Berry, n. sp.

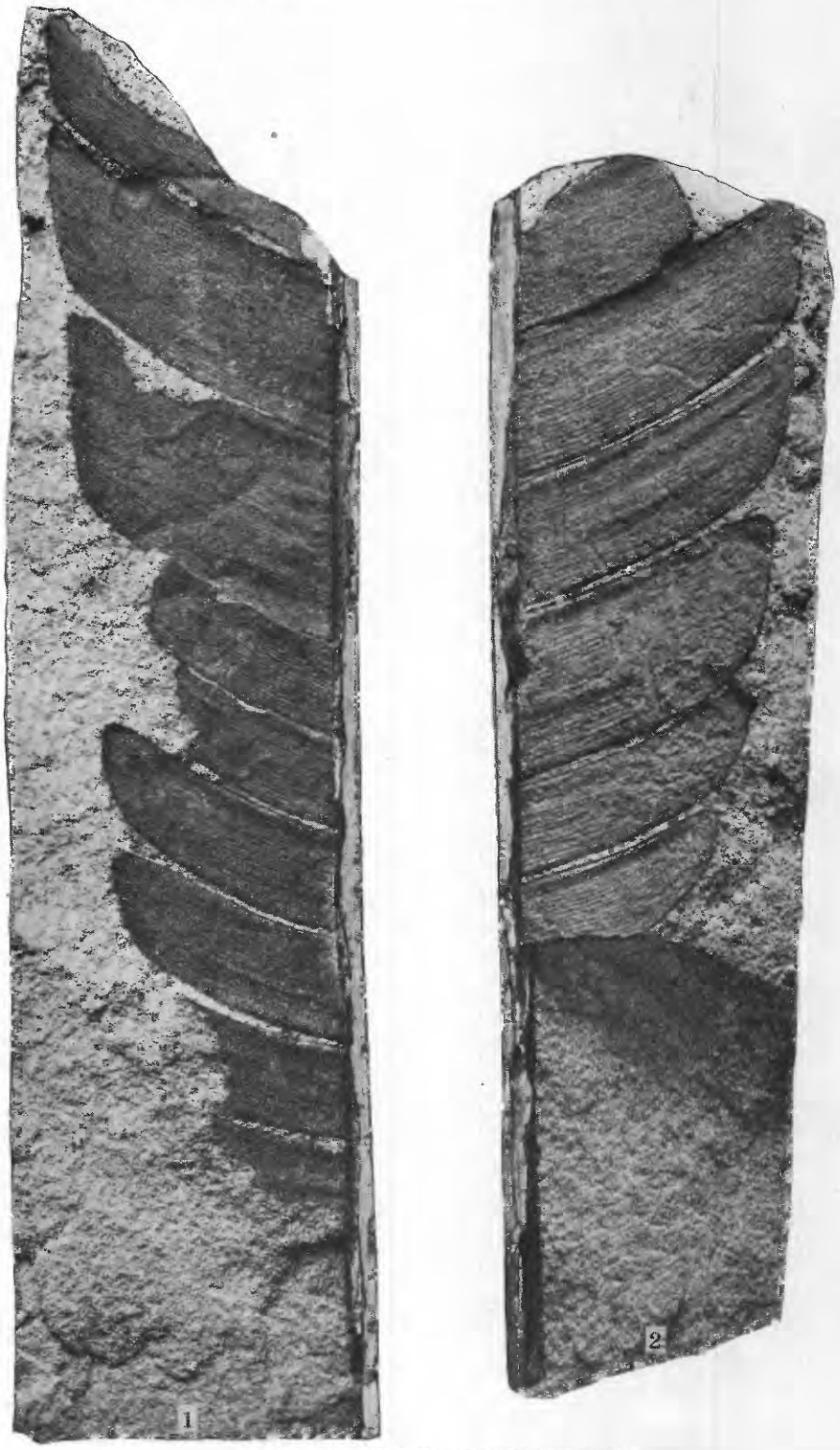
Plate 20

Petiole preserved for a length of 22 centimeters below the lamina. Something less than basal half of lamina preserved, amounting to 18 centimeters. Nine pinnules. Maximum width of lamina 9.5 centimeters. Pinnules falcate, the lower six *Pterophyllum*-like, uniformly 13 to 14 millimeters wide, increasing in length upward. The seventh pinnule is 3 centimeters wide, the eighth 2.5 centimeters, and the ninth similar but partly broken. The basal pinnule is pointed, the tip being close to the distal margin and the proximal margin forming an arc. The second pinnule is much less cut away below, and each succeeding one upward is more truncate, the outer edge of the wider pinnules being almost parallel with the rachis, the outer distal corner being obtusely pointed and the outer proximal corner being rounded off. The rachis is of medium size, about 4 millimeters in diameter as preserved. The pinnules are inserted in the center of its upper face. The veins are stout, immersed in the coriaceous substance, closely spaced, and parallel with one another and with the lateral margins of the pinnules, about 26 in number in the narrower pinnules and similarly spaced in the wider. Species named for Dr. M. G. Mehl, of the University of Missouri, who assisted Brown in the collection and shipment of the material.

This handsome species is much the largest known from so young a horizon. The exact locality is the NW. ¼ sec. 17, T. 6 N., R. 3 W. Wind River meridian. The genus appears in the Triassic, is especially characteristic of the Rhaetic and Oolitic, and may be said to be cosmopolitan in the Jurassic. It was less abundant but still widely distributed in Lower Cretaceous time, being recorded from all the continents except Africa. It became rare in the Upper Cretaceous but is represented by several undoubted species—three in Japan, two on Sakhalin Island, one in the Atane beds of western Greenland, and one in the Cenomanian of Bohemia. These other Upper Cretaceous forms are mostly small and more delicate, the Greenland form being the most robust but prevailingly entire instead of lobate. The form most similar to this Frontier species is *Nilsonia densinervis* (Fontaine) Berry,[4] of the Lower Cretaceous (Patuxent and Arundel formations) of the Atlantic Coastal Plain. This is somewhat narrower and often entire; when lobate the lobes are narrower and somewhat different in outline but essentially similar in venation.

The genus was established by Brongniart in 1825 on material from the Rhaetic of Sweden and has been discussed at length by Saporta, Nathorst, Seward, and others. It may be characterized in the following terms: Frond coriaceous, elongate-lanceolate, entire or commonly more or less deeply pinnatifid by being split, usually to the rachis, into a number of more or less irregular segments which are contiguous, usually broad and truncate. Lamina attached to the upper surface of the rachis, the simple and parallel, equal lateral veins running almost or quite to the median line. In material showing only the under surface of the fronds the stout midrib is prominent and unsegmented specimens are scarcely distinguishable from *Taeniopteris* and allied forms; the segmented varieties approach *Anomozamites* or even some species of *Pterophyllum* in appearance.

[4] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 362, pls. 57, 58, 1911.



FLORA OF THE FRONTIER FORMATION

Nilsonia mehli Berry, n. sp.

FLORA OF THE FRONTIER FORMATION

1, 2, 4, Protophyllocladus subintegrifolius (Lesquereux) Berry; 3, Ficus inaequalis Lesquereux. An undeterminable leaf of Ficus is shown associated with Figure 4.

Phylum CONIFEROPHYTA

Order PINALES

Family CUPRESSINACEAE

Genus SEQUOIA Endlicher

Sequoia reichenbachi (Geinitz) Heer

Sequoia reichenbachi Knowlton, U. S. Geol. Survey Bull. 257, p. 131, pl. 14, figs. 3–5, 1905.

There are a few rather poorly preserved coniferous twigs in the Frontier sandstones, and these are identical with the rather common coniferous twigs in the Judith River formation which Knowlton referred to this world-wide and protean species. I am not at all certain that they are identical botanically with other occurrences—in fact, the wide range, both in time and space, of *Sequoia reichenbachi* strongly suggests that it is a composite species.

The identity of the present specimens with the Judith River specimens furnishes an element in which the Frontier flora resembles younger floras.

Occurrence: Sec. 8, T. 32 N., R. 99 W., 6 miles south-southeast of Lander.

Family PHYLLOCLADACEAE?

Genus PROTOPHYLLOCLADUS Berry

Protophyllocladus subintegrifolius (Lesquereux) Berry

Plate 21, Figures 1, 2, 4

Protophyllocladus subintegrifolius Berry, Torrey Bot. Club Bull., vol. 30, p. 440, 1903; vol. 31, p. 69, pl. 1, fig. 5, 1904; New Jersey State Geologist Ann. Rept. for 1905, p. 139, 1906; Maryland Geol. Survey, Upper Cretaceous, p. 796, pl. 56, fig. 2, 1916; U. S. Geol. Survey Prof. Paper 112, p. 57, 1919; Johns Hopkins Circ. 199, pp. 89–91, fig. 6, 1907.

Kryshtofovich, Coll. Sci. Imp. Univ. Tokyo Jour., vol. 40, art. 8, p. 41, fig. 6, 1918.

Phyllocladus subintegrifolius Lesquereux, Am. Jour. Sci., vol. 46, p. 92, 1868; The Cretaceous flora, p. 54, pl. 1, fig. 12, 1874; U. S. Geol. Survey Mon. 17, p. 34, pl. 2, figs. 1–3, 1892.

Thinnfeldia lesquereuxiana Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 37, pl. 44, figs. 9, 10; pl. 46, figs. 11, 12 a, b, 1882.

Hollick, New York Acad. Sci. Trans., vol. 11, p. 99, pl. 3, fig. 6, 1892; New York Acad. Sci. Annals, vol. 11, p. 58, pl. 3, figs. 4, 5, p. 419, pl. 36, fig. 6, 1898; New York Bot. Garden Bull., vol. 2, p. 403, pl. 41, figs. 13, 14, 1902; U. S. Geol. Survey Mon. 50, p. 36, pl. 5, figs. 1–6, 1907.

Newberry, U. S. Geol. Survey Mon. 26, p. 59, pl. 11, figs. 1–17, 1895.

This species was discussed by me at some length in 1903 and 1907 and need not be redescribed in the present connection. It was described originally by Lesquereux, who referred it to the existing genus *Phyllocladus*. Heer subsequently recorded it from the Atane beds of western Greenland and transferred it to the genus *Thinnfeldia* of Ettingshausen. In 1903 I showed that it could not be related to *Thinnfeldia* and proposed the new genus *Protophyllocladus* for its reception. Before and since it has been shown to have a wide range in the earlier half of the Upper Cretaceous, having been recorded from Massachusetts, New York, New Jersey, Maryland, and Alabama in this country and from Russian Sakhalin in eastern Asia. Three additional species have been described—*Protophyllocladus lobatus* Berry, from the Magothy, Black Creek, and Ripley formations in Maryland, South Carolina, and Tennessee, respectively; and *P. lanceolatus* (Knowlton) Berry and *P. polymorphus* (Lesquereux) Berry, from the Eagle and Livingston formations of Montana. The species is exceedingly abundant in the recent collection from the Frontier formation and agrees in every detail with the Dakota sandstone types from Kansas and Nebraska. One specimen shows a possible tendency toward lobation, but it happens to be poorly preserved and indecisive. This habit is well marked in the Raritan material of the species and may therefore be considered to be without special significance. The somewhat younger Coastal Plain species, *P. lobatus*, is uniformly lobate. A tendency toward lobation is also seen in some specimens of *P. polymorphus*.

In view of the great range in size of the specimens from the Frontier formation there does not seem to be a single reliable character for differentiating *P. subintegrifolius* from *P. polymorphus* and *P. lanceolatus*, and I am inclined to think all three represent a single long-lived botanic species. The precise relationship of *Protophyllocladus* has never been settled. After having handled a large amount of material I am of my original opinion that it is undoubtedly coniferous and probably related to the existing genus *Phyllocladus*.

Occurrence: Sec. 8, T. 32 N. R 99 W., 6 miles south-southeast of Lander.

Phylum ANGIOSPERMOPHYTA

Class MONOCOTYLEDONAE

Order ARECALES

Family ARECACEAE

Genus SABALITES Saporta

Sabalites sp.

The recent collections contain very fragmentary specimens that undoubtedly represent the broken leaves of a fan palm, which are tentatively referred to the genus *Sabalites*. They were obtained 6 miles south-southeast of Lander, in sec. 8, T. 32 N., R. 99 W.

Class DICOTYLEDONAE

Order FAGALES

Genus DRYOPHYLLUM Debey

Dryophyllum lanceolatum (Knowlton) Berry

Dryandroides lanceolata Knowlton, U. S. Geol. Survey Prof. Paper 108, p. 89, pl. 34, fig. 7, 1917.

This form, which is confined to the type locality in Lincoln County, Wyo., was identified by Knowlton

as a species of *Dryandroides*, a genus usually referred to the family Proteaceae and supposed to be related to the genus *Dryandra* of the present Australian region.

Dryandroides has been recorded from a considerable number of regions in both Upper Cretaceous and Tertiary strata, but its botanic relationship has always been a matter of much difference of opinion among botanists. This is happily removed in the case of the present form by reason of the fact that it is not *Dryandroides* but belongs to the fagalean genus *Dryophyllum*. I have had the good fortune to handle a large amount of excellently preserved material of *Dryophyllum*, and this Frontier plant is surely a member of that genus.

Occurrence: Sec. 8, T. 32 N., R. 99 W., 6 miles south-southeast of Lander.

Order URTICALES

Family MORACEAE

Genus FICUS Linné

Ficus inaequalis Lesquereux

Plate 21, Figure 3

Ficus inaequalis Lesquereux, U. S. Geol. Survey Mon. 17, p. 82, pl. 49, figs. 6–9; pl. 50, fig. 3, 1892.
Berry, Torrey Bot. Club Bull., vol. 34, p. 194, pl. 12, figs. 2, 3, 1907; U. S. Geol. Survey Prof. Paper 112, p. 80, pl. 12, fig. 1, 1919.

This species was described by Lesquereux from the Dakota sandstone near Fort Harker, Kans., and was subsequently recorded by me from the Black Creek formation of North Carolina and the Tuscaloosa formation of Alabama.

As the Black Creek formation is considerably younger than either the Dakota or Tuscaloosa there is nothing remarkable in the fact that this species ranges as high as the Frontier formation in the Colorado group. It is not uncommon in the Wind River Basin, but, like most of the dicotyledons found there, it is not especially well preserved.

Occurrence: Sec. 8, T. 32 N., R. 99 W., 6 miles south-southeast of Lander.

Ficus fremonti Knowlton

Ficus fremonti Knowlton, U. S. Geol. Survey Prof. Paper 108, p. 87, pl. 34, figs. 4–6; pl. 35, figs. 4c, 5, 1917.

The type of this species was collected by Fremont in Lincoln County in 1843 and was referred to *Glossopteris* by Hall. It was re-collected by Knowlton and Stanton in 1908 at or near the type locality. It unquestionably represents a dicotyledon, but its reference to the genus *Ficus* is somewhat questionable.

Occurrence: I am able to add two new localities in Fremont County—near Westbrook quarry, southeast of Lander, in sec. 22, T. 33 N., R. 99 W. (collected by T. W. Stanton); 6 miles south-southeast of Lander, in sec. 8, T. 32 N., R. 99 W. (collected by N. H. Brown).

Ficus? sp. Knowlton

Ficus? sp. Knowlton, U. S. Geol. Survey Prof. Paper 108, p. 88, pl. 34, figs, 2. 3, 1917.

This form is based upon very incomplete and questionable material, and there is no conclusive reason for considering it to represent a *Ficus*. The type material came from Lincoln County, and it is included in the present report simply for the purpose of recording the two new localities in Fremont County.

Occurrence: Near Westbrook quarry, southeast of Lander, in sec. 22, T. 33 N., R. 99 W. (collected by T. W. Stanton); 6 miles south-southeast of Lander, in sec. 8, T. 32 N., R. 99 W. (collected by N. H. Brown).

Order MALVALES

Family STERCULIACEAE

Genus STERCULIA Linné

Sterculia towneri (Lesquereux) Berry

Sterculia towneri Berry, U. S. Geol. Survey Prof. Paper 120, p. 217, pl. 57, fig. 1; pl. 60; pl. 61, fig. 1, 1922.
Aralia towneri Lesquereux, U. S. Geol. and Geog. Survey Terr. Bull., vol. 1, p. 394, 1875 [1876]; Ann. Rept. for 1874, p. 349, pl. 4, fig. 1, 1876; Cretaceous and Tertiary floras, p. 62, pl. 6, fig. 4, 1883; U. S. Geol. Survey Mon. 17, p. 132, pl. 23, figs. 3, 4; pl. 31, fig. 1, 1892.
Sterculia drakei Cummings, Texas Geol. Survey Third Ann. Rept., p. 210, fig. 8, 1892.
Knowlton, in Hill, Am. Jour. Sci., 4th ser., vol. 1, p. 213, 1895.
Sterculia snowii Lesquereux, U. S. Geol. Survey Mon. 17, p. 183, pl. 30, fig. 5; pl. 31, figs. 2, 3; pl. 32, figs. 1–4, 1892.
Hollick, U. S. Geol. Survey Mon. 50, p. 94, pl. 34, fig. 20, 1907.
Aralia towneri Hollick, New York Acad. Sci. Trans., vol. 16, p. 132, pl. 14, figs. 11, 12, 1897.
Berry, New York Bot. Garden Bull., vol. 3, p. 92, 1903.

Leaves of variable and often very large size, palmately two to seven lobed. The lobes are prevailingly conical and acuminate, occasionally widening somewhat medially and less acutely pointed, separated by generally open and rounded sinuses extending about halfway to the base. The angles that the lobes form with one another and the form of the sinuses vary with the number of lobes, as does also the character of the base, which ranges from truncate to decurrent. The median lobe is generally slightly wider than the others but may be smaller. The normal form is five-lobed. The texture is so coriaceous that these leaves are not rare in coarse sediments like those of the Dakota and Frontier sandstones or the eolian sands of the Cheyenne. The margins are entire. Length 8 to 20 centimeters; maximum width 6 to 24 centimeters. Petiole stout, usually broken away, 12 centimeters or more in length. Midvein stout, prominent; lateral primaries stout, basal or subbasal; secondaries thin, regularly spaced, camptodrome, usually more or less immersed in the leaf substance.

This is an exceedingly well marked species and, like most Sterculias, both ancient and modern, shows the characteristic variability of the genus. It was described originally from material collected in the Dakota sandstone of Kansas and occurs in the Tucumcari Mountains of New Mexico in beds referred to the Dakota. It is recorded from the Magothy formation of New Jersey, from rocks of the same age on Marthas Vineyard, and from the Cheyenne sandstone of Kansas. Only fragments have been found in the Frontier, but they are sufficiently characteristic to establish this species as a member of the Frontier flora.

Occurrence: Sec. 8, T. 32 N., R. 99 W., 6 miles south-southeast of Lander.

POSITION UNCERTAIN

Phyllites cretaceus (Ettingshausen) Berry

Artocarpidium cretaceum Ettingshausen, Kreideflora von Niederschoena: K. Akad. Wiss. Wien Sitzungsber., Band 55, p. 251, pl. 2, fig. 4, 1867.

Lesquereux, U. S. Geol. Survey Mon. 17, p. 86, pl. 50, fig. 7, 1892.

Although it is highly improbable that the leaf from the Dakota sandstone of Kansas is identical with the single fragment from the Cenomanian of Austria to which Ettingshausen gave this name, neither shows any features warranting reference to the Moraceae or suggesting any relationship with *Artocarpus*. The type material did not warrant any identification and should not have been described, and it may well be transferred to the noncommital genus *Phyllites* along with the leaf from the Dakota sandstone. The latter is complete, but I am unable to suggest its probable botanic affinity.

This is of interest chiefly as constituting another older element in the flora of the Frontier formation.

Occurrence: Sec. 8, T. 32 N., R. 99 W., 6 miles south-southeast of Lander.

Phyllites grandifolius-cretaceus (Lesquereux) Berry

Smilax grandifolia-cretacea Lesquereux, U. S. Geol. Survey Mon. 17, p. 40, pl. 46, fig. 3, 1892.

Much as I dislike the pseudogeneric term *Phyllites*, I can see no basis for referring this leaf to the genus *Smilax*, and there are a variety of unrelated existing genera that have leaves of this type. The species was based upon a single imperfect specimen from the Dakota sandstone of Kansas, which apparently was compared by its describer with pictures of fossil European forms in the works of Unger, Ettingshausen, and Heer and not with existing leaves.

A fragmentary specimen from the Frontier is exactly like Lesquereux's type except for being somewhat larger. If a considerable amount of material were available it would be worth the trouble of an extended search among existing forms to test the possibility of arriving at the true botanic affinity. In the absence of such material it is more scientific to face the fact that such specimens are undeterminable botanically.

Occurrence: Flank of Table Mountain, in the SE. ¼ sec. 8, T. 32 N., R. 99 W.

Phyllites crassipes (Heer) Berry

Juglans crassipes Heer, Schweizerische Gesell. Neue Denkschr., Band 23, p. 23, pl. 6, fig. 3, 1869; Flora fossilis arctica, Band 7, p. 27, pl. 61, fig. 4; pl. 65, fig. 9, 1883.

Lesquereux, U. S. Geol. Survey Mon. 17, p. 69, pl. 49, figs. 1–3, 1892.

Hollick, U. S. Geol. Survey Mon. 50, p. 55, pl. 9, figs. 3–5, 1907.

This species was described from the Cenomanian of Moravia and was subsequently recorded by its describer from the much younger Patoot beds of western Greenland. It was identified by Lesquereux in the Dakota sandstone of Kansas and by Hollick in the Raritan and Magothy formations of the Atlantic Coastal Plain.

It represents one of those fossil foliar types which are found to be common in unrelated existing genera and which entirely lack diagnostic generic features. There is not a shred of evidence that it is related to *Juglans*, nor is there any reason for supposing that the European, Greenland, and American specimens represent the same botanic species. On the other hand, the considerable geographic and geologic range is emphatically opposed to such a conclusion.

However, the recorded occurrences represent indistinguishable remains with which the material from the Frontier formation is identical. Beyond the evidence which it affords of a new type of plant in the Frontier flora I regard it as entirely worthless either botanically or geologically, and I much doubt if a clue to its relationship can ever be obtained.

Occurrence: Flank of Table Mountain, in the SE. ¼ sec. 8, T. 32 N., R. 99 W.