

ADDITIONS TO THE FLORA OF THE GREEN RIVER FORMATION

By ROLAND W. BROWN

This paper adds a number of new species to those already described by other workers as belonging to the flora of the Green River formation. Most of the new species were collected by Prof. O. M. Ball, of the Agricultural and Mechanical College of Texas, during the summers of 1924 to 1926, in the region between the headwaters of Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.¹

The study of this new material further confirms the opinion expressed by Knowlton² that the Green River floral remains represent a mixture of elements from warm lowland and cool upland ecologic provinces. The presence of conifers in this flora, hitherto indicated only by pollen grains in the oil shale, is now further established by the finding of what appear to be coniferous leaves (pl. 70, fig. 4) and a winged seed (pl. 70, fig. 5). The leaves, which I have called *Taxites eocenica*, are suggestive of such genera as *Taxus*, *Taxodium*, *Tumion*, *Abies*, and *Pseudotsuga*. The seed resembles most closely those of living *Picea*, and I have called it *Picea piniifructus*.

The Green River is a middle Eocene formation, about 2,000 feet in thickness, and of threefold character, comprising a lower group of light-brown to buff sandy calcareous shale, a middle group of darker shale, and an upper group of light-colored sandy shale. The formation originally covered an area of about 300 by 150 miles in the contiguous corners of Colorado, Utah, and Wyoming, but erosion subsequent to the time when this area ceased to be a basin of lacustrine deposition and was elevated several thousand feet has deeply dissected parts of it and has thereby isolated patches of the formation.

The most abundant plant fossils are found in the upper part of the formation and are most readily collected at the test pits made by oil-shale prospectors. The principal localities where fossil plants have been found are Green River and Alkali Station, Wyo.; Cathedral Bluffs (20 miles west of Rio Blanco post

office); the Smith ranch (on Greasewood Creek 40 miles southwest of Meeker); and on Carr Creek and Brush Creek (30 miles northwest of De Beque), Colorado; and north of White River, Utah.

Lesquereux³ included the first description of the Green River in his "Tertiary flora" and devoted a chapter to it in his later volume, "Cretaceous and Tertiary floras," but many of the plants which he regarded as belonging to the Green River formation have since been found by a strict definition of the formation to belong at other horizons.

Newberry⁴ added a number of species to Lesquereux's list.

Knowlton⁵ in 1923 assembled the scattered information on this flora, passed critical judgment upon it, and placed it upon a satisfactory systematic basis for future study. Knowlton's list included 81 species. To that list Cockerell⁶ in 1925 added the following new species or new combinations:

- Lejeunea eophila* Cockerell.
- Populus wilmattae* Cockerell.
- Bumelia coloradensis* Cockerell.
- Amorpha utensis* Cockerell.
- Clethra? lepidioides* Cockerell.
- Potentilla? byrami* Cockerell.
- Alsinites revelatus* Cockerell.
- Lomatia obtusiuscula* Cockerell.
- Banksites lineatulus* Cockerell.
- Liquidambar callerche* Cockerell.
- Firmianites aterrimus* Cockerell.
- Dalbergia knowltoni* (Knowlton) Cockerell, n. comb. for *Dalbergia retusa* Knowlton. Proposed because *D. retusa* is preempted for a living species.

Berry⁷ in 1924 added the new combination *Sparganium antiquum* (Newberry) Berry to include *Bra-senia? antiqua* Newberry⁸ and *Pontederites hesperia* Knowlton.⁹

¹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, 1878; and vol. 8, pp. 127-213, 1883.

² Newberry, J. S., U. S. Geol. Survey Mon. 35, pp. 140-151, 1898.

³ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, pp. 133-182, 1923.

⁴ Cockerell, T. D. A., U. S. Nat. Mus. Proc., vol. 66, art. 19, pp. 1-13, 1925.

⁵ Berry, E. W., *A Sparganium* from the middle Eocene of Wyoming: Bot. Gaz., vol. 78, pp. 342-348, figs. 1-7, 1924.

⁶ Newberry, J. S., U. S. Nat. Mus. Proc., vol. 5, p. 514, 1882; U. S. Geol. Survey Mon. 35, p. 93, pl. 68, fig. 7, 1898.

⁷ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 154, pl. 36, fig. 6, 1923.

¹ The first consignment of this material was studied by me and described in a dissertation for the degree of doctor of philosophy in the department of geology, Johns Hopkins University, May, 1926.

² Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 147, 1923.

From the O. M. Ball collections the following new species or new combinations are hereby proposed:

Thallophyta:

Caenomyces planerae Brown.

Pteridophyta:

Aneimia delicatula Brown.

Arthropphyta:

Equisetum winchesteri Brown.

Spermatophyta:

Taxites eocenica Brown.

Picea pinifruetus Brown.

Sparganium eocenicum Brown.

Myrica torreyi Lesquereux.

Myrica alkalina Lesquereux.

Hicoria juglandiformis (Sternberg) Knowlton.

Betula eocenica Brown.

Planera nervosa Newberry.

Celtis debequensis Brown.

Ficus mississippiensis (Lesquereux) Berry.

Ficus omballi Brown.

Lomatia coloradensis (Knowlton) Brown.

Lomatia acutiloba Lesquereux.

Banksia cockerelli Brown.

Oreodaphne knowltoni Brown.

Chrysobalanus lacustris Brown.

Mimosites debequensis Brown.

Mimosites falcatus Brown.

Cassia hesperia Brown.

Banisteria bradleyi Brown.

Rhus balli Brown.

Schmaltzia vexans (Lesquereux) Cockerell.

Anacardites schinoloxus Brown.

Celastrophyllum lesquereuxii Brown.

Celastrophyllum emarginatum Brown.

Maytenus berryi Brown.

Thouinia eocenica Brown.

Ilex affinis Lesquereux.

Grewiopsis cissifolius Brown.

Sterculia coloradensis Brown.

Ternstroemites viridiflumensis Brown.

Fraxinus petiolata Brown.

Apocynophyllum wilcoxense Berry.

Apocynospermum coloradensis Brown.

Cucurbita glandulosa Brown.

Objects of uncertain identification:

Phyllites juncooides Brown.

Carpolithus cassioides Brown.

Carpolithus ellipticus Brown.

Carpolithus capsularis Brown.

Carpolithus palmitis Brown.

Carpolithus serratifolius Brown.

Antholithes vitaciflora Brown.

Antholithes dubia Brown.

Antholithes polemonioides Brown.

Antholithes pendula Brown.

Caulinites acanthus Brown.

Caulinites prehensus Brown.

Rhizocaulon natans Brown.

Rhizocaulon dichotomum Brown.

Exclusive of the objects of uncertain identification, the grand total of species in the Green River flora is now 130. The distinctly new genera in this flora having living species are as follows:

Aneimia, 50 tropical American species, one reaching the southern part of Florida, types of coastal or even drier regions.

Taxites, which may represent a Temperate Zone coniferous tree growing in a moist situation, like *Taxodium* or *Tumion* on the western slopes of the Sierra Nevada, or *Taxus*, a subordinate forest shrub or tree of the Old and New Worlds.

Picea, 37 species in the colder and temperate regions of the Northern Hemisphere. In the United States the southern limit is northern New Mexico and Arizona and the southern Appalachians. The spruces prefer well-drained mountain slopes or moist situations on elevated plateaus.

Sparganium, 10-12 species rather discontinuously distributed in temperate and cool regions, and growing in wet or in some cases, in submerged situations; 5-6 species range from Newfoundland to British Columbia and south to Florida, Louisiana and California.

Betula, 28-30 species from the Arctic Circle to Texas, to southern Europe, the Himalayas, China, and Japan, and found on alluvial bottoms and mountain slopes.

Planera, a monotypic genus in the warm and wet regions of southeastern North America.

Celtis, a large genus distributed over the world.

Banksia, 50 species confined to Australia in a variety of habitats.

Cassia, 300-400 species in the warmer regions of both hemispheres, some in the temperate zones.

Chrysobalanus, 2-3 species on the sandy coasts of the tropics and subtropics.

Banisteria, 70 species of climbing shrubs from southern Mexico to the West Indies and Brazil.

Schmaltzia, partly synonymous with *Rhus* and of no special significance.

Anacardites, a form-genus for plants assigned indefinitely to the Anacardiaceae.

Celastrus, 27 species in the tropics and subtropics of both hemispheres, but especially in the uplands of southeastern Asia and the East Indies.

Celastrophyllum, a form-genus for indefinite Celastraceae.

Maytenus, 70 species in the Tropics and subtropics of America from southern Florida to Brazil and Chile, inhabitants of coasts and low situations.

Thouinia, 14 species of shrubs and trees in Mexico and the West Indies, growing in rocky coppices and scrub lands.

Grewiopsis. *Grewia* has 80 species, distributed from Arabia to China and Japan, Malaysia, and Australia, and from Abyssinia to South Africa, of mesophytic type.

Sterculia, 100 species in the warmer regions of the world, particularly in the East Indies.

Ternstroemites. *Ternstroemia* has 45 species in tropical America and the warmer parts of Asia and the East Indies, of mesophytic habit.

Fraxinus, 40 species in the temperate regions of both hemispheres and within the Tropics (Cuba and Java), in a variety of habitats.

Cucurbita, 10 species in the warmer regions of America, of mesophytic habit, with a preference for rich, well-drained sandy soil.

Apocynospermum, which includes the fruits of Asclepiadaceae and Apocynaceae.

Forms of uncertain identity can, of course, have little significance in this connection until their identification is more complete.

A glance through the total list of Green River genera and their modern representatives shows, in regard to water requirements, an overwhelming proportion of broad-leaved, mesophytic types. I find no strictly xerophytic types in this flora, although a number of the drier mesophytic forms indicate by their thick,

coriaceous foliage an ability to withstand strong insolation and perhaps periods of drought as well as temperatures close to 0° C., without injury. The hydrophytes include microscopic aquatic algae, fungi, and such near-shore plants as *Equisetum*, *Sparganium*, *Arundo*, *Cyperus* (probably), and *Juncus* (probably).

Such a preponderance of subtropical mesophytes and especially the presence of many forms like palms, *Planera*, and *Acrostichum*, which require an abundance of rainfall and a warm climate, but the presence also of temperate forms like *Quercus*, *Populus*, *Betula*, *Juglans*, and *Liquidambar*, point to the conclusion that this flora grew in a warm temperate region, a part of which, at least, received a plentiful supply of rain. It must not be concluded, however, that all the species found fossil together in one locality necessarily grew close together in a comparatively small area. On the contrary, winds and streams conspired to bring together a mixture of types from widely separated localities.

The general region in which this flora flourished was an inland mountain basin, the site of a body of water or series of bodies of water—ponds, lakes, and meandering streams—the whole of which extended at one time or another over a length of some 300 miles north and south and a width of 150 miles east and west. This makes a difference of 4° of latitude between the upper and lower ends of the basin. It seems quite conceivable that local conditions of climate, influenced in part by the mountains that flanked the basin on the north, east, and west, might vary considerably in such a basin. The occurrence of mud cracks locally in this formation is taken to mean playa deposits and periods of drought. Mud cracks, however, are not uncommon in valley and bottom flats in regions that have abundant rainfall but are subject to short periods of drought. It may be that parts of the Uinta Basin area, where the mud cracks are principally found, were subject to more severe droughts than other parts of the Green River Basin and that the evaporation of shallow pools caused the water to become alkaline and to deposit salt in the mud cracks at the next period of flooding and evaporation.

Although local conditions varied throughout the basin, it yet seems possible to formulate a general conclusion concerning the nature of the total environment. I picture a broad, low-lying warm inland region, with shallow ponds, lakes, and marshes, fed by slow streams, which meandered through muddy and sandy swamps as they flowed out of the distant cooler foothills and surrounding mountains. In these waters or in the adjacent open marshes grew *Sparganium*, *Cyperus*, *Arundo*, *Juncus*, *Equisetum*, and no doubt *Potamogeton*, *Alisma*, and other plants whose remains have not yet been found or identified. On the sandy or muddy flats farther back grew palms, *Acrostichum*, *Aneimia*, *Ficus*, *Sophora*, and other

Leguminosae, together with such lianes as *Dalbergia* and *Cucurbita*. These were succeeded gradually on drier ground by *Oreodaphne*, *Zizyphus*, *Planera*, *Ternstroemia*, *Maytenus*, *Cinnamomum*, *Lomatia*, *Bankisia*, *Myrica*, *Cassia*, *Mimosites*, *Sapindus*, *Celastrus*, *Euonymus*, *Pimelea*, *Thouinia*, *Rhus*, *Taxodium* (if *Taxites* is interpreted as that), and such lianes as *Banisteria*, *Cissus*, and the fern *Lygodium*. Along the streams and adjacent meadows higher in the foothills flourished willows, poplars, *Aralia*, *Ilex*, Apocynaceae, *Clethra*, *Sambucus*, *Juglans*, *Hicoria*, *Liquidambar*, *Potentilla*, *Betula*, *Alsinites*, *Acer*, *Quercus*, *Fraxinus*, species of *Rhus*, *Ailanthus*, and the vine *Parthenocissus*. Oaks and maples finally gave way to forests of pine and spruce at higher altitudes.

Of such an environment as I have conjured up for the Green River flora there is perhaps no exact duplicate on the earth to-day, but the climatic conditions of the southeastern Gulf States plus those of parts of the Great Valley of California would, it seems to me, roughly approximate those of the Green River Lake area.

Phylum THALLOPHYTA

Class FUNGI

Series ASCOMYCETES

Order LABOULBILIALES

Family LABOULBILIACEAE

Genus CAENOMYCES Berry

Caenomyces planerae Brown, n. sp.

A leaf of *Planera nervosa* shows three circular impressions such as have been described by other authors as leaf-spot fungi. The marginal spot is the most conspicuous. It is 2 millimeters in diameter. The center is depressed, as if a heavy mass of material had been there but had been removed with the counterpart to this imprint. No details of structure are distinguishable.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Phylum PTERIDOPHYTA

Order FILICALES

Family SCHIZEACEAE

Genus ANEIMIA Swartz

Aneimia delicatula Brown, n. sp.

Plate 70, Figures 1-2

This fragment is a portion of a bipinnately or perhaps tripinnately divided frond. The lanceolate pinnules are attached by their entire bases, whose margins are decurrent on the rachis and join the pinnules above and below. Distad the pinnules tend to become fused and pass into an acuminate tip. They diverge from the rachis at angles of 45° below but at

more acute angles distad. The pinnules are sharply acuminate, with margins carrying few subopposite to alternate, usually simple serrate pointed teeth. Rachis prominent, flexuous. Midrib of pinnules diverges from the rachis at a very acute angle but soon curves outward and branches, though remaining prominent almost to the apex. Few secondaries are given off from the midrib, but these diverge at narrow angles, pursue almost straight courses, and branch dichotomously, the lower branch remaining simple, the upper branch dividing before reaching the margin in a notch or tooth.

A. eocenica Berry,¹⁰ from the Wilcox and Claiborne of the southeastern United States, is very closely comparable to this species but is larger and coarser.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Phylum ARTHROPHYTA

Order EQUISETALES

Family EQUISETACEAE

Genus EQUISETUM Linné

Equisetum winchesteri Brown, n. sp.

Plate 70, Figure 3

This fragment represents a sheath at a node. Length 2 centimeters; width 2 centimeters. There are 30 attenuated teeth, each 7 millimeters long, around the sheath. This is a larger species than *Equisetum wyomingense* Lesquereux¹¹ but compares in size with the rhizomes of *E. haydenii* Lesquereux.¹² The two may be identical species.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Phylum SPERMATOPHYTA

Class GYMNOSPERMAE

Order CONIFERALES

Family TAXACEAE

Genus TAXITES Brongniart

Taxites eocenica Brown, n. sp.

Plate 70, Figure 4

Small, linear coriaceous leaves, 2.3 centimeters long and 3 millimeters wide, slightly narrowed to the blunt-pointed apex. Base abruptly cuneate or rounded inequilateral. Petiole 2 millimeters long, somewhat curved. Midrib prominent, but no further details of venation are distinguishable. Margin entire, revolute, decurrent, forming a narrow wing on the petiole.

¹⁰ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 164, pl. 9, fig. 7; pl. 10, fig. 2; pl. 11, figs. 1, 2, 1916; U. S. Geol. Survey Prof. Paper 92, p. 41, 1924.

¹¹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 69, pl. 6, figs. 8-11, 1878.

¹² Idem, p. 67, pl. 6, figs. 2-4.

These leaves are suggestive of such coniferous genera as *Taxus*, *Taxodium*, *Tumion*, *Abies*, and *Pseudotsuga*. They differ from *T. olriki* Heer¹³ in being more prominently petiolate.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family PINACEAE

Genus PICEA Link

Picea pinifructus Brown, n. sp.

Plate 70, Figure 5

A winged seed, 1 centimeter long. Boundaries of the seed itself very clearly defined. The seed is elliptical in outline, pointed, and about one-third the length of the entire object. The wing is membranaceous, but no venation is distinguishable. Maximum width of the wing 3 millimeters, near the distal end. Upper margin straight for half its length, then sharply curved downward to the distal point. Lower margin widened about one-third the distance from the distal end, then gradually narrowed toward the seed. Proximal end obliquely truncated and pointed. The upper margin of the wing is slightly more angular than that of living *Picea* seeds, and the maximum width of the wing is slightly more distad.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Subclass MONOCOTYLEDONES

Order PANDANALES

Family SPARGANIACEAE

Genus SPARGANIUM Linné

Sparganium eocenicum Brown, n. sp.

Plate 71, Figure 1

A fragment of a stem, 2 millimeters thick, bearing two mature leaves and the beginning of a third around the growing point. Leaves linear, lanceolate, 10 to 12 centimeters long and 1 centimeter wide medianly, joining the stem by a broad, somewhat expanded, sheathed base. The venation is so obscure that details are indistinguishable, but the stem shows faint parallel striations.

In appearance this form is like some recorded fossil species of *Cyperacites*, *Potamogeton*, and *Poacites*. It resembles most closely *Sparganium valdense* Heer¹⁴ but is somewhat smaller.

Berry¹⁵ has demonstrated clearly that the material described by Newberry¹⁶ as *Brasenia? antiqua* is the

¹³ Heer, Oswald, Flora fossilis arctica, vol. 1, p. 95, pl. 1, figs. 21-24; pl. 45, figs. 1a b, c, 1868.

¹⁴ Heer, Oswald, Flora tertiaria Helvetiae, pt. 1, p. 100, pl. 45, figs. 6-8; pl. 46, figs. 6, 7, 1855.

¹⁵ Berry, E. W., A *Sparganium* from the middle Eocene of Wyoming: Bot. Gaz., vol. 78, pp. 342-248, 1924.

¹⁶ Newberry, J. S., U. S. Nat. Mus. Proc., vol. 5, p. 514, 1882; U. S. Geol. Survey Mon. 35, p. 93, pl. 68, fig. 7, 1898.

fruiting portion of a *Sparganium* stem and may belong to leaves described by Knowlton¹⁷ as *Pontederites hesperia*. This new combination is called *Sparganium antiquum* (Newberry) Berry. The species I have here described is not well preserved but differs from *Sparganium antiquum* (Newberry) Berry in having narrower leaves.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Subclass DICOTYLEDONES

Order MYRICALES

Family MYRICACEAE

Genus MYRICA Linné

Myrica torreyi Lesquereux

Myrica torreyi Lesquereux, U. S. Geol. Survey Terr. Rept. for 1872, p. 392, 1873; U. S. Geol. Survey Terr. Rept., vol. 7, p. 129, pl. 16, figs. 3-10, 1878.

Ward, U. S. Geol. Survey Sixth Ann. Rept., p. 551, pl. 40, fig. 4, 1886; U. S. Geol. Survey Bull. 37, p. 32, pl. 14, fig. 5, 1887.

Knowlton, U. S. Geol. Survey Bull. 163, p. 34, pl. 6, figs. 1-3, 1900; U. S. Geol. Survey Prof. Paper 98, p. 90, pl. 17, fig. 7, 1915; pl. 86, fig. 1, 1916; U. S. Geol. Survey Prof. Paper 101, p. 256, pl. 37, figs. 2-4, 1918.

Cockerell, Colorado Univ. Studies, vol. 7, p. 150, 1910.

Coriaceous leaves, lanceolate, elongated above the middle to an obtusely acuminate apex. Length 10 centimeters; maximum width, below middle of the blade, 2.3 centimeters. Margin undulate to crenate-serrate below, becoming merely undulate toward the apex. Base cuneate, slightly decurrent. Midrib strong, curved. Secondaries thin, numerous, with intermediaries, diverging from the midrib at wide angles, running almost straight to within a short distance of the margin, some of them forking. Short branches from the secondaries unite to form a thin intramarginal vein and send nervilles into the teeth. Finer nervation not distinguishable.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Myrica alkalina Lesquereux

Plate 71, Figures 2, 3

Myrica alkalina Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8, p. 149, pl. 45a, figs. 10-15, 1883.

This specimen tallies very well with Lesquereux's material and seems to be identical or at least very little different, especially in comparison with Lesquereux's Figure 15. That material came from Alkali Station, Wyo.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

¹⁷ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 154, pl. 36, fig. 6, 1923.

Order JUGLANDALES

Family JUGLANDACEAE

Genus HICORIA Rafinesque

Hicoria juglandiformis (Sternberg) Knowlton

Plate 71, Figures 4, 5

Hicoria juglandiformis (Sternberg) Knowlton, U. S. Geol. Survey Bull. 152, p. 117, 1898.

Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 80, 1908.

Phyllites juglandiformis Sternberg, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, vol. 4, index 40, pl. 36, fig. 1, 1825.

Juglans bilinica Unger, Genera et species plantarum fossilium, p. 469, 1850.

Carya bilinica (Unger) Ettingshausen, Die fossile Flora des Tertiär-Beckens von Bilin, pt. 3, p. 46, pl. 51, figs. 4-6, 13-15; pl. 52, figs. 3, 4, 7-11, 1869.

Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8, p. 191, pl. 39, figs 1, 2, 13, 1883.

Coriaceous, lanceolate-elongate leaflets, 10 centimeters long, 3 centimeters wide just above the base. Inequilateral, rounded at the base of the wider portion of the blade, cuneate at the base of the narrower portion. Petiole 1 centimeter long, 1 millimeter thick. Margin finely serrate throughout except for a short distance near the base. Midrib prominent. Secondaries numerous, thin, obscure in these specimens, diverging from the midrib at an angle of almost 90°, little curved until near the margin, then abruptly camptodrome. Finer nervation not distinguishable.

This species, new to the Green River flora as now conceived, coincides with the form described by Lesquereux as *Carya bilinica* from Florissant, where it is fairly abundant. *Hicoria juglandiformis*, if not identical with *Carya bilinica*, would certainly seem to be ancestral to it. Both Unger and Ettingshausen, referred to above, show excellent figures of what seems to be the same species.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order FAGALES

Family BETULACEAE

Genus BETULA Linné

Betula eocenica Brown n. sp.

Plate 71, Figure 6

Slightly equilateral leaves of fine texture, ovate outline, and pointed apex. Length, 3 to 5 centimeters; width, 2 to 4 centimeters below the middle of the lamina. Petiole apparently short. Margin sinuate-dentate with few, widely spaced, blunt teeth. Midrib prominent, flexuous. Secondaries, five pairs, alternate, diverging from the midrib at 50°, almost straight near the base of the leaf but becoming gradually curved toward the apex, all of them craspedodrome to the blunt teeth, occasionally branching to a subordinate tooth. Finer areolation indistinct.

This form resembles *B. heterodonta* Newberry,¹⁸ from the upper Clarno beds of Oregon and the Oligocene of Quilchena, British Columbia. It is not unlike *B. gracilis* Ludwig, described by Lesquereux¹⁹ from Golden, Colo., but doubtfully referred to *Betula*.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order URTICALES

Family ULMACEAE

Genus PLANERA Gmelia

Planera nervosa Newberry

Plate 71, Figures 7-9

Planera nervosa Newberry, U. S. Nat. Mus. Proc., vol. 5, p. 508, 1882; U. S. Geol. Survey Mon. 35, p. 83, pl. 67, figs. 2, 3, 1898.

Myrica praedrymeja Knowlton, U. S. Geol. Survey Prof. Paper 131, p. 157, pl. 36, figs. 1-3, 1923.

Leaves of firm texture, variable in size and shape but nevertheless retaining certain specific distinguishing characteristics. Length, 2 to 7 centimeters; maximum width median, from 6 millimeters to 2.7 centimeters. Linear-elliptic or ovate-elliptic to broadly lanceolate. Apex acute or rounded; base equilateral to slightly inequilateral, cuneate to cuneate-rounded. Petiole stout, 2 to 6 millimeters long. Margin entire for a short distance above the base, then undulate to crenulate-serrate, with large, rounded, sometimes minutely pointed teeth. Midrib strong, straight, or curved. Secondaries numerous, 12 to 18 pairs, alternate, parallel, equidistant, diverging from the midrib at 45°, straight or slightly curved but curving perceptibly upward into the teeth. Finer nervation of transverse connections between the secondaries, and a network of irregular quadrangle meshes.

These leaves suggest very strongly the foliage of the Ulmaceae, and on the basis of foliar resemblance alone they might perhaps better be designated *Zelkova* than *Planera*. The four living species of *Zelkova* are distributed in the region of the Caspian Sea, the Caucasus, and Japan. *Planera* is a monotypic genus restricted to the Atlantic Coastal Plain of the southern United States. The leaves of *P. aquatica* differ from those of *P. nervosa* in being more inequilateral and in having usually doubly serrate teeth.

This species is less inequilateral than *Planera inaequilateralis* (Lesquereux) Knowlton.²⁰ It may be that *P. inaequilateralis* represents extreme variants in leaf form of *P. nervosa*. In some variants of these leaves there is a strikingly close approach to those

Florissant forms described by Lesquereux²¹ as *Planera longifolia*. The chief interest in this connection is that *Planera longifolia*, because of the finding of fruits with the leaves, has turned out to be closely related to if not identical with *Fagus* and has been renamed *Fagopsis longifolia* (Lesquereux) Hollick.²² No fruits of *Ulmus*, *Planera*, or *Fagus* have come to light in the Green River formation; but it is hoped that such evidence may be found and that it may clarify our knowledge as to the exact generic identity of these forms. *Myrica praedrymeja* Knowlton²³ matches in figure and description a number of specimens of *P. nervosa* in this collection and therefore comes under this new designation.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus CELTIS Tournefort

Celtis debequensis Brown, n. sp.

Plate 72, Figure 1

Leaf of fine texture, lanceolate, somewhat pointed, inequilateral. Length 5 centimeters, width 1.75 centimeters just above the base. Apex acute, base rounded to cuneate. Margin serrate with fine teeth. Petiole 1 centimeter long, thin. Midrib slender. Secondaries 7 or 8 pairs, alternate, branching from the midrib at angles of 40° or less, slightly curved, ending in the marginal teeth. Nervilles connecting the secondaries transverse. Further nervation irregular quadrangle meshes.

This species seems to have been a forerunner of *C. mccoshii* Lesquereux,²⁴ from Florissant, Colo., and Uinta County, Wyo.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family MORACEAE

Genus FICUS Linné

Ficus mississippiensis (Lesquereux) Berry

Ficus mississippiensis (Lesquereux) Berry, U. S. Geol. Survey Prof. Paper 131, p. 9, pls. 6, 7, 8, 1923. See synonymy given by Berry.

In the reference given above Berry has discussed the genetic interrelationship of a number of similar species of fossil *Ficus* and has proposed the new combination to include the forms listed in his synonymy. One specimen in this collection conforms to the description and figures given by Lesquereux for *Ficus pseudopopulus*, and that, being included in Berry's

¹⁸ Newberry, J. S., U. S. Geol. Survey Mon. 35, p. 64, pl. 44, figs. 1-4; pl. 45, figs. 1, 6, 1898.

¹⁹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 138, pl. 17, fig. 20, 1878.

²⁰ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 161, 1923.

²¹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 189, pl. 27, figs. 4-6, 1878.

²² Knowlton, F. H., U. S. Nat. Mus. Proc., vol. 51, p. 265, pl. 20, fig. 5, 1917.

²³ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 157, pl. 36, figs. 1-3, 1923.

²⁴ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 8, p. 163, pl. 38, figs. 7, 8, 1883.

synonymy, therefore comes under this new designation.

This species resembles at once *Cinnamomum*, *Zizyphus*, *Populus*, and *Ficus*, a fact that Lesquereux remarked. It differs from *F. wyomingiana* Lesquereux²⁵ by the presence of secondary nerves in the upper half of the leaf. However, *F. wyomingiana* may be only a variety or even abnormal form of *F. pseudopopulus* and therefore may also be classed under *F. mississippiensis*. *F. pseudopopulus* has been described as being abundant in the Raton formation. It is also found in the Wilcox group of Tennessee.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Ficus omballi Brown, n. sp.

Plate 72, Figure 2

A fine, large, ovate-lanceolate leaf of firm texture. Length 14 centimeters; width 4.2 centimeters about 4 centimeters above the base. Apex not present in this specimen but apparently acute; base equilateral, rounded. Midrib prominent, secondaries numerous, with scattered intermediaries, diverging from the midrib at right angles, parallel, slightly curved and united near the margin to form a conspicuous intramarginal vein. The nervilles between the secondaries form a network of large irregular meshes.

This species resembles closely the living *F. glabrata*, of Panama, and also an apocynaceous form, *Ranwolfia tetraphylla*, of Cuba. Among closely related fossils is *F. newtonensis* Berry.²⁶

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order PROTEALES

Family PROTEACEAE

Genus LOMATIA Robert Brown

***Lomatia coloradensis* (Knowlton) Brown**

Plate 72, Figures 3-6

Phyllites coloradensis Knowlton, U. S. Geol. Survey Prof. Paper 131, p. 176, pl. 38, fig. 3, 1923.

Lomatia obtusiuscula Cockerell, U. S. Nat. Mus. Proc., vol. 66, art. 19, p. 7, pl. 1, fig. 4, 1925.

Coriaceous leaves, pinnately once or twice compound, the ultimate leaflets themselves entire or irregularly lobed. The terminal leaflet is generally larger and more lobed than the laterals. Lobes pointed or obtuse. Angles between lobes rounded or acute. Margins entire, decurrent, forming a narrow alation on the rachis. Petiolules of the terminal leaflets 1 centimeter or less in length. Lateral leaflets ovate-

lanceolate, sessile or nearly so. Rachis slightly alate, heavy, flexuous. Midrib of leaflets strong, curved. Secondaries to lobes distinct, diverging from the midrib at 50°, straight or slightly curved, sometimes excurrent into a blunt point. Subordinate secondaries of the lobed leaflets and secondaries of the entire leaflets obscure, but from 4 to 6 pairs, alternate, diverging from the midrib at wide angles, each arching well within the margin to the secondary next above. Minute areolation not distinguishable.

The generic reference for these forms is somewhat doubtful. In the living Proteaceae, the name of which indicates their great diversity of characters, the forms of the leaves vary so much that differentiation on that basis is of uncertain validity. The leaves of some genera simulate those of *Myrica*, *Sapindus*, *Phacelia*, and others. In venation and form some of the specimens in the collection resemble certain living species of *Sapindus* and such fossil species as *S. affinis* Newberry and *S. angustifolius* Lesquereux.²⁷ Some of the elongated, lobed terminal leaflets may also be compared with *Myrica oeningsensis* Heer.²⁸

This species was evidently closely related to *Lomatia tripartita*, *L. terminalis*, and *L. spinosa* Lesquereux,²⁹ from Florissant. Cockerell remarked on the compoundness of the leaves of *L. tripartita*.³⁰

From the evidence shown by material in this collection it seems altogether justifiable to include *Phyllites coloradensis* Knowlton under this designation, as in the synonymy above.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

***Lomatia acutiloba* Lesquereux**

Lomatia acutiloba Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8, p. 167, pl. 43, figs. 11-16, 20, 1883.

Cockerell, Am. Naturalist, vol. 42, p. 579, fig. 10, 1908.

A coriaceous, deeply divided leaf. Lobes linear-lanceolate, blunt at the apex, sessile along the entire base, which is decurrent to the lobe next below. The lobes spread away from the main axis at narrow angles and are widely and alternately spaced. Margins entire. Main axis slender and flexuous. Midribs of lobes prominent, diverging from the axis at acute angles, bending upward in the lobes and extending to their apices. Secondary venation not observable.

This specimen resembles most closely the type to which it is referred, which comes from Florissant. It is also like *Lomatia (Todea) saportiana* Lesquereux.³¹

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

²⁷ Newberry, J. S., U. S. Geol. Survey Mon. 35, p. 116, pl. 30, fig. 1, 1898. Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, 265, pl. 49, figs. 2-7, 1878.

²⁸ Heer, Oswald, Flora tertiaria Helvetiae, pt. 2, p. 33, pl. 70, figs. 1-4, 1856.

²⁹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 8, pp. 166, 167, pl. 43, figs. 1-10, 1883.

³⁰ Cockerell, T. D. A., Am. Naturalist, vol. 42, p. 577, figs. 8-9, 1908.

³¹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 6, p. 48, pl. 29, figs. 1-4, 1874.

²⁵ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 205, pl. 34, fig. 3, 1878.

²⁶ Berry, E. W., U. S. Geol. Survey Prof. Paper 92, p. 58, pl. 9, figs. 1-3, 1924.

Genus *BANKSIA* Forster*Banksia cockerelli* Brown, n. sp.

Plate 72, Figure 7

Coriaceous, linear leaves, at least 11 centimeters long and 1 centimeter wide at about the middle of the leaf. Apex acute, base narrowly cuneate. Nature of petiole not known, because lower part of leaf is missing. Margin sinuate, minutely and distantly dentate. Midrib strong, flexuous. Secondary venation scarcely distinguishable from finer areolation. Numerous branches come off from the midrib at or near 90° and branch irregularly toward the margin, where they curve upward and unite in an intramarginal network that runs the length of the leaf.

This species resembles *B. saffordi* Berry,³² from the Wilcox group, but differs in having much larger angles for the divergence of the secondaries.

The seed *Banksites lineatulus* Cockerell³³ may belong to this species. If this well-defined seed does nothing more, it at least adds substantially to the evidence that Proteaceae were present in the Green River flora.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order THYMELEALES

Family LAURACEAE

Genus *OREODAPHNE* Nees*Oreodaphne knowltoni* Brown, n. sp.

Plate 72, Figure 9

A coriaceous leaf with entire margin; ovate-lanceolate, 9 centimeters long and 3.5 centimeters wide medianly. Apex elongated and probably bluntly acuminate; base rounded gradually to a stout petiole, of which the portion present is 1.5 centimeters long. Midrib heavy below but very thin toward the apex. All the secondaries are irregularly spaced and diverge from the midrib at varying angles. The first secondaries to come off from the midrib near the base are subopposite, weak, but loop upward in broad arches well within the margin to the secondaries next above, which are alternate and stronger and which almost reach the apex of the blade. From the middle of the leaf upward the secondaries again thin out into a tertiary meshwork of irregularly quadrangular meshes.

This species differs from *O. viridiflumensis* Knowlton,³⁴ of the Green River formation, in being more ovate toward the base and in having more regularly disposed secondaries. It is closely similar to if not

identical with *O. puryearensis* Berry,³⁵ from the Wilcox group of Tennessee.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order ROSALES

Family ROSACEAE

Genus *CHRYSOBALANUS* Linné*Chrysobalanus lacustris* Brown, n. sp.

Plate 72, Figure 8

An orbiculate, emarginate leaf of medium texture. Length 3 centimeters; width 3 centimeters. Apex notched, rounded; base round. Petiole thick, 4 millimeters long. Margin entire. Midrib strong, inclined to be straight. Secondaries 8 or 9 pairs, diverging from the midrib at right angles near the base but with increasingly smaller angles toward the apex, each recurved upward near the margin to join the secondary next above. Some secondaries may be bifurcated. Intermediate nervation irregularly transverse, and finer areolation indistinct.

The leaves of the living *Chrysobalanus icaco*, of the extreme southern United States, are in general somewhat larger than this specimen.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family LEGUMINOSAE

Subfamily MIMOSACEAE

Genus *MIMOSITES* Bowerbank*Mimosites debequensis* Brown, n. sp.

Plate 73, Figures 1-3

Thick-textured leaflets, 3 to 4.5 centimeters long and 1 centimeter wide just above the base. Lanceolate, slightly falcate. Apex narrowed, pointed or blunt; base inequilateral, rounded on both sides. Margin entire, somewhat undulate in a few forms. Petiolule stout; 1 to 2 millimeters long, oblique. Midrib prominent, curved. Secondaries, 9 to 12 pairs alternate, thin, diverging from the midrib at wide angles, straight or slightly curved for some distance, then each camptodrome well within the margin to the secondary next above. Finer nervation obscure.

The general form of these leaflets refers them to *Mimosites*. They also bear a close resemblance to *Gleditsiophyllum eocenicum* Berry³⁶ but are smaller and have more inequilateral bases.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

³² Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 208, pl. 36, figs. 5, 6, 1916.³³ Cockerell, T. D. A., U. S. Nat. Mus. Proc., vol. 66, art. 19, p. 8, pl. 2, fig. 3, 1925.³⁴ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 131, p. 163, pl. 38, fig. 6, 1923.³⁵ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 301, pl. 83, fig. 1, 1916.³⁶ Idem, p. 238, pl. 46, figs. 1-7.

Mimosites falcatus Brown, n. sp.

Plate 73, Figures 4, 5

Thick leaflets, 3 to 4 centimeters long, and 4 to 6 millimeters wide medianly. Linear, falcate. Apex acuminate; base cuneate, equilateral or only slightly inequilateral. Petiolule 2 millimeters long, oblique, stout. Margin entire. Midrib prominent. Secondary venation not distinguishable.

This species may be a variety of *M. coloradensis*, as some of those forms approach a linear falcate outline. A closely similar form is *M. linearifolius* Lesquereux,³⁷ from Florissant, but that species is somewhat smaller.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Subfamily CAESALPINIACEAE

Genus CASSIA Linné

Cassia hesperia Brown, n. sp.

Plate 73, Figure 6

Leaflets subcoriaceous, 3.8 centimeters long, 1.3 centimeters wide just below the middle of the blade. Ovate-lanceolate, with a narrowed but blunt emarginate apex and a broadly cuneate base. Margin entire, slightly undulate. Petiolule 2.5 millimeters long, stout. Midrib stout but relatively slender. Secondaries thin, 6 to 8 subopposite to alternate pairs, diverging from the midrib at angles of about 50° running straight for two-thirds of the distance to the margin, then each camptodrome to the secondary next above:

This species resembles *C. glenni* Berry³⁸ but has a longer petiolule and is smaller.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order GERANIALES

Family MALPIGHIACEAE

Genus BANISTERIA Linné

Banisteria bradleyi Brown, n. sp.

Plate 73, Figure 7

Leaves thick, 2.7 centimeters long, 1.4 centimeters wide below the middle of the blade. Ovate. Apex narrow, rounded, base broadly cuneate. Margin entire. Petiole oblique, relatively stout, enlarged at the point of attachment like the pulvinus on some Leguminosae. Midrib not prominent, thin. Secondaries, 7 to 9 alternate pairs, thin, irregular, diverging from the midrib at 60°, each curving upward and anastomosing with the secondary next above close to the margin. Finer nervation a meshwork of quadrangular blocks.

There are 70 living species of *Banisteria*. They range from southern Mexico to the West Indies and

Brazil. They are common in the oak forests of upland Mexico.

Occurrence: Piceance Creek, near junction with White River, Colo.

Order SAPINDALES

Family ANACARDIACEAE

Genus RHUS Linné

Rhus myricoides Knowlton

Plate 73, Figure 9

Rhus myricoides Knowlton, U. S. Geol. Survey Prof. Paper 131, p. 168, pl. 37, fig. 9 [not figs. 10, 11, which are *R. variabilis* (Newberry) Knowlton], 1923.

This fine species resembles in some respects the living *Rhus typhina* and *R. glabra* of North America and *R. coriaria* of Europe. Among fossil species it is so like *R. coriaroides* Lesquereux,³⁹ of Florissant, that they may be identical, or at least one may be ancestral to the other.

Knowlton's Figure 9 is clearly different from his Figures 10 and 11, and it would seem best therefore to retain Figure 9 as the type of this species and to transfer Figures 10 and 11 to *R. variabilis* (Newberry) Knowlton, to which they seem most closely allied.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Rhus balli Brown, n. sp.

Plate 73, Figure 10

An odd-pinnate compound leaf with alate rachis and 5 or more pairs of lateral leaflets of almost uniform size and a terminal leaflet somewhat larger than the laterals. The paired leaflets are opposite, sessile or nearly so, attached at a wide angle, with internodes 1 centimeter long near the apex of the leaf but increasing in length toward the base. Length of entire leaf more than 8 centimeters; width 3 centimeters for most of the length. Leaflets 1.5 centimeters long and 1 centimeter wide, irregularly ovate and inequilateral. Margin entire on lower edge of leaflets, crenulate on the more or less truncate apices, and beset with few, relatively large and variable crenate-serrate teeth on the upper edges. Terminal leaflet obovate, with an elongated cuneate base. Wings of the alate rachis 1 millimeter wide at the top of an internode but decreasing to zero at the base. Midrib of leaflets straight, extending to the apex without forking. Secondaries, usually 6 pairs, subopposite, thin, diverging from the midrib at wide angles, curving gradually upward into the teeth, sometimes forking and sending branches into the notches below the teeth.

This remarkably beautiful species bears some resemblance to the living and variable *R. copallina*, or dwarf sumac, widely distributed on dry hillsides from north-

³⁷ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 300, pl. 59, fig. 7, 1878; vol. 8, p. 203, pl. 37, figs. 10-13, 1883.

³⁸ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 233, pl. 45, figs. 15, 16, 17a, 18; pl. 52, fig. 6, 1916.

³⁹ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 8, p. 193, pl. 41, fig. 3, 1883.

ern New England to southern Florida and Cuba and west to Iowa, Nebraska, Kansas, and Texas. The leaflets of *R. copallina* are entire or nearly so for the most part, but in some varieties they are prominently serrated. They differ, however, from those of *R. balli* in having acuminate apices.

Casually observed this species might be taken for others belonging to other families and genera, such as *Dictamnus* (Rutaceae), *Athyana* (Sapindaceae), *Weinmannia* (Cunoniaceae). Of these *Weinmannia* seems to compare most closely with *R. balli*, but it differs markedly by several distinguishing characteristics, of which the principal one is that the secondary veins of the *Weinmannia* leaflets enter the notches between the teeth and the midrib forks near the apex without reaching the tip. Thus one can distinguish the two genera in specimens whose leaflets are toothed.

Lesquereux has described three species of *Weinmannia* from Florissant—*W. obtusifolia*, *W. haydenii*, and *W. integrifolia*. At first he was disposed to call these forms *Rhus*, but on the basis of some figures of *Weinmannia* (collected by Probst from the Tertiary of Biberach) communicated to Lesquereux by Heer, Lesquereux decided upon *Weinmannia*. If now we examine the specimens in the United States National Museum or Lesquereux's figures⁴⁰ we find that in *W. haydenii* and *W. integrifolia* the secondary veins enter the teeth. It seems clear, therefore, that these two forms at least are not *Weinmannia*. Concerning *W. obtusifolia*⁴¹ the evidence is not so clear, because the leaflets have nearly if not quite entire margins, thus necessitating a different alinement of the secondaries from that which would occur in a toothed leaflet. I find, however, that even here the alinement simulates that of a *Rhus* in which the leaflets are entire and that the midrib of the leaflets terminates in the apex and does not divide as in typical *Weinmannia*. I should decide that this also is a *Rhus*.

A form that bears some resemblance to *R. balli* is the fragment described by Lesquereux as *R. rosaefolia* Lesquereux,⁴² from South Park, west of Florissant.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus SCHMALTZIA Desveaux

Schmaltzia vexans (Lesquereux) Cockerell

Schmaltzia vexans (Lesquereux) Cockerell, *Torreyia*, vol. 6, p. 12, 1906; *Colorado Univ. Studies*, vol. 3, p. 17, 1906.

Rhus vexans Lesquereux, *U. S. Geol. Survey Terr. Rept.*, vol. 8, p. 195, pl. 41, fig. 20, 1883.

In form and details this leaflet of a trifoliate leaf conforms to the type described from Florissant and is

⁴⁰ Lesquereux, Leo, *U. S. Geol. Survey Terr. Rept.*, vol. 8, p. 178, pl. 41, figs. 4-10; pl. 42, figs. 1-7, 8-13, 1883.

⁴¹ *Idem*, p. 178, pl. 49, figs. 4-10.

⁴² Lesquereux, Leo, *U. S. Geol. Survey Terr. Rept.*, vol. 7, p. 293, pl. 42, figs. 7-9, 1878.

similar to a living variety (*Rhus trilobata* Nuttall) of *Rhus aromatica*, now found in Texas.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus ANACARDITES Saporta

Anacardites schinoloxxus Brown, n. sp.

Plate 73, Figure 8

A winged fruit 3 centimeters long, resembling superficially a maple schizocarp. Boundaries of the seed itself indefinite, but about one-third the length of the entire fruit. Wing thin, 1 centimeter wide two-thirds distad. Upper margin not perceptibly thickened (as in *Acer*), bowed down slightly in the middle. Distal point rounded. Lower margin undulate, widened from the distal end to a point just short of the middle, then gradually narrowed and forming a border around the seed to the rounded base. Entire fruit supported by a clavate peduncle, 1 millimeter long. Veins thin over entire wing, close, and running parallel to the upper margin, curving downward and bifurcating toward the outer and lower margins. Intermediate areolation composed of irregular, elongated cells. Seed itself wrinkled or striated irregularly.

In casting about for a living fruit that might resemble this well-preserved specimen, I considered the following possibilities among genera: *Acer* (Aceraceae), *Banisteria*, *Heteropteris*, *Stigmatophyllum*, *Acridocarpus* (Malpighiaceae), *Securidaca* (Polygalaceae), *Thouinia*, *Atalaya* (Sapindaceae), *Embothrium*, *Hakea*, *Rymandra* (Proteaceae), *Pinus* (Pinaceae), *Schinopsis*, *Loxopterygium* (Anacardiaceae).

Because the peduncle protrudes forward in a characteristic manner and because no straight cleavage surface seems to be present on either side of the seed, as there would be in a schizocarp, it appears certain that this specimen is a single fruit and not a twin. That point being established, the following genera of those listed are automatically eliminated: *Acer*, *Banisteria*, *Heteropteris*, *Stigmatophyllum*, *Acridocarpus*, *Thouinia*, and *Atalaya*. On the basis of difference in form and venation the genera *Pinus*, *Embothrium*, *Hakea*, and *Rymandra* also drop out. *Securidaca* agrees in form but differs in having a thickened dorsal border and a seed which is less than one-third the length of the entire fruit and in not having a smooth, free peduncle when falling off at maturity. *Schinopsis* agrees in practically every respect except that the capsular fruit is smooth and shows no venation. *Loxopterygium* meets every requirement except that the venation is more open and the fruit is longer and narrower. It seems reasonable, therefore, to conclude that this fruit belongs within or close to the two last-mentioned genera. I have indicated the resemblance in assigning the specific name.

Loxopterygium is a genus inhabiting the Guianas. It has pinnately compound leaves with narrow lanceolate

leaflets. *Schinopsis* resembles *Loxopterygium* in habit and form and is found in Brazil, Paraguay, and Argentina.

It is possible that some of the leaflets found in this formation and described as *Rhus* may belong to a genus and species that produced this fruit.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family CELASTRACEAE

Genus CELASTROPHYLLUM Göppert

Celastrophyllum lesquereuxii Brown, n. sp.

Plate 74, Figure 1

Subcoriaceous leaves, 5 to 9 centimeters long, 1 to 1.7 centimeters wide medianly. Narrowly lanceolate, falcate, acuminate at the apex, cuneate at the equilateral base, which is decurrent on the petiole. Margin entire for one-third of the distance above the base, then serrate or crenate-serrate, with prominent, more or less aquiline teeth, becoming more widely spaced and low-dentate toward the apex. Midrib prominent, flexuous. Secondaries 5 or 6 subopposite to alternate pairs, emerging from the midrib at wide angles but rapidly curving upward, sending nervilles into the teeth. Finer nervation of irregular polygonal blocks.

This form is like *C. variabilis* Berry,⁴³ from the Ripley formation, but it is larger.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Celastrophyllum emarginatum Brown, n. sp.

Plate 74, Figure 2

A thick, inequilateral leaf, 2.3 centimeters long, 1.5 centimeters wide near the apex. Irregularly obcordate. Apex broadly rounded, emarginate; base narrowly rounded on the larger side, cuneate on the other. Margin entire except for two rounded, crenate lobes or teeth on the larger side, one on the smaller side, narrowly decurrent on the petiole. Midrib strong. Secondaries few, diverging from the midrib at 50°, curving upward and outward, forking, anastomosing, and finally disappearing in the leaf substance near the margin. Finer nervation indistinguishable.

This leaf resembles some living species of *Celastrus* from South America, particularly Brazil.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus MAYTENUS Molina

Maytenus berryi Brown, n. sp.

Plate 74, Figure 3

A thin-textured, linear-lanceolate, falcate leaf with pointed apex and narrowly tapered, decurrent base.

Petiole not present on this specimen. Length 9 centimeters, maximum width 1.2 centimeters medianly. Margin entire for a short distance above the base, then beset with irregularly spaced and variable serrate teeth. Midrib stout, curved. Secondaries thin, 7 or 8 pairs, alternate, emerging from the midrib at 40° or less and each soon curving upward in an irregular loop well within the margin and joining the secondary next above. Finer nervation very irregular.

In venation this leaf suggests the living *M. boari*, of the West Indies. Among fossils it is like *M. puryearensis* Berry,⁴⁴ from the Wilcox of Tennessee.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family SAPINDACEAE

Genus THOUINIA Poiteau

Thouinia eocenica Brown, n. sp.

Plate 74, Figure 4

Inequilateral leaflets, 3 to 7.5 centimeters long, 1 to 1.8 centimeters wide medianly. Ovate-lanceolate. Apex elongated, blunt-pointed. Petiole stout, of variable length, modified somewhat by the decurrent margin of the inequilateral base. Margin distantly and minutely serrate. Midrib strong, flexuous. Secondary nervation of numerous thin veins, 10 to 12 pairs, alternate, with intermediaries, unevenly spaced, arising from the midrib at wide angles, straight or slightly curved till near the margin, then each looped upward to the secondary next above. Branches from the loops form a network next to the margin. Finer areolation composed of irregular meshes. Texture subcoriaceous.

This form compares well with such living species of *Thouinia* as *T. paucidentata*, of Yucatan and the West Indies, and *T. australis*, of the Dutch East Indies. In form it resembles *Thouinidium decandrum*, of Mexico, but differs markedly in venation.

Among recorded fossil species, which are few, *T. occidentalis* Engelhardt⁴⁵ is like this species but resembles the living *T. australis* more.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Family AQUIFOLIACEAE

Genus ILEX Linné

Ilex affinis Lesquereux

Ilex affinis Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 7, p. 270, pl. 50, figs. 2, 3, 1878.

Berry, U. S. Geol. Survey Prof. Paper 91, p. 264, 1916.

These thick, broadly lanceolate leaves, with few, sharp, long-pointed or rounded teeth on the margins,

⁴³ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 264, pl. 61, fig. 5, 1916.

⁴⁵ Engelhardt, Hermann, Die alttertiäre Flora von Messel, p. 95, pl. 31, fig. 1, 1922.

⁴³ Berry, E. W., U. S. Geol. Survey Prof. Paper 136, p. 65, pl. 13, fig. 1, 1925.

compare well with those of certain living species and with *Ilex dissimilis* Lesquereux,⁴⁶ from Sage Creek, Mont.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order MALVALES

Family TILIACEAE

Genus GREWIOPSIS Saporta

Grewiopsis cissifolius Brown, n. sp.

Plate 74, Figure 8

Leaf 10 centimeters long, 5 centimeters wide medi-
anly. Ovate-angular. Apex acute, base abruptly
rounded, truncate, or slightly cordate. Margin rev-
olute, thickened, sinuate-toothed, the larger teeth prom-
inently but bluntly pointed by the excurrent second-
ary veins. What appears to be the beginning of a
lobe is an extension of the blade on both margins at
about the middle of the leaf. Petiole 12 millimeters
long, stout, and thickened toward the point of attach-
ment. The secondary veins curve upward slightly,
some of them forking as they run out from the prom-
inent midrib into the teeth, the angle of emergence
ranging from a right angle at the base to 40° near the
apex. The lowest secondaries are subopposite. The
finer areolation is a net work of quadrangular meshes.
Texture subcoriaceous.

This leaf belongs to a puzzling group of Eocene forms
which simulate the leaves of many genera—*Grewia*,
Grewiopsis, *Populus*, *Alnus*, *Cissus*, *Cissites*, *Quercus*,
Viburnum, *Ficus*, *Platanus*. The specimen in hand
differs little from *Fagus papyracea* Knowlton,⁴⁷ from
the Raton formation. That specimen, however, can
hardly be *Fagus* because of the forking veins and the
nature of the tertiary venation.

This species differs only in the sharper teeth from
Grewiopsis populifolia Ward,⁴⁸ from the Fort Union
formation.

Occurrence: Between Carr and Brush Creeks, 30
miles northwest of De Beque, Colo.

Family STERCULIACEAE

Genus STERCULIA Linné

Sterculia coloradensis Brown, n. sp.

Plate 74, Figures 6, 7

Long-petioled, simple leaves, entire or deeply lobed.
The entire leaves or the lobes of the lobed leaves are
generally lanceolate, tapering to an acute apex.
Margin entire. Petiole 2.5 centimeters long, slender.
From the base of the leaf arise primary and lateral

veins, which are relatively clear and strong. From
these principal veins diverge at wide angles numerous
secondaries, which may be straight but are more
generally irregular and curved upward near the margin.
Many fork and lose themselves in the tertiary vena-
tion.

These specimens suggest very strongly the living
Sterculia diversifolia, of Australia. *Sterculia* com-
prises about 100 species distributed in the warmer
regions of the world.

Occurrence: Between Carr and Brush Creeks, 30
miles northwest of De Beque, Colo.

Order PARIETALES

Family TERNSTROEMIAEAE

Genus TERNSTROEMITES Berry

Ternstroemites viridiflumensis Brown, n. sp.

Plate 74, Figure 5

Coriaceous leaves, lanceolate to ovate-lanceolate,
elongated above the middle to an acuminate apex.
This fragment shows a conspicuous constriction near
the apex, but whether this is a normal condition or not
is uncertain. Length 10 to 12 centimeters; maximum
width 2 centimeters at or below the middle of the leaf.
Margin undulate to crenate-serrate to a point within
a short distance of the apex. Petiole not present.
Midrib strong, curved. Secondaries thin, numerous,
diverging from the midrib at wide angles, straight or
slightly curved, arched near the margin to the sec-
ondary above. Finer nervation not distinguishable.

This species resembles *T. preclaibornensis* Berry,⁴⁹
from the Wilcox formation, but differs in dentation of
the margin and in texture.

Occurrence: On the eastern border of Carr Creek,
Garfield County, Colo.

Order OLEALES

Family OLEACEAE

Genus FRAXINUS Linné

Fraxinus petiolata Brown, n. sp.

Plate 75, Figures 1-4

Leaflets coriaceous, 10 to 15 centimeters long, 2.5 to
4.5 centimeters wide at a point below the middle of
the blade. Ovate-lanceolate. Apex tapering gradually,
then abruptly and bluntly acuminate, as in some living
species; base inequilateral, cuneate on the lower side,
rounded on the other, or both sides rounded when
nearly equal in position. Petiolule 2 centimeters long,
inflated at the point of attachment. Margin obtusely
dentate-serrate or merely undulate. Midrib promi-
nent, flexuous. Secondaries strong, 10 to 12 pairs,
sometimes with short intermediaries, diverging from

⁴⁶ Lesquereux, Leo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 177, pl. 50, figs. 7-9, 1878.

⁴⁷ Knowlton, F. H., U. S. Geol. Survey Prof. Paper 101, p. 295, pl. 68, fig. 1, 1917.

⁴⁸ Ward, L. F., U. S. Geol. Survey Sixth Ann. Rept., p. 556, pl. 55, figs. 8-10, 1886; U. S. Geol. Survey Bull. 37, p. 90, pl. 40, figs. 3-5, 1887.

⁴⁹ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 295, pl. 78, figs. 1-4, 1916.

the midrib at wide angles, nearly parallel, straight or slightly curved until well within the margin, then camptodrome, forming simple bows to the secondaries above. Nervilles from the bows enter the teeth. Transverse nervilles between the secondaries, finer areolation composed of irregular quadrated meshes.

This species is like *F. eocenica* Lesquereux,⁵⁰ from Golden, Colo., but has less rounded teeth and longer petiolules and is more lanceolate.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order GENTIANALES

Family APOCYNACEAE

Genus APOCYNOPHYLLUM Unger

Apocynophyllum wilcoxense Berry

Apocynophyllum wilcoxense Berry, U. S. Geol. Survey Prof. Paper 91, p. 342, pl. 103, figs. 2, 3; pl. 108, fig. 4. Knowlton, U. S. Geol. Survey Prof. Paper 101, p. 345, pl. 103, fig. 3; pl. 105, figs. 1, 2; pl. 106, fig. 1, 1917.

This form has been referred to *Apocynophyllum* because of its close resemblance to leaves of certain genera in the Apocynaceae, particularly to *Nerium oleander* Linné. A number of *Apocynophyllum*s have been recognized in American Tertiary floras. This species has been described by Berry from the Wilcox group, and by Knowlton from the Raton formation.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus APOCYNOSPERMUM Reid

Apocynospermum coloradensis Brown, n. sp.

An elliptic, somewhat flattened, striated achene, 5 millimeters long, 2 millimeters in diameter, surmounted by a pappus 2 centimeters or more in length. This specimen is similar to numerous species described by Heer⁵¹ and others as *Cypselites* or *Bidentites* of the Compositae. The probability however, is that most of these forms, as shown recently by Reid and Chandler,⁵² belong either to the Apocynaceae or to the Asclepiadaceae.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Order CAMPANULALES

Family CUCURBITACEAE

Genus CUCURBITA (Tournefort) Linné

Cucurbita glandulosa Brown, n. sp.

Plate 75, Figure 6

A part of the basal portion of a large palmately lobed leaf. Veins very thick. Petiole stout and fleshy.

⁵⁰ Lesquereux, Loo, U. S. Geol. Survey Terr. Rept., vol. 7, p. 229, 1878; vol. 8, p. 123, pl. 20, figs. 1-3, 1883.

⁵¹ Heer, Oswald, Flora tertiaria Helvetiae, pt. 3, pp. 3-6, pl. 101, 1859.

⁵² Reid, E. M., and Chandler, M. E. J., Catalogue of Cainozoic plants in the department of geology, vol. 1, The Bembridge flora, London, British Mus., 1926.

Areolation of transverse nervilles and large quadrangular cells. The distinguishing characteristic of this leaf is the minute punctation distributed over the surface of the vein and areolation. This seems to indicate that the leaf was hairy or glandular. Taking all the characteristics into consideration I conclude that this form is most like a *Cucurbita*, and it is so designated.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Phyllites juncoides Brown, n. sp.

Plate 75, Figure 5

A narrow, linear falcate leaf with entire margin. Without midrib, petiole, or evidence of venation.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus CARPOLITHUS Allioni

Carpolithus cassioides Brown, n. sp.

Plate 76, Figure 1

A small, flat, leathery leguminous pod, 1.5 centimeters long and 6 millimeters wide. Oblong in outline except that the base is the reverse of the apex. Pod attached by the lowest part of the rounded base.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Carpolithus ellipticus Brown, n. sp.

Plate 76, Figure 2

An oval elliptic flattened fruit, 12 millimeters long and 6 millimeters wide. Central ovoid mass apparently a stony seed, surrounded by a corona of pulp 1.5 millimeters wide. The whole is supported on a slender capitate pedicel of indefinite length.

Occurrence: On Piceance Creek near junction with White River, Colo.

Carpolithus capsularis Brown, n. sp.

Plate 76, Figure 3

An orbicular, flattened capsule, pod, or fruit, supported by a relatively thick, capitate pedicel. Diameter 7 millimeters.

Occurrence: On Piceance Creek near junction with White River, Colo.

Carpolithus palmites Brown, n. sp.

Plate 76, Figure 4

This broken specimen is apparently the fruit or husk of the fruit of some palmlike species. It resembles *Nipadites burtini umbonatus* Bowerbank,⁵³ from the Grenada formation of Mississippi.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

⁵³ Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 176, pl. 112, figs. 13, 14, 1916

Carpolithus serratifolius Brown, n. sp.

Plate 76, Figure 5

A slender fruiting branch bearing two leaves and a raceme of small ovate fruits. The leaves are narrow, linear, alternate, petioled, 3.5 centimeters long and 2 millimeters wide. Margin finely but sparsely serrate. Midrib flexuous, prominent. Petiole 3 to 4 millimeters long. Secondary and tertiary venation not shown. Fruits 1 to 2 millimeters in diameter, ovate, thickened, borne on slender pedicels 2 to 4 millimeters long, the whole forming a raceme.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus ANTHOLITHES Brongniart**Antholithes vitaciflora Brown, n. sp.**

Plate 76, Figure 8

A cymose cluster of flowers well advanced in the fruiting condition. Main stem and branchlets of the cyme relatively thick and fleshy. Pedicels of the flowers clavate, 2.5 millimeters long. Remains of perianth obscure. Ovary superior, flat spherical, narrowing abruptly into a persistent style, 1.5 millimeters long. These flowers seem to belong to some species of the Vitaceae.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Antholithes dubia Brown, n. sp.

Plate 76, Figure 7

A flower, 1 centimeter in diameter. Petals or lobes of the perianth present, 8, ovate. The center of the flower is a mass of carbonaceous material, of which the details are not recognizable.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Antholithes polemonioides Brown, n. sp.

Plate 76, Figure 6

A flower. Ovary superior, globular, 15 millimeters in diameter, apparently two-celled. Styles two, distinct, slender, 1 millimeter long, surmounted by short, broad, conical stigmas. Perianth, presumably the calyx, deeply divided, only two or three lobes being recognizable. Lobes 3 millimeters long, abruptly acuminate. The flower was supported on a clavate peduncle 2 millimeters long. No stamens or petals being present, it seems that they were removed together, as would occur with stamens inserted on a

sympetalous corolla. The characteristics above set forth would seem to bring this specimen within such a group of families as the Ebenaceae, Convolvulaceae, and Boraginaceae.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Antholithes pendula Brown, n. sp.

Plate 76, Figure 9

This seems clearly to be a staminate catkin. At one end of the dense aggregation of flowers can be seen a short portion of the peduncle. Such a catkin would suggest *Salix*, *Populus*, *Betula*, *Alnus*, *Juglans*, *Hicoria*, etc.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus CAULINITES Brongniart**Caulinites acanthus Brown, n. sp.**

Plate 76, Figure 10

A portion of a spiny stem with thorns of varying lengths, the largest 2.5 centimeters long, the shortest 5 millimeters long, relatively broad at the base and tapering gradually to a sharp point. Stem 3.5 millimeters thick.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Caulinites prehensus Brown, n. sp.

Plate 76, Figure 11

A tendril, 1.5 millimeters thick, belonging to one of the climbing plants, such as *Parthenocissus* or *Cucurbita*.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Genus RHIZOCAULON Saporta**Rhizocaulon natans Brown, n. sp.**

Plate 76, Figure 13

A small rootlet with rhizoids like those occurring on the water chestnut (*Trapa natans*).

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

Rhizocaulon dichotomum Brown, n. sp.

Plate 76, Figure 12

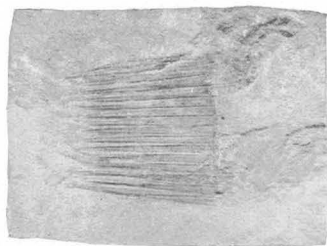
A root or stem, showing one dichotomy.

Occurrence: Between Carr and Brush Creeks, 30 miles northwest of De Beque, Colo.

PLATES 70-76



4



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2

FLORA OF THE GREEN RIVER FORMATION

1, 2. *Anetmia delicatula* Brown (p. 281).
3. *Equisetum winchesteri* Brown (p. 282).

4. *Taxites eocenica* Brown (p. 282).
5. *Picea pinifructus* Brown (p. 282).



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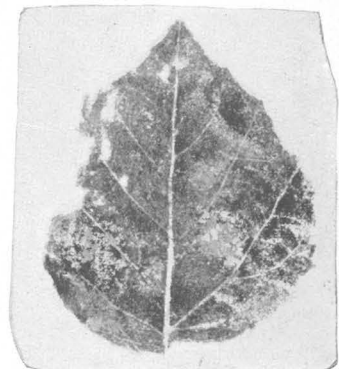
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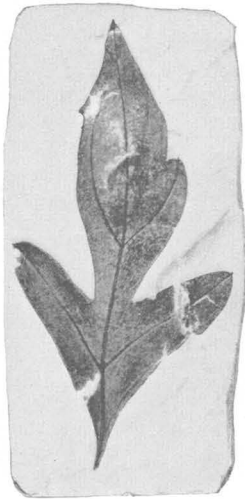
FLORA OF THE GREEN RIVER FORMATION

1. *Sparganium eocenicum* Brown (p. 282).
2, 3. *Myrica alkalina* Lesquereux (p. 283).
4, 5. *Hicoria juglandiformis* (Sternberg) Knowlton (p. 283).

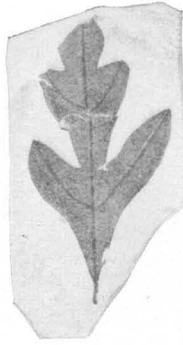
6. *Betula eocenica* Brown (p. 283).
7-9. *Planera nervosa* Newberry (p. 284).



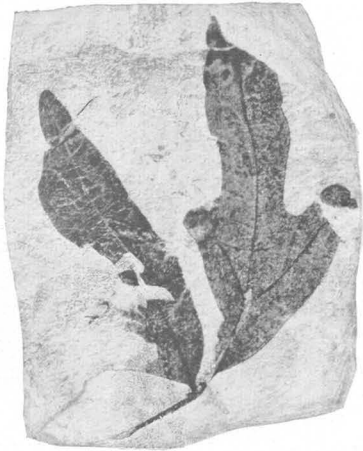
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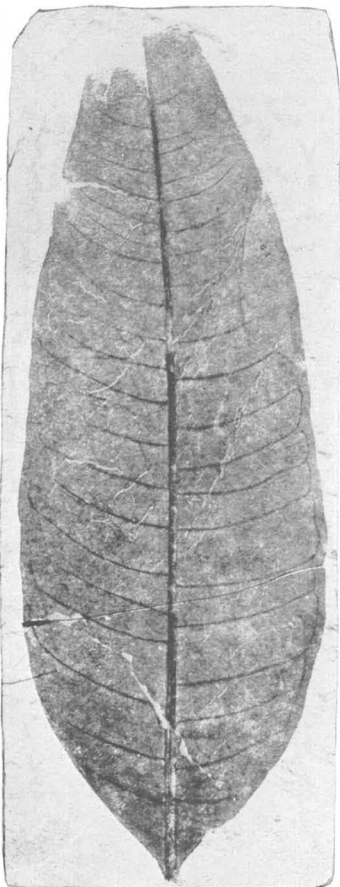
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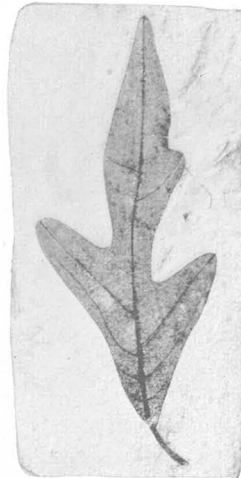
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FLORA OF THE GREEN RIVER FORMATION

1. *Celtis debequensis* Brown (p. 284).

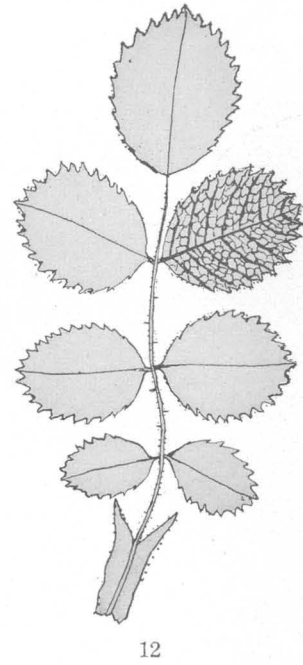
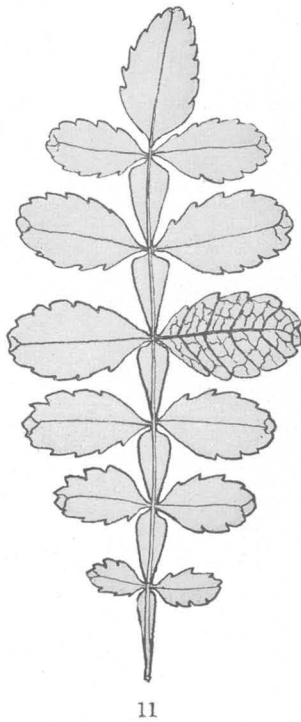
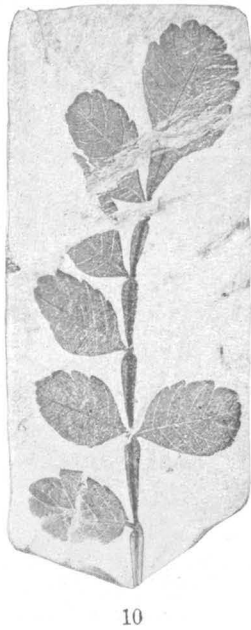
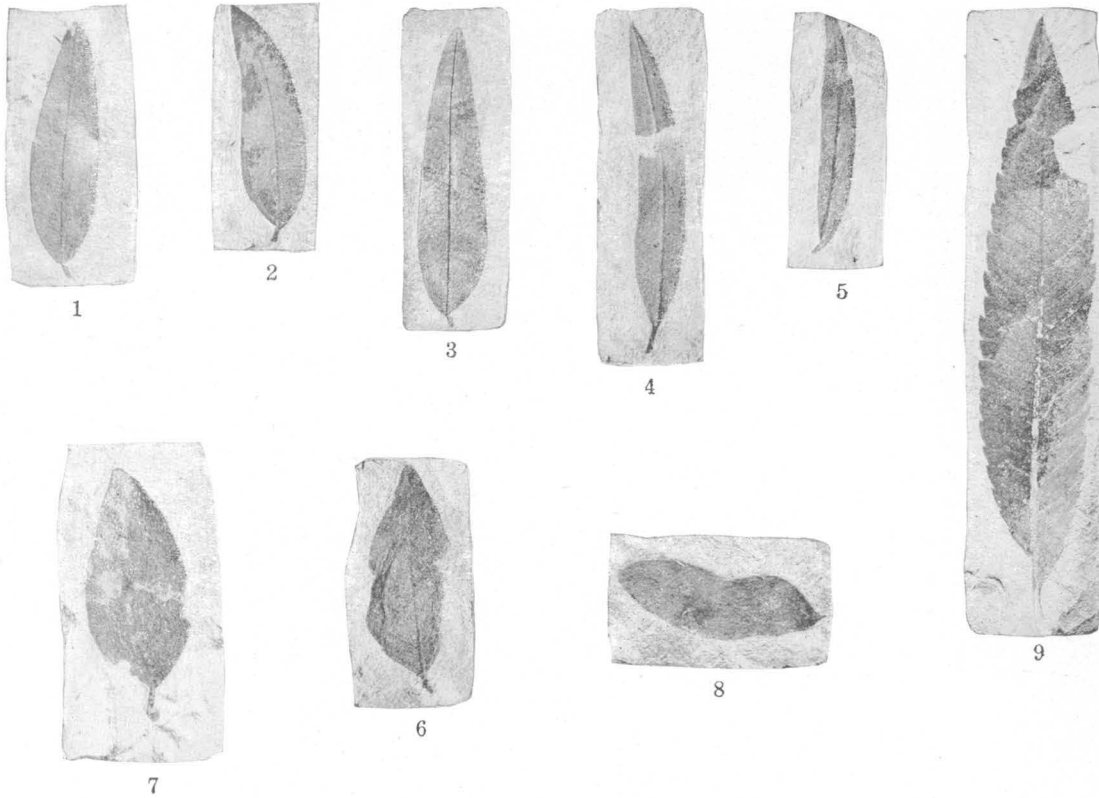
2. *Ficus omballi* Brown (p. 285).

3-6. *Lomatia coloradensis* (Knowlton) Brown (p. 285).

7. *Banksia cockerelli* Brown (p. 286).

8. *Chrysobalanus 'acustris* Brown (p. 286).

9. *Oreodaphne knowltoni* Brown (p. 286).



FLORA OF THE GREEN RIVER FORMATION

- 1-3. *Mimosites debequensis* Brown (p. 286).
- 4, 5. *Mimosites falcatus* Brown (p. 287).
- 6. *Cassia hesperia* Brown (p. 287).
- 7. *Banisteria bradleyi* Brown (p. 287).
- 8. *Anacardites schinolozus* Brown (p. 288).

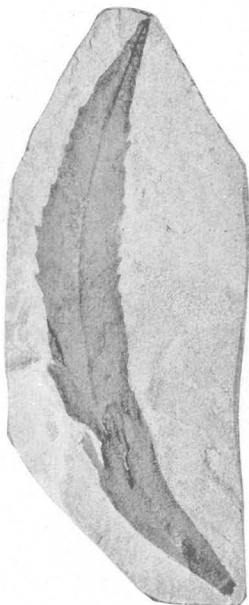
- 9. *Rhus myricoides* Knowlton (p. 287).
- 10. *Rhus balli* Brown (p. 287).
- 11. *Weinmannia pinnata*, of Mexico, introduced for comparison.
- 12. *Rosa rubiginosa*, of the eastern United States, introduced for comparison.



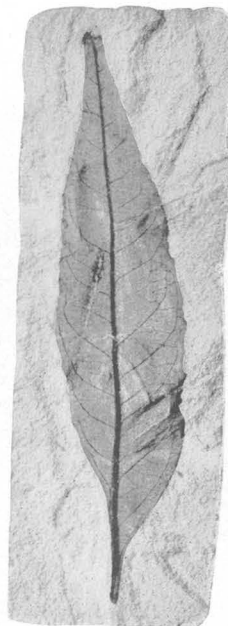
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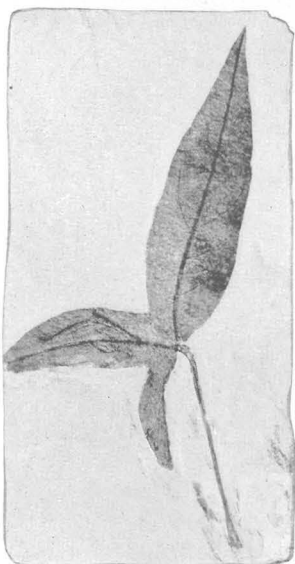
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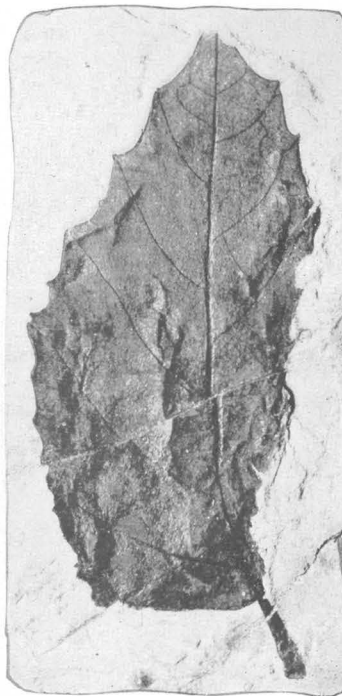
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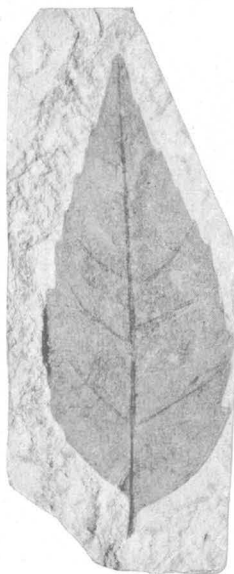


8

FLORA OF THE GREEN RIVER FORMATION

- 1. *Celastrophyllum lesquereuxii* Brown (p. 289).
- 2. *Celastrophyllum emarginatum* Brown (p. 289).
- 3. *Maytenus berryi* Brown (p. 289).
- 4. *Thouinia eocenica* Brown (p. 289).

- 5. *Ternstroemites viridifumensis* Brown (p. 290).
- 6, 7. *Sterculia coloradensis* Brown (p. 290).
- 8. *Grewiopsis cissifolius* Brown (p. 290).



1



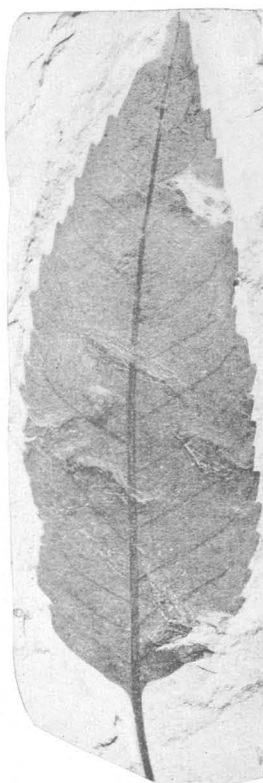
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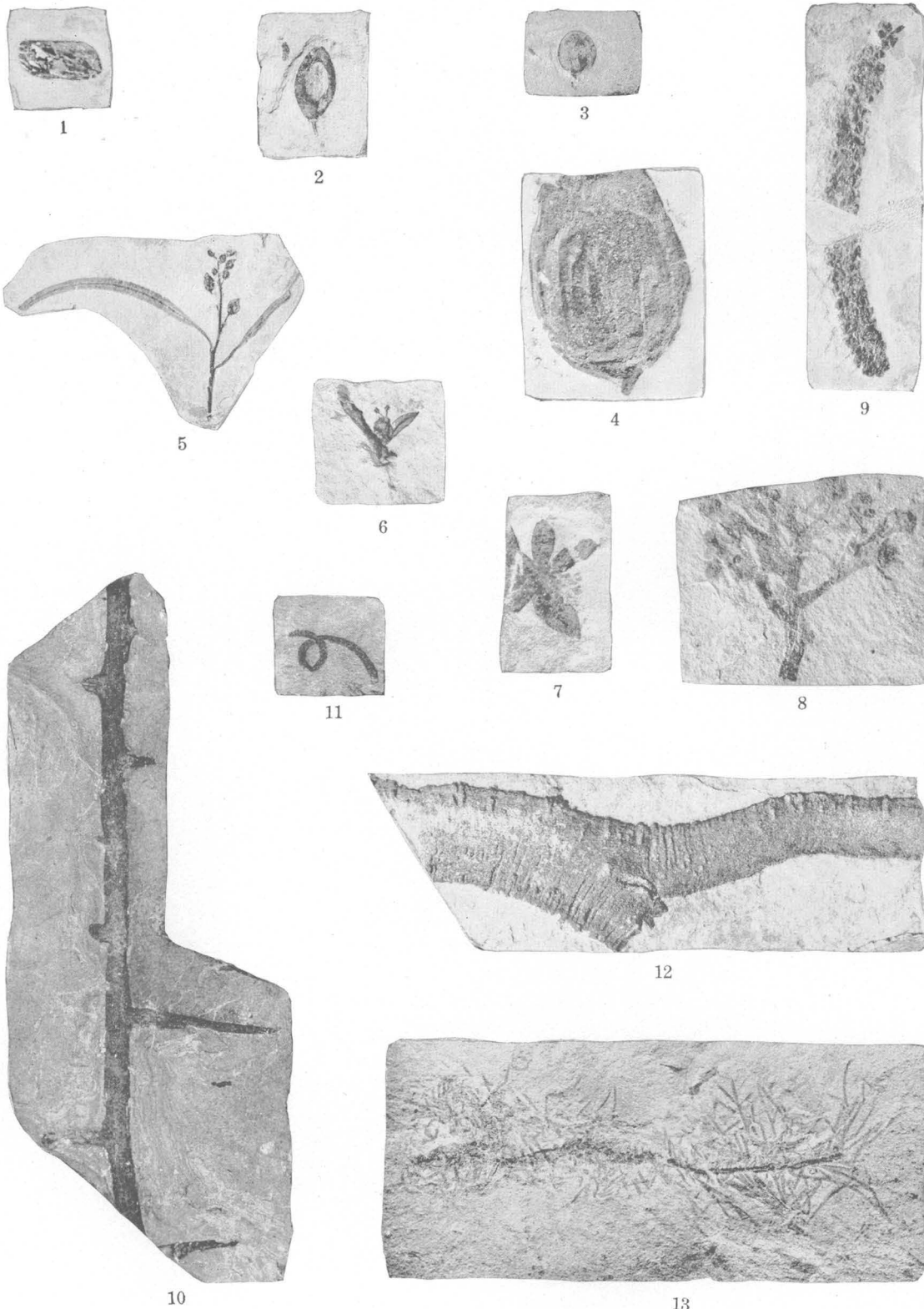
4

FLORA OF THE GREEN RIVER FORMATION

1-4. *Frazinus petiolata* Brown (p. 290).

5. *Phyllites juncooides* Brown (p. 291).

6. *Cucurbita glandulosa* Brown (p. 291).



FLORA OF THE GREEN RIVER FORMATION

- 1. *Carpolithus cassioides* Brown (p. 291)
- 2. *Carpolithus ellipticus* Brown (p. 291).
- 3. *Carpolithus capsularis* Brown (p. 291).
- 4. *Carpolithus palmities* Brown (p. 291).
- 5. *Carpolithus serratifolius* Brown (p. 292).

- 6. *Antholites polemonioides* Brown, $\times 2$ (p. 292).
- 7. *Antholites dubia* Brown, $\times 2$ (p. 292).
- 8. *Antholites viticiflora* Brown, $\times 2$ (p. 292).
- 9. *Antholites pendula* Brown (p. 292).

- 10. *Caulinites acanthus* Brown (p. 292).
- 11. *Caulinites prehensus* Brown (p. 292).
- 12. *Rhizocaulon dichotomum* Brown (p. 292).
- 13. *Rhizocaulon natans* Brown, $\times 2$ (p. 292).