CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES, FORESTS AND SCIENTIFIC SERVICES BRANCH

GEOLOGICAL SURVEY BULLETIN
No. 13

UPPERMOST CRETACEOUS AND PALEOCENE FLORAS OF WESTERN ALBERTA

BY
W. A. Bell

OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
KING'S PRINTER AND CONTROLLER OF STATIONERY
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PREFACE

In order to prepare geological maps and to apply geological principles to practical problems it is necessary to determine the mode of origin and the relative ages of the rock formations. Of the various lines of evidence used in judging the time of a geological event, the most conclusive are those that are based on fossils contained in the rocks. By the accurate identification of fossil species, individual rock formations can be correctly fixed in the world-wide chronology that is being built up by palæontological research.

The accompanying report represents the results obtained from a study of plant remains that were collected by geologists, at intervals and over a period of many years, from rock formations of western Alberta. It presents the evidence for fixing these remains in the geological time-scale, and for assisting the geologist in dating the formations and the geological events revealed by them.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, December 1, 1948

UPPERMOST CRETACEOUS AND PALEOCENE FLORAS OF WESTERN ALBERTA

INTRODUCTION

The main purpose of this report is to present available palæobotanical evidence for the correlation of uppermost Cretaceous and earliest Tertiary formations of western Alberta. The work is supplementary to earlier studies of E. W. Berry (1926; 1930; 1935)[1] on fossil plants from Alberta and Saskatchewan. Previously, our knowledge of the fossil floras of this region was due entirely to Sir William Dawson (1875; 1881; 1883; 1886; 1887; 1888; 1890). Dawson's conclusions as to the age of the floras showed remarkable discernment, but his plant species were generally too inadequately described and too poorly figured for later workers to recognize them or critically evaluate their testimony.

To facilitate the recognition of each species in this report the prevailing variations of leaf forms have been illustrated, where material so permitted. Otherwise there would be a strong tendency on the part of later workers towards over-speciation, and the stratigraphic significance of a species as an age indicator or factor in correlation might thereby be overlooked.

In the description of species (pages 36-82) the author was guided in the order in which the genera are placed by that presented by Dr. Richard Wettstein in his "Handbook der Systematischen Botanik", which follows closely that in Engler's "Naturlich Pflanzenfamilien". Although it was realized during compilation of the accompanying illustrations (Plates I to LXVII) that a sequence of species that followed more closely the order of stratigraphic succession would be more satisfactory to the geologist, economy of space, and other factors, such as the receipt of specimens after many plates had been compiled, prevented such an ideal arrangement.

With the exception of the Bearpaw, which has yielded a single species, the formations dealt with in this report, from which identifiable plants were obtained, are dominantly of freshwater deposition, marine or brackish water beds being limited to a few in the basal part of the St. Mary River formation and in the Edmonton formation below the Kneehills tuff.

The floras here dealt with should be particularly helpful in establishing the position of the Cretaceous-Tertiary boundary, although in the case of the Willow Creek formation the number of plants so far obtained is too few to fix this important horizon with confidence. Past controversy on the value of angiospermous floras as time indices arose in many instances from careless collecting and consequent intermingling of plants actually derived from widely separate stratigraphic horizons. As a result, many of the old lists of plant species are composite and useless to the stratigrapher. A second error, which has cast doubt on the value of the plant evidence, was lack of discrimination in judging the value of each species as an age indicator. A prerequisite to accurate judgment on this problem is careful collecting of the plants from bed to bed in a stratigraphic sequence in order

[1]Dates, in parentheses, are those of publications listed in References, pages 88-93.

to establish as accurately as circumstances permit the vertical or stratigraphic range of each species. As this requires detailed field studies and much time devoted to systematic collecting, our knowledge of specific ranges is acquired slowly, and the palæobotanist must frequently make judgments on collections that were gathered more or less casually or haphazardly. Such collections are very likely to contain an undue proportion of long-ranging species, which are commonly the most abundant and most widely distributed elements of a flora. Few of the collections that furnished data for the present report were the fruits of detailed stratigraphic work or of painstaking collecting. Consequently, they do not furnish sufficient data for floral zoning nor for the compilation of tables of accurate ranges of species. Nevertheless, collections from some of the formations present a sufficiently complete representation of the flora to permit correlations with one or more of the standard stages into which the rock systems are subdivided.

The Alberta fossil plants studied form a part of Geological Survey collections made by G. M. Dawson (1874), A. R. C. Selwyn (1880), J. W. Dawson (1883), T. C. Weston (1883-89), J. B. Tyrrell (1884, 1886), R. G. McConnell (1888), C. H. Sternberg (1912), G. F. Sternberg (1915), J. S. Stewart (1915), C. M. Sternberg (1924-26, 1946), W. S. Dyer (1925), B. R. MacKay (1927), C. O. Hage (1941), H. H. Beach (1943), A. H. Lang (1943), O. A. Erdman (1944-45), Imperial Oil Limited (1944-45), L. D. Burling (1945), R. J. W. Douglas (1945), and W. A. Bell (1946-47). In addition, the writer is indebted to W. R. Fulton of Drumheller for donations of specimens from the Edmonton formation, and to Roy Fowler, Aldersyde, for specimens from the Paskapoo formation.

Brief descriptions of the formations or broader lithological units containing the plants are presented in the following pages. These descriptions were extracted wholly from published reports, in which it may be seen that some of the units, for example the Brazeau formation, the upper limit of which was originally indefinite, have been redefined on the basis of the stratigraphic sequence beyond the type area.

ABSTRACTS OF PUBLISHED DESCRIPTIONS OF PLANT-BEARING FORMATIONS OR GROUPS

Bearpaw Formation (J. B. Hatcher and T. W. Stanton, 1903, p. 212)

The Bearpaw formation of Canada is an extension of that of Montana, in the United States. The name was originally proposed by Hatcher and Stanton for "dark clay shales with many calcareous concretions immediately overlying the Judith River beds". In central Montana these shales are overlain by the Lennip sandstone, in northwestern Montana by the Horsethief sandstone. In southernmost Alberta, the Horsethief sandstone is represented by the Blood Reserve formation (Russell, 1932a, p. 32), but farther north the latter thins and becomes indistinguishable as a separate formation, and the Bearpaw is defined as being limited above by the Edmonton formation. The lower limit of the Bearpaw in Alberta is the Oldman formation. The Bearpaw formation in the Plains region of Alberta has been recognized as far north as North Saskatchewan River, where it is probably not more than 100 feet thick as compared with more than 700 feet in the south. In the Foothills belt the formation has been recognized little farther north than Highwood River. According to Russell (1932a, p. 27) the typical Bearpaw sediment of Alberta is a "rather dark grey, friable or fissile shale, with weather stains of red, blue or yellow. Beds of sandy shale or true sandstone are not uncommon. Numerous bentonitic beds varying in thickness from mere streaks to 2-foot zones, are distributed throughout the section".

Blood Reserve Formation (Russell, 1932a, p. 32)

The Blood Reserve formation at its type locality on St. Mary River lies above the Bearpaw and below the St. Mary River formations. It is described by Russell as consisting of "very massive, rather medium-grained sandstone, light grey or grey-buff in colour. It commonly weathers to a buff, yellow or greenish tinge. The cement is in places calcareous, in others argillaceous. Crossbedding and irregular concretions commonly are developed, and the sandstone varies from hard to rather soft". It is stated to be about 80 feet thick, but to the north the sandstone thins rapidly, and "on Oldman river only 40 feet could be identified with confidence as Blood Reserve". Russell considered the formation to be of brackish or freshwater origin. To date it has yielded no unequivocal plant remains.

St. Mary River Formation (St. Mary River series, G. M. Dawson, 1883, p. 5)

As defined by Russell (1932a, p. 33), the St. Mary River formation is a "thick series of alternating sandstones and shales, overlying the Blood Reserve (Horsethief) sandstone throughout southeastern Alberta and adjacent Montana. The sandstones are usually hard, massive, medium-grained, and light grey. The proportion of calcium carbonate is relatively high. These sandstone beds are very lenticular. The shales are friable, and poorly bedded and commonly have an appreciable content of sand. Greenish grey is the usual colour, but grey and brown shales also occur. Thin beds of lignite are present in places, especially towards the base of the formation. The repeated alternation of sandstone and shale, and the prevailing light colour of the sediments give a characteristic appearance to outcrops of St. Mary River beds".

The formation thickens from 1,500 to 1,600 feet in the east (Russell, 1932a, p. 34) to 2,700 to 3,000 feet in the western disturbed Foothills belt (Stewart, 1919, p. 40). It carries freshwater molluscs at various horizons, and brackish water species near the base in beds that have generally been regarded as passage beds from the underlying Blood Reserve or Bearpaw formations.

Edmonton Formation (Edmonton coal beds, A. R. C. Selwyn, 1874, p. 50; Edmonton series, J. B. Tyrrell, 1887, p. 127E)

Tyrrell described the formation as "soft whitish sandstones and white or grey, often arenaceous clays, with bands and nodules of clay ironstone and numerous seams of lignite" (Tyrrell 1887, p. 127E)...."The top of the formation is marked by an extensive coal deposit....The bottom of the series lies conformably on the Pierre shales, without any sharp line of demarcation between the two" (ibid., p. 132E). The Pierre shales referred to belong to the Bearpaw formation, and the uppermost coal deposit is now known as the Ardley seam. Williams and Dyer (1930, p. 44) amplify the above descriptions as follows: "The composition of the Edmonton beds varies greatly both laterally and vertically. The formation consists of thin alternating beds of white and pale grey, argillaceous sands, grey and brown clay, arenaceous shales, black carbonaceous shales, and coal. Most of the beds are soft and weather into typical badland forms. There are thin, pure beds of bentonite and many of the sands contain an admixture of fine colloidal clay which may be bentonitic and which renders them very greasy and slippery when wet. There are few sandstone members with the exception of certain hard, flaggy, crossbedded strata that occur in well-defined horizons and being resistant to erosion, form ledges and often cap mesas and buttes in the badlands. Elliptical, sandstone and calcareous concretions, and small, nodular, calcareous concretions coated with red and brown iron oxide are abundant, and on weathered outcrops strew the banks....some bands of hard siliceous shales occur. There are also a few hard bands of calcium and iron carbonate....coal seams are more or less regularly distributed throughout the formation".

The Edmonton almost as far south as Little Bow River is overlain disconformably by the Paskapoo formation. The nature of this contact will be more fully noted in the description of the latter. At the south of Little Bow River the Edmonton in whole or in large part grades laterally into the St. Mary River formation and possibly an upper part grades into the lower part of the Willow Creek formation. North of Little Bow River, presumably as far as Pembina River, the Edmonton formation continues to lie conformably upon the Bearpaw (Russell, 1932b, p. 125; Allan, J. A., and Rutherford, R. L., 1934, p. 24; Feniak, M., 1944, pp. 13-15). Northwest of Pembina River, on Athabaska River and beyond, the Edmonton where present, due to absence of the marine Bearpaw, is separated with difficulty from underlying Belly River strata. A like difficulty, and for the same reason, is met in the Foothills north of township 17, and there stratigraphic equivalents of the Edmonton have at times been included in mappable, thick units, such as that of the Saunders group or of the Brazeau formation.

In the Plains region, the Edmonton has been assigned a maximum thickness of 1,225 feet (Allan, J. A., 1924, p. 38), and a mean of about 1,000 feet.

Brazeau Formation (Malloch, G. S., 1911; redefined, MacKay, B. R., 1943b, p. 13)

The Brazeau formation of the Bighorn coal basin was stated by Malloch to consist "of alternating beds of black and brown shales, with greenish-grey sandstone containing pebbles of chert....The section measured is nearly 1,700 feet, but this does not represent the true thickness of the formation, since the top has been removed by erosion" (Malloch, 1911, p. 38).

It will be noted later, in connection with the Saunders group, that Allan and Rutherford considered their Lower Saunders formation as probably an equivalent of the Brazeau formation. B. R. MacKay at one time went much further, and extended the use of the Brazeau to such a degree that it became synonymous with the whole of the Saunders. He stated that "the Brazeau formation of the Bighorn-Nikanassin basin was found to correspond with that designated as the 'Saunders formation' by Allan and Rutherford in 1923; hence, the earlier designation is here retained" (MacKay, 1930, p. 482). However, it was later found that in some areas at least an equivalent of the Saunders group could be subdivided into formations. Thus, H. H. Beach (1942) made use of the term "Brazeau formation" for the Marble Mountain area. He divided the post-Wapiabi strata of this area into the Brazeau (1,080 to 1,500 feet thick), Edmonton (more than 3,800 feet thick), and Paskapoo formations. He was the first to give an upper boundary to the Brazeau, defining it as "the base of a pebble, locally cobble conglomerate" (Beach, 1942, p. 10). He, furthermore, mentioned certain general criteria that might be utilized to differentiate the Edmonton from the Brazeau, but added that "despite the differences pointed out between the strata assigned to the Brazeau and to the Edmonton much difficulty is experienced in allocating isolated sandstone outcrops to one or the other formation. Certain sandstones of the lower part of the Edmonton are indistinguishable from beds in the Brazeau" (op. cit., p. 11). Beach considered the Brazeau formation as he defined it to be equivalent to, if not synonymous with, the Belly River formation. The cobble-conglomerate used by him to define its summit is obviously not the same as that subsequently used by MacKay to limit the top of a formation, redefined Brazeau, underlying a coal-bearing series (*See* below). Seemingly, geologists working in areas of the Foothills northwest of Marble Mountain were unable to differentiate the Brazeau in such a restricted sense as that employed by Beach.

MacKay (1943b), in a preliminary report on the Foothills belt of central Alberta, also made a threefold division of the Saunders group into Brazeau, Edmonton, and Paskapoo. His use of the term Brazeau in this paper was much more restricted than his earlier use, but more extended than that of Beach. MacKay drew the upper boundary of the Brazeau at the base of a cobblestone quartzite-conglomerate that in the Blackstone River section he considered to lie about 900 feet below the lowest coal seam of his so-called Edmonton. Lang later (1944, p. 2) used a similar conglomerate (Entrance conglomerate) to mark the upper limit of the Brazeau. This definition of the Brazeau formation is still in use by the Geological Survey of Canada. Until recently its age was supposedly all pre-Edmonton; for the overlying coal beds, which are equivalent to those included in the original "Saunders coal series" of Allan and Rutherford, were considered mainly to be Edmonton or older (Allan and Rutherford, 1923, p. 55; Russell, 1932b, Plate 2, p. 145).

The lithology of the Brazeau formation of the Athabaska Valley area was treated fully by A. H. Lang. According to him (1944, pp. 6-7) the formation, about 6,000 feet thick, consists "essentially of interbedded sandstone, shale and conglomerate, with minor bentonitic beds and thin coal seams. The sandstone is generally grey, weathers brown and greenish grey, and some of it has a 'pepper and salt' appearance due to inclusion of small, black, lignitic fragments. The shales are grey and greenish grey. The conglomerate contains small pebbles of grey chert. It forms numerous beds in the lower part of the formation and fewer in the upper part. The uppermost bed of the formation is a distinctive, massive bed of grey, buff-weathering sandstone about 70 feet thick.

"The lowest bed mapped with the Brazeau in this area, is a hard, fine-grained, grey, brown-weathering quartzitic sandstone, which is a very useful horizon marker and which is known locally as the 'Solomon sandstone'... the maximum exposed thickness being 87 feet... It is succeeded by a transitional zone of sandstone and shale, with plant remains, up to 122 feet thick, and this, in turn, is overlain by the lowest conglomerate bed of the Brazeau formation. The Solomon sandstone and the overlying transitional beds have been included with the Brazeau formation.

"The upper part of the formation contains Upper Cretaceous plant remains at several horizons and from a bed near Entrance Mr. R. C. Sibley, of Entrance, has collected several dinosaur bones... The massive sandstone bed at the top of the Brazeau is overlain by a distinctive bed of conglomerate about 20 feet thick that is used to mark the base of the Edmonton[1] in this area... The term 'Entrance conglomerate' is proposed for the conglomerate".

The dinosaur bones recorded by Lang were identified by Barnum Brown as a tooth, probably of *Gorgosaurus libratus*, and a toe bone, probably of *Corythosaurus casuarius?*. These remains, which, however, were stated to show evidence of 'wash accumulation', were believed to belong to Belly River genera.

Erdman (1945, p. 12) considered the Entrance conglomerate to lie about 675 to 800 feet stratigraphically below the base of the coal-bearing zone at Alexo and Saunders, or in a stratigraphic position comparable with that of the conglomerate on Blackstone River used by MacKay to limit the Brazeau.

Saunders Group (Allan, J. A., and Rutherford, R. L., 1923; Saunders formation, Allan and Rutherford, 1924)

The type area of this group is the Saunders and Nordegg coal basins. The beds were first defined as a group of three formations, totalling 11,000 feet or more thick, conformably overlying the marine Wapiabi formation. For descriptive purposes the group was divided into *Lower Saunders* formation, *Saunders coal series*, and *Upper Saunders* formation.

Describing the Lower Saunders formation, 5,500 to 6,000 feet thick, Allan and Rutherford (1923, pp. 52-53) state that: "The lower members consist of alternating beds of sandstones and shales. Both the sandstone and shale members range up to over 50 feet in thickness. The sandstones are fairly well cemented, light grey to buff in colour, and of medium grain. Scattered lenses of conglomerate frequently occur associated with the sandstone. Crossbedding is prevalent, but the curve of the crossbedded structure is usually short, averaging about 10 inches in length. The interbedded shales are quite siliceous and break with angular blocks... These shales frequently weather to dark browns and greens... About 1,800 feet from the top of the formation a few small coal seams occur, ranging up to one foot in thickness. These are overlain by massive sandstones and clay shales, which continue to the top of the formation, where they are in contact with coal seams of commercial thickness. The upper part of the formation differs from the lower in that the sandstones are coarser grained, more highly crossbedded, and lenticular in lateral extent. Many beds of sandstone enclosing clay pellets occur in this part of the formation... The

[1] Later (Lang, 1947b, p. 4) placed in Paleocene.

upper limit of the lower Saunders formation has been placed at the horizon where coal seams of commercial thickness occur". The authors state further (op. cit., p. 51) that: "The lower Saunders formation in all probability corresponds with what Malloch has called the 'Brazeau formation' in the Bighorn basin", and "from the stratigraphic position and preliminary palæontological evidence the lower Saunders formation is lower Montana in age and is correlated with the lower Belly River beds in central Alberta and with the Allison formation of the Crowsnest district" (op. cit., p. 53).

According to Allan and Rutherford the *Saunders coal series* "includes beds that separate the upper and lower Saunders formations (op. cit., p. 54)... No definite statigraphic horizons can be taken as the top and the base of the Saunders coal measures, as the beds change gradually upwards and downwards into the upper and lower Saunders formations respectively" (op. cit., p. 61). The coal-bearing beds were assigned a thickness of about 170 feet.

The Upper Saunders formation was described as follows: "The lower part of this section begins with light grey massive sandstones and coal seams interbedded with clay shales. The members are comparatively thick, the sandstone members vary up to 100 feet and the shale beds 50 feet in thickness... These thick members consist of sandstone, coarse grained, light grey and buff in colour. The cementing material is not as strong as it is in the massive sandstone members in the lower Saunders formation. In many cases lenses of conglomerate occur within the sandstones. Frequently the sandstone member begins with a layer of clay pellets cemented with sandstone. Rising stratigraphically the amount of clay shale increases and sandstone diminishes... The upper part of this formation is dominantly clay shale interbedded with fine grained argillaceous sandstones, and occasionally large lenses of coarser sandstone occur... The upper limit of this formation has not yet been determined in these areas" (op. cit., pp. 53-54). The exposed beds were estimated to be about 6,000 feet thick.

As a result of later work, in areas north of the Saunders coal field, Allan and Rutherford could find no satisfactory basis for retaining the subdivision of the Saunders group in three formations, and referred the whole series to a "Saunders formation", which was differentiated only into a lower and upper member. The underlying basis for this new concept was an increase in the thickness and number of coal seams in the northern areas within that part of the series formerly designated the Lower Saunders formation (Allan and Rutherford, 1924, p. 34). Altogether, five coal-bearing zones were now recognized within the formation, widely separated stratigraphically. Of these the lower four zones were placed in the lower member of the formation, and only the uppermost of these was correlated with the "Saunders coal series". Lithologically the clastic beds of both members were stated to be similar, except that the beds of the lower member were on the whole better cemented, a factor ascribed to greater overlying weight of sediment. Subsequently Rutherford tended to emphasize this difference in lithology, for he stated that "There is a difference in lithological character between the basal and upper strata, but any changes are gradational, so it has all been mapped as one formation. There is, however, a possibility of the youngest beds of this series being younger than Cretaceous age, but definite evidence of this has not yet been obtained" (Rutherford, 1925, p. 9). Again: "While...the formation cannot be readily divided into two or more divisions based on lithology, the upper strata of the formation are quite easily distinguishable from the beds near the base of the formation. The upper beds are in general much softer, not so well consolidated and more often of a yellowish to brownish colour, whereas the basal beds, especially the sandstones, are usually light grey or greenish grey in colour" (Rutherford, 1925, p. 45). In this later report Rutherford drew attention for the first time to a conglomerate member, lying at a high horizon within the group, as follows: "In one locality a bed of these large pebbles is rather extensive, and forms a coarse pebble conglomerate that in part caps High-Divide ridge in township 50, ranges 24 and 25. The pebbles in this bed average from two to six inches in diameter, and are poorly cemented with fine sand... A section of this conglomerate exposed at the north end of the ridge shows it to be at least 50 feet in thickness. The conglomerate is high in the Saunders formation, and is very similar in appearance to a conglomerate that occurs in the Saunders beds on the ridge top, east of Sterco on the Alberta Coal Branch in township 47, range 20. The two conglomerate beds cannot be correlated other than both are stratigraphically high in the Saunders formation, but there is nothing in their lithology that is not common to other strata of the Saunders, except that they represent local thick aggregations of material that is much coarser than the average of the Saunders beds" (op. cit., p. 46). A possible Tertiary age for the upper member or for a part of it was again suggested (op. cit., p. 48). Although this conglomerate was considered by Lang (1947b, p. 35) to be only local in distribution, its horizon seemingly is approximately equivalent to that of the base of the Paskapoo in Red Deer Valley. For a concise summary of the history of investigations of these late Cretaceous and early Tertiary sediments the reader is referred to a recent publication by Lang (1947b, pp. 30-36).

The reports of Allan and Rutherford and later work of MacKay, Crombie, Erdman, and Lang show that the "Saunders group" may yet be a convenient lithological term to retain where it is not possible to subdivide the late Upper Cretaceous and Paleocene strata into formations. Where such subdivision is practical the lower member, as high stratigraphically as the base of the Entrance conglomerate, can most conveniently be included in the Brazeau formation.

Wapiti Group (Wapiti River sandstones, Wapiti River group, G. M. Dawson, 1881, pp. 115, 124, 128)

This group was defined by Dawson for the Peace River area as "upper sandstones and shales with lignite coals", overlying dark shales that he named "Smoky River shales". In the type area of the lower part of Wapiti River the series was stated to consist of "sandstones, generally soft and flaggy, shaly sandstones, shales and clays. The sandstones are often nodular, and hold bands and sheets of ironstone, together with coaly fragments and obscure fossil plants. They are yellowish or greyish, or bluish-grey in tint, while the shales and clays have often a brownish earthy appearance...it would appear that at least one bed of soft rusty conglomerate is included in it. The pebbles in this are composed chiefly of Rocky Mountain quartzites... The total thickness of beds exposed belonging to this subdivision, is not great, probably not more than 200 to 300 feet" (Dawson, 1881, p. 124).

In the area of Lower Smoky River, F. H. McLearn (1919) defined the Wapiti beds as follows: "The Wapiti succeeds the Smoky River and in the section studied, 900 feet of it are exposed; its upward extension is not known. It is a cliff-marker and is intermittently exposed from Bezanson almost to the mouth of Bad Heart river. The sandstone beds are thick, massive and crossbedded. They contain rootlets and in places, flat concretions. The shales vary from a couple of feet to over 50 feet in thickness, are grey to dark carbonaceous, and show vertical rootlets. A coal bed with a maximum thickness of 4 inches occurs 580 feet above the base, and a second coal seam 3 inches to 4 inches thick, 180 feet above the base. This formation is evidently of subaerial origin" (McLearn, 1919, p. 5C). According to McLearn the base of the Wapiti, so far as its stratigraphic position is concerned, could be equivalent in age to that of the Foremost and Oldman formations.

R. L. Rutherford (1930) later gave fuller descriptions of the formations. "Lithologically the Wapiti formation consists of sandstones and shales of fresh-water deposition. The units vary in thickness being more often 10 to 20 feet. All phases of gradation between sandstone and shale are common. The more massive sandstones are frequently crossbedded and concretionary masses are common in eroded faces. Light grey and buff are the prevailing colours, and on the whole fine grained textures are most common. The shales are poorly stratified... It is not possible to divide the Wapiti into definite lithological units from data obtained thus far. The lower 150 to 200 feet are predominately argillaceous, consisting of compact, poorly stratified clay shales that weather to variegated colours. Thin bands of clay ironstone nodules are common in these, and a thin coal seam ranging from a few inches up to 2 feet in thickness occurs, wherever these lower beds are exposed... The upper Wapiti beds have been removed from this area by erosion, but in adjacent districts the Wapiti is at least 1,100 feet thick... No invertebrate fossils were collected from the Wapiti beds. It is of interest to note that a few fragmentary vertebrate bones, probably dinosaurian, were found in the lower Wapiti in section 16, township 76, range 5, west of 6th meridian... The Wapiti formation, at least the lower part, is considered the stratigraphical equivalent of the Belly River formation in the plains and foothills of the southern half of Alberta, and is Montanan in age" (op. cit., p. 31).

In the Grande Prairie area Rutherford tentatively considered that 1,100 feet of beds assigned to the Wapiti were equivalent in age to the Belly River (Rutherford, 1930, pp. 32, 58). At least 250 feet of higher beds, correlated by him with the Edmonton formation, are stated to occur in the Swan and Kleskun Hills. From this report it is not clear whether Rutherford included these last mentioned beds within the Wapiti formation. Later, however, they were presumably so included, for Allan and Rutherford state that "the Edmonton is extended west across the Smoky through the Grande Prairie district where the upper part of the Wapiti is correlated with the Edmonton on a lithological basis... Exposures showing these lithological characteristics occur along Wapiti and Red Willow rivers south and west of Grande Prairie and especially in the badland type of erosional forms in the eastern part of the Kleskun Hills in township 72, range 4, west of the 6th meridian" (Allan and Rutherford, 1934, p. 24).

C. S. Evans and J. F. Caley (1930, p. 38) regarded strata of Nose Mountain in tps. 63 and 64, rge. 11, W. 6th mer., as belonging to the Wapiti. The formation is described as "sandstone and shale and some coal seams. The sandstone on fresh fracture is light grey and it varies from medium to coarse grain. It is crossbedded and contains bone fragments in many places. Along Wapiti River it weathers to a cream colour and in many places presents a semi-detached, pillar-like structure. On Pinto Creek this form of weathering is less common and the colour is darker. The shale is mostly greenish grey, shows little evidence of bedding, and crumbles easily when weathered...the thickness of this formation was not determined; that part of it exposed between Wapiti River and Nose Mountain is estimated to be 1,100 feet thick".

J. A. Allan and J. L. Carr (1946, p. 14) divided the Wapiti into five members, of which the lowermost, 1,100 to 1,300 feet thick, comprises beds that have tentatively been considered to be equivalent in age to a part of the Belly River formation. The upper four members, totalling about 3,000 feet thick, consist of interbedded sandstone, shale, and coal, with many thin beds of bentonite. The lower half of this section furnished some dinosaur bones. The remainder, exposed mainly on Nose Mountain, has provided so far only plants and invertebrates.

Post-Brazeau, Paleocene Beds

Strata overlying the Brazeau formation, 5,000 feet or more thick, were grouped together until recently as "Edmonton and Paskapoo". They comprise also an upper part of the Saunders group of Allan and Rutherford. Russell (1932b, pl. 2, p. 145) tentatively carried the base of the Paleocene well down into the Saunders group, suggesting that the age of the "Saunders coal series" was "Edmonton or Bearpaw at the oldest" (op. cit., p. 147). He thus considered the greater part of the original "Upper Saunders formation" to be Paleocene in age, and more definitely dated a mammalian tooth, which was collected from a bed lying about 1,000 feet above the Saunders coal series, as not older than Middle Paleocene.

B. R. MacKay (1943b, p. 4) made a subdivision of post-Brazeau beds into Edmonton and Paskapoo. He stated: "overlying the Edmonton beds in the northern part of the map-area, without any apparent erosional unconformity, is a series of coarse, brown-weathering sandstones, conglomerates and earthy shales that, on the uplands of Wawa Creek, weather into large, fantastically shaped 'hoodoos'. Lithologically and in their general appearance these beds closely resemble the massive basal strata of the Tertiary, Paskapoo formation of the Fallentimber area farther south and have been correlated with them". The so-called Edmonton division of these post-Brazeau strata were estimated to be about 3,000 feet thick.

Lang (1944, p. 7) described the post-Brazeau beds as follows: "Overlying the Entrance conglomerate is a thick succession of relatively soft, interbedded sandstone and shale, with minor pebble beds and bentonite beds, at least two commercial coal seams, and several minor seams. The sandstone is rather coarse, and weathers grey, brown, and green; much of it is crossbedded. The shale is generally greenish grey and clayey".

Neither Lang, Crombie, nor Erdman at first found satisfactory evidence to subdivide the post-Brazeau strata into formations, although the presence of Paleocene plant beds was noted (Crombie and Erdman, 1945; descriptive notes). But in a later preliminary report on the Entrance map-area Lang (1945, p. 6) subdivided the post-Brazeau into Edmonton (about 3,500 feet thick) and Paskapoo. Although this division was based at first not on lithology but on the presence of Paleocene plants in beds above 3,500 feet, Lang drew attention to a cobble-conglomerate on High Divide ridge at an horizon about 3,500 feet above the Entrance conglomerate or base of the post-Brazeau beds. Still later Lang (1947b, p. 4) considered the Entrance conglomerate to mark the base of the Paleocene.

The present report includes the description of plants from that lower part of the post-Brazeau sequence that was designated Edmonton in the earlier reports of MacKay and Lang. These plants, as will be noted later, are considered to be Paleocene.

Willow Creek Formation (Willow Creek beds, G. M. Dawson, 1883, p. 3)

Dawson originally defined the Willow Creek formation as "reddish and purplish clays, with grey and yellow sandstones" (1883, p. 4). Later (1884, p. 67) he amplified this description by stating that the beds comprise "pale purplish, reddish and greenish grey clays or sandy clays, with soft sandstones and occasional bands of ironstone. The bedding is uniform and regular, and the whole series has a soft character, which causes it in some places to weather with miniature bad-land forms. In some clayey layers, peculiar whitish-weathering, irregularly reniform, and generally small sized concretions abound". These concretions, it may be added, consist of lime carbonate, and are similar to cornstone or *kunkur*. Limestone is also rarely present as thin beds (Stewart, 1919, p. 44).

Dawson and all later authors noted that the reddish beds were particularly characteristic of a southern area, drained by St. Mary, Belly, and Waterton Rivers. They are also present, mainly in the lower part of the formation, on Oldman River. But the upper part of the formation, as exposed on Willow Creek west of Granum and to the contact with the overlying Porcupine Hills formation, contains very few reddish or maroon beds, and these only in thin bands or zones in dominantly grey or dark grey siltstones and silty mudstones. Williams and Dyer (1930, p. 59) noted some reddish shale on Mosquito Creek and as far north as Nanton, and several thin, maroon beds were noted by the writer on Mosquito Creek in secs. 33 and 34, tp. 15, rge. 27, W. 4th mer. But the containing strata on Mosquito Creek are mapped on the Calgary sheet (204A) as Paskapoo, and they exemplify the lateral passage of the upper part of the Willow Creek formation into the Paskapoo formation. The Upper Willow Creek beds, in addition to prevailing grey colours, differ from the lower in the presence of more numerous beds of sandstone, some of which weather yellowish or buff. Such beds become thicker and commonly harder and more resistant to erosion towards the contact with the overlying Porcupine Hills formation, and the boundary between these two formations in the east limb of the Alberta syncline is, consequently, generally indefinite and arbitrarily drawn (Williams and Dyer, 1930, p. 59).

The writer would draw a division between a lower and upper part of the Willow Creek formation along a line running west of Granum from

NE. ¼ sec. 112, tp. 10, rge. 27, W. 4th mer., to Little Bow River at NE. ¼ sec. 28, tp. 14, rge. 25, W. 4th mer. The basal bed of the upper division, which outcrops at the foregoing localities, is a medium- to coarse-grained, crossbedded sandstone characterized by lenses of conglomerate carrying cobbles of quartzite and more rarely of dark limestone and reddish granitic rock. This boundary, extended 5 miles to the northeast, would coincide, west of Champion, with the generally accepted boundary between the Edmonton and Paskapoo formations (*See* Map 204A). However, an alternative allocation of the whole of the Willow Creek formation to the Tertiary (Russell and Landes, 1940, p. 93) cannot at present be invalidated on fossil evidence.

The Willow Creek beds east of Porcupine Hills seemingly undulate at low angles, and lack of diagnostic horizons to correlate beds in the scattered outcrops precludes reliable estimates of thickness. Williams and Dyer (1930, p. 59) give the thickness here as 1,000 feet. Russell (1940, p. 93) increases this by 200 feet by including grey sandstone beds at the base, which the writer considers, as did Williams and Dyer, to belong to the St. Mary River formation, for they contain roots of *Equisetum perlaevigatum* in common with St. Mary River beds below.

According to Douglas (1947; descriptive notes) the contact of the Willow Creek formation with the St. Mary River formation is transitional, whereas the upper contact with the Porcupine Hills formation is an erosional disconformity. This disconformity was earlier emphasized by Douglas (1946; descriptive notes), who stated that "the relationships of these formations in this map-area (Callum Creek) and in the Langford Creek map-area to the north show that the Porcupine Hills and Paskapoo formations are stratigraphic equivalents, and that an erosional disconformity of considerable magnitude separates the Porcupine Hills-Paskapoo formations from the underlying Willow Creek-St. Mary River-Edmonton formations. This would appear to indicate a late Upper Cretaceous age for the Willow Creek formation, although previous determinations on fossils collected from these beds have suggested a Paleocene age". In view of the palæontological evidence and the transitional relationships existing in the opposite or eastern limb of the Alberta syncline, the writer would not accept the apparent disconformable relationship in the western limb as evidence for drawing the boundary between the Upper Cretaceous and Paleocene. The Porcupine Hills formation is interpreted to be an alluvial deposit, and if so its base might be expected to transect the underlying Willow Creek formation with pronounced, local, erosional features. That the position of the contact between the Porcupine Hills and Willow Creek formations, in some places at least, in the western as in the eastern limb of the syncline might depend on the viewpoint of the observer is evident from the rock section at the junction of Crowsnest and Oldman Rivers. The writer would place this contact on Oldman River about 600 feet east of its junction with the Crowsnest at the base of a thick, crossbedded sandstone, which has a pebbly bed at its base carrying well rounded, quartzite pebbles up to 1 inch long, whereas C. O. Hage (1945) placed the contact more than half a mile to the west. That the presence of maroon bands is not in itself a reliable criterion for the recognition of the Willow Creek formation is attested by the presence of two, thin, but well defined, maroon bands carrying small limestone concretions in the Porcupine Hills formation on Oldman River near the centre of sec. 35, tp. 7, rge. 1, W. 5th mer.

Freshwater molluscs occur at scattered horizons in the upper part of the Willow Creek formation, and these, according to Russell (Russell and Landes, 1940, p. 93), indicate a Paleocene age for that part.

Porcupine Hills Formation (Porcupine Hills series, G. M. Dawson, 1883, p. 4)

The Porcupine Hills formation is differentiated from the underlying Willow Creek formation by the dominance of thick sandstone beds, which are generally more strongly crossbedded and harder than those of the Willow Creek. Williams and Dyer (1930, p. 62) described the beds as consisting "mainly of fine-grained, crossbedded, light grey ledge-making sandstones, with interbedded shaly clays. The ledge-making sandstones are the most markedly crossbedded sediments found in southern Alberta, the true bedding being determined with difficulty.....No true conglomerates were seen but some beds of conglomeratic sandstone with clay and sandstone pellets were found, and mudcracks and ripple-marks occur. The sandstone commonly weathers with brown colours". Lenses of conglomerate do occur locally at or near the base of the formation, for the writer noted a 5-foot pebble bed at the base of a thick sandstone in the east bank of Oldman River above its junction with Crowsnest River. The pebbles, generally not more than an inch in diameter, consist of well rounded grey quartzite. The main sandstone bed, which is at least 50 feet thick, also has lenses of conglomerate carrying limestone nodules or pebbles that are apparently concretions and of intraformational origin, although they may have been derived from erosion of *kunkur*-bearing siltstones and mudstones of the Willow Creek formation. This sandstone is considered by the writer to be the basal bed of the Porcupine Hills formation, for the underlying strata, which include bands of dark, silty mudstones, resemble upper beds of the Willow Creek formation. As this interpretation would place the Porcupine Hills contact at this place more than half a mile farther east than where mapped on the Cowley sheet, it illustrates the difficulty of mapping a boundary in some localities between the two formations.

R. G. McConnell (in G. M. Dawson, 1884, p. 96) and J. S. Stewart (1919, p. 46) assign a thickness of about 2,500 feet to the Porcupine Hills formation, without any upper rock contact. North and northwest of Claresholm, the Porcupine Hills formation, and apparently an upper part of the Willow Creek formation, grade insensibly into the Paskapoo formation, beds of transitional character between Willow Creek and Paskapoo lithology being exposed on Mosquito Creek as far west as Nanton. One bed worthy of special note outcrops on the north side of Mosquito Creek in SE. ¼ sec. 33, tp. 15, rge. 27, W. 4th mer. It is a 5-foot bed of hard, impure limestone with lime nodules, probably algal in origin, and a few unios. A little lower in the exposed section, a thin, maroon band is interbedded with grey sandstones, siltstones, and mudstones, some of which carry abundant lime concretions.

Paskapoo Formation (Paskapoo series, J. B. Tyrrell, 1887, pp. 127, 135-138)

The Paskapoo formation was originally intended to include "all Laramie rocks lying above those of the Edmonton series" (Tyrrell, J. B., 1887, p. 135E) and was defined as follows:

"The beds consist of more or less hard, light grey or yellowish, brownish weathering sandstone, usually thick-bedded, but often showing false bedding; also of light bluish-grey and olive sandy shales, often interstratified with bands of hard, lamellar, ferruginous sandstone, and sometimes with bands of concretionary blue limestone. . . the sandstones consist of very irregular, though slightly rounded, grains of quartz, feldspar, and mica, cemented together in a calcareo-argillaceous matrix" (Tyrrell, J. B., 1887, p. 136).

The Paskapoo of the type area of Blindman River (formerly Paskapoo River) has scattered, thin, carbonaceous or coal seams. Tyrrell (1887, p. 83) recorded a 5-inch seam of lignite on Blindman River, which he estimated to lie about 300 feet above the base of the formation, and G. M. Dawson (1884, p. 83) previously had noted one or two thin coals, a few inches thick, on the lower part of Highwood River. But west of Edmonton in central Alberta thicker coals begin to make their appearance. Thus, Tyrrell (1887, pp. 106, 148) recorded a coal seam, 8 to 15 feet thick, on North Saskatchewan River, outcropping in tps. 49 and 50, rges. 6 and 7, W. 5th mer., which was estimated to lie about 400 to 500 feet above the base of the Paskapoo formation. In this area as well as on Blindman River, the Paskapoo rocks form part of the northeastern limb of the Alberta syncline. Farther west, in the southwestern limb of this syncline, workable coals of good quality and thickness occur in the Coalspur area and to the southeast in the Saunders area. Although these last-mentioned coals belong to an older stage in the Paleocene than the Paskapoo beds on Blindman River, the lithology of the sediments associated with them has not changed sufficiently to remove the stage on that basis alone from the Paskapoo formation. Their differentiation from the Paskapoo must be based either on the additional fact that they include coal seams of workable size, or on the impracticability of mapping them separately from underlying beds that differ in lithology from the Edmonton formation. They were in fact at first included by Allan and Rutherford in a comprehensive Saunders formation, as noted in a previous section of this report.

The contact of the Paskapoo with the Edmonton formation is a disconformable one, and evidence has been presented that the disconformity locally represents an erosion of as much as 450 feet of Edmonton strata. The disconformable contact was first discovered by Sanderson in 1924 (Allan, J. A., and Sanderson, J. O. G., 1925, p. 161; ibid., 1945, p. 36). Allan and Sanderson also noted a marked difference in lithology between Paskapoo and Edmonton sandstones; for "the coarser constituents of the Edmonton are mainly highly angular, relatively unaltered, plagioclase fragments, and milky, angular, quartz grains" (op. cit., 1945, p. 55). In contrast with this arkosic constitution of the Edmonton sediments, samples of Paskapoo sandstone showed that "quartz grains constitute the bulk of Paskapoo sands; feldspars are present in small amount, and are usually highly decomposed. Shale, lime, chert, and quartzite fragments make up an important percentage of typical Paskapoo sandstone" (op. cit., 1945, p. 97). As to grain size "the clastics of the Edmonton possess remarkable uniformity in one respect, no grains over 1 mm. in diameter have been observed in the many samples which the writer (Sanderson) has analysed. The whole formation is composed of remarkably fine-grained clastics" (op. cit., p. 65). Recently, however, C. M. Sternberg pointed out that the above remarks apply only to differences between the Paskapoo and that part of the Edmonton lying below the Kneehills tuff. Sternberg recorded that "a large proportion of the Upper Edmonton is composed of fairly well sorted, moderately coarse sandstone. Moreover, three samples, taken from different localities and horizons, show that much of the material is quartz, whereas in Sanderson's samples feldspar predominates. On the other hand samples of Paskapoo sandstone collected and analysed by Sanderson show a close similarity to those collected by the writer, as to sorting, grain size, and the predominance of quartz" (Sternberg, C. M., 1947, p. 8).

From the above observations it is evident that where an erosional surface is not detected there might be difficulty in separating Paskapoo from the upper part of the Edmonton. Thus, G. S. Hume noted in the Turner Valley area that "in most places any attempt to fix precisely the boundary between the Edmonton and Paskapoo yields rather unsatisfactory results. As stated by Slipper, the greenish mudstones and sandstones of the Edmonton grade upwards into the more massive and light-coloured sandstones of the Paskapoo" (Hume, 1927, p. 7). Locally, however, according to Hume, "a conglomeratic sandstone, with quartzite pebbles up to 3 inches in diameter, is exposed at what is considered the base of the Paskapoo. Below the conglomeratic sandstone is green clay shale presumed to be Edmonton" (op. cit., p. 2). Williams and Dyer recorded similar conglomeratic layers at the base of the Paskapoo on Bow River, about 7 miles west of Gleichen (1930, p. 46), and another outcrop was seen by the writer on East Arrowwood Creek. Lenses of conglomerate of this character in sandstone of freshwater deposits would not generally be considered specifically significant, but their widely scattered, local presence in the basal beds of the Paskapoo formation may assist in tracing that horizon. The occurrence and apparent significance of such conglomerate within the Willow Creek formation near Granum are noted elsewhere in this report in the description of that formation.

Slipper (1919, p. 14) assigned a thickness of 3,000 feet to the Paskapoo formation in southern Alberta, whereas Tyrrell recorded more than 5,700 feet on Little Red Deer River. The formation is undoubtedly thickest in the area bordering the Foothills in central Alberta, and an unknown part has been removed by Tertiary erosion.

SPECIFIC FLORAS

Summary

The Bearpaw formation has yielded only a single identifiable plant species, which occurs also in a lower part of the Edmonton formation. Plants from the St. Mary River are largely aquatic; those from the upper half of the formation correlate best with the Whitemud flora. The Edmonton formation carries two floras, which lie respectively below and above the Kneehills tuff member, which has been correlated lithologically with the Battle formation of southeastern Alberta and Saskatchewan. The lower flora indicates an age approximating that of the Fox Hills and lower part of the Medicine Bow formation of the United States, whereas the Upper Edmonton flora is correlated with the Lance formation. No specifically identified plants have been obtained from the lower part of the Brazeau formation; those from the uppermost Brazeau indicate a probable correlation with an upper part of the Lower Edmonton, although it is possible that an equivalent of the Upper Edmonton may be present. A like correlation is made for the plants that have been gathered from the Wapiti formation. The flora of the post-Brazeau beds shows little difference from that of the Paskapoo formation and is considered to be definitely Paleocene. Vertebrate and stratigraphic relations, however, both testify that the flora should belong to an earlier stage in the Paleocene than the Paskapoo, and the presence of *Dombeyopsis nebrascensis*, which has survived from the Upper Cretaceous, is in agreement with this. The upper part of the Willow Creek formation has provided a few plants that are also considered to be Paleocene. The precise age of the lower part of the Willow Creek cannot, from lack of palæontological evidence, as yet be evaluated, but from field relations the writer tentatively considers an uppermost Cretaceous age more probable. The Paskapoo flora is considered to be approximately the same age as the Ravenscrag flora of southeast Alberta and Saskatchewan. Only thirty-seven species have been differentiated, and of these less than 20 per cent range downwards into Cretaceous formations. Graphically, the correlations thus summarized are expressed in the following table.

Correlation Table

	Plains of southwest Alberta	Plains of southeast Alberta	West-central Alberta: Plains	West-central Alberta: Foothills (Saunders and Wapiti groups)	Eastern Montana, U.S.A. (in part)	Characteristic plants	Ages
Paleocene	Porcupine Hills — erosion —	Ravenscrag	Paskapoo — erosion —	Paskapoo and post-Brazeau beds	Fort Union	*Viburnum asperum* *Platanus basilobata* *Dennstaedtia blomstrandi* *Onoclea hebridica* *Androvettia catenulata* *Elatocladus nordenskioldi*	Thanetian
	Willow Creek (upper) ↑			Entrance conglomerate			Montian?
Upper Cretaceous	Willow Creek (lower)	Frenchman — erosion —	Edmonton: Upper	Brazeau	Hell Creek — erosion —	*Anona robusta* *Fraxinus leii*	Danian
	St. Mary River	Battle	Edmonton: Kneehills tuff		Fox Hills: Colgate member	*Nilssonia serotina* *Nymphaeites striatus* *Elatocladus intermedius* *Torreyites tyrrellii*	Maestrichtian
		Whitemud	Edmonton: Lower		Fox Hills		
		Eastend					
	Blood Reserve	Bearpaw: Oxarart member					
	Bearpaw	Bearpaw	Bearpaw		Bearpaw		
	Belly River	Oldman	Oldman		Judith River		Campanian
		Foremost	Foremost				
		Pakowki	Lea Park		Claggett		
		Milk River			Eagle		

Flora of Bearpaw Formation

The Bearpaw formation is marine and has yielded only a single plant species, namely *Torreyites tyrrellii.* It occurs also in the lower part of the Edmonton formation, and apparently does not range into higher horizons.

Flora of St. Mary River Formation

The known flora of the St. Mary River formation consists of:

Equisetum perlaevigatum Cockerell
Adiantum ? paululum Bell
Carpolithus (Cycadinocarpus?) ceratops (Knowlton)
Elatocladus intermedius (Hollick)
Thuites interruptus (Newberry)
Dombeyopsis nebrascensis (Newberry)
Nymphaeites angulatus (Newberry)
N. striatus (Berry)
Antholithes (Nymphaeites?) marsilioides Bell
Leguminosites stagnum Bell
Typa sp. Dorf

This florule was gathered from the formation in the Callum Creek map-area of the Foothills belt where it has a computed thickness of 3,100 feet. Although diagnostic species are too few to lead to reliable judgment on the precise age, there is nothing to indicate an age earlier than that of the Whitemud formation for the upper half of the formation. Plants gathered from the lower 1,400 feet of the formation are too long ranging for precise age correlation. The Whitemud flora is represented in the upper part of the formation by *Equisetum perlaevigatum*, *Elatocladus intermedius*, *Thuites interruptus*, and *Nymphaeites striatus*. *Carpolithus ceratops*, although extremely rare, was collected from an horizon estimated to lie about 2,760 feet above the base of the formation. Its presence suggests that the St. Mary River may possibly range upward to beds that are equivalent to the lower part of the Frenchman (or Lance). On the other hand, only a single specimen of this species has been gathered from the St. Mary River, and the mere presence of this species there should not be overstressed in correlation, so that there is as yet no satisfactory evidence that the St. Mary River formation ranges as high stratigraphically as the Upper Edmonton. Of the 11 species enumerated above, 4 are held in common with the Lower Edmonton flora. These are *Equisetum perlaevigatum*, *Elatocladus intermedius*, *Thuites interruptus*, and *Nymphaeites angulatus*.

Flora of Edmonton Formation

Our knowledge of the Edmonton flora as a whole is rather scanty at present. The known flora is limited to about 24 species, distributed among 14 families and 20 genera. Equisitae are represented by 1 species, ferns by 1, cycadophytes by 3, ginkgophytes by 3, conifers by 6, and dicotyledons by 10. Of the conifers *Sequoiites* and *Elatocladus intermedius* are particularly abundant in the lower part of the formation. Among dicotyledonous trees *Platanus* is a common genus in the upper part of the formation. *Dombeyopsis* and *Vitis* are plentiful and widespread in the lower part, but, if the species concerned are correctly referred to these genera, they are presumably climbing plants and not arboreous. The presence of brackish water beds within the formation indicates a coastal plain environment, and this explains a widely scattered distribution of water plants.

Species so far identified comprise the following:

Equisetum perlaevigatum Cockerell
Filicites knowltoni Dorf
Nilssonia sp.
N. serotina Heer
Ginkgoites sp.
Carpolithus (Ginkgoites?) fultoni Bell
C. (Ginkgoites?) kneehillensis Bell
Torreyites tyrrellii (Dawson) n. comb.
Cunninghamiostrobus? sp.
Sequoiites artus Bell
S. dakotensis Brown
Elatocladus intermedius (Hollick)
Thuites interruptus (Newberry)
Platanus raynoldsii integrifolia Lesquereux
Platanophyllum sp.
Trochodendroides arctica (Heer)
Jenkinsella arctica (Heer) n. comb.
Anona robusta Lesquereux
Dombeyopsis nebrascensis (Newberry) n. comb.
Nymphaeites angulatus (Newberry) n. comb.
N. striatus (Berry) n. comb.
Vitis stantoni (Knowlton) Brown
Fraxinus leii Berry

The flora of the Edmonton formation, meagre as it is, may be divided into two sub-floras, one occurring above the Kneehills tuff bed in the upper Edmonton, the other below this bed in the remaining lower part of the Edmonton.

The flora of the lower part of the Edmonton has 18 species, namely:

Equisetum perlaevigatum
Nilssonia sp.
N. serotina
Ginkgoites sp.
Carpolithus (Ginkgoites?) fultoni
C. (Ginkgoites?) kneehillensis
Torreyites tyrrellii
Cunninghamiostrobus? sp.
Sequoiites artus
S. dakotensis
Elatocladus intermedius
Thuites interruptus
Juniperites gracilis
Trochodendroides arctica
Jenkinsella arctica
Dombeyopsis nebrascensis
Nymphaeites angulatus
Vitis stantoni

Probably none of these species, taken singly, is of value for precise age determination, although the assemblage as a whole is most characteristic of formations having an age approximately that of the Fox Hills and lower part of the Medicine Bow formation of the United States. Some of the species are of value for correlating other formations, as, for example, the Brazeau within the province. The most important species for this purpose are: *Equisetum perlaevigatum*, *Nilssonia serotina*, *Sequoiites artus*, *Elatocladus intermedius*, and *Dombeyopsis nebrascensis*. Fortunately, the age of the Lower Edmonton is fixed by that of a Lance equivalent above and of marine Bearpaw below.

The Upper Edmonton flora comprises:

Filicites knowltoni
Carpolithus (Cycadinocarpus?) ceratops (Knowlton)
Sequoiites dakotensis
Platanus raynoldsii integrifolia
Platanophyllum sp.
Anona robusta
Nymphaeites angulatus
Vitis stantoni
Fraxinus leii

Of these 9 species, 3, namely *Sequoiites dakotensis*, *Nymphaeites angulatus*, and *Vitis stantoni*, occur in the lower part of the Edmonton. They are long-ranging forms and useless for refined age correlation. *Platanus raynoldsii integrifolia* is probably also too long-ranging to be of much value, although it may be possible to differentiate it as a distinct specific form from *Platanus raynoldsii* of the Paleocene. There remain only four diagnostic species, viz.: *Filicites knowltoni*, *Carpolithus ceratops*, *Anona robusta*, and *Fraxinus leii*. These are all characteristic forms in the Lance formation, and two of the most diagnostic forms, *Carpolithus ceratops* and *Fraxinus leii*, occur in the Frenchman formation. It is concluded, therefore, that the upper part of the Edmonton formation is equivalent in age to that of the Lance.

Flora of Upper Part of Brazeau Formation

No plants have yet been forthcoming from the Brazeau formation at its type locality, nor from the presumably equivalent lower beds of the Brazeau formation elsewhere. Strata near the top of the formation, however, have yielded a small flora, comprising the following:

Ginkgoites sp.
Nilssonia sp.
N. serotina (Heer)
Sequoiites artus Bell
Elatocladus intermedius (Hollick)
Dryophyllum sp. cf. *D. moorii* Knowlton (? *non* Lesquereux)
Platanus sp.
Magnoliaephyllum pulchrum ? (Ward)
Jenkinsella arctica (Heer) forma *minor* (Berry)
Celastrinites insignis ? (Heer)
Vitis stantoni (Knowlton) Brown
Viburnum simile Knowlton
Spirodela acutata Dawson

Age. With the exception of *Dryophyllum* sp., *Magnoliaephyllum pulchrum ?*, and *Viburnum simile* the above species are all present in the Edmonton formation. The *Dryophyllum* is seemingly closely allied to *Dryophyllum moorii* Knowlton from the base of the Raton formation, which may be equivalent in age to the Lance formation (Dorf, 1942, p. 116). The second specifically identifiable species, *Viburnum simile*, which is close to *Viburnum montanum*, is a constituent of the flora of the Vermejo formation, Colorado, which may be in part equivalent in age to the Fox Hills formation. The species held in common with the Edmonton mainly occur in that formation below the horizon of the Kneehills tuff. It is concluded that the florules from the Brazeau formation so far gathered are equivalent in age to a part of the Edmonton formation, and seemingly are more probably synchronous with an upper part of the Lower Edmonton than with the Upper Edmonton.

Flora of Wapiti Group

Only a few well authenticated species have so far been gathered from the Wapiti group. They comprise:

Sphenopteris (Dennstaedtia?) burlingi Bell
Sequoiites artus Bell
S. dakotensis ? (Brown)
Elatocladus intermedius (Hollick)
Trochodendroides arctica (Heer)
Dombeyopsis nebrascensis (Newberry)
Jenkinsella arctica (Heer)
Viburnum montanum ? (Knowlton)

This florule, although scanty in species, indicates an age probably equivalent to the flora of the upper part of the Brazeau formation and of a part of the Lower Edmonton formation.

In addition to the above, collections from the area of Nose Mountain include the following:

Ginkgoites adiantoides (Unger)
Elatocladus (Taxites?) olriki Heer
Sequoiites artus Bell
S. langsdorfii ? (Brongniart)
Sequoiites (cones)
Platanus raynoldsii integrifolia Lesquereux
Nymphaeites angulatus (Newberry)
N. striatus ? (Berry)
Pterospermites sp.
Aralia ? sp.

This assemblage seems to be somewhat younger than the first one noted above, and it suggests an age equivalent to that of an upper part of the Lower Edmonton or possibly to a part of the Upper Edmonton.

Flora of Post-Brazeau Beds

The post-Brazeau beds considered here include an upper part of the Saunders group, or have been mapped together with younger beds as "Edmonton and Paskapoo". They rest accordantly upon the Brazeau formation, comprise 3,000 to 3,500 feet of sediment, and are overlain by typical Paskapoo (Lang, A. H., 1947, pp. 31, 32, 35). Except for the presence of workable coals the lithology is similar to that of the Paskapoo.

The flora of these sediments ranges downward to an horizon a few hundred feet below the Mynheer coal seam, and is well represented in the roof strata of that seam. The following have been identified by the writer:

Equisetum alexoensis Bell
E. boreale Heer
Cladophlebis groenlandica (Heer)
Onoclea hebridica (Forbes)
Elatocladus (Taxites?) olriki (Heer)
Sequoiites langsdorfii (Brongniart)
Cryptomerites lambii Bell
Elatocladus (Cryptomerites?) nordenskioldi (Heer)
Thuites interruptus (Newberry)
Dryophyllum (Castanea?) sp.

Quercus praegroenlandica Berry
Platanus raynoldsii Newberry
Trochodendroides arctica (Heer)
Jenkinsella arctica (Heer)
Dombeyopsis nebrascensis (Newberry) n. comb.
Nymphaeites angulatus (Newberry) n. comb.
Paranymphaea crassifolia (Newberry)
Celastrinites insignis (Heer)
Zizyphoides colombi (Heer)
Z. mackayi Bell
Aralia alexoensis Bell
Oreopanax ? sp.
Dicotylophyllum contractinervosum Bell
Carpolithus symplocoides ? Heer
Spirodela scutata Dawson

Of the above 25 species, 8 are the ubiquitous, long-ranging species or hold-overs from the Cretaceous. These are *Thuites interruptus*, *Platanus raynoldsii*, *Trochodendroides arctica*, *Jenkinsella arctica*, *Nymphaeites angulatus*, *Dombeyopsis nebrascensis*, *Celastrinites insignis*, and *Spirodela scutata*. These species, with the exception of *Dombeyopsis nebrascensis*, are represented in both the Paskapoo and Ravenscrag floras. Of the remaining 17 species, 6 are present in the Paskapoo formation, namely, *Equisetum boreale*, *Onoclea hebridica*, *Sequoiites langsdorfii*, *Cryptomerites lambii*, *Elatocladus (Cryptomerites?) nordenskioldi*, and *Paranymphaea crassifolia*. As to their distribution in the Paskapoo, *E. boreale* was gathered from Rocky Mountain House, *P. crassifolia* from the mouth of Sheep Creek, and the remainder from the Paskapoo type area, near the mouth of Blindman River.

The presence of these and of *Quercus praegroenlandica*, which occurs in the Ravenscrag, is considered sufficient to place the flora in the Paleocene, although it is quite possible that the beds carrying this flora are of an earlier Paleocene age than basal Paskapoo beds in the eastern limb of the Alberta syncline.

Flora of Upper Part of Willow Creek Formation

The writer succeeded in getting a few plant remains from the upper part of the Willow Creek formation at a locality on Willow Creek in SW. ¼ sec. 1, tp. 13, rge. 28, W. 4th mer.; those identified are:

Equisetum sp.
Carpolithus (Ginkgoites?) selwyni Bell
Androvettia catenulata Bell
Elatocladus (Taxodites?) tinajorum (Heer)
Platanus raynoldsii Newberry

Of these *Androvettia catenulata* occurs in the Paskapoo formation on Tongue Creek in NE. ¼ sec. 17, tp. 17, rge. 29, W. 4th mer., and the remainder in Paleocene beds elsewhere. In addition to the above plants *Aclistochara compressa* was gathered from Upper Willow Creek beds lying west of Granum in SE. ¼ sec. 36, tp. 10, rge. 27, W. 4th mer. The remains of this charophyte fruit are associated with freshwater shells that Russell (1932b, p. 140) considered to be essentially Paskapoo and Fort Union species. The florule itself is inferred to indicate most probably a Paleocene age, and this conclusion is strengthened if the plants from near the mouth of Crowsnest River, listed in the following section, belong to the Upper Willow Creek rather than to the Porcupine Hills formation.

Flora of Porcupine Hills (?) Formation

C. O. Hage made a small collection of plants from strata outcropping near the mouth of Crowsnest River, which he considered to belong to the Porcupine Hills formation. This locality was visited by the writer, and some additional specimens obtained. The Porcupine Hills-Willow Creek contact should be placed, in his opinion, above these beds at the base of a thick sandstone with conglomerate lenses, which outcrops on the east side of the north fork of Oldman River near its junction with the Crowsnest. If so, the plant-bearing beds from this locality would belong to an upper part of the Willow Creek formation.

The florule gathered here consists of the following:

Elatocladus (Cryptomerites?) nordenskioldi (Heer)
Platanus raynoldsii Newberry
Pterospermites haguei? Knowlton
Cornus denverensis Knowlton
Aralia alexoensis Bell
Viburnum trinervum Berry
V. lakesii Knowlton

Two of the above species, namely *Cornus denverensis* and *Viburnum lakesii*, are at present useless for correlation because the precise horizons within the Denver or Dawson formation that furnished Knowlton's species are not known. *Pterospermites haguei?* is too fragmentary for reliable identification, and *Platanus raynoldsii* is too long-ranging for purposes of close correlation. However, the presence of *Elatocladus (Cryptomerites?) nordenskioldi*, *Aralia alexoensis*, and *Viburnum trinervum* is considered to be sufficient evidence of a Paleocene age, more probably early Paleocene.

Flora of Paskapoo Formation

The Paskapoo formation has yielded only about 37 species, mostly from the type area near the mouth of Blindman River and from the vicinity of Calgary and High River. These are distributed among 27 genera and 22 families. Equisetae, ferns, and ginkgos are all rather rare, as are monocotyledons, so that the flora is dominantly coniferous and dicotyledonous. Of the conifers *Sequoiites* and *Cryptomerites* are dominant, and of 20 dicotyledons the most abundant and widespread genera are *Platanus*, *Trochodendroides*, *Celastrinites*, and *Viburnum*. The assemblage, therefore, is essentially a temperate forest one, with a moderate admixture of plants from bushland, forest border, and undergrowth, and with a few forms of aquatic and riparian habit.

The following list comprises forms identified by the writer:

Equisetum arcticum Heer
E. boreale Heer
Osmunda macrophylla (Penhallow)
Dennstaedtia blomstrandi (Heer)
Onoclea sensibilis fossilis Newberry = *Onoclea hebridica* (Forbes)
Asplenium ? penhallowi Bell
Ginkgoites adiantoides (Unger)
Carpolithus (Ginkgoites?) selwyni Bell
Androvettia catenulata Bell
Sequoiites langsdorfii (Brongniart)
Cryptomerites lambii Bell
Elatocladus (Cryptomerites?) nordenskioldi (Heer) n. comb.

Thuites interruptus (Newberry)
Corylites fosteri (Ward)
Juglans leconliana Lesquereux
J. thermalis Lesquereux
Populus carneosa (Newberry) n. comb.
P. ? daturaefolia (Ward) n. comb.
P. penhallowi Bell
Trochodendroides arctica (Heer)
Jenkinsella arctica (Heer) n. comb.
Platanus raynoldsii Newberry
P. basilobata Ward
Laurophyllum laraminum (Dawson)
Nelumbites protoluteus Berry
Nymphaeites angulatus (Newberry) n. comb.
Paranymphaea crassifolia (Newberry)
Pterospermites whitei Ward
P. dawsoni (Knowlton) n. comb.
Celastrinites insignis (Heer) n. comb.
Rhamnites ovatus (Penhallow)
R. marginatus (Lesquereux)
Viburnum antiquum (Newberry)
V. asperum Newberry
Majanthemophyllum grandifolium Penhallow
Cannophyllites magnifolia (Knowlton)
Spirodela scutata Dawson

Age. Of the above 37 species, only 7 occur, so far as known, in the underlying Edmonton formation, namely *Ginkgoites adiantoides, Thuites interruptus, Platanus raynoldsii, Trochodendroides arctica, Jenkinsella arctica, Nymphaeites angulatus*, and *Spirodela scutata.* The upper part of the Edmonton formation has recently been correlated on both plant and vertebrate evidence (Sternberg, C. M., 1947) with the Lance formation. The fact that very few plant species range from the Edmonton to the Paskapoo formation strongly indicates that the latter is early Tertiary in age.

The Edmonton formation is in part equivalent to the Frenchman (formerly Lower Ravenscrag) and Whitemud formations of southern Saskatchewan. Taking Berry's list of plants from the Whitemud formation, the following species occur also in the Paskapoo formation:

Berry	Usage in this report
Ginkgo adiantoides	=*Ginkgoites adiantoides*
Thuja interrupta	=*Thuites interruptus* (Newberry)
Grewia crenata	=*Trochodendroides arctica* (Heer)
Leguminosites arachioides var. *minor*	=*Jenkinsella arctica* (Heer)
Trapa ? microphylla	=*Nymphaeites angulatus* (Newberry)
Nelumbo tenuifolia	=*Nelumbites protoluteus* (Berry)
Nelumbites striatus	=*Nymphaeites striatus*
Euonymus xantholithensis ?	=*Celastrinites insignis* (Heer)

This list of long-ranging species is much the same as that derived from consideration of the flora of the Edmonton formation. Berry included *Sequoia nordenskioldi* and *Viburnum antiquum* in his list of Whitemud species. Examination by the writer of specimens so identified show that they belong respectively to *Sequoiites artus* Bell, a common Edmonton species, and to *Viburnum montanum,* neither of which has been found in the Paskapoo formation.

Species common to the Frenchman and Paskapoo formations are *Equisetum arcticum*, *Ginkgoites adiantoides*, and *Euonymus xantholithensis* (=*Celastrinites insignis*). Although Berry records *Pterospermites penhallowi* in addition to the above, the writer failed to find any trace of this species in the material studied by Berry.

Two of the long-ranging species cited in the above Cretaceous lists, namely *Ginkgoites adiantoides* and *Equisetum arcticum*, may actually belong to *Ginkgoites laramiensis* and *Equisetum perlaevigatum* respectively, and be confined to the Cretaceous. The specimens are too few and too fragmentary to be certain of correct reference.

The Frenchman formation of Saskatchewan is correlated on vertebrate evidence with the Lance formation of eastern Wyoming and with the Hell Creek formation of eastern Montana. The Whitemud formation is correlated with the Colgate member of the Fox Hills formation of Montana (Fraser, F. J., *et al.*, 1935, p. 35). It would be expected, therefore, that these Cretaceous formations of the United States would carry a few of the long-ranging species present in the Paskapoo. For many years a flora allocated to the Lance formation was a composite one, for it actually included many species from the Fort Union formation. Only recently has the true Lance flora been differentiated (Brown, R. W., 1939a, p. 243; Dorf, E., 1942, pp. 91-95). Comparing the Paskapoo flora with Dorf's lists of species from the type Lance, the following five species are held in common:

Dorf	Usage in this report
Ginkgo adiantoides ?	*Ginkgoites adiantoides*
Cercidiphyllum arcticum *C. ellipticum*	=*Trochodendroides arctica* (Heer)
Trapa ? microphylla	=*Nymphaeites angulatus* (Newberry)
Celastrus ? taurinensis	=*Celastrinites insignis* (Heer)
Canna ? magnifolia	=*Cannophyllites magnifolia* (Knowlton)

Combining the above records of species that occur in both the Paskapoo and Upper Cretaceous formations, there are at least 9 long-ranging species in the Paskapoo flora, viz.: *Equisetum arcticum*, *Ginkgoites adiantoides*, *Thuites interruptus*, *Trochodendroides arctica*, *Jenkinsella arctica*, *Nelumbites protoluteus*, *Nymphaeites angulatus*, *Celastrinites insignis*, and *Cannophyllites magnifolia*.

Although this list is probably incomplete there remain about 30 species, or 75 per cent of the Paskapoo flora, that have no recorded distribution in Cretaceous floras. There is, accordingly, evidence of a distinct palæobotanical break at the Cretaceous-Paskapoo boundary. Stratigraphically, as noted elsewhere in this report, the Paskapoo rests upon the Edmonton, in some areas at least, with marked erosional unconformity.

As upper Edmonton beds have been correlated with the Lance formation on vertebrate evidence (Sternberg, C. M., 1947, pp. 5, 10), it might be expected that the flora of the overlying Paskapoo formation would be closely allied to that of the Ravenscrag formation that overlies the Frenchman formation or Lance equivalent in Saskatchewan. Berry listed about 64 species from the Ravenscrag formation *sensu stricto*. The writer would combine several of Berry's species, which would reduce his list to about

58 species. With such a revised list as a basis for comparison, the following 19 species, or a third of the Ravenscrag flora, occur in the Paskapoo formation:

Berry	Usage in this report
Dennstaedtia americana	=*Dennstaedtia blomstrandi* (Heer)
Onoclea sensibilis fossilis	=*Onoclea hebridica* (Forbes)
Ginkgo adiantoides	*Ginkgoites adiantoides*
Taxodium dubium	=*Elatocladus tinajora* (Heer)
Glyptostrobus europaeus ?	=*Cryptomerites lambii* Bell
Sequoia nordenskioldi pars	=*Elatocladus (Cryptomerites?) nordenskioldi* (Heer)
Thuja interrupta	=*Thuites interruptus* (Newberry)
Platanus basilobata	*Platanus basilobata*
P. sp.	=*Platanus raynoldsii* Newberry
Grewiopsis mclearni *Trochodendroides cuneata* *Grewia crenata*	=*Trochodendroides arctica* (Heer)
Leguminosites arachioides minor	=*Jenkinsella arctica* (Heer)
Trapa ? microphylla	=*Nymphaeites angulatus* (Newberry)
Paranymphaea crassifolia	*Paranymphaea crassifolia*
Pterospermites minor *P. penhallowi* *Protophyllum canadensis*	=*Pterospermites dawsoni* (Knowlton)
Celastrus ferrugineus *C. taurinensis* *Hicoria antiquorum*	=*Celastrinites insignis* (Heer)
Viburnum antiquum	*Viburnum antiquum* (Newberry)
V. antiquum mut. *trinervum*	=*V. trinervum*
V. asperum	*V. asperum*
Spirodela scutata	*Spirodela scutata* Dawson

Excluding the long-ranging *Ginkgoites adiantoides, Thuites interruptus, Platanus raynoldsii, Trochodendroides arctica, Nymphaeites angulatus,* and *Celastrinites insignis* from both floras, there remain 13 species in common among a total of 28 in the Paskapoo and 52 in the Ravenscrag. Of these 13, *Dennstaedtia blomstrandi, Onoclea hebridica, Cryptomerites lambii, Elatocladus (Cryptomerites?) nordenskioldi, Paranymphaea crassifolia, Pterospermites dawsoni, Viburnum antiquum,* and *Viburnum asperum* are considered to be most diagnostic and to lead to the conclusion that the Paskapoo and Ravenscrag formations carry essentially the same flora, and are, consequently, of the same approximate age. Berry earlier (1935, p. 10) came to the same conclusion. He stated, furthermore, that the most abundant forms individually in the Ravenscrag flora are the leaves of *Trochodendroides, Celastrus (=Celastrinites),* and *Viburnum* (Berry, 1935, p. 9). These with the addition of *Platanus* are likewise the most abundant genera in the Paskapoo.

In the collections from the Ravenscrag of the Cypress Hills area, Berry identified a small flora consisting of the following:

Berry	Usage in this report
Equisetum sp.	=*Equisetum alexoensis* Bell
Ginkgo ? stones	=*Carpolithus (Ginkgoites?) selwyni* Bell
Taxodium dubium	=*Elatocladus (Taxodites?) tinajora* (Bell)
Sequoia nordenskioldi	=*Elatocladus (Cryptomerites?) nordenskioldi* (Heer)

Ficus viburnifolia	
Aristolochia crassifolia	=*Paranymphaea crassifolia* (Newberry)
Trochodendroides cuneata *T. speciosa*	=*Trochodendroides arctica* (Heer)
Trapa ? microphylla	=*Nymphaeites angulatus* (Newberry)
Cercocarpus ravenscragensis	
Leguminosites williamsi	
Juglans nigella	*Juglans nigella*
Celastrus wardi *C. taurinensis* *Euonymus splendens* *Viburnum finale* *Apeibopsis discolor*	=*Celastrinites insignis* (Heer)
Rhamnites knowltoni	=*Rhamnites marginatus* Lesquereux
Paliurus ? sp.	
Viburnum limpidum	=*Viburnum antiquum* (Newberry)
Phyllites aquaticus	

Of the 16 species here recorded, 8 occur also in the Paskapoo formation.

Before leaving the discussion of the flora of the Ravenscrag formation it is well to note that Berry identified some specimens as *Fraxinus leii* and *Laurophyllum ripleyensis*, two characteristic Cretaceous species. The writer considers that both these identifications are in error. He would assign these particular specimens of *Fraxinus leii* to *Pterocarya septentrionalis*, which occurs in the Tertiary of Alaska. The so-called *Laurophyllum ripleyensis* of the Ravenscrag he considers to belong to *Salix laramina* Dawson (=*Laurophyllum laraminum*). The leaves of the latter were not seemingly coriaceous as were those of *Laurophyllum ripleyensis;* the secondaries, obliquely percurrent tertiaries, and nervilles are generally well preserved, and there are doubtful, obscure denticulations in the apical region.

As the Paskapoo plants point to a Tertiary age, the flora should show close affinities with the Fort Union flora of North Dakota and Montana. The flora of the Fort Union is a large one, comprising in Knowlton's list (Knowlton, 1919, pp. 768-773) more than 250 species. The flora is badly in need of revision, however, and there has been much over-speciation, especially among the forms referred to *Populus*, *Celastrus*, and *Viburnum*. Of the 37 species identified from the Paskapoo formation no less than 23 are present in the Fort Union flora. These include 6 of the usual, long-ranging species, leaving 17 index species common to the two formations, or a little more than half of the significant part of the Paskapoo flora. It is inferred, therefore, that the Paskapoo formation is of the same age as a part, at least, of the Fort Union formation, which is generally conceded to be of Paleocene age.

Very few species of the Paskapoo flora are present in the Wilcox (Lower Eocene) flora of the southeastern United States. Several of the long-ranging species, e.g., *Jenkinsella arctica*, *Nelumbites protoluteus*, and *Celastrinites insignis*, occur in both floras, but of the other Paskapoo species only *Rhamnites marginatus* occurs in the Wilcox. It is concluded, therefore, that no part of the Paskapoo formation is as late as Eocene *sensu stricto*.

Flora of Paskapoo Equivalent in Mackenzie River Valley

In the collections of the Geological Survey of Canada are a few plants from Mackenzie River Valley. Those identified comprise:

Cladophlebis groenlandica (Heer)
Elatocladus (Taxites?) olriki (Heer)
Trochodendroides arctica
Pterospermites whitei Ward
Acer arcticum Heer
Nordenskioldia borealis Heer

Two of these species, namely *Cladophlebis groenlandica* and *Elatocladus (Taxites?) olriki*, are present in the Paleocene post-Brazeau beds of central Alberta. *Pterospermites whitei* and *Acer arcticum* are both members of the Fort Union flora, and *Nordenskioldia borealis* occurs in the Arctic Tertiary. The flora, accordingly, is considered to be definitely Paleocene, although it may be somewhat older than the Paskapoo flora.

Summary of Distribution of Species in Formations of Western Canada

The distribution of species, arranged in order of their taxonomic relationships, is presented in the following table.

Table of Distribution of Species in Formations of Western Canada

	Bearpaw formation	St. Mary River formation	Edmonton formation (lower part)	Edmonton formation (upper part)	Brazeau formation (upper part)	Wapiti group	Post-Brazeau Paleocene beds	Willow Creek formation (upper part)	Porcupine Hills ? or Willow Creek	Paskapoo formation	Paskapoo equivalent in Mackenzie River Valley	Whitemud	Frenchman formation	Ravenscrag formation	Paleocene ? B.C. or Yukon
Phylum Euthallophyta															
Order Charales															
Family Characeae															
Aclistochara compressa								×							
Subphylum Pteridophyta															
Order Equisetales															
Family Equisetaceae															
Equisetum perlaevigatum		×	×												
E. alexoensis							×							×	
E. arcticum										×			×	×	
E. boreale							×			×					
Order Filicales															
Family Osmundaccae															
Osmunda macrophylla										×					
Cladophlebis groenlandica							×				×				
Family Dennstaedtiaceae															
Dennstaedtia blomstrandi										×				×	
Sphenopteris (Dennstaedtia?) burlingi						×									

Table of Distribution of Species in Formations of Western Canada—Continued

	Bearpaw formation	St. Mary River formation	Edmonton formation (lower part)	Edmonton formation (upper part)	Brazeau formation (upper part)	Wapiti group	Post-Brazeau Paleocene beds	Willow Creek formation (upper part)	Porcupine Hills ? or Willow Creek	Paskapoo formation	Paskapoo equivalent in Mackenzie River Valley	Whitemud	Frenchman formation	Ravenscrag formation	Paleocene ? B.C. or Yukon
Family Polypodiaceae															
Onoclea hebridica							×			×				×	
Dryopterites georgii ?													×		
Asplenium ? penhallowi										×					
Adiantum ? paululum		×													
Incertae sedis															
Filicites knowltoni				×											
Group Cycadophyta															
Incertae sedis															
Nilssonia serotina			×		×										
N. sp.			×												
Carpolithus (Cycadinocarpus?) ceratops		×		×									×		
Group Ginkgoales															
Family Ginkgoaceae															
Ginkgoites adiantoides						×				×		×	×	×	
G. sp.			×												
Carpolithus (Ginkgoites?) fultoni		?	×												
C. (Ginkgoites?) kneehillensis			×												
C. (Ginkgoites?) selwyni								×		×				×	

Group Coniferales															
Family Taxaceae															
Torreyites tyrrellii	×		×												
Elatocladus (Taxites?) olriki						×	×				×				
Androvettia catenulata								×		×					
Family Cupressaceae															
Pityostrobus (Cunninghamiostrobus?) sp.			×												
Sequoiites langsdorfii						?	×			×					
S. artus			×		×	×						×			
Elatocladus (Sequoiites?) ungeri															×
S. couttsiae ?															×
S. dakotensis			×	×		?							×		
Cryptomerites lambii							×			×				×	
Elatocladus (Cryptomerites?) nordenskioldi							×		×	×				×	
E. (Taxodites?) tinajorum								×						×	×
E. intermedius		×	×		×	×									
Thuites interruptus		×	×				×			×		×		×	
Juniperites gracilis			×												
Class Dicotyledones															
Order Fagales															
Family Betulaceae															
Alnus serrata														×	
Corylites fosteri										×					
Family Fagaceae															
Dryophyllum (Castanea?) sp.							×								
Quercus praegroenlandica							×								
Order Juglandales															
Family Juglandaceae															
Juglans lecontiana										×					
J. thermalis										×					
J. nigella														×	
Order Salicales															
Family Salicaceae															
Populus carneosa										×					
P. penhallowi										×					
P. ? daturaefolia										×					

Table of Distribution of Species in Formations of Western Canada—Continued

	Bearpaw formation	St. Mary River formation	Edmonton formation (lower part)	Edmonton formation (upper part)	Brazeau formation (upper part)	Wapiti group	Post-Brazeau Paleocene beds	Willow Creek formation (upper part)	Porcupine Hills ? or Willow Creek	Paskapoo formation	Paskapoo equivalent in Mackenzie River Valley	Whitemud	Frenchman formation	Ravenscrag formation	Paleocene ? B.C. or Yukon
Order Hamamelidales															
Family Cercidiphyllaceae															
Trochodendroides arctica			×		×	×				×	×	×	×	×	
Jenkinsella arctica			×			×				×		×		×	
Family Platanaceae															
Platanus basilobata										×				×	
P. raynoldsii							×	×	×	×				×	
P. raynoldsii integrifolia				×		×									
Platanophyllum sp.				×											
Order Ranales (Polycarpicae)															
Family Anonaceae															
Anona robusta				×											
Family Lauraceae															
Laurophyllum laraminum										×				×	
Family Menispermaceae															
Menispermites belli												×			
Dombeyopsis nebrascensis		×	×		×	×	×						×		

Family Nymphaeaceae															
Nelumbites protoluteus										×		×			
Nymphaeites angulatus		×	×	×		×	×			×		×		×	
N. striatus		×				?						×			
Antholithes (Nymphaeites?) marsilioides		×													
Paranymphaea crassifolia							×			×				×	
Order Rosales															
Incertae sedis															
Leguminosites stagnum		×													
Order Malvales															
Family Sterculiaceae															
Pterospermites whitei										×	×				
P. dawsoni										×				×	
P. haguei ?									×						
Order Sapindales (Terebinthales)															
Family Aceraceae															
Acer arcticum											×				
Order Celastrales															
Family Celastraceae															
Celastrinites insignis							×			×		×	×	×	
Order Rhamnales															
Family Rhamnaceae															
Rhamnites ovatus										×					
R. marginatus										×				×	
Zizyphoides colombi							×							×	
Z. mackayi							×								
Family Vitaceae															
Vitis stantoni			×	×								×			
Order Umbellales (Umbelliflorae)															
Family Cornaceae															
Cornus denverensis									×						
Family Avaliaceae															
Oreopanax ? sp.							×								
Aralia alexoensis							×		×						

Table of Distribution of Species in Formations of Western Canada—Concluded

	Bearpaw formation	St. Mary River formation	Edmonton formation (lower part)	Edmonton formation (upper part)	Brazeau formation (upper part)	Wapiti group	Post-Brazeau Paleocene beds	Willow Creek formation (upper part)	Porcupine Hills ? or Willow Creek	Paskapoo formation	Paskapoo equivalent in Mackenzie River Valley	Whitemud	Frenchman formation	Ravenscrag formation	Paleocene ? B.C. or Yukon
Order Ligustrales															
Family Oleaceae															
Fraxinus leii	....	....	....	×	....	....	....	....	....	....	....	....	....	....	....
Order Rubiales															
Family Caprifoliaceae															
Viburnum antiquum	....	....	....	....	....	....	....	....	×	....	....	....	....	×	....
V. simile	....	....	....	....	×	....	....	....	....	....	....	×	....	....	....
V. trinervum	....	....	....	....	....	....	....	....	×	....	....	....	....	×	....
V. lakesii	....	....	....	....	....	....	....	....	×	....	....	....	....	....	....
V. asperum	....	....	....	....	....	....	....	....	....	×	....	....	....	×	....
Incertae sedis															
Dicotylophyllum contractinervosum	....	....	....	....	....	....	×	....	....	....	....	....	....	....	....
Nordenskioldia borealis	....	....	....	....	....	....	....	....	....	....	×	....	....	....	....
Carpolithus symploeoides ?	....	....	....	....	....	....	×	....	....	....	....	....	....	....	....
Class Monocotyledones															
Incertae sedis															
Majanthemophyllum grandifolium	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....
Cannophyllites magnifolia	....	....	....	....	....	....	....	....	....	×	....	....	....	....	....

Order Spadiciflorea															
Family Araceae															
Pistia corrugata											×				
Family Lemnaceae															
Spirodela scutata					×		×			×				×	
Order Pandanales															
Family Typhaceae															
Typa sp.		×													

DESCRIPTION OF SPECIES

Aclistochara compressa (Knowlton) Peck

Plate XXII, figures 1, 2, 3, 5, 7, 8

Remarks. The specimens included here are all gyrogonites, oblate-spheroidal in shape, with length eight-tenths to nine-tenths of width. Seven to nine convolutions are visible in side view. The length varies from 550 to 600 microns and width 700 to 800 microns. These dimensions, and number of convolutions crossing the face of the spores, are less than those in the types of *Aclistochara compressa*, but the difference doubtfully surpasses the limits of specific variation.

The wall formed by the five enveloping cells consists of amber-coloured calcite, and when the containing limestone is crushed it is commonly stripped off from the calcite filling of the interior of the oogonium, on which only spiral ridges, representing the spaces between the spiral cells, are preserved. It was not clear from the few specimens of entire gyrogonites seen whether the apex is a calcified coronula or simply the upturned apical ends of the spiral cells, for no distinct lines of separation were visible.

Occurrence. Willow Creek formation (upper part), locality 1618.

Types. Plesiotypes, G.S.C.[1] Nos. 6366 to 6371.

Equisetum perlaevigatum Cockerell

Plate VI, figures 4 to 7

Equisetum arcticum Berry in Sternberg, Canadian Field Naturalist, vol. 38, pp. 69, 131, fig. 1 (1924).[2]

Remarks. Subterranean rhizomes, up to 3 cm. at least wide, with nodes up to more than 10 cm. apart, provided generally with two or more opposite tuberous branches, which are given off directly below constricted nodal lines. Tubers, forming chains, with internodes commonly about 3 cm. long and about 1·3 cm. wide, about equally thick throughout, except at greatly constricted nodal lines, irregularly corrugated by pressure during fossilization. Sheaths on parent rhizomes, appressed, with basal leaves up to 2·5 mm. wide and 1·8 mm. long, adherent for about half their length, free ends acuminately pointed. On an average stem there are about 16 to 18 leaves in a sheath.

The species is distinguished generally from the Paleocene *E. arcticum* Heer by its more regularly cylindrical tubers and more robust form, and parent rhizomes are seemingly more constricted at the nodal lines.

Occurrence. St. Mary River formation, locality 3587; Edmonton formation (lower part), locality 1615.

Types. Plesiotypes, G.S.C. Nos. 6180, 6181, 6182.

Equisetum alexoensis n.sp.

Plate XXII, figure 4; Plate XXIII, figures 5, 6, 7, 9;
Plate LXVII, figure 5

Description. Aerial stems, up to 1 cm. wide, ribbed and longitudinally striated, constricted at nodes, which are 5 cm. or a little more apart.

[1] The abbreviation G.S.C. is used for the type specimens in the collection of the Geological Survey of Canada

[2] The references given below specific headings refer to Canadian material only.

Leaves, seemingly 24 or more to a node, form sheaths about 12 mm. long, the leaves being united for 8 or 9 mm., then free and acuminate. Tubers, apparently belonging to the species, 3 to 12 mm. long by 1·5 to 7 mm. wide, broad at proximal end and contracted distally with rounded or pointed ends generally in whorls of 5 around narrow rhizomes with closely spaced nodes.

Remarks. The aerial stems are much like those of *Equisetum arcticum* Heer, except for the larger number of leaves in stems of comparable size. The tubers, however, are broadest proximally and not distally like those of *E. arcticum.* The smallest whorls of tubers observed are attached to an axis only 1·5 mm. wide; they resemble superficially a gamopetalous flower, and particularly a specimen from the Wilcox group described by Berry as *Solanites saportana* (U.S. Geol. Surv., Prof. Paper 91, Pl. CVI, fig. 4).

Occurrence. Post-Brazeau, Paleocene beds, localities 3435, 3438, 3448; Ravenscrag formation, Saskatchewan, locality 2189.

Types. Holotype, G.S.C. No. 6138; paratypes, Nos. 5521 (=*Equisetum* sp. Berry), 6139, 6145, 6146, 6357.

Equisetum arcticum Heer

Plate XXIII, figures 2, 4, 8

Physagenia parlatorii Dawson (*non* Heer), Rept. Geol. and Resources 49th Parallel, Appendix A, p. 329, Pl. 16, figs. 3, 4 (1875).

Equisetum sp. Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 22, Pl. I, fig. 2 (1887).

Equisetum arcticum Penhallow, Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 49 (1902).

Remarks. The specimens to hand are all tuberous rhizomes. Specimen 6256 (Plate XXIII, figure 8) shows a node with remains of six tubers, each 2 to 2·5 cm. long by 1 to 1·5 cm. wide, attached to a rhizome about 1 cm. wide. A second specimen (Plate XXIII, figure 4) shows a node on a rhizome 1·7 cm. wide having traces of four tubers, the most complete of which is 3·6 cm. long by 1·4 cm. wide. Specimen 5554 (Plate XXIII, figure 2) represents a node of a smaller rhizome, 6 mm. wide; there are imprints of two tubers, the probable bases of two or three more, and traces of four or five roots. These three rhizomes agree well with specimens from Spitzbergen figured by O. Heer (1871). Dawson's figured specimens show similar tubers, presumably four to a node. Neither the size nor actual number of tubers per node is likely to be a character of specific importance.

Equisetum perlaevigatum Cockerell from the Upper Cretaceous is a closely allied species, and by some authors is united to *E. arcticum.* It is, however, a more robust species, and is considered by the present writer to be specifically distinct.

Occurrence. Paskapoo formation, Alberta, localities 1202, 3443; Ravenscrag formation, Saskatchewan, localities 2189, 4091.

Types. Plesiotypes, G.S.C. Nos. 5554, 6256, 6257.

Equisetum boreale Heer

Plate XXI, figure 1; Plate XXIII, figures 1, 3

Remarks. This species is marked by slender, ribbed rhizomes, which have small globular tubers at the nodes. Generally a pair of tubers, 1 cm. or less in diameter, are preserved at a node. A specimen from the Lance formation of Wyoming, apparently belonging to this species, is illustrated by E. Dorf (1942, p. 127, Pl. 6, fig. 3) as *Equisetum* sp.

Occurrence. Paskapoo formation, locality 3460; post-Brazeau Paleocene beds, locality 1608.

Types. Plesiotypes, G.S.C. Nos. 615, 6131, 6132.

Osmunda macrophylla Penhallow

Plate XXIV, figure 2; Plate XXV, figures 1, 3, 4

Osmunda macrophylla Penhallow, Geol. Surv., Canada, Pub. 1013, p. 65, text fig. 15 (1908).

Remarks. Frond, large, bipinnate. Pinnules, alternate, lanceolate; lower ones neuropteroid, with very short stalks of attachment and commonly more or less emarginate; more distal ones, sessile and more or less obliquely truncate at base; upper ones, attached by broad base, and inferior lowermost nerve originating in rachis; end pinnule, large and basally lobed. Apex of pinnules, bluntly acute; margin, finely crenulate. Midrib, fairly stout, continuous to, or bifurcate at, apex. Laterals, up to 20 pairs or more, about 45 degrees to midvein, pursuing nearly straight course to margin; lower ones divided close to origin, and each arm generally divided again before or near midcourse; upper ones divided once about midway; basal nerves divided about five times forming a fanwise group of branches.

The species is obviously close to, and perhaps conspecific with, *Osmunda doroschkiana* Goeppert. It is retained as a separate species only on account of the crenulate margins and the seemingly more divided basal nerves.

Occurrence. Paskapoo formation, localities 3441, 3443, 3444.

Types. Plesiotypes, G.S.C. Nos. 6163 to 6166.

Cladophlebis groenlandica (Heer)

Plate XXVI, figure 2

Pteris sitkensis Dawson (*non* Heer), Geol. Surv., Canada, new ser., vol. IV, pt. D, p. 97 (1890); Roy. Soc., Canada, Trans., vol. VII, sec. IV, p. 70, Pl. X, fig. 1 (1890).

Remarks. Included here are rare and fragmentary remains, indistinguishable from Heer's species. The figured specimen has more obtuse pinnules than the others, but the margins appear to be entire, and not denticulate as in *Pteris sitkensis* Heer. It is very similar to a specimen figured as an obtuse variety of *C. groenlandica* by Heer (1883, Pl. 70, fig. 5), and is perhaps conspecific also with a specimen named by Hollick (1936, p. 40, Pl. 5, fig. 2) *Osmunda dubiosa.* The six or seven pairs of lateral veins divide once, except the uppermost, and rarely the upper arms of the lower laterals divide again.

Occurrence. Post-Brazeau Paleocene beds, locality 3428; Paleocene beds of Mackenzie River Valley, locality 1552.

Type. Plesiotype, G.S.C. No. 5587 (*Pteris sitkensis* Dawson).

Dennstaedtia blomstrandi (Heer) Hollick

Plate XXIV, figures 1, 4; Plate XXVI, figure 5

Davallia (Stenoloma) tenuifolia Dawson (*non* Swartz), Brit. N.A. Boundary Commission, Rept. Geol. and Resources 49th Parallel, Appendix A, p. 329, Pl. 16, figs. 1, 1a, 2, 2a (1875); Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 21, Pl. I, figs. 1, 1a, 1b (1887).

Sphenopteris blomstrandi Penhallow, Roy. Soc., Canada, Trans., sec. IV, vol. VIII, p. 48 (1902); Rept. Tert. Plants, B.C., Geol. Surv., Canada, Pub. 1013, p. 52 (1908).

Remarks. This species was named *Dennstaedtia americana* by Knowlton in 1910, and this name has been retained by some American authors, although Knowlton himself later incorporated *Sphenopteris blomstrandi* as a synonym of *D. americana.* Hollick rightly gave priority to Heer's original specific name. The species was well described by Knowlton (1910, p. 492). The material so far gathered from the Paskapoo formation is sterile.

Occurrence. Paskapoo formation, localities 262, 3443; Ravenscrag formation, Saskatchewan, locality 4091.

Types. Plesiotypes, G.S.C. Nos. 6167, 6168, 6254.

Sphenopteris (Dennstaedtia?) burlingi n.sp.

Plate II, figures, 2, 3; Plate XIV, figures 1, 2, 4

Description. Frond, tripinnate or tripinnatifid. Secondary or penultimate pinnæ, lanceolate, 6 cm. or more long and 2 cm. or more broad, acutely pointed; rachis slender, distally winged. Tertiary or ultimate pinnæ, short, elliptical, obtuse, up to 15 mm. long by 6 mm. broad, alternate, oblique, pinnatifidly lobed; rachis, winged. Pinnules or lobes, 2 or 3 oblique, lateral pairs and terminal one, obtuse, elliptical; margin, entire proximally, sharply toothed distally, basally connate by axial wing; in apical region of secondary pinna the tertiary pinnæ become narrow, simple, toothed pinnules. A single vein enters each tertiary pinna and gives off a single branch to each lobe or pinnule, which may divide several times, the ultimate divisions entering the sharp, marginal teeth.

Remarks. The species is apparently closely allied to *Dennstaedtia blomstrandi* Heer, differing only on superficial view by the somewhat deeper cutting of the pinnules or lobes and the presence of short, sharp, marginal teeth instead of crenæ.

The small simple pinnules in the apical region of an ultimate pinna bear some resemblance to the larger, normal pinnules of *Sphenopteris miertschingi* Heer, but the pinnatidly lobed pinnules lower down on the pinnæ of *S. burlingi* are quite distinct from the obovate-cuneate pinnules of Heer's species.

The species is named after its collector, L. D. Burling.

Occurrence. Wapiti formation, localities 3663, 3674.

Types. Holotype, G.S.C. No. 6365; paratypes, Nos. 6362 to 6364.

Onoclea hebridica (Forbes)

Plate XX, figure 5; Plate XXIV, figures 3, 5; Plate XXV, figure 2

Onoclea sensibilis Dawson, Roy, Soc., Canada, Trans., vol. IV, sec. IV, p. 21 (1886); Geol. Surv., Canada, Ann. Rept., new ser., vol. II, pt. E, p. 136 (1887).
Onoclea sensibilis fossilis Berry, Geol. Surv., Canada, Mem. 182, p. 16, Pl. I, figs. 2, 3; Pl. II (1935).

Newberry's description of Onoclea sensibilis fossilis. "Frond pinnate, large; pinnæ, lanceolate in outline, with waved margins, more or less deeply lobed or pinnatifid, connate at their bases, forming a broad wing on the rachis of the frond; nervation, strongly marked, more or less reticulated, the nerve of each lobe or pinnule springing from a common trunk, having a dendroid form, with waving branches, which often unite to form elongated lacunæ of which the largest border the rachis of the pinnæ on either side, and are formed by the nerve branches of each lobe reaching over and touching, or closely approaching, the base of the nervation of the next superior lobe or pinnule" (Newberry, J. S., 1898, p. 8).

Remarks. Newberry noted the close correspondence between his specimens and that from the Isle of Mull figured by E. Forbes (1851, Pl. 2, fig. 2) and named *Filicites ? hebridicus.* Although noting the fact that the veins in the fossil species are less frequently anastomosing than is generally the case in the living *Onoclea sensibilis*, the latter showed so much variation in this character that he felt justified in uniting the fossil forms with the modern species. Yet lacking at present any knowledge of the fructification it is considered better practice to retain Forbes' designation for the early Tertiary forms.

Although the species is common in Paleocene formations of Canada, the specimens so far gathered are fragmentary, all are sterile, and they add little to our knowledge of the species.

Occurrence. Paskapoo formation, locality 3698; post-Brazeau Paleocene beds, localities 3363, 3397, 3477, 3572; Ravenscrag formation, Saskatchewan, localities 1549, 4091, 4126, 4134, 4135, 4143.

Types. Plesiotypes, G.S.C. Nos. 5459e, 5481, 5922, 7393, 7394, 7395.

Dryopteris georgei ? Knowlton

Plate IV, figure 1

Remarks. The only specimen to hand comprises a single, ultimate pinna embedded in a ferruginous siltstone, and immediately surrounded by a concretionary, smoothly bordered lamina of clay-ironstone. On account of this peculiar preservation the specimen resembles a section of a pod-like fruit. But otherwise the pinnule-like segments have the size and form of those of Knowlton's species (Knowlton, 1922, p. 108, Pl. 1, figs. 6, 7); they are evidently coriaceous, sessile, contiguous, 6 mm. long by 2 to 2·5 mm. wide, and mucronately tipped; each has a more or less well-defined imprint of what is interpreted to be a strong midrib; lateral veins, however, are not preserved, and this precludes satisfactory specific reference. The rachis of the pinna is remarkably stout, about 1·5 mm. wide at the basal end.

The specimen was collected, and kindly donated to the Geological Survey, by H. S. Jones, Eastend, Saskatchewan.

Occurrence. Frenchman formation, Saskatchewan, locality 3707.

Type. Plesiotype (?), G.S.C. No. 6352.

Asplenium ? penhallowi n.sp.

Plate XXVI, figures 1, 3, 4

Lastrea fischeri Penhallow (*non* Heer), Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 48 (1902).
Sphenopteris guyottii Penhallow (*non* Lesquereux), Roy. Soc., Canada, Trans., 2nd. ser., vol. VIII, sec. IV, p. 48 (1902).

Description. Frond, bipinnate. Pinnæ, lanceolate, up to 2 cm. or more broad, rather abruptly contracted at apex; rachis, stout, winged. Pinnules, attached to rachis at open angles, sub-oblong, entire, with obtuse to bluntly acute apices, the proximal ones more or less free, the remainder becoming more connate towards apex of pinna, nearly straight to sub-falcate. Midrib, pronounced, distally curved or flexuous. Laterals, 5 to 7 pairs, alternate, oblique, simple or rarely once divided, more or less curved upwards, particularly the basal pair, which arise at base of midrib and run parallel with the narrow sinuses between the pinnules without anastomosing with basal vein of adjacent pinnule.

Remarks. The sterile frond differs from that of *Lastrea fischeri* Heer and *Asplenium alaskanum* Hollick mainly in its less elongate and stouter pinnæ, and in the pinnules possessing fewer lateral veins. *Sphenopteris guyottii*, recorded by Penhallow from the Paskapoo formation, is quite distinct from Lesquereux's species. His identification was based on a single fragment (Plate XXVI, figures 3 and 4), the apical end of an ultimate pinna, and is considered by the writer to belong to *Asplenium ? penhallowi*, which occurs within the same beds.

Occurrence. Paskapoo formation, localities 262, 1202.

Types. Holotype, G.S.C. No. 5553; paratype, No. 5551.

Adiantum ? paululum n.sp.

Plate I, figures 2, 4, 6, 10

Description. Leaf, very small, cuneate, petiolate, coriaceous or sub-coriaceous; blades, 5 to 6 mm. wide and 5 to 8·5 mm. long; petiole, 0·5 to 0·75 mm. wide and up to 1 cm. or more long. Attachment to main axis unknown, but in several specimens the leaves lie singly at the ends of a dichotomous-like division of an axis similar to that of the petioles. The base of the leaf is rounded-cuneate, rising like an expansion of the petiole, and the sides nearly straight or flatly convex; upper margin is truncate to flatly convex, and is furnished with 8 to 12 acute, triangular, sharply pointed teeth with intervening rounded sinuses; similar teeth very rarely are seen down the sides. Veins, relatively thick and strong, dichotomously divided, spreading fanwise from base of blade; a few leaves show very rare anastomosing veins. Fertile organs, unknown.

Occurrence. St. Mary River formation, localities 1272, 3583.

Types. Holotype, G.S.C. No. 6172; paratypes, Nos. 6173, 6174, 6190.

Filicites knowltoni Dorf

Plate I, figures 1, 3

Original Description. "Pinnules relatively small, averaging 6·9 mm. long and 3·5 mm. wide, oblong-elliptic, entire-margined, and with fine, numerous anastomosing veins obliquely diverging from an indistinct midrib; pinnules closely spaced on pinna in alternate arrangement, attached only by central part of base; ultimate disposition of pinnæ unknown; fertile parts not preserved" (Dorf, E., 1942, p. 127).

Remarks. A single specimen from the Edmonton formation adds little to the above diagnosis of the species. The pinnule substance would seem to have been thick, and the imprints of the pinnules of our specimen are microscopically and closely punctate. The veins of this specimen divide two or three times, but anastomose rarely.

Occurrence. Edmonton formation (upper part), locality 4110.

Type. Plesiotype, G.S.C. No. 5194.

Nilssonia serotina Heer

Plate I, figures 5, 7; Plate IV, figure 4

Remarks. Imperfect specimens of a *Nilssonia* probably referable to *N. serotina*, as interpreted by Hollick. The frond is cut, seemingly in large part by splitting, into pinnatiform segments, 4 to 8 mm. wide by 15 mm. long, attached to upper face of a stout rachis, about 3 mm. wide. Veins, simple, strong, 0·5 to 0·75 mm. apart. Under a hand lens the surface is striated by a cell-like reticulum.

Occurrence. Edmonton formation (lower part), localities 1632, 3470; Brazeau formation (upper part), locality 3275.

Types. Plesiotypes, G.S.C. Nos. 5173, 5936, 6336.

Nilssonia sp.

Plate IV, figure 3

Remarks. Fragments of leaves, originally entire or split into uneven segments about 4 cm. wide. The veins are a little less than a right angle to the midrib, are slightly curved in their course to the margin, and spaced 8 to 10 in 5 mm. It is questionable whether these leaves belong either to *Nilssonia johnstrupi* Heer or to *N. gibbsii* (Newberry), two species that are united by some authors, but which are regarded as specifically distinct by the writer. *Nilssonia johnstrupi* is a late Lower Cretaceous form, whereas *N. gibbsii* occurs in the mid-Upper Cretaceous.

Occurrence. Edmonton formation (lower part), localities 3470, 3677.

Type. Figured specimen, G.S.C. No. 6335.

Carpolithus (Cycadinocarpus?) ceratops (Knowlton)

Plate XII, figures 3, 6

Aesculus antiqua Dawson *pars*, Rept. British N. A. Bound. Comm. (Rept. Geol. and Resources, vicinity 49th Parallel), Appen. A, p. 330, Pl. 16, fig. 9 (? *non* fig. 8) (1875).
Ficus ceratops Berry, Geol. Surv., Canada, Mem. 182, p. 28 (1936).

Remarks. In the Frenchman formation (formerly Lower Ravenscrag) a large number of seeds are preserved as imprints and casts. They are obovate in longitudinal section, circular in cross-section, when unflattened by crushing, up to 5 cm. long by 4 cm. broad. The apical end is broadly rounded; the proximal end, constricted and truncated. The nucellus forms the largest part of the seed, and is up to 4·5 cm. long by 3 cm. broad. In some states of preservation it is marked by rather regular, longitudinal costæ, which run from the chalazal end to converge, and seemingly anastomose near the apical pit. These costæ are interpreted to be the spaces between vascular strands that surround the nucellus, and the apical pit is thought to represent a pollen chamber. The nucellar area is surrounded by a thin sclerotesta, commonly turned to coal, and an outer, thick, originally fleshy coat, from 1 to 6 mm. wide, the variable width apparently due to differential shrinkage. In one specimen of exceptional preservation one surface (outer?) of the sclerotesta is marked by microscopic, delicate, longitudinal, irregularly anastomosing, flexuous striæ, about 10 per millimetre, which, in common with the intervening spaces, are crossed by even more minute, closely spaced, transverse lines.

The resemblance of the nucellar part of these seeds to *Ficus ceratops* is sufficiently close to infer that the latter are nucellar casts that lack preservation of the sarcotesta. Possibly the seeming 'collars' that R. A. Brown (1939, p. 248) observed in some specimens of *Ficus ceratops* are remains of this outer coat. The narrow end of the nucellar cast in some of the Canadian specimens is marked on the exposed half by two furrows, about 1 cm. long, 0·5 cm. apart at the chalazal end, diverging to 1 cm. apart internally. The significance of these furrows is unknown.

The seeds are comparable in size to those of some living cycads, as *Cycas circinalis.*

One at least of the two syntypes of *Aesculus antiqua* Dawson (G.S.C. No. 5451a, and figure 9 of the above reference) is certainly conspecific with *C. ceratops*. This would give Dawson's species priority, but the published figure is too poor to form the basis of a species, and the description is based primarily upon the other syntype (G.S.C. No. 5451). This latter, which has irregular flange-like projections, may be a distinct species, and considered as the lectotype of *antiqua,* or it may be only a pathological form of *C. ceratops*.

Occurrence. ? St. Mary River formation, locality 3581; Edmonton formation (upper part), locality 3678; Frenchman formation, Saskatchewan, localities 3687, 4173.

Types. Plesiotypes, G.S.C. Nos. 5201, 5203.

Ginkgoites adiantoides (Unger)

Plate XXXII, figures 1, 3

Remarks. Leaves, long-petiolate, with fan-like blades up to 7 cm. or more broad, entire or bilobate or marginally lobed. Lamina is decurrent on petiole, and base may be cuneate or truncate. Veins palmately spreading from petiole, well defined, dichotomizing several times, averaging about 0·7 mm. apart in middle of blade.

Occurrence. Wapiti group, locality 3671; Paskapoo formation, locality 3446.

Types. Plesiotypes, G.S.C. Nos. 6152, 6153.

Ginkgoites sp.

Plate III, figures 1, 2

Remarks. Two specimens of *Ginkgo* leaves figured here draw attention to the fact that laciniate or deeply lobed, cuneate leaves comparable to *G. digitata*, common in the Jurassic and early Cretaceous, were present as well in the closing stages of the Cretaceous, in addition to the entire or slightly bilobate, cuneate leaves usually assigned to *G. laramiensis* Ward or to *G. adiantoides* (Unger) Heer.

Occurrence. Edmonton formation (lower part), locality 4167.

Types. Figured specimens, G.S.C. Nos. 5174, 5175.

Carpolithus (Ginkgoites?) fultoni n.sp.

Plate XII, figures 4, 7; Plate XIII, figures 1, 2

Description. Seeds, excluding sarcotesta, which is not preserved, slightly obovate, 9 to 12 mm. long by 7·5 to 9 mm. wide, with a minute mucron at apical end, when well preserved, and seeming traces of two vascular bundles passing through the sclerotesta at chalazal end. Sclerotesta, about 1 mm. wide, smooth, slightly flattened externally to form two obscure, rounded, lateral keels, but less pronounced than in seeds of *Ginkgo biloba.* Nucellus, smooth, but commonly siliceous casts have longitudinal, anastomosing ridges.

Remarks. In some ironstone nodules and lenses in the Edmonton formation, such seeds are abundant, preserved only as siliceous casts (but not showing structure) of the nucellus; in some instances the silica was deposited only next the inner wall of the sclerotesta, leaving the central part hollow.

The species is named after W. R. Fulton of Drumheller, Alberta, who has collected many fine plant remains from the Edmonton formation.

Occurrence. Edmonton formation (lower part), localities 3467, 3470; ? St. Mary River formation, locality 3583.

Types. Holotype, G.S.C. No. 5142; paratypes, Nos. 6285, 6286, 6288.

Carpolithus (Ginkgoites?) kneehillensis n.sp.

Plate XI, figures 1, 2

Description. Seeds excluding sarcotesta, which is not preserved, subcircular in longitudinal cross-section, up to about 18 mm. diameter; elliptical in transverse cross-section. Sclerotesta, about 1 mm. wide. Nucellus, smooth. Traces of what are interpreted to be those of vascular bundles, pass through the sclerotesta at chalazal end to merge with cast of nucellus.

Remarks. The seed is similar to, but about twice the size of, *C. fultoni.* The species is named after the settlement of Kneehill near Drumheller, Alberta.

Occurrence. Edmonton formation (lower part), locality 3683.

Type. Holotype, G.S.C. No. 6323.

Carpolithus (Ginkgoites?) selwyni n. sp.

Plate LXVI, figure 1

Description. Seeds like *Carpolithus fultoni*, but relatively broader, generally a little longer than wide, and without an apical mucron. They are obovate to globular, 11 or 12 mm. long by 9 or 10 mm. wide, with basal (?) end truncated by a tangential, collar-like swelling, inwardly from which two parallel, raised areas cross the wing to meet the border of the nucellar area.

Remarks. The species is named after A. R. C. Selwyn, former Director of the Geological Survey of Canada, and an early pioneer in the study of the geology of western Canada.

Occurrence. Ravenscrag formation, Alberta, locality 2188; Paskapoo formation, locality 4118; Willow Creek (upper part), locality 3700.

Type. Holotype, G.S.C. No. 6290.

Torreyites tyrrellii (Dawson)

Plate VII, figures 3, 4; Plate VIII, figures 1, 4

Abietites tyrrellii Dawson, Roy. Soc., Canada, Trans., vol. III (1885), sec. IV, p. 17 (1886).

Remarks. Twigs, sparingly branched. Leaves, lanceolate, spirally disposed, up to 3·5 cm. long by 4 mm. wide, straight to subfalcate, rather thick, flatly triangular or plano-convex in cross-section, obliquely ascending or spreading to a position normal to axis. Midrib, concealed, its position being marked on lower surface by rounded keel. Lower surface of leaf marked by two, flat, pustulose bands, $\frac{1}{4}$ to $\frac{1}{2}$ mm. wide, one on each side of median line, about halfway to margin, apparently representing stomatiferous bands, the bands being slightly depressed below surface of leaf. Leaf scars on axis, pronounced, rhomboidal to obovate.

Although *Cunninghamites elegans* Heer (? *non* Corda) from the Patoot beds of Greenland has a superficial likeness to this species, no mention is made of stomatal bands, and the median nerve is stated to be well marked. *Tumion carolinianum* Berry, with somewhat narrower leaves, is seemingly closely related to Dawson's species, if not actually conspecific, agreeing in the non-distichous arrangement of the leaves, in the presence of two stomatiferous bands, and in the obscure preservation of a midrib.

Araucarites longifolia (Lesquereux) Dorf is another species superficially like the present one, but its leaves are apparently notably constricted at the base, lack stomatiferous bands, and are marked by a distinct midrib.

At first the writer was inclined to consider Dawson's species as abietinean on account of associated ovoid-globular cones described elsewhere in this report as *Pityostrobus* sp., but no proof was found of any organic connection between cones and foliage.

Occurrence. Bearpaw formation, Alberta, locality 3263; Edmonton formation (lower part), localities 12, 3469.

Types. Lectotype, G.S.C. No. 6459; plesiotypes, Nos. 5399, 6281, 6283.

Elatocladus (Taxites?) olriki Heer

Plate XXIX, figure 5; Plate XXX, figure 2

Taxites olriki Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 23, fig. 5 (1887).

Remarks. Although the leaves of *T. olriki* may be as long as 5 cm., surpassing the largest leaves of *Sequoiïtes langsdorfii*, it is sometimes difficult, owing to conditions of preservation, to differentiate between the two species. This is due to the contracted base of *S. langsdorfii*, which when twisted into one plane gives a false appearance of non-decurrence. However, actual decurrence in such cases may be inferred from ridges, or grooves, running from the base of a leaf obliquely downward and across the axis of the stem. Ridges and grooves occurring on the stems of *T. olriki* do not run thus obliquely, but parallel the axis of the stem. The leaves of *T. olriki* are abruptly contracted at the base to peg-like stalks not more than 0·5 mm. broad which are round in cross-section. The leaves, like those of *S. langsdorfii*, are microscopically striated. The midveins are broad, usually broader and more conspicuous than those of *S. langsdorfii*. The apices of the leaves are rounded or obtusely pointed and lack the mucronate points commonly seen in *S. langsdorfii*.

Occurrence. Wapiti group, locality 3671; post-Brazeau Paleocene beds, locality 3428; Paleocene of Mackenzie River Valley, locality 4092.

Types. Plesiotypes, G.S.C. Nos. 3981, 5465.

Androvettia catenulata n.sp.

Plate XV, figures 1 to 5; Plate XVI, figure 4; Plate XXVII, figures 5, 7, 8

Description. Axis of branches, phylloclad-like, constricted at regular intervals into obovate, triangular, wedge-shaped segments, each of which may have a pair of opposite, distichous branches arising obliquely from its upper, expanded part. Each segment is provided with a central vascular strand and two pairs of strongly ascending, opposite, lateral veins, which are slightly curved outwards. The lower of these pairs are simple, rise at the base of each segment opposite the marginal constrictions, and terminate at the top of the segment a short distance within the margin; the other pair rises about a third of the length of a segment from the base, gives off an adaxial, thin branch about halfway in its course, and continues as the midvein of the lateral branch.

Remarks. Mr. R. L. Fowler of Aldersyde, Alberta, has the honour of discovering this representative of a remarkable genus, and this so far as known to the writer is its first recorded appearance in strata later than Upper Cretaceous. Unfortunately, the remains are few and fragmentary and the lateral, distichous branches are preserved only rarely. The species is apparently closely allied to *Androvettia carolinensis* Berry (1910, p. 183, Pl. 19, figs. 1-6; 1919, p. 62, Pl. VII, figs. 1-10) from the Tuscaloosa formation, but the leaves have undergone apparently even greater reduction, and are no longer discernible in the specimens to hand. It is probable that the ultimate branches are marginally lobate like those of *A. carolinensis*.

Occurrence. Paskapoo formation, locality 1191; Willow Creek formation (upper part), locality 3700.

Types. Holotype, G.S.C. No. 6303; paratypes, Nos. 6346 to 6350

Pityostrobus (Cunninghamiostrobus?) sp.

Plate VII, figures 1, 2

Remarks. Cones, ovoid-globular, 2 to 2·5 cm. broad and a little longer; cone scales, broad, concavo-convex, seemingly shaped much like those of the living *Cunninghamia sinensis.*

Occurrence. Edmonton formation (lower part), locality 12.

Types. Figured specimens, G.S.C. Nos. 5081, 5082.

Sequoiites langsdorfii (Brongniart) Heer

Plate XXVII, figures 4, 6; Plate XXIX, figures 1, 3

Remarks. Sequoiites langsdorfii is most apt to be confused with certain forms identified by American authors as *Taxodium dubium,* and with sterile foliage in certain states of preservation differentiation may be difficult. *Sequoiites langsdorfii,* however, in general may be reliably identified by its apparent opposite and distichously disposed leaves that have decurrent, somewhat contracted bases; twisting of the decurrent leaves into one plane is commonly revealed by raised lines running from the bases of the leaves obliquely across the axis of the shoot. In species classed as *Taxodium dubium* the bases of the leaves are still more contracted, and the axis is most commonly marked by raised lines running down from the leaf stalks parallel with the axis. Moreover, when the proximal ends of the deciduous shoots of *Sequoiites langsdorfii* are preserved they are marked by a short tuft of scale-like leaves, absent in *Taxodium.*

R. W. Chaney (personal communication) recently allocated this species to *Metasequoia,* but owing to absence of attached cones the writer prefers to employ the form genus *Sequoiites.*

Occurrence. Post-Brazeau Paleocene beds, localities 3426, 3428, 3435, 3445; Paskapoo formation, locality 3462.

Types. Plesiotypes, G.S.C. Nos. 5991, 5992, 5995, 6133.

Sequoiites artus n.sp.

Plate IV, figures 7, 8; Plate V, figures 4, 6; Plate XVI, figure 2; Plate XVIII, figures 1, 4

Sequoia nordenskioldi Berry pars (*non* Heer), Geol. Surv., Canada, Mem. 182, p. 18 (1935).

Description. Branch foliage, with pseudo-distichous, narrow, sessile, moderately decurrent, nearly straight-sided, acutely pointed, relatively thick leaves. Leaves, 0·75 to 1·75 mm. wide and up to 1·2 cm. long, little constricted at base. Midrib, relatively broad, and generally well marked. Associated cones, which may belong to this species, are similar to those of *Sequoia dakotensis* Brown.

Remarks. It is not always possible to separate this species from *Sequoiites langsdorfii.* When many specimens are available, however, the form here described differs from typical specimens of *S. langsdorfii* in its narrower and seemingly thicker leaves, which are commonly alternately disposed, and less constricted at the base. It differs much more from *Elatocladus (Cryptomerites?) nordenskioldi* (Heer), lacking any short, semifalcate leaves and conspicuous decurrence of the leaves on the axes. *Sequoia nordenskioldi* Dorf (*non* Heer) (1938, p. 45, Pl. I, fig. 10) is considered to be conspecific with this form.

Occurrence. Edmonton formation (lower part), localities 9, 12, 13, 1612, 3467, 3470, 3677, 3683; St. Mary River formation, locality 4102; Brazeau formation (upper part), locality 3476; Wapiti group, localities 3670, 3674.

Types. Holotype, G.S.C. No. 5192; paratypes, Nos. 5951, 6325, 6326, 6358.

Elatocladus (Sequoiites?) ungeri (Heer)

Plate XXVIII, figures 1 to 3

Description. Sterile foliage, profusely branched at acute angles. Leaves acicular, decurrent, up to 5 or 6 mm. long by 0·5 mm. wide, oblique to highly ascending, mucronately tipped, nearly straight to slightly falcate, not constricted at base, a few at base of branchlets shorter (about 1 mm. long) and more or less falcate. Female cones, terminal, oval, about 1 cm. long by 6 mm. broad, with 4 or 5 peltate or distally expanded scales on each side of axis in a median section; each scale 3 or 3·5 mm. broad by 2·5 mm. long including stalk of 1·5 mm.

Remarks. A small cone-bearing branch referred by Heer to a young branch of *Sequoiites langsdorfii* (Heer, 1868, Pl. 47, figs. 15, 15b), seemingly belongs to this species. The foliage of the species is finer and more delicate than that of *Elatocladus (Cryptomerites ?) nordenskioldi* or of *C. lambii*.

Occurrence. Paleocene (?), British Columbia, locality 3488.

Types. Holotype, G.S.C. No. 6264; paratype, No. 6265.

Sequoiites ? couttsiae ? (Heer)

Plate XXXI, figure 1

Remarks. Single specimen of a well branched foliage shoot. Leaves adpressed to stem or with their apices slightly free, 2 or 3 mm. long by 0·5 mm. broad, acutely tipped. They agree closely with Oligocene specimens from Bovey Tracey, England. Some at least of Heer's specimens from Greenland, with more spreading leaves, and which were separated by J. S. Gardiner (1883, pp. 35, 39) as a distinct species, *Sequoia whymperi*, appear to belong more probably to *Cryptomerites lambii*. Until better specimens and fertile remains are secured from the beds at Lewes River the specific reference and taxonomic relations to *Sequoia* or to *Cryptomeria* must remain questionable.

Occurrence. Paleocene (?), Lewes River, Yukon, locality 4009.

Type. Plesiotype ?, G.S.C. No. 7464.

Sequoiites dakotensis (Brown)

Plate V, figures 1 to 3

Remarks. Various cones, each with about 25 peltate scales, probably conspecific with *Sequoia dakotensis* Brown.

Occurrence. Edmonton formation (lower part), locality 13; Edmonton formation (upper part), localities 1633, 4120; ? Wapiti group, locality 3674; Frenchman formation, Saskatchewan, locality 2172.

Types. Plesiotypes, G.S.C. Nos. 5178, 5179, 5927.

Cryptomerites lambii n.sp.

Plate XXIX, figures 2, 4; Plate XXX, figures 1, 3, 4, 5; Plate XXXI, figure 4; Plate XXXII, figures 2, 4

Sequoia couttsiae Dawson (*non* Heer), in Tyrrell, Geol. Surv., Canada, Ann. Rept. 1886, new ser., vol. II, pt. E, p. 136 (1887).

Glyptostrobus sp. Dawson, Geol. Surv., Canada, Ann. Rept., new ser., vol. III, pt. I, pt. B, p. 149 (1889).

Sequoia couttsiae Penhallow (*non* Heer), Roy. Soc., Canada, Trans., vol. VIII, sec. IV, p. 50 (1902).

Description. Sterile, ultimate twigs, rather sparingly branched at acute angles, clothed with spirally disposed leaves. Leaves, 0·5 to 1·5 mm. wide and up to 7 mm. long, linear-lanceolate, sharply pointed, uninerved, nearly straight to falcate, and awl-like, highly ascending to spreading, alternate, decurrent. Female cones, sub-globose, 10 mm. diameter or more, with distally broad, deeply fringed scales. Male aments, oval, about 4 mm. long by 2 to 3 mm. wide.

Remarks. Specimen 5524 (Pl. XXXII, fig. 4) shows two cones attached to a foliar shoot. Although the details of the scales are obscure, they have deeply fringed, apical borders, recalling those of the living *Cryptomeria japonica.* The species is seemingly close to *Cryptomerites du noyeri* (Baily) Seward, differing, however, in the more slender ultimate branches, less crowded leaves, and smaller cones. The sterile shoots are similar to those figured by Gardiner from Eocene beds of England as *Taxodium europaeum*, which Seward stated furnished no convincing evidence of close relationship to the living *Glyptostrobus heterophyllus.*

Smaller leaves of *Elatocladus (Cryptomerites?) nordenskioldi* may be confused with leaves of *C. lambii*, but with sufficient specimens the thicker, broader, pagiophylloid and falcate or sub-falcate leaves of *C. lambii* may readily be differentiated.

Specimen 7466 (Pl. XXXII, fig. 2), Dawson's *Glyptostrobus* sp., which has somewhat larger falcate leaves than most specimens of *C. lambii*, was first believed to represent *Araucarites goepperti* Gardner (=*Araucarites sternbergi* Goeppert, Seward). It agrees, however, so closely with *C. lambii*, that it probably belongs with that species. This specimen resembles *Elatides curvifolia* from the Lower Cretaceous as well as specimens referred to *Geinitzia reichenbachi* (Geinitz). Both these last mentioned species, however, have generally longer leaves than those of *C. lambii.*

Occurrence. Paskapoo formation, localities 1202, 3441; post-Brazeau Paleocene beds, localities 3374, 3375, 3426.

Types. Holotype, G.S.C. No. 5524; paratypes, Nos. 5523, 5537, 5549, 5550, 6140, 6259, 6262, 7466.

Elatocladus (Cryptomerites?) nordenskioldi (Heer)

Plate XXXI, figures 2, 3, 5

Sequoia nordenskioldi Penhallow, Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 50 (1902).
Sequoia nordenskioldi Berry, Geol. Surv., Canada, Mem. 163, pp. 63, 64 (1930).
Sequoia nordenskioldi Berry (*pars*), Geol. Surv., Canada, Mem. 182, p. 18 (1935).

Remarks. Sterile twigs, moderately branched at acute angles. Leaves, heterophyllous, markedly decurrent, uninerved, varying from small, lanceolate, sub-falcate, highly ascending, acutely pointed, to spreading, linear, mucronate, from 0·5 to 1·5 mm. wide and 2 to 18 mm. long; the leaf base is not contracted, or only slightly so adaxially; the decurrent part forms a wing to the parent axis.

Heer noted that the leaves of his specimens were sharply pointed; although this character is not shown in most of his figures of specimens from Spitzbergen, it is better displayed in illustrations of Greenland specimens (Heer, 1875, Pl. I, fig. 30). Commonly the very short, upwardly directed, mucronate tips are hidden in the matrix. Where our specimens depart most widely from those figured by Heer is in the presence of branches with spreading, relatively long, linear, distichously arranged leaves similar to those figured by Newberry (1898, Pl. 26, fig. 4). But in a few instances such leaves are present with smaller, spirally disposed ones on the same branching system (Pl. XXXI, fig. 3). Heer referred a sequoiaceous cone to his species; this reference, however, has little to support it, for the same beds (dark shales at Cape Staratschin, Spitzbergen) furnished specimens of *Sequoia brevifolia* Heer (=*S. langsdorfii*), and the cone is comparable in size with those associated elsewhere with *S. langsdorfii*. Specimens from Fort Union beds assigned by Newberry (1898, Pl. XXVI, figs. 6-8) to *Glyptostrobus europaeus* are considered by the writer to belong to *Cryptomarites lambii*. Knowlton (1898, p. 681) considered these specimens to have come from Fort Union beds at the mouth of Yellowstone River; he was inclined to think them conspecific with *Sequoia couttsiae*, and not to belong to *Glyptostrobus*.

The sterile shoots are practically indistinguishable from those figured by Gardner as *Taxodium europaeum*, which Seward (1919, p. 329) regarded as doubtfully referable to that species.

Specimens from the Whitemud formation of Saskatchewan identified by Berry as *Sequoia nordenskioldi* do not belong to that species, but are elsewhere in this report described as *Elatocladus intermedius* (Hollick). So far as the writer knows *Elatocladus nordenskioldi* has not been found in any Upper Cretaceous formation in western Canada.

Occurrence. Paskapoo formation, localities 1202, 3441, 3443, 3444, 3462, 3468; post-Brazeau Paleocene beds, localities 3374, 3375, 3426, 3428, 3433, 3435, 3445; Ravenscrag formation, Saskatchewan, localities 1548, 4078, 4124, 4130, 4135, 4136, 4137, 4141, 4145, 4147.

Types. Plesiotypes, G.S.C. Nos. 6134, 6261, 6263.

Elatocladus (Taxodites?) tinajorum (Heer)

Plate XVI, figure 3; Plate XXXII, figure 5

Taxodium tinajorum Dawson, Geol. Surv., Canada, new ser., vol. III, pt. 1, pt. B, p. 149 (1889).

Remarks. Sterile twigs, provided with strongly ascending, pseudodistichally arranged, linear, apically acute leaves. Leaves, up to 3 cm. long or more and 2 mm. wide, contracted at base to 0·3 to 0·5 mm. at point of attachment, non-decurrent. Midrib, broad, overlain by a furrow on dorsal surface.

The above description is practically the same as that given for *Elatocladus (Taxodites?) intermedius* in another place in this report. The only tangible difference in appearance is the strongly ascending leaves of *E. tinajorum* (commonly about 25 degrees to the axis) as compared with the generally more spreading or lax leaves of *E. intermedius*. But the leaves on certain specimens of the latter in the apical region of the twigs may likewise ascend strongly, and with no suite of specimens for comparison the differentiation of the two species by macroscopic inspection is not possible. Whether the two species are really different will probably only be proved when comparisons are made with the aid of cuticular preparations.

All the twigs to hand are unbranched, as are Heer's types. The leaves are more ascending, relatively more narrow, and contracted more gradually at base than those of *Taxites olriki*.

Occurrence. Paleocene (?), Yukon, locality 4009; Paleocene, British Columbia, locality 3488; Willow Creek formation (upper part), locality 3700.

Types. Plesiotypes, G.S.C. Nos. 6365, 7463.

Elatocladus intermedius (Hollick)

Plate V, figures 7 to 9; Plate VI, figures 1 to 3

Remarks. Sterile shoots, unbranched or rarely so; leaves, spirally disposed but distichously arranged, commonly rather distant, narrow, about 45 degrees to axis or more spreading, up to 3 cm. long by 1·5 mm. broad, linear, with nearly parallel sides and acute apices, contracted at base to a pseudo-petiole, non-decurrent. Axis below basal insertion of leaf is commonly marked by one or two raised lines parallel with the axial borders. Midrib, generally distinct, relatively broad. Surface of leaves, when well preserved, marked by microscopic, longitudinal striæ.

The species apparently includes forms designated by Hollick *Cephalotaxopsis microphylla laxa* and *Tumion gracillimum*, the only difference being width of leaf and obliquity of their insertions. To the writer Hollick's specimens have no close affinity with *Cephalotaxopsis microphylla* Fontaine (=*C. brevifolia* Fontaine). Similar sterile foliage has been identified commonly by American authors as *Taxodium dubium* (Sternberg) Heer, but the Cretaceous material here described is not believed to be conspecific nor likely congeneric with Tertiary forms referred to *Taxodium dubium*, regardless of their superficial resemblance (*See T. dubium* Knowlton, 1926, p. 27, Pl. IX, figs. 8, 9). Whether the present species is a *Taxodites* is doubtful. An unattached cone (*See Conites* sp., Plate V, figure 5, of this report) occurs in the same beds as specimens of the species, and also several isolated small cone scales similar in form to *Dammarites* although much smaller. The cone is small, 2 cm. long by 1 cm. wide, elliptical, and has crowded, imbricating scales, each about 4 mm. wide; the details of the scales are obscure, but they seemingly have narrow stalks, and broad ends with pointed tips. If the cones actually belong to *E. intermedia*, the latter is not taxineous, but more probably araucarinean or abietinean.

The species is distinguishable from *Sequoiites artus* by its generally unbranched twigs and by its contracted leaf bases.

Occurrence. Edmonton formation (lower part), locality 1612; Brazeau formation (upper part), localities 3274, 3466; Wapiti group, localities 3590, 3663, 3674; St. Mary River formation, locality 3585.

Types. Plesiotypes, G.S.C. Nos. 5176, 5944, 5966, 6113, 6278.

Thuites interruptus (Newberry)

Plate XXVII, figures 1 to 3

Thuja interrupta Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 22, Pl. 1, figs. 3, 4 (1887).
Thuja interrupta Berry, Geol. Surv., Canada, Mem. 182, p. 21, Pl. 3, fig. 1 (1935).

Remarks. Slender twigs with distichous, opposite branches. Leaves decussate; those in middle rows, ovate-lanceolate to rhomboid, abruptly acute at apex, appressed throughout; those in lateral rows, appressed and broad below, distally free, slightly falcate, and oblique or more spreading, narrowly pointed at apex. Midvein on middle leaves, prominent and raised.

Occurrence. St. Mary River formation, locality 3585; Edmonton formation (lower part), locality 12; post-Brazeau Paleocene beds, localities 3426, 3428, 3433, 3434, 3435; Paskapoo formation, locality 2063.

Types. Plesiotypes, G.S.C. Nos. 6142 to 6144.

Juniperites gracilis (Heer) Seward and Conway

Plate IV, figure 5

Remarks. The preservation is too poor to make out the details of the single specimen to hand. There are at least two small leaves in each whorl, in axils of which are bud-like structures about 2 mm. long and 1 mm. broad, which may be male aments.

Occurrence. Edmonton formation (lower part), locality 3677.

Type. Plesiotype, G.S.C. No. 6324.

Alnus serrata Newberry

Plate XXXIII, figure 6

Remarks. Leaf, subovate to rounded-rectangular, with truncate or slightly cordate base, coarsely and simply toothed above, and smaller teeth below. A short, simple, basal vein at right angles to midrib may be present below the main secondaries: secondaries, about 9 pairs, alternate or more rarely sub-opposite, 30 to 40 degrees to midrib or lowest more spreading; lower ones with 2 or 3 branches, upper ones with a single branch;

commonly deflected somewhat at point of branching, the branches running to the teeth. Tertiaries, transverse to secondaries, once divided or simply percurrent.

The proper generic reference is questionable, for the character of the teeth and division of the secondaries recall *Viburnum*. On the other hand, the transverse tertiaries and spreading basal secondaries are more like the venation of the *Betulaceae*.

The teeth are somewhat coarser and seemingly blunter than those of the type specimen.

Occurrence. Ravenscrag formation, Saskatchewan, locality 2301.

Type. Plesiotype, G.S.C. No. 6218.

Corylites fosteri (Ward)

Plate XXXIII, figures 1, 2, 3, 4, 5, 7

Remarks. Leaf, ovate, petiolate, commonly inequilateral; base, cordate; tip, acute or acuminate. Margins, serrate; teeth, broad at base with acute apices, 1 to 5 between the secondaries, subequal, or those at end of secondaries slightly larger. Secondaries, 6 to 8 pairs, commonly subopposite, 40 to 50 degrees to midrib, rather evenly spaced, craspedodromus, slightly curved upwards; lowermost with about 6 branches on lower side, remainder with 4 to 1 branches, or upper ones simple. Tertiaries, mixed, percurrent and divided, transverse to secondaries. Nervilles, mainly transverse to the tertiaries.

The writer would combine with this species *Corylus rostrata* Ward (1886, p. 551, Pl. XXXIX, figs. 1-4; 1887, p. 29, Pl. 13, figs. 1-4); *Corylus rostrata fossilis* Newberry (1898, p. 63, Pl. XXXII, figs. 1-3); and *Corylites nostratus* Seward and Conway (1935a, p. 21, text fig. 5).

Occurrence. Paskapoo formation, locality 3460.

Types. Plesiotypes, G.S.C. Nos. 6120 to 6125.

Dryophyllum (Castanea?) sp.

Plate XXXIV, figure 1

Remarks. A single specimen, with base missing, of a narrowly lanceolate leaf, seemingly close to *Castanea orientalis* Chaney, but tertiary veins, except rarely near the margin, not preserved. Margins, crenate-serrate, with low, broad crenulations capped by minute, forwardly directed, sharp teeth. Midrib, strong, slightly curving near apex. Craspedodromus secondaries straighter and more distant than those of *Dryophyllum subfalcatum* from the Upper Cretaceous, and straighter than those of *Castanea orientalis*. The Canadian specimen may be conspecific with *Dryophyllum longipetiolatum* Hollick (*non* Knowlton).

Occurrence. Post-Brazeau Paleocene beds, locality 3428.

Type. Figured specimen, G.S.C. No. 6136.

Quercus praegroenlandica Berry

Quercus praegroenlandica Berry, Geol. Surv., Canada, Mem. 182, p. 26, Pl. III, figs. 3-7 (1935).

Remarks. The specimens from Alexo area agree in all respects with the types from the Ravenscrag formation. A few of the secondaries may bifurcate. The tertiaries, in place of being mainly percurrent, are largely broken or irregularly flexuous among the nervilles. The teeth are broad, rounded-triangular, with abrupt, short, spine-like apices that are directed outwards and not upward.

Occurrence. Post-Brazeau Paleocene beds, locality 3428.

Types. Syntypes, G.S.C. Nos. 7398 to 7401.

Juglans lecontiana Lesquereux

Plate LVII, figure 1

Juglans lecontiana Penhallow, Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 60 (1902); Geol. Surv., Canada, Tert. Plants British Columbia, Pub. 1013, p. 59 (1908).

Remarks. This is a single specimen, on which Penhallow based his identification. It is too fragmentary for reliable identification, and may be an aberrant leaf of *Rhamnites marginatus* (Lesquereux) with which it is associated. However, the secondaries are much less ascending, and for the present Penhallow's identification is retained.

Occurrence. Paskapoo formation, locality 1202.

Type. Plesiotype, G.S.C. No. 5696.

Juglans thermalis Lesquereux

Plate LVII, figures 2, 3

Juglans acuminata Penhallow (*non* Braun), Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 61 (1902); Geol. Surv., Canada, Pub. No. 1013, p. 59 (1908).

Juglans laurifolia Penhallow (*non* Knowlton), Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 61 (1902); Geol. Surv., Canada, Pub. No. 1013, p. 60 (1908).

Remarks. Leaflets, entire, ovate-elliptical to oblong-ovate, with cuneate base and acute or acutely rounded apex. Midvein, moderately strong, straight or curved. Lowest pair of secondaries, opposite to sub-opposite, close to base or more suprabasalar, 35 to 40 degrees to midrib, camptodromus, united in lower half of leaf to succeeding pair of secondaries by tertiaries in a single series of loops. Remaining secondaries, 5 or 6 pairs, alternate, at open angles to midrib, brachyodromous, being simply looped together well within margin, rather unevenly spaced, with intermediate shorter veins of about equal strength, which anastomose with transverse and oblique tertiaries so as to form a loose, irregular network. Leaf substance, seemingly thin but firm.

These leaflets agree closely with Lesquereux's type specimen from the Middle Park formation, but not with the second specimen from the Denver formation, which may belong to a distinct species.

Occurrence. Paskapoo formation, locality 1202.

Types. Plesiotypes, G.S.C. Nos. 5699 (identified by Penhallow as *Juglans acuminata*) and 5698 (identified by Penhallow as *Juglans laurifolia*).

Juglans nigella Heer

Plate LVII, figure 5

Juglans nigella Berry, Geol. Surv., Canada, Mem. 163, p. 64 (1930); Nat. Mus., Canada, Bull. 63, p. 19 (1930); Geol. Surv., Canada, Mem. 182, p. 24 (1935).

Remarks. The leaflet figured here is oblong-elliptical, and somewhat inequilateral; the tip is missing; the vein pattern agrees closely with Heer's types, but the teeth are less conspicuous, although this is seemingly due in part to an inrolling of the margin.

Occurrence. Ravenscrag formation, Saskatchewan, locality 2187.

Type. Plesiotype, G.S.C. No. 5493.

Populus carneosa (Newberry)

Plate XXXV, figures 1 to 3; Plate XXXVI, figures 1 to 6

Remarks. Leaves, very variable, orbicular to elliptical to obovate with long petioles. Base, cuneate, to rounded, to broadly truncate. Apex rounded or bluntly acute. Margin, generally irregularly crenate-dentate to undulate-crenate in upper half, smooth below. Midrib, fairly broad in lower half, moderately straight or somewhat flexuous. Basal two pairs of secondaries, commonly more closely spaced than succeeding ones, at open to right angles to midrib, or acutely inserted and recurved outwards so as to parallel the margin. Remaining secondaries, more acutely inserted, irregularly spaced, the upper ones strongly curved to a position subparalleling midrib, or in more elliptical leaves less curved and running to the teeth. Secondaries may be joined in simple loops to branches from secondaries above, or both secondaries and branches on upper part of leaf may run to marginal crenæ. Tertiaries, transverse or slightly oblique to secondaries, percurrent or once divided.

Phyllites cupanioides (Newberry, 1898, p. 135, Pl. 41, figs. 3, 4) and *Populus mutabilis* Hollick (1936, p. 68, Pl. 33, fig. 1b) are considered by the writer to belong to this species. Although the generic reference of these leaves is still open to question, they bear considerable resemblance to *Populus mutabilis* Heer. One or two illustrated leaves from the Paleocene of Spitzbergen (Heer, A., 1877, pt. I, Pl. XXI, fig. 5), assigned by Heer to *Parrotia pristina* Ettingshausen, resemble the species, but apparently differ in having a trinerved appearance, which is due to their opposite, nearly basal, and ascending lower secondaries. Heer later (1883, Pl. LXXXIII, figs. 7, 7b, 8) described two much smaller leaves from Greenland as *Crataegus subtilis* and *C. tenuipes*, which appear to belong to a single species, and except for size strongly resemble *Populus carneosa*.

Occurrence. Paskapoo formation, localities 262, 3442, 3443, 3444, 3462.

Types. Plesiotypes, G.S.C. Nos. 5706, 5915 to 5917, 6119, 6248 to 6251.

Populus penhallowi n.sp.

Plate XXXV, figure 4

Description. Leaf, seemingly membranaceous, ovate-orbicular, entire, petiolate; base, truncate, slightly inequilateral, slightly cuneate at petiole. Midrib, well marked, thinning above, straight. Secondaries, about 6 pairs, alternate, or upper ones subopposite, about 50 degrees to midrib, distal half curved upwards and camptodromus, unevenly spaced, united by loops with secondary branches. Tertiaries, oblique to secondaries, divided, forming a loose mesh.

Remarks. Leaf and venation much like *Populus hyperborea* Lesquereux from Dakota group, but with broadly truncated base, and comparable also with *Dicotylophyllum shottoni* Seward and Conway (1935b, p. 32, text fig. 32), but with less upwardly curved secondaries. *Populus ungeri* Lesquereux, to which Penhallow originally referred this leaf, has more ascending and evenly spaced secondaries.

Occurrence. Paskapoo formation, locality 1202.

Type. Holotype, G.S.C. No. 5560.

Populus ? daturaefolia (Ward) Cockerell

Plate XXXIV, figures 2 to 6

Remarks. Leaves very variable, commonly inequilateral, ovate to obovate to orbicular, generally cuneate at petiole, which is long and commonly curved; margins, irregularly marked by spinulose teeth. Veins both craspedodromus and camptodromus; median nerve, thick in lower half of leaf, commonly curved. Secondaries, about 6 pairs, alternate to subopposite, variably inclined to midrib, and variably curved upwards; upper ones, strong, curved parallel to midrib; a basal, submarginal and opposite pair of nerves present in some instances. Usually 1 to 3 abaxial branches from secondaries of lower half of leaf; where one only is present there may be an appearance of pseudodichotomy. Surface, commonly wrinkled, and tertiaries poorly preserved, but where present mainly transverse and simply percurrent or divided.

Although there is some resemblance to such species of Cretaceous *Credneria*, e.g., *C. acerifolia*, and to some species of *Populus*, the true taxonomic relationship of the species remains decidedly questionable.

Occurrence. Paskapoo formation, locality 3460.

Types. Plesiotypes, G.S.C. Nos. 6126 to 6130.

Trochodendroides arctica (Heer)

Plate IV, figure 2; Plate IX, figure 4; Plate XX, figure 3; Plate XLIV, figure 2; Plate XLV, figures 1, 2; Plate XLVI, figures 1 to 3

Populus arctica Heer, Flora Fossilis Arctica, vol. I, p. 137, Pl. II, figs. 14, 15a (1868).
Populus richardsoni Heer, Idem, p. 137, Pl. XXIII, figs. 2a, 3 (1868).
Populus hookeri Heer, Idem, p. 137, Pl. XXI, fig. 16 (1868).
Hedera macclurii Heer, Idem, p. 138, Pl. XXI, fig. 17a (1868).
Populus arctica Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, Pl. I, fig. 8 (1887); Idem, vol. VII, sec. IV, Pl. X, figs. 2, 4 (1890).
Populus richardsoni Dawson, Roy. Soc., Canada, vol. IV, sec. IV, p. 27 (1887).
Populus hookeri Dawson, Roy. Soc., Canada, Trans., vol. VII, sec. IV, Pl. X, fig. 5 (1890).
Populus obtrita Dawson, Roy. Soc., Canada, Trans., vol. VIII, sec. IV, p. 8, text fig. 12 (1891).
Trochodendroides arctica Berry, Geol. Surv., Canada, Bull. 42, p. 109, Pl. XIII, figs. 1-4 (1926).
Trochodendroides speciosa Berry, Nat. Mus., Canada, Bull. 63, p. 22, Pl. V, fig. 8 (1930).
Trochodendroides cuneata Berry, Nat. Mus., Canada, Bull. 63, p. 20, Pl. V, figs. 2, 3 (1930); Geol. Surv., Canada, Mem. 182, p. 34, Pl. VI, figs. 1-6 (1935).
Grewiopsis mclearni Berry, Geol. Surv., Canada, Mem. 182, p. 50, Pl. XII,. fig 3; Pl. XIV, fig. A (1935).

Remarks. A baffling diversity of leaf forms is included here, and more than one species may be represented, but if so it would be extremely difficult to differentiate any except the extreme forms. The above synonymy includes only previously figured Canadian species. The Upper Cretaceous leaves assigned to this species are similar to the smaller leaves of the species in the Paleocene formations, and large leaves of the form of *P. richardsoni* Heer are particularly characteristic of the Paleocene.

Fruit, probably of this species, is described elsewhere as *Jenkinsella arctica* (Heer).

Occurrence. Edmonton formation (lower part), localities 1612, 1613; Brazeau formation (upper part), localities 3274, 3466, 3476; Wapiti group, locality 3663; Frenchman formation, Saskatchewan, locality 4139; Paskapoo formation, localities 1202, 4120; post-Brazeau Paleocene beds, localities 3426, 3428, 3435; Paleocene beds of Mackenzie Valley, locality 1552; Ravenscrag formation, Saskatchewan, localities 2182, 4127, 4133, 4138, 4148.

Types. Plesiotypes, G.S.C. Nos. 5040, 5506, 5581, 5582, 5695, 5918, 5919, 6114, 6345.

Jenkinsella arctica (Heer)

Plate IV, figure 6, Plate XLIV, figure 1

Leguminosites ? borealis Dawson, Geol. Surv., Canada, Ann. Rept. 1888-89, new ser., vol. IV, pt. D, p. 97 (1890).

Leguminosites ? arachioides Penhallow, Report on Tertiary Plants of British Columbia, Geol. Surv., Canada, Pub. 1013, p. 61, fig. 14 (1908).

Leguminosites arachioides Berry, Roy. Soc., Canada, Trans., 3rd ser., vol. XX, sec. IV, p. 196 (1926).

Leguminosites dawsoni Berry, Geol. Surv., Canada, Bull. 42, p. 112 (1926).

Leguminosites arachioides minor Berry, Geol. Surv., Canada, Mem. 182, p. 64 (1935).

Remarks. Heer (1870, p. 477, Pl. XLIII, fig. 12c; Pl. L, figs. 5-7) was apparently the first to describe and figure the species. Specimens described by Lesquereux (1873, p. 403) first as *Carpolithes arachioides*, and afterwards (1878, p. 30, Pl. LIX, figs. 13, 14) as *Leguminosites ?arachioides*, are more complete and show the individual fruits to be attached to the axis of spike, similar to specimens figured later by Penhallow (above reference) and by Hollick (1936, Pl. 30, fig. 4b; Pl. 120, figs. 8, 10-12). Hollick, erroneously, if Heer's figures are at all accurate, identified his specimens with *Nyssidium ekmani* Heer, which differs in the possession of more regular and continuous longitudinal costæ, which converge at the base and top of the fruit and between which are fine punctuate or pustulose striæ. Hollick, however, recognized the similarity of his fruits to *Leguminosites ? arachioides* Lesquereux, stating: "the only apparent difference between them being a matter of size".

A fruit spike of the species from the Eocene of England was illustrated by M. E. J. Chandler (1926, pp. 47, 48, Pl. VIII, fig. 6). It was compared by Chandler with the fruit of the living *Orites* of the family *Proteaceae*, and was designated *Orites* sp. Subsequently, isolated pods from the London Clay were described by Reid and Chandler (1933, p. 481, Pl. 28, figs. 1-5) as a new species *apocynoides*, and a new genus *Jenkinsella* was created for their reception. Reid and Chandler suggested a taxonomic position within the families *Apocynaceae* or *Asclepiadaceae*.

R. W. Brown, however, has presented rather convincing, circumstantial evidence in support of his conclusion that these fruits are closely related to those of the living *Cercidiphyllum* (Brown, 1939, pp. 485-499). Winged seeds similar to those of *Cercidiphyllum* were found at numerous localities in association, although not in organic connection, with the pod-like fruits. It is true that the fruits in Canadian formations occur ubiquitously within beds that carry abundant leaves of *Trochodendroides* belonging to the comprehensive species *T. arctica*, and they may well be the fruits of that species. Heer's specific name *arctica* may, accordingly, be an odd coincidence.

Berry's variety *minor*, except in size, is indistinguishable from the types of the species. Although small pods, which may be designated forma *minor*, are especially abundant in late Upper Cretaceous formations, the types came from the Wilcox flora, and similar pods occur commonly with larger ones in the Paleocene of western Canada. Accordingly, a specific differentiation on basis of size alone seems unwarranted, although other characters, unrecognized as yet, may prove that more than one species is represented.

Occurrence. Edmonton formation (lower part), locality 3677; Wapiti group, locality 3663; Paskapoo formation, locality 3442; Paleocene beds of Mackenzie River Valley, locality 1552.

Types. Plesiotypes, G.S.C. Nos. 6255, 6337; in collections, Geol. Surv., Canada, Ottawa.

Platanus basilobata Ward

Plate XLII; Plate XLIII, figures 1 to 3

Viburnum oxycoccoides Dawson, Roy. Soc., Canada, Trans., vol. III, sec. IV, p. 17 (1886); vol. IV, sec. IV, p. 29, Pl. II, fig. 15 (1887).
Platanus nobilis Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 24, Pl. I, fig. 7 (1887).
Platanus basilobata Berry, Geol. Surv., Canada, Mem. 182, p. 32, Pl. VI, fig. 7 (1935).

Remarks. Two forms of leaf are abundantly associated at locality 3446. The one is indistinguishable from the type specimens of *Platanus basilobata*, having entire margins, camptodromus, secondary veins, and variously developed pseudo-stipular, basal lobes. The other has slightly toothed margins, except along the base of leaf, dominantly craspedodromus secondaries, and seemingly lacks basal lobes, in all of which characters it is indistinguishable from *Platanus nobilis* Newberry. The writer prefers to regard these two forms as conspecific, in which case the proper specific designation would be *Platanus nobilis*, which was the name originally applied to specimens from the Ravenscrag formation by Dawson. However, none of the toothed forms so far to hand is sufficiently complete to justify discarding *basilobata* at this time, and there is a possibility that two distinct species are represented.

Associated with these leaves are a few fruits, about 2 cm. in diameter, composed of long, slender achenes attached to a central axis. The apices of the achenes are long, acuminate, and comparable with those of the living *Platanus racemosa*, the California sycamore. It is perhaps significant to note that the living species has both smooth and lightly toothed leaves.

Occurrence. Paskapoo formation, locality 3446.

Types. Plesiotypes, G.S.C. Nos. 5914, 6149, 6150, 6356; in collections, Geol. Surv., Canada, Ottawa.

Platanus raynoldsii Newberry

Plate XXXVII, figure 2; Plate XXXVIII; Plate XXXIX; Plate XL; Plate XLI; Plate XLIV, figure 3; Plate LX, figure 3

Remarks. Leaves, medium to rather large, variable, rotund to more usually ovate, up to 23 cm. long by 17 cm. wide, rarely more or less trilobate, with acute and occasionally extended apex, and rounded or broadly truncate base, though generally cuneate and decurrent along petiole; margin, undulate-crenate to dentate, with each crena marked asymmetrically by a commonly upwardly directed mucro, about 0·5 mm. long. Veins, commonly rather strongly ascending; primary laterals, subopposite, commonly slightly curved upwards, although occasionally straight or reflected slightly downwards, originating generally well above top of petiole, and meeting margin well above middle of leaf. But in inequilateral leaves one side may have a short, primary lateral meeting margin well below the centre. Each primary lateral is provided on its lower side with up to 6 or 7 branches, which may be craspedodromus or camptodromus. A thin pair of basal veins is commonly present below the primary laterals. Secondaries, 5 to 12 pairs, subopposite to alternate, 20 to 40 degrees to midvein and subparallel to primary laterals, except in tip of leaf where they may be more spreading, generally craspedodromus. Tertiary veins, rather distant, wavy or curved, both simple and divided, meeting secondaries a little obliquely or nearly at right angles. Nervilles, forming a network of quadrangular or polygonal cells ranging down to 0·5 mm. wide.

Knowlton (1930, p. 77) noted the unsatisfactory differentiation of this species from *Platanus haydeni* Newberry. The type specimens of both species were obtained presumably from Fort Union beds on Yellowstone River. If the specimen of *Platanus haydeni* figured by Newberry (1878, Pl. XIX) be considered the holotype of that species, it differs from the type of *P. raynoldsii* (Newberry, 1878, Pl. XVIII) mainly in the more pronounced trilobing, for Knowlton stated that the teeth of the type of *P. raynoldsii* were simple as in *P. haydeni* and not doubly serrate. Knowlton, nevertheless, differentiated *P. haydeni* on the basis of origin of the primary laterals, which were stated to arise at base of blade, which was not decurrent on petiole. Unfortunately, the base of the type of *P. haydeni* is missing, but in any case this is a character of doubtful specific importance among platanoid leaves. Supplementary type materials of *P. haydeni* (Newberry, 1898, Pl. XXXVIII; Pl. LVI, fig. 3) were considered to represent two young leaves of the species, although Knowlton doubted their reference to *P. haydeni*. Both have the characteristic non-lobed or faintly lobed form of the Paskapoo leaves assigned to *P. raynoldsii*. Additional figured material of *P. raynoldsii* was largely differentiated as var. *integrifolia* by Lesquereux, and was gathered from the Denver formation of Golden, Colorado. According to Knowlton the margins of these leaves are indefinite or destroyed.

Occurrence. Paskapoo formation, localities 3443, 3444; Porcupine Hills formation ? or Willow Creek (upper part), locality 3140; post-Brazeau Paleocene beds, localities 3426, 3428.

Types. Plesiotypes, G.S.C. Nos. 5977 to 5979, 6191, 6243, 6244, 6355.

Platanus raynoldsii integrifolia Lesquereux

Plate XIX, figure 4

Remarks. Knowlton drew attention to the uncertain status of *Platanus raynoldsii integrifolia* Lesquereux, at the same time recording his opinion that "Lesquereux was probably right in believing that these leaves from Golden (Colorado) are more nearly entire than the types from the Fort Union formation, but they are not so entire-margined as the figures would imply" (Knowlton, 1930, p. 79). In the upper part of the Edmonton formation large fragments of a *Platanus* occur that agree well with Lesquereux's reconstruction of his Denver species. They differ from the type of *Platanus raynoldsii* Newberry in their sub-orbicular outline, the absence or faintness of lobing, and in a prevailing undulate-crenate margin. The marginal crenæ, when well preserved, are capped by a minute mucro at the ends of the veins. The primary laterals are opposite or subopposite and arise generally well above the top of the petiole, as in *P. raynoldsii.* There is a variable number of basilar, tertiary, camptodromus veins below the primary laterals.

The blade of the largest leaf observed is about 20 cm. long and about the same wide, with petiole more than 8 cm. long. Its opposite primary laterals arise well above the top of petiole at an angle of 35 degrees to the midvein. Unfortunately, the margin of this specimen is missing, except at the base where it is entire. But in other fragments of equally large leaves the margin is seen to be undulate-crenate as noted above.

These leaves seemingly are specifically distinct from the Paleocene *Platanus raynoldsii*, but in view of the lack of a complete specimen to serve as a suitable type, the writer prefers at this time to retain their present allocation as a form of *Platanus raynoldsii.*

Occurrence. Edmonton formation (upper part), locality 3679; Wapiti group, locality 3668.

Type. Plesiotype, G.S.C. No. 6313.

Platanophyllum sp.

Remarks. This leaf is too fragmentary to be worthy of anything but passing notice on the presence in the Edmonton formation of rather large, deeply dissected, trilobed leaves similar to *Aralia ? serrata* Knowlton (1917, p. 341, Pl. CVIII, fig. 4). Knowlton (op. cit., p. 341, Pl. CVII, fig. 2) recorded another species in the Raton formation, *Aralia coloradensis*, which has a secondary pair of basal lobes and smaller marginal teeth than *serrata.* In the single specimen from the Edmonton formation the leaf has a cuneate base, with the three primary veins arising at the base; only one lateral lobe is preserved, and that poorly; it is about 14 cm. long by 3·5 cm. wide and has about 12 parallel, craspedodromus secondaries, the midvein being slightly curved outwards. A somewhat similar leaf, although smaller and with its secondaries partly camptodromus, from the Lance formation, was allocated by E. Dorf (1942, p. 136, Pl. 9, figs. 1, 4) to *Platanophyllum montanum* (Brown).

Occurrence. Edmonton formation (upper part), locality 3681.

Type. Specimen, G.S.C. No. 6322.

Anona robusta Lesquereux

Plate XV, figure 6

Remarks. A single specimen from the Edmonton formation seemingly belongs to this species. It is characterized by a thick, slightly curved midrib, and camptodromus secondaries, which in basal part of leaf are more crowded than those above and attached at much broader angles to the midrib. The rounded, somewhat inequilateral base rather suggests a leaflet, such as *Inga heterophylla* Knowlton, and the correct identification must remain rather doubtful until better preserved material is available. The resemblance of the species to *Ficus uncata* Lesquereux, as noted by R. W. Brown, is also close.

Occurrence. Edmonton formation (upper part), locality 3681.

Type. Plesiotype, G.S.C. No. 6322.

Laurophyllum laraminum (Dawson)

Salix laramina Dawson, Roy. Soc., Canada, Trans., vol. IV, 1886, sec. IV, p. 28, Pl. I, fig. 10 (1887).

Laurophyllum ripleyensis Berry *pars* Geol. Surv., Canada, Mem. 182, p. 51, Pl. XV, figs. 1, 2 (1935).

Remarks. Leaves, petiolate, entire, elongate to ovate-lanceolate, with acute or acuminate apex and cuneate base; midrib, strong, commonly curved. Secondaries, 9 or more pairs, subopposite to alternate, 45 to 50 degrees to midrib, rather abruptly curved upwards well within the margin and thereafter lost in a fine tertiary network, or simply looped with secondary above; rarely a shorter intermediary present between successive secondaries. Tertiaries, represented by a few percurrent veins, transverse or oblique, and nervilles form a fine network of quadrangular or polygonal, nearly equidimensional cells.

The longest petiole preserved is 2 cm. The species resembles in many respects the living *Umbellularia californica*, but the basal secondaries, although they commonly ascend more strongly than the succeeding ones, scarcely have the pseudo-palmate arrangement that according to La Motte is characteristic of *Umbellularia.* The leaf is apparently less coriaceous than that of the types of *Laurophyllum ripleyensis,* in which the tertiaries are obsolete, and the apex is less attenuated.

Occurrence. Paskapoo formation, locality 4104; Ravenscrag formation, Saskatchewan, localities 4098, 4131, 4144.

Types. Holotype, G.S.C. No. 5419; plesiotypes, Nos. 7441, 7442.

Menispermites belli Berry

Plate XII, figure 5

Menispermites belli Berry, Geol. Surv., Canada, Mem. 182, p. 36 (1935).

Lesquereux's Description. "Leaves petioled, broadly reniform, subcordate or subpeltate, rounded upward; borders crenulate, primary nerves palmately five to seven, the middle ones straight, the upper lateral ones somewhat stronger than the lower, curving inward, branching and anastomosing with the branches of the middle nerve, which are few and distant from the base; veinlets thick, transversal, forming by subdivisions an embossed-like, very distinct, polygonal areolation" (Lesquereux, 1878, p. 207).

Remarks. The species was originally united by Lesquereux to the European Tertiary species *Ficus asarifolia* Ettingshausen. Knowlton, however, doubted this reference, pointing out its strong resemblance to species of *Menispermum*, and Berry later assigned it definitely to *Menispermites*. The prominent, quadrangular network of tertiary veins is a marked, distinguishing character of the species.

Occurrence. Whitemud formation, Saskatchewan, localities 3258, 4129.

Type. Plesiotype, G.S.C. No. 7419.

Dombeyopsis nebrascensis (Newberry) n.comb.

Plate II, figures 1, 4; Plate IX, figures 1 to 3; Plate X, figure 1; Plate XII, figures 9, 10; Plate XIX, figure 1; Plate XX, figure 1; Plate XXII, figure 6; Plate XLVI, figure 4; Plate XLVIII, figure 1

Remarks. Leaves, very variable, obovate to orbicular to elliptical, long-petiolate, generally widest at, or above, middle, rarely obscurely trilobed, cuneate or rounded-cuneate to truncate at base. Margin, entire at base, crenate-sinuate to crenate-dentate above. Venation, 3 to 5 palmate, mainly craspedodromus. Midvein, moderately strong, straight or slightly flexuous. First pair of lateral primaries, about as strong as midrib, generally rising at top of petiole, more rarely suprabasilar, strongly ascending to meet upper half of margin, generally somewhat curved inwards, and commonly somewhat flexuous; external pair of lateral primaries, thinner than the others, meeting margin near, or below the middle of leaf, or more generally looping with branches from the primaries above. The first lateral primaries have 4 to 6 craspedodromus, or in part camptodromus, branches on outer side. Connected with the external primaries are looped or camptodromus tertiaries. Secondaries, 3 or 4 pairs, opposite to alternate, craspedodromus. Tertiaries, mainly bowed, once divided or percurrent. Quaternaries form a loose network of polygonal (mainly quadrangular) cells enclosing a finer network of nervilles.

The species was recently combined with *Trochodendroides (Cercidiphyllum?) ellipticum* (Newberry) by R. W. Brown (1939, p. 492) and E. Dorf (1942, p. 141). The type specimens of *T. ellipticum*, from the Dakota group, have a cuneate base, transversely elliptical outline, and the brachydodromus venation characteristic of *Trochodendroides rhomboideum* (Lesquereux). *Dombeyopsis nebrascensis* on the other hand has a dominant craspedodromus venation, and there seems little justification for its allocation to *Trochodendroides ellipticum* or to the genus *Trochodendroides*.

Knowlton's figures of leaves from the Denver formation assigned to *Populus nebrascensis*, under varietal names of *grandidentata*, *rotundata*, *acutidentata*, and *longifolia*, illustrate well the extreme variability of the leaves, but the vein pattern remains essentially constant (Knowlton, 1930, pp. 56-57, Pl. 19, figs. 4-7; Pl. 20, figs. 1-8; Pl. 21, figs. 1-5). Others of Knowlton's species from the Denver formation, viz., *Populus jacksoni* (Knowlton, 1930, p. 58, Pl. 21, figs. 6-8; Pl. 22, fig. 7), *P. lacoeana* (Knowlton, 1930, p. 60, Pl. 22, fig. 5), and *P. zaddachi ?* (Knowlton, 1930, p. 60, Pl. 22, fig. 8), together with the associated *P. tenuinervata* Lesquereux (Knowlton, 1930, p. 58, Pl. 22, figs. 1-4, 6), all fall well within the variation of *P. nebrascensis*, and are considered by the writer to belong to the last-named species. The leaves so far gathered from Upper Cretaceous and Paleocene formations of western Canada show less variation, inasmuch as their margins are all crenate or obtusely dentate. No leaves have yet been found with deltoid outline, sharp teeth, and abruptly acuminate apex such as those from the Medicine Bow formation assigned by Dorf (1938, p. 61, Pl. 11, figs. 1, 4, 6, 7) to the species.

The proper generic allocation of the species is doubtful. Although almost certainly not a *Populus*, the craspedodromus venation seemingly precludes its reference to *Trochodendroides*. Because species of *Trochodendroides* with venation similar to that of *T. arctica* are present in Upper Cretaceous formations from Cenomanian time onwards, there is no proof that any fruits of the type of *Leguminosites ? arachioides (=Jenkinsella arctica)* present in the same beds as *Dombeyopsis nebrascensis* had any organic connection with the latter species. Such fruits have been found in western Canada in late Upper Cretaceous and Paleocene formations in which leaves attributable to *Trochodendroides arctica* or to allied species abound. Similar leaves and fruits from the Lance formation were figured by Dorf (1942, Pl. 10, figs. 2-5).

Hollick (1936, p. 149, Pl. 118, fig. 3) described a leaf from the Paleocene of Alaska as *Abutilon eakeni* that is probably congeneric with *Dombeyopsis nebrascensis*, if not actually that species. The possibility of *Dombeyopsis nebrascensis* being a member of the Malvaceae should not be overlooked. For Paleocene fruits, *Nordenskioldia borealis* Heer, described elsewhere in this report, might conceivably be capsular fruits of a species allied to *Abutilon*. On the other hand, *Nordenskioldia borealis*, in Canada at least, has not been found as yet in beds that carry *Dombeyopsis nebrascensis*.

The venation pattern and crenate or crenate-sinuate leaf margin of *Dombeyopsis nebrascensis* bears considerable resemblance to *Dombeyopsis trivialis* Lesquereux. In general, however, the margin of *D. nebrascensis* is much more crenulated or is crenate-dentate, and specimens showing a tendency towards trilobing are rare.

The present reference of the species to *Dombeyopsis* has at least the merit of drawing attention to its greater resemblance to species previously assigned to *Dombeyopsis* than to species of *Trochodendroides*. Dorf expressed the opinion that *Dombeyopsis trivialis* was not closely allied to the living *Dombeya*, and notes its resemblance to some members of the Menispermaceae and of the Vitaceae.

Occurrence. Edmonton formation (lower part), localities 1193, 1278, 1573, 1612, 3677; Brazeau formation (upper part), locality 3476; Wapiti group, localities 3668, 3671, 3674; St. Mary River formation, localities 1279, 3257; post-Brazeau Paleocene beds, localities 3428, 3445; Frenchman formation, Saskatchewan, locality 4182.

Types. Plesiotypes, G.S.C. Nos. 5042, 5165 to 5167, 6155, 6245, 6333, 6341 to 6343, 6360, 6361.

Nelumbites protoluteus (Berry)

Plate LXIII, figure 5

Nelumbo tenuifolia Berry (*non* Lesquereux), Geol. Surv., Canada, Mem. 182, p. 37, Pl. VII, figs. 2, 3 (1935).

Remarks. Leaf, palmate; marginal outline, subcircular; petiolar insertion, subcentral. Primary veins, 24 or 25 in number, radiating from petiolar area, commonly dichotomosing once about halfway to margin and again near the margin where the branches loop together submarginally. Tertiary veins, where preserved, form an open network between the primaries, although some are simple and percurrent.

Berry identified two incomplete specimens of the species from Saskatchewan as *Nelumbo tenuifolia* (Lesquereux) with which he combined *Nelumbium lakesianum* Lesquereux and *Nelumbium lakesii* Lesquereux. He pointed out, however, that in the Saskatchewan leaves the primary veins were regularly forked whereas in the Colorado types they had lateral branches. Berry, at the same time discounted any specific significance to the number of veins. Nevertheless, the number of primary veins in the complete specimen from the Paskapoo of Alberta, described above, is the same as the number in *N. protolutea* and the primaries have the same mode of branching. The Alberta leaf is a little longer than the smallest from the Grenada formation of Mississippi, figured by Berry, but much smaller than the largest leaves of *N. protoluteus.*

The Geological Survey is indebted to Mr. Roy Fowler of Aldersyde, Alberta, for the discovery and donation of the complete, figured specimen.

Occurrence. Paskapoo formation, locality 2064.

Type. Plesiotype, G.S.C. No. 6301.

Genus *Nymphaeites* Sternberg emended

The genus comprises species *incertae sedis* in the family Nymphaeaceae. Originally based on rhizomes (genotype *Nymphaea arethusae* Brongniart), the conception of the genus was enlarged by Heer (1870) to include non-peltate leaves with palmate veins branching at acute angles. The genus is here further emended to include non-peltate leaves with mixed pinnate and palmate veins, like those of *Trapa ? microphylla* Lesquereux, as well as peltate or sub-peltate leaves with similar nervation and excentric petiole. It excludes peltate leaves possessing more or less central petiole and radial nerves forking like those of *Nelumbo* or *Cabomba*, which properly belong to *Nelumbites* Berry.

Nymphaeites angulatus (Newberry)

Plate XVII, figures 4, 7

Trapa microphylla Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 31, Pl. II, figs. 19, 19a (1887).
Trapa ? microphylla Berry, Geol. Surv., Canada, Mem. 182, p. 61, Pl. XIX, figs. 1-11 (1935).
Fucus lignitum Berry, Geol. Surv., Canada, Mem. 182, p. 65 (1935).

Remarks. The taxonomic position of *Trapa ? microphylla* Lesquereux (=*Neuropteris angulata* Newberry) has remained questionable ever since Lesquereux's description of the species. Its allocation to *Trapa* was upheld by J. W. Dawson (1886, p. 14; 1887, p. 31) who identified associated fruits as *Trapa borealis* Heer. The figured type of *Trapa borealis* Dawson is missing from collections of the Geological Survey of Canada, and it is not known whether the specimen came from Upper Cretaceous or Paleocene beds. Three other specimens, identified by Dawson as *Trapa borealis*, are present in the collections, but all are very poorly preserved, and none in the writer's opinion is unquestionably a fruit of *Trapa*.

The species was well described and figured by Newberry (1861, p. 131, Pl. III, fig. 5), Lesquereux (1876a, p. 369; 1876b, pp. 296, 304; 1878, p. 295, Pl. LXI, figs. 16-17, 24, 24a), Knowlton (1899, p. 761, Pl. 77, figs. 3, 4; 1900, p. 62, Pl. 5, fig. 74), Ward (1886, p. 554, Pl. 49, figs. 2-5; 1887, p. 64, Pl. 28, figs. 2-5), and Berry (above references). The venation is best displayed by figures of Lesquereux and Berry. Both these authors, however, show the veins terminating craspedodromusly at the margins, whereas actually the veins, or at least most of them, in specimens observed by the writer are joined in a pseudo-marginal vein very close to the margin as in *Nymphaeites striatus* (Berry). Most commonly the finer details of the venation are not preserved, and in many instances the veins are entirely obscured, as if the leaf substance were thick and fleshy. Not uncommonly the surface has a microscopic, granular or pitted appearance. There is considerable variation in the prominence of midvein. In general it is thicker than the other veins rising from the top of the petiole, so that a pinnate appearance overshadows a palmate one. Lesquereux mentioned alternate venation in his diagnosis, but the veins arising from the base are commonly five or more. The areoles resulting from junction of the nerve branches are generally elongated in the direction of the main nerves, and not commonly isodiametric as illustrated by Lesquereux (1878, Pl. LXI, fig. 16).

Berry was the first to note a peculiar character displayed by some leaves of the species from the Whitemud formation. This was a swollen area in a central part of the leaf, which he interpreted as an air chamber. The writer considers it to be due to aerenchymatous tissue rather than to a chamber, for some leaves show traces of a network of large cells in similarly situated areas. Certain specimens of *N. striatus* also showed similar traces of aerenchymatous tissue.

The axes bearing the leaves are microscopically striated longitudinally and microscopic cross-bars result in a reticulum of approximately isodiametric or slightly elongated cells. A similar microscopic reticulum is more rarely preserved on the leaves. A feature of the stems is the presence at nodal lines of profusely branched filiform organs. These were described by Lesquereux, and later by Berry, as *Fucus lignitum*. Berry regarded them as obviously not belonging to *Fucus*, and considered them as probably rootlets or submerged dissected foliage of some aquatic plant. Some living members of the Nymphaeaceae, e.g., *Cabomba*, have finely divided, compound, submerged leaves. If the filiform organs of *N. angulatus* are actually submerged leaves, and not adventitious rootlets, the rosette forms of the floating vegetation may indicate a more primitive adaptation to a floating habit than in living water-lilies. Although the foliage axes and petioles of the leaves most commonly appear smooth, except for the microscopic striations or reticulations, a couple of specimens, possibly referable to a distinct species, show a dense pubescence (Pl. XVII, fig. 7). The hairs are 0·5 to 0·75 mm. long. A pubescence of lower surface of leaves and of petioles is a character of some living North American species, e.g., *Nymphaea ovata*, *N. microcarpa*, *N. orbiculata*, and *N. bombycina*.

No undoubted rhizomes have so far been found. The axes bearing the filamentous leaves or adventitious roots are commonly 3 or 4 mm. wide, with some internodes, 4 cm. long, noted. The presumably floating leaves are given off from foreshortened and crowded nodal lines in opposite pairs, those of adjacent superimposed nodal lines being at right angles to one another as shown in a specimen from the Paleocene (Pl. XVII, fig. 4). The youngest or uppermost five pairs of leaves on this specimen are simple, the axes of the sixth and seventh pairs are compound, each leaf rising from a single secondary nodal line, which gives rise to two opposite leaves and a terminal one. The eighth pair of axes have each five leaves, the secondary nodal line giving off not simple leaves, but a lateral pair of opposite secondary axes, from each of which a tertiary nodal line provides one lateral and one terminal leaf. It is possible that in some instances two opposite laterals may be given off from such tertiary zonal lines. With such a system of axial branching it is doubtful whether the branches should be considered as divisions of a compound leaf. There was evidently a tendency for the leaves to separate or break off at the ultimate nodal lines, for isolated leaves greatly outnumber attached ones. The opposite case cited by Knowlton (1900, p. 64) is certainly unusual, and cannot be justly seized upon as an indication of another species. Compound foliage axes with attached leaves occur in Canadian deposits in association with detached leaves in the Upper Cretaceous Whitemud, Edmonton, and St. Mary River formations as well as in Paleocene formations.

Although the dominant form of *N. angulatus* has a rounded or truncate base, it may show a variation on the one hand to a more cuneate base, and on the other to a slightly cordate base such as that present in Newberry's type specimen of the species.

A variation to the peltate leaf of *Nymphaeites striatus* is likewise strongly suggested. The two species are closely associated in the same beds in both the Upper Cretaceous Whitemud and St. Mary River formations. The change from an elongate-lanceolate, non-peltate leaf to a peltate leaf is illustrated by the succession of embryonic leaves in *Nymphaea victoria*, where the third leaf shows an apparent fusion of basal lobes of the lamina at the petiolar insertion (*See* Gwynne-Vaughan, D. T., 1897, pp. 287-299).

The St. Mary River formation carries remains of what are considered to be nymphaeaceous fruits, described elsewhere in this report as *Antholithes (Nymphaeites?) marsilioides*.

Nymphaeites angulatus was one of the few species that crossed the Cretaceous-Paleocene boundary, but it apparently had its acme in late Upper Cretaceous time. *Nymphaeites striatus* has not yet been found in Canadian Paleocene formations, a fact that may support its status as a distinct species, but, as pond or lake deposits are more rare in these formations, its apparent absence may be due to greater rarity of preservation.

The relationship of *Trapa ? cuneata* Knowlton to *N. angulatus* and *N. striatus* is uncertain. Knowlton's species was founded on a single specimen to which was later added a second; the leaf base is more cuneate than that of *N. angulatus*, with which it is comparable in size, and in that respect and in the crenulate margin is closer to *N. striatus*. The fact that Knowlton's form is so rare suggests that it is merely a variant or aberrant form of *N. angulatus*.

Occurrence. St. Mary River formation, localities 1272, 3583, 4103; Edmonton formation (upper part), localities 4108, 4109, 4172; Edmonton formation (lower part), localities 3470, 3471; Wapiti group, locality 3591; post-Brazeau Paleocene beds, localities 3364, 3426, 3435, 3440; Whitemud formation, Saskatchewan, locality 2149.

Types. Plesiotypes, G.S.C. Nos. 6185, 6277.

Nymphaeites striatus (Berry) n. comb.

Plate XVII, figures 1 to 3, 5, 6

Nelumbites striatus Berry, Geol. Surv., Canada, Mem. 182, p. 38, Pl. VIII, figs. 1-3 (1935).

Remarks. Berry's description and figures quite adequately portray the species. Although the margins may appear only as scalloped, they not uncommonly show small mucronate teeth similar to those of *N. angulatus*. The venation, too, corresponds so closely with that species that the only differentiating feature of *N. striatus* is the excentric to submarginal insertion of the petiole. Berry himself suggested a possible relationship between the two species (page 38 of above reference). Variation in the position of the petiolar insertion is best seen in specimens from the Whitemud formation in the material studied by Berry, and it ranges from excentric to submarginal.

In specimen 6186 (Pl. XVII, fig. 1), which is 1·9 cm. long, the base of the leaf is slightly emarginate, and the petiole is inserted about 1 mm. inside the margin. A similar leaf, 2·2 cm. long, is specimen 6187 (fig. 3, in right-hand lower corner). A second leaf, lying near the last mentioned, is approximately the same size, but its petiole is inserted 3 mm. above a rounded base (fig. 3, left hand, upper corner). A further expression of this tendency towards a peltate leaf is seen in specimen 6188 (fig. 5), where the petiole enters a leaf, 4·2 cm. long, at a point 12 mm. inside a well-rounded base. Specimens in the St. Mary River formation almost all have a submarginal petiole, and at first glance have more the appearance of unusually large *Nymphaeites angulatus* than of the type specimens of *N. striatus*. They are, moreover, associated in the same formation with non-peltate leaves assigned to *N. angulatus*.

The striation that gave the species its name is rarely seen. The striæ, 4 or 5 per millimetre, apparently represent bast-fibres. More generally, under a hand lens the surfaces of the leaves are marked by a fine reticulation similar to that noted by Berry in his description of *Trapa ? microphylla* (page 63 of above reference) as "a finely meshed areolation... approximately isodiametric". A similar reticulation on the foliage axes of *N. angulatus* was noted elsewhere in this report.

Occurrence. Whitemud formation, Saskatchewan, locality 2149; St. Mary River formation, localities 3580, 3581, 4103; ? Wapiti group, locality 3591.

Types. Plesiotypes, G.S.C. Nos. 6169, 6183, 6186 to 6188.

Antholithes (Nymphaeites ?) marsiliodes n.sp.

Plate XIII, figure 3

Description. Sepals or bracts, in a whorl of four, in contact in central area with an impression of a corrugated mass of tissue that may represent remains of an ovary (or receptacle). Individual sepals (or bracts), triangular, with cuneate, free, sessile basis, nearly straight sides and rolled distal margins; surface marked by a few radially disposed nerves, spreading in general fanwise from base, but one or two, at least in midregion, are branched; some segments show in addition a close, microscopic striation.

Remarks. The imprint of a corrugated central mass of tissue, interpreted as the remains of an ovary or receptacle, is continuous between the sepal-like segments. It apparently overlies them if the distal margins are considered to turn downwards. Such an impression might conceivably be made by the torus of a nymphaeaceous fruit. The fruit of *Nymphaea lutea*, for example, has a persistent calyx attached to the base of the ovary.

The form, size, and striation of the sepal-like segments are similar to the larger leaves of *Nymphaeites striatus* occurring in the same formation. If the assumed fruit actually belongs to that species the so-called sepals may be modified leaves. Their occurrence in a whorl of four is consistent with the type of foliar axial branching already discussed under *Nymphaeites angulatus*, which is closely allied to, if not conspecific with, *Nymphaeites striatus*.

Superficially the specimens resemble some species of *Marsilia*, but lack an inosculating pattern of veins, and have traces of some continuous, adherent, seemingly spongy mass of central tissue.

Occurrence. St. Mary River formation, locality 3580.

Type. Holotype, G.S.C. No. 6179.

Paranymphaea crassifolia (Newberry) Berry

Plate L, figure 3; Plate LII, figure 5

Paranymphaea crassifolia Berry, Geol. Surv., Canada, Mem. 182, p. 39, Pl. VII, figs. 4, 5; Pls. IX, X.

Remarks. These Paleocene leaves have been well figured and described by Berry. In the Paskapoo and other Paleocene formations of Alberta the size varies greatly, comparable with that noted by Berry from specimens of the Ravenscrag formation. Associated with the Paskapoo leaves are rhizomes, not attached to any leaves, 2·5 cm. or more in diameter, irregularly striated, sending off branches (possibly leaf petioles) and small roots with attached rootlets.

Occurrence. Post-Brazeau Paleocene beds, localities 3426, 3434, 3435, 3463, 4165; Paskapoo formation, locality 3442.

Types. Plesiotypes, G.S.C. Nos. 5169, 5923.

Leguminosites stagnum n.sp.

Plate I, figures 8, 9

Description. Leaflets, small, sessile, seemingly opposite, obovate; base, truncate-cuneate; apex, broadly rounded except for slight emargination. Midvein, moderately strong. Secondaries, about four pairs, brachyodromus, alternate, irregularly spaced, the lowermost pair most ascending and rising at or near base; the remaining ones rising at more open but variable angles, curving upwards and connecting, well inside margin, directly and angularly, or by means of tertiary branches, with secondaries above; tertiaries, mainly faint or not preserved. Dark spots are commonly visible at apex of midvein and at ends of the secondaries, which may represent glands.

Remarks. The nervation and form of leaf recalls that some of the Mimosaceae, such as *Acacia sphaerocephala,* and a somewhat similar leaf, though larger, from the Wilcox group as described by Berry as *Caesalpinites bentonensis.* Comparison may also be made with *Mimosites marchallanus* Knowlton from the Laramie formation, which agrees in its obovate form; it is a much larger leaf, however, and little is known of its venation. Outside the Leguminosae comparison may be made with some of the Lythraceae. *Peplis portula,* for example, is an aquatic form with somewhat similar leaves.

Occurrence. St. Mary River formation, locality 3582.

Types. Holotype, G.S.C. No. 6171; paratype, No. 6344.

Pterospermites whitei Ward

Plate XLVII, figures 1, 3, 5

Original Description. "Leaves thick and coriaceous, large (7 to 8 cm. wide, 12 cm. long), oblong, heart shaped, regularly sinuate or rounded dentate; petiole 3 to 4 cm. long, straight, very thick, broadening downward, and grooved or fluted, the auricles of the leaf overlapping the summit from the under side; nervation pinnate, craspedo-camptodrome; midrib strong, rapidly diminishing, slightly inflated at the nodes, more or less curved or sinuous above; secondary nerves five or six on a side, lowest pair opposite, very thin and short, strictly basilar, the rest alternate, distant, horizontal or ascending, curving upwards and forming arches, or more frequently giving off tertiary nerves from near their extremities, which pass directly into the rounded teeth of the margin; nervilles very prominent, passing into tertiary nerves, simple and percurrent or forked and variously intersected, those from the midrib curved, forming an open concentric web" (Ward, L. F., 1887, p. 94).

Remarks. Ward described and figured other leaves of *Pterospermites* from the Fort Union beds as *Pterospermites cordatus* and *Pterospermites minor.* The former of these is based on fragments that are entirely inadequate for specific diagnosis. But *Pterospermites minor* came from the same locality as the types of *P. whitei,* and differs only from that species in its smaller size, and in the presence of triangular instead of crenate teeth. In the writer's opinion, neither difference is of specific importance in this group of leaves. As all the leaves agree in the possession of a cordate or auriculate base, and in the character of the venation, they are considered to belong to *P. whitei.*

For the same reason, at least two of Hollick's species from the Paleocene of Alaska, viz., *Pterospermites imparilis* (Hollick, 1936, p. 151, Pl. 89, fig. 1; Pl. 90, fig. 1) and *P. auriculaecordatus* (ibid., p. 151, Pl. 92, figs. 1-5; Pl. 93, figs. 1, 2), are considered to be only variable forms of *P. whitei* Ward.

The relation of *Pterospermites dentatus* Heer to *P. whitei* is still doubtful. The former species was established on fragments of leaves from the Mackenzie River area. They apparently differ from *P. whitei* in the possession of a peltate basal margin, but whether this is of specific importance is as yet uncertain. For the present it is expedient to consider *Pterospermites dentatus* Heer, *P. spectabilis* Heer, and possibly *P. conjunctivis* Hollick as a group of closely allied species differentiated from *P. whitei* by the possession of either a peltate or *Credneria*-like base.

Occurrence. Paskapoo formation, locality 3444; Paleocene beds, Mackenzie River Valley, locality 2287.

Types. Plesiotypes, G.S.C. Nos. 6247, 6275, 6276.

Pterospermites dawsoni (Knowlton)

Plate XLVII, figures 2, 4; Plate XLIX, figures 1, 2

Quercus platania Dawson (*non* Heer), Roy. Soc., Canada, Trans., vol. 7, p. 72, Pl. XI (1889).
Quercus dawsoni Knowlton, U.S. Geol. Surv., Bull. 152, p. 191 (1898).
Protophyllum sp. Berry, Roy. Soc., Canada, Trans., 3rd ser., vol. XX, sec. IV, p. 194, fig. 1 (1926).
Pterospermites penhallowi Berry, Geol. Surv., Canada, Mem. 182, p. 49, Pl. XIII (1935).
Pterospermites minor Berry, Geol. Surv., Canada, Mem. 182, p. 48, Pl. XI, fig. 4 (1935).
Protophyllum canadensis Berry, Geol. Surv., Canada, Mem. 182, p. 31, Pls. IVB, V (1935).

Remarks. Leaves, large, petiolate, ovate to oblong-ovate; base, broadly to narrowly rounded, cordate to auriculate, entire; lateral margins, entire or irregularly and sparsely toothed, particularly towards apex; apex, acute to acuminate. The teeth may be sharply acute and prominent or rarely bluntly acute. Midrib, strong, straight or distally somewhat curved. Nervation, camptodromus in entire leaves, mixed craspedodromus and camptodromus in dentate leaves. Basilar veins, one to three pairs, downwardly curved to horizontal, and camptodromus. Lowest pair of secondaries, opposite to alternate, horizontal or inclined up to 40 degrees to midrib, camptodromus and with up to seven or eight camptodromus and distally looped tertiary branches on lower side; remaining secondaries becoming more ascending and with fewer and more distal branches, which loop together within margin where margin is entire or otherwise enter marginal teeth; where the teeth are prominent the secondaries feeding them have transverse, looped, tertiary branches. Tertiaries, platanoid, transverse, simple and percurrent to once divided or openly meshed.

As the margin shows a great range in variation from entire to toothed forms, the species is not sharply delimited from *Pterospermites whitei*, and eventually it may be shown that it is conspecific with it; generally, however, the teeth tend to be sharp and not crenate or undulate-crenate.

Occurrence. Paskapoo formation, localities 1637, 2295; Ravenscrag formation, Saskatchewan, localities 4128, 4160.

Types. Holotype, G.S.C. No. 6307; plesiotypes, Nos. 6305, 6306, 6308, 7403, 7404 (syntypes of *Protophyllum canadensis* Berry), 7430 (*Pterospermites minor* Berry), 7438, 7439 (syntypes of *Pterospermites penhallowi* Berry).

Pterospermites haguei ? Knowlton

Plate LII, figure 1

Remarks. A single incomplete leaf that shows many of the characters of the type, but apparently with a greater number of low teeth between the ends of the secondaries. These intermediary teeth are fed by branches in the tertiary system of nerves, and are capped by minute peg-like points.

Occurrence. Porcupine Hills (?) or Willow Creek formation (upper part), locality 3140.

Type. Plesiotype?, G.S.C. No. 6236.

Acer arcticum Heer

Plate XLVIII, figure 2

Populus acerifolia Dawson, Roy. Soc., Canada, Trans., vol. 4, sec. 4, p. 27 (1887).

Remarks. Leaves, petiolate, variable, as long or longer than broad, with truncate or emarginate base, and irregular, obtuse or bluntly acute teeth. Nervation, palmate, with a pair of spreading, main lateral primaries almost as strong as midrib, and a pair of outer primaries only slightly weaker; a fine, basal, secondary vein commonly given off at base of the outer laterals, and parallel with the basal margin of leaf. The primaries give off abaxial branches and distally a few adaxial branches. Secondaries 3 or 4 subopposite pairs, ending in marginal teeth. Commonly the leaf is more or less 3-lobed, the main lateral primaries entering the lateral lobes, but lobation commonly inconspicuous. Tertiaries, mainly bowed and branched, but a few percurrent.

Populus acerifolia Newberry (=*Populus newberryi* Cockerell) (Newberry, 1868, p. 65; 1898, p. 37, Pl. XXVIII, figs. 5-8; Cockerell, 1906, p. 312) is considered by the writer to be conspecific with *Acer arcticum.*

Occurrence. Paleocene beds, Mackenzie River Valley, locality 2287.

Type. Plesiotype, G.S.C. No. 6154; in collections, Geol. Surv., Canada, Ottawa.

Celastrinites insignis (Heer) emend. (Hollick)

Plate XXXVI, figure 4 pars; Plate LIII; Plate LIV, figures 1 to 4; Plate LV, figures 1, 2,; Plate LVI, figures 1, 3, 4; Plate LVII, figure 4; Plate LVIII, figures 2, 3; Plate LIX, figure 4

Carya antiquorum Penhallow *pars* (*non* Newberry), Roy. Soc., Canada, Trans., 2nd ser., vol. 8, sec. 4, p. 60 (1902).
Celastrus taurinensis Berry, Nat. Mus., Canada, Bull. 63, p. 24 (1930).
Apeibopsis discolor Berry (*non* Lesquereux), Nat. Mus., Canada, Bull. 63, p. 27 (1930).
Viburnum finale Berry, Nat. Mus., Canada, Bull. 63, p. 27, Pl. V, fig. 4 (1930).

Remarks. Leaves very variable in form, petiolate, oblong-ovate to broadly ovate-lanceolate, commonly inequilateral, apically acute to acuminate, basally broadly truncate, more rarely cordate, and in some instances cuneate and decurrent on petiole; margins, finely serrate to cuneate-serrate, except at base. Midrib, stout below, gradually thinning above, straight or slightly curved. Secondaries, up to 12 or more pairs, rarely divided by bifurcation, alternate or more rarely subopposite, commonly unequally distant, more crowded in base of leaf, subparallel, or those at base and at top more spreading, 35 to 90 degrees to midrib, curving upwards, strongly so near the margin, so as to subparallel the midrib, uniting submarginally, by simple loops or by chain of loops, from which short branches extend to teeth. Tertiaries generally oblique to secondaries, more rarely nearly at right angles, about equally percurrent and divided or more dominantly percurrent.

Heer's type specimen, originally described as an *Ilex*, was incomplete, and it remained for Hollick to provide better illustrations (Hollick, 1936, Pl. 73; Pl. 74, fig. 1). Hollick pertinently expressed the opinion that the leaves resembled those of some members of Celastraceae. *Celastrus ferrugineus* Ward, *C. ovatus* Ward (=*Celastrus wardi* Knowlton and Cockerell), *C. curvinervis* Ward, *Euonymus xantholithensis* Ward, *Celastrus serratus* Knowlton, and *Viburnum finale* Ward are all considered by the writer to be synonymous with Heer's species, and more doubtfully *Elaeodendron serrulatum* Ward, *E. polymorphum* Ward, and *Mohrodendron inopinum* Hollick *pars* (Hollick, 1936, Pl. 103).

This type of leaf is one of the commonest and most widespread in Paleocene floras. The species is close to *Euonymus splendens* Berry from the Wilcox group, but the tertiaries of the latter lie at right angles to the secondaries, and the apex of the leaf is more narrowly acuminate. The leaf substance was apparently not very firm, for in some specimens the margin is slightly inrolled, obscuring the teeth. The petioles, some straight, others curved, seem to have been commonly about 1·5 cm. long, the longest associated with the more cuneately based leaves, which were apparently terminal. Width of midvein at base is 1 to 3 mm. The teeth, variable in size on different leaves, were stiff, although scarcely subspinous as defined by Heer. The largest leaf of the species among the specimens to hand is about 17 cm. long by 10·5 cm. broad at widest part, the smallest 4 cm. by 2 cm.

Occurrence. Post-Brazeau Paleocene beds, localities 3427, 3428; Paskapoo formation, localities 262, 3441, 3444; Ravenscrag formation, Saskatchewan, localities 2182, 2301.

Types. Plesiotypes, G.S.C. Nos. 5488, 5490, 5491, 5702, 5986, 5990, 6237 to 6242, 6246, 6258, 6304, 6354.

Rhamnites ovatus (Penhallow)

Plate L, figure 2; Plate LI, figures 2 to 4

Carya antiquorum Penhallow *pars* (*non* Newberry), Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 60 (1902).

Viburnum ovatum Penhallow, op. cit., p. 62, text fig. 2 (1902).

Remarks. Leaf, inequilateral, sub-elliptical, with cuneate base, and bluntly acute apex; margin, entire, undulate, or sparingly and irregularly crenate. Midrib, strong in lower half of leaf; tending to be somewhat flexuous. Secondaries, 5 to 8 pairs, alternate or lower ones subopposite, strongly ascending and curving inwards, generally camptodromus, but when apical region is crenately toothed some of the upper secondaries may enter the teeth. Tertiaries, percurrent or once divided, transverse or slightly oblique to secondaries, rather distant, enclosing, when preserved, a loose network of veins.

Penhallow's type specimen is incomplete, and he was unjustified in assuming a cordate base. This specimen poorly represents the species on account of its strongly toothed character and closely spaced tertiaries. It came, however, from the same locality as the other specimens figured here, and there is little doubt that the latter are conspecific. The writer considers that *Piper septentrionalis* Hollick (1936, Pl. 114, fig. 10) and *Piper concavum* Hollick (ibid., Pl. 115, figs. 1, 2) probably belong to this species; the figured specimens are all incomplete, and it is not known whether the margins were wholly entire. At any rate they resemble closely specimen 6266 (Pl. LI, fig. 4) from the Paskapoo formation, which likewise is toothless. *Rhamnites berchemiaformis* Berry from the Wilcox group is seemingly a closely allied species. The tendency to scattered teeth recalls that of *Nyssa aquatica*, and this suggests a possible position within the Cornaceae rather than in Rhamnaceae.

Occurrence. Paskapoo formation, localities 1202, 3444.

Types. Holotype, G.S.C. No. 5701; plesiotypes, Nos. 5704 (*Carya antiquorum* Penhallow), 6266, 6267.

Rhamnites marginatus (Lesquereux)

Plate LX, figures 1, 2; Plate LXI, figure 5

Cornus rhamnifolia Penhallow (*non* Weber), Roy. Soc., Canada, Trans., vol. VIII, sec. IV, p. 46 (1902).

Remarks. Although the Paskapoo specimens to hand are much smaller than the original, and previously described, secondary types, the diagnostic characters for the species are retained. These are the notably thick petiole and lower part of midrib, the relatively thick secondaries that are joined submarginally by a chain of narrow loops and the relatively thin, percurrent tertiaries, which are oblique to the secondaries or transverse to the longitudinal axis of the leaf.

Occurrence. Paskapoo formation, localities 1202, 3444.

Types. Plesiotypes, G.S.C. Nos. 5573, 5574, 6253.

Zizyphoides colombi (Heer) Seward and Conway

Plate L, figure 1; Plate LI, figure 1; Plate LII, figures 2 to 4

Paliurus colombi Berry, Geol. Surv., Canada, Mem. 182, p. 46 (1935).

Remarks. Leaf, entire, elliptical to acute-ovate, with greatest breadth below middle. Basal margin, cuneate to broadly rounded. The largest leaves might be confused with some small, entire leaves of *Trochodendroides arctica*, although the apex and base are more acute or even acuminate. *Paliurus borealis* Heer as figured is a more acuminate and narrower leaf than typical forms of *P. colombi* Heer, and the tertiaries are more regularly transverse and percurrent. Yet a more acuminate apex is hardly a character of specific importance, and specimen 6158 (Plate LII, figure 2) is assigned to *Z. colombi* rather than to *P. borealis*. *Hakea alaskana* Hollick (1936, p. 111, Pl. 116, fig. 8) is considered to be conspecific with *Z. colombi*. It may be compared with specimen 6117 (Plate L, figure 1) from the Paleocene of Alberta. It is rather an aberrant form, being obovate-spatulate, and decurrent on the petiole.

The only essential difference that could be detected between the smallest leaves included here and those referred to *Paliurus pulcherrimus* Berry is the entire margin of the former. So far all the entire marginal leaves were found at a separate locality from the denticulated ones, and for the present at least it is expedient to consider them specifically distinct.

The veins of *Z. colombi* are acrodromus, with three primaries rising from top of petiole, and a pair of external, very thin, basal veins. The lateral primaries have a few strongly ascending secondary branches, although these are rarely preserved.

Occurrence. Post-Brazeau Paleocene beds, localities 3369, 3428, 3433, 3435; Ravenscrag formation, Saskatchewan, locality 4135.

Types. Plesiotypes, G.S.C. Nos. 5956, 5957, 6117, 6157, 6158.

Zizyphoides mackayi n.sp.

Plate XIX, figures 2, 3; Plate XX, figures 2, 4

Description. Leaf, petiolate, elongate-elliptical to elliptical-lanceolate with obtuse, bluntly pointed apex, and cuneate base; commonly inequilateral, trinerved-palmate, with an additional pair of much thinner, external, primary laterals, except in the smallest leaves. Margin, smooth at base, crenulate-dentate above, the teeth, inconspicuous or obsolete in smallest leaves. Midvein, well marked to apex. First pair of primary laterals, nearly as strong as midvein, arising from top of petiole or almost so, and acrodromus. A few thin ascending branches on outer side loop within the borders. External primary laterals, very thin, ascending, looping near, or below, middle of leaf with secondaries from the first pair of laterals. Midvein, devoid of real secondaries, but ascending tertiaries branching from it simulate secondaries. Tertiaries, inosculating and forming an open network, which contains an equally strong network of nervilles.

Remarks. *Zizyphus colorandensis* Knowlton (1922, p. 157, Pl. XV, fig. 5) from the Laramie of Colorado is too fragmentary and too imperfectly preserved for adequate comparison with the Canadian species. *Zizyphus cinnamomoides* (Lesquereux) from the Tertiary Green River formation (Lesquereux, 1872, p. 289; 1878, p. 277, Pl. LII, figs. 7, 8; Ward, 1886, p. 554, Pl. LII, fig. 3) has similar dentition and similar tertiary venation to *Zizyphoides mackayi*, but it differs in its much shorter primary laterals and absence of external laterals. *Paliurus pulcherrimus* Berry, from the Ravenscrag formation of Saskatchewan, differs in its ovate-lanceolate outline, and the tertiaries connecting with the midrib are more transverse.

The species is named after its collector, Dr. B. R. MacKay, Geological Survey of Canada.

Occurrence. Post-Brazeau Paleocene beds, locality 1608.

Types. Holotype, G.S.C. No. 621; paratypes, Nos. 623, 624.

Vitis stantoni (Knowlton) Brown

Plate III, figure 3; Plate IX, figure 5; Plate X, figures 2, 3; Plate XI, figure 3

Vitis dakotana Berry, Geol. Surv., Canada, Mem. 182, p. 47, Pl. XII, figs. 1, 2 (1935).

Remarks. Leaf, probably thin, but of strong consistency, variable, triangular-rotund to slightly trilobed; apex, obtusely pointed; base, truncate or broadly cordate, slightly decurrent on petiole, which is up to 4 cm. or more long. Margin, smooth at base, elsewhere denticulate to rather coarsely dentate with triangular, sharply pointed, outwardly directed teeth, separated by rounded, shallow furrows. Venation, pinnate, craspedodromus, but pseudopalmately trinerved. Midrib, stout in basal part of leaf, rapidly thinning above, straight or somewhat curved in apical region. Primary laterals, rising from top of petiole, or very slightly above, at angles 25 to 35 degrees, commonly slightly bent upwards, reaching margin in upper half of leaf, proximally nearly as thick as midrib, resulting in a trinerved appearance, provided with 6 to 8 branches on lower side; remaining laterals, 5 to 7 pairs, alternate to subopposite, inclined 30 to 40 degrees to midrib, commonly slightly bowed upwards, lowermost pair with 2 to 4 distal branches on lower side, succeeding pairs with fewer branches and upper ones simple. The branches of the primary laterals, which generally are bowed upwards, are themselves branched, the ultimate divisions entering the marginal teeth, except those opposite the smooth basal margin, which are camptrodromus. Tertiaries, transverse, percurrent or divided, generally slightly bowed. Quaternaries, also transverse, simple or once divided.

Although the teeth remain rather constant in form they vary in size on different specimens from denticulations similar to those present in Berry's *V. dakotana* from the Whitemud formation to rather coarse teeth illustrated by Berry in a specimen from the Lower Lance of South Dakota (U.S. Geol. Surv., Prof. Paper 185F, Pl. 27). The basal margin may be nearly straightly truncate, but more commonly is doubly emarginate, with a sinus on each side of a narrow, cuneate, petiolar area, although some leaves have a deeply cordate base similar to *V. dakotana* Berry and to some of Brown's specimens from the Fox Hills and Lance formations (Brown, R. W., Pl. 59, fig. 6). Although some specimens agree in all essentials with the type of *Castalia stantoni* Knowlton, the Edmonton material is commonly differentiated: (a) by its more platanoid venation, the secondaries being generally more regular and not zigzag at their branch junctions; (b) by the subtriangular instead of broadly rounded leaf apices and by a tendency towards trilobing, again a platanoid character; and (c), as already noted, by the prevalent, slight decurrence of the base of the leaf blade on the petiole. These factors may not be of specific importance, but they may prove valuable in distinguishing between the older, Belly River forms and the younger forms of the Edmonton. These platanoid characters of Edmonton examples of the species, particularly where the leaf margins are obscure, may cause some difficulty in distinguishing them from associated forms referred elsewhere in this report to *Platanus raynoldsi integrifolia* Lesquereux.

Occurrence. Edmonton formation (lower part), localities 1613, 3681; Edmonton formation (upper part), localities 1575, 3679 to 3681.

Types. Plesiotypes, G.S.C. Nos. 6310 to 6312, 6338, 6340.

Cornus denverensis Knowlton

Plate LVI, figure 5 *(pars)*

Remarks. Leaf, subelliptical, entire, with rounded base, and gradually narrowing from the middle to a more narrow apex. Midrib straight, pronounced; secondaries, about 7 pairs, alternate to subopposite, highly ascending, camptodromus near margin, the basal 2 or 3 pairs close together. Tertiaries, pronounced, rather closely spaced, mainly percurrent, transverse to the secondaries. Numerous, short, camptodromus branches given off from abaxial side of lowest main secondaries, and a few from distal ends of succeeding secondaries.

The leaf is nearly twice the size of Knowlton's type, and slightly broader relatively at base, but otherwise closely comparable. The species is apparently closely allied to *Cornus ovalis* Lesquereux, which is, however, more ovate than elliptical, and which has more distant tertiaries and more inwardly curving secondaries.

Occurrence. Porcupine Hills (?) or Willow Creek formation (upper part), locality 3140.

Type. Plesiotype, G.S.C. No. 6233.

Oreopanax ? sp.

Plate LIX, figures 2, 3

Remarks. Leaflets inequilateral, bilobate and simple (?), acuminately tipped, irregularly serrate, cuneate at base. Midrib, rather thick, striated, commonly curved distally. Secondaries, thin, strongly ascending, curved upwards, camptodromus, thinning distally well within margin or joining secondary above by a simple loop, sending off short tertiaries to teeth. Tertiaries, generally not preserved, but those observed, percurrent and oblique to secondaries.

The leaflets are too fragmentary for specific diagnosis. There is some resemblance to *Oreopanax wilcoxensis crenulatus* Berry, the lobes of which are equilateral, and secondaries at more open angles to the midrib. The leaf seemingly is a member of the Araliaceae, although reference to *Oreopanax* is somewhat doubtful.

Occurrence. Post-Brazeau Paleocene beds, locality 3448.

Types. Figured specimens, G.S.C. Nos. 6147, 6148.

Aralia alexoensis n.sp.

Plate LVI, figures 2, 5 *(pars)*; Plate LIX, figure 1

Description. Leaf, compound, odd-pinnate. Leaflets, opposite, ovate-lanceolate, inequilateral, with cuneate or partly rounded base and abruptly acute apex, sessile or petiolulate. Margin, smooth at base, irregularly dentate above, the triangular teeth having upwardly directed sharp tips. Median nerve, commonly flexuous; lateral veins, 7 or 8 pairs, mainly alternate, variably inclined to midrib, commonly flexuous, and varying in upward curvature, the larger forked or with one or two abaxial branches, the divisions entering marginal teeth; the lowest secondaries, camptodromus, the remainder generally craspedodromus. Only a few percurrent tertiaries are preserved.

Remarks. *Quercus meriani* Hollick (*non* Heer) (1936, p. 102, Pl. 44, fig. 1) is considered synonymous with *Aralia alexoensis*, whereas *Quercus meriani* Heer (1856, p. 53, Pl. LXXVI, fig. 12) from the Oeningen Tertiary of Switzerland is more regularly elliptical, and has fewer, larger, and bluntly pointed teeth.

Pterocarya septentrionale Hollick (1936, p. 84, Pl. 40, figs. 5-7) is narrower, less quercoid in appearance, and has a cuneate base and acuminate tip.

Occurrence. Post-Brazeau Paleocene beds, locality 3428; Porcupine Hills (?) or Willow Creek formation (upper part), locality 3140.

Types. Holotype, G.S.C. No. 5985; paratypes, Nos. 5989, 6232.

Fraxinus leii Berry

Plate VIII, figures 2, 3

Fraxinus leii Berry, U.S. Geol. Surv., Prof. Paper 185-F, p. 132, Pl. 25, figs. 1-5 (1934); Geol. Surv., Canada, Mem. 182, p. 55, Pl. XV, fig. 4 (1935).

Remarks. A specimen from the Edmonton formation, is an elongated willow-like leaf comparable with that of Plate 25, figure 3, of the first of the above references. It has spinous-serrate teeth nearly to the base, but the secondary veins are not preserved. The specimen is inequilateral, 9 cm. long (minus the apex), and, where broadest, is 2 cm. wide.

Occurrence. Edmonton formation (upper part), locality 1650.

Type. Plesiotype, G.S.C. No. 5195.

Viburnum antiquum (Newberry) Hollick

Plate LXI, figure 4

Remarks. A few leaves from the Paskapoo formation, locality 3446, are of the form of *Platanus guillelmae* Ward (*non* Goeppert) (= *V. antiquum*), and of *Grewiopsis viburnifolia* Ward (= *V. antiquum*). They form another link between the flora of the Paskapoo and that of the Ravenscrag formation.

Occurrence. Paskapoo formation, locality 3446.

Type. Plesiotype, G.S.C. No. 6151.

Viburnum simile Knowlton

Plate XVI, figure 1; Plate XVIII, figure 3; Plate XXI, Figures 2, 4 to 6

Remarks. Leaves, petiolate, slightly inequilateral, thin, but of strong consistency, elliptical, with acute apex and cuneate base, some slightly decurrent on petiole, entire for variable distance from base, rather irregularly toothed above; teeth, crenulate to acute, separated by shallow asymmetric furrows or by almost straight, entire intermargins. Midvein, stout, about 1 mm. broad, gradually thinning to apex. Secondaries, 6 to 7 pairs, alternate to subopposite, nearly straight or slightly curved upwards or slightly flexuous, craspedodromus, 20 to 35 degrees to midribs; lowest pair of secondaries provided with 6 or 7 pairs of abaxial branches giving a pseudo-trinerved appearance, the lowest branches where margin of leaf is entire being camptodromus; one or two basal, camptodromus veins generally present below these branched secondaries; remaining secondaries with fewer and distal branches; tertiaries, transverse to oblique, mainly percurrent, a few once-divided; quaternaries, rarely preserved, forming a network of irregular quadrangular cells.

The generic reference to *Viburnum* is somewhat doubtful. A similar leaf, which the writer regards as conspecific, was originally named *Alnus rugosa* Lesquereux (*non* Koch), and later *Alnus auraria* by Knowlton and Cockerell. It was first figured by Knowlton (1930, p. 49, Pl. 15, fig. 6), much later than his figure and description of *Viburnum simile* (Knowlton, 1917, p. 277, Pl. XLIX, fig. 3). Hollick (1930, p. 114, Pl. 85, fig. 8) identified a specimen from the Upper Cretaceous of Alaska as *Viburnum simile*, which, although fragmentary, agrees well with the Canadian material here described.

Occurrence. Brazeau formation (upper part), localities 3466, 3476; Upper Cretaceous, Alberta, locality 3431; Whitemud formation, Saskatchewan, locality 4129.

Types. Plesiotypes, G.S.C. Nos. 6330 to 6332, 6334, 6359.

Viburnum trinervum Berry

Plate LXI, figures 2, 3

Viburnum antiquum mutant *trinervum* Berry, Geol. Surv., Canada, Mem. 182, p. 60, Pl. VII, fig. 6; Pl. XV, fig. 6 (1933).

Viburnum castrae Berry (*non* Knowlton and Cockerell), ibid., p. 65, Pl. XV, fig. 5 (1935).

Remarks. This species is differentiated from *V. antiquum* by its more extended apex, more narrowly rounded teeth, and, particularly, by the highly ascending, primary lateral veins that rise well above the middle of the leaf, and by the marked distance of the first secondaries from the primary laterals.

The base of the larger leaves is generally cordate, but may vary to rounded-truncate. Although essentially presenting a trinerved appearance, the larger leaves may have an additional pair or two of laterals that rise at the base of the leaf. The tertiaries are more irregular than those of *V. antiquum,* and more commonly flexuous or bowed, in this respect recalling the tertiaries of *Acer arcticum.* Percurrent and divided quaternary veins run transverse to the tertiaries, their intervening spaces crossed by nervilles, which make a network of dominantly quadrangular cells.

Viburnum castrae Berry from the Ravenscrag formation is obviously a young or small leaf of the species.

Occurrence. Porcupine Hills (?) or Willow Creek formation (upper part), locality 3140; Ravenscrag formation, Saskatchewan, localities 1549, 4135.

Types. Syntypes, G.S.C. Nos. 7417, 7447 (both marked holotypes of mutant *trinervum* by Berry); plesiotypes, Nos. 6196, 6199.

Viburnum lakesii Lesquereux

Plate XIV, figure 3; Plate XXXVII, figure 1; Plate LVIII, figure 1; Plate LXI, figure 1; Plate LXII, figures 1, 3, 4

Remarks. The leaves ascribed to this species show great variation in the degree of trilobing, as does the living analogous species *Viburnum* *acerifolium*. The characters that remain constant are: (1) flatly rounded or truncate base, and greatest breadth of leaf at or slightly above the middle; (2) trinerved venation from top of petiole; (3) sharp, and commonly upwardly pointed teeth, with intervening asymmetric sinuses; the teeth not greatly differentiated from one another, although those at ends of main nerves may be somewhat larger; (4) craspedodromus secondaries and platanoid tertiaries. The main variable characters are: (1) amount of upward curving of the primary lateral veins, and their obliquity to the midrib, which varies from 25 to 45 degrees; (2) degree of trilobing, which varies from fairly distinct to absent; and (3) distance of first pair of secondaries above the primary laterals; this distance may be approximately equal to, greater, or less than the distance to the succeeding secondaries. The extent and character of these variations are best seen by reference to the figures.

The species differs from *Viburnum castrae* Knowlton and Cockerell in the sharp, rather than narrowly rounded, teeth, and in its tendency to trilobing.

Occurrence. Porcupine Hills (?) or Willow Creek formation (upper part), locality 3140.

Types. Plesiotypes, G.S.C. Nos. 6192 to 6195, 6197, 6198, 6235.

Viburnum asperum Newberry

Plate LXII, figure 2; Plate LXVII, figures 4, 6

Viburnum asperum Dawson, Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 29 (1887); Geol. Surv., Canada, Ann. Rept., new ser., vol. VII, pt. C, p. 36 (1896).
Viburnum saskatchuense Dawson, Roy. Soc., Canada, Trans., vol. V, sec. IV, p. 35 (1888).
Viburnum asperum Berry, Geol. Surv., Canada, Mem. 182, p. 56, Pl. 16 (1935).

Remarks. Although abundant in the Upper Ravenscrag formation of Saskatchewan, this distinctively Paleocene species has to the present been found at few localities in the Paskapoo formation. On Red Deer River, however, just above Red Deer, leaves 15 cm. long by 8 cm. wide were gathered by the writer. Two other leaves from the same beds measured, respectively, 11·5 cm. long by 8 cm. wide, and 9·5 cm. long by 4 cm. wide. All the Paskapoo leaves show the characteristic ovate-acuminate form, and highly ascending, numerous secondaries.

Occurrence. Paskapoo formation, localities 3464, 4106; Ravenscrag formation, Saskatchewan, locality 4126.

Types. Plesiotypes, G.S.C. Nos. 5921, 7449 to 7452.

Dicotylophyllum contractinervosum n.sp.

Plate LXII, figure 5; Plate LXVII, figure 3

Description. Leaf, elliptical, membranous, entire, rounded-truncate at base. Veins, palmately trinerved, or 5 nerved, camptodromus; midvein, fairly stout and more pronounced than the others. Lateral primaries, strongly ascending, flexuous, reaching more than half length of leaf, curving inwards, and meeting or looping with secondaries above; each may have a branch from inner side that runs subparallel with midrib to meet also the secondaries above; irregularly spaced branches from the outer side of the lateral primaries curve inwards and loop with one another well within the leaf margin. External, lateral primaries, where present, thin and looping with branches of primaries above. Secondaries, subopposite or alternate, 3 or 4 pairs, flexuous, curved inwards and looped together by tertiary branches. Tertiaries irregular, mainly flexuous, ascending, and looping together or anastomosing in a loose network, although a few may be transverse and percurrent.

Remarks. The species resembles fairly closely one syntype of *Hakea arctica* Heer (1868, Pl. XV, fig. 5). Heer's leaf, however, is too fragmentary for adequate comparison; it has a cuneate base, and the primary laterals are said to be equally as strong as the midrib, and the leaf substance to be coriaceous.

Occurrence. Post-Brazeau Paleocene beds, locality 3428.

Types. Holotype, G.S.C. No. 6118; paratypes, Nos. 6116, 6137.

Nordenskioldia borealis Heer

Plate XVIII, figure 2; Plate XXI, figure 3

Nordenskioldia borealis Dawson, Roy. Soc., Canada, Trans., vol. VII, sec. IV, p. 71, Pl. X, fig. 6 (1889).

Remarks. Several specimens have been gathered from the Canadian Paleocene, one of which was that figured by Dawson. It shows the apical end of a capsulary dry fruit, comprising a cyclic whorl, 1·2 cm. diameter, of ten segments, which have been interpreted as carpels. The apices of these contiguous segments bend downward into a circular depression about 3 mm. wide. Remnants of the carpellary walls are preserved as coal. A second specimen from the same locality shows twelve carpellary segments.

Occurrence. Paleocene beds, Mackenzie River Valley, locality 1552.

Types. Plesiotypes, G.S.C. Nos. 5585, 5886.

Carpolithus symplocoides ? Heer

Plate LXIII, figure 4; Plate LXVII, figure 2

Remarks. In form and size these seeds are closely comparable with *Carpolithus symplocoides* Heer (1868, p. 128, Pl. XVI, figs. 8a, 9). Heer remarked that his specimen had four flat longitudinal furrows. There are seven specimens to hand from the Canadian Paleocene, and although some show several folds and intervening flat furrows, these appear to be caused by contraction resulting from fossilization. Whether Heer was correct in considering the blunt end of these seeds to be the apex is doubtful.

Occurrence. Post-Brazeau Paleocene beds, locality 3426.

Types. Plesiotypes ?, G.S.C. Nos. 6268, 6269.

Majanthemophyllum grandifolium Penhallow

Plate LXIII, figure 2; Plate LXIV, figures 1, 3; Plate LXVI, figures 2, 3

Majanthemophyllum grandifolium Penhallow, Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 54, text fig. 5 (1902).

Clintonia oblongifolia Penhallow, op. cit., p. 55, text fig. 6, p. 56 (1902).

Majanthemophyllum oblongifolium Berry, Roy. Soc., Canada, Trans., 3rd ser., vol. XX, sec. IV, p. 193 (1926).

Remarks. All specimens except Penhallow's type of *Clintonia oblongifolia* (G.S.C. No. 5558), an abnormally small or young leaf, are very incomplete, and Penhallow's restoration of the base of his type of *M. grandifolium* (G.S.C. No. 5559) (Plate LXVI, figure 2, of this report) is without any foundation. The base of the leaf was actually acute or acuminate, and is best shown in G.S.C. No. 6161 (Plate LXVI, figure 3). The numerous primary parallel veins, which converge at the apex and are crowded in the midregion of the base, are less regular than in Penhallow's figure. They are joined by both transverse and oblique cross veins of nearly equal strength, 1 mm. to several mm. apart, and in addition a variable number of finer, interstitial longitudinal veins are generally 0·3 to 0·7 mm. apart; these interstitial veins are not continuous for long distances, but terminate against the transverse or oblique cross veins, and are themselves joined by transverse nervilles.

The allocation of these leaves to *Majanthemophyllum* is decidedly questionable, and only to be tolerated because of ignorance of their true botanical relationship.

Occurrence. Paskapoo formation, localities 1202, 3443, 3444.

Types. Holotype, G.S.C. No. 5559; plesiotypes, Nos. 5558 (holotype of *Clintonia oblongifolia* Penhallow), 6161, 6162, 6252.

Cannophyllites magnifolia (Knowlton)

Plate LXIV, figure 2; Plate LXV

"Dubious species", Penhallow, Roy. Soc., Canada, Trans., 2nd ser., vol. VIII, sec. IV, p. 63, text fig. 8 (1902).

Canna ? dawsoni Berry, Geol. Surv., Canada, Bull. 42, p. 99 (1926).

Remarks. Leaves, large, commonly more than 12 cm. broad, lanceolate-acuminate, with strong broad "midrib" made up of thick vascular strands. The heavy strands of midrib gradually disperse by division into the veins, and disappear before apex of leaf is reached. Veins, numerous, rising at very acute angles (15 to 20 degrees from midvein), dichotomizing several times close to origin, but distally undivided, commonly of nearly equal size, but in places stronger veins may be separated by weaker ones, the latter commonly three, about 0·3 mm. apart, gradually paralleling margin in their course upward, reduced in numbers upward by merging at, or meeting, margin, and by terminating against transverse veinlets. Space between adjacent primaries is crossed by numerous transverse, or more commonly oblique, veinlets, about 0·7 to 1·5 mm. apart in any longitudinal row.

The only difference between the fragmentary specimens from the Burrard Inlet formation described by Berry and the Paskapoo leaves is the closer veins (about ¼ mm. apart) and the narrow midrib, both characters of doubtful specific value.

Occurrence. Paskapoo formation, localities 1202, 3441, 3443, 3444.

Types. Plesiotypes, G.S.C. Nos. 5557 (figured by Penhallow), 6159, 6160.

Pistia corrugata Lesquereux

Plate XII, figures 1, 2

Pistia corrugata Berry, Geol. Surv., Canada, Mem. 182, p. 23 (1935).

Remarks. The specimens agree in all essential characters with those represented by Lesquereux (1878, Pl. 61, figs. 1, 3, 6-8). The average breadth of the leaves varies from 4 to 6 cm. One specimen has a petiole about 3·5 cm. long by 5 mm. broad, from the top of which about 8 veins rise. In a central and larger part of a leaf the main veins branch irregularly and inosculate with loose areoles, but outside this area, and marginally, the main veins roughly parallel the margin in wavy lines, and are joined by transverse, radial, closely spaced veins, which enclose a finer network of nervilles.

Occurrence. Whitemud formation, Saskatchewan, localities 3258, 4129.

Types. Plesiotypes, G.S.C. Nos. 5925, 5926.

Spirodela scutata Dawson

Plate LXIII, figures 1, 3; Plate LXVII, figure 1

Lemna (Spirodela) scutata Dawson, Brit. N.A. Boundary Comm. Rept. Geol. and Resources, 49th Parallel, Appendix A, p. 328, Pl. 16, figs. 5, 6, 7a (1875); Roy. Soc., Canada, Trans., vol. IV, sec. IV, p. 23, Pl. 1, fig. 6 (1887).

Spirodela scutata Dawson, Geol. Surv., Canada, Mem. 182, p. 23 (1935).

Remarks. Plant body, small, up to 1·5 cm. diameter, suborbicular, recessed at axial side, which is indicated by a submarginal small nodal area about 1 mm. diameter. In one of Dawson's syntypes (No. 5456b) this recess or indentation has a secondary, small foliar lobe. Veins, palmate, commonly not preserved, except for an apparent marginal vein. On one specimen there appear to be numerous hair bases on the foliar surface, and another specimen has a reticulum of nearly equidimensional cell-like areas that may represent aerenchymatous tissue. Many associated rootlets occur in the rock matrix and probably belong to this species, and in several instances numerous similar rootlets radiate from the node of the axis. A primary root or stem, 1 to 1·5 mm. wide, is also commonly associated with the plant body as if attached at its axial node.

Occurrence. Brazeau formation (upper part), locality 3466; Paskapoo formation, locality 2063; post-Brazeau Paleocene beds, locality 3461; Ravenscrag formation, Saskatchewan, locality 4095.

Types. Plesiotypes, G.S.C. Nos. 3461, 5456b, 6135.

Typa sp. Dorf

Plate XII, figure 8

Remarks. No discernible differences of specific value differentiate specimens included here and a specimen from the Medicine Bow formation figured by Dorf (1938, Pl. 1, fig. 12). The St. Mary specimens are somewhat narrower leaves (averaging about 1 cm. broad), and the spaces between the heavier veins (0·5 to 1 mm. apart) are filled by 2 or 3 lighter, longitudinal veins. Transverse cross veins between the heavy longitudinal ones occur at irregular intervals.

Occurrence. St. Mary River formation, localities 3580, 3581.

Type. Plesiotype, G.S.C. No. 6176.

INDEX TO LOCALITY NUMBERS

Bearpaw Formation

1692. Vermilion River, tp. 52, rge. 14, W. 4th mer. Coll. J. B. Tyrrell, 1886.
3263. Berry Creek, tp. 25, rge. 12, W. 4th mer. Coll. J. B. Tyrrell, 1844.
4155. Railway cut, sec. 4, tp. 9, rge. 14, W. 3rd mer. From sandstone bed at, or near, top of Bearpaw. Coll. P. S. Warren, 1928.

St. Mary River Formation

1272. Belly River, south side, centre sec. 3, tp. 9, rge. 24, W. 4th mer. Coll. W. S. Dyer, 1925.
1279. Crowsnest River, east of Lundbreck, on south bank. Coll. J. S. Stewart, 1915.
3257 =1279.
3580. Oldman River, north bank, SW. sec. 12, tp. 10, rge. 2, W. 5th mer. Coll. R. J. W. Douglas, 1945.
3581. Oldman River, north bank, centre sec. 1, tp. 10, rge. 2, W. 5th mer. Coll. R. J. W. Douglas, 1945.
3582. Oldman River, sec. 6, tp. 10, rge. 1, W. 5th mer.; fault zone St. Mary River and Willow Creek formations. Coll. R. J. W. Douglas, 1945.
3583 =3580
3584 =3580
3585. Oldman River, west-central sec. 12, tp. 10, rge. 2, W. 5th mer. Coll. R. J. W. Douglas, 1945.
3586 =3580
3587 =3580
4102 =1279
4103. Pincher Creek, Alta. Coll. T. C. Weston, 1883.

Edmonton Formation

9. One mile east of Wigmore ferry (Drumheller area), Red Deer River, 25 feet above river level. Coll. C. H. Sternberg, 1912 (Lower Edmonton).
12. Right of Acme Road, 2 miles southeast of Drumheller. Coll. C. H. Sternberg, 1912 (Lower Edmonton).
13. Red Deer River, ½ mile above Drumheller and above C.N.R. bridge. Coll. C. H. Sternberg, 1912 (Lower Edmonton).
20. Forks of Michichi Creek, 6 miles northeast of Drumheller. Coll. C. H. Sternberg, 1912 (Lower Edmonton).
330. Red Deer River, 350 feet above river, 3 miles north of Johnson ferry. Coll. G. F. Sternberg, 1915 (Lower ? Edmonton).
1193. North side Highwood River above coal seam. Coll. G. S. Hume.
1278. Sec. 12, tp. 24, rge. 6, W. 5th mer. Coll. G. S. Hume, 1927.
1573 =9
1575. Red Deer River, NE. ¼ sec. 18, tp. 34, rge. 21, W. 4th mer. Coll. C. M. Sternberg, 1926 (Upper Edmonton).
1612. Red Deer River, sec. 32, tp. 31, rge. 21, W. 4th mer. Coll. C. M. Sternberg, 1924 (Lower Edmonton).
1613 =12
1615. Red Deer River, NW. ¼ sec. 6, tp. 33, rge. 21, W. 4th mer.; 8 miles southwest of Morrin, and about 20 feet above oyster bed. Coll. C. M. Sternberg, 1925 (Lower Edmonton).
1632. Red Deer River, 10 miles northwest of Munson. Coll. C. M. Sternberg, 1924 (Lower Edmonton).
1633. Red Deer River, 260 feet above river level, sec. 35, tp. 34, rge. 21, W. 5th mer. Coll. C. M. Sternberg, 1926 (Upper Edmonton).
1650. Red Deer River, SE. ¼ sec. 12, tp. 34, rge. 22, W. 4th mer., 300 feet above river level. Coll. C. M. Sternberg, 1926 (Upper Edmonton).

3467. Red Deer River, Drumheller; south of C.N.R. bridge and above small coal seam. Coll. W. A. Bell, 1945 (Lower Edmonton).
3469. Waste dump from Atlas coal mine near Drumheller, Alta. Coll. W. R. Fulton.
3470. Red Deer River, Drumheller; horizon unknown. Coll. W. R. Fulton (Lower ? Edmonton).
3471. Drumheller, mouth of Michichi Creek, right of highway No. 9. Coll. W. A. Bell, 1945 (Lower Edmonton).
3677. Seven miles northwest of Drumheller, opposite mouth Kneehill Creek in road-cut about 225 feet below shell bed. Coll. C. M. Sternberg, 1946 (Lower Edmonton).
3678. Fifteen to twenty feet above tuff bed, SE. ¼ sec. 14, tp. 33, rge. 21, W. 4th mer. (Upper Edmonton).
3679. NE. ¼ sec. 10, tp. 34, rge. 22, W. 4th mer., about 50 feet above Kneehills tuff. Coll. C. M. Sternberg, 1946 (Upper Edmonton).
3680. NW. ¼ sec. 14, tp. 34, rge. 22, W. 4th mer., 50 to 75 feet above base of Upper Edmonton. Coll. C. M. Sternberg, 1946.
3681. SW. ¼ sec. 15, tp. 34, rge. 22, W. 4th mer., about 75 feet above base of Upper Edmonton. Coll. C. M. Sternberg, 1946.
3683. NE. ¼ sec. 18, tp. 29, rge. 20, W. 4th mer., about 75 feet below shell bed. Coll. C. M. Sternberg, 1946 (Lower Edmonton).
4108. Red Deer River, tp. 38, rge. 22, W. 4th mer., 2 miles below Tail Creek. Coll. J. B. Tyrrell, 1884 (Upper Edmonton).
4109. Rosebud River, tp. 27, rge. 21, W. 4th mer. Coll. J. B. Tyrrell, 1884 (Upper ? Edmonton).
4110. Sarcee Butte, tp. 31, rge. 22, W. 4th mer., on Ghost Pine Creek. Coll. J. B. Tyrrell, 1884 (Upper Edmonton).
4120. North Saskatchewan River, west side, sec. 5, tp. 51, rge. 3, W. 5th mer. Coll. J. B. Tyrrell, 1886 (Upper Edmonton).
4167. Sauffer ranch, Red Deer River. Coll. G. F. Sternberg, 1914 (Lower Edmonton).
4172. North Saskatchewan River, south side, sec. 12, tp. 51, rge. 3, W. 5th mer. Coll. J. B. Tyrrell, 1886 (Upper Edmonton).
4179. Eight miles southwest of Rumsey (20 feet above oyster bed); N.W. ¼ sec. 6, tp. 33, rge. 21, W. 4th mer. Coll. C. M. Sternberg, 1925 (Lower Edmonton).

Brazeau Formation (Upper Part)

3259. Sec. 1, tp. 51, rge. 26, W. 5th mer. End of R. R. bridge across Athabasca River east of Entrance. Coll. B. Rose, 1920.
3274. Near mouth Prairie Creek, tributary to Athabasca River. Coll. A. H. Lang, 1943.
3275. Old railway grade, ½ mile east of Entrance, Alberta. Coll. A. H. Lang, 1943.
3466. South side old abandoned railway grade, Athabasca River, Entrance area. Coll. W. A. Bell, 1945.
3476. Upper Cripple Creek. Coll. O. A. Erdman, 1945.

Wapiti Group

3096. Wapiti River, north bank, near Alberta-British Columbia boundary. Coll. E. M. Speaker, 1940.
3590. Sandstone ledge at top of Nose Mountain at Theresa Point. Coll. L. D. Burling, 1945.
3591. West of Nose Mountain Lake, 850 feet below top of ledge on crest of Nose Mountain. Coll. L. D. Burling, 1945.
3663. In small cut bank just north of trail up left side of Smoky River Valley, about 2 miles west of mouth of Sheep Creek. Coll. L. D. Burling, 1946.
3668. Nose Mountain, Alberta, from valley of Muddy Creek south of Settlers Flats, where latitude line 54° 35′ crosses the Nose Mountain trail. Coll. L. D. Burling, 1946.
3669. Basal part of section exposed at head of canyon of Cutbank Creek, Alberta, about 3 miles south of Theresa on Nose Mountain trail. Coll. L. D. Burling, 1946.
3670. Same locality as 3669, in beds about 250 feet stratigraphically higher in the section. Coll. L. D. Burling, 1946.
3671. Same locality as 3669, in beds about 500 feet stratigraphically higher in the section. Coll. L. D. Burling, 1946.
3674. In black shale below a massive sandstone, striking across Mistanusk River (locally known as Pine River), above a tributary entering from the south about 5 miles north-northwest of where British Columbia-Alberta boundary crosses Mistanusk River. Coll. L. D. Burling, 1945.

Post-Brazeau and Miscellaneous Paleocene

1552. Mackenzie River 20 miles above Bear River. Coll. R. G. McConnell, 1888.
1608. Sterco and Coal Valley. Coll. B. R. MacKay, 1927.
2287. Bear River near Fort Norman, west bank Mackenzie River. Coll. G.S. Hume.
3312. Smoky River area, Alta., from coal seam horizon on Berland River, ¾ mile downstream from forestry cabin. Coll. H. H. Beach, 1943.
3363. Pedley area, Alta., from McLeod River. Coll. E. J. W. Irish, 1944.
3364. Rock Creek, Pedley area, Alta. Coll. E. J. W. Irish, 1944.
3369. Saunders area, west edge, 1,200 feet east of Shark, on south side C.N.R., 150 to 200 feet below coal of West Saunders. Coll. O. A. Erdman, 1944.
3374. Alexo area, North Saskatchewan River, west side, 100 feet up small creek at sharp bend of river, and about 600 feet below a 5-foot coal seam. Coll. O. A. Erdman, 1944.
3375. Alexo area, North Saskatchewan River, west side, 1,000 feet up small creek. Coll. O. A. Erdman, 1944.
3397. Coalspur area, Alta., from near mouth of Jackson Creek in roof of Mynheer coal seam. Coll. Imperial Oil Ltd., 1944.
3426. Sterco Valley from roof of Mynheer coal seam, north side railway at mine tipple of Coal Valley Coal Co. Coll. W. A. Bell, 1945.
3427. Shunga Creek, tributary to North Saskatchewan River, near mouth of tributary creek. Coll. W. A. Bell, 1945.
3428. Alexo area, tp. 40, rge. 13, W. 5th mer. Coll. W. A. Bell, 1945.
3433. About 1 mile southeast of Alexo at mile-post 134, C.N.R. Coll. W. A. Bell, 1945.
3434. About ½ mile southeast of Alexo on C.N.R. cut. Coll. W. A. Bell, 1945.
3435. Roof of Mynheer coal seam in Sterling cut about ½ mile east of Sterco. Coll. W. A. Bell, 1945.
3438. About ⅞ mile west of Sterco, at rock cut C.N.R. Coll. W. A. Bell, 1945.
3440. Coal Valley, from Sterling open-cut opposite C.N.R. mile-post 48 plus 400 feet, roof Mynheer coal seam. Coll. W. A. Bell, 1945.
3445. Coalspur, roof Mynheer coal seam. Coll. W. A. Bell, 1945.
3448. Sterco, rock cut 700 feet from 46 mile-post, C.N.R. Coll. W. A. Bell, 1945.
3461. Alexo area. Rock cut on C.N.R. directly above Shunga Range Station about 1 mile east of Alexo. Coll. W. A. Bell, 1945.
3463. Rock cut C.N.R., 840 feet short of 1 mile east of Alexo. Coll. W. A. Bell, 1945.
3477. Hay River, Alberta; north bank of river. Coll. E. J. W. Irish, 1945.
3488. Three miles east-northeast of mouth of Niven River, British Columbia. Coll. C. S. Lord, 1945.
3572. Athabasca River, Alta., l.s.d. 1, sec. 4, tp. 58, rge. 20, W 5th mer. Coll. J. Y. Smith, Imperial Oil Ltd., 1945.
4009. Lewes River, Yukon. Coll. G. M. Dawson.
4092 =1552
4165. Roof of coal at Sterling colliery, tp. 48, rge. 20, W. 5th mer. Coll. D. B. Dowling.

Willow Creek Formation (Upper Part)
and
Porcupine Hills (?) or Willow Creek Formation

1618. SE. ¼ sec. 36, tp. 10, rge. 27, W. 4th mer. Coll. J. Webb, 1925.
3140. Crowsnest River, l.s.d. 8, sec. 34, tp. 7, rge. 1, W. 5th mer., approximately 200 feet above junction with Oldman River. Coll. C.O. Hage, 1941.
3700. SW. ¼ sec. 1, tp. 13, rge. 28, W. 4th mer. Coll. W. A. Bell, 1947.
3701 =3140. Coll. W. A. Bell, 1947.

Paskapoo Formation

262. Red Deer River, at mouth Blindman River. Coll. T. C. Weston, 1888-89.
1191. Tongue Creek, NE. ¼ sec. 17, tp. 19, rge. 29, W. 4th mer. Coll. R. L. Fowler.
1202 =262
1637. Calgary, Alta. Coll. G. C. Weston, 1888.
1965. North Saskatchewan River, near Rocky Mountain House, sec. 33, tp. 39, rge. 7, W. 5th mer. Coll. J. B. Tyrrell, 1886.
2063. Near Aldersyde, Alberta. Coll. R. Fowler.
2064. Highwood River, tp. 20, rge. 28, W. 4th. mer. Coll. R. Fowler.
2295 =2063

3441. North side Blindman River, about 1,000 feet above junction with Red Deer River. Coll. W. A. Bell, 1945.
3442. East side Highwood River, about 700 to 1,000 feet below mouth of Sheep Creek, near Aldersyde, Alberta. Coll. W. A. Bell, 1945.
3443. Red Deer River, from roof of 1-inch coal at mouth Blindman River, to 1,000 feet below mouth. Coll. W. A. Bell, 1945.
3444. Red Deer River, north side, about 1½ miles above mouth of Blindman River, from roof of 3-inch coal. Coll. W. A. Bell, 1945.
3446. Brickburn, NE. ¼ sec. 23, tp. 24, rge. 2, W. 5th mer. Coll. W. A. Bell, 1945.
3460. North Saskatchewan River, east side, at small brook about 800 feet above C.N.R. bridge at Rocky Mountain House. Coll. W. A. Bell, 1945.
3462. South side of road on hill slope to bridge over Red Deer River, about 9½ miles east of Red Deer. Coll. W. A. Bell, 1945.
3464. SE. ¼ sec. 18, tp. 38, rge. 27, W. 4th mer.; south side Red Deer River, near Red Deer. Coll. W. A. Bell, 1945.
3468. Pembina River at Entwistle, in small gully in east bank above highway bridge; 25 feet below massive sandstone bed. Coll. W. A. Bell, 1945.
3698. Red Deer River, 10 to 15 feet above Ardley coal seam, NE. ¼ sec. 33, tp. 38, rge. 23, W. 4th mer. Coll. C. M. Sternberg, 1947.
4104 =1965
4106. North Saskatchewan River, east side, sec. 11 or 14, tp. 47, rge. 9, W. 5th mer. Coll. J. B. Tyrrell, 1886.
4118. Forks of Spruce Lake and Antler Hill Creek in area of headwaters of Kneehills Creek. Coll. J. B. Tyrrell, 1886.
4120. North Saskatchewan River, west side; sec. 5, tp. 51, rge. 3, W. 5th mer. Coll. J. B. Tyrrell, 1886.

APPENDIX: SASKATCHEWAN LOCALITIES

Whitemud Formation

2149. North side Big Muddy Valley, Sask. Coll. F. H. McLearn, 1930.
3258 =2149
4129. Wood Mountain Creek, west side, Sask., NW. ¼ sec. 15, tp. 5, rge. 3, W. 3rd mer. Coll. F. H. McLearn, 1930.

Frenchman Formation

1548. Big Muddy Valley, south side, west of Bengough road. Coll. F. H. McLearn, 1930.
2172. Sec. 26, tp. 6, rge. 21, W. 3rd mer. Coll. C. M. Sternberg.
3687. NE. ¼ sec. 6, tp. 5, rge. 18, W. 3rd mer., on north side Frenchman River. Coll. C. M. Sternberg, 1946.
3707. Near Eastend, Sask. Coll. H. S. Jones.
4173. About 4 miles southwest of Eastend, Sask. Coll. C. M. Sternberg, 1928.
4182. Sec. 14, tp. 1, rge. 5, W. 3rd mer.; below lower coal seam on Morgan Creek. Coll. C. M. Sternberg, 1921.

Ravenscrag Formation

1549. Rock Glen, Sask., sec. 33, tp. 2, rge. 30, W. 2nd mer. Coll. F. H. McLearn, 1930.
1651. Short Creek, Souris River at Roche Percée. Coll. A.R.C. Selwyn, 1880.
2182. Ravenscrag Butte, Sask., near centre sec. 27, tp. 6, rge. 23, W. 3rd mer. Coll. M. Y. Williams, 1926.
2187. Ravenscrag Butte, Sask. Coll. M. Y. Williams, 1926.
2188. Along road on hill, SW. ¼ sec. 28, tp. 7, rge. 3, W. 4th mer. Coll. M. Y. Williams, 1926.
2189. Tp. 7, rge. 24, W. 3rd mer., below road bridge, central branch Fairwell Creek. Coll. M. Y. Williams, 1926.
2301. Eastend, Sask. Coll. H. Jones, Sask.
4078. Ravenscrag, Sask. Coll. F. H. McLearn, 1927.
4091. Porcupine Creek (=Poplar River), Sask. Coll. G. M. Dawson, 1874.
4095. Badlands south of Wood Mountain. Coll. G. M. Dawson, 1874.
4098. Great Valley, Sask. Coll. G. M. Dawson.
4124. Sec. 27, tp. 3, rge. 24, W. 2nd mer. Coll. F. H. McLearn, 1930.
4126. Willowbunch member, Sask., sec. 18, tp. 4, rge. 2, W. 3rd mer. Coll. F. H. McLearn, 1930.

4127. NE. sec. 32, tp. 4, rge. 3, W. 3rd mer. Coll. F. H. McLearn, 1930.
4128. Near base Willowbunch member, sec. 19, tp. 1, rge. 22, W. 2nd mer., Sask. Coll. F. H. McLearn, 1930.
4130. Morgan Creek, Sask. Coll. F. H. McLearn, 1930.
4131 =1549
4133. NE. ¼ sec. 24, tp. 3, rge. 25, W. 2nd mer. Coll. F. H. McLearn, 1930.
4135. SE. sec. 3, tp. 5, rge. 1, W. 3rd mer. Coll. F. H. McLearn, 1930.
4136. NW. sec. 35, tp. 5, rge. 1, W. 3rd mer. Coll. F. H. McLearn, 1930.
4137. Above Willowbunch member, sec. 1, tp. 1, rge. 22, W. 2nd mer. Coll. F. H. McLearn, 1930.
4138. Base buff facies, southeast of Pickthall. Coll. F. H. McLearn, 1930.
4141. Above Willowbunch member, NE. sec. 13, tp. 3, rge. 24, W. 2nd mer. Coll. F. H. McLearn, 1930.
4144 =4137
4145. Lower part of buff facies, SW. sec. 2, tp. 5, rge. 2, W. 3rd mer. Coll. F. H. McLearn, 1930.
4146. Base of grey facies, NE. sec. 8, tp. 6, rge. 1, W. 3rd mer. Coll. F. H. McLearn, 1930.
4147 =4145
4148. Grey facies, south arm Big Muddy Lake. Coll. F. H. McLearn, 1930.
4160. Above Willowbunch member, sec. 30, tp. 1, rge. 21, W. 2nd mer., Sask. Coll. F. H. McLearn, 1930
4181. Morgan Creek, sec. 15, tp. 1, rge. 5, W. 3rd mer., above upper coal seam. Coll. C. M. Sternberg, 1921.

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Plate I

Upper Cretaceous

Figure 1. *Filicites knowltoni* Dorf. Plesiotype, G.S.C. No. 5194 x 2. Locality 4110. (Page 41.)

Figure 2. *Adiantum ? paululum* Bell. Paratype, G.S.C. No. 6190. Locality 4187. (Page 41.)

Figure 3. *Filicites knowltoni* Dorf. Plesiotype, G.S.C. No. 5194. Locality 4110. (Page 41.)

Figure 4. *Adiantum ? paululum* Bell. Paratype, G.S.C. No. 6173 x 2. Locality 3583. (Page 41.)

Figure 5. *Nilssonia serotina* Heer. Plesiotype, G.S.C. No. 5936. Locality 3275. (Page 42.)

Figure 6. *Adiantum ? paululum* Bell. Paratype, G.S.C. No. 6174 x 2. Locality 3583. (Page 41.)

Figure 7. *Nilssonia serotina* Heer. Plesiotype, G.S.C. No. 5173. Locality 1632. (Page 42.)

Figure 8. *Leguminosites stagnum* Bell. Paratype, G.S.C. No. 6344 x 3. Locality 3582. (Page 68.)

Figure 9. *Leguminosites stagnum* Bell. Holotype, No. 6171 x 3. Locality 3582. (Page 68.)

Figure 10. *Adiantum ? paululum* Bell. Holotype, G.S.C. No. 6172 x 2. Locality 3583. (Page 41.)

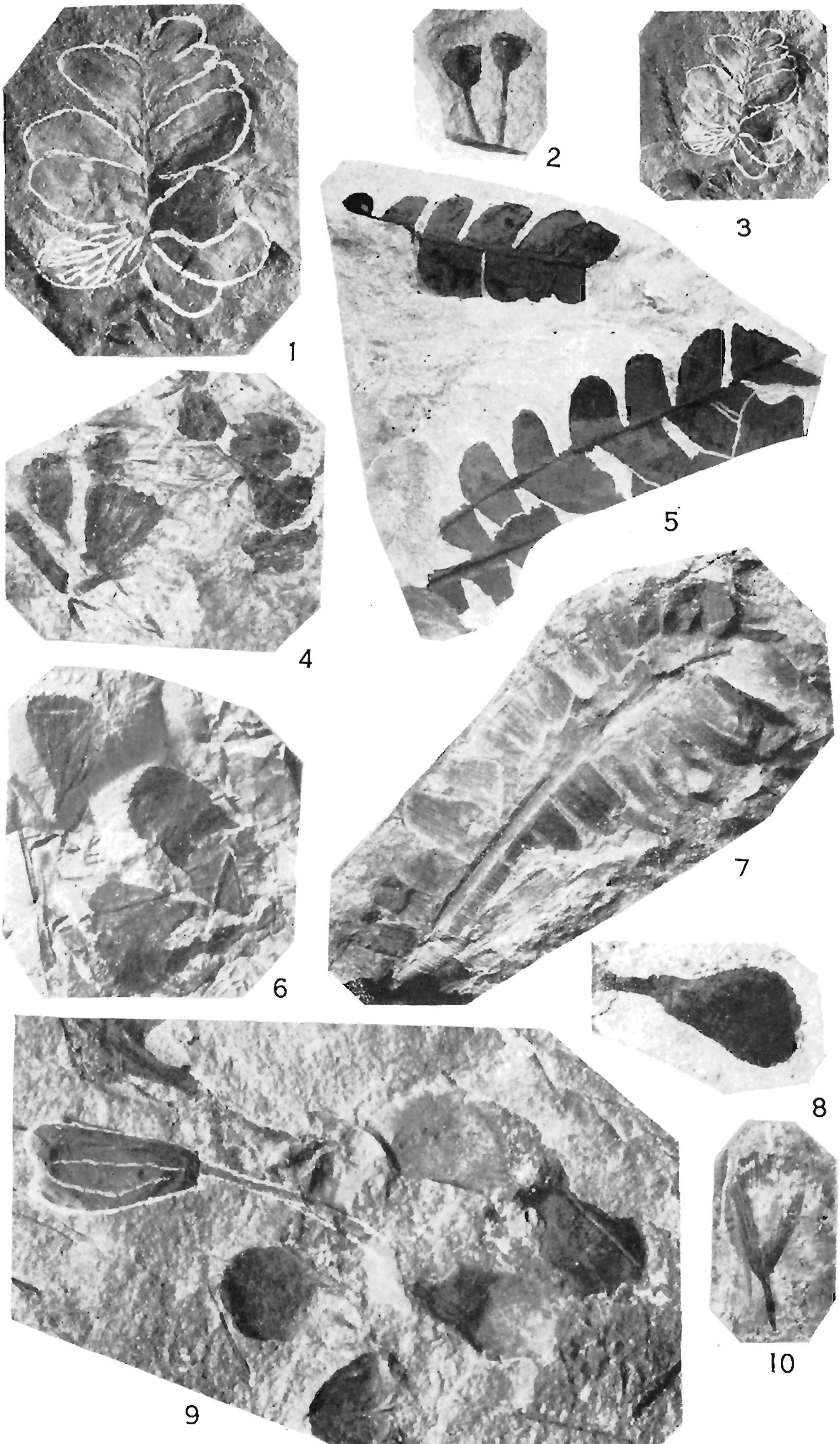
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Plate II

Upper Cretaceous

Figure 1. *Dombeyopsis nebrascensis* (Newberry) Plesiotype, G.S.C. No. 6360. Locality 3674. (Page 62.)

Figure 2. *Sphenopteris (Dennstaedtia?) burlingi* Bell. Paratype, G.S.C. No. 6364 x 3. Locality 3674 (Page 39.)

Figure 3. *Sphenopteris (Dennstaedtia?) burlingi* Bell. Paratype, G.S.C. No. 6362. Locality 3674. (Page 39.)

Figure 4. *Dombeyopsis nebrascensis* (Newberry). Plesiotypes, G.S.C. Nos 6361 (right), 6458 (left). Locality 3674. (Page 62.)

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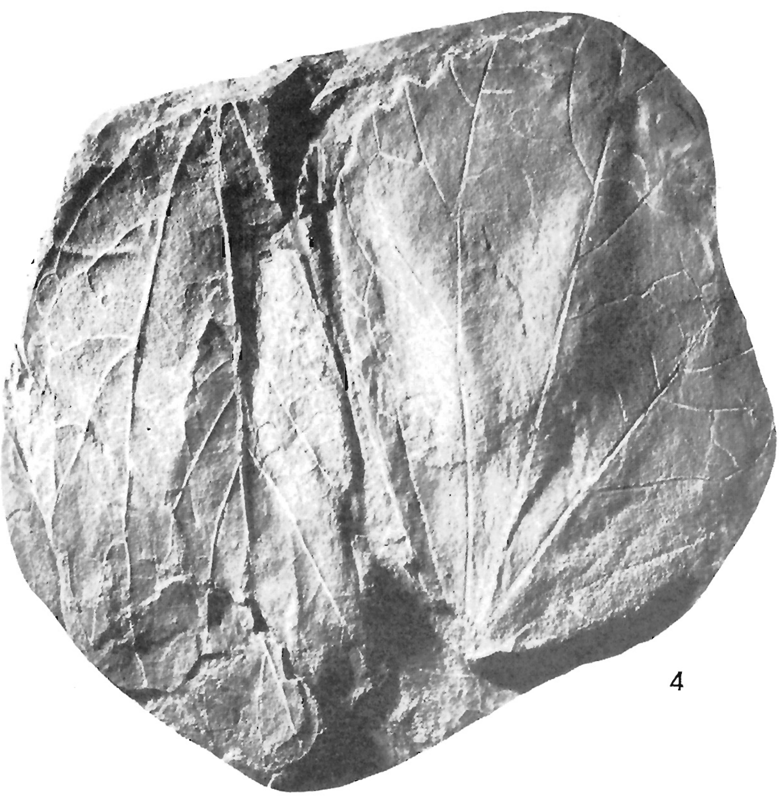

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Plate III

Upper Cretaceous

Figure 1. *Ginkgoites* sp. G.S.C. No. 5174. Locality 4167. (Page 44.)

Figure 2. *Ginkgoites* sp. G.S.C. No. 5175. Locality 4167. (Page 44.)

Figure 3. *Vitis stantoni* (Knowlton). Plesiotype, G.S.C. No. 6338. Locality 3681. (Page 75.)

Plate III

Plate IV

Upper Cretaceous

Figure 1. *Dryopteris georgii ?* Knowlton. Plesiotype (?), G.S.C. No. 6352. Locality 3707. (Page 40.)

Figure 2. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5040. Locality 1613. (Page 56.)

Figure 3. *Nilssonia* sp. G.S.C. No. 6335. Locality 3470. (Page 42.)

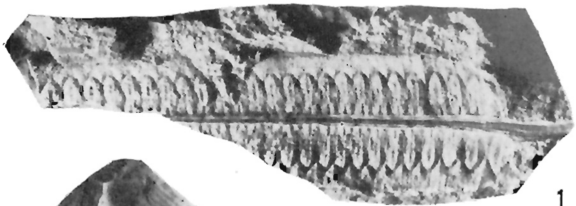
Figure 4. *Nilssonia serotina* Heer. Plesiotype, G.S.C. No. 6336 x 2. Locality 3470. (Page 42.)

Figure 5. *Juniperites gracilis* (Heer) Seward and Conway. Plesiotype, G.S.C. No. 6324 x 4. Locality 3677. (Page 52.)

Figure 6. *Jenkinsella arctica* (Heer). Plesiotype, G.S.C. No. 6337 x 4. Locality 3677 (Page 57.)

Figure 7. *Sequoiites artus* Bell. Paratype, G.S.C. No. 6326. Locality 6383. (Page 47.)

Figure 8. *Sequoiites artus* Bell. Paratype, G.S.C. No. 6326 x 2. Locality 3683. (Page 47.)



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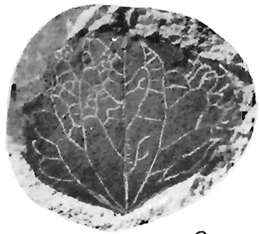

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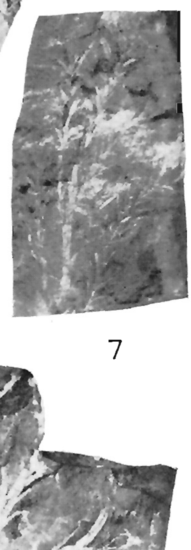

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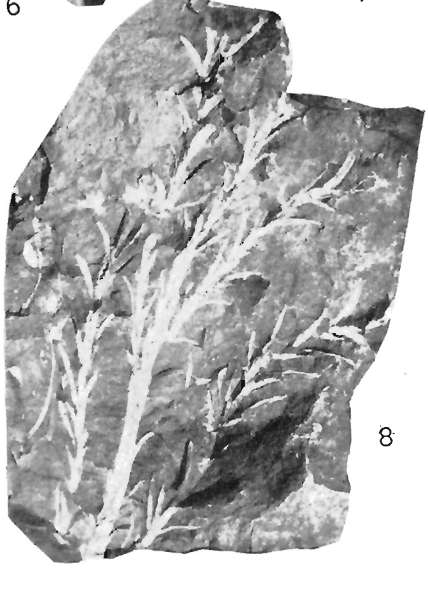

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Plate V

Upper Cretaceous

Figure 1. *Sequoiites dakotensis* (Brown). Plesiotype, G.S.C. No. 5178. Locality 1633. (Page 48.)

Figure 2. *Sequoiites dakotensis* (Brown). Plesiotype, G.S.C. No. 5179. Locality 2172. (Page 48.)

Figure 3. *Sequoiites dakotensis* (Brown). Plesiotype, G.S.C. No. 5927. Locality 1633. (Page 48.)

Figure 4. *Sequoiites artus* Bell. Holotype, G.S.C. No. 5192. Locality 1612. (Page 47.)

Figure 5. *Conites* sp. G.S.C. No. 5945. Locality 3274. (Page 51.)

Figure 6. *Sequoiites artus* Bell. Paratype, G.S.C. No. 5951. Locality 1613. (Page 47.)

Figure 7. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 6278. Locality 3466. (Page 51.)

Figure 8. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 5966 (the appearance of branching is deceptive). Locality 3466. (Page 51.)

Figure 9. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 5176. Locality 1912. (Page 51.)

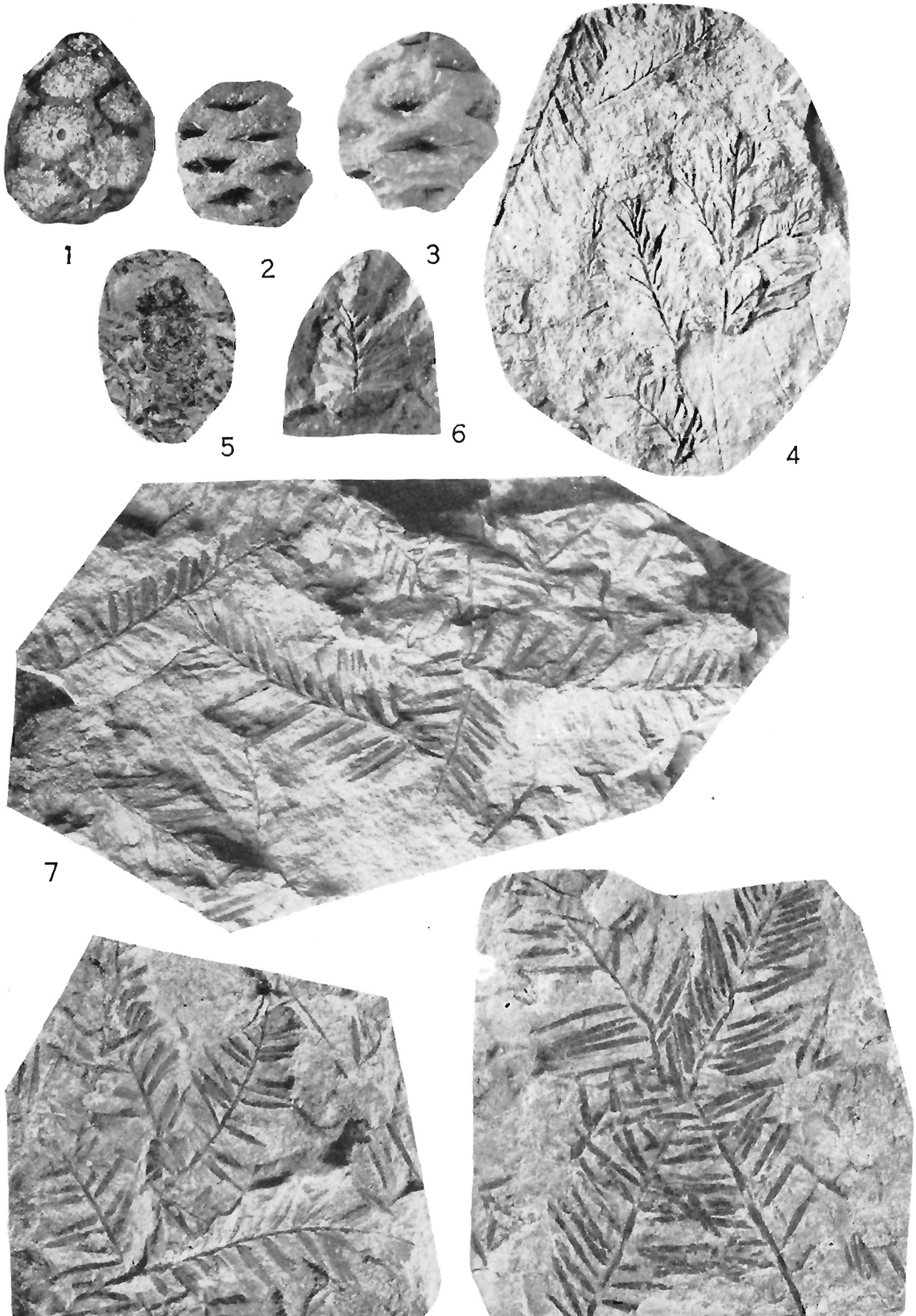
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Plate VI

Upper Cretaceous

Figure 1. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 5944. Locality 3274 (Page 51.)

Figure 2. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 6113. Locality 3466. (Page 51.)

Figure 3. *Elatocladus intermedius* (Hollick). Plesiotype, G.S.C. No. 5944 (reverse side). Locality 3274. (Page 51.)

Figure 4. *Equisetum perlaevigatum* Cockerell. Plesiotype, G.S.C. No. 6181. Locality 3587. (Page 36.)

Figure 5. *Equisetum perlaevigatum* Cockerell. Plesiotype, G.S.C. No. 6180. Locality 3587. (Page 36.)

Figure 6. *Equisetum perlaevigatum* Cockerell. Plesiotype, G.S.C. No. 6182 (rhizome). Locality 3587. (Page 36.)

Figure 7. *Equisetum perlaevigatum* Cockerell. Plesiotype, G.S.C. No. 6182 (external mould, showing same node as that of Figure 6, with attached tuberous roots). Locality 3587. (Page 36.)

PLATE VI

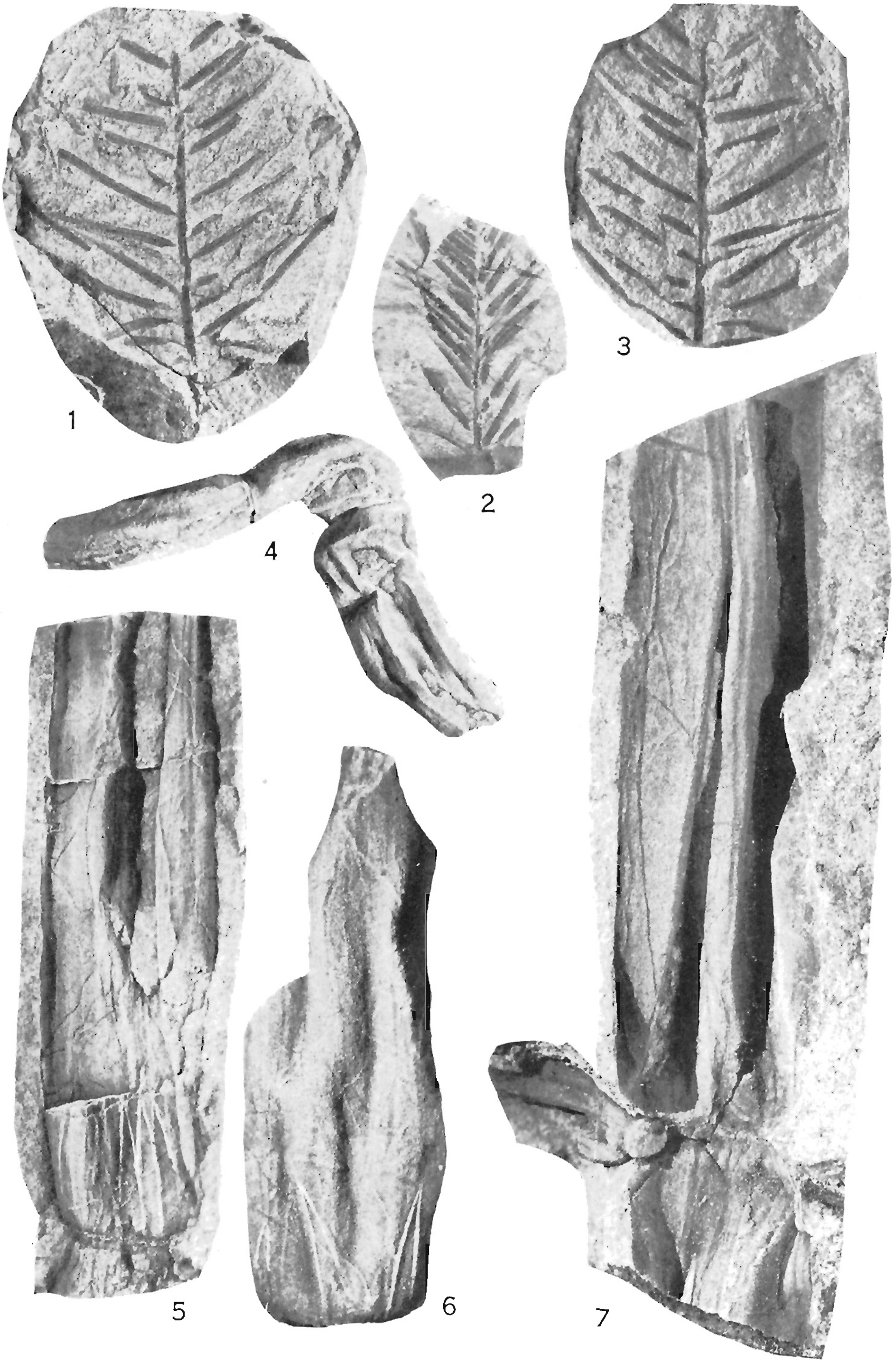

Plate VII

Upper Cretaceous

Figure 1. *Pityostrobus (Cunninghamiostrobus?)* sp. G.S.C. No. 5081. Locality 12. (Page 47.)

Figure 2. *Pityostrobus (Cunninghamiostrobus?)* sp. G.S.C. No. 5082. Locality 12. (Page 47.)

Figure 3. *Torreyites tyrrellii* (Dawson). Lectotype, G.S.C. No. 6459. Locality 3263. (Page 45.)

Figure 4. *Torreyites tyrrellii* (Dawson). Plesiotype, G.S.C. No. 6281. Locality 3469. (Page 45.)

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PLATE VIII

Upper Cretaceous

Figure 1. *Torreyites tyrrellii* (Dawson). Plesiotype, G.S.C. No. 5399. Locality 4100. (Page 45.)

Figure 2. *Fraxinus leii* Berry. Plesiotype, G.S.C. No. 5195 (imprint of lower surface). Locality 1650. (Page 77.)

Figure 3. *Fraxinus leii* Berry. Plesiotype, G.S.C. No. 5195 (imprint of upper surface). Locality 1650. (Page 77.)

Figure 4. *Torreyites tyrrellii* (Dawson). Plesiotype, G.S.C. No. 6283 x 12 (showing stomatal bands). Locality 1613. (Page 45.)

PLATE VIII

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Plate IX

Upper Cretaceous

Figure 1. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6343. Locality 3677. (Page 62.)

Figure 2. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6342. Locality 3677. (Page 62.)

Figure 3. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6341. Locality 3677. (Page 62.)

Figure 4. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 6345. Locality 1612. (Page 56.)

Figure 5. *Vitis stantoni* (Knowlton). Plesiotype, G.S.C. No. 6340. Locality 3680. (Page 75.)

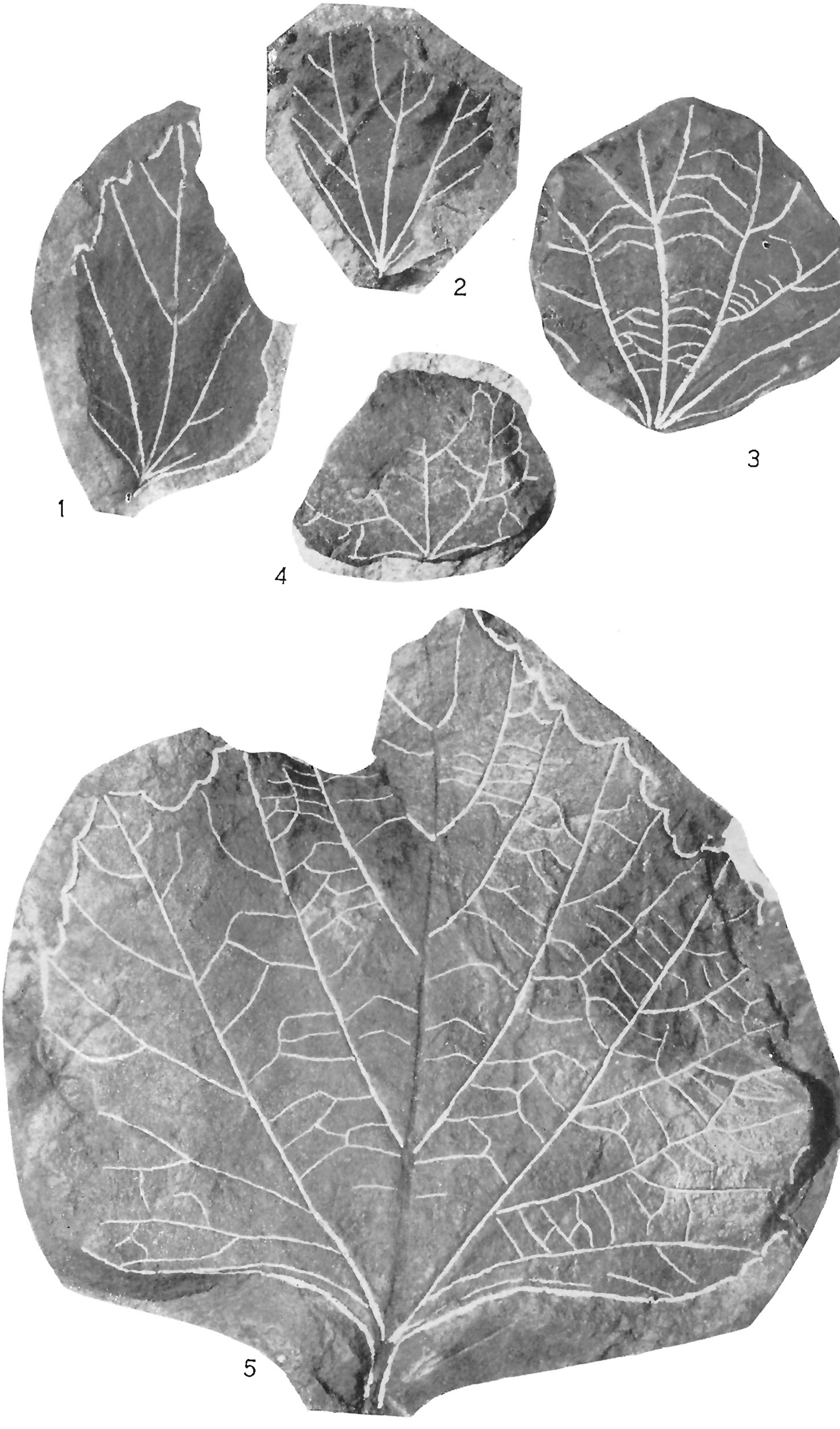
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Plate X

Upper Cretaceous

Figure 1. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, No. 5167. Locality 1612. (Page 62.)

Figure 2. *Vitis stantoni* (Knowlton). Plesiotype, G.S.C. No. 6311. Locality 3679. (Page 75.)

Figure 3. *Vitis stantoni* (Knowlton). Plesiotype, G.S.C. No. 6310. Locality 3679. (Page 75.)

Plate X

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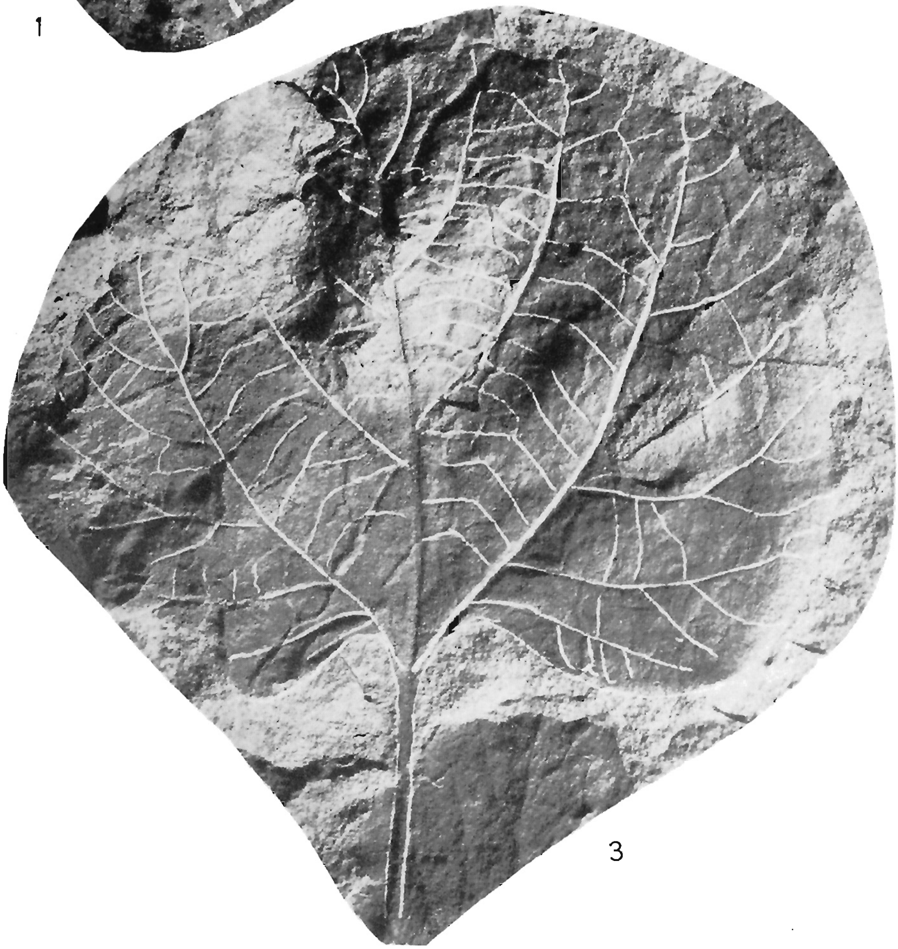

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Plate XI

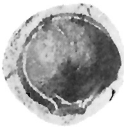
Upper Cretaceous

Figure 1. *Carpolithus kneehillensis* Bell. Holotype, G.S.C. No. 6323 x ¾. Locality 3683 (Page 44.)

Figure 2. *Carpolithus kneehillensis* Bell. Holotype, G.S.C. No. 6323 x 1½. Locality 3683. (Page 44.)

Figure 3. *Vitis stantoni* (Knowlton). Plesiotype, G.S.C. No. 6312 x ¾. Locality 3679. (Page 75.)

PLATE XI



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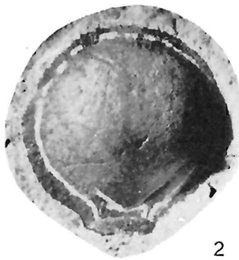

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PLATE XII

Upper Cretaceous

Figure 1. *Pistia corrugata* Lesquereux. Plesiotype, G.S.C. No. 5926. Locality 4129. (Page 81.)

Figure 2. *Pistia corrugata* Lesquereux. Plesiotype, G.S.C. No. 5925. Locality 4129. (Page 81.)

Figure 3. *Carpolithus (Cycadinocarpus?) ceratops* (Knowlton). Plesiotype, G.S.C. No. 5203. Locality 4173. (Page 42.)

Figure 4. *Carpolithus (Ginkgoites?) fultoni* Bell. Paratype, G.S.C. No. 6288 x 4. Locality 3467. (Page 44.)

Figure 5. *Menispermites belli* Berry. Plesiotype, G.S.C. No. 7419. Locality 4129. (Page 60.)

Figure 6. *Carpolithus (Cycadinocarpus?) ceratops* (Knowlton). Plesiotype, G.S.C. No. 5201. Locality 4173. (Page 42.)

Figure 7. *Carpolithus (Ginkgoites?) fultoni* Bell. Paratypes, G.S.C. Nos. 6285 and 6286, underlain by holotype, No. 5142. Locality 3470. (Page 44.)

Figure 8. *Typha* sp. Dorf. Plesiotype, G.S.C. No. 6176. Locality 3580. (Page 82.)

Figure 9. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 5042. Locality 1612. (Page 62.)

Figure 10. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 5166. Locality 1612. (Page 62.)

PLATE XII

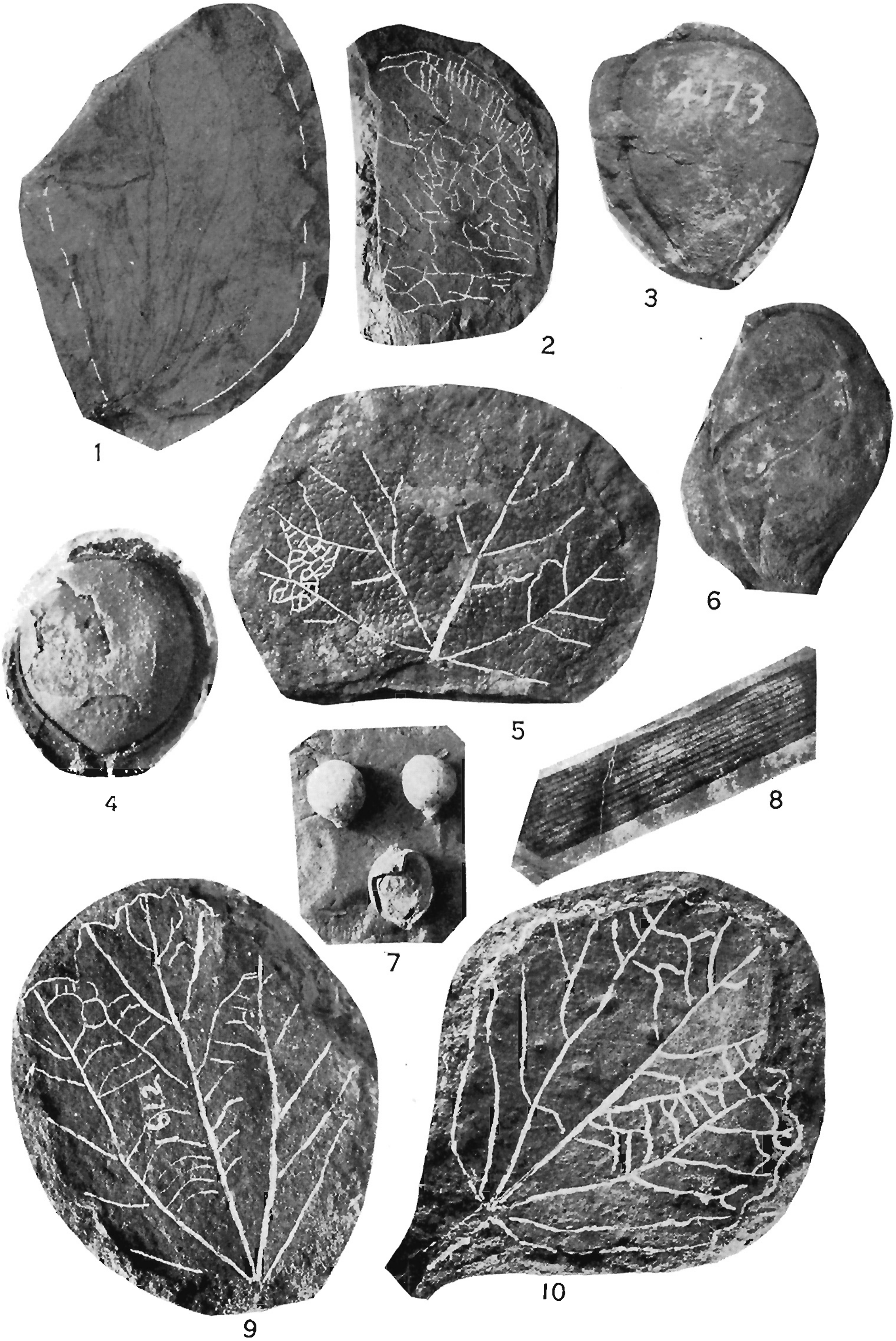

Plate XIII

Upper Cretaceous

Figure 1. *Carpolithus (Ginkgoites?) fultoni* Bell. Paratype, G.S.C. No. 6285 x 4. Locality 3470. (Page 44.)

Figure 2. *Carpolithus (Ginkgoites?) fultoni* Bell. Holotype, G.S.C. No. 5142 x 4. Locality 1616. (Page 44.)

Figure 3. *Antholithes (Nymphaeites?) marsilioides* Bell. Holotype, G.S.C. No. 6179. Locality 3586. (Page 68.)

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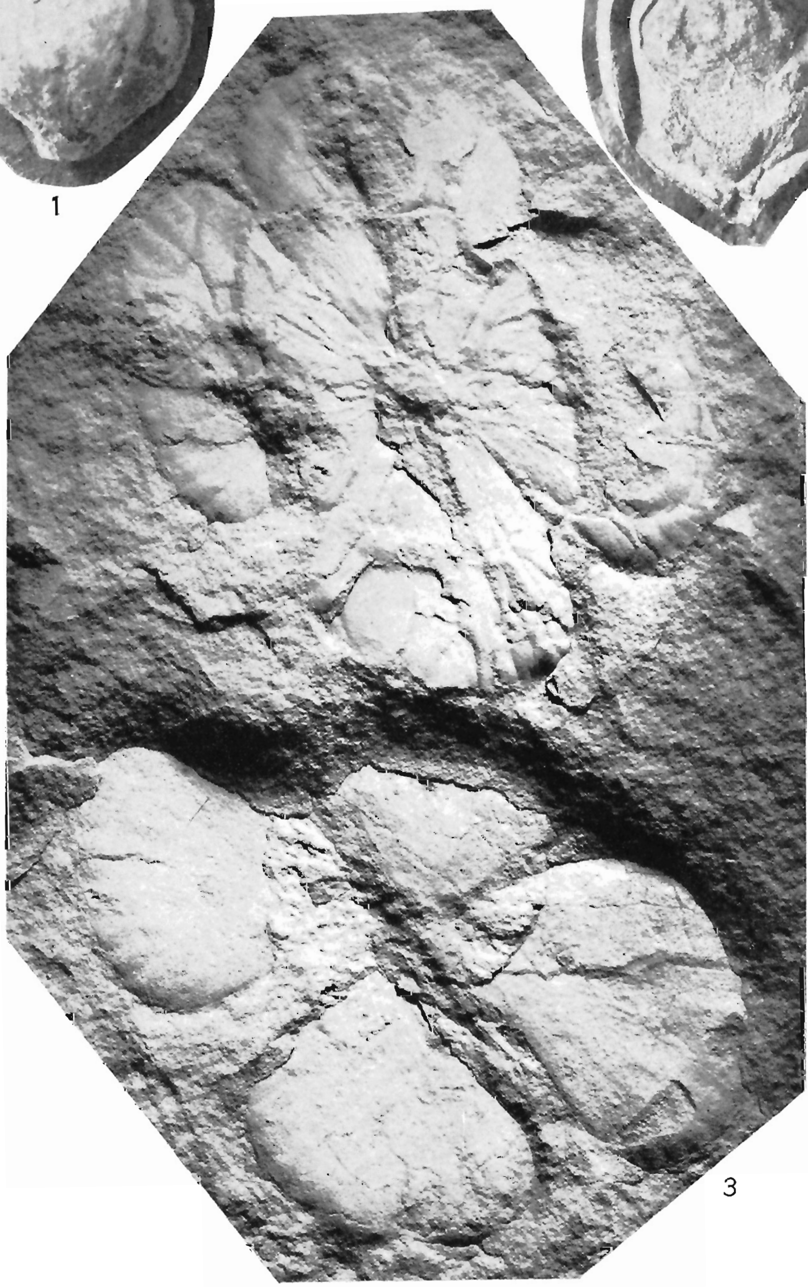

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PLATE XIV

Upper Cretaceous, Figures 1, 2, 4; *Paleocene*, Figure 3

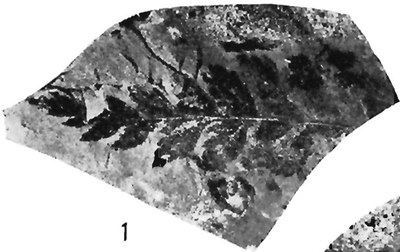
Figure 1. *Sphenopteris (Dennstaedtia?) burlingi* Bell. Holotype, G.S.C. No. 6365. Locality 3700. (Page 39.)

Figure 2. *Sphenopteris (Dennstaedtia?) burlingi* Bell. Holotype, G.S.C. No. 6365 x 2 Locality 3700. (Page 39.)

Figure 3. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6197. Locality 3140. (Page 78.)

Figure 4. *Sphenopteris (Dennstaedtia?) burlingi* Bell. Paratype, G.S.C. No. 6363 x 2. Locality 3674. (Page 39.)

PLATE XIV



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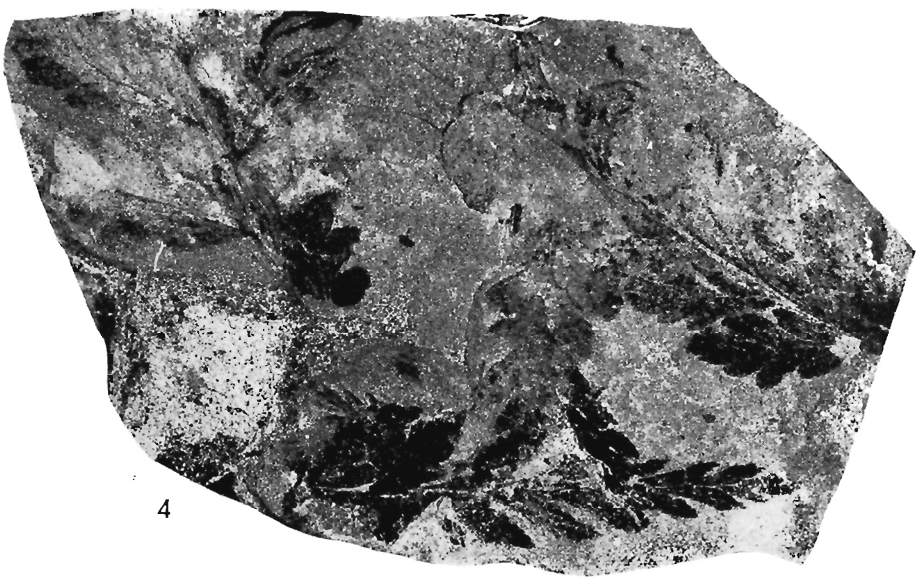

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PLATE XV

Upper Cretaceous, Figure 6; *Paleocene*, Figures 1-5

Figure 1. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6346 x 2. Locality 3700. (Page 46.)
Figure 2. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6350 x 2. Locality 3700. (Page 46.)
Figure 3. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6349. Locality 3700. (Page 46.)
Figure 4. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6348. Locality 3700. (Page 46.)
Figure 5. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6347. Locality 3700. (Page 46.)
Figure 6. *Anona robusta* Lesquereux. Plesiotype, G.S.C. No. 6322. Locality 3681. (Page 60.)

PLATE XV

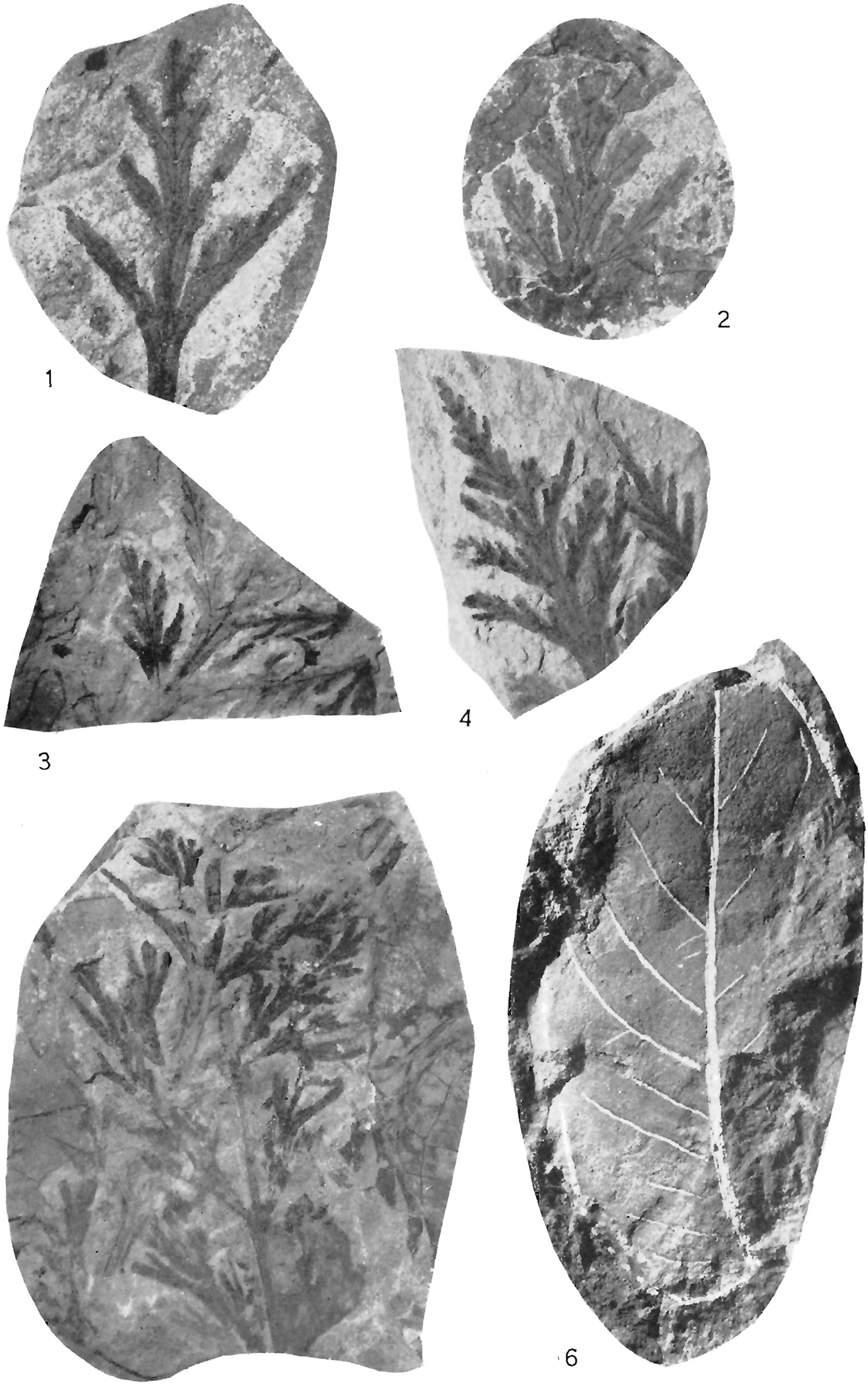

Plate XVI

Upper Cretaceous, Figures 1, 2; *Paleocene*, Figures 3, 4

Figure 1. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6359. Locality 4129. (Page 77.)

Figure 2. *Sequoiites artus* Bell. Paratype, G.S.C. No. 6358 x 2. Locality 3476. (Page 47.)

Figure 3. *Elatocladus (Taxodites?) tinajorum* (Heer). Plesiotype, G.S.C. No. 6365. Locality 3700. (Page 51.)

Figure 4. *Androvettia catenulata* Bell. Paratype, G.S.C. No. 6349 x 2. Locality 3700. (Page 46.)

PLATE XVI

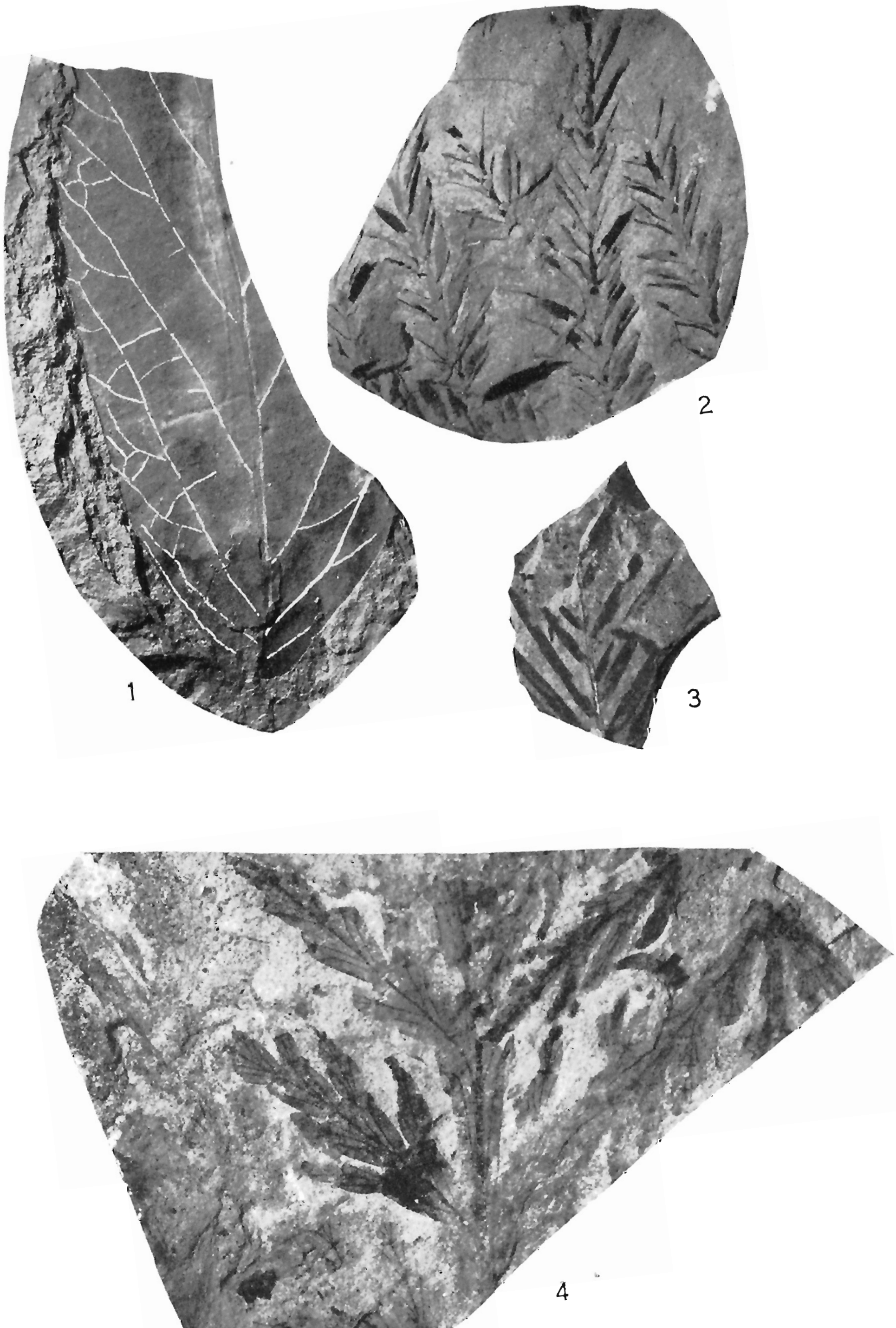

PLATE XVII

Upper Cretaceous, Figure 1-3, 5-7; *Paleocene*, Figure 4

Figure 1. *Nymphaeites striatus* (Berry). Plesiotype, G.S.C. No. 6186. Locality 2149. (Page 67.)

Figure 2. *Nymphaeites striatus* (Berry). Plesiotype, G.S.C. No. 6183. Locality 3584. (Page 67.)

Figure 3. *Nymphaeites striatus* (Berry). Plesiotype, G.S.C. No. 6187. Locality 2149. (Page 67.)

Figure 4. *Nymphaeites angulatus* (Newberry). Plesiotype, G.S.C. No. 6185. Locality 3364. (Page 64.)

Figure 5. *Nymphaeites striatus* (Berry). Plesiotype, G.S.C. No. 6188. Locality 2149. (Page 67.)

Figure 6. *Nymphaeites striatus* (Berry). Plesiotype, G.S.C. No. 6169. Locality 3584. (Page 67.)

Figure 7. *Nymphaeites angulatus ?* (Newberry). Plesiotype, G.S.C. No. 6277 Locality 3583. (Page 64.)

PLATE XVII

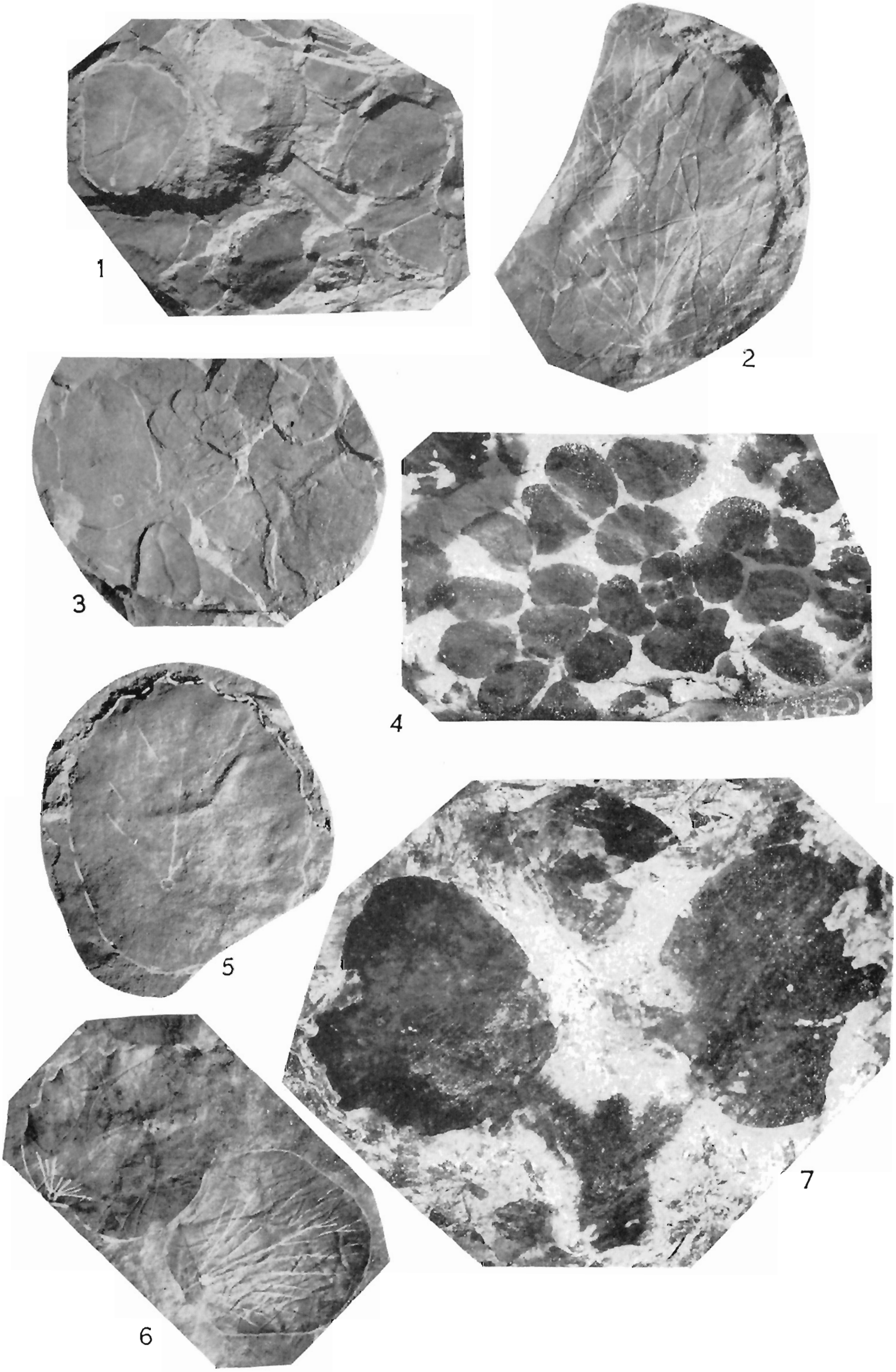

Plate XVIII

Upper Cretaceous, Figures 1, 3, 4; *Paleocene,* Figure 2

Figure 1. *Sequoiites artus* Bell. Paratype, G.S.C. No. 6325. Locality 3677. (Page 47.)

Figure 2. *Nordenskioldia borealis* Heer. Plesiotype, G.S.C. No. 5586. Locality 1552. (Page 80.)

Figure 3. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6331. Locality 3476. (Page 77.)

Figure 4. *Sequoiites artus* Bell. Paratype, G.S.C. No. 6325 x 2. Locality 3677. (Page 47.)

PLATE XVIII

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Plate XIX

Upper Cretaceous, Figures 1, 4; *Paleocene*, Figures 2, 3

Figure 1. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6333. Locality 3476. (Page 62.)

Figure 2. *Zizyphoides mackayi* Bell. Paratype, G.S.C. No. 623 x 2. Locality 1608. (Page 74.)

Figure 3. *Zizyphoides mackayi* Bell. Paratype, G.S.C. No. 623. Locality 1608. (Page 74.)

Figure 4. *Platanus raynoldsi integrifolia* Lesquereux. Plesiotype, G.S.C. No. 6313. Locality 3679. (Page 60.)

PLATE XIX

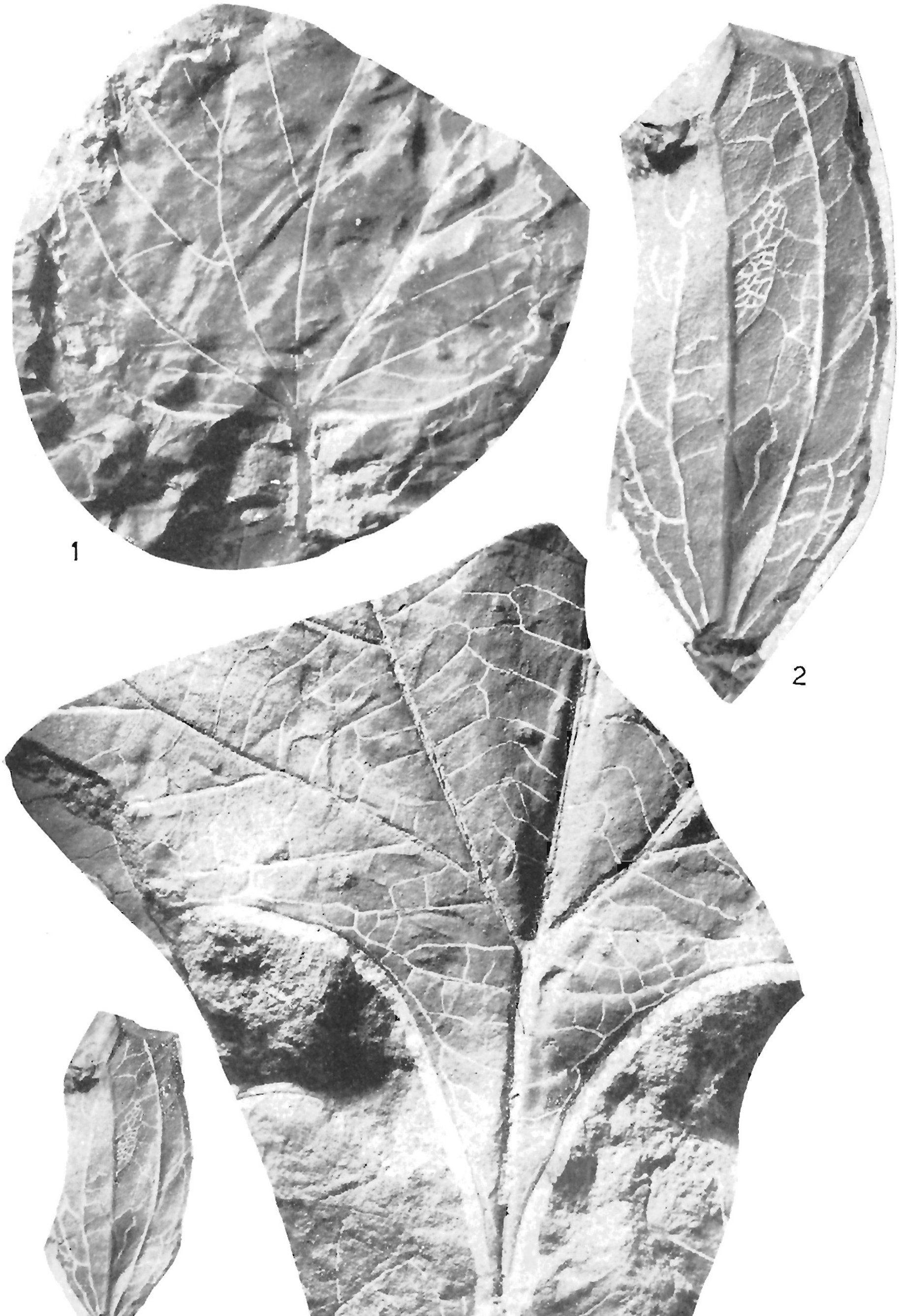

Plate XX

Upper Cretaceous, Figure 1; *Paleocene,* Figures 2-5

Figure 1. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 5165. Locality 1612. (Page 62.)

Figure 2. *Zizyphoides mackayi* Bell. Paratype, G.S.C. No. 624 x 2. Locality 1608. (Page 74.)

Figure 3. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5582. Locality 1552. (Page 56.)

Figure 4 *Zizyphoides mackayi* Bell. Holotype, G.S.C. No. 621. Locality 1608. (Page 74.)

Figure 5. *Onoclea hebridica* (Forbes). Plesiotype, G.S.C. No. 5459e x 10. Locality 4095. (Page 40.)

PLATE XX

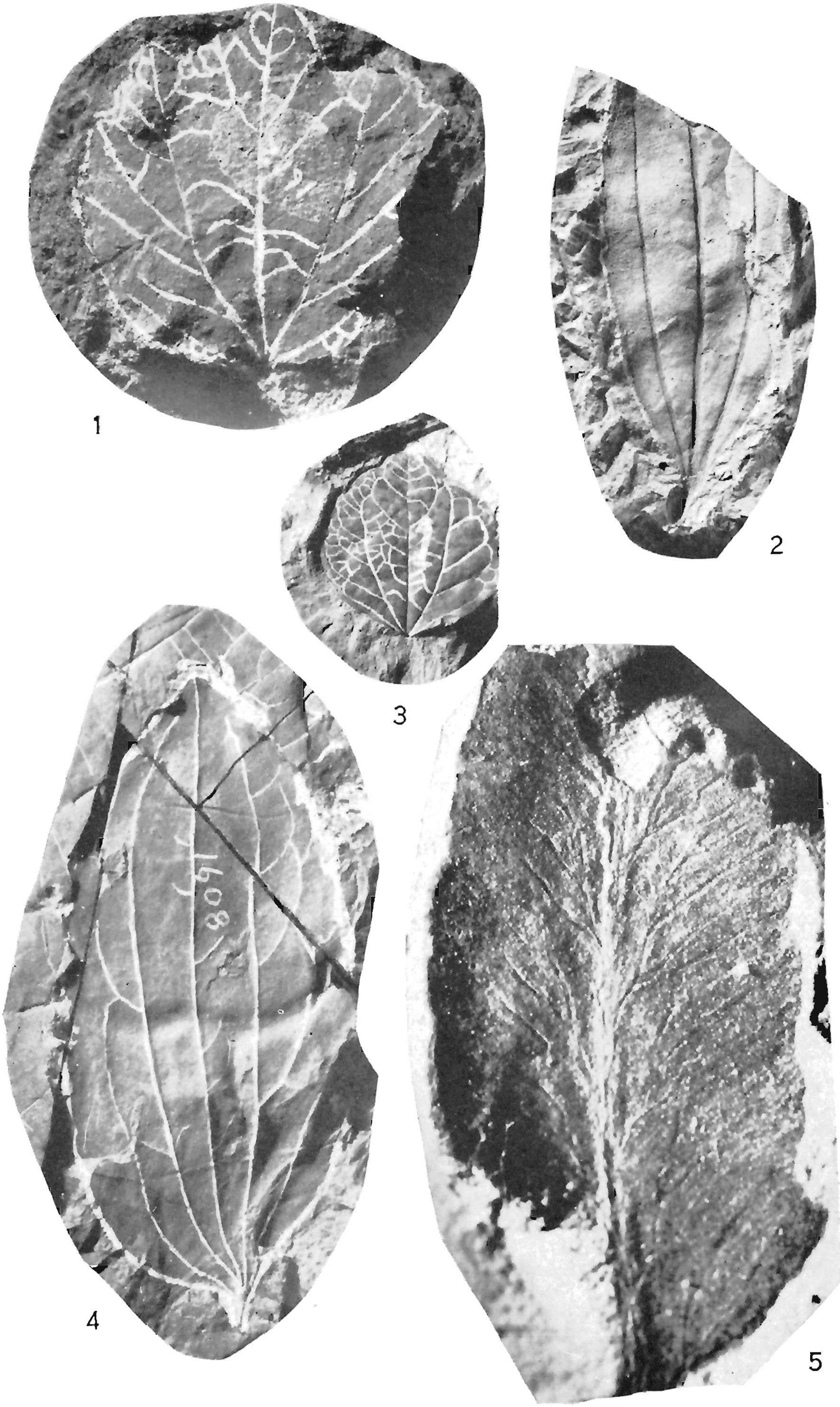

Plate XXI

Upper Cretaceous, Figures 2, 4-6; *Paleocene,* Figures 1, 3

Figure 1. *Equisetum boreale* (Heer). Plesiotype, G.S.C. No. 615. Locality 1608. (Page 38.)

Figure 2. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6334 x 3. Locality 3476. (Page 77.)

Figure 3. *Nordenskioldia borealis* Heer. Plesiotype, G.S.C. No. 5585 x 2. Locality 1552. (Page 80.)

Figure 4. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6332 x 2. Locality 3476. (Page 77.)

Figure 5. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6332 x 2. Locality 3476. (Page 77.)

Figure 6. *Viburnum simile* Knowlton. Plesiotype, G.S.C. No. 6330. Locality 3466. (Page 77.)

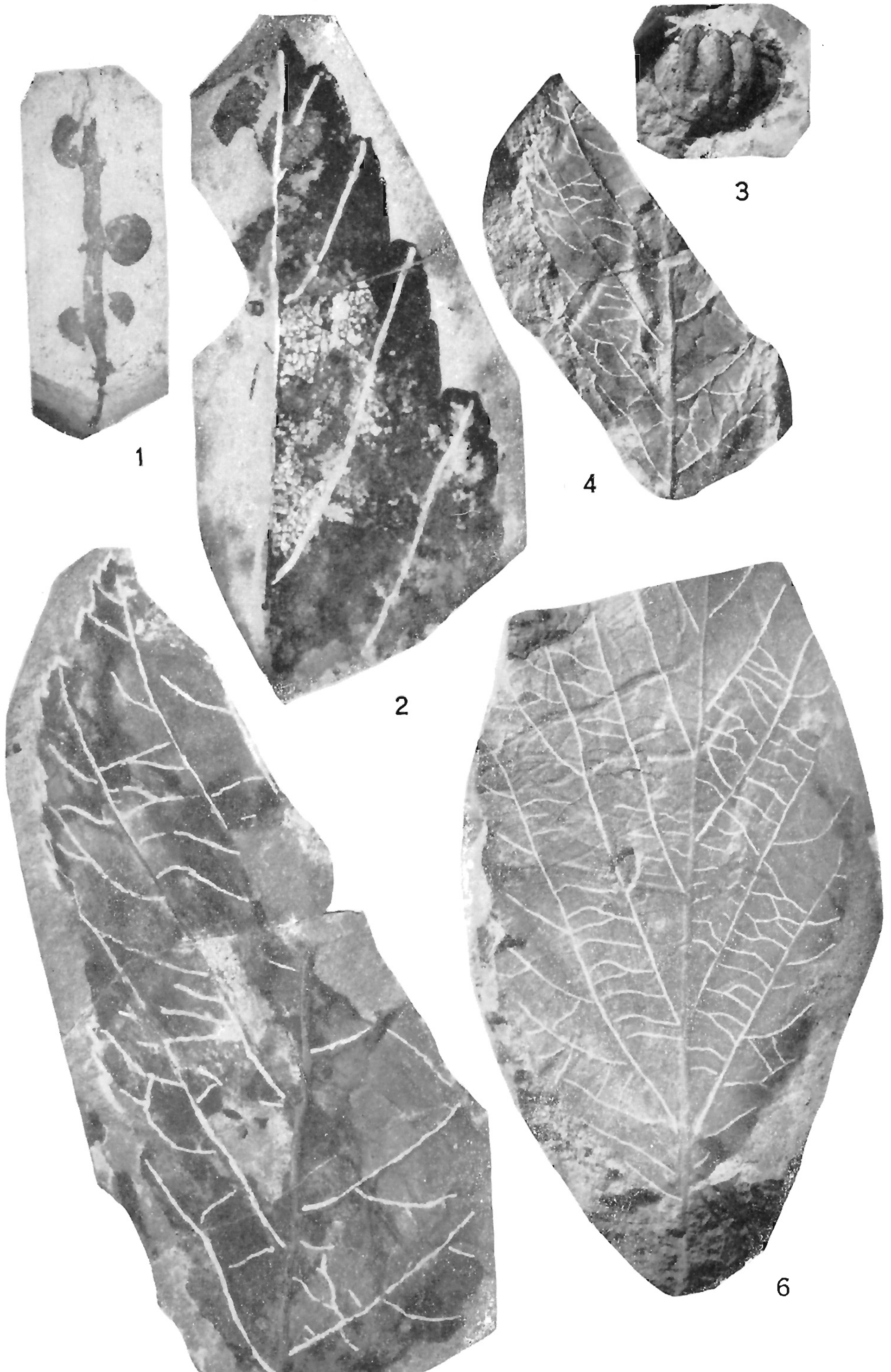
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Plate XXII

Paleocene

Figure 1. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6455 x 35 (upper end view). Locality 1618. (Page 36.)

Figure 2. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6457 x 35 (lower end view). Locality 1618. (Page 36.)

Figure 3. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6369 x 25 (lower end view of cast of interior of gyrogonite). Locality 1618. (Page 36.)

Figure 4. *Equisetum alexoensis* Bell. Paratype, G.S.C. No. 6139. Locality 3438. (Page 36.)

Figure 5. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6368 x 25 (side view of cast of interior of gyrogonite). Locality 1618. (Page 36.)

Figure 6. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6155. Locality 3445. (Page 62.)

Figure 7. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6366 x 25 (side view of cast of interior of gyrogonite). Locality 1618. (Page 36.)

Figure 8. *Aclistochara compressa* (Knowlton). Plesiotype, G.S.C. No. 6456 x 35 (upper end view showing broken ends of three of the enveloping cells). Locality 1618. (Page 36.)

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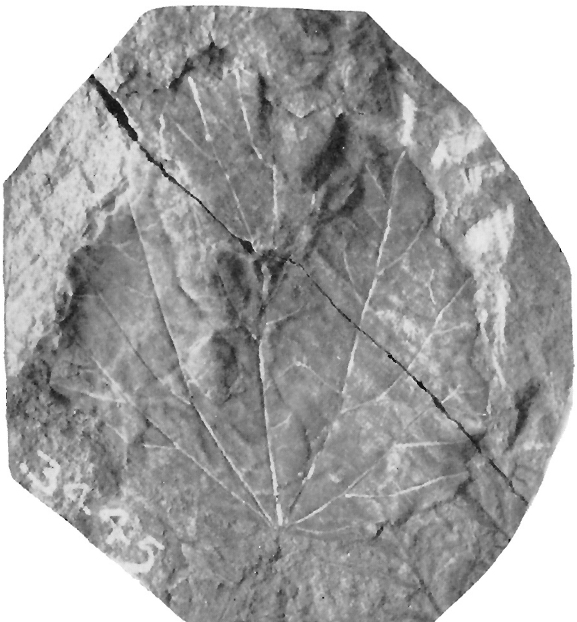

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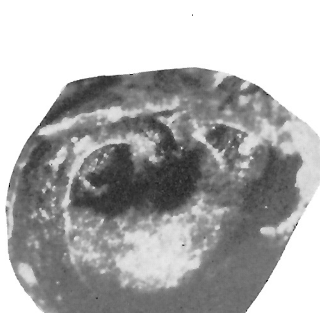

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Plate XXIII

Paleocene

Figure 1. *Equisetum boreale* Heer. Plesiotype, G.S.C. No. 6132. Locality 3460. (Page 38.)

Figure 2. *Equisetum arcticum* Heer. Plesiotype, G.S.C. No. 5554. Locality 1202. (Page 37.)

Figure 3. *Equisetum boreale* Heer. Plesiotype, G.S.C. No. 6131. Locality 3460. (Page 38.)

Figure 4. *Equisetum arcticum* Heer. Plesiotype, G.S.C. No. 6257. Locality 3443. (Page 37.)

Figure 5. *Equisetum alexoensis* Bell. Holotype, G.S.C. No. 6138. Locality 3438. (Page 36.)

Figure 6. *Equisetum alexoensis* Bell. Paratype, G.S.C. No. 6146 x 4. Locality 3448. (Page 36.)

Figure 7. *Equisetum alexoensis* Bell. Paratype, G.S.C. No. 5521. Locality 2189. (Page 36.)

Figure 8. *Equisetum arcticum* Heer. Plesiotype, G.S.C. No. 6256. Locality 3443. (Page 37.)

Figure 9. *Equisetum alexoensis* Bell. Paratype, G.S.C. No. 6145 x 4. Locality 3448. (Page 36.)

PLATE XXIII

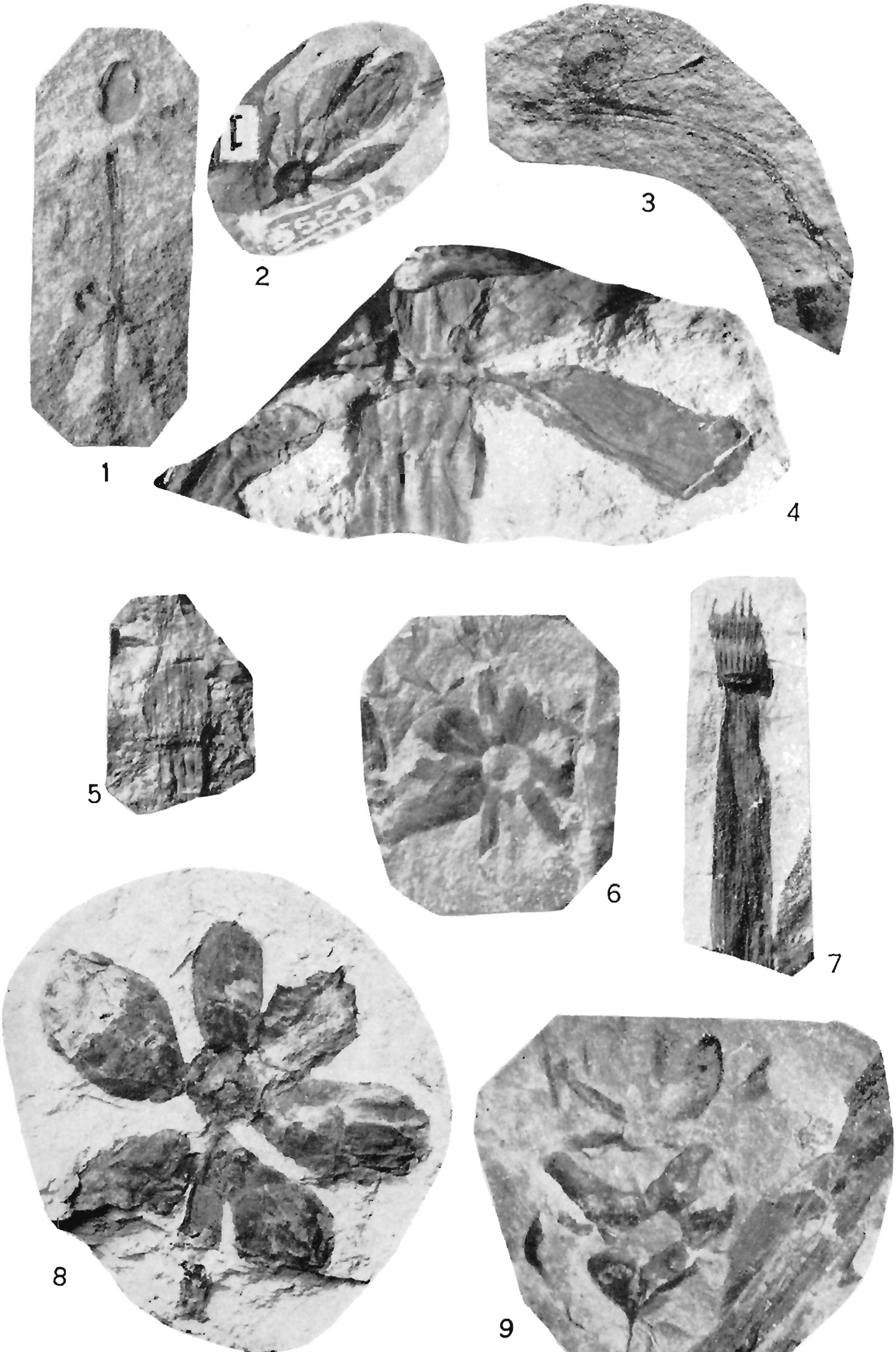

Plate XXIV

Paleocene

Figure 1. *Dennstaedtia blomstrandi* (Heer). Plesiotype, G.S.C. No. 6167. Locality 3443. (Page 39.)

Figure 2. *Osmunda macrophylla* (Penhallow). Plesiotype, G.S.C. No. 6164. Locality 3441. (Page 38.)

Figure 3. *Onoclea hebridica* (Forbes). Plesiotype, G.S.C. No. 5922. Locality 3363. (Page 40.)

Figure 4. *Dennstaedtia blomstrandi* (Heer). Plesiotype, G.S.C. No. 6168. Locality 3443. (Page 39.)

Figure 5. *Onoclea hebridica* (Forbes). Plesiotype, G.S.C. No. 5481 x 2. Locality 4091. (Page 40.)

PLATE XXIV

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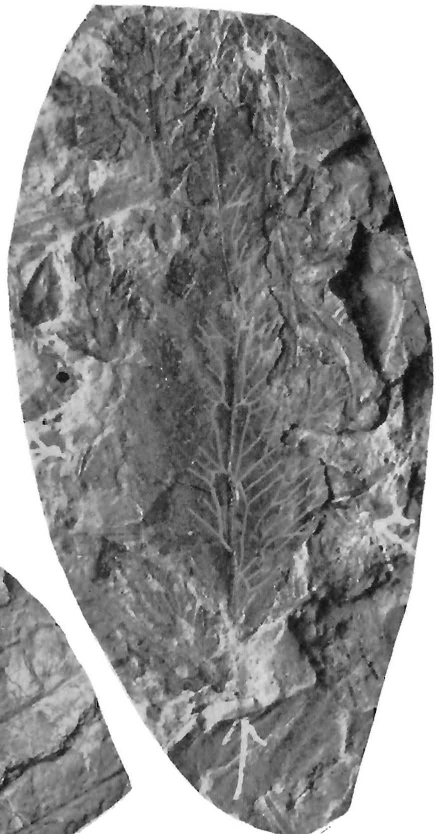

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Plate XXV

Paleocene

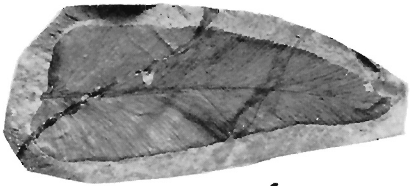
Figure 1. *Osmunda macrophylla* (Penhallow). Plesiotype, G.S.C. No. 6163. Locality 3441. (Page 38.)

Figure 2. *Onoclea hebridica* (Forbes). Plesiotype, G.S.C. No. 7393. Locality 4143. (Page 40.)

Figure 3. *Osmunda macrophylla* (Penhallow). Plesiotype, G.S.C. No. 6166. Locality 3444. (Page 38.)

Figure 4. *Osmunda macrophylla* (Penhallow). Plesiotype, G.S.C. No. 6165. Locality 3443. (Page 38.)

Plate XXV



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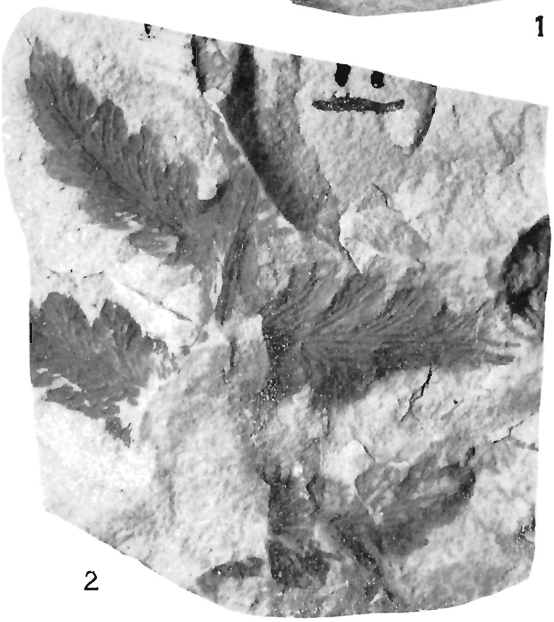

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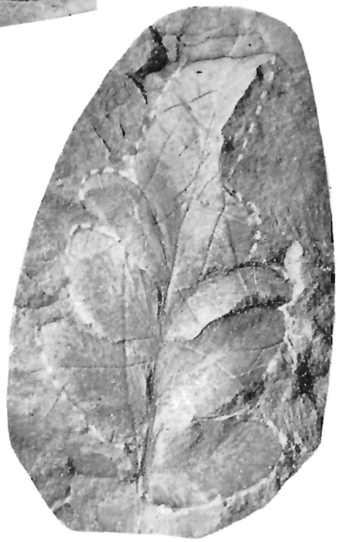

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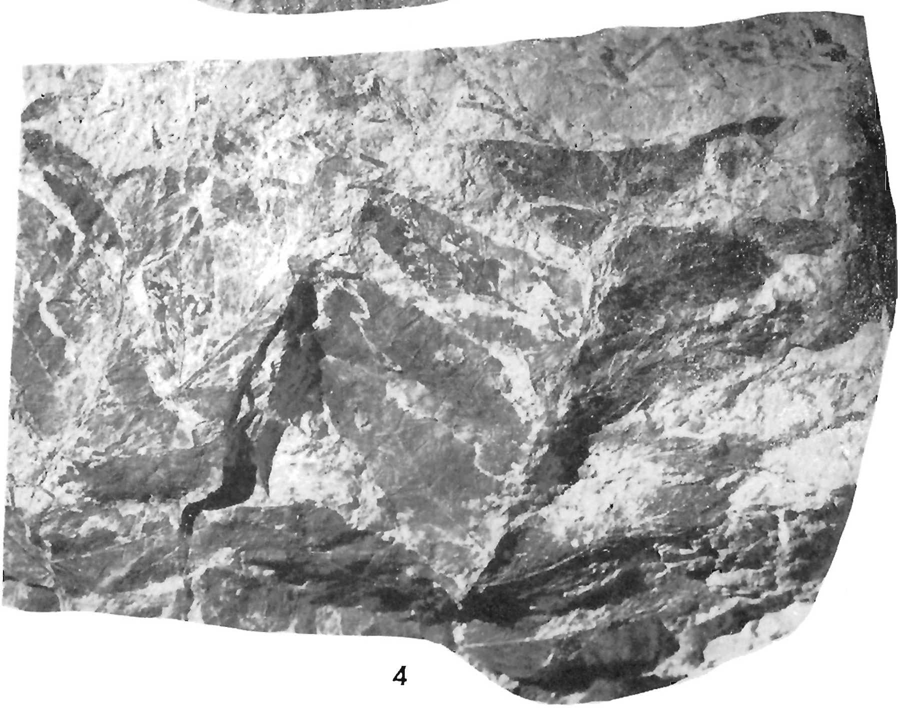

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PLATE XXVI

Paleocene

Figure 1. *Asplenium ? penhallowi* Bell. Holotype, G.S.C. No. 5553. Locality 1202. (Page 41.)

Figure 2. *Cladophlebis groenlandica* (Heer). Plesiotype, G.S.C. No. 5587. Locality 1552. (Page 38.)

Figure 3. *Asplenium ? penhallowi* Bell. Paratype, G.S.C. No. 5551. Locality 1202. (Page 41.)

Figure 4. *Asplenium ? penhallowi* Bell. Paratype, G.S.C. No. 5551 x 3. Locality 1202. (Page 41.)

Figure 5. *Dennstaedtia blomstrandi* (Heer). Plesiotype, G.S.C. No. 6254. Locality 3443. (Page 39.)

PLATE XXVI

Plate XXVII

Paleocene

Figure 1. *Thuites interruptus* (Newberry). Plesiotype, G.S.C. No. 6144. Locality 3435. (Page 52.)

Figure 2. *Thuites interruptus* (Newberry). Plesiotype, G.S.C. No. 6142. Locality 3426. (Page 52.)

Figure 3. *Thuites interruptus* (Newberry). Plesiotype, G.S.C. No. 6143. Locality 3428. (Page 52.)

Figure 4. *Sequoiites langsdorfii* (Sternberg). Plesiotype, G.S.C. No. 5995. Locality 3435. (Page 47.)

Figure 5. *Androvettia catenulata* Bell. Holotype, G.S.C. No. 6303. Locality 1191. (Page 46.)

Figure 6. *Sequoiites langsdorfii* (Sternberg). Plesiotype, G.S.C. No. 5992. Locality 3435. (Page 47.)

Figure 7. *Androvettia catenulata* Bell. Holotype, G.S.C. No. 6303 x 3. Locality 1191. (Page 46.)

Figure 8. *Androvettia catenulata* Bell. Holotype, G.S.C. No. 6303 x 3 (whole specimen including reverse of Figure 7). Locality 1191. (Page 46.)

Plate XXVII

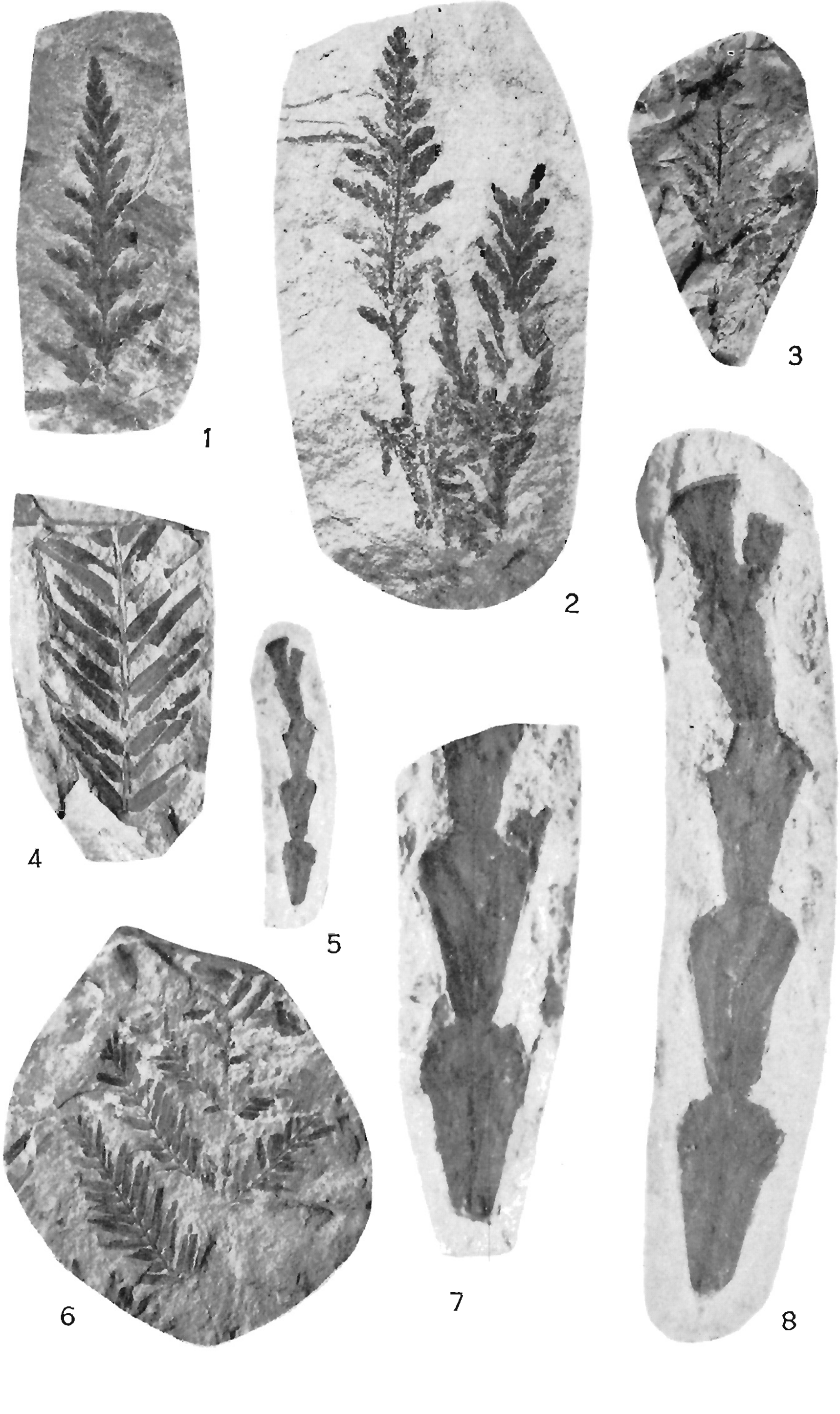

Plate XXVIII

Paleocene

Figure 1. *Elatocladus (Sequoiites?) ungeri* (Heer). Holotype, G.S.C. No. 6264. Locality 3488. (Page 48.)

Figure 2. *Elatocladus (Sequoiites?) ungeri* (Heer). Paratype, G.S.C. No. 6265. Locality 3488. (Page 48.)

Figure 3. *Elatocladus (Sequoiites?) ungeri* (Heer). Holotype, G.S.C. No. 6264 x 3 approx. Locality 3488. (Page 48.)

PLATE XXVIII

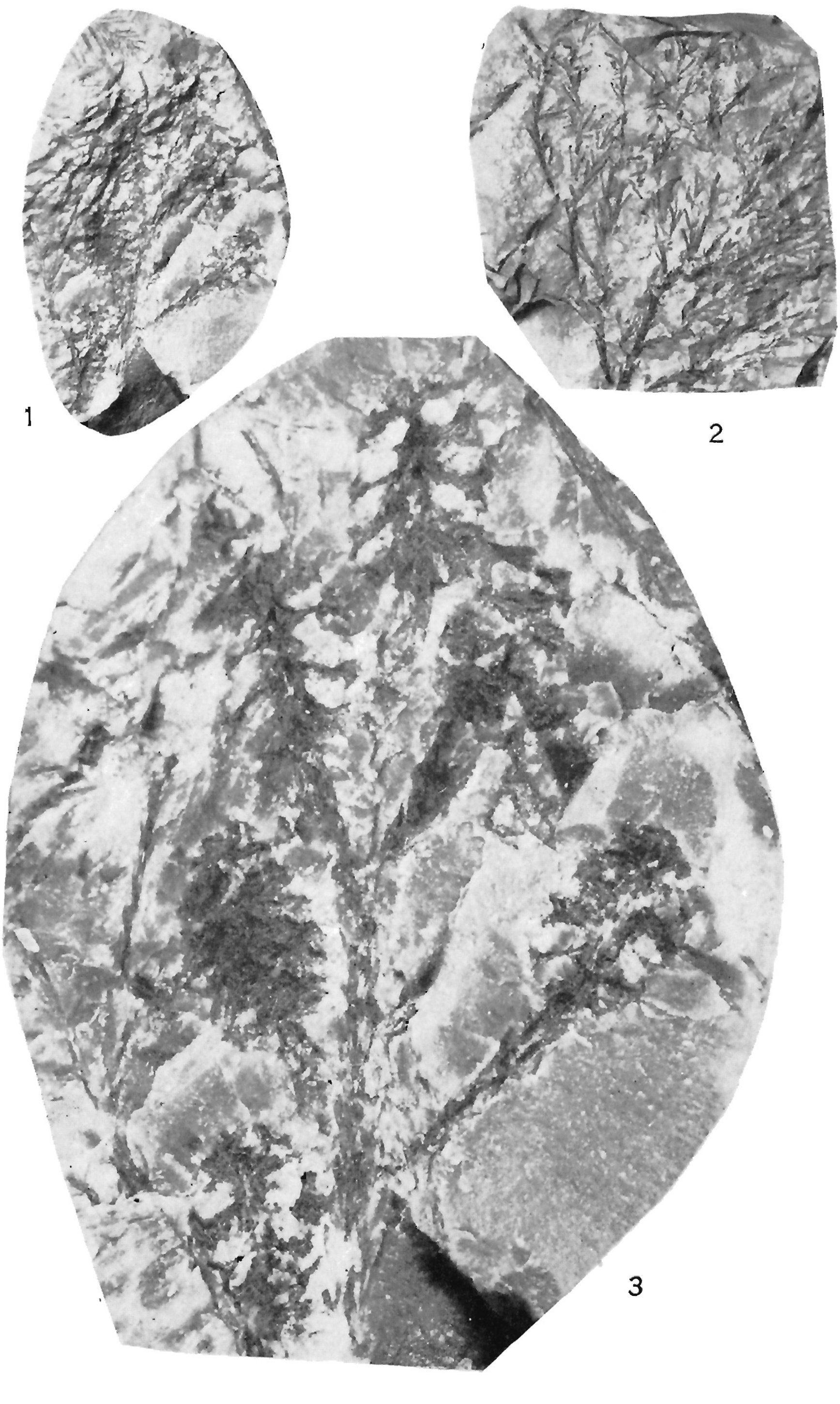

PLATE XXIX

Paleocene

Figure 1. *Sequoiites langsdorfii* (Sternberg). Plesiotype, G.S.C. No. 5991. Locality 3435. (Page 47.)

Figure 2. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 5537. Locality 4090. (Page 49.)

Figure 3. *Sequoiites langsdorfii* (Sternberg). Plesiotype, G.S.C. No. 6133. Locality 3462. (Page 47.)

Figure 4. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 6140. Locality 3441. (Page 49.)

Figure 5. *Elatocladus (Taxites?) olriki* Heer. Plesiotype, G.S.C. No. 5465. Locality 1651. (Page 46.)

Plate XXIX

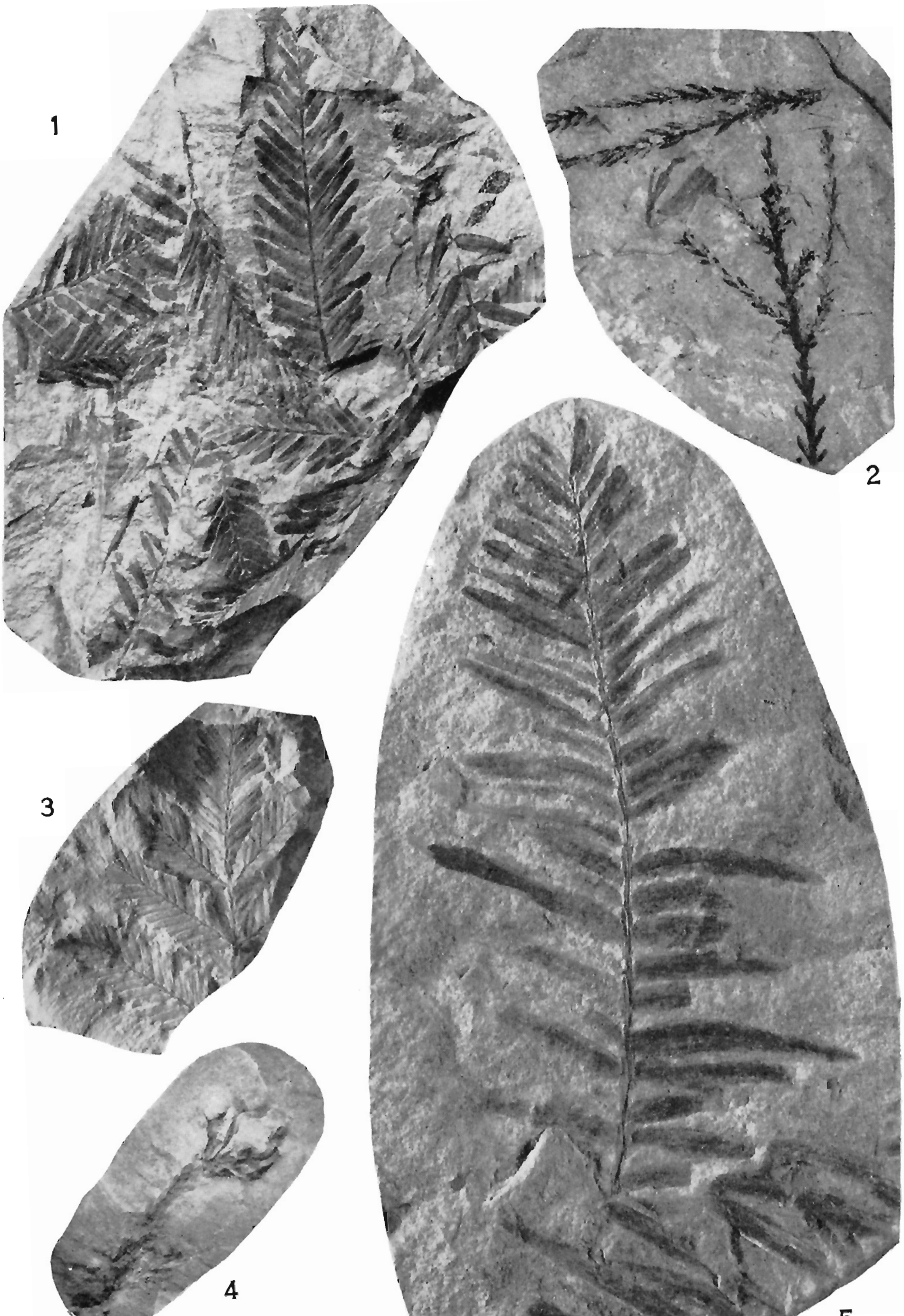

PLATE XXX

Paleocene

Figure 1. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 5550. Locality 3375. (Page 49.)

Figure 2. *Elatocladus (Taxites?) olriki* Heer. Plesiotypye, G.S.C. No. 3981. Locality 3428. (Page 46.)

Figure 3. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 5549. Locality 3374. (Page 49.)

Figure 4. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 6262. Locality 3441. (Page 49.)

Figure 5. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 6259. Locality 3441. (Page 49.)

PLATE XXX

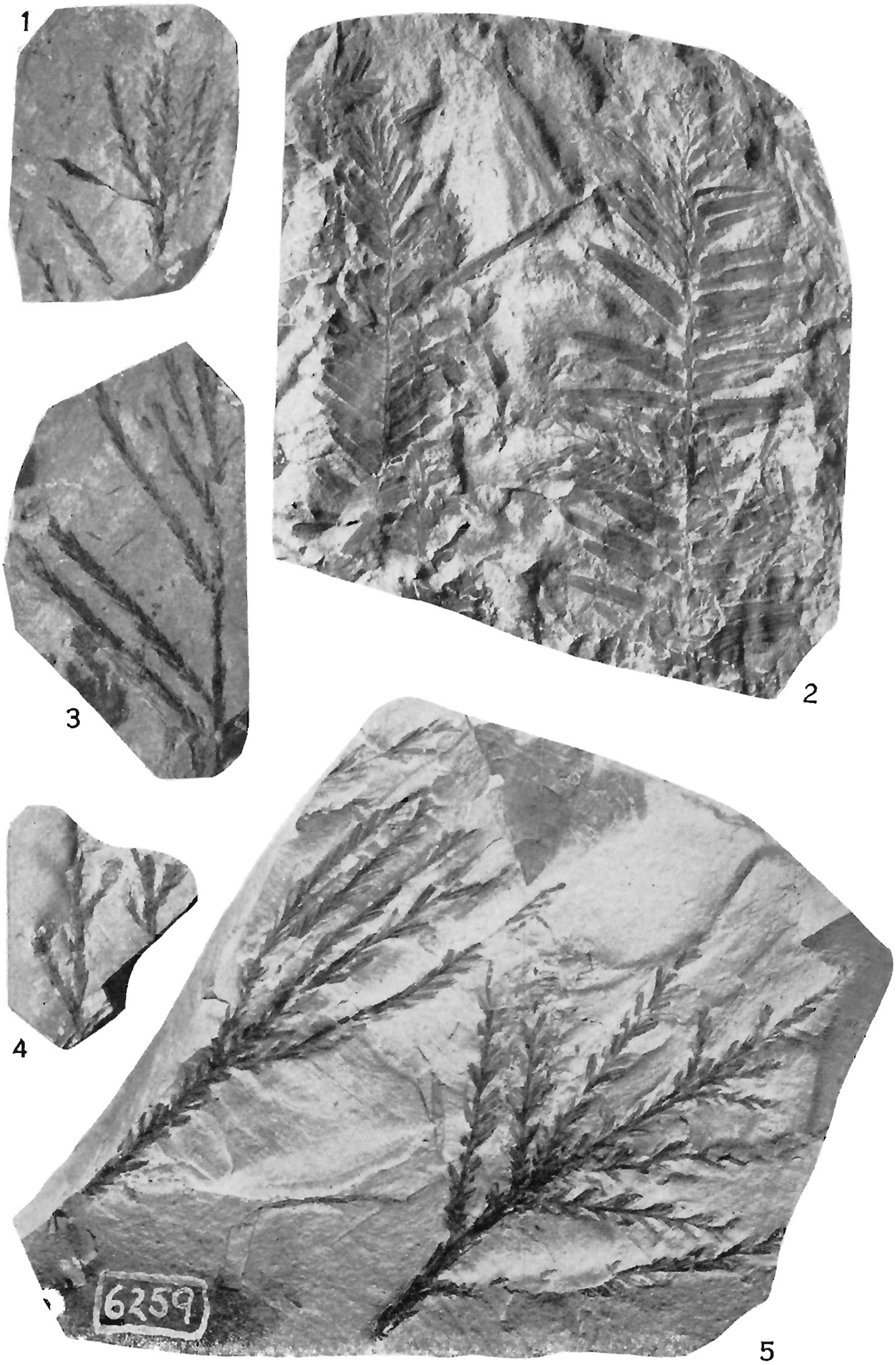

Plate XXXI

Paleocene

Figure 1. *Sequoiites ? coultsiae ?* (Heer). Plesiotype ?, G.S.C. No. 7464. Locality 4009. (Page 48.)

Figure 2. *Elatocladus (Cryptomerites?) nordenskioldi* (Heer). Plesiotype, G.S.C. No. 6261. Locality 3441. (Page 50.)

Figure 3. *Elatocladus (Cryptomerites?) nordenskioldi* (Heer). Plesiotype, G.S.C. No. 6263. Locality 3435. (Page 50.)

Figure 4. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 5523. Locality 1202. (Page 49.)

Figure 5. *Elatocladus (Cryptomerites?) nordenskioldi* (Heer). Plesiotype, G.S.C. No. 6134. Locality 3428. (Page 50.)

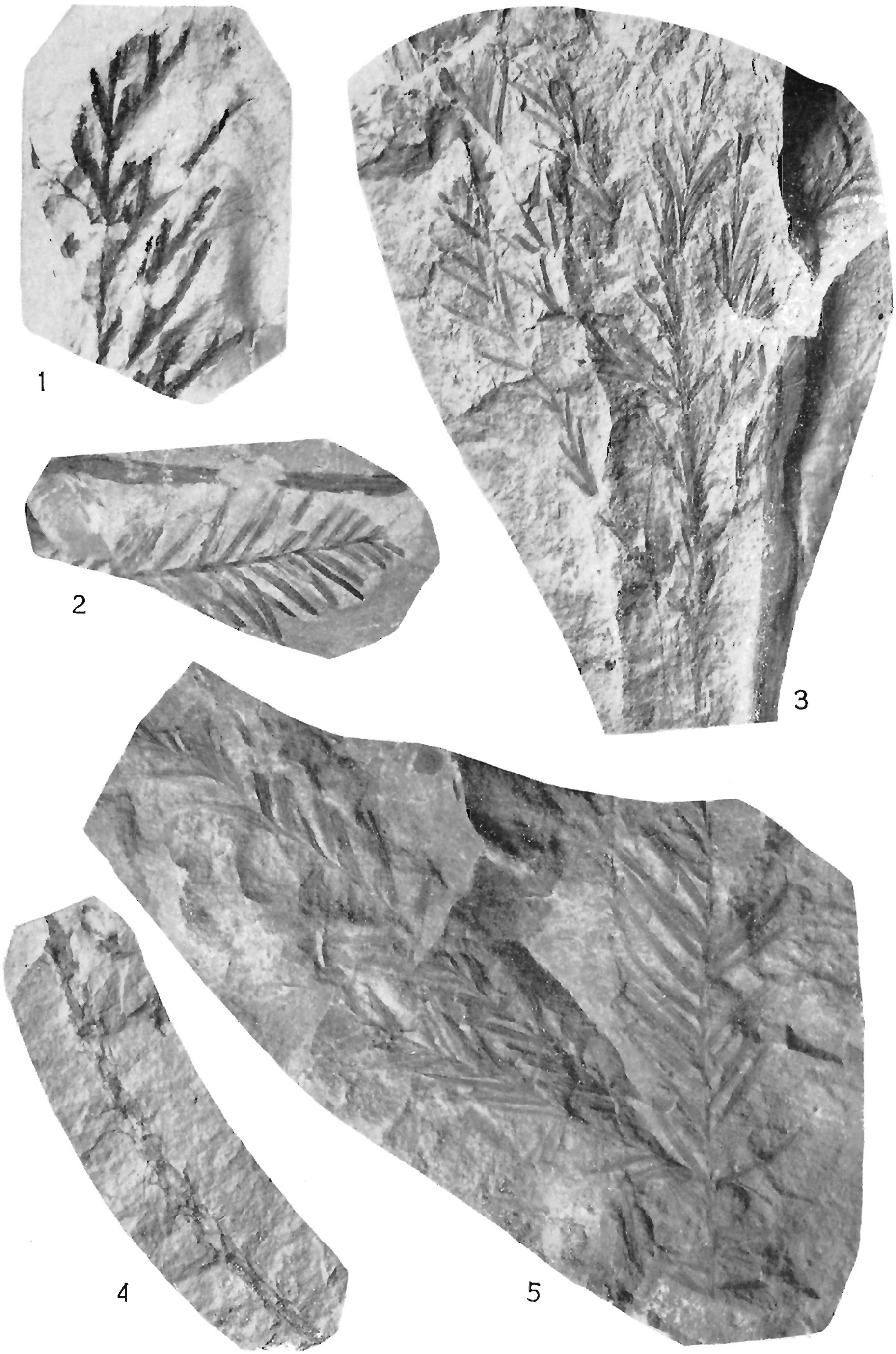
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Plate XXXII

Paleocene

Figure 1. *Ginkgoites adiantoides* (Unger). Plesiotype, G.S.C. No. 6152. Locality 3446. (Page 43.)

Figure 2. *Cryptomerites lambii* Bell. Paratype, G.S.C. No. 7466. Locality 4009. (Page 49.)

Figure 3. *Ginkgoites adiantoides* (Unger). Plesiotype, G.S.C. No. 6153. Locality 3446. (Page 43.)

Figure 4. *Cryptomerites lambii* Bell. Holotype, G.S.C. No. 5524. Locality 1202. (Page 49.)

Figure 5. *Elatocladus (Taxodites?) tinajorum* (Heer). Plesiotype, G.S.C. No. 7463. Locality 4009. (Page 51.)

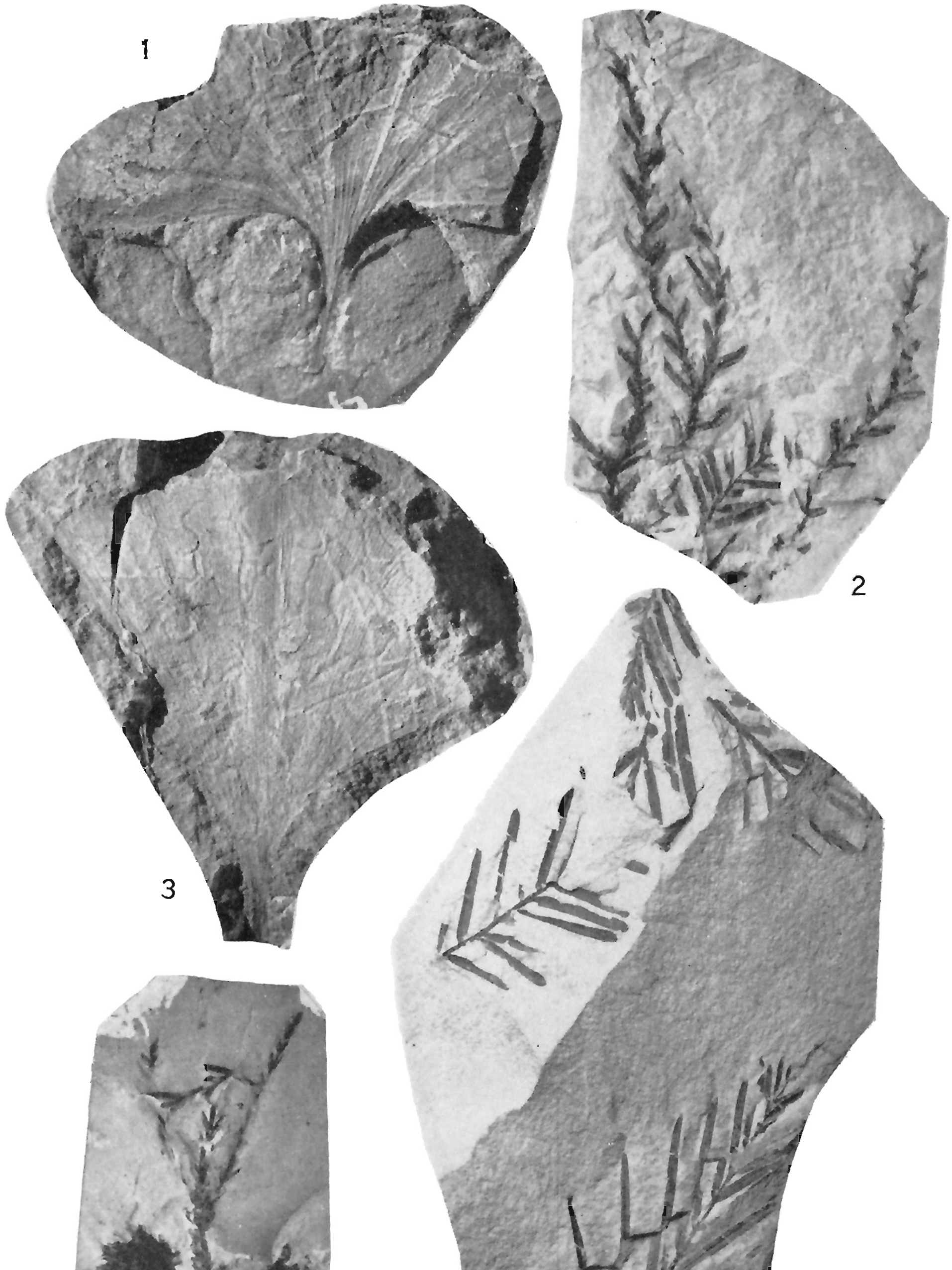
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Plate XXXIII

Paleocene

Figure 1. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6122. Locality 3460. (Page 53.)
Figure 2. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6123. Locality 3460. (Page 53.)
Figure 3. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6125. Locality 3460. (Page 53.)
Figure 4. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6124. Locality 3460. (Page 53.)
Figure 5. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6121. Locality 3460. (Page 53.)
Figure 6. *Alnus serrata* Newberry. Plesiotype, G.S.C. No. 6218. Locality 2301. (Page 52.)
Figure 7. *Corylites fosteri* (Ward). Plesiotype, G.S.C. No. 6120. Locality 3460. (Page 53.)

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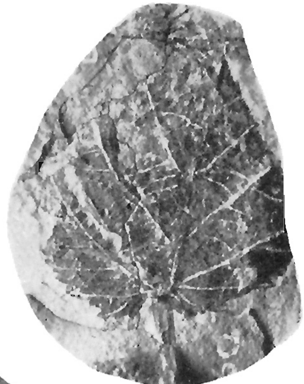

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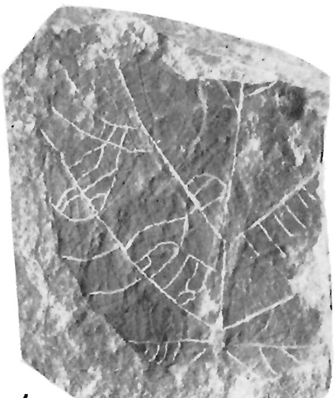

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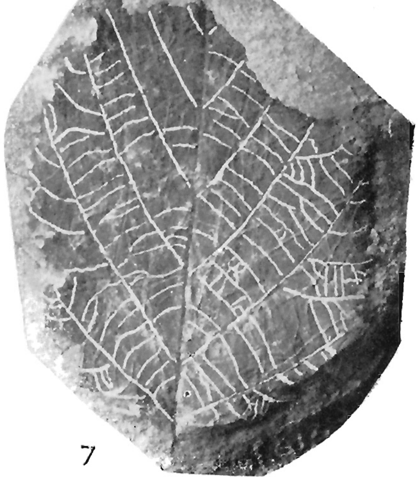

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PLATE XXXIV

Paleocene

Figure 1. *Dryophyllum (Castanea?)* sp. G.S.C. No. 6136. Locality 3428. (Page 53.)
Figure 2. *Populus ? daturaefolia* (Ward). Plesiotype, G.S.C. No. 6129. Locality 3460. (Page 56.)
Figure 3. *Populus ? daturaefolia* (Ward). Plesiotype, G.S.C. No. 6127. Locality 3460. (Page 56.)
Figure 4. *Populus ? daturaefolia* (Ward). Plesiotype, G.S.C. No. 6130. Locality 3460. (Page 56.)
Figure 5. *Populus ? daturaefolia* (Ward). Plesiotype, G.S.C. No. 6126. Locality 3460. (Page 56.)
Figure 6. *Populus ? daturaefolia* (Ward). Plesiotype, G.S.C. No. 6128. Locality 3460. (Page 56.)

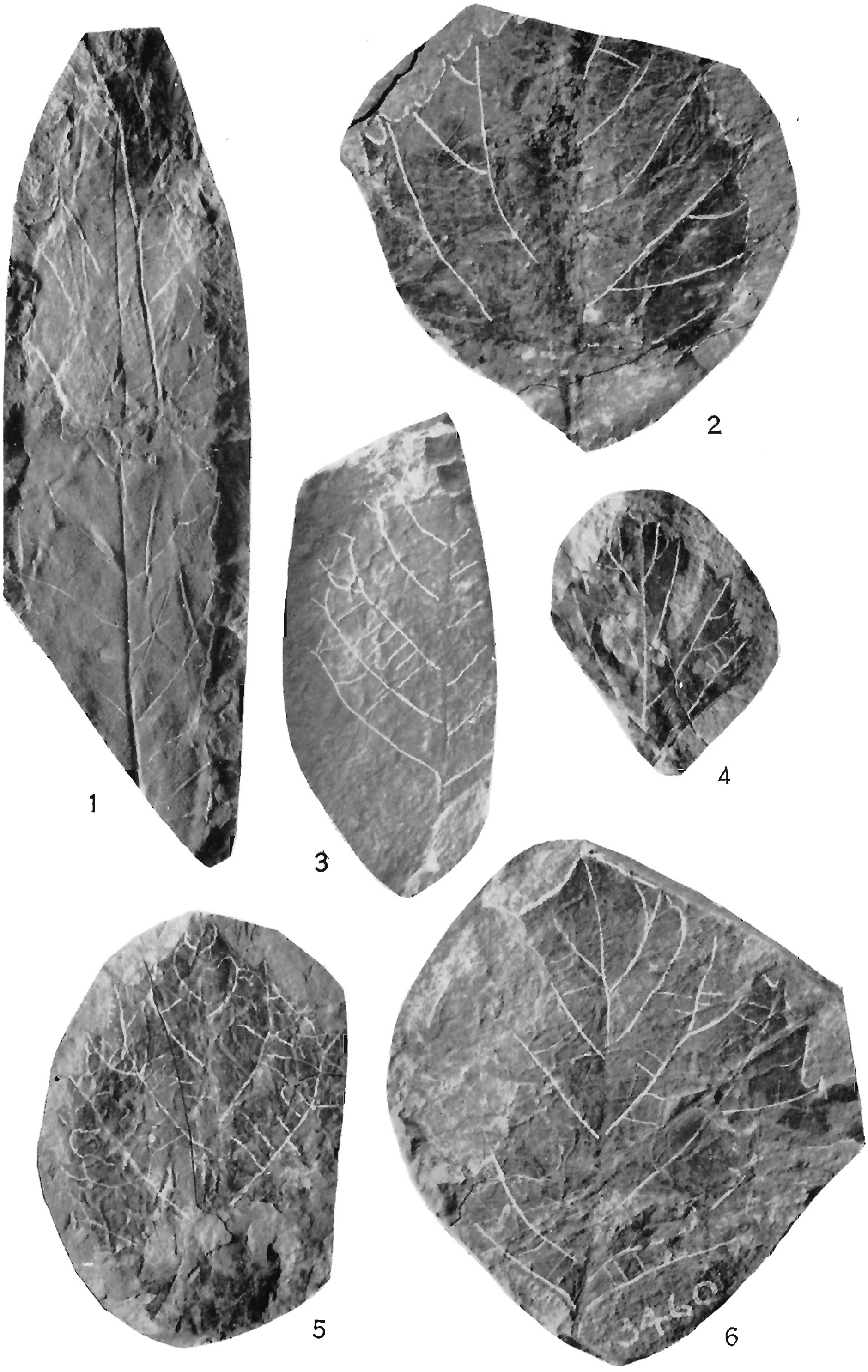
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Plate XXXV

Paleocene

Figure 1. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 5915. Locality 4090. (Page 55.)

Figure 2. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 5706. Locality 1202. (Page 55.)

Figure 3. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 6119. Locality 3462. (Page 55.)

Figure 4. *Populus penhallowi* Bell. Holotype, G.S.C. No. 5560. Locality 1202. (Page 55.)

Plate XXXV

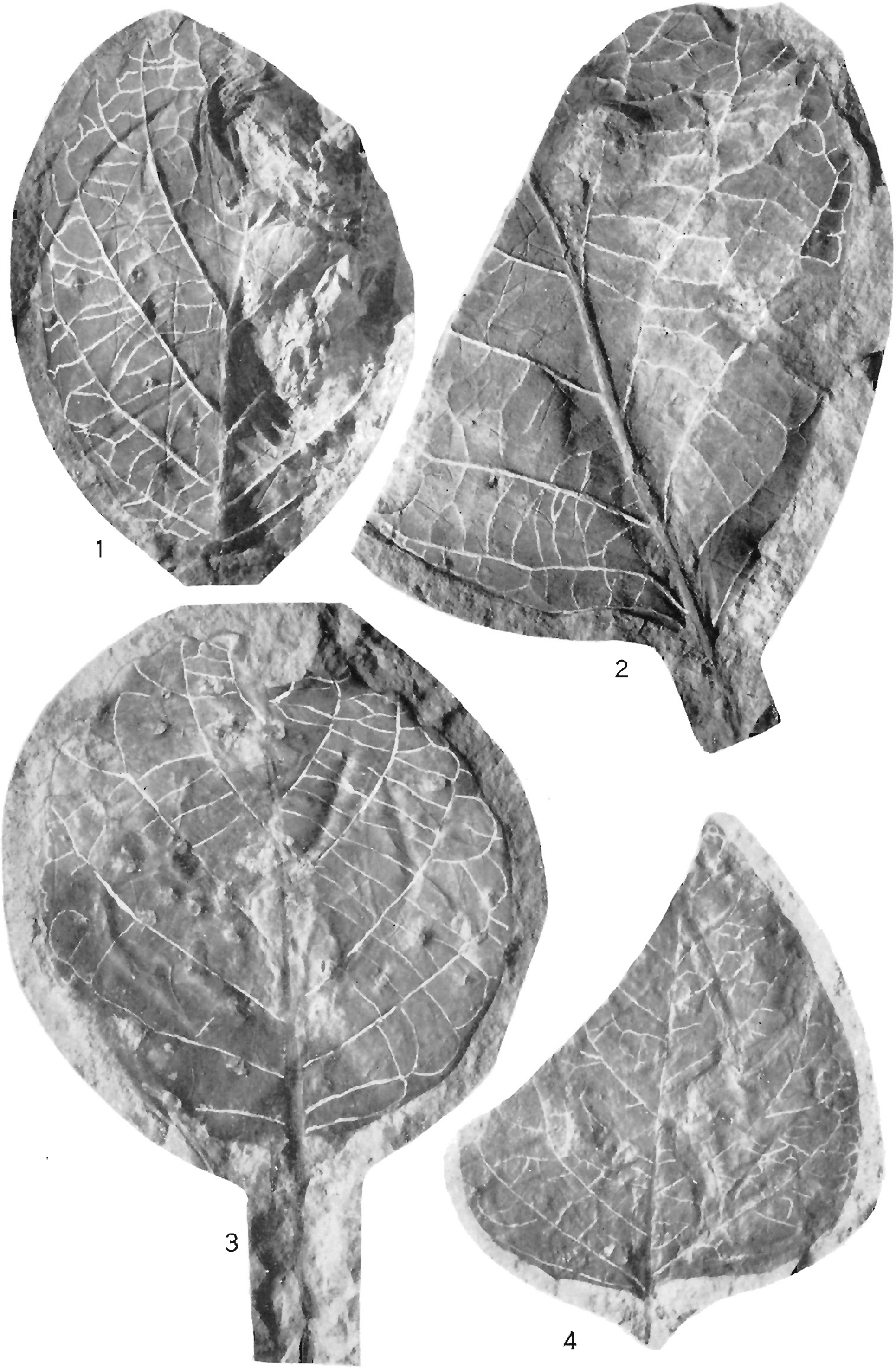

Plate XXXVI

Paleocene

Figure 1. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 5916. Locality 1202. (Page 55.)

Figure 2. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 6250. Locality 3444. (Page 55.)

Figure 3. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 6249. Locality 3444. (Page 55.)

Figure 4. *Populus carneosa* (Newberry) (lower specimen). Plesiotype, G.S.C. No. 6248. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6354. Locality 3444. (Pages 55, 71.)

Figure 5. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 6251. Locality 3443. (Page 55.)

Figure 6. *Populus carneosa* (Newberry). Plesiotype, G.S.C. No. 5917. Locality 262. (Page 55.)

Plate XXXVI

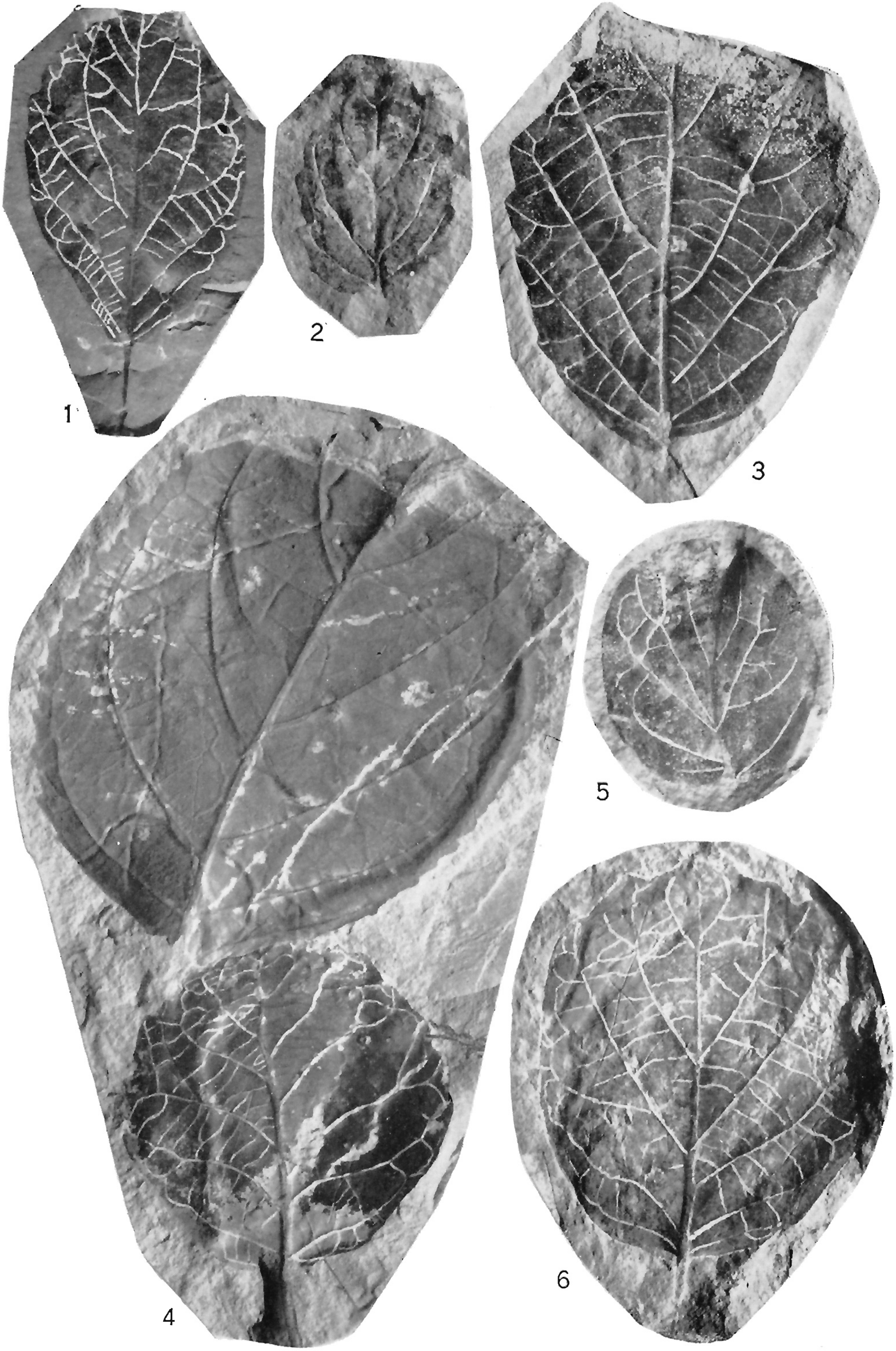

Plate XXXVII

Paleocene

Figure 1. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6198. Locality 3140. (Page 78.)

Figure 2. *Platanus raynoldsii* Newberry. Plesiotype, G.S.C. No. 6243. Locality 3443. (Page 59.)

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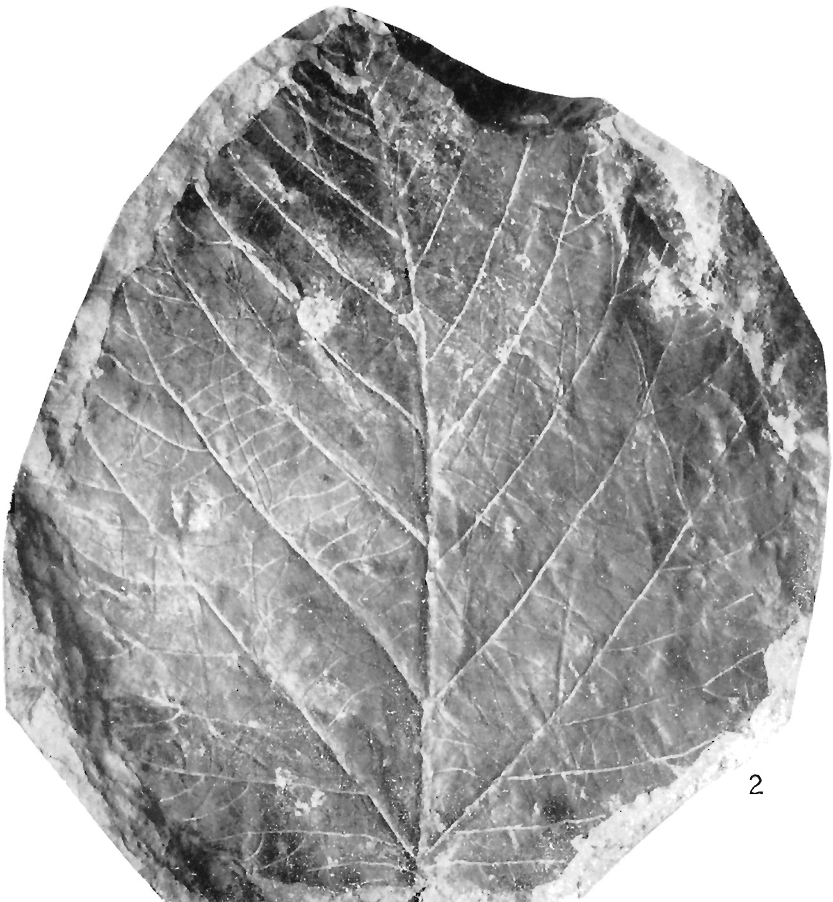

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PLATE XXXVIII

Paleocene

Platanus raynoldsii Newberry. Plesiotype, G.S.C. No. 5979. Locality 3428. (Page 59.)

Plate XXXVIII

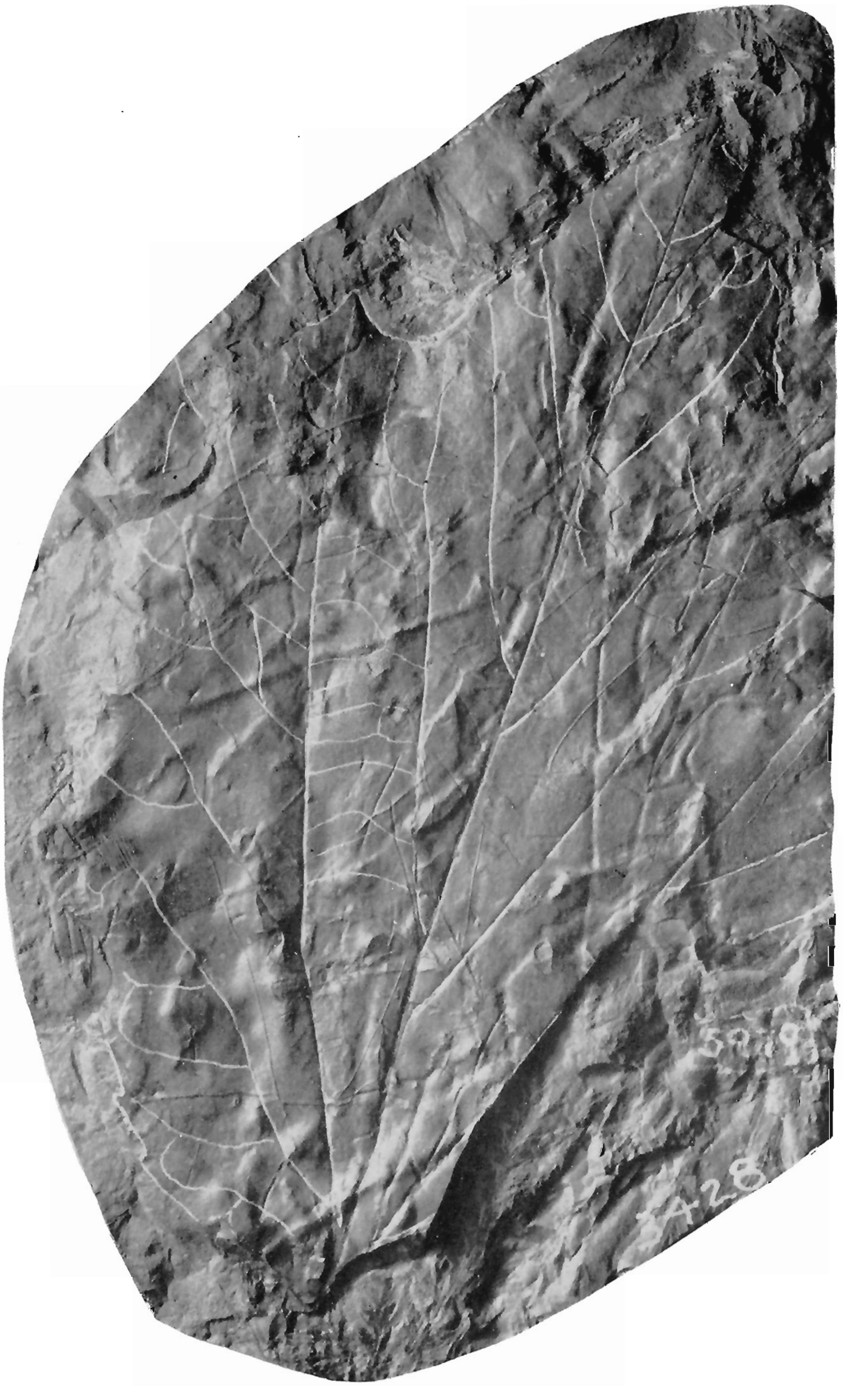

PLATE XXXIX

Paleocene

Platanus raynoldsii Newberry. Plesiotype, G.S.C. No. 6191. Locality 3140. (Page 59.)

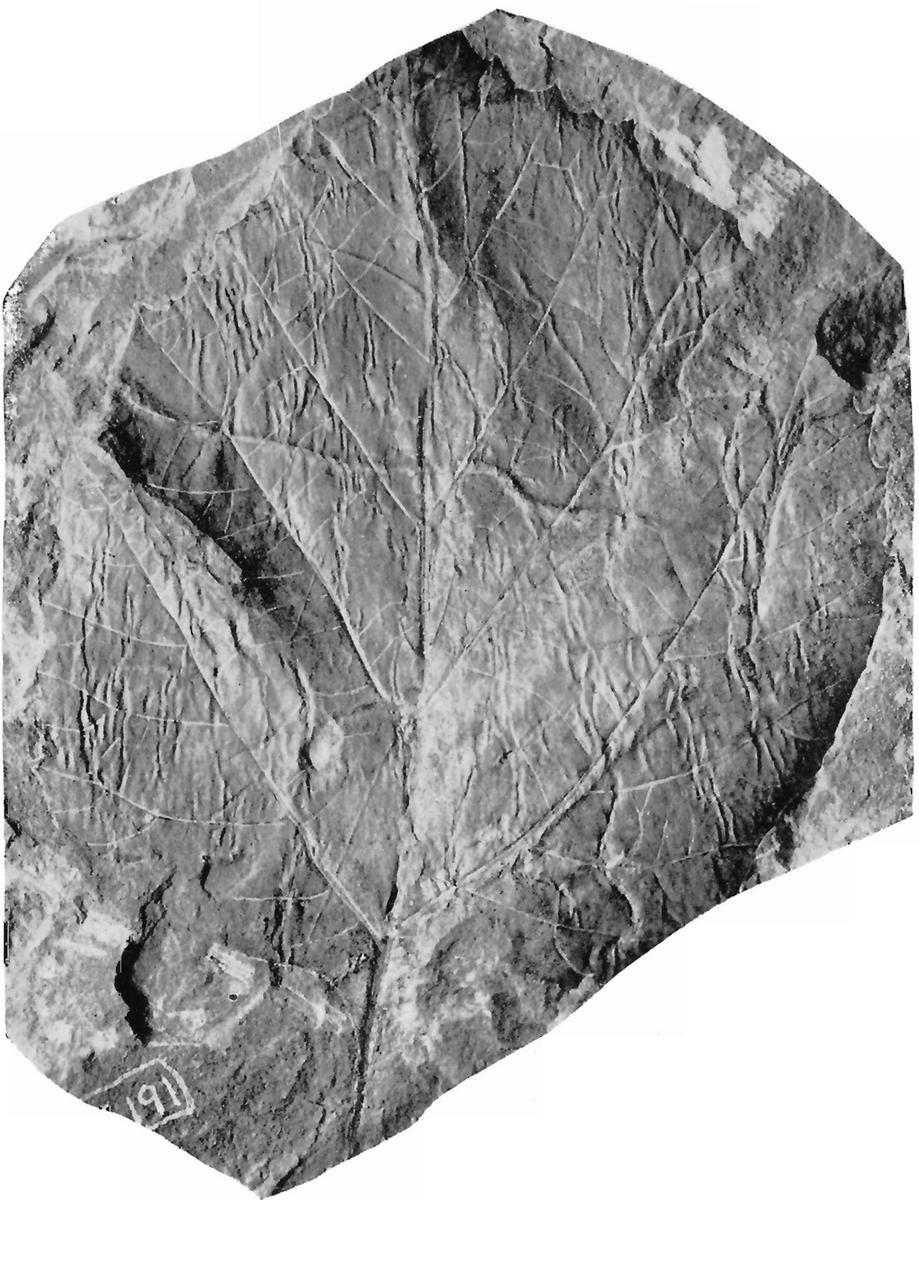
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PLATE XL

Paleocene

Platanus raynoldsii Newberry. Plesiotype, G.S.C. No. 6355. Locality 3428. (Page 59.)

PLATE XL

PLATE XLI

Paleocene

Platanus raynoldsii Newberry. Plesiotype, G.S.C. No. 5977 x $\frac{2}{3}$. Locality 3428. (Page 59.)

PLATE XLII

Paleocene

Platanus basilobata Ward. Plesiotype, G.S.C. No. 5914 x $\frac{2}{3}$. Locality 2293. (Page 58.)

Plate XLIII

Paleocene

Figure 1. *Platanus basilobata* Ward. Plesiotype, G.S.C. No. 6150. Locality 3446. (Page 58.)

Figure 2. *Platanus basilobata* Ward. Plesiotype, G.S.C. No. 6356. Locality 3446. (Page 58.)

Figure 3. *Platanus basilobata* Ward. Plesiotype, G.S.C. No. 6149. Locality 3446. (Page 58.)

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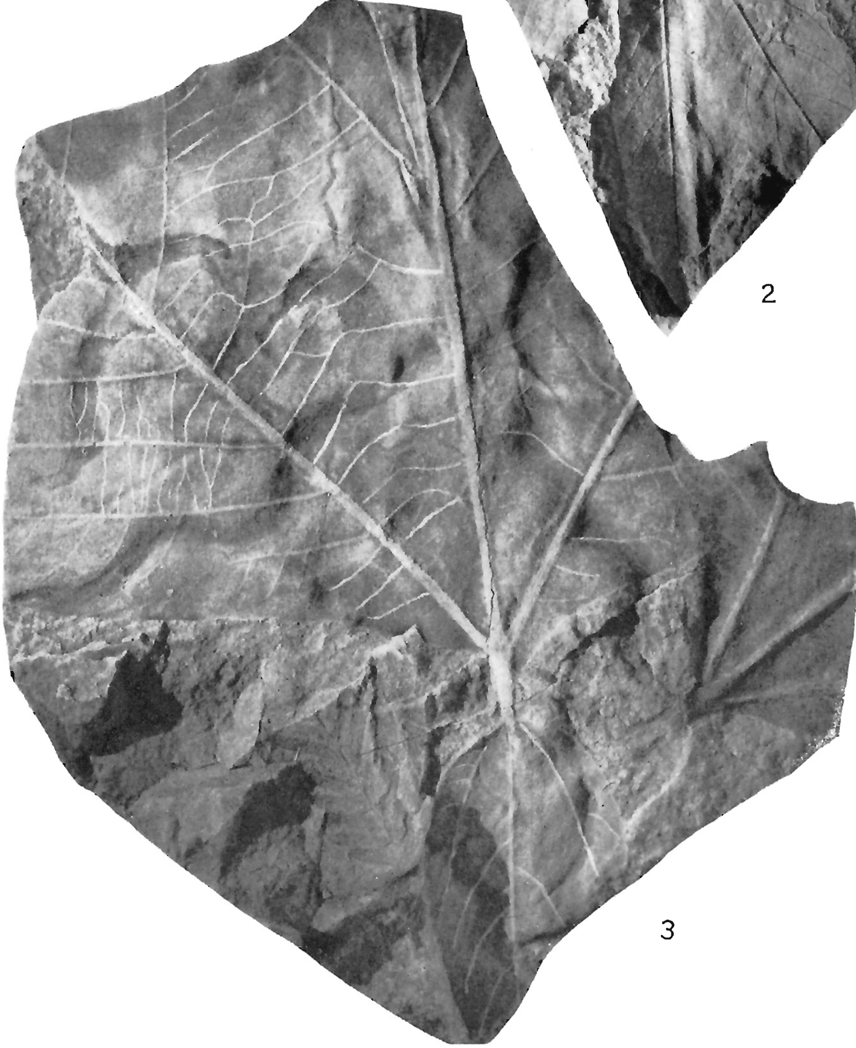

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Plate XLIV

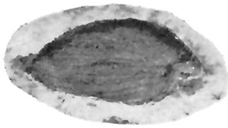
Paleocene

Figure 1. *Jenkinsella arctica* (Heer). Plesiotype, G.S.C. No. 6255. Locality 3442. (Page 57.)

Figure 2. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5919. Locality 2176. (Page 56.)

Figure 3. *Platanus raynoldsii* Newberry. Plesiotype, G.S.C. No. 5978. Locality 3428 (Page 59.)

PLATE XLIV



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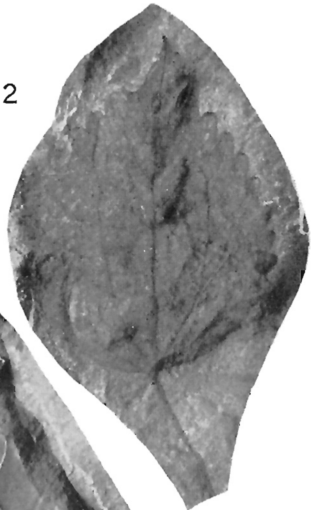

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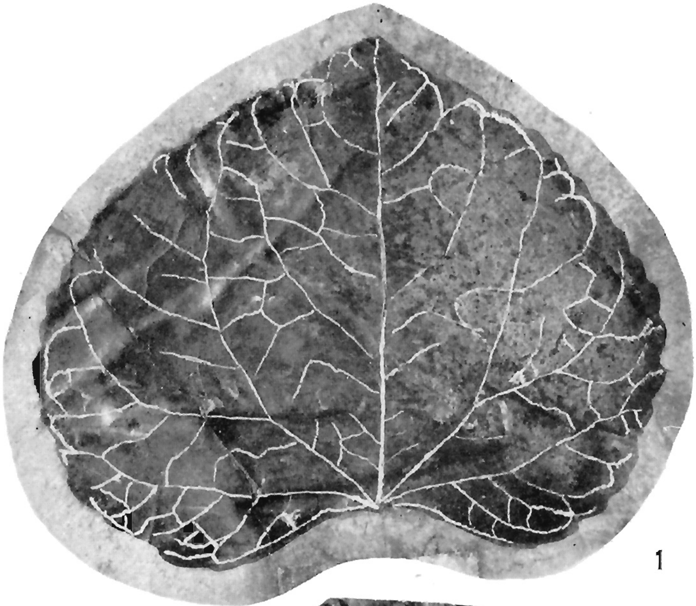
PLATE XLV

Paleocene

Figure 1. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5695. Locality 262. (Page 56.)

Figure 2. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 6114. Locality 3428. (Page 56.)



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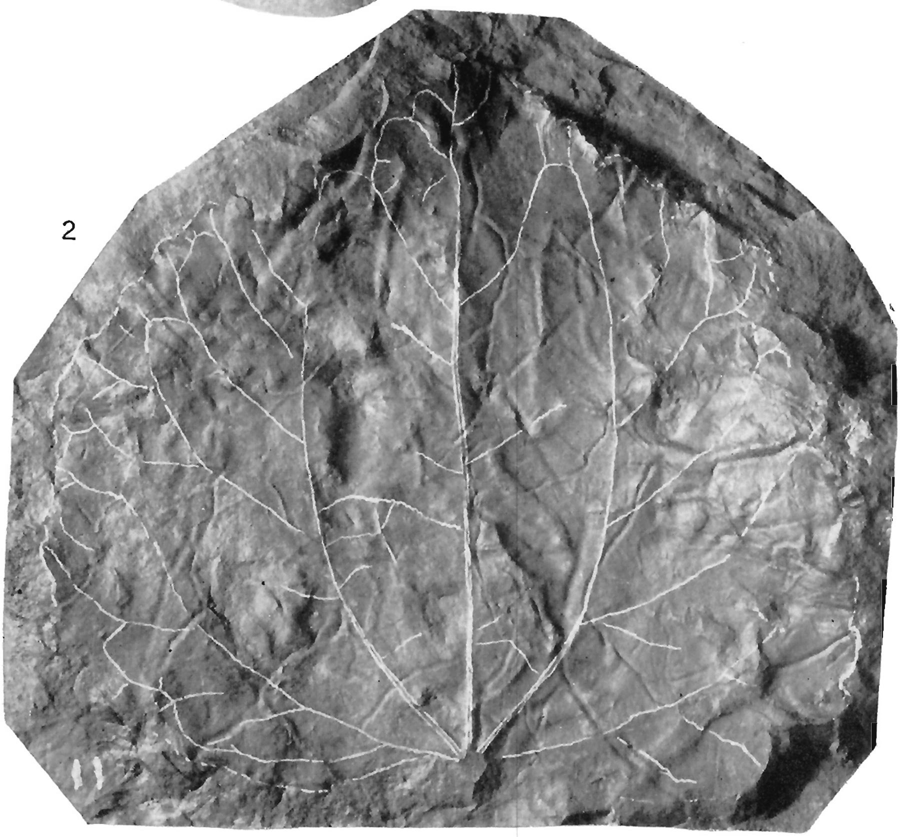

Plate XLVI

Paleocene

Figure 1. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5918. Locality 2176. (Page 56.)

Figure 2. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5581. Locality 4092. (Page 56.)

Figure 3. *Trochodendroides arctica* (Heer). Plesiotype, G.S.C. No. 5506. Locality 2176. (Page 56.)

Figure 4. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6155. Locality 3445. (Page 62.)


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Plate XLVII

Paleocene

Figure 1. *Pterospermites whitei* Ward. Plesiotype, G.S.C. No. 6276 x $\frac{2}{3}$. Locality 2287. (Page 69.)

Figure 2. *Pterospermites dawsoni* (Berry). Plesiotype, G.S.C. No. 6305 x $\frac{2}{3}$. Locality 2295. (Page 70.)

Figure 3. *Pterospermites whitei* Ward. Plesiotype, G.S.C. No. 6247 x $\frac{2}{3}$. Locality 3444. (Page 69.)

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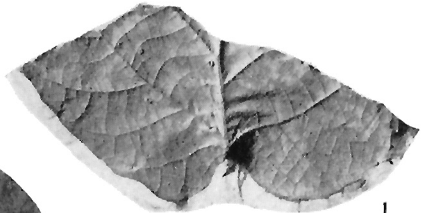
Figure 5. *Pterospermites whitei* Ward. Plesiotype, G.S.C. No. 6275 x $\frac{2}{3}$. Locality 2287. (Page 69.)

PLATE XLVII



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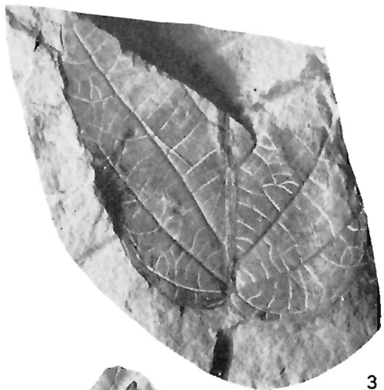

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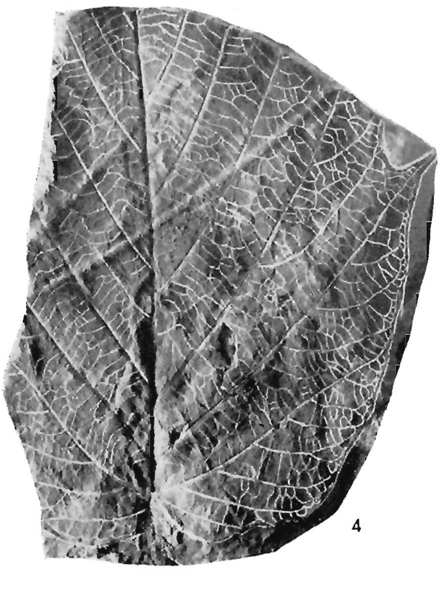

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Plate XLVIII

Paleocene

Figure 1. *Dombeyopsis nebrascensis* (Newberry). Plesiotype, G.S.C. No. 6245. Locality 3428. (Page 62.)

Figure 2. *Acer arcticum* Heer. Plesiotype, G.S.C. No. 6154. Locality 2287. (Page 71.)

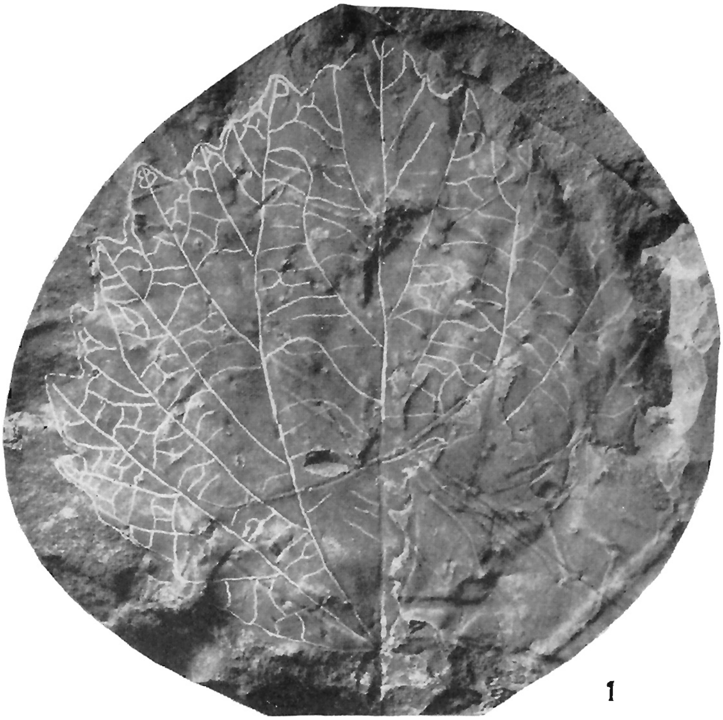

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Plate XLIX

Paleocene

Figure 1. *Pterospermites dawsoni* (Knowlton). Plesiotype, G.S.C. No. 6308 x ½. Locality 1637. (Page 70.)

Figure 2. *Pterospermites dawsoni* (Knowlton). Holotype, G.S.C. No. 6307 x ½. Locality 1637. (Page 70.)


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Paleocene

Figure 1. *Zizyphoides colombi* (Heer). Plesiotype, G.S.C. No. 6117. Locality 3435. (Page 73.)

Figure 2. *Rhamnites ovatus* (Penhallow). Holotype, G.S.C. No. 5701. Locality 1202. (Page 72.)

Figure 3. *Paranymphaea crassifolia* (Newberry). Plesiotype, C.S.C. No. 5169. Locality 4165. (Page 68.)

PLATE L

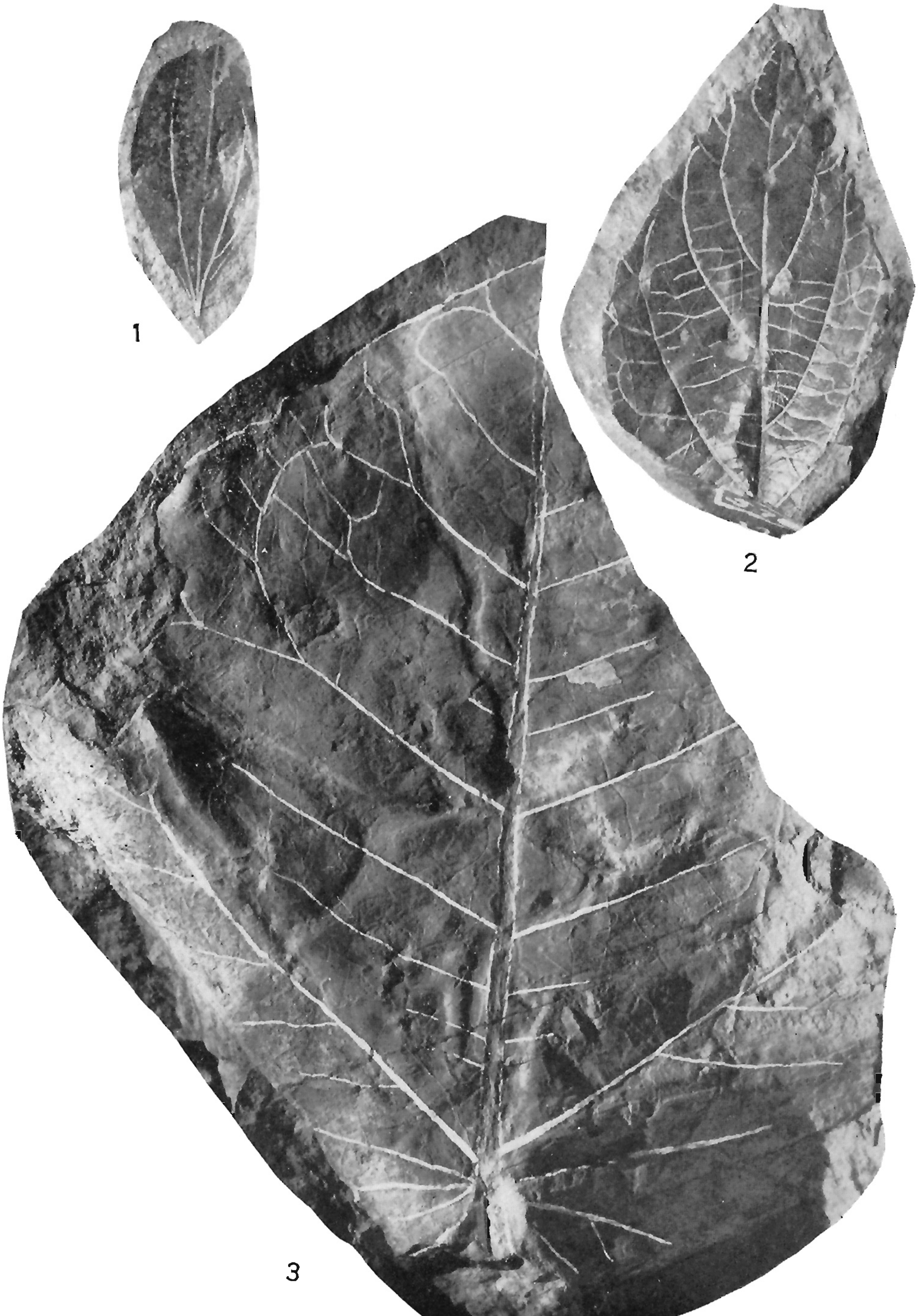

PLATE LI

Paleocene

Figure 1. *Zizyhpoides colombi* (Heer). Plesiotype, G.S.C. No. 5956. Locality 4135. (Page 73.)

Figure 2. *Rhamnites ovatus* (Penhallow). Plesiotype, G.S.C. No. 6267. Locality 3444. (Page 72.)

Figure 3. *Rhamnites ovatus* (Penhallow). Plesiotype, G.S.C. No. 5704 (specimen originally identified by Penhallow as *Carya antiquorum*). Locality 1202. (Page 72.)

Figure 4. *Rhamnites ovatus* (Penhallow). Plesiotype, G.S.C. No. 6266. Locality 3444. (Page 72.)

Plate LI

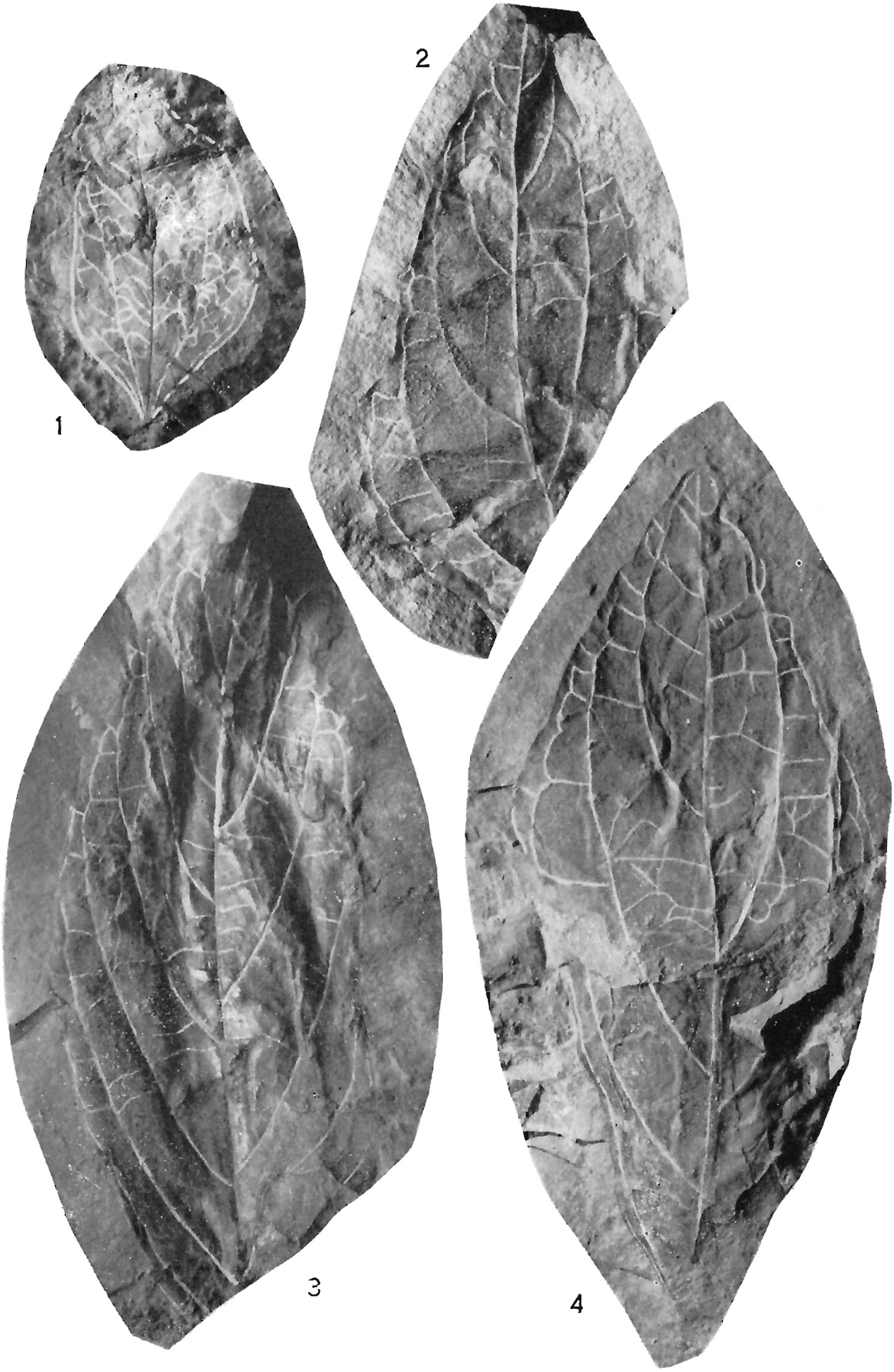

Plate LII

Paleocene

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Figure 2. *Zizyphoides colombi* (Heer). Plesiotype, G.S.C. No. 6158. Locality 3433. (Page 73.)

Figure 3. *Zizyphoides colombi* (Heer). Plesiotype, G.S.C. No. 5957. Locality 4135. (Page 73.)

Figure 4. *Zizyphoides colombi* (Heer). Plesiotype, G.S.C. No. 6157. Locality 3369. (Page 73.)

Figure 5. *Paranymphaea crassifolia* (Newberry). Plesiotype, G.S.C. No. 5923. Locality 1191. (Page 68.)

PLATE LII

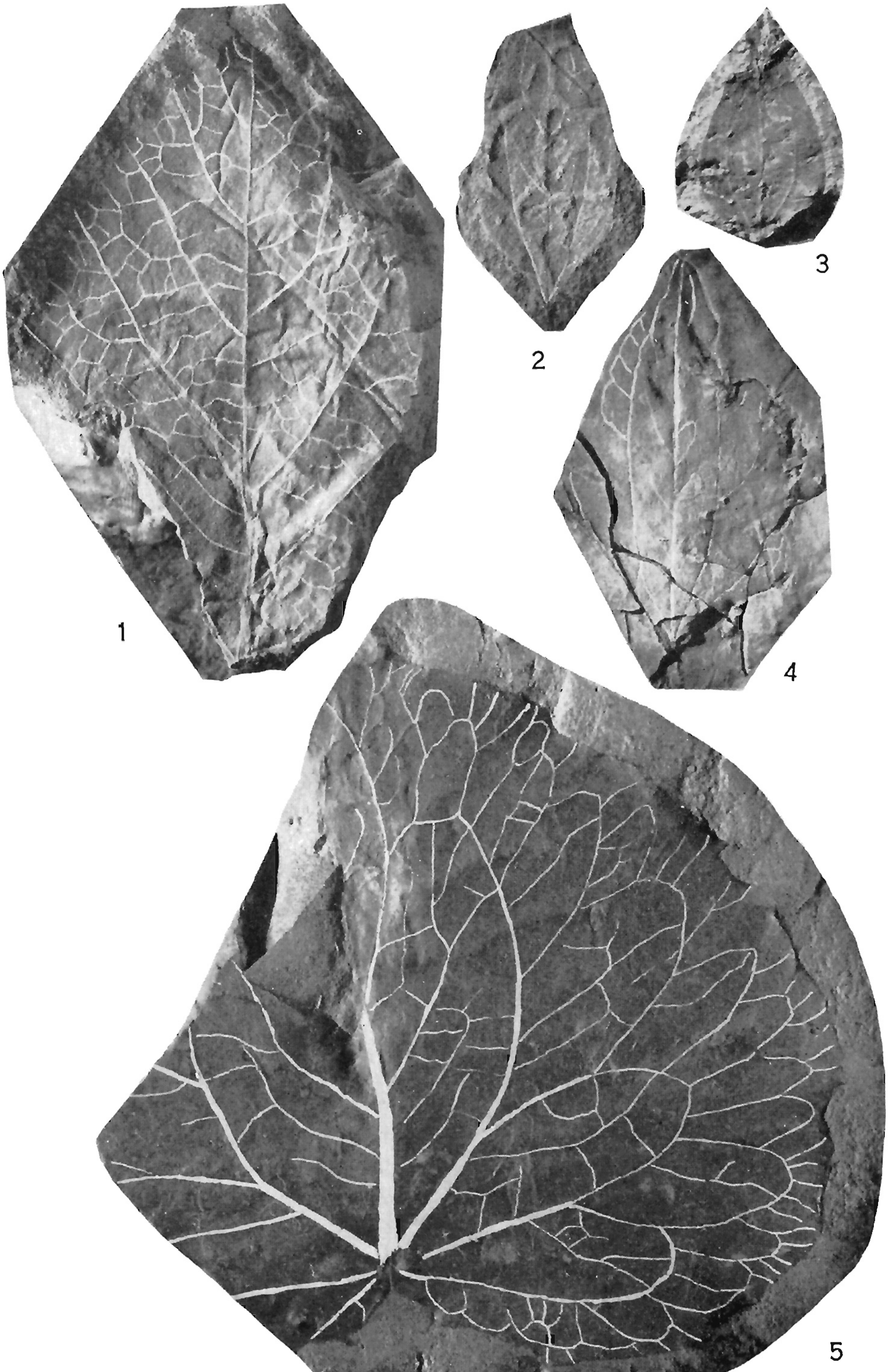

PLATE LIII

Paleocene

Celastrinites insignis (Heer). Plesiotype, G.S.C. No. 6246. Locality 3427. (Page 71.)

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Paleocene

Figure 1. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6241. Locality 3441. (Page 71.)

Figure 2. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6258. Locality 3444. (Page 71.)

Figure 3. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6238. Locality 3444. (Page 71.)

Figure 4. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6237. Locality 3444. (Page 71.)

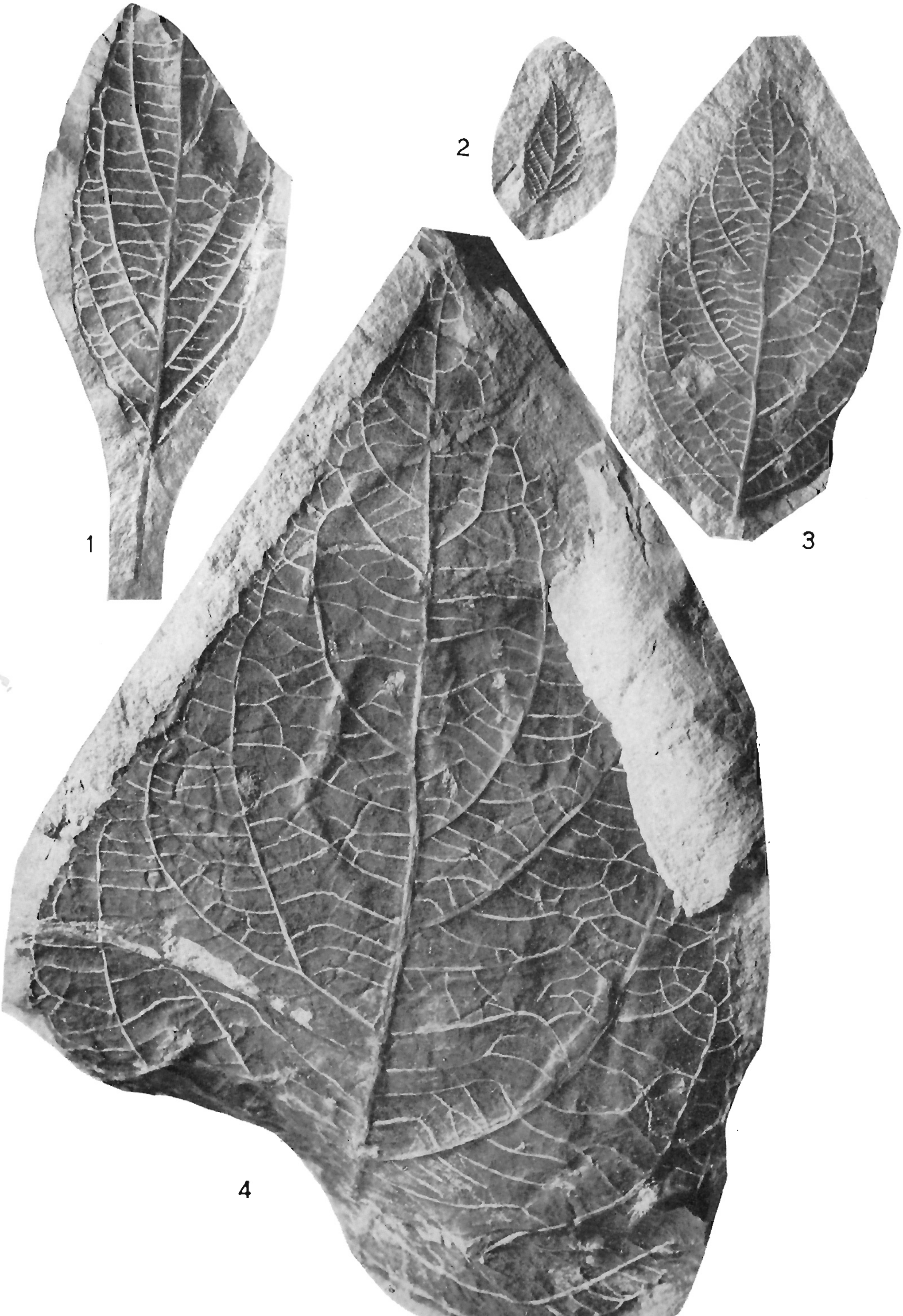
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Plate LV

Paleocene

Figure 1. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6242. Locality 3441. (Page 71.)

Figure 2. *Celastrinites insignis* (Heer). Plesiotypes, G.S.C. Nos. 5490 and 5491. Locality 2182. (Page 71.)

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Plate LVI

Paleocene

Figure 1. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6240. Locality 3444. (Page 71.)

Figure 2. *Aralia alexoensis* Bell. Paratype, G.S.C. No. 5989. Locality 3428. (Page 76.)

Figure 3. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6239. Locality 3444. (Page 71.)

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Figure 5. *Aralia alexoensis* Bell. Paratype, G.S.C. No. 6232 (upper leaf). *Cornus denverensis* Knowlton. Plesiotype, No. 6233 (lower leaf). Locality 3140. (Page 76.)

PLATE LVI

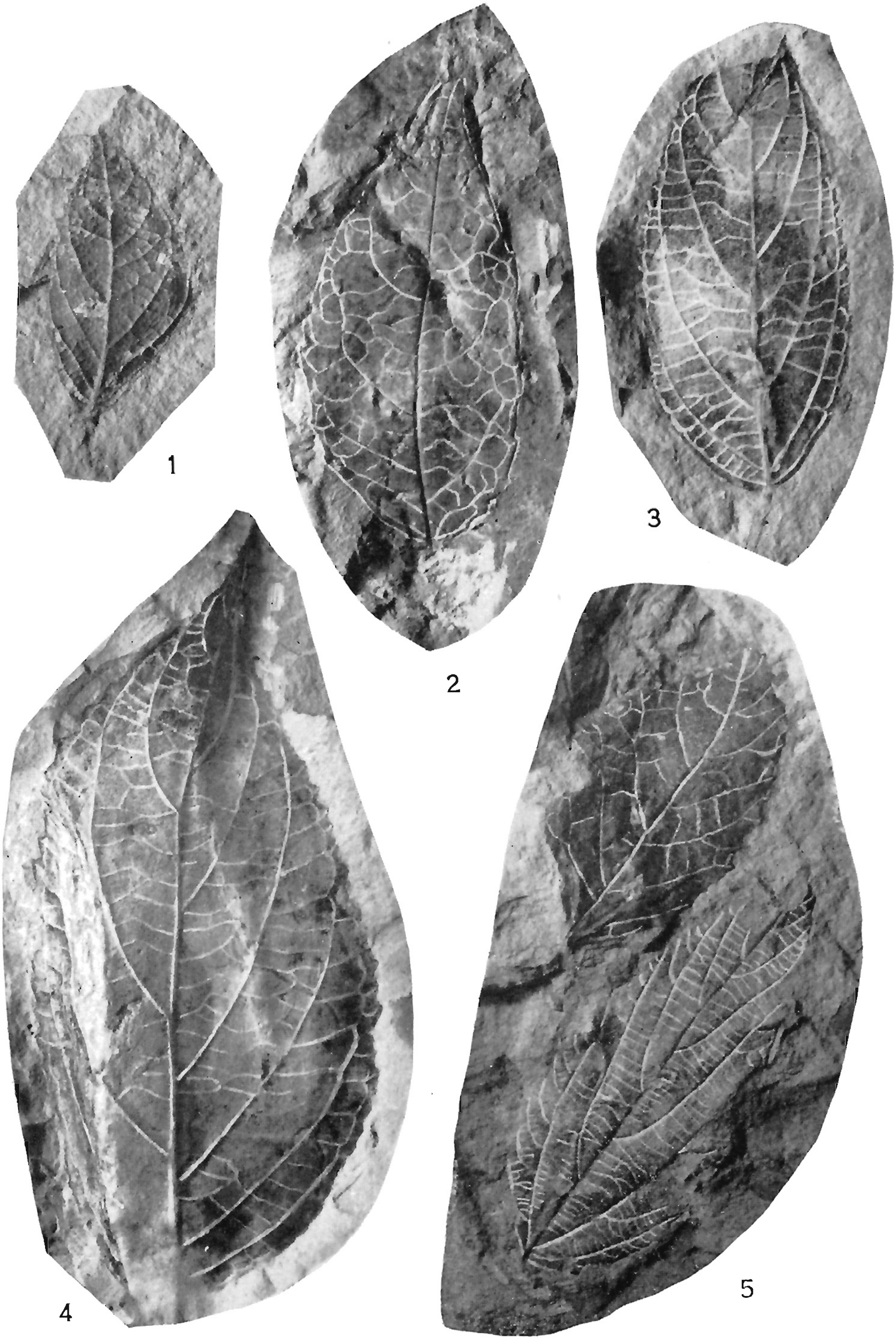


Plate LVII

Paleocene

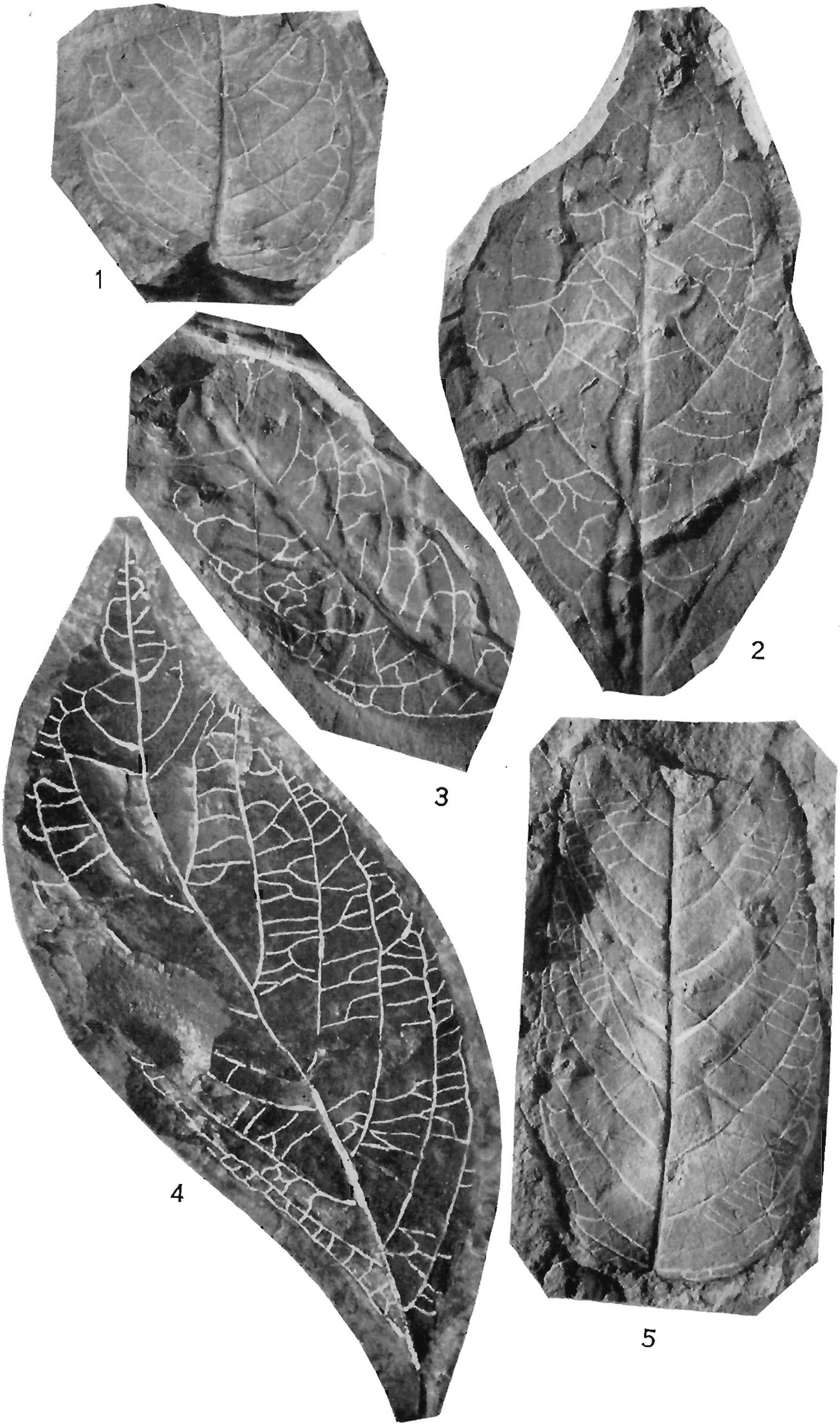
Figure 1. *Juglans leconliana* Lesquereux. Plesiotype, G.S.C. No. 5696. Locality 262. (Page 54.)

Figure 2. *Juglans thermalis* Lesquereux. Plesiotype, G.S.C. No. 5699. Locality 1202. (Page 54.)

Figure 3. *Juglans thermalis* Lesquereux. Plesiotype, G.S.C. No. 5698. Locality 1202. (Page 54.)

Figure 4. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 5488 (specimen originally identified by Penhallow as *Carya antiquorum*). Locality 262. (Page 71.)

Figure 5. *Juglans nigella* Heer. Plesiotype, G.S.C. No. 5493. Locality 2187. (Page 55.)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Paleocene

Figure 1. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6235. Locality 3140. (Page 78.)

Figure 2. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 6304. Locality 2301. (Page 71.)

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Paleocene

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Figure 2. *Oreopanax ?* sp. G.S.C. No. 6147. Locality 3448. (Page 76.)
Figure 3. *Oreopanax* ? sp. G.S.C. No. 6148. Locality 3448. (Page 76.)
Figure 4. *Celastrinites insignis* (Heer). Plesiotype, G.S.C. No. 5986. Locality 3428. (Page 71.)

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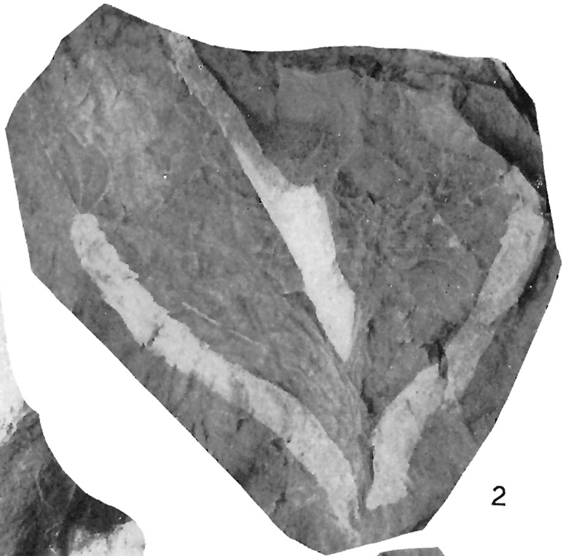

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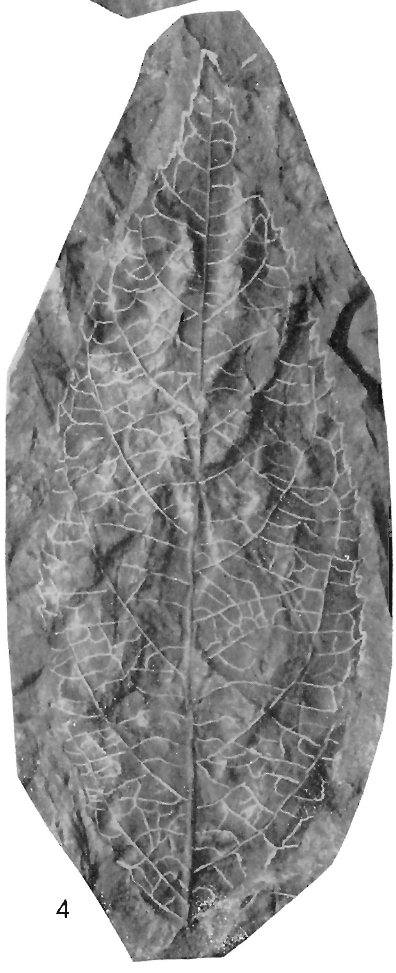

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Plate LX

Paleocene

Figure 1. *Rhamnites marginatus* (Lesquereux). Plesiotype, G.S.C. No. 5574. Locality 1202. (Page 73.)
Figure 2. *Rhamnites marginatus* (Lesquereux). Plesiotype, G.S.C. No. 6253. Locality 3444. (Page 73.)
Figure 3. *Platanus raynoldsii* Newberry. Plesiotype, G.S.C. No. 6244. Locality 3444. (Page 59.)

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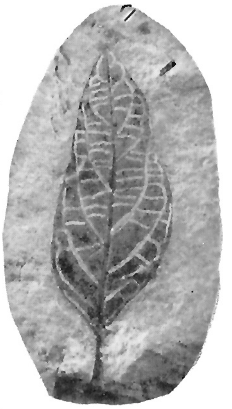

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Plate LXI

Paleocene

Figure 1. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6195. Locality 3140. (Page 78.)

Figure 2. *Viburnum trinervum* Berry. Plesiotype, G.S.C. No. 6199. Locality 3140. (Page 78.)

Figure 3. *Viburnum trinervum* Berry. Plesiotype, G.S.C. No. 6196. Locality 3140. (Page 78.)

Figure 4. *Viburnum antiquum* (Newberry). Plesiotype, G.S.C. No. 6151. Locality 3446. (Page 77.)

Figure 5. *Rhamnites marginatus* (Lesquereux). Plesiotype, G.S.C. No. 5573. Locality 1202. (Page 73.)

PLATE LXI

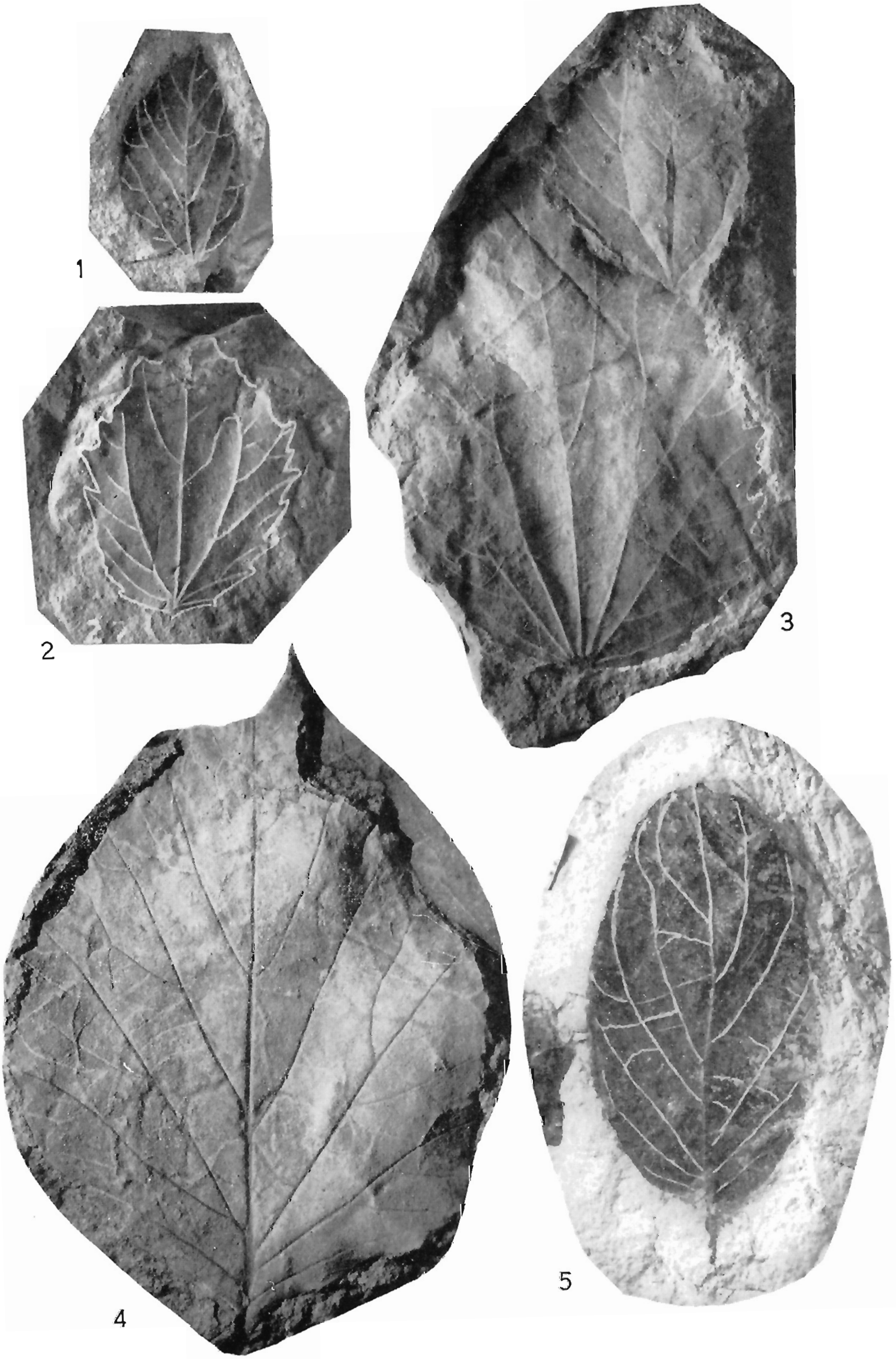


Plate LXII

Paleocene

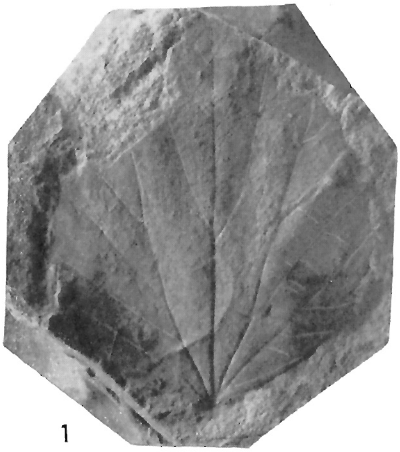
Figure 1. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6192. Locality 3140. (Page 78.)

Figure 2. *Viburnum asperum* Newberry. Plesiotype, G.S.C. No. 5921. Locality 4126. (Page 79.)

Figure 3. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6193. Locality 3140. (Page 78.)

Figure 4. *Viburnum lakesii* Lesquereux. Plesiotype, G.S.C. No. 6194. Locality 3140. (Page 78.)

Figure 5. *Dicotylophyllum contractinervosum* Bell. Holotype, G.S.C. No. 6118 (upper leaf), and paratype No. 6116 (lower leaf). Locality 3428. (Page 79.)



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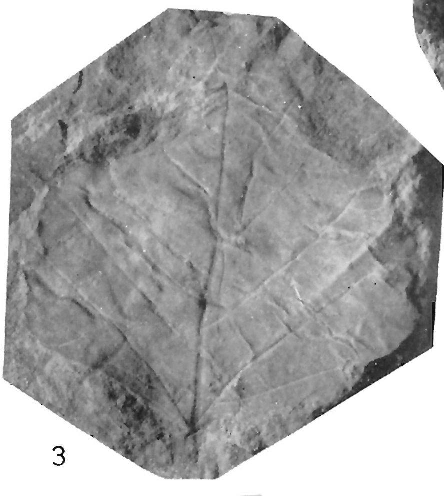

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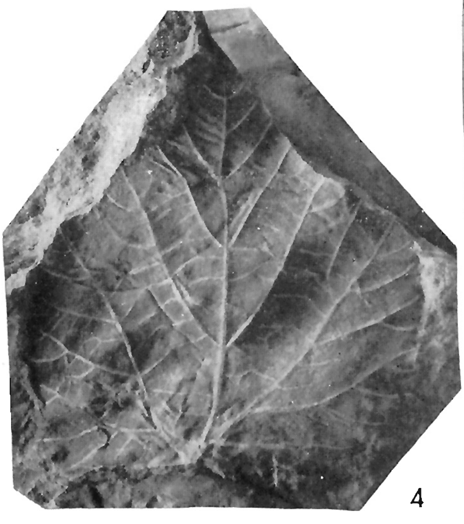

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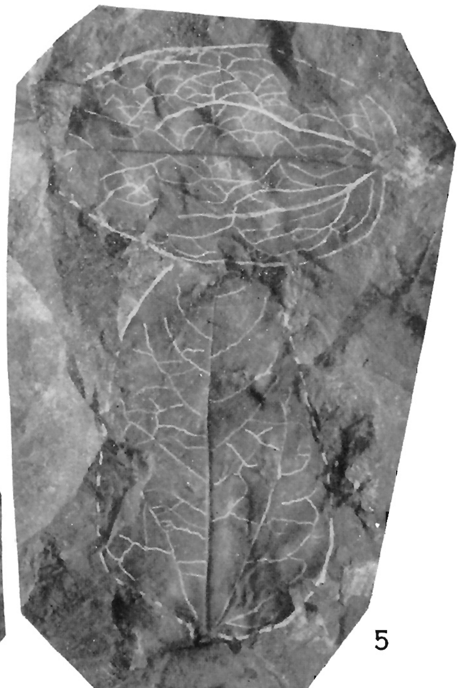

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Plate LXIII

Paleocene

Figure 1. *Spirodela scutata* Dawson. Syntype, G.S.C. No. 5456b x 4. Locality 4095. (Page 82.)

Figure 2. *Majanthemophyllum grandifolium* Penhallow; holotype of *Clintonia oblongifolia* Penhallow. Plesiotype, G.S.C. No. 5558. Locality 1202. (Page 80.)

Figure 3. *Spirodela scutata* Dawson. Plesiotype, G.S.C. No. 6135 x 2. Locality 3461. (Page 82.)

Figure 4. *Carpolithus symplocoides ?* Heer. Plesiotype (?), G.S.C. No. 6269 x 4. Locality 3426. (Page 80.)

Figure 5. *Nelumbites protoluteus* (Berry). Plesiotype, G.S.C. No. 6301. Locality 2064. (Page 64.)

Plate LXIII

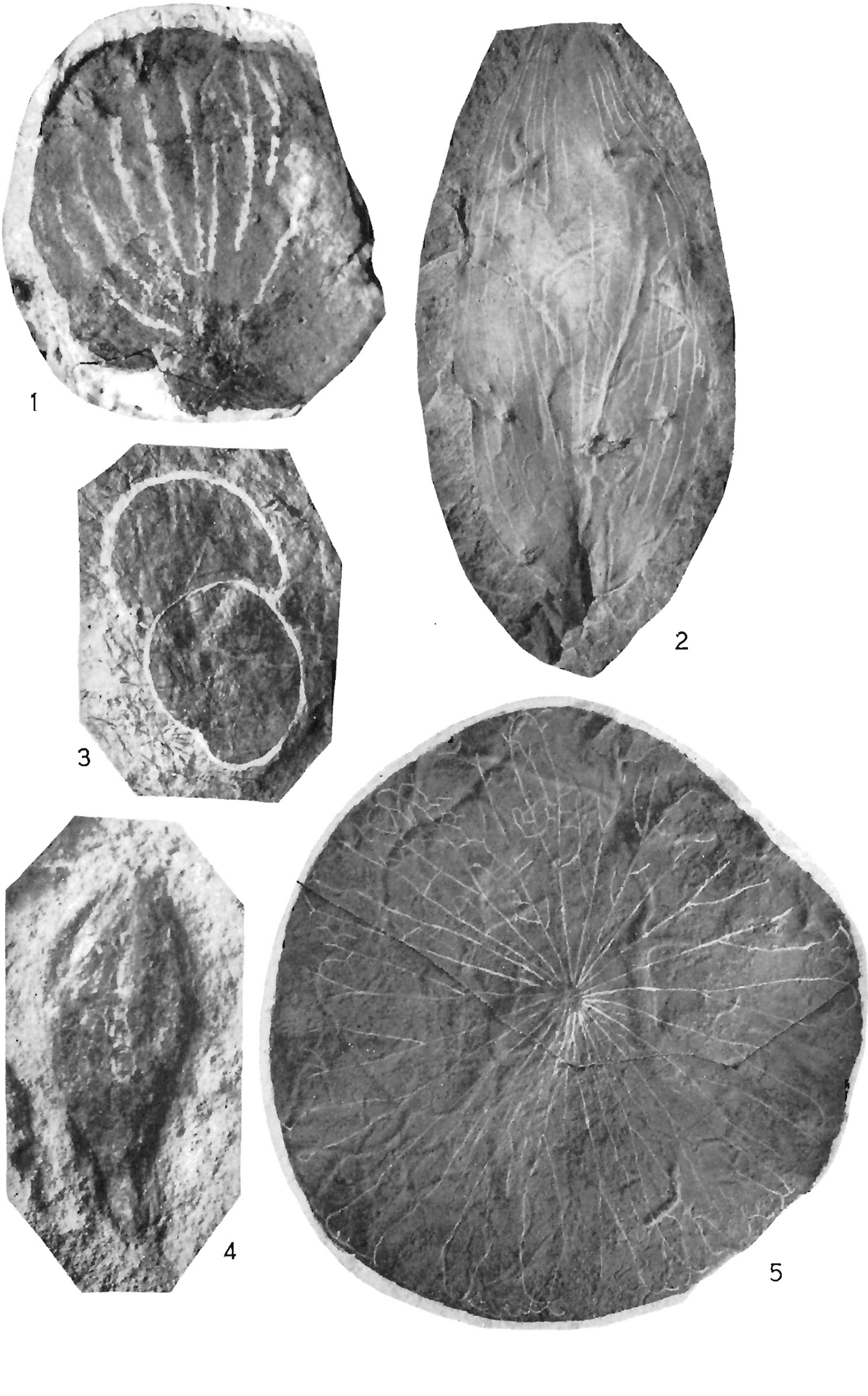

Plate LXIV

Paleocene

Figure 1. *Majanthemophyllum grandifolium* Penhallow. Plesiotype, G.S.C. No. 6252. Locality 3444. (Page 80.)

Figure 2. *Cannophyllites magnifolia* (Knowlton). Plesiotype, G.S.C. No. 6160. Locality 3444. (Page 81.)

Figure 3. *Majanthemophyllum grandifolium* Penhallow. Plesiotype, G.S.C. No. 6162. Locality 3444. (Page 80.).

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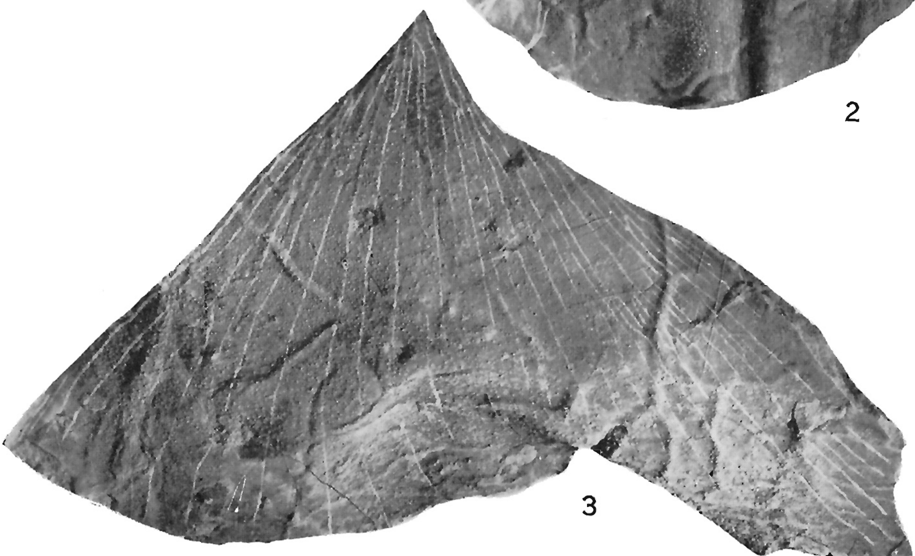

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PLATE LXV

Paleocene

Cannophyllites magnifolia (Knowlton). Plesiotype, G.S.C. No. 6159 x $\frac{5}{6}$. Locality 3444. (Page 81.)

Plate LXV

PLATE LXVI

Paleocene

Figure 1. *Carpolithus (Ginkgoites ?) selwyni* Bell. Holotype, G.S.C. No. 6290 x 4. Locality 2188. (Page 45.)

Figure 2. *Majanthemophyllum grandifolium* Penhallow. Holotype, G.S.C. No. 5559. Locality 1202. (Page 80.)

Figure 3. *Majanthemophyllum grandifolium* Penhallow. Plesiotype, G.S.C. No. 6161. Locality 3444. (Page 80.)

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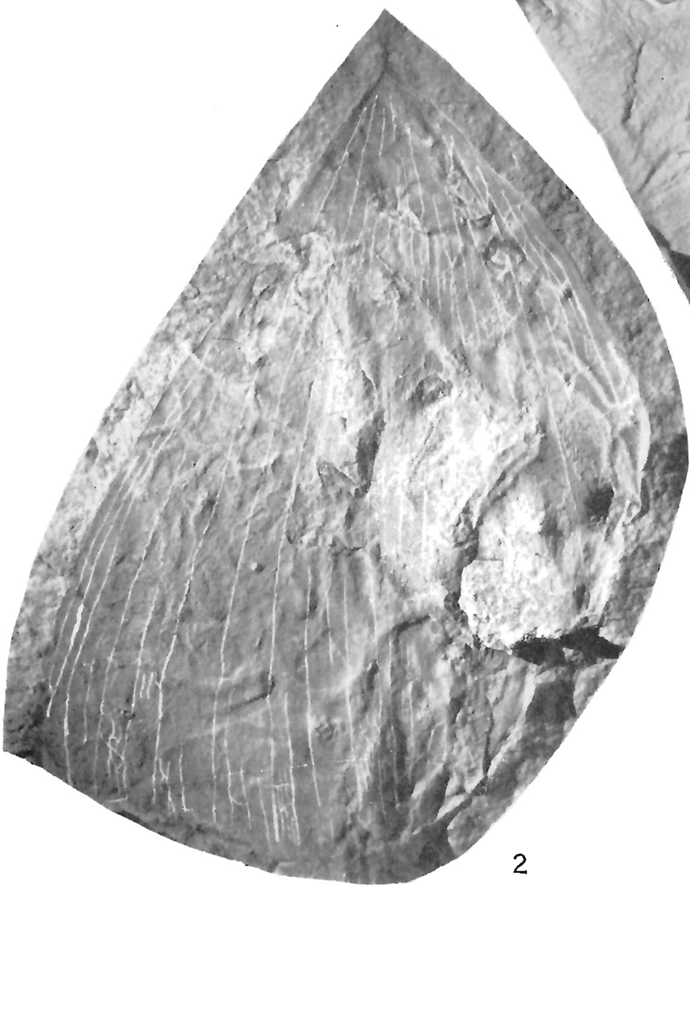

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Plate LXVII

Paleocene

Figure 1. *Spirodela scutata* Dawson. Plesiotype, G.S.C. No. 3461 x 2. Locality 2063. (Page 82.)

Figure 2. *Carpolithus symplocoides ?* Heer. Plesiotype (?), G.S.C. No. 6268 x 4. Locality 3426. (Page 80.)

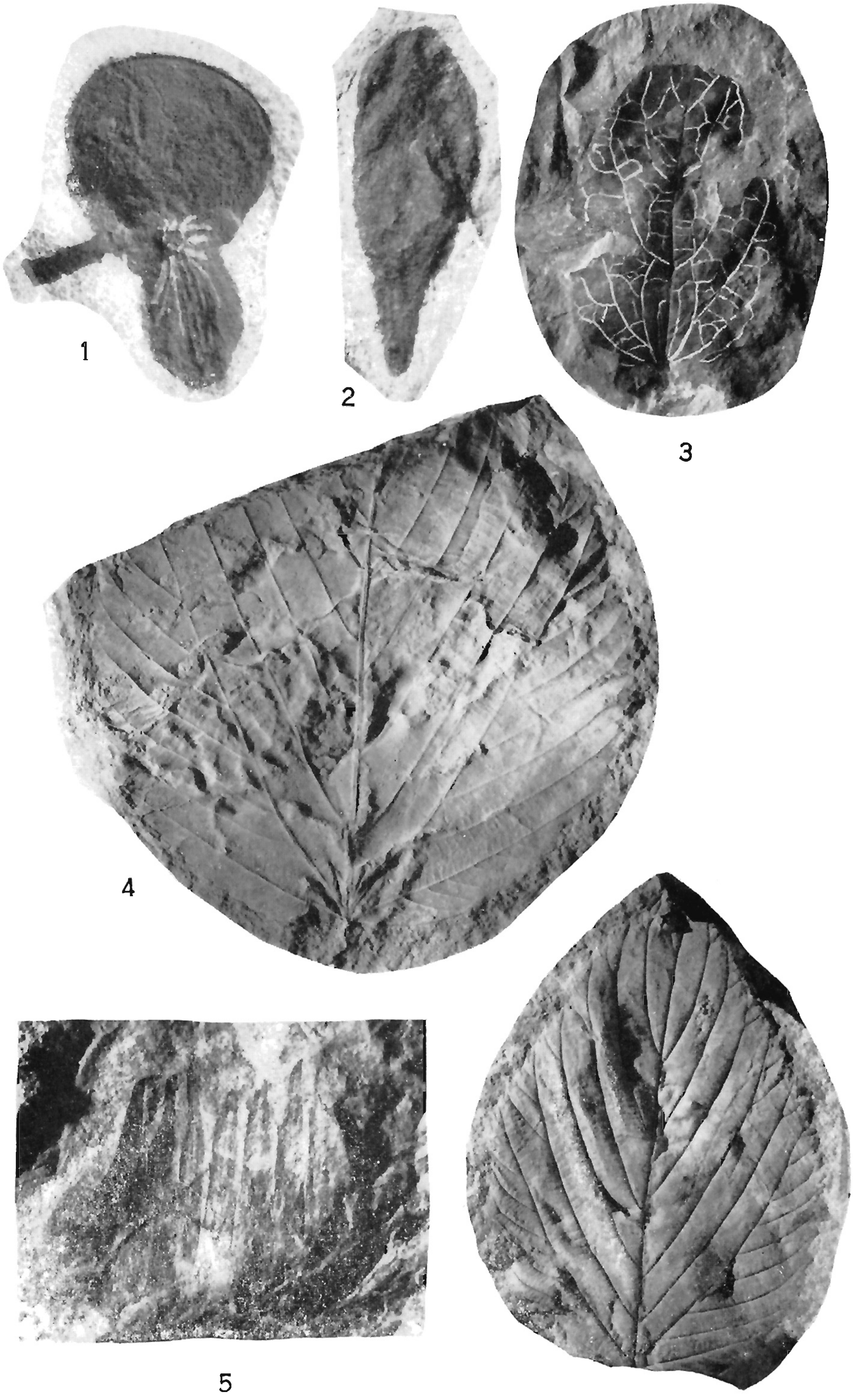
Figure 3. *Dicotylophyllum contractinervosum* Bell. Holotype, G.S.C. No. 6137. Locality 3428. (Page 79.)

Figure 4. *Viburnum asperum* Newberry, Plesiotype, G.S.C. No. 7452. Locality 4126. (Page 79.)

Figure 5. *Equisetum alexoensis* Bell. Paratype, G.S.C. No. 6357 x 4. Locality 3438. (Page 36.)

Figure 6. *Viburnum asperum* Newberry. Plesiotype, G.S.C. No. 7450. Locality 4126. (Page 79.)

PLATE LXVII



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