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REVISIONS TO ROLAND BROWN'S NORTH AMERICAN PALEOCENE FLORA

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Abstract. The Paleocene megafossil flora of the Rocky Mountains and Great Plains region in the United States of America, including leaves, cones, fruits, and seeds, monographed by Roland W. Brown in 1962, has been reevaluated and updated to include subsequent taxonomic revisions. The scope of this investigation included thousands of specimens from more than 450 localities of the Fort Union, Evanston, Ferris, Raton, Bear, Lebo, Melville, Ludlow, Tongue River and Sentinel Butte strata of New Mexico, Colorado, Wyoming, Montana and North and South Dakota. A large number of floristic elements remain uncertain as to their modern familial affinities due to limited diagnostic characters, or insufficient comparative investigations. Nevertheless, many of Brown's determinations have been upheld and several newly recognized genera and families have strong support. The flora includes greater diversity of Platanaceae and Cornales than Brown had recognized. These, together with Fagales (particularly Betulaceae and Juglandaceae), Saxifragales (*Trochodendroides*, *Archeampelos* and *Nyssidium*), are widespread and prominent members of the flora. New combinations introduced here include *Ensete goldianum* (Lesquereux) comb. nov., *Macginitiea nobilis* (Newberry) comb. nov., *Platanites raynoldsii* (Newberry) comb. nov., *Trochodendroides genetrix* (Newberry) comb nov., *Cucurbitaciphyllum lobatum* (Knowlton) comb. nov., and *Mciveraephyllum nebrascense* (Schimper) comb. nov. Georeference data are provided for all of the localities cited by Brown.

■ angiosperms, conifers, ferns, fossil plants, leaves, Paleocene, Rocky Mountains, North America, systematics, taxonomy

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Introduction

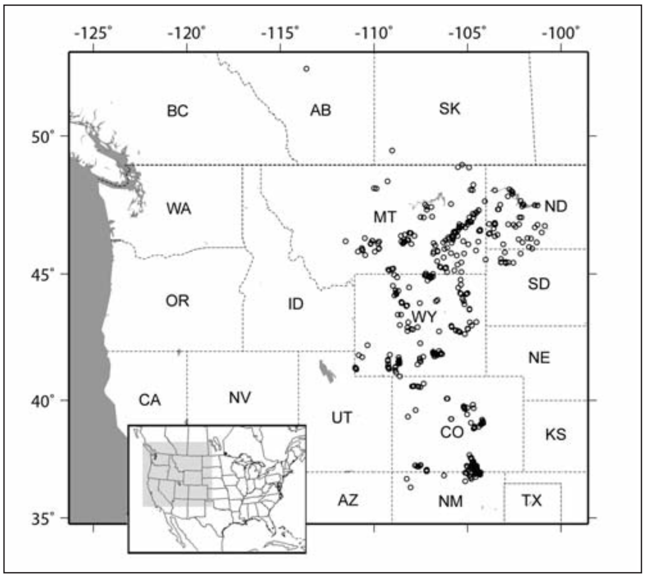
The monograph of Roland W. Brown (1962) stands as the most comprehensive treatment of the Paleocene flora of the Rocky Mountain and Great Plains region in the USA based on specimens from more than 450 localities scattered across New Mexico, Colorado, Wyoming, Montana, South Dakota, and North Dakota. In that treatment, he reexamined collections made earlier by Newberry (1898), Lesquereux (1878), Ward (1886, 1887), and Knowlton (1917, 1922, 1924, 1930), and reassessed affinities of the taxa and stratigraphic positions, augmented by many new sites that he had collected during the 1930s through 50s (Text-fig. 1). In the monograph, published posthumously, Brown described 35 new species and made several new combinations. Initially, these lacked designation of types and repository numbers, but this was rectified with the designation of lectotypes by Watt (1971).

Subsequent treatments, such as monographs of the Golden Valley (Hickey 1977) and Almont (Crane et al. 1990, Zetter et al. 2011) floras of North Dakota and the Ravenscrag flora in Saskatchewan (McIver and Basinger 1993) have expanded and augmented the regional flora, but the overview provided by Brown remains an essential guide to the diversity of North American Paleocene megafossil plants and their distribution patterns across the Rocky Mountain and Great Plains region during the Paleocene. This work has been useful to many authors of biostratigraphic and paleoecological investigations (e.g., Barclay et al. 2003, Ellis et al. 2003, Gemmill and Johnson 1997, Hickey 1980, Hoffman and Stockey 1999, Johnson 2002, Peppe 2010, Peppe and Hickey 2014, Stockey et al. 2013, 2014, Wilf 2002, Wilf et al. 1998, Wing, 1998, Wing et al. 1995, Wing and Currano 2013).

The scope of Brown's monograph included Paleocene strata from New Mexico, Colorado, Wyoming, Montana, North Dakota, South Dakota and a few sites in Canada (Text-fig. 2), distributed in several structural depressions including the Williston, Bull Mountain, Crazy Mountains, Clark's Fork, Bighorn, Powder River, Wind River, Hanna, Carbon, Green River, Denver, Raton, and San Juan basins (Fig. 1A, B in Peppe and Hickey 2014). Stratigraphically, the source sediments include the Fort Union, Raton, Denver, Bear, Lebo, Ferris Formations. In North Dakota, where the Fort Union is treated as a Group, the Ludlow, Tongue River and Sentinel Butte Formations, as well as parts of the Golden Valley Formation, were included. With greatly increased improvements to stratigraphic resolution in many of these basins through the Paleocene and especially proximal to the Creteaceous-Paleocene and Paleocene-Eocene boundaries (Hicks et al. 2003, Johnson et al. 2003, Belt et al. 2004, Peppe et al. 2009, Secord et al. 2006, Sprain et al. 2014), there is the excellent potential to place Brown's taxa according to more precise stratigraphic and chronologic ranges, but that is beyond the scope of the present article.

The systematic affinities of many of the species recognized by Brown (1962) have been revised over the past five decades, but the information is scattered among numerous publications. The ferns documented by Brown were reviewed in the context

Text-fig. 1. Roland W. Brown in the field in SW Wyoming, June 30, 1941. Courtesy Nate Carroll, Carter County Museum, Ekalaka, Montana.



Text-fig. 2. Map showing the distribution of localities included in the treatment of Brown (1962), based on the coordinates presented in Appendix Table 1. Localities are distributed across New Mexico (NM), Colorado (CO), Wyoming (WY), Montana (MT), South Dakota (SD) and North Dakota (ND). Also plotted are cited Canadian localities: Joffre Bridge, in Alberta (AB), and Ravenscrag, in Saskatchewan (SK). Map generated with Map-It (2014) website.

of a broader Cenozoic treatment by Collinson (2001), but there has been no comprehensive review of the seed plants since Brown's original monograph. The Platanaceae, Saxifragales (Cerdiphyllaceae, Hamamelidaceae and others), Betulaceae, Juglandaceae, and Cornales figure prominently in the Paleocene of North America—more than was appreciated at the time of Brown's synthesis. For this article, all the taxa that Brown recognized are reviewed, indicating their botanical systematic positions as currently recognized. This account does not include some of the taxa recognized more recently that were unknown to Brown (1962) which can be found in the review of Pigg and DeVore (2010).

Because the sleuthing of correct botanical affinities for fossils that are incompletely preserved is a tedious process, the traditional binomial system of nomenclature has, in some cases, been effectively replaced by numerical morphotype designations that can be tallied quickly and used statistically in site-to-site comparisons for assessment of changes in floristic diversity and climate (Barclay et al. 2003; Ellis et al. 2003; Johnson 2002).

In another approach to dealing with uncertain taxonomic affinities, Hickey (1977) and others have found it useful to retain binomials from the older literature, even when the original generic assignment is considered to be correct, by placing the generic name in quotation marks, e.g. "*Ficus*" *planicostata* LESQUEREUX. In this example, the generic placement by Lesquereux is no longer considered correct, but the true botanical affinities remain uncertain, and a fossil-generic name has not been established to accommodate it. The use of such quotation marks in this treatment should be viewed as a warning that the modern generic name is not accepted and should not be used in ecological assessments of the flora nor for calibrating molecular phylogenies–unless new data are recovered from the fossils to justify the former assignments.

Most of the localities that Brown cited as the sources for his species (Text-fig. 2) were presented in a listing that provided geographic coordinates according to the township and range system and/or a brief text description. Here is provided an updated listing of the original localities along with their latitude/longitude coordinates.

Material and Methods

Specimens were studied at the US Natural History Museum, Smithsonian. This study is limited primarily to the localities cited by Brown (1962), which include sites of Newberry, Lesquereux, Ward and Knowlton as well as those collected by Brown, himself. Other relevant localities from more recent fieldwork of L. J. Hickey, S. Wing, K. Johnson, D. Peppe, and S. Manchester are mostly outside the scope of this article. Many of the sites in Wyoming, Montana and North Dakota were physically revisited. Other sites were located as closely as possible from original Township and Range coordinates using the Earthpoint (2014) website for conversion to latitude and longitude, and/or site descriptions, and were "digitally revisited" via GoogleEarth (2014) to obtain latitude/longitude coordinates adjusted to the WGS84 datum. Localities were plotted on the geographic map using the Map-It (2014) website. Geologic horizons represented include the Fort Union Formation/Group, and the Denver, Raton, Animas, Evanston, and Ferris Formations. We have excluded taxa that are exclusively from the Coalmont Formation of Colorado as it is likely of early Eocene, rather than Paleocene age (Hail and Leopold 1960). Appendix Table 1 lists the localities, their coordinates, and taxa recorded from them by Brown (1962). In addition, some of specimens are figured and/or cited herein are from localities represented in the collections at Florida Museum of Natural History, Gainesville (specimen numbers prefixed UF). These include Killpecker Creek, Wyoming (UF 18126: 41°35.635' N, 109°15.197' W), Black Buttes Mine pit 3, Wyoming (UF 15886: 41°29.41', N 108°41.22' W), the Almont, North

Dakota (UF 15722: 46°55.32' N, 101°30.38' W), and Yellowstone Bridge, Miles City, Montana (UF19021: 46 25.69'N, 105 50.96W).

The repeated association of particular fruit and leaf types among different localities, as well as at other sites discovered subsequent to Brown's work, was used along with other evidence to link multiple organs of the same species when possible as in the cases of *Macginitiea, Nordenskioeldia, Polyptera*, *Aesculus, Davidia*, *Beringiaphyllum*, and *Browniea*.

The names used here are believed to be those with priority according to the International Code of Botanical Nomenclature (McNeill et al. 2012, Turland 2013). The Latin endings from previous publications have been corrected, when appropriate. Such corrections can be done without altering the author attribution (McNeill et al. 2012, Turland 2013). For example, *Nordenskioeldia* was spelled *Nordenskioldia* by Brown (1962) and by Crane et al. (1990, 1991), but as the name honors Nordenskiöld, the "o" with umlaut is to be replaced by "oe" rather than simply "o". The most common correction was the use of the suffix, "*ii*" rather than *"i*" in the case of species recognizing a man's name when preceded by a consonant (except "r", which is treated as a vowel). Hence, for example, *Betula stevensoni* Lesquereux, as spelled by Brown (1962), is corrected to *Betula stevensonii* Lesquereux. For brevity, I have not repeated the synonymies provided already by Brown, unless our opinions differ.

Taxonomic Composition of the Flora

Table 1 lists currently recognized taxa according to their position in phylogeny as currently understood. In addition, Table 2 repeats the taxonomic listing from Brown (1962), in the same sequence as he presented it, with indication of revised taxonomic placements and/or indication of whether the taxonomic placement is accepted or in need of revision. The following discussion of taxonomic composition of the flora is presented by major taxonomic groups, i.e., ferns, gymnosperms, and angiosperms divided into the morphologically distinctive groups, monocots and dicots. The dicots are treated in more or less phylogenetic sequence (sensu APG III 2009): e.g., Platanaceae, Saxifragales, Fagales (Betulaceae, Juglandaceae), Rosales (Ulmaceae), Cornales (Cornaceae, Nyssaceae, Davidiaceae), followed by those of uncertain affinity.

Bryophytes

Free-sporing plants are subdominant to seed plants in most Paleocene leaf localities and bryophytes are rare. Liverworts are represented by *Marchantia lignitica* (Ward) R. W. Brown, *M. pealei* Knowlton and *Preissites wardii* Knowlton (Brown 1962), and mosses by "*Hypnum" coloradense* R. W. Brown and "*Mnium" montanense* R. W. Brown.

Lycophytes

Lycopods include three species of *Selaginella* (*S. berthoudii* Lesquereux, *S. collieri* Knowlton, and *S. monstrosa* (Hollick) R. W. Brown) and *Isoetites horridus* (Dawson) R. W. Brown. The corms, leaves and sporangia of *Isoetites horridus*, indicate relationship to extant *Isoetes*, but the species is distinguished from the extant genus by differences in vegetative characters, for example, shape of the leaf apices, which are spatulate in the fossil (Brown 1939a, McIver and Basinger 1993). *I. horridus* was shown by Hickey (1977) to produce megaspores similar to the dispersed spore taxon, *Minerosporites dissimilis;* McIver and Basinger (1993) found both megaspores of *Minerosporites*, and microspores of *Lavigaetisporities gracilis* Wilson et Webster *in situ*.

Sphenophytes

Equisetum is sometimes present, represented by stems and/or rhizomes and sometimes by rhizome nodules but detailed comparative studies with other fossil and extant species have not been done. Brown (1962) cited various epithets that had been applied earlier for specimens from the Rocky Mountains and Great Plains region, but did not settle on an appropriate bionomial, noting that "When, however, these species are examined in the light of the material now on hand, they do not seem to be readily distinguishable. Size of stem, number of teeth in the sheaths, shape of the tubers—all vary so greatly, with gradations from one to another, and with no apparent constancy in any set of features, that I shall not attempt to define the species" (Brown 1962, p. 46). Among Paleocene examples from this region, *Equisetum globulosum* Lesquereux (1883, p. 222, pl. 48, fig. 3) appears to have nomenclatural priority. A strobilus was also illustrated by Brown (1962, pl. 67, fig. 43).

Filicalean Ferns

Brown (1962) recognized 13 genera of ferns. The phylogenetic positions of some of these remain questionable because of poor preservation (as Brown acknowledged for "*Hymenophyllum" confusum*), lack of fertile material, and/or problems of convergent morphology in multiple unrelated extant fern genera. Nevertheless, some of the identifications can be considered to be secure including *Lygodium*, *Woodwardia*, *Onoclea*, and *Osmunda*.

Schizaeaceae

In the Schizaeaceae, *Lygodium coloradensis* Knowlton can be identified with confidence based the diagnostic fertile foliage and the palmately lobed pinnules (Brown 1962, pl.8 figs 9, 10) (confirmed by a small piece of fertile foliage resembling that of *L. kaulfussii*). *Lygodium* is very rare in the Paleocene of this region, but becomes abundant in the Eocene. The generic assignment of *Anemia elongata* (Newberry) Knowlton is in question because only sterile foliage is known, and because similar fossil foliage, including *A. eocenica* Berry, was reassigned to the related extinct genus *Ruffordia* Saporta by Barthel (1976) on the basis of similarity to more completely documented Eocene European fossils that differ from extant *Anemia* in various details, including the presence of monolete, rather than trilete spores within the sporangia. *Ruffordia* differs from *Anemia* in having less reduced fertile laminae, more spores per sporangium (256 vs 128) and in epidermal anatomy (Barthel 1976), but these features are not known for "*Anemia*" *elongata.* Collinson (2001) cautiously listed this species under "*Anemia*-like sterile foliage."

Osmundaceae

Brown recognized two species of osmundaceous foliage, *Osmunda greenlandica* (Heer) R. W. Brown [original spelling of epithet *groenlandica* (Heer 1869)] and *O. macrophylla* Penhallow, noting that both were known only from sterile foliage without fertile fronds. Additional evidence favoring the identification of this genus came from Tidwell and Parker (1987) who described permineralized osmundaceous stem remains associated with pinnules that they identified as *O. greenlandica* from the Fort Union Formation at Black Buttes Coal Mine on the west side of the Rock Springs uplift in Wyoming. *O. macrophylla* foliage was also observed in the Golden Valley Formation (Hickey 1977, p. 59).

Onocleaceae

The generic placement of *Onoclea hesperia* R. W. Brown was accepted by Rothwell and Stockey 1991, but they argued, based on a suite of material from the Paleocene Paskapoo Formation of Alberta, Canada, that these fossils should be placed in the extant species, *O. sensibilis* L.—in agreement with the original assignment of Newberry (1898). McIver and Basinger (1993) applied Brown's binomial to sterile material from Paleocene of Ravenscrag, Saskatchewan.

? Dennstaedtiaceae

"Dennstaedtia" americana Knowlton is known from both fertile and sterile fronds (Knowlton 1910; Brown 1962; McIver and Basinger 1993). McIver and Basinger (1993) illustrated and described additional material of this species from the Paleocene of Saskatchewan. Kvaček and Manum (1993) noted that it can be difficult to distinguish sterile and even fertile fronds of *Dennstaedtia* and *Saccoloma* (Dennstaedtiaceae) from those of certain genera of the unrelated tree fern family, *Dicksoniaceae.* They transferred a Paleogene species from Spitsbergen, previously considered to be *Dennstaedtia*, to the fossil genus *Coniopteris* Brongniart: *Coniopteris blomstrandii* (Heer) Kvaček et Manum. They also recommended that *D. americana* be reconsidered in this light, but did not make a formal transfer. A more detailed investigation is requried, aimed at revealing the morphology of sporangia and spores.

The fern that Brown (1962) placed in *Saccoloma gardneri* (Lesquereux) Knowlton was subsequently treated as an extinct genus *Dennastra* under the name *D. sorimarginata* McIver et Basinger (1993). *Dennastra* leaves show a reticulate venation at the outer edges of the pinnules (Knowlton 1930, McIver and Basinger 1993). The specimen illustrated by Knowlton (1930) shows an elongate, entire-margined pinnule at least 6 cm long and 1 cm wide with thick midvein, thin dichotomizing secondary veins, and a thick marginal band of sori. Similar specimens occur in the Ravenscrag Formation of Saskatchewan (McIver and Basinger 1993). The proper placement of Lesquereux's species remains uncertain; McIver and Basinger (1993, p. 21) reported that, "Evidence from Ravenscrag Butte fossils indicates that this fern is not assignable to *Saccoloma*, and that fertile pinnules of this type are unlikely to be conspecific with the type specimen of the basionym *Pteris gardneri*." Collinson (2001, p. 216), concluded "The characteristics of *Dennastra* are closely comparable to those of modern *Saccoloma,* especially *S. elegans* Kaulf., though slight differences in venation occur in addition to the spore differences. The inclusion of *Dennastra* in Dennstaedtiaceae seems to be well-supported by the published data."

Blechnaceae

The generic identification of *Woodwardia arctica* (Heer) R. W. Brown from Wyoming and North Dakota is secure because of the prominent, continuous bands of sori that follow both sides of the rachis and both sides of the midvein of each pinnule. The venation and soral development are particularly similar to the extant species, *Woodwardia virginica,* sometimes placed in its own genus, *Anchistea*. *W. arctica* was also reported from the Eocene of Japan (Endo 1968), and from the Zeya-Bureya depression of far eastern Russia (Kvaček and Manum 1993; Fedotov 1970). Hickey (1977) and McIver and Basinger (1993) applied the name *Woodwardia gravida* Hickey for similar specimens from which spores were obtained. *Woodwardia maxonii* Knowlton, from the Paleocene of Wyoming and North Dakota (McIver and Basinger 1993, Hickey 1977) differs from *W. arctica* by having separate elliptical sori, rather than continuous linear sori.

Incertae sedis ferns

Allantodiopsis erosa (Lesquereux) Knowlton et Maxon is a fern of uncertain affinity. The pinnules have feather-like venation. Secondary veins are approximately at right angles to the midveins and have dichotomous forking near the midvein and sometimes again near the margin. Although Knowlton and Maxon (in Knowlton 1919) and Brown (1962) included both entire-margined and nonentire-margined pinnae in *A. erosa*, McIver and Basinger (1993) advised that this species should be restricted to the nonentire-margined form matching the original specimens of Lesquereux, because the entire-margined lamina from Knowlton and Maxon's locality overlaps with a co-occurring species that Knowlton called *Saccoloma gardneri* (Lesquereux) Knowlton (cf. *Dennastra sorimarginata* McIver et Basinger 1993).

"Blechnum" anceps (Lesquereux) R. W. Brown. This species is known only from sterile foliage, and thus the assignment should be regarded as tentative. Each pinnule has a midvein and closely spaced fine secondary veins. The distal portions of the secondary veins are almost at right angles to the midvein, and "the vein terminations in the margin are conspicuously enlarged or club shaped" Brown (1962, p. 41).

Brown recognized three species of *Dryopteris,* two based in part on fertile fronds, *D. lakesii* (Lesquereux) Knowlton, and *D. meeteetseana* R. W. Brown showing sori but lacking preservation of spores, and the third based on sterile foliage called *D. serrata* R. W. Brown, for which he stated "no comparison with a living species is suggested, and the reference to *Dryopteris* is entirely nominal" (Brown 1962, p. 42). Collinson (2001) considered all paleobotanical reports of *Dryopteris,* including these, to be in need of revision.

"Lastrea" goldiana (Lesquereux) Lesquereux. Brown (1962, p. 42) stated that "fertile pinnae are scarce ..., but when present have small round sori on the secondary veins midway between the midrib and margin." This is similar to a fern from the Paleocene of Alberta given the name *Speirseopteris orbiculata* and assigned to Thelypteridaceae by Stockey et al. (2006). The venation and position of sori correspond, with a circular sorus terminating each secondary vein inside the margin, but the pinnules are shorter with fewer secondary veins than in the specimens illustrated by Brown of *L. goldiana*.

"Gleichenia" hesperia R. W. Brown was described based on sterile pinnules, but Brown (1962, p. 44) admitted, "The specimens are only nominally assigned to *Gleichenia*."

Gymnosperms

Gymnosperms present in Paleocene assemblages of the Rocky Mountains and Great Plains include *Ginkgo*, conifers, and cycads.

Cycads

Brown recognized the cycads *Zamia coloradensis* (Knowlton) R. W. Brown and *Z. wyomingensis* R. W. Brown. However, in the absence of epidermal characters and cones, it is difficult to confirm that they represent extant *Zamia*. Other Paleocene cycads with superficial similarities to *Zamia* have been shown on epidermal characters to represent an extinct genus, *Dioonopsis* Horiuchi et Kimura (Erdei et al. 2012). According to B. Erdei (pers. comm. 2013), the type specimens of these species both lack well preserved cuticle so it cannot be confirmed whether they represent *Zamia*, or another genus. In addition to the kinds recognized by Brown (1962), the extinct cycad genus, *Eostangeria* Barthel, with feather-like venation and well preserved cuticle, has been recovered from the Paleocene of Wyoming, including Little Bitter Creek Canyon and Sand Draw localities in Wyoming (Kvaček and Manchester 1999).

Ginkgoaceae

Brown (1962) referred to the leaves of *Ginkgo*, as *Ginkgo adiantoides* (Unger) Heer. Zhou et al. (2012) described the same species from well preserved leaves and reproductive structures from silicified specimens, and named them *Gingko cranei* Zhou, Quan et Liu, because the type material of *G. adiantoides* from the Pliocene of Italy is known only from leaf impression material lacking many of the characters known for *G. cranei.* I was recently reminded, however that *Ginkgo wyomingensis* Manum (1966) was also described from Palaeocene of USA (reviewed by Golovneva 2010) and the structure of its cuticle is the same that of *G. cranei*, so the nomenclature needs to be revisited.

Conifers

Conifers include Amentotaxaceae and Cupressaceae. Leaves that Brown called *Amentotaxus campbellii* (Gardner) Florin were transferred to *Amentotaxus gladifolia* (Ludwig) Ferguson, Jähnichen et Alvin by Jähnichen (1990). Although Pinaceae are well represented in the palynoflora, e.g., *Abietineaepollenites foveoreticulatus*, *Pinus*, *Picea*, *Abietineaepollenites latisulcatus*, *Pinuspollenites elongatus*, and *Cathaya* sp. (Zetter et al. 2011), but they are not known from megafossils.

Araucaria longifolia (Lesquereux) R. W. Brown

Brown's determination of compressed cones and foliage as *Araucaria longifolia* (Lesquereux) R. W. Brown has not been formally challenged. However, the identification to this family is in need of careful scrutiny, as it would be among the youngest records of this family for the Northern Hemisphere.

In the taxoidioid Cupressaceae, *Metasequoia* and *Glyptostrobus* are well represented based on foliage and cones. *Glyptostrobus* is represented by foliar branches with terminal cones, and by dispersed seeds.

Glyptostrobus europaeus (Brongniart) Unger

Brown (1962) used the name *Glyptostrobus nordenskioldii* (Heer) R. W. Brown, based on similarity to original material from the Paleogene of Spitsbergen (recently reanalyzed by Budantesev and Golovneva 2009). Hickey (1977) argued that there were insufficient foliage and cone characters to distinguish the North American fossil *Glyptostrobus* species from that of Europe, and that the name *Glyptostrobus europaeus* (Brongniart) Heer should be applied both to North American and European material. LePage (2007) observed that this combination was actually published earlier by Unger (1850), and so should be cited as *Glyptostrobus europaeus* (Brongniart) Unger. LePage (2007) reported that more than 30 binomials have appeared in the literature on fossil occurrences of *Glyptostrobus* around the Northern Hemisphere ranging from Cretaceous to Pliocene, most of which appear indistinguishable based on their diagnoses and stressed that there is need for more detailed comparative work among them.

Taxodium olrikii (Heer) R. W. Brown was reported from the Rocky Mountain and Great Plains region based on leaves, but no confirming seeds or cone fragments have been recognized so the identification of *Taxodium* remains unconfirmed. This species was originally recognized from the Paleocene of Greenland, and then from Spitsbergen, but convincing reproductive material remains to be documented (Budantsev and Golovneva 2009).

Metasequoia occidentalis (Newberry) Chaney

Metasequoia occidentalis (Newberry) Chaney is correctly identified to genus based on the oppositely arranged needle leaves, and cones with decussate arrangement, based on specimens collected from the Paleocene of Wyoming, Montana and North Dakota. From Paleocene strata in Alberta, Stockey et al. (2001) recognized another species, *M. foxii* STOCKEY, ROTHWELL et FALDER, distinguished by cones with helical arrangement of five rows of cone scales, rather than four decussate rows. This seems to represent a different species from most of the material illustrated by Brown (1962). Crane et al. (1990) placed permineralized taxodioid megafossils from the Paleocene of Almont, North Dakota, in "cf. *Parataxodium* ARNOLD et LOWTHER"; however, subsequent collections and study indicate that these remains mostly represent the foliage, pollen and seed cones, and dispersed seeds of *Metasequoia occidentalis*. A characteristic seed of *Glyptostrobus*, recovered more recently from Almont, indicates that the *Glyptostrobus*-like foliage that Crane et al. (1990) considered to be variation within cf. *Parataxodium*, was likely produced instead by *Glyptostrobus europaeus*.

Ditaxocladus catenulatus (W.A. BELL) S.X. GUO, Z. KVAČEK, MANCHESTER et Z.K. ZHOU.

The cupressaceous foliage that Brown (1962) referred to as *Fokienia catenulata* (BELL) R. W. BROWN (MCIVER and BASINGER 1990) was subsequently found with attached cones and placed in the extinct genus *Ditaxocladus* GUO et SUN. The species was transferred to *Ditaxocladus catenulatus* by Guo et al. (2012). *Fokeniopsis* MCIVER et BASINGER (1993) is a junior synonym of *Ditaxocladus* GUO et SUN (in Guo et al. 1984).

Mesocyparis borealis MCIVER et BASINGER

Foliar branches referred to *Thuja interrupta* NEWBERRY by Brown (1962) have been revised multiple times. Hickey (1977) called this species *Thuites interruptus* (NEWBERRY) BELL, using Sternberg's genus *Thuites*. McIver and Basinger (1987) placed them in *Cupressinocladus interruptus* (NEWBERRY) SCHWEITZER, adopting Schweitzer's (1974) recommendation that the form-genus *Cupressinocladus* Seward be applied to vegetative material when reproductive organs are not present. The same kind of foliage, with attached cones, was placed in a new genus and species, *Mesocyparis borealis,* from the Paleocene of Ravenscrag, Saskatchewan (McIver and Basinger 1987). A short time later, Golovneva (1988) published a similar new genus and species as *Microconium beringianum.* In their subsequent survey of Cretaceous and Tertiary *Thuja*-like remains, McIver and Basinger (1989, p. 1911) considered oppositely branching foliage as *Chamaecyparis interruptus* (NEWBERRY) SCHWEITZER, but it seems likely that these represent fragments of *Mesocyparis*. Under the philosophy that vegetative and reproductive branches be treated separately, the appropriate names for this taxon are *Cupressinocladus interruptus* (NEWBERRY) SCHWEITZER, and (if cones are attached) *Mesocyparis borealis* MCIVER et BASINGER. The reason for this is that the same kind of foliage could be produced by more than one genus of Cupressaceae, and is thus placed in a catchall fossil-genus. The presence of cones permits a better resolved identification.

Angiosperms

Nymphaeaceae

Brown included *Cabomba inermis* (NEWBERRY) HOLLICK, *Nymphaea leei* (KNOWLTON) R. W. BROWN, *Nymphaea pulchella* (KNOWLTON) R. W. BROWN, and *Paleonuphar hesperium* R. W. BROWN among the water lilies cited from the Paleocene floras. The leaves assigned to *Nyphaea* appear to be correctly identified. The remains assigned to *Cabomba* are dichotomously branched unwebbed structures that correspond closely to roots known for the non-nymphaealean extinct genus, *Quereuxia*. The extinct genus *Paranymphaea* was subsequently transferred to Polygonaceae by McIver and Basinger (1993; see below).

Magnoliaceae

"Bauhinia" wyomingana R. W. BROWN. Although bilobed with a laminar outline similar to that of *Bauhinia*, the illustrated specimen differs in venation (pinnate, rather than actinodromous) and lacks the petiole morphology expected for that genus, and other legumes. It appears, instead to represent a leaf of Magnoliaceae, cf. *Liriodendron*. It is closely similar to the leaf known as *Liriodendron iijimae* TANAI from the upper Cretaceous (Senonian) of Japan (Tanai 1979). Kirk Johnson (1996, in his discussion of another taxon, *Liriodendrites bradacii* K. JOHNSON) mentioned that more specimens of this kind occur in the Great Divide Basin. "*B." wyomingiana* is represented only by the single specimen illustrated by Brown, and the upper fragment is missing from the type collection, so that only the basal part of the illustrated specimen is available for continued study. The original site for this species is no longer accessible due to completed mining activity.

Although Brown (1962) treated several species as *Magnolia*, the leaf architectural characters of extant *Magnolia* are not unique to that genus or family. Entire-margined pinnately veined leaves occur in many families so the assignment of *Magnolia* is based on general similarity rather than on diagnostic characters.

Lauraceae

Leaves of Lauraceae are entire-margined with pinnate secondaries that in some genera can be arranged with a basal or suprabasal pair of acrodromous secondaries. Similar venation can occur elsewhere among angiosperms, for example in Araliaceae, Hamamelidaceae, and Menispermaceae. When cuticle is preserved documenting paracytic stomata and oil cells, the affinities with Lauraceae can be substantiated, but cuticle was not examined for the species investigated by Brown. The familial and generic assignments for these taxa need verification: *Cinnamomum sezannense* WATELET, *Laurophyllum caudatum* (KNOWLTON) R. W. BROWN; *Laurophyllum perseanum* R. W. BROWN; *Laurus socialis* LESQUEREUX; *Lindera obtusata* (WARD) R. W. BROWN; *Persea brossiana* LESQUEREUX; and *Sassafras thermale* (LESQUEREUX) R. W. BROWN.

"Melastomites" montanensis R. W. BROWN. Brown (1962) noted that the leaves he attributed to *Melastomites*

Unger are similar to those of *Sassafras* and *Cinnamomum* (Lauraceae) as well as with *Tococa* of Melastomataceae. The leaves do not, however, show the strongly impressed percurrent tertiaries typical of *Tococa* and other Melastomataceae. Brown indicated that "surfaces of the better preserved leaves display minute dots, about 300 per sq cm, that were probably glandular". These might represent the hardened contents of oil cells common in Lauraceae.

"Artocarpus" lessigiana (Lesquereux) Knowlton. Brown (1962) provided a helpful synonymy of the previously published occurrences of this species. The leaves are large, and deeply pinnately lobed with deep, rounded intralobal sinuses, superficially resembling extant *Artocarpus*. Kirk Johnson (pers. comm. 2014) noted: "We dug hundreds of "*Artocarpus*" leaqves in the Denver Basin, most from the first 2–3 million years of the Paleocene. They could be quite large, up to 20 inches long so they continue the resemblance to *Artocarpus*, but lack all of the distinctive venation of Moraceae. At Castle Rock, we also collected leaves that were strikingly similar to true *Sassafras* in their morphology and venation. Close comparison of the big lobed "*Arctocarpus*" with the *Sassafras* suggested affinity to the Lauraceae." Garland Upchurch studied the cuticles of similar specimens from the Denver and Raton Basin and also indicated lauralean affinities (Kaufmann et al. 1990; Upchurch and Wolfe 1987).

Chloranthaceae

"Myrtophyllum" torreyi (Lesquereux) Dorf

This species is a rare element of the Paleocene flora. In their discussion of the mid-Cretaceous chloranthaceous species, *Crassidenticulum decurrens* (Lesquereux) Upchurch et Dilcher, Upchurch and Dilcher (1990) noted that "*C. decurrens*" closely resembles "*Myrtophyllum*" *torreyi* (Lesquereux) Dorf, such as specimens photographically illustrated by Brown (1962, pl. 50, figs 1–4, 7–9), in nearly all preserved features but differs in having secondary veins that arch apically and directly enter the teeth, rather than connect with an intramarginal vein. Thus, while the two species may be congeneric, they are distinct." Accordingly, the leaves of *M. torreyi* may also represent Chloranthaceae. The genus *Myrtophyllum* Heer (1869) (non Turcz.), based on a type from the Cretaceous of Bohemia, is inappropriate to accommodate this species.

Monocots

Monocots in the Paleocene of the Rocky Mountain and Great Plains region include palms, gingers, and aquatic araceous representatives. The palms include leaves named *Chamaedorea danae* (Lesquereux) Berry, *Paloreodoxites plicatus* (Lesquereux) Knowlton [Fossil genus of Knowlton, accepted by Read and Hickey 1972], *Sabal grayana* Lesquereux, *S. imperialis* Dawson, *S. powellii* Newberry [= *Sabalites powellii* (Newberry) E.W. Berry sensu Read and Hickey], *Thrinax dorfii* R. W. Brown [= *Palmacites dorfii* (R.W. Brown) Read et Hickey].

Araceae

Limnobiophyllum scutatum (Dawson) Krassilov

Brown (1962) agreed with the concept of Hantke (1954) that the fossil species, *Hydromystria expansa* (Heer) Hantke included two morphologically distinct kinds of foliage, firstly the thin, orbicular peltate leaves that Dawson had called *Spirodela scutata* and secondly a thick kidney-shaped structure interpreted as float leaves which were later called *Porosia verrucosa* Hickey (Hickey 1977, emended by Manchester and Kodrul 2014). The orbicular, thin, leaves were subsequently reassigned to a new extinct genus, *Limnobiophyllum* by Krassilov (1973 1976) who recognized the same species in the Paleocene of E Asia). *Limnobiophyllum scutatum* (Dawson) Krassilov was proven to represent Araceae-Lemnaceae based on specimens with attached flowers containing stamens with pollen (Stockey et al. 1997), whereas the *Porosia* structures, mentioned again below, have turned out to represent unrelated single-seeded dicotyledonous fruits of possible rutaceous affinity as revealed by permineralized specimens (Manchester and Kodrul 2014).

Zingiberales

The leaf attributed to *Canna? magnifolia* Knowlton (Brown 1962, pl. 15, fig. 2) was transferred to *Zingiberopsis isonervosa* Hickey by Hickey and Petersen (1978), and considered to represent Zingiberaceae. *Zingiberites dubius* Lesquereux is based on a fragmentary specimen from the Denver Formation was that reexamined by Brown, but no additional Paleocene specimens have been recovered for more detailed evaluation.

Ensete goldianum (Lesquereux) comb. nov.

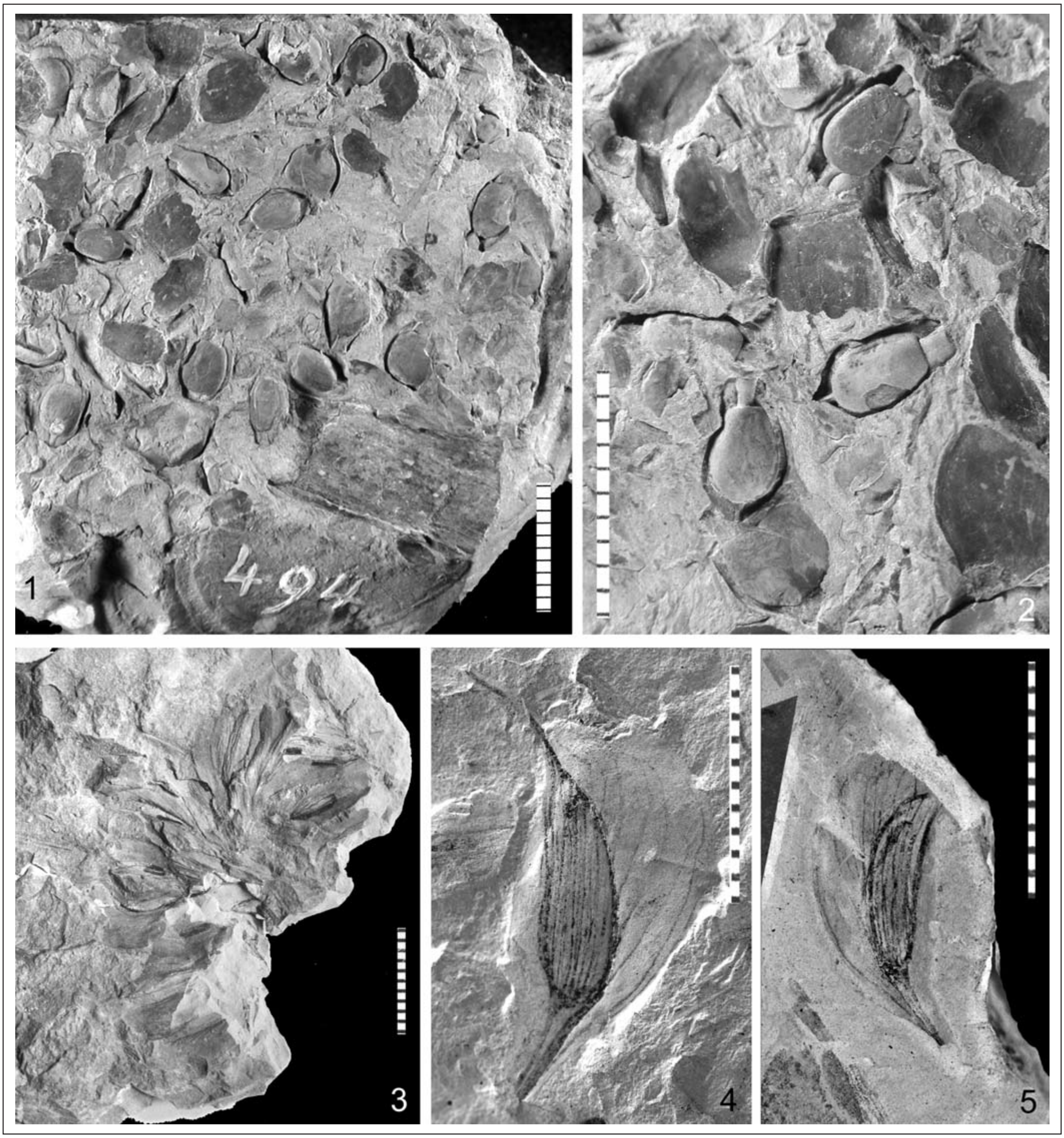
Text-figs 3.1, 3.2

1878 *Viburnum goldianum* Lesquereux, Rept. U. S. Geol. Surv. Terr., 7, p. 227, pl. 60, figs 2, 2a-c (holotype and basionym).

This species, based on a grouping of seed impressions preserving both internal and external details, also represents Zingiberales. These smooth, subelliptical seeds with a truncate apex show an opercular collar similar to the configuration in extant and fossil *Ensete*. Although the chalazal chamber is not preserved in the casts, there is an axial perforation of the seedcoat at the base similar to that seen in extant *Ensete*. These resemble those described from better-preserved permineralized specimens from the Eocene of Oregon (Manchester and Kress 1993).

Other monocots

Haemanthophyllum sp. 3. sensu Golovneva (1997). Brown (1962) assigned leaves to *Alismaphyllites grandifolius* (Penhallow) R. W. Brown, using the generic *Alismaphyllites* Knowlton (1917) based on specimens from the Raton Formation near Trinidad, Colorado (Knowlton 1917, p. 286, pI. 55, fig. 1). The original specimen of *Alisma-*



Text-fig. 3. 1, 2. *Ensete goldianum* (LESQUEREUX) comb. nov, Holotype, USNM 494, Golden Colorado. 1. Numerous seeds on a slab. 2. Detail of seed molds and casts. 3-5 "*Sagittaria*" *megasperma* R. W. BROWN. 3. Infructescence head. USNM 167488, lectotype selected by Watt 1971. 4. Isolated fruit showing veins of wing, and longitudinally striate central body and single style, USNM 313282, 5. Additional isolated fruit, USNM 313283. Images 4, 5 light-dark inverted. Scale = 1 cm.

phyllites crassifolium KNOWLTON (1917), the type species of *Alismaphyllites*, was a stem with three attached broad monotyledonous leaves, but the venation is not sufficiently preserved for detailed comparison with the leaves later assigned to *Haemanthophyllum*. Golovneva (1997) designated the illustrated specimens of Brown (1962) as "*Haemanthophyllum* sp. 3." Golovneva (1997) studied various extant families with foliage similar to *Haemanthophyllum*, e.g., Alismataceae, Potamogetonaceae and Aponogetonaceae. She concluded that Aponogetonaceae was more probable as to its affinities, but, also stated "The most similar to *Haemanthophyllum*, the alismatacean genus *Caldesia,* has smaller leaves." So far, the reproductive organs of this plant remain unknown.

"Sagittaria" megasperma R. W. BROWN (Text-figs 3.3–3.5) is based on globose infructescences of winged fruits. The distinctive leaves of *Sagittaria* have not been observed. The winged fruits show a single style and asymmetrical to

less commonly symmetrical wing development. The seed body is covered by closely spaced longitudinal veins. The wings have longitudinal veins unlike modern species of *Sagittaria*, so the affinities of this distinctive plant are uncertain.

The globose infructescences that Brown (1962) referred to *Sparganium antiquum* (Newberry) Berry are not monocots but instead represent Platanaceae. They were found at the same locality (USGS 2416) as *Macginitiea nobilis*.

Ceratophyllaceae

Ceratophyllum furcatispinum Herendeen, Les et Dilcher

Among the unidentified specimens curated in the USGS collections by Brown, but not included in his publication, were spiny fruits subsequently identified as those of *Ceratophyllum* (Herendeen et al 1990). Several specimens of *Ceratophyllum furcatispinum* Herendeen, Les et Dilcher were cited, all from a single locality in Montana.

Menispermaceae

Fruits found in Paleocene strata of North Dakota and Wyoming subsequent to the publication of Brown's monograph confirm the presence of Menispermaceae. Horseshoe-shaped endocarps have been described from Almont, North Dakota, as cf. *Canticocculus* Chandler (Crane et al. 1990, fig. 5A–C) and as *Palaeoluna* sp. from Linch, Wyoming (Fig. 17 in Herrera et al. 2011). Corresponding leaves remain elusive. Those that Hickey (1977) regarded as Menispermaceae, i.e., "*Cocculus*" *flabella* (Newberry) J. Wolfe and *Menispermites parvareolatus* Hickey, were subsequently transferred to *Zizyphoides* Seward et Conway, and probably belonging to same plant as *Nordenskioeldia* fruits (Crane et al. 1991).

Sabiaceae

The presence of Sabiaceae is confirmed on the basis of distinctive well preserved endocarps of *Meliosma rostellata* (Lesquereux) Crane, Manchester et Dilcher at Almont, North Dakota, and Golden, Colorado. The corresponding leaves, however, remain uncertain. *Meliosma* today can have either serrate or entire-margined leaves, and pinnate venation with well organized percurrent tertiary venation and orthogonal higher order venation, and such leaves are known from the Eocene of Oregon (Chaney and Sanborn 1933, Manchester 1981). Hickey (1977) applied the name *Meliosma longifolia* (Heer) Hickey to some of the same leaves that had earlier been called *Quercus sullyi* by Brown (1962); however, the specimens illustrated by Hickey, and most of those treated as *Q. sullyi* by Brown, instead appear to represent the extinct genus *Dyrana* Golovneva (1994, Budantsev and Golovneva 2009). The rounded sinuses and glandular (rather than spinose) teeth may indicate that they represent Platanaceae, rather than Sabiaceae.

Nelumbonaceae

Among the several aquatic angiosperms recognized by Brown, *Nelumbium montanum* R. W. Brown, *Nelumbium tenuifolium* Lesquereux, and *Paleonelumbo macroloba* Knowlton are peltate leaves that appear to be related to extant *Nelumbo*. An excellent specimen of *Paleonelumbo macroloba* was figured by Barclay et al. (2003, figs 9a–c).

Nelumbago montanum (R. W. Brown) McIver et Basinger

Nelumbium montanum R. W. Brown was transferred to a new genus *Nelumbago* by McIver and Basinger (1993) who indicated that *Nelumbium* was inappropriate because it is simply an orthographic variation of *Nelumbo*. They illustrated an additional nice leaf from the Ravenscrag Formation of Saskatchewan, Canada. McIver and Basinger (1993) did not, however, indicate any nomenclatural change for *Nelumbium tenuifolium* Lesquereux, and they specifically excluded that species from the synonymy of *N. montanum*. Brown (1962, p 69) indicated that "there appears to be a close relationship between [*N. tenuifolium*] and *Paleonelumbo macroloba* Knowlton, and the former may be merely a variant of the latter."

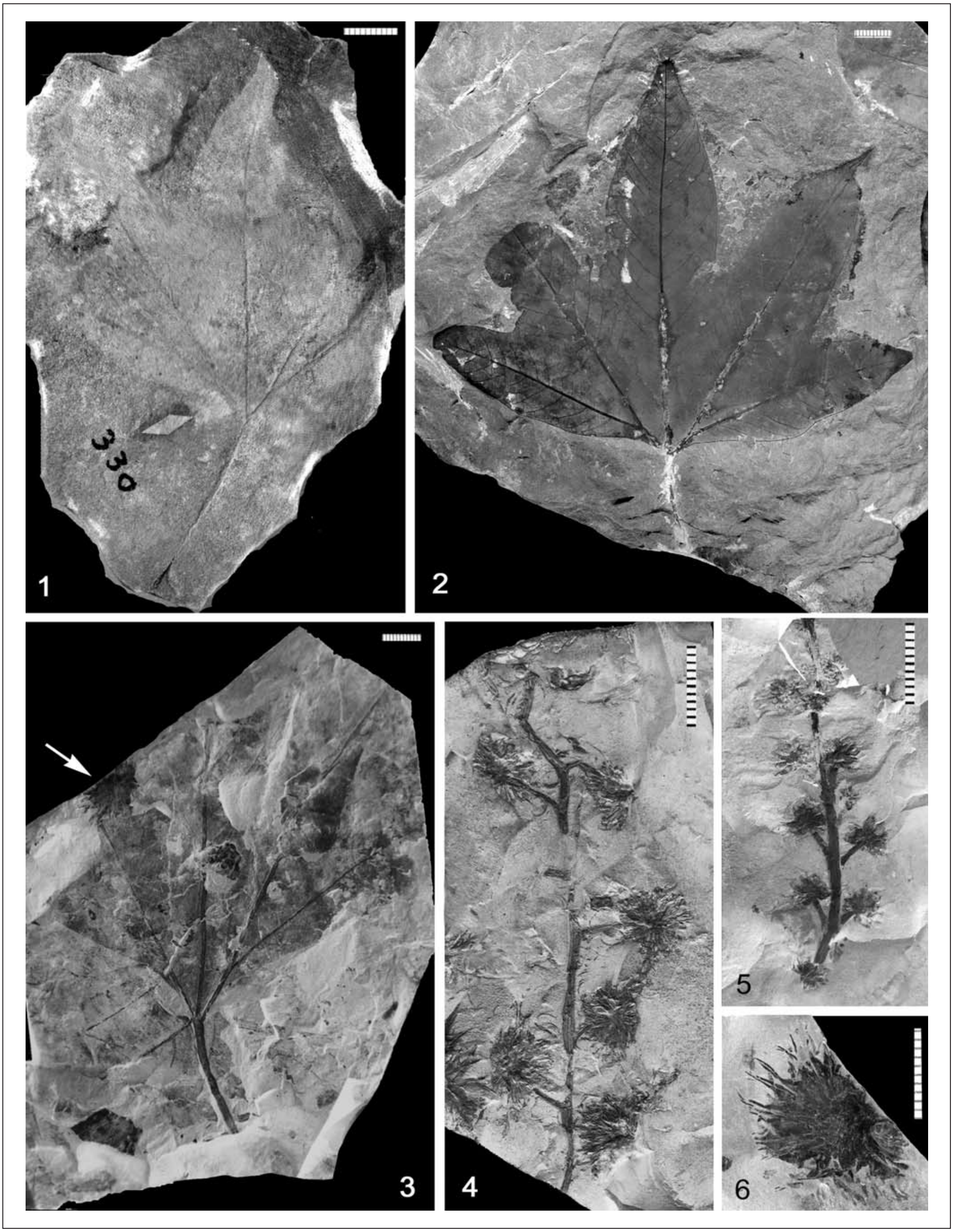
Platanaceae

Brown recognized only two species of Platanaceae, which he referred to as *Platanus nobilis* Newberry and *P. raynoldsii* Newberry. Subsequent studies indicate that the sycamore/plane tree family was diverse in the Paleocene of the Rocky Mountains and Great Plains region with at least six species readily distinguishable on the basis of foliar characters.

Macginitiea J. Wolfe et Wehr

Leaves of the extinct genus *Macginitiea* are distinguished from those of extant *Platanus* by a narrower angle between adjacent primary veins, and a chevron pattern formed by interconnected secondary veins between adjacent primaries in the lower part of the lamina (Manchester 1986, Wolfe and Wehr 1987), and are consistently associated with infructescences that differ from those of modern Platanaceae by the lack of dispersal hairs on the fruits (*Macginicarpa*) and stamens dispersed in floral units of five, adhering by their elongate connectives (*Macginistemon*; Manchester 1978). The stamen units illustrated as "calyx of a flower" by Brown (1962, pl. 68, fig. 27–29) correspond to *Macginistemon mikanoides* (MacGinitie) Manchester (1978), and probably derive from the same trees as *Macginitiea*.

Brown (1962) considered both 3- and 5-lobed leaves to represent a single species, *Platanus nobilis* Newberry. However, it seems probable that the 5- and 3-lobed populations represent distinct species, because many localities are greatly dominated by, or exclusively represented by, one kind or the other. Trilobate leaves are lacking from some of the other species of *Macginitiea*, e.g., *M. angustiloba* and *M. whitneyi* from the Eocene of California and Oregon (Manchester 1986).



Text-fig. 4. Platanaceae 1–3. *Macginitiea gracilis* (LESQUEREUX) J. WOLFE et WEHR leaves and associated reproductive structures 1. Holotype of *Aralia gracilis* LESQUEREUX from Bridger Pass, Wyoming, USNM 330. 2. Specimen showing the typical configuration of five lobes, Killpecker Creek flora, Wyoming. UF 18126-13242. 3. Silicified *M. gracilis* leaf from Almont, North Dakota; arrow indicates adjacent *Macginicarpa* infructescence, UF 15722-29202a. 4. *Macginicarpa* infructescence from Almont, UF15722-35493. 5. *Platananthus* sp., Almont, UF 15722-62019. 6. *Macginicarpa glabra* MANCHESTER infructescence, enlarged from fig. 3, UF 15722-29202b. Specimens in figs 3-6 collected and donated by John Curtis. Scales = 1 cm. Images 3–6 light-dark inverted.

Macginitiea gracilis (Lesquereux) J. Wolfe et Wehr

Text-figs 4.1–4.3

Macginitiea gracilis is the type species of *Macginitiea* as designated by Wolfe and Wehr (1987), based on a deeply 5-lobed specimen collected by Hayden from Bridgers Pass, Wyoming from a fine sandstone of probable Maastrichtian age. The type specimen (Text-fig. 4.1) was initially named *Liquidambar gracilis* (Lesquereux 1872) and later figured as *Aralia*? *gracilis* Lesquereux (1878, pl. 39, fig. 1). Wolfe and Wehr (1987) applied this same epithet to specimens from the Eocene of Republic, Washington. Among the numerous specimens from the Clarkforkian Killpecker Creek flora at Rock Springs, Wyoming (Wilf 2002), all are deeply five-lobed, while those from the Tiffanian Joffre Bridge site, Alberta (discussed below; Pigg and Stockey 1991) are three-lobed. Among the many Paleocene leaves that Brown (1962) included as *Platanus nobilis* Newberry, those with five prominent digitate lobes are now treated as *M. gracilis*, while those with three lobes are treated as *Macginitiea nobilis*. The leaves vary from entire to serrate, have palinactinodromous venation, and usually long petioles with expanded bases.

Macginitiea nobilis (Newberry) comb. nov.

Text-figs 5.1–5.3

1868 *Platanus nobilis* Newberry, Lyceum Nat. Hist. New York Ann., 9, p. 67. (basionym).

1898 *Platanus nobilis* Newberry, U. S. Geol. Surv. Monogr., 35, p. 106, pl. 34.

Lectotype, here designated: USNM 1070. Originally figured by Newberry (1898, pl. 34), here refigured as Text-fig 5.2, from near Fort Clark, North Dakota.

The synonymies of *Platanus nobilis* provided by Brown (1962) and Hickey (1977) included both trilobate and pentalobate leaves but I reserve this epithet for primarily 3-lobed leaves of *Macginitiea*, whereas the deeply 5-lobed leaves mentioned above belong to *M. gracilis*. Among the originally described specimens of *M. nobilis* from near Fort Clarke, North Dakota, some have only three lobes, and others have five lobes, of which the middle three greatly dominate (Text-fig. 5.1, 5.2).

The Paleocene (Tiffanian) flora of Joffre Bridge, Alberta, is particularly informative, showing a range in leaf morphology for this species, including seedlings documenting early leaf development, as well as mature, trilobate leaves (Pigg and Stockey 1991). Lobes of the lamina vary from mostly entire-margined, to mostly serrate, and a basilaminar lobe extending proximally from the junction of petiole and lamina, is usually absent, but sometimes present (e.g., Pigg and Stockey 1991, pl. 1, fig. 2; Brown 1962, pl. 29, figs 1, 3). Pigg and Stockey (1991) refrained from naming their foliage, but Maslova (2008) concluded that it conformed to *P. nobilis* and made the argument that this species should belong to *Macginitiea*: "on the one hand, morphologically similar leaves of *Macginitiea* and *Platanus nobilis* (which include transitional forms) are associated with the same reproductive structures and, on the other hand, leaves of *P. nobilis*, which are assigned to the extant genus, co-occur with inflorescences and infructescences essentially distinguished from those of the plane tree. This probably supports the assignment of these leaf remains to the genus *Macginitiea*; however, this necessitates further detailed examination." (Maslova 2008, p. 1399). The narrow angle between adjacent primary veins also supports the assignment to *Macginitiea*. I hereby emend the generic diagnosis of *Macginitiea* to indicate that the number of lobes on the lamina may vary from 3 to 9. The number of lobes was not specified in the original diagnosis of Wolfe and Wehr (p. 224, 225 in Manchester 1986).

Also present at the Joffre Bridge locality are nearly complete staminate axes with up to 12 pedicellate heads (*Platananthus speirsae* Pigg et Stockey) having long-pedunculate heads with well preserved tricolpate reticulate pollen closely matching extant *Platanus* pollen morphologically in both SEM and TEM (Pigg and Stockey 1991, pl. 4, 5), plus fruiting axes bearing at least 7 pedicellate heads (*Macginicarpa manchesteri* Pigg et Stockey). The correlation between *Macginitiea* foliage, *Macginicarpa* infructescences and *Platananthus* inflorescences was also found at Eocene locations in California, Oregon, and Wyoming (Manchester 1986).

Macginicarpa fruiting material consists of a racemose axis bearing numerous pedunculate, globose heads (Text-fig. 4.4), each composed of numerous florets of five apocarpous fruits each (Text-fig. 4.6), differing from extant *Platanus* by the lack of dispersal hairs on the individual fruits and by a prominent perianth (Manchester 1986). In addition, the staminate flowers, with similarly well-developed perianth, had the unique characteristic that the five stamens of each floret were apically connected by intertwining connective hairs, resulting in the shedding of 5-stamen units, in contrast to the shedding of single stamens in other genera of the family (Manchester 1986). Such dispersed stamen units, now called *Macginistemon mikanoides* (MacGinitie) Manchester, were figured from Paleocene sites by Brown (1962, pl. 68, figs 27–29) as "pedicellate flowers or fruits," and by Pigg and Stockey (1991, pl. 4, figs 8, 9) as "isolated group of stamens," and "disagregating stamen inflorescence."

Staminate inflorescences earlier called *Sparganium stygium* Heer from Seven Mile Creek, Montana (Text-fig. 5.4; Ward 1887, pl. 3, fig. 7, showing at least ten heads on a raceme) also represent *Platananthus speirsae*. From the same site, the specimens that Brown (1962, pl 14, fig. 5) called *Sparganium antiquum* (Newberry) Berry correspond to *Macginicarpa manchesteri* Pigg et Stockey (1991). The same location produced mainly large trilobate leaves of the *M. nobilis* kind (Pl. 41, fig. 1 of Ward 1885b).

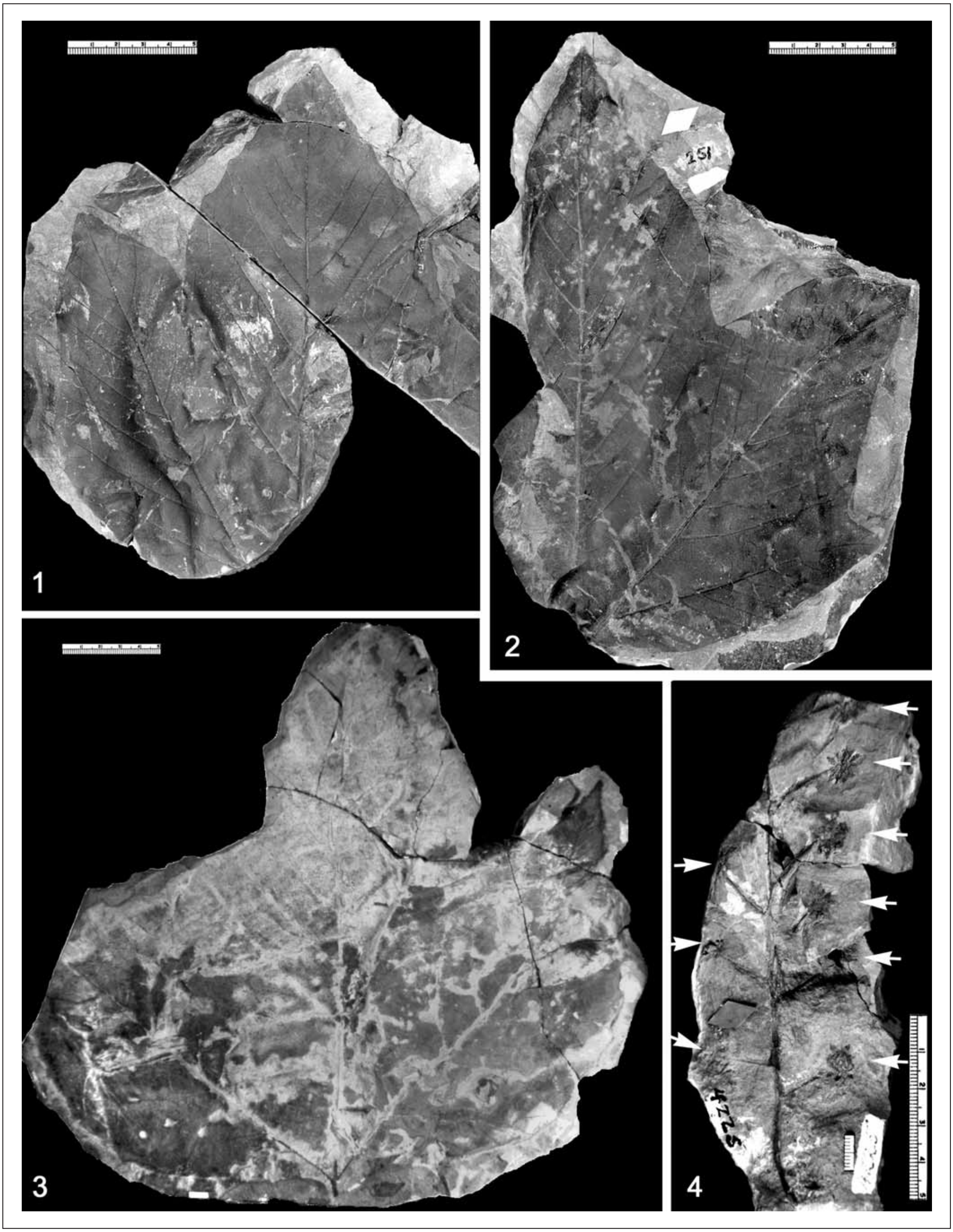
Platanites raynoldsii (Newberry) comb. nov.

Text-figs 6.1–6.4

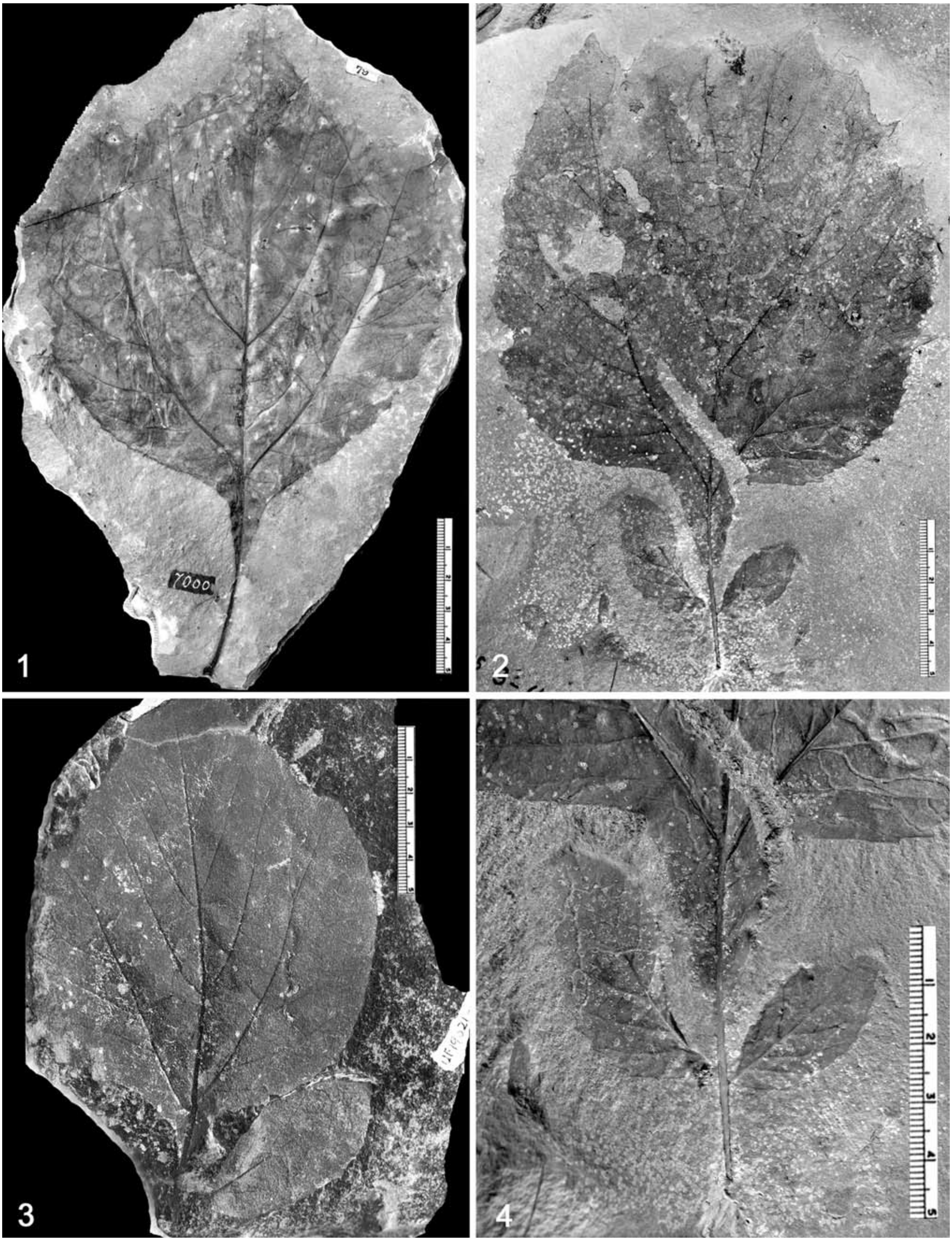
1868 *Platanus raynoldsi* Newberry, Lyceum Nat. Hist. New York Ann., 9, p. 69 (basionym); 1898 *Platanus raynoldsi* Newberry, U. S. Geol. Surv. Monogr., 35, p. 109, pl. 35.

1993 *Platanites canadensis* McIver et Basinger, p. 38, pl. 23, pl. 24, figs 1–4.

2008 *Ettingshausenia raynoldsii* (Newberry) Moiseeva, p. 324 [excluding all of the Asian figured specimens].



Text-fig. 5. Platanaceae 1–3. *Macginitiea nobilis* (NEWBERRY) comb. nov. 1. This specimen is labeled as corresponding to Newberry 1898, pl. 50, fig. 1 although it does not match the published drawing exactly. From near Fort Clark, North Dakota, USNM 6964. 2. Lectotype from Newberry (1898, pl. 34), from near Fort Clark, North Dakota; composite picture assembled from images of both counterparts. USNM 1070. 3. Trilobed leaf from Seven Mile Creek, Montana (orig. figured as *Platanus nobilis* NEWBERRY by Ward 1886, pl. 41, fig. 1). USNM 4093. 4. *Platananthus speirsae* PIGG et STOCKEY axis with at least 9 attached pedunculate staminate inflorescences (arrows), Seven Mile Creek, Montana (orig. Ward 1885b, pl. 32, fig. 7), USNM 4225. Scale bars 5 cm.



Text-fig. 6. Platanaceae 1–3. *Platanites raynoldsii* (Newberry) comb. nov. 1. Holotype of *Platanus raynoldsii* Newberry (1868, 1898), Banks of the Yellowstone River, Montana, USNM 7000. 2. Holotype of *Platanites canadensis* McIver et Basinger (1993), here treated as synonym of *P. raynoldsii*, showing clearly the position of the lateral leaflets, US 3-66, Ravenscrag Formation, Saskatchewan, Canada. 3. Specimen from Yellowstone Bridge, Miles City, Montana. UF19021-39390. 4. Detail from fig. 2. Scale bars 5 cm.

McIver and Basinger (1993) illustrated a beautifully complete compound leaf of *Platanites* from the Paleocene Ravenscrag Formation of southern Saskatchewan, Canada, showing a pair of lateral elliptical leaves attached to the "petiole" of a leaf matching architecturally to the holotype of *Platanus raynoldsii* (reillustrated here, Text-fig. 6.2). Hence, the petiole of *P. raynoldsii* is actually the rachis of a compound leaf. Because Newberry's species has long been considered to be a simple leaf, as expected for extant *Platanus*, McIver and Basinger (1993) considered the the Ravenscrag material to be distinct and described it as a new species, *Platanites canadensis.* They used the generic name based on similar compound platanaceous leaves from Scotland (*P. hebridicus* FORBES; Crane et al. 1988).

Close comparison between Newberry's holotype specimen of *P. raynoldsii* (Text-fig. 6.1) and the holotype of *P. canadensis* (Text-fig. 6.2) indicates that they are architecturally identical, leading to the conclusion that they are conspecific. Other compound leaves of *P. raynoldsii* have been recovered occasionally in the Late Cretaceous and Paleocene of North America (e.g., specimens figured by Knowlton 1930, pl 45, fig. 10 as *Negundo decurrens* LESQUEREUX, and by Ellis et al. 2003, fig. 9a as *Platanites marginata* (LESQUEREUX) K. JOHNSON, but usually the petiole/rachis lacks lateral leaflets, giving appearance that "they leaves" were simple. We do not know whether this is due to deciduousness and/or damage prior to deposition, or if *P. raynoldsii* might have been variable, producing both simple and compound leaves on the same individual (perhaps a difference between seedling and mature leaves, for example). Nevertheless, the tendency to produce compound leaves distinguishes this species from all extant species of *Platanus*, and justifies its assignment to the extinct genus, *Platanites*.

Prior to the realization that this species represents a compound-leaved plant, Brown (1962), adopted the name *Platanus raynoldsii* (and included Newberry's *P. haydeni* in synonymy), for most weakly trilobate platanaceous leaves from the Paleocene of the Rocky Mountains and Great Plains region and provided a thorough synonymy of earlier published specimens from the works of Newberry, Lesquereux, Ward and Knowlton. The same epithet was applied to similar laminae from the late Cretaceous and Paleocene of Far Eastern Russia (Krassilov 1976). Based mainly on her investigations of the far eastern Russian material, Moiseeva (2008) established a new combination, *Ettingshausenia raynoldsii*, for the species, applying the fossil-genus name *Ettingshausenia* STIEHLER (1857). However, *Ettingshausenia* is believed to be a simple-leaved genus. It is possible that the genus *Ettingshausenia* is appropriately applied to the Asian fossils, but a different specific epithet is needed from that applied to the North American species considered here. It is not appropriate to use the name *Ettingshausenia* in the case of the type material of *P. raynoldsii* NEWBERRY, which conforms instead to *Platanites* FORBES.

Platanites marginata (LESQUEREUX) K. JOHNSON

1873 *Viburnum marginatum* LESQUEREUX, p. 395; 1878 p. 223, pl 37, fig. 11, pl. 38, figs 1–4. (basionym).

For synonymy see Johnson (1996).

The compound-leaved plant formerly called *Cissus marginata* (LESQUEREUX) BROWN was recombined as *Platanites marginata* (LESQUEREUX) K. JOHNSON (1996). In addition to the complete compound-leaved specimens illustrated by Brown (1962), excellent examples are known from the uppermost Cretaceous Hell Creek Formation (Johnson 1996). Brown (1962, p. 65) noted "The leaves of *P. raynoldsii* are in general not strongly lobed, and they resemble the terminal leaflets of *Cissus marginata* (LESQUEREUX) BROWN [here treated as *Platanites marginata*] so closely that separation of the two species, especially when they are poorly preserved, is virtually impossible". It is possible that *P. marginata* and *P. raynoldsii* are conspecific–if so, then the older epithet, *raynoldsii,* takes priority. However, the type specimen of *Platanites marginata* have a narrower angle between primary and secondary veins than is typical of *P. raynoldsii.*

Although compound leaves do not occur in extant *Platanus,* some of the extinct Cretaceous and Tertiary genera of Platanaceae were indeed compound. *Platanites* is recognized by its trifoliately compound leaves. Extinction of *Platanites* apparently occurred sometime after the middle Eocene; the youngest known occurrences are from the Eocene of Kisinger Lakes, Wyoming (MacGinitie 1974, pl. 14, fig. 1), and John Day Gulch, Oregon (UF 27869, 27870, loc. 265). A related extinct genus, *Erlingdorfia,* with more distinct lobing of the trilobed terminal leaflet and markedly asymmetrical bilobed lateral leaflets, is apparently confined to the Late Cretaceous (Johnson 1996).

"Platanus" bella (HEER) Z. KVAČEK, MANCHESTER et S.X. GUO

In addition to the above platanaceous taxa recognized by Brown (1962), Hickey (1980) found compound leaves that he referred to as *Debeya* sp. from the Paleocene of Montana. KVAČEK et al. (2001) showed that these trifoliate leaves match, in epidermal as well as architectural characters, those from the Paleocene of Greenland and China known as *Platanus bella*. Like *Platanites*, the leaves were compound, but in this species the leaflets were elliptical, without any lobation. Thus they resemble the lamina shape of extant *Platanus kerrii*, but that species, like all extant *Platanus* species, has only simple leaves. Cuticular investigations have revealed epidermal anatomy in this species conforming with extant *Platanus* (Kvaček et al. 2001). Although Kvaček et al. placed the leaves in an extinct subgenus of *Platanus*, named *Glandulosa*, it can be argued, based on the current concept of ranks within the family, including *Macginitiea*, and *Platanites* as genera distinct from *Platanus*, that this taxon also requires separate generic status. Kvaček et al. (2001) explained, however, that names previously considered, including *Dewalquea* and *Debeya* would be inappropriate for this species due to differences from the type material.

Dyrana flexuosa (NEWBERRY) GOLOVNEVA

This species is based on leaves found initially in the late Paleocene or early Eocene Chuckanut Formation of coastal Washington, and subsequently recognized to have been distributed in the Rocky Mountain region, treated as *Dicotylophyllum flexuosa* (NEWBERRY) J. WOLFE (1966). Golovneva (1994b) established the genus *Dyrana* based on specimens from the Paleogene of the Koryak Highlands of

NE Russia, and subsequently transferred the North American species to the same genus (Golovneva, L. B. 2000, Budantsev and Golovneva 2009). Budantsev and Golovneva also illustrated numerous examples of *D. flexuosa* from the early Paleocene Barensburg flora of Spitsbergen. The leaves are elliptical to ovate, with pinnate craspedodromous secondary veins and teeth with rounded sinuses. As mentioned above, these leaves were treated as *Quercus sullyi* NEWBERRY by Brown (1962) and *Meliosma longifolia* (HEER) HICKEY 1977. The attribution to Platanaceae is supported by glandular teeth with rounded sinuses, petioles with expanded bases, and the orthogonal pattern of higher order venation, but epidermal characters remain unknown and associated reproductive structures have not been clearly demonstrated.

Trochodendraceae

Nordenskioeldia borealis HEER

Nordenskioeldia borealis HEER (Brown 1962, pl. 67, figs 13, 45) was widely distributed in the late Cretaceous and Paleocene of the Northern Hemisphere and is represented at numerous localities of the Rocky Mountains and Great Plains region. This genus and species was reviewed in detail by Crane et al. (1991) and Wang et al. (2009). It is known from infructescences, whole fruits, dispersed fruitlets, and shed seeds. The seeds, which were figured and described as "seeds with papillose inner surface" by Brown (1962, Pl. 67, figs 9, 10, 14–16, 22, 23), are known to belong to this extinct genus because one is shown dispersing from a fruitlet in figs 28, 29 of Crane et al. (1991), and they are preserved *in situ* with fruits of the silicified specimens from Almont, North Dakota (Crane et al. 1991, figs 16, 28). *Nordenskioeldia* associates with the same kind of extinct leaf in the Late Cretaceous to Paleocene of the Northern Hemisphere, and even in the Miocene refugial populations (Manchester et al. 1991). Leaves of *Zizyphoides* SEWARD et CONWAY in the Paleocene of North America have been called *Z. flabella* (NEWBERRY) CRANE, MANCHESTER et DILCHER; the holotype is from the Chuckanut Formation of west coastal Washington.

Cercidiphyllaceae

Text-figs 7, 8

Brown (1939b, 1962) called attention to the co-occurrence of leaves, fruits, and winged seeds resembling extant *Cercidiphyllum* at numerous Paleocene and Eocene sites in North America. He assigned the fossils to the extant genus, collectively as *Cercidiphyllum arcticum* (HEER) R. W. BROWN although he noted that the fruits differ from those of extant species in the genus in having more prominent transverse and diagonal striations, and are borne on racemose rather than clustered inflorescences (e.g., Text-fig. 7.4). In a comparative study of similar leaves from the Paleocene of England, Crane (1984) applied separate fossil-generic names, *Trochodendroides* BERRY for leaves and *Nyssidium* HEER for the fruits. The same kind of infructescences were documented in detail from the Paleocene of Asia (Feng et al. 2000). The Joffre Bridge locality of Alberta yielded such leaves, fruits, and seeds in association with both pistillate and staminate inflorescences, twigs showing phyllotaxy, and young seedlings, providing an especially complete reconstruction of the plant named *Joffrea spiersii* (Crane and Stockey 1985).

Brown had inadvertently included multiple kinds of leaves in his concept of fossil *Cercidiphyllum arcticum* foliage (Hickey 1977). Some, usually with evenly serrate margins, belong to *Trochodendroides* and presumably correspond, as he surmised, with the fruits he described and illustrated (ie., *Nyssidium arcticum* (HEER) ILJINSKAYA sensu Crane 1984). Other leaves (e.g., Brown 1930b, plate 53, figs 3–5) with irregular crenations and/or sometimes entire-margins are consistently found in co-occurrence with fruits of another extinct fruit genus, *Nordenskioeldia* HEER (Crane et al. 1991). These were subsequently treated as "*Cocculus" flabella* (NEWBERRY) J. WOLFE (1966), *Menispermites parvareolatus* HICKEY (1977), and then, using the oldest available generic name, collectively transferred to *Zizyphoides flabella* (NEWBERRY) CRANE, MANCHESTER et DILCHER (1991). These leaves are discussed herein along with *Nordenskioeldia borealis*. Although the organs have not been found in mutual attachment, they co-occur at numerous sites of late Cretaceous and Paleocene age throughout the Northern Hemisphere, and even in Miocene refugial populations (Manchester et al. 1991).

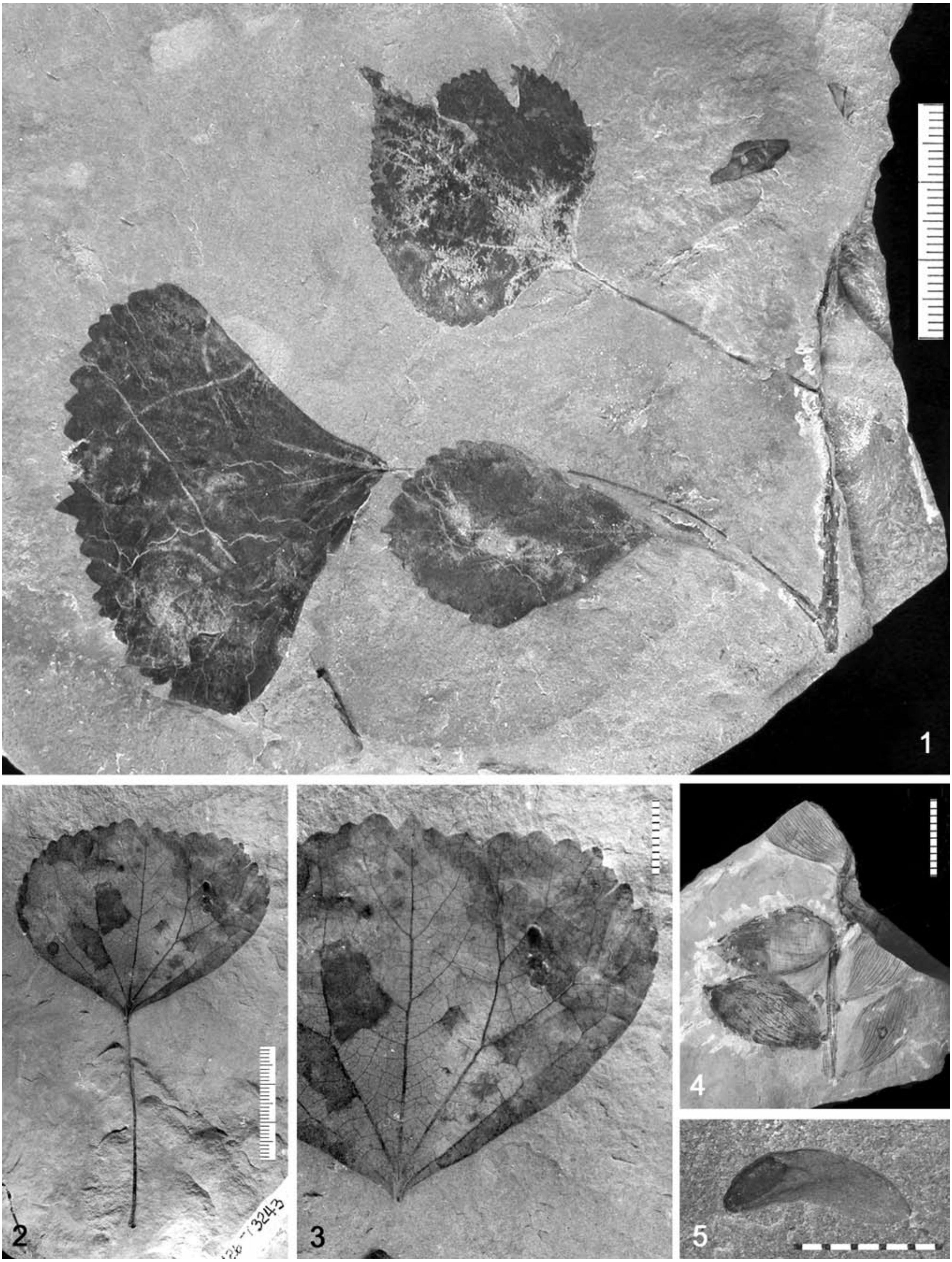
Even from the first recognition of the species described as *Populus arctica* by HEER from Greenland, the species concept included variation ranging from entire-margined and irregularly crenate leaves now thought to coincide with *Nordenskioeldia* fruits, as well as those with more regularly spaced crenations believed to represent the *Nyssidium* plant. As noted by Budantsev and Golovneva (2009), the lectotype of *Populus arctica* HEER (basionym of *Trochodendroides arctica* (HEER) BERRY) resembles the leaves treated by Crane et al. (1991) and Manchester et al. (1991) as *Zyziphoides*. Thus, it is possible that the type species of *Trochodendroides arctica* (HEER) BERRY coincides with the *Nordenskioeldia* plant, rather than with the *Nyssidium* plant to which it has often been associated. To avoid further confusion, I hesitate to use the epithet *arctica*, based on Greenland material, for the North American taxa representing this group.

Trochodendroides genetrix (NEWBERRY) comb. nov.

Text-figs 7.1–7.3

1868 *Populus genetrix* NEWBERRY, Lyceum Nat. Hist. New York Ann., 9, p. 64; 1898 U. S. Geol. Surv. Monogr., 35, p. 44, pl. 27. fig. 1 [Basionym].
1939a *Cercidiphyllum arcticum* (HEER) BROWN p. 492–494, pl. 53, figs 1, 6, Pl. 54, figs 1–3, 7; Pl. 56, fig. 1.
1962 *Cercidiphyllum arcticum* (HEER) BROWN p. 70, pl. 38, figs 1, 8, 14, 16.
1977 *Cercidiphyllum genetrix* (NEWBERRY) HICKEY p. 124, pl. 22, figs 1, 2, 4–7; pl. 23, fig. 2, pl. 24 fig. 1.

A recently recovered twig with attached leaves (Text-fig. 7.1) shows the great variation of leaf from elliptical to ovate to obovate, and fan-shaped forms, and serration ranging from fine to coarse, proving that they indeed represent one species. This leads to the conclusion that the leaves called *Cercidiphyllum genetrix* (NEWBERRY) HICKEY, *Trochodendroides serrulata* (WARD) J. WOLFE (See Hickey 1977 for



Text-fig. 7. Cercidiphyllaceae 1–3. ***Trochodendroides genetrix*** (Newberry) comb. nov. and associated reproductive structures (4, 5) from Killpecker Cr., Rock Springs, Wyoming (UF loc. 18126). 1. Twig with three attached leaves, showing variation in leaf shape and serration; composite figure assembled from images of both counterparts, UF 35427. 2. Complete leaf including petiole, UF 13243. 3. Same as 2, detail of venation. 4. *Nyssidium arcticum* (Heer) Iljinskaya fruits on an incomplete axis, UF 35454. 5. Dispersed winged seed, UF 35479. Scale = 3 cm in 1, 2; 1 cm in 3, 4; 0.5 cm in 5.

review) and many of those formerly treated by Brown as *Cercidiphyllum arcticum* (syn. *Trochodendroides arctica*) represent variation in a single species. Because these leaves do not match the lectotype of *T. arctica* from Greenland, it seems prudent to recognize this widespread and common type of foliage from the North American Paleocene under the new combination *Trochodendroides genetrix.* The generic name, *Trochodendroides* BERRY, is based on a similar, but finely serrate, leaf from the Cretaceous Dakota Formation of Nebraska.

Archeampelos acerifolia (NEWBERRY) MCLVER et BASINGER

Text-fig. 8

1868 *Populus acerifolia* Newberry, p. 65; 1898, p. 37, pl. 28, figs 5–8 (Basionym)
1962 *Ampelopsis acerifolia* (Newberry) Brown, 1962, [part], p. 78, pl. 51, figs 1, 3, 4, 8, 13, 16, 17.
1993 *Archeampelos acerifolia* (Newberry) McIver and Basinger, 1993, p. 47 (but not their figured specimens)

Lectotype, designated here: USNM 551, the leaf originally figured as plate 28, fig. 5 by Newberry (1878), here refigured as Text-fig. 8.1, 8.2.

Leaves of this species vary from wide-ovate to trilobate with regularly spaced rounded glandular teeth and have moderately long petioles. Both Brown (1962) and McIver and Basinger (1993) assigned this species to Vitaceae. Despite similarities to Vitaceae, including the tendency for shallowly trilobate leaves, the architectural similarities with *Trochodendroides* are stronger. The teeth are rounded and somewhat larger than those typically seen in *Trochodendroides arcticum* but have the same morphology and gland position. At some localities, for example, Bison Basin, Wyoming, the leaves co-occur with an unnamed species of *Nyssidium* having relatively large fruits. The association of *Nyssidium* infructescences with leaves of *Trochodendroides* at some sites, and with leaves of *Archeampelos* at other sites, suggests that the plants producing these two leaf types were closely related.

McIver and Basinger (1993) used a broad species concept for this taxon, accommodating specimens of "*Populus*" *nebrascensis* NEWBERRY as well as "*Populus*" *acerifolia* NEWBERRY. However, Peppe (2009) documented three morphologically distinct species of *Archeampelos* with different stratigraphic ranges. Although McIver and Basinger's combination *Archeampelos acerifolia,* based on Newberry's original material from Fort Union, North Dakota (Text-Fig. 8), applies to many Paleocene leaf populations, for example those studied by Gemmill and Johnson (1997) from Bison Basin, Wyoming, it is inappropriate for the specimens that McIver and Basinger (1993) illustrated from the Ravenscrag Formation. Although the required new combination has not yet been published, the Ravenscrag population conforms to another widespread species of the same genus that includes the type specimen of "*Populus*" *nebrascensis* NEWBERRY (1868). PEPPE (2009) documented useful morphological characters for distinguishing three species of *Archeampelos* that each have distinctive stratigraphic ranges in North America.

Hamamelidaceae

The leaf called *Hamamelites inaequalis* (NEWBERRY) R. W. BROWN was considered to be similar to extant *Hamamelis virginiana* L, but Brown (1962) noted that neither fruits nor seeds have been found to confirm the identification. The genus *Hamamelites* was erected by Saporta (1865, 1868) for leaves from the Paleocene of Sezanne, France. The leaves illustrated by Brown also resemble the extinct platanaceous genus, *Platimeliphyllum* MASLOVA 2002.

The infructescence illustrated by Brown (1962) as a "longitudinal hollow studded with bilobed projections" (pl. 65, fig. 44), seems likely to represent an infructescence of Hamamelidaceae. Fruiting capsules of this family will appear to have bilobed projections due to the persistence of paired styles. Unequivocal silicified fruits and of Hamamelidaceae, and their explosively dehiscent seeds, are known from the Paleocene of Almont, North Dakota (Crane et al. 1990, Benedict et al. 2008).

Brown (1962) described *Liquidambar dakotense* R. W. BROWN based on winged seeds from the Anarchist Hill site in South Dakota, but he did not provide a clear justification for the generic assignment. *Liquidambar* seeds have a raphe along the median line of the wing, which is not present in this fossil. The other genus that Brown included in discussion of this fossil was *Exbucklandia.* That extant genus has seeds that are indeed very similar to this fossil. However, the seeds also fall within the range of variation of those Brown had earlier considered to be produced by *Cercidiphyllum articum*. In my opinion, the seed represents *Nyssidium arcticum* and is a part of the *Trochodendroides genetrix* plant.

Cucurbitaceae

Cucurbitaciphyllum gen. nov.

Diagnosis. Leaves palmately trilobed, petiole narrow, not swollen at junction with lamina. Lamina base cordate, lobe apices acute; lobal sinuses rounded, margins of the three main lobes with smaller lobes and teeth. Venation actinodromous with a primary vein directed into each major lobe. Secondary veins pinnate, camptodromous to semicraspedodromous, sometimes interconnecting to form an intramarginal vein in lower portion of the lobes. Lower surface of leaf covered by closely spaced trichomes.

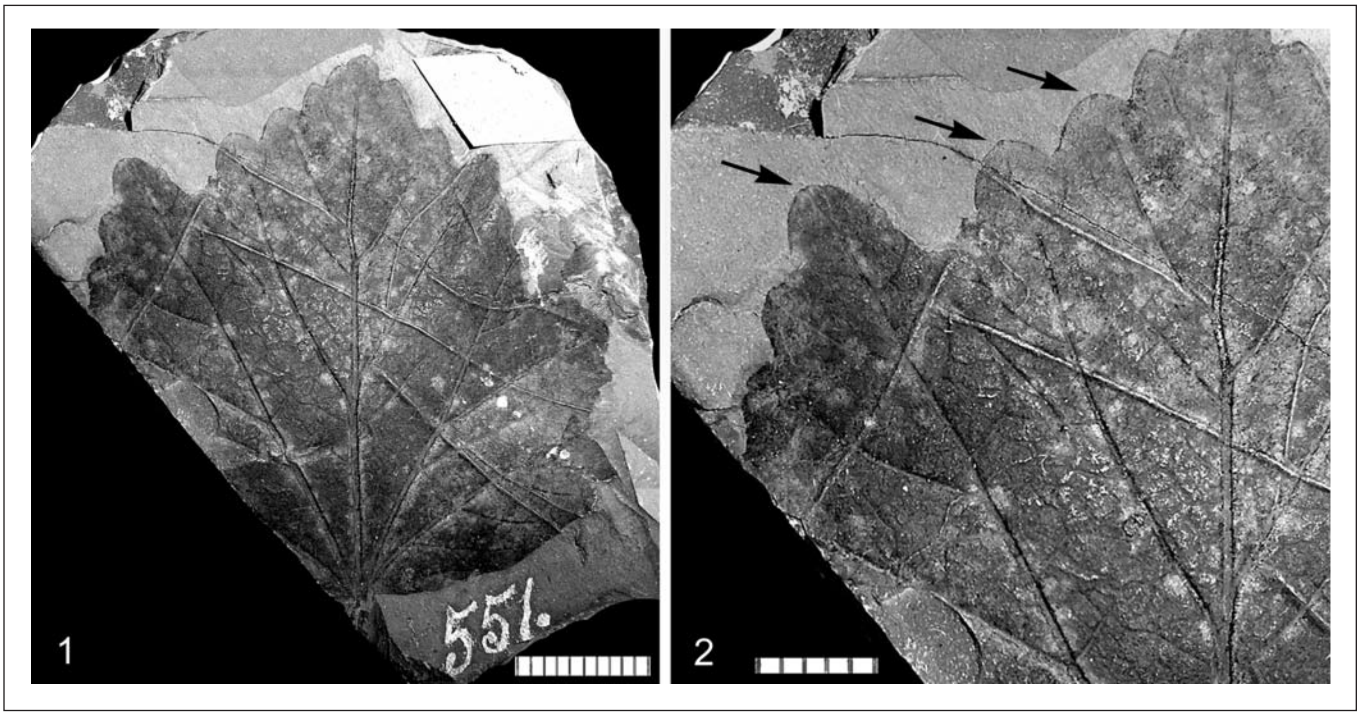
Type species. *Cucurbitaciphyllum lobatum* (KNOWLTON) comb. nov.

Etymology. The generic name combines the roots, Cucurbitac-, referring to the family Cucurbitaceae, which has similar leaves among extant genera, and -phyllon (Gr. = leaf).

Cucurbitaciphyllum lobatum (KNOWLTON) comb. nov.

Text-figs 9.1–9.4

1924 *Aralia lobata* KNOWLTON, U. S. Geol. Surv. Prof. Paper 134, p. 93, pl. 17, figs 1, 2 (Basionym)
1962 *Vitis lobata* (KNOWLTON) R. W. BROWN, p. 82, figs 3, 7, 10.



Text-fig. Fig. 8. Cercidiphyllaceae. *Archeampelos acerifolia* (NEWBERRY) MCIVER et BASINGER. 1, 2 Lectotype, from Fort Union, North Dakota. 1. The leaf originally figured as plate 28, fig. 5 by Newberry (1878). USNM 551. 2. Detail of marginal dentition, showing a small gland at each tooth apex (arrows). Scale = 1 cm in 1; 0.5 cm in 2.

Lectoype designated here: USNM 36675, fig. 1 of Knowlton 1924.

Emended diagnosis. Leaves palmately trilobed, 3.5 to 15 cm long, 5 to 13 cm wide. Petiole narrow, not swollen at junction with lamina. Lamina base cordate. Lobes obovate, with smaller lobes and teeth along the margins; lobe apices acute. Sinuses of lobes and teeth usually rounded. Venation actinodromous, with a primary vein in each lobe, that of the central lobe symmetrically placed, those of the lateral lobes, placed asymmetrically, closer to the proximal margin. Often with an strong secondary or subprimary vein, arising near the base on abaxial side of the lateral primaries and feeding to a basal large tooth or small external lobe. Secondary veins pinnate in 7 to 9 pairs per lobe, camptodromous to semicamptodromous; lower pairs arising at 80 to 90° from the midvein and interconnecting to form an incomplete intramarginal vein (where the margin is untoothed); upper secondaries arising at narower angles (30–45°), craspedodromous where teeth are present. Intersecondary veins common. Tertiary veins percurrent to reticulate. Lower surface dotted impressions of numerous hair-like trichomes. Simple trichomes are seen as densely spaced protrusions on impression surfaces representing the lower surface of the lamina.

Jack Wolfe (cited in Raven and Axelrod 1974, p. 569) determined that *Vitis lobata* (KNOWLTON) BROWN (1962) clearly belongs to the Cucurbitaceae, but the characters leading to his conclusion were not stated. Wolfe's identification is supported by the palmate lobing, scattered teeth, rounded lobal sinuses, partial intramarginal vein and simple trichomes scattered over the lamina surface. This architectural pattern occurs in more than one modern genus of the family, including *Kedrostis*, *Melothria*, and *Zehneria*. Accordingly, a new genus is established here to accommodate this species. This is significant because the fossil record of Cucurbitaceae is poorly known.

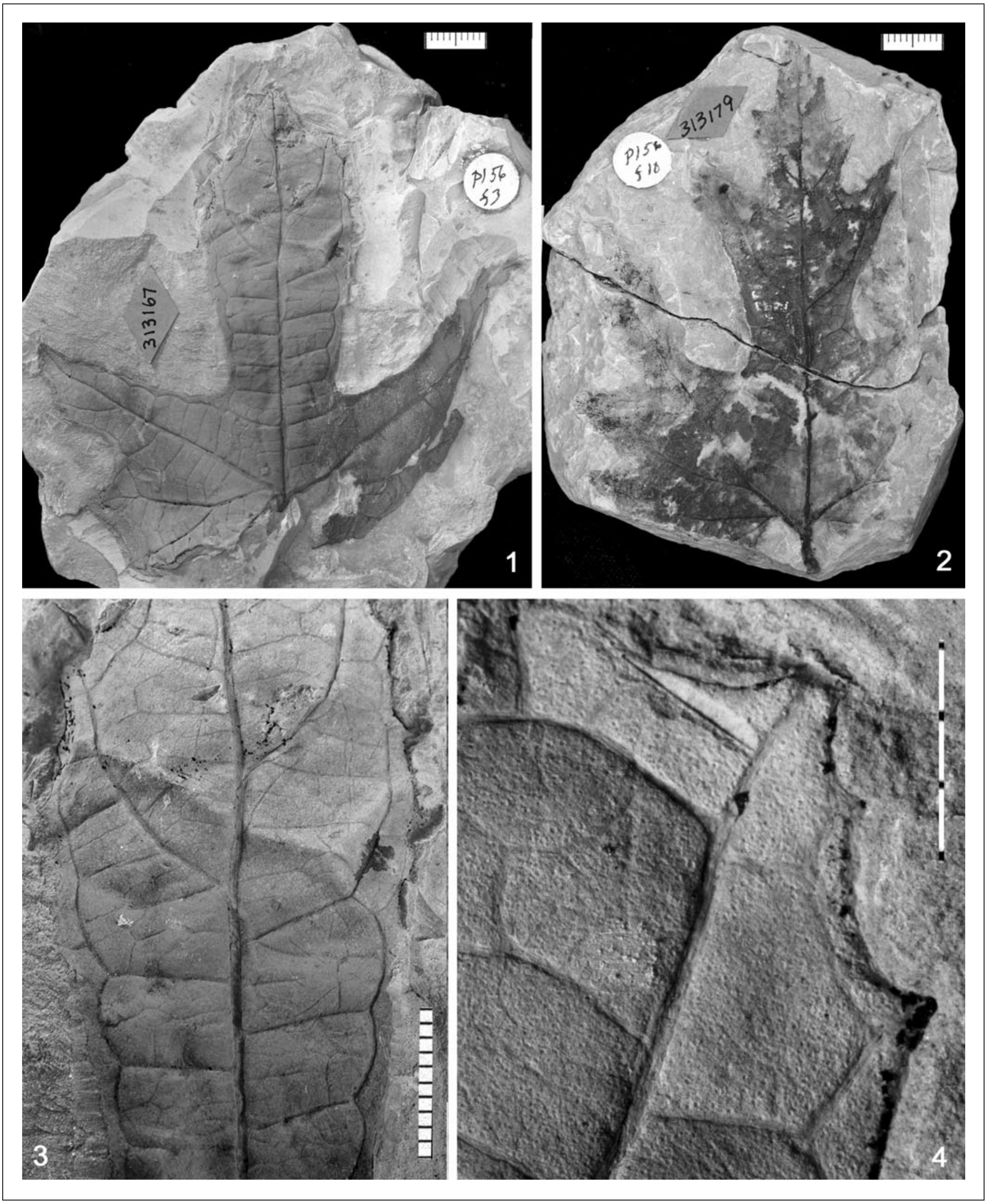
? Fagaceae

Brown attributed several leaf types to Fagaceae, including *Castanea intermedia* LESQUEREUX, *Quercus asymmetrica* TRELEASE, *Q. greenlandica* HEER, *Q. macneilii* R. W. BROWN, *Q. sullyi* NEWBERRY, and *Q. yulensis* R. W. BROWN. However, the affinities, even to the family level, are questionable as no unequivocal cupulate fruits of Fagaceae have been recovered. *Quercus greenlandica* was subsequently transferred to *Fagopsiphyllum groenlandicum* (HEER) MANCHESTER 1999. *Q. yulensis* also appears related to *Fagopsiphyllum* differing mainly by its more prominent teeth.

Leaves that Brown treated as *Quercus sullyi* NEWBERRY were subsequently treated as *Dicotylophyllum flexuosum* (NEWBERRY) J. WOLFE (1966) and then *Meliosma longifolia* (HEER) HICKEY (1977), but most recently, they have been assigned to the extinct genus *Dyrana* GOLOVNEVA, as discussed herein under Platanaceae.

Betulaceae

Brown (1962) recognized two kinds of foliage assigned to the Betulaceae: *Betula stevensonii* LESQUEREUX, and *Corylus insignis* HEER. *Betula stevensonii*, established based on leaves from the Evanston Formation of southwestern Wyoming, might be Betulaceae, but the fine serration appears simple, rather than compound—unusual for *Betula* and for the family. The type locality is literally mined out and now occupied by a Walmart parking lot and adjacent lake. Although the attribution to Betulaceae may be correct, the



Text-fig. Fig. 9. Cucurbitaceae 1–4. *Cucurbitaciphyllum lobatum* (Knowlton) comb. nov. Specimens from Shirley Canal, Montana, USGS loc. 8519. 1. Trilobate leaf, with rounded lobal sinues, and entire to serrated margin. USNM 313167. 2. Leaf with pronounced secondary lobes and cordate base, USNM 313179. 3. Detail of central lobe from fig. 1. 4. Higher magnification, showing abundant trichome impressions. Scales = 3 cm in 1–3; 3 mm in 4.

assignment to *Betula* is questionable. None of the distinctive trilobed infructescence bracts of *Betula* have been observed in this or other Paleocene sites of the Rocky Mountains or Great Plains region, but they are frequently found with fossil leaves of *Betula leopoldae* from the Eocene of Washington (Crane and Stockey 1987).

Palaeocarpinus joffrense Sun et Stockey

Infructescences and spiny-bracted fruits of the extinct betulaceous genus *Palaeocarpinus* Crane were described by Brown as bur-like objects. The examples figured by Brown (1962 pl. 67, figs 39–42, 47) and Crane (1989, fig. 6.5F) correspond to *Palaeocarpinus joffrense* Sun et Stockey which was described based on infructescences and fruits from the Paleocene of Alberta (Sun and Stockey 1992) and the late Paleocene-early Eocene Storvola flora of Spitsbergen (Golovneva 2002, Budantsev and Golovneva 2009). Leaves that Brown called *Corylus insignis* were likely produced by the same plant. Brown (1962) used the name *Corylus insignis* Heer based on the specimens Heer (1871) identified from Greenland. Golovneva (2002) showed that the epithet *malmgrenii* (from *Tilia malmgrenii* Heer 1868 from the Eocene of Spitsbergen) takes priority for such leaves and observed that the "American leaves are morphologically identical to the leaves from Spitsbergen, associated with fruits of the same species." The genus *Corylites* has been considered appropriate for leaves of this kind in association with *Palaeocarpinus* (Manchester and Guo 1996), but Golovneva (2002) argued in favor of the genus *Craspedodromophyllum* Crane. Golovneva provided a new combination *Craspedodromophyllum malmgrenii* (Heer) Golovneva, using the fossil-genus that Crane had established for foliage associated with *Palaeocarpinus* fruits from the Paleocene Reading Beds of England. Thus, *C. malmgrenii* applies to the *Corylus*-like leaves associated with *Palaeocarpinus joffrense* (i.e., leaves Brown identified as *Corylus insignis*) known from several localities in North Dakota, Montana and Wyoming as well as Alberta and Spitsbergen.

Other species of *Palaeocarpinus* include fruits with very spiny bracts known from two localities in North Dakota (*P. dakotensis* Manchester, Pigg, et Crane 2004), and those with mostly entire-margined bracts from some sites in southwestern Wyoming (*P. aspinosa* Manchester et Chen 1989). These all co-occur with *Corylus*-like leaves that can be attributed to *Corylites* or *Craspedodromophyllum*, although formal specific epithets have not been proposed. As noted by Brown (1962), the single nut specimen that he assigned to *Corylus* was surprisingly small in comparison with extant *Corylus* nuts. It may have been either a nut of *Palaeocarpinus*, or a seed of *Taxus*, both of which have a longitudinally striate surface and truncate base where the involucre (*Corylus*) or aril (*Taxus*) attached.

Staminate catkins commonly associated with *Palaeocarpinus* contain *Corylus*-like pollen (Manchester and Chen 1996; Manchester et al. 2004; Sun and Stockey 1992). Given the similarities of the leaves and pollen to that of extant *Corylus*, and the relatively minor differences between *Palaeocarpinus* and extant *Corylus* it seems clear that *Palaeocarpinus* was very close to extant *Corylus*, possibly plesiomorphic within the same lineage.

An additional betulaceous element common in the Paleocene of Wyoming, not treated by Brown, was the extinct genus *Cranea*, known from the Bighorn and Powder River basins of Wyoming, consisting of elongate infructescences with some similarity to modern *Ostryopsis*. Leaves associated with *Cranea* are more elongate than those of *Corylites malmgrenii* and have more closely spaced parallel secondary veins (Manchester and Chen 1998).

Juglandaceae

The Juglandaceae are represented by leaves and fruits in the Paleocene floras reviewed by Brown (1962). Pollen of the family is also well represented and useful in biostratigraphy (Nichols and Ott 1978, 2006). Brown (1962) used the broad concept of the extant genus *Pterocarya* (including *Cyclocarya*), and accordingly attributed two species to *Pterocarya* that are now treated as the distinct genera *Cyclocarya*, and *Polyptera* Manchester et Dilcher (1982, 1997).

Cyclocarya hispida (R. W. Brown) comb. nov.

1962 *Pterocarya hispida* R. W. Brown U. S. Geol. Surv. Prof. Pap.; 1971 Watt. Taxon, 20 (4), p. 640 (Basionym).

Lectotype designated by Watt (1971): USNM 167492 (Brown 1962, pl. 18, fig. 11).

Circular winged fruits and compound foliage that Brown called *Pterocarya hispida* are now treated as *Cyclocarya,* a genus now endemic to central China. The fruits were renamed *Cyclocarya brownii* Manchester et Dilcher (1982; Manchester 1997). The leaves were not formally renamed, but should not be accepted as representing extant *Pterocarya*. I therefore supply here the new combination, *Cyclocarya hispida* (R. W. Brown) comb. nov. Associated dispersed pollen, usually triporate and lacking special exinous thinning patterns (Manchester 1987) goes by the name *Momipites wyomingensis* Nichols et Ott.

Polyptera manningii Manchester et Dilcher

Fruits and foliage that Brown called *Pterocarya glabra* R. W. Brown are now treated as an extinct genus. The fruits were described as *Polyptera manningii* Manchester et Dilcher. The foliage, found in consistent association at more than a dozen sites in Wyoming and Montana (plus a recently discovered site in central Colorado—Baptist Road locality, DMNH loc. 2177) is treated as *Juglandiphylloides glabra* (R. W. Brown) Manchester et Dilcher. The leaves have five to seven leaflets. One of the distinctive features of this species is the long petiolules that can be 2.5–10 mm long, in contrast to the subsessile leaflets of other juglandaceous leaf types known from these Paleocene deposits. Associated catkins yield triporate isopolar pollen of *Maceopolipollenites annellus* (Nichols et Ott) Manchester et Dilcher (referred to *Momipites annellus* by Nichols and Ott 1978). *Polyptera* is the oldest of the juglandaceous fruit genera known from the Rocky Mountain region, being known from Puercan and Torrejonian sites, and not found in co-occurrence with *Cyclocarya* or *Juglandicarya*. *J. glabra* leaflets, which are serrate to rarely entire-margined, are readily distinguished from other Paleocene Juglandaceae by the long petiolules.

Juglandicarya simplicarpa Manchester

1987 *Juglandicarya simplicarpa* Manchester p. 14, fig. 4.

Juglandicarya simplicarpa Manchester fruits are known from several localities in the Rocky Mountains region. These are molds and casts of a relatively large, wingless nut 14 to 20 mm in equatorial diameter. The locule casts show typical juglandaceous morphology, but have only a primary septum without a secondary septum or other intrusions. These casts and molds resemble the permineralized fruit of *Juglandicarya cantia* Reid et Chandler from the London Clay flora, but the internal anatomy of that fruit type has not been documented to show whether it is more closely related to *Carya* or to *Juglans*. Based on the common co-occurrence with *Caryapollenites* pollen (Nichols and Ott 1978), and apparent absence of *Juglans* like pollen, we infer that these fruits may have belonged to the Hicorieae tribe of Juglandaceae (Manchester 1987).

"*Carya*" *antiquorum* Newberry

Newberry's hickory, "*Carya*" *antiquorum* Newberry (1898), was based on leaflets recovered from a site at the mouth of the Yellowstone River. The original type specimens are accepted as representing Juglandaceae, but most of those included in the species by Brown (1962) and those described by Hickey (1977) have been shown to represent *Aesculus hickeyi* Manchester, with palmately, rather than pinnately, compound foliage (Manchester 2001). The syntypes of "*C.*" *antiquorum*, isolated leaflets originally depicted with drawings, were illustrated photographically by Manchester (2001, fig. 5A, B, E) for contrast with leaflets of *Aesculus*. Another specimen from a site near the type locality, with rachis bearing paired scars of detached lateral leaflets, indicates that this species was imparapinnate (Manchester 2001, fig. 5C, D). The more precise affinities of Newberry's "*C.*" *antiquorum* have not been determined. The leaflets lack gland impressions thus distinguishing them from *Cyclocarya hispida,* but this could be a preservational difference from site to site. There is a good possibility that "*Carya*" *antiquorum* coincides with the plant that produced *Juglandicarya simplicarpa* fruits.

The generic and familial assignments of "*Juglans*" *berryana* (Knowlton) R. W. Brown and "*Juglans*" *taurina* R. W. Brown and are questionable. The first of these was initially described by Knowlton (1924), as *Dryophyllum berryana* Knowlton and as *Magnolia angustifolia* Newberry (based on counterpart impressions of the same leaf specimen). "*J.*" *taurina* has asymmetrical broad-ovate, entire-margined laminae with well-impressed transverse tertiary veins and appear to represent leaflets, but in the absence of additional diagnostic characters, it is not possible to rule out affinities with numerous other families having compound leaves.

? Rosaceae

Brown (1962) recognized four species of *Prunus,* i.e., *P. coloradensis* Knowlton, *P. careyhurstia* R. W. Brown, *P. maclearnii* Berry, and *P. perita* R. W. Brown, and one species of fruit, *Prunus corrugis* R. W. Brown. As stated by Wolfe (1977) "Brown (1962) has attributed some leaves from the Rocky Mountain Paleocene to *Prunus,* but none of these leaves has the acropetiolar glands or glandular teeth characteristic of *Prunus.*" There are many extant species of *Prunus* that do not display the acropetiolar glands, but without that character, it is difficult to distinguish this genus from others in the Rosaceae and other families, which leaves these identifications in some question. The fruits called *Prunus corrugis* R. W. Brown were subsequently shown to represent Icacinaceae and were transferred to *Icacinicaryites corruga* by Pigg et al. (2008). A new fossil genus, *Prunites,* was established based on one of Brown's species, resulting in the new combination, *Prunities maclearnii* (Berry) McIver et Basinger. McIver and Basinger (1993) agreed that it is close to extant *Prunus*, but noted the details of fine venation and fruits are not known.

Ulmaceae

Ulmus-like leaves were assigned by Brown (1962) to three different genera and species: *Planera microphylla* Newberry, *Ulmus rhamnifolia* Ward and *Zelkova planeroides* (Ward) R. W. Brown. The familial assignment is believed to be correct because of the distinctive combination of characters including asymmetrical lamina, short thick petioles, blunt, simple to doubly compound, non-glandular teeth, and percurrent tertiary venation. It is puzzling, however, that no fruits of Ulmaceae have been identified in association with these leaves at any of the Paleocene sites in North America or Asia (Manchester 1989, and subsequent observations). The fruits that Brown attributed to *Ulmus rhamnifolia* were subsequently shown to represent Polygonaceae and later identified as *Polygonocarpum curtisii* Manchester et O'Leary (Brown 1962, pl. 24, fig. 17) and *Podopterus antiqua* Manchester et O'Leary (Brown 1962, pl. 24, fig. 18).

Ulmites microphylla (Newberry) comb. nov.

Text-fig. 10

1868 *Planera microphylla* Newberry, Lyceum Nat. Hist. New York Ann., 9, p. 55 [basionym]; 1898 Newberry U. S. Geol. Surv. Monogr., 35, p. 81, pl. 33, figs 3, 4.

1977 *Chaetoptelea microphylla* (Newberry) Hickey, Geol. Soc. Amer Mem. 150, p. 122, and synonymy therein.

Brown (1962) distinguished three species of ulmaceous foliage on the basis of shape (e.g., cordate base in *Planera microphylla* vs cuneate or rounded base in *Zelkova planeroides*) and size (relatively large in *Ulmus rhamnifolia*), but it seems likely that these represent variation within one species, given the range of morphology documented in leaves of modern individuals (Denk and Dillhoff 2005). Kvaček et al. (1994) adopted the non-committal name *Ulmites* Dawson for Paleogene leaf types that may not unequivocally belong to the genus *Ulmus.*

Hickey (1977) reassigned *Planera microphylla* Newberry to *Chaetoptelea*, a segregate genus of *Ulmus* that was subsequently demoted to subgeneric status. A twig bearing several leaves of *Ulmites microphylla* from Black Buttes Coal Mine Pit 3, in southwestern Wyoming shows the distichous attachment of leaves to a twig as expected for Ulmaceae (Text-fig. 10). No fossil fruits of *Ulmus* (including

Text-fig. 10. Ulmaceae. *Ulmites microphylla* (NEWBERRY) comb. nov. Twig with distichously attached leaves, Black Buttes Mine pit 3, Wyoming, UF 15886-14248. Scale bar = 1 cm.

Chaetoptelea morphology) have been recovered from Paleocene strata, although they are relatively common in the Eocene of western North America (Manchester 1989; Denk and Dillhoff 2005). I recommend that these leaves be placed in the genus *Ulmites* DAWSON and here above establish the new combination *Ulmites microphylla* (NEWBERRY) comb. nov. In addition to the species placed in synonymy by Hickey (under the name *Chaetoptelea microphylla* (NEWBERRY) HICKEY), I consider the leaves of *U. rhamnifolia* and *Zelkova planeroides* sensu Brown (1962) to be representatives of this species.

In reviewing specimens from the Paleocene of Russia and China they attributed to *U. furcinervis,* Feng et al. (2003, p. 149) observed, "Fossils described here are comparable to *C. microphylla* in the frequently forked secondary veins, the percurrent tertiary and the convex to acuminate apical side and the convex basal side of marginal teeth. We suggest that these fossils are probably conspecific considering their close similarities. Further works should be done to get more evidence and to verify this idea." If indeed conspecific, Newberry's epithet, *microphylla*, will take priority.

Celtidaceae/Cannabaceae

Brown (1962) attributed two species to the genus *Celtis*, i.e., *Celtis newberryi* KNOWLTON et COCKERELL, and *Celtis peracuminata* R. W. BROWN. The first of these has not been disputed, although a more detailed study is warranted. *Celtis peracuminata* R. W. BROWN appears to be too symmetrical and regularly serrate to be reliably assigned to *Celtis*. This leaf, recorded only from a single Paleocene site, resembles *Grewiopsis wyomingensis* BERRY that became common in the middle Eocene.

Celtis aspera (NEWBERRY) MANCHESTER, AKHMETIEV et KODRUL

Manchester et al. (2002) reassigned leaves of *Viburnum asperum* NEWBERRY to *Celtis aspera* based on a suite of foliar features common to Cannabaceae/Celtidaceae such as blunt teeth with submedial vein insertion, abundant, regularly spaced agrophic veins, and noted a consistent association with diagnostic reticulately sculptured endocarps of *Celtis* at Paleocene sites both in North America and Asia. None of the extant species of *Celtis* has identical leaf architecture, but the presence of corresponding leaf architecture in one of the extant species of the related genus *Aphananthe* (Manchester et al. 2002; Stockey et al. 2013), shows the potential for this leaf architectural pattern in the family and supports the conclusion that this foliage type was probably produced by the same plant as the *Celtis* endocarps. Endocarps of extant *Aphananthe* species differ from *Celtis* by having a smooth, rather than reticulate, outer surface. Stockey et al. (2014) disagree with the *Celtis* interpretation and refer the leaves to *Aphananthe* sp., although *Aphananthe*-like fruits are absent and *Celtis* fruits are present at their localities as at other Paleocene sites in North America and Asia cited by Manchester et al. (2002).

Malvaceae s.l.

Penosphyllum cordatum (WARD) HICKEY.

This species was treated by Ward (1887) and Brown (1962) under the name *Pterospermites*, but that generic name, based on probable winged seeds from the Miocene of Oeningen, had been incorrectly applied to leaves, so Hickey (1977) coined the genus *Penosphyllum*. The leaves resemble those of some sterculioid Malvaceae.

Sapindaceae

Aesculus hickeyi MANCHESTER

2001 *Aesculus hickeyi* MANCHESTER p. 986, figs 1–4.

Aesculus hickeyi was common in the Paleocene of Wyoming, Montana, North Dakota, and Alberta. It is known from completely preserved palmately compound leaves as well as abundant shed leaflets, occasional spiny fruit capsule remains, and associated dispersed pollen (Manchester 2001). The leaflets are recognizable by acute bases, short or absent petiolule, and, in this species, a marginal serration consisting of very fine, closely spaced teeth. Tertiary venation is percurrent and weakly impressed.

Acer sp.

Some of the samaras that were called *Acer* sp. by Brown (1962, especially pl. 46, figs 9, 10) appear to be genuine examples of that genus, having an oblique proximal scar indicating schizocarpic separation—one of the diagnostic features of *Acer*. Similar *Acer*-like samaras were recognized by Crane et al. (1990) from Almont, North Dakota, although corresponding foliage was not recognized.

Acer fragilis Knowlton 1917 was transferred to *Cissites panduratus* Knowlton by Wolfe and Tanai (1987).

Acer newberryi R. W. Brown was revised as *Dicotylophyllum trilobum* (Newberry) by Wolfe and Tanai (1987). "The only criterion on which the foliage just cited has been placed in *Acer* is a trifoliate condition. The leaflets lack bifurcating secondary veins that brace dental sinuses (as are present in *Negundo*); the dental sinuses are braced by an apically directed external secondary vein that originates from a secondary vein subjacent to the sinus, a morphology unknown in *Acer.* Although the tertiary veins are A-A [referring to Hickey's (1973) terminology, i.e., convex-percurrent; forming acute angles with the sub- and superadjacent secondary veins], they are more closely spaced than in *Acer* and have a "stringy" appearance. No extant family combines such characters." (Wolfe and Tanai 1987, p. 212).

Leguminosae

Leguminosites coloradensis Knowlton. The genus *Leguminosites* was based on seeds from the London Clay that are not of leguminous affinity (Wang 2012). Instead, this species should perhaps be placed in the genus *Leguminocarpum* Dotzler. However, Brown (1962, p. 74) expressed uncertainty whether these fruits represent pods of legumes, "or perhaps some other family of plants such as the Bignoniaceae."

"*Robinia*" *wardii* (Knowlton) Ward. These pods from the Fort Union Formation differ from the type material of *Robinia wardii* from Eocene of Yellowstone National Park and therefore require a different specific epithet. They are clearly legume fruits, but the generic assignment is in need of revision (Herendeen, pers. comm. 2014).

? Rhamnaceae

The presence of Rhamnaceae in these floras is not fully proven, but some of the leaves, e.g. *Rhamnus cleburnii* Lesquereux and *Zizyphus fibrillosus* (Lesquereux) Lesquereux have distinctive venation that is consistent with some extant Rhamnaceae. *"Rhamnus" geowandrewsii* Watt (syn. *Rhamnus hirsuta* R. W. Brown), does not appear to represent Rhamnaceae and is treated here among insertae sedis.

Rhamnites cleburnii (Lesquereux) McIver et Basinger

Brown (1962) indicated that *Rhamnus cleburnii* and *R. goldiana* (types both from the same locality) are very similar except that the former has a cuneate base and the latter is cordate. The cordate-based leaves have a series of strong agrophic veins. McIver and Basinger (1993) designated *R. cleburnii* as the type species of the fossil genus, *Rhamnites*, and established the new combination *Rhamnites cleburnii*. The closely spaced percurrent tertiaries are consistent with *Berchemia*, *Karwinskia*, *Rhamnidium*, *Rhamnus*, and some other genera of Rhamnaceae. The leaves are always entire-margined, contrasting with the serrate condition in many extant species of *Rhamnus*. From the same locality, an entire-margined leaf that Brown (1962, Pl. 39, fig. 2) figured as *Magnolia regalis* Heer, has closely spaced opposite-percurrent tertiary veins unlike *Magnolia* and appears to represent *Rhamnites cleburnii*. Leaves with similar architecture including the scalariform type of intercostal venation, occur in Dipterocarpaceae (e.g., *Hopea*, *Parashorea*, *Shorea*), and Dilleniaceae (e.g. *Tetracera*). Wolfe (1977) attributed leaves from the Paleogene of Alaska, to Dipterocarpaceae, but the distinctive winged fruits of that family have not been recovered from Alaska or any other North American paleobotanical sites.

"Zizyphus" fibrillosus (Lesquereux) Lesquereux

This species resembles some Rhamnaceae in 1) the closely spaced percurrent tertiaries, and 2) in the acrodromous pattern with numerous agrophics. However, the first pattern, found in genera like *Rhamnus*, *Karwinskia*, *Berchemia*, is not generally linked with the second pattern in the same genera. When actinodromy occurs, for example in *Ziziphus*, *Colubrina*, etc., the tertiary venation is more irregular and not closely spaced percurrent. It therefore seems unlikely that this leaf belongs in an extant genus of the Rhamnaceae, and the assignment to *Ziziphus* is probably incorrect. The generic name for this species was also placed in quotation marks by Ellis et al. (2003), indicating that that they were not convinced that it represents extant *Zizyphus*.

Vitaceae

Brown (1962) confirmed the presence of the grape family by documenting a seed with the characteristic paired ventral infolds, which he assigned to *Vitis* sp. The dorsal side of the seed is not known. A silicified seed of *Ampelocissus* was also identified from the Paleocene of North Dakota (Chen and Manchester 2007).

Reports of Vitaceae based on leaves have not been completely convincing. These include *Ampelopsis acerifolia* (reassigned to *Archeampelos acerifolia* (Newberry) McIver et Basinger, see Cercidiphyllaceae, above), *Cissus marginata* and (reassigned to Platanaceae as *Platanites marginata*), *Vitis lobata* (Knowlton) R. W. Brown (reassigned *to Cucurbitaciphyllum lobatum*, above). The leaf identified as *Vitis olrikii* Heer by Brown (1962) was separated from the Greenland species and given a new binomial, *Dicotylophyllum hansonium* Peppe et Hickey (2014). Others that require additional study are *Cissites rocklandensis* R. W. Brown, and *Parthenocissus ursina* R. W. Brown. *Cissites rocklandensis* has a broadly ovate lamina with three asymmetrically and weakly developed lobes, with a rounded sinus between the middle lobe and each of the lateral lobes. This resembles the leaves of *Gyrocarpus* (Hernandiaceae) and *Exbucklandia* (Hamamelidaceae).

Ericaceae

"Kalmia" elliptica R. W. BROWN

This species is represented by elliptic leaves with entire margins, and pinnate secondaries that arise decurrently from the midvein. Hickey (1977) considered the attribution to Ericaceae likely to be correct, based on several apparently unique leaf architectural characters.

Cornales

The order Cornales was particularly well represented in the Paleocene of the Rocky Mountains and Great Plains region. Examples include *Cornus* (already recognized by Brown 1962), *Davidia*, *Amersinia/Beringiaphyllum* (previously treated as *Viburnum*), and *Browniea* (previously treated as *Eucommia*). At some sites one or more of the latter three genera are dominants of the community. Pollen of *Nyssapollenites thompsonianus* THIERGART ex POTONIE and *Cornus* sp. are known from Almont, North Dakota (Zetter et al. 2011).

Cornus swingii MANCHESTER, XIANG, KODRUL et AKHMETIEV

Brown (1962) recognized two species of dogwoods: *Cornus hyperborea* HEER, and *C. nebrascensis* SCHIMPER. However, the holotype of *C. nebrascensis* SCHIMPER (= *C. acuminata* NEWBERRY and *C. newberryi* HOLLICK) has marginal teeth (Brown 1962; Johnson 2002), unlike any extant *Cornus*, lacks the distinctive double-armed trichome impressions expected for *Cornus* (Manchester et al. 2009), and now serves as the basis for a new extinct genus, *Mciveraephyllum*, established here on p. 178. Additionally, the lectotype of *Cornus hyperborea* HEER, from the Paleocene of Greenland, might be *Cornus*, but other affinities, e.g., to Lauraceae, cannot be ruled out because it lacks impressions of the diagnostic compass-needle like trichomes. In order to accommodate leaves from the Paleocene of Wyoming, Montana and North Dakota that could be placed with confidence in *Cornus*, due to the preservation of their distinctive trichomes, Manchester et al. (2009) established a new binomial, *Cornus swingii*. The fruits produced by *Cornus swingii* remain unknown, but anatomically preserved fruits of *Cornus* subgenus *Cornus* have been described from the Paleocene of North Dakota (Manchester et al. 2010) as *Cornus piggae*.

Davidia antiqua (NEWBERRY) MANCHESTER

Davidia, the dove tree*,* was particularly common in the Paleocene of Wyoming, Montana, and North Dakota (Manchester 2002). Although the laminae are similar in general form to some extant species of *Viburnum* and were called *Viburnum antiquum* (NEWBERRY) HOLLICK sensu Brown (leaves), and the associated detached fruits were called *Viburnum tilioides* WARD (Brown 1962), the leaves can be distinguished from most *Viburnum* by their long petioles, and the fruits by the presence of germination valves, five or more radially arranged single-seeded locules and lack of a well-defined axial vascular bundle (Manchester 2002). Fruits of *Davidia antiqua* were borne singly on an elliptical inflorescence head, subtended by scars that bore large bracts like those of modern *Davidia involucrata* of China.

Beringiaphyllum cupanioides (NEWBERRY) MANCHESTER, CRANE et GOLOVNEVA

In addition to the modern genera mentioned above, Cornales were well represented by extinct genera. One of these was *Amersinia* MANCHESTER, CRANE et GOLOVNEVA, the fruits of which are known from China and Far Eastern Russia, as well as Wyoming, Montana, North Dakota, and Alberta. *Amersinia* bore elliptical infructescence heads on long peduncles, bearing numerous trilocular fruits with apical germination valves. The morphology and anatomy of these fruits, preserved in silicified specimens, confirms their position within Nyssaceae having characters shared with extant *Davidia* and *Camptotheca*. Consistently associated with *Amersinia* fruiting material, both in North America and eastern Asia, are leaves of *Beringiaphyllum cupanioides* MANCHESTER, CRANE et GOLOVNEVA, which Brown had called *Viburnum cupanioides* (Manchester et al. 1999; Feng et al. 2002). The *Beringiaphyllum-Amersinia* plant appears to have been common near sites of lacustrine deposition during the Paleocene.

Browniea serrata (NEWBERRY) MANCHESTER et HICKEY

Browniea serrata (NEWBERRY) MANCHESTER et HICKEY (2007) is a species of an extinct genus related to extant *Camptotheca* (Nyssaceae) that was common in the Paleocene of Colorado, Wyoming, Montana, and North Dakota. The leaves, formerly called *Eucommia serrata* (NEWBERRY) BROWN (1962), have pinnate venation with semicraspedodromous secondaries, and regularly serrate margins, and they bear microscopic impressions of probable calcium oxylate idioblasts like the leaves of modern *Camptotheca*. At many localities, these leaves co-occur with globose multi-fruited infructescences resembling those of *Camptotheca*. The spindle-shaped fruits, which Brown referred to as "Probably fruits with remnants of calyces" (1962, pl. 67, figs 11, 12, 17) are similar to those of *Camptotheca* in shape and epigynous calyx, but the calyx is much better developed in the fossil taxon. Flowers with attached stamens yield pollen of *Caprifoliipites paleocenicus* POCKNALL et NICHOLS (Manchester and Hickey 2007). A specimen illustrated by Brown as "calyx of a flower (pl. 67, fig. 46), matches that of *Browniea*. Additional specimens were illustrated as *Amelanchites similis* (NEWBERRY) MCIVER et BASINGER (1993, pl. 29, figs 1–5; pl. 30, fig. 3) from Ravenscrag Butte, Saskatchewan, Canada; Early Paleocene, although the type of that species actually belongs to *Celtis aspera* (NEWBERRY) MANCHESTER, AKHMETIEV et KODRUL.

Icacinaceae

Unequivocal fruits of Icacinaceae occur in the North American Paleocene, but corresponding foliage has not yet been identified. The specimen illustrated as "impression of a seed showing pits arranged in longitudinal rows" (Brown 1962, pl. 67, fig. 26), and specimens from other Paleocene localities in Wyoming and Montana, have been assigned to the extinct genus *Palaeophytocrene*, as *Palaeophytocrene piggae* Stull, and clearly belong to the tribe Phytocreneae (Stull et al. 2012) which is now restricted to the Old World tropics.

Reticulately ridged fruits formerly placed in *Prunus corrugis* R. W. Brown were transferred to *Icacinicaryites corruga* (R. W. Brown) Pigg, Manchester et DeVore (large fruit—3.8 cm long), and *Icacinicaryites linchensis* Pigg, Manchester et DeVore (smaller fruits—1.5–2.7 cm long). Along with anatomically preserved silicified specimens given different taxonomic assignments these fruits conform to those of the icacinaceous tribe Iodeae (Pigg et al. 2008).

Bignoniaceae

Seeds of Bignoniaceae. Brown (1962 pl. 68, figs 17–22) illustrated several biwinged seeds from a single locality in SE Montana. These small seeds have a triangular central body, with two elongate strap-like wings arising at 90° to the vertical seed axis. The wings are membranous, and without veins, and conform well with the pattern of seeds in the Bignoniaceae.

Elaeocarpaceae

Sloanea ungeri (Heer) Manchester et Z. Kvaček

Sloanea ungeri (Heer) Manchester et Z. Kvaček is based on spiny capsular fruits with long peduncle and hypogynous disk that conform well with the morphology of extant *Sloanea* (Manchester and Kvaček 2009). It is disconcerting, however, that no obvious leaves of *Sloanea* have been found in co-occurrence. Leaves of extant *Sloanea* have prominent thickening and a twist at the junction of lamina with petiole that has not been observed among the leaves associated with these fossil fruits. One of the specimens was referred to as "elliptic fruit with a fringe of hairs or filaments" (Brown 1962, pl. 67, fig. 35).

Polygonaceae

Paranymphaea crassifolia (Newberry) Berry

Leaves of *Paranymphaea crassifolia* (Newberry) Berry were studied in detail by McIver and Basinger (1993) who demonstrated that the leaf architecture is very distinct from that of *Nymphaea* and other Nymphaeaceae and appears instead to be diagnostic of Polygonaceae, e.g., *Polygonum* and *Rheum*. This is distinctive leaf type is mostly confined to the lower Paleocene of the Rocky Mountain region.

Polygonocarpum curtisii Manchester et O'Leary

A winged fruit of *Polygonocarpum curtisii* fruit was figured as *Ulmus rhamnifolia* Ward by Brown (1962, pl. 24, fig. 17) this fruit type was compared informally with *Wimmeria* by Crane et al. (1990). The fruits are are pedicellate, wide-elliptical with an emarginate base and apex, 9–10 mm high and 12–14 mm wide, with three radially arranged longitudinal wings diverging from a central fusiform, single-seeded endocarp. Several longitudinal veins run the full length of the fruit body. The wings are chartaceous, with a dense anastomosing network of fine venation but lacking marginal veins (Manchester and O'Leary 2010).

Podopterus antiqua Manchester et O'Leary

A fruit of *Podopterus antiqua* was previously figured as *Ulmus rhamnifolia* Ward by Brown (1962, pl. 24, fig. 18). The fruits are obovate, composed of three longitudinal chartaceous wings with an emarginate apex and cuneate base, an elliptical, single-seeded endocarp, and narrow pedicel. The wings have a dense anastomosing network of fine venation but lack a distinct marginal vein. All of these features conform well to those seen in the modern genus *Podopterus* (Manchester and O'Leary 2010).

Extinct taxa of uncertain affinities

Averrhoites affinis (Newberry) Hickey

Averrhoites affinis was established by Hickey (1977) for the pinnately compound leaves that Brown (1962) called *Sapindus affinis* (Newberry) Brown. The leaves bear as many as 11 leaflets that are asymmetrical, ovate to elliptic, and entire-margined with 8 to 13 pairs of secondary veins. Although the familial affinities remain uncertain, it is noteworthy that this foliage type very often co-occurs with flowers of *Calycites polysepala* Newberry. Scott Wing (pers. comm.) has obtained *Pistilipollentites* pollen from stamens of these flowers, indicating that they are equivalent to (and have nomenclatural priority) over the genus, *Pistillipollianthus* that was established on flowers from the Eocene of Horsefly, British Colombia (Stockey and Manchester 1988).

Quereuxia angulata (Newberry) Kryshtofovich

A distinctive floating aquatic plant known as *Quereuxia angulata* (Newberry) Kryshtofovich ranged from the upper Cretaceous through Paleocene of North America and Asia (Stockey and Rothwell 1997; as *Trapago angulata*). The plant was called *Trapa angulata* (Newberry) R. W. Brown (1962) but represents an extinct genus. It was named *Trapago* by McIver and Basinger (1993) but this is a junior synonym of *Quereuxia* (see Hickey 2001 for nomenclatural review). The laterally compressed rhizome with attached leaves and roots illustrated as *Trapa paulula* (Bell) R. W. Brown (1962) also appears to represent this genus.

Dicotylophyllum silberlingii
(R. W. Brown) J. Wolfe et Tanai

Acer silberlingii R. W. Brown (1962, p. 76. pl. 46, fig. 7) was transferred to *Dicotylophyllum silberlingii* by Wolfe and Tanai (1987). According to those authors, "The single specimen of *"Acer" silberlingii* has intercostal venation comprised of many admedially oriented tertiary veins, some camptodromous secondary veins, narrowly arcuate dental sinuses, and veins that enter teeth have strong lateral bracing veins. The specimen is clearly not *Acer,* but we are unable to suggest a valid familial assignment." (Wolfe and Tanai 1987, p. 211–212). From another upper Paleocene locality, however, Scott Wing (pers. comm., 2014), has observed this leaf species in close association with schizocarpic fruits that do indeed represent *Acer*—leading to the suggestion that the possible affinity of these leaves to *Acer* needs to be reconsidered.

Porosia verrucosa (Lesqueruex) Hickey emend. Manchester et Kodrul

1878 *Carpites verrucosus* Lesquereux p. 305, Pl. 10, fig. 9 (basionym)
1962 *Hydromystria expansa* (Heer) Hantke in Brown 1962 (part); p. 52, Pl. 16, figs 1, 3, 10, only
1977 *Porosia verrucosa* (Lesquereux) Hickey 1977, p. 114, pl. 54, figs 1, 3, 4 (not 2).
2014 *Porosia verrucosa* (Lesquereux) Hickey emend Manchester et Kodrul 2014 p. 82–83, Pl. 1–5.

Porosia verrucosa is a distinctive fruit type that existed from the Campanian to the Eocene; it was particularly common in the Paleocene of western North America and Far Eastern Russia (Hickey 1977; Manchester and Kodrul 2014). The fruits were borne in schizocarpic pairs on stout pedicels with hypgynous perianth scar and bore numerous prominent circular cavities within the wall of each endocarp. The affinities are still uncertain although general similarities with Rutaceae have been noted (Manchester and Kodrul 2014). Brown (1962) included these remains, along with leaves now treated separately as *Limnobiophyllum,* in his concept of *Hydromystria expansa* (Heer) Hantke. Although considered at that time to be float leaves of an aquatic plant, the internal structure revealed in permineralized specimens, confirms that *Porosia* were unilocular, single-seeded fruits (Manchester and Kodrul 2014).

Deviacer wolfei Manchester

Brown (1962, pl. 67, fig. 67, 7) illustrated this fruit type as "maplelike samaras, but probably of sapindaceous affinity." The fruits are not *Acer b*ecause they are borne singly on the pedicel, lacking the schizocarpic condition and possess a small rudder like protuberance arising from the thickened edge of the wing near the distal edge of the seed body which is not present in *Acer*. A similar rudder like protuberance occurs in superficially similar fruits of extant *Securidaca* (MacGinitie 1974; Pigg et al. 2008) but the basal perianth scar seen in dispersed fruits of modern *Securidaca* has not been observed in any of the fossil specimens. Brown's "maplelike samaras" correspond to the extinct taxon *Deviacer wolfei* Manchester (1994), known from the Paleogene of western North America, China, and Denmark (pers. obs.). The familial affinities are uncertain to me.

"Koelreuteria" annosa R. W. Brown

This name was established by Brown (1956) for an elliptical fin-winged fruit from the vicinity of Jim Bridger coal mine, east of Rock Springs, Wyoming. Later, he included a leaflet, from a different site in Montana, under the same name (Brown 1962). More specimens of the winged fruit have been recovered from sites near the type locality, but detailed study shows that they are not *Koelreuteria*. The pedicel is extremely thin compared to that of *Koelreuteria*, and the fruit has bilateral, rather than trifold, symmetry. The specimens also lack the globose seeds typically found in *Koelreuteria* fruits, and have a fusiform locular area that is narrower than that of *Koelreuteria*. Despite a survey of fin-winged fruits in more than 140 extant genera in 45 angiosperm families (Manchester and O'Leary 2010), it has not been possible to find a close match for these fruits. "*Koelreuteria*" *annosa* is similar to fruits of extant Rutaceae in being indehiscent, and nonschizocarpic, with hypogynous perianth scar, but the venation is not as reticulate as in extant *Ptelea*, *Balfourodendron*, and *Spathelia* (Manchester and O'Leary 2010). The association of this species with the foliage illustrated by Brown (1962) is tenuous, and the identification of that specimen requires reexamination.

Leepierceia preartocarpoides (R. W. Brown) K. Johnson

Leepiercea K. Johnson is an extinct genus of possible hamamelidalean affinity, known mostly from the Late Cretaceous. One of the Paleocene specimens attributed to *Ficus arctocarpoides* by Brown (1962, pl. 24, fig. 4) was reassigned to this species by Johnson (1996).

Mciveraephyllum gen. nov.

D i a g n o s i s . Leaves simple, with elliptical to obovate lamina, apex acute, base acute to cordate. Petiole slender and at least ¼ as long as the lamina. Lamina entire-margined to (more commonly) serrate, especially in the apical half. Teeth prominent, acute, but not spinose, apparently nonglandular with rounded sinuses. Venation pinnate, eucamptodromous to craspedodromous with 7–9 pairs of uniformaly spaced secondary veins arising at acute angles from the midvein. Intersecondary veins absent. Tertiary veins percurrent, weakly impressed.

T y p e s p e c i e s. *Mciveraephyllum nebrascense* (Schimper) comb. nov.

E t y m o l o g y. Named in memory of paleobotanist, Elisabeth E. McIver (1942 to 2001).

Mciveraephyllum nebrascense (Schimper) comb. nov.

Text-fig. 11

1868 *Cornus acuminata* Newberry, Lyceum Nat. Hist. New York Ann., 9, p. 71. [non Webber 1852].
1874 *Cornus nebrascensis* Schimper, Traité de paléontologie végétale 3, p. 54 [basionym].
1898 *Cornus newberryi* Hollick in Newberry, p. 124, pl. 37, figs 2–4.
1962 *Ficus artocarpoides* Lesquereux auct non. Brown [part], pl. 28, fig. 1–3, 5–7, not 4.
1993 *Cornophyllum newberryi* (Hollick) McIver et Basinger p. 45, pl. 35, figs 2–5, Pl. 36, figs 1–3.

L e c t o t y p e (designated here): USNM 8937 (Text-fig. 11.1; pl. 37, fig. 4 of Newberry 1898).

E m e n d e d D i a g n o s i s provided by McIver and Basinger (1993, "*Cornophyllum newberryi*"

As summarized by Peppe (2009), the diagnostic features of this species are the highly ascending, evenly spaced, eucamptodromous secondary veins that turn sharply up near the margin and become increasingly decurrent in their attachment to the mid-vein towards the base, and the tendancy for prominent marginal teeth. This species was initially called *Cornus acuminata* Newberry (1868) (subsequently renamed twice because the binomial was a junior homonym of *Cornus acuminata* Webber: *Cornus nebracensis* Schimper 1874 and *Cornus newberryi* Hollick in Newberry 1898) was founded on three syntypes from "Yellowstone River, Montana" [probably in the vicinity of present-day Miles City] ranging from entire-margined to, in the case of the lectotype, having prominent teeth in the upper half of the lamina (text-fig. 11; Brown 1962, Manchester et al. 2009).

Although extant *Cornus* can have a minutely erose margin (Hickey 1977), no species of this genus have prominent teeth, so the original assignment of this species to *Cornus* is not supported. One of the diagnostic features of *Cornus* leaves is the presence of abundant calcified double-armed acicular trichomes. This feature also does not occur in Newberry's species, although the trichomes are preseved and visible as impressions under high magnification in many genuine *Cornus* leaves from various sites of the Fort Union Formation (*Cornus swingii* Manchester, Xiang, Kodrul et Akhmetiev 2009). The lectotype, and other architecturally similar specimens, do not show any such trichomes. Although it is clear that Newberry's species does not belong to *Cornus*, the true systematic affinities remain uncertain. I therefore propose a new genus, *Mciveraephyllum,* accommodating *Mciveraephyllum nebrascense* (Schimper) comb. nov. McIver and Basinger (1993) also concluded that this species cannot be *Cornus*, and reassigned it to the genus *Cornophyllum* Newberry. However, *Cornophyllum* was diagnosed on the basis of entire-margined leaves from the Cretaceous Raritan of New Jersey (Newberry 1895), and therefore is not appropriate for this leaf type which commonly is toothed. Because the original binomial, *Cornus acuminata,* was illegitimate, the epithet with priority is *nebrascensis*, as explained by Peppe (2009).

Most of the leaves placed by Brown (1962) in *Ficus artocarpoides* Lesquereux belong to *Mciveraephyllum nebrascensis* [except for one of the figured specimens (Brown 1962, pl. 24, fig. 4) that subsequently transferred to *Leepierceia preartocarpoides* (R. W. Brown) K. Johnson (Johnson 1996)]. *M. nebrascensis* leaves vary from entire margined to dentate, with sharp, widely spaced teeth and rounded sinuses and have moderately long petioles. *Leepierceia* has laminae with similar teeth, but the base is usually cordate, and the tertiaries and higher order veins are much more prominent (Johnson 1996).

Wardiaphyllum daturaefolium (Ward) Hickey.

Brown (1962) attributed this distinctively toothed, long-petiolate leaf type to *Credneria? daturaefolia* Ward. These leaves are also common in the Paleocene Gao mine flora of Alberta (Stockey et al. 2013). No association with fruits or flowers has been detected.

Remaining species whose generic and familial assignments remain unproven

Other species included in Brown's monograph that have not been subjected to more detailed study include: *Apocynophyllum lesquereuxii* Ettingshausen (fragmentary leaves of uncertain affinity), *"Asimina" vesperalis* R. W. Brown, *Calycites hexaphylla* Lesquereux, "*Cercocarpus" ravenscragensis* Berry, *Dillenites garfieldensis* R. W. Brown, *Dombeyopsis magnifica* Knowlton, *"Fraxinus" eocenica* Lesquereux, *Hydrangea antica* R. W. Brown, *Phyllites demoresi* R. W. Brown, *Phyllites disturbans* R. W. Brown, *Phyllites pagosensis* Knowlton, *Ilex artocarpidioides* (Lesquereux) R. W. Brown, *Paliurus?* sp., *Zyzyphoides mackayi* Bell, *"Staphylea" minutidens* (Knowlton) R. W. Brown, *"Salix" aquilina* R. W. Brown ("These fragmentary leaves are referred to *Salix* with some hesitation." Brown 1962, p. 55).

"Ficus" affinis (Lesquereux) R. W. Brown. This entire-margined ovate leaf, "hesitatingly assigned to *Ficus*" by Brown (1962, p. 61) has three primary veins and 3–5 pairs of secondary veins arising from the upper half of the midvein. Particularly strong outer secondary veins arise somewhat above the base of both lateral primaries. The base of the lamina is decurrent on the petiole. Brown expanded the concept of this species to include narrow elliptical leaves based on co-occurrence with the broader ovate specimens on which the species was founded. Identification to the genus *Ficus* was not justified on the basis of morphological characters. Lesquereux's original assignment to *Cinnamomum*, or at least the familial attribution to Lauraceae, appears more likely to be correct. However, unique characters to identify this leaf with certainty have not been noted.

"Ficus" minutidens Knowlton has a broad ovate serrate lamina. Brown (1962 p. 62) stated that the acceptance of these leaves as *Ficus* "is made with reservations because they also resemble somewhat the leaves of *Hydrangea*, *Morus*, *Populus*, *Tilia*, and some *Vitis.*"

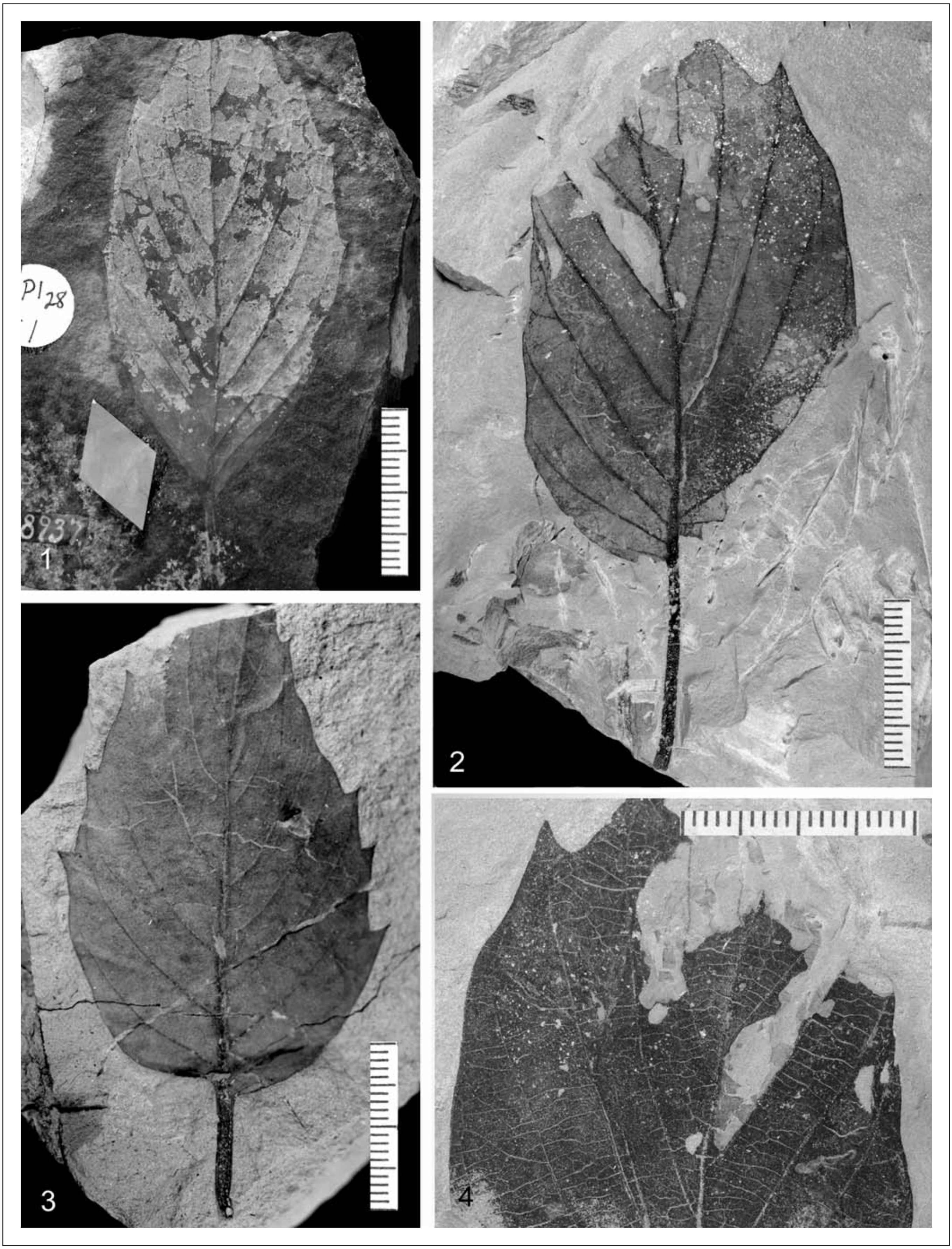
"Ficus" planicostata Lesquereux. These leaves are wide-ovate to elliptical with basally acrodromous venation consisting of a midvein and two strongly ascending lateral primaries. Agrophic veins are common in the lower half of the lamina, and well-marked percurrent tertiary veins are common. The petiole is stout, suggesting an evergreen leaf. Leaves of this species resemble those of some Lauraceae.

"Ficus" subtruncata Lesquereux has entire-margined elliptical leaves. "The assignment of these leaves to *Ficus* is unsatisfactory, but I have no better suggestion" (Brown 1962, p. 63).

"Ficus" uncata Lesquereux. "These leaves resemble some species of *Combretum* and *Magnolia*, and their present allocation is dubious." (Brown 1962, p. 64).

"Morus" montanensis R. W. Brown. This is an ovate leaf with a cordate base, attenuate apex and numerous small crenations. The crenations cover the lower and middle part of the lamina, but are missing from the apical area. Brown noted he had not found any lobed leaves like those from the living species of *Morus*.

"Nyssa" alata (Ward) R. W. Brown. Brown provided a synoymy for this species including 17 previously recorded occurrences. These are elliptical entire-margined leaves with



Text-fig. 11. Indet. family. ***Mciveraephyllum nebrascense*** **(Schimper) comb. nov. 1. Lectotype of** ***Cornus acuminata*** **Newberry 1868 [non Webber 1852] =** ***Cornus nebrascensis*** **Schimper 1874, p. 54, originally pl. 37, fig. 4 in Newberry 1898. Yellowstone River, Montana, USNM 8937. 2. Specimen from Black Buttes pit 3, Wyoming showing moderately long petiole and rounded tooth sinus. UF 15886-14308. 3. Specimen with more abundant teeth, Ludlow Formation, locality DMNH 563, Slope County, North Dakota, Collection of K. Johnson, DMNH 2206. 4. Detail of tertiary venation, counterpart specimen of that figured in 2. Scale bar = 2 cm.**

pinnate secondary veins—a common leaf architectural pattern not confined to *Nyssa*. As Brown stated then, "The assignment of these leaves to *Nyssa* is unconfirmed by any authentic seeds suggestive of the genus." (Brown 1962, p. 85).

"Nyssa" borealis R. W. Brown. This entire-margined leaf type, with secondaries arising at obtuse angles from the midvein, was named as a new species by Brown (1962). The base and apex are not preserved in the specimen figured.

"Nyssa?" obovata Knowlton. "No further light on the identity of this specimen has appeared" Brown (1962, p. 85).

"Rhamnus" geowandrewsii Watt. *Rhamnus hirsuta* R. W. Brown is a junior homomym of an extant species, so Watt, (1975) provided a new name, *Rhamnus geowandrewsii* Watt, for the species. Brown (1962, p. 77) stated "there is some doubt that these leaves represent *Rhamnus"*. Among those that he figured, all from the Shirley Canal site, Montana, there appears to be more than one taxon. Watt (1975) designated, fig. 3, of Brown (1962, pl. 39) as the lectotype which shows a lanceolate, entire-margined lamina with prominent percurrent tertiary veins. Some of the other figures appear to represent the same taxon showing development of scattered teeth. But figs 9, 10 of Brown (1962, pl. 39) with sharp prominent teeth, seem to represent two other unrelated taxa. No justification was been given for placing these leaves in Rhamnaceae. When present, teeth of Rhamnaceae should be blunt and glandular. The familial and generic affinity of "*Rhamnus*" *geowandrewsii* remains unknown.

Miscellaneous fruits/seeds

Although Brown's chief emphasis was on fossil leaves, he collected and analyzed reproductive structures as well. He provisionally retained several species of palms from earlier literature: *Palmocarpon commune* Lesquereux, *Palmocarpon compositum* Lesquereux, *Palmocarpon lineatum* Lesquereux, *Palmocarpon subcylindricum* Lesquereux, and *Palmocarpon truncatum* Lesquereux as components of the Paleocene flora but expressed some doubt as to whether they really represent palms (Brown 1962). I have not reexamined the specimens. Brown (1962) also devoted two plates near the end of his monograph to images of various reproductive structures, mostly unidentified, and labeled with some characteristic features, such as "flattened, carbonized fruit with scars," "spike or catkin of seeds," "oval fruit with several locules" etc. The affinities of some of these are now known as indicated in Table 2 (numbers 169–192).

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References

APG III (2009): An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants. – Bot J. Linnean Soc. 161(2), 105–121. http://dx.doi.org/10.1111/j.1095-8339.2009.00996.x

Arnold, C. A., Lowther, J. S. (1955): A new Cretaceous conifer from northern Alaska. – Am. J. Bot., 42: 522–528. http://dx.doi.org/10.2307/2438688

Ball, M. W., Stebinger, E. (1910): The eastern part of the Little Snake River Coal Field, Wyoming. – U. S. Geol. Surv. Bull., 471: 186–213.

Belt, E. S., Hartman, J. H., Diemer, J. A., Kroeger, T. J., Tibert, N. E., & Curran, H. A. (2004): Unconformities and age relationships, Tongue River and older members of the Fort Union Formation (Paleocene), western Williston Basin, USA. – Rocky Mountain Geol., 39(2): 113-140. http://dx.doi.org/10.2113/39.2.113

Barclay, R. S., Johnson, K. R., Betterton, W. J., Dilcher, D. L. (2003): Stratigraphy and megaflora of a K-T boundary section in the eastern Denver Basin, Colorado. – Rocky Mt. Geol., 38(1): 45–71. http://dx.doi.org/10.2113/gsrocky.38.1.45

Barnett, V. H. (1914): The Douglas oil and gas field, Converse County, Wyoming. – U. S. Geol. Surv. Bull., 541: 49-88.

Barthel, M. (1976): Eozäne Floren des Geiseltales: Farne und Cycadeen. Abhandlungen des Zentralen Geologischen Institutes. – Paläontol. Abhand., 26: 439–498.

Bauer, C. M., Herald, F. A. (1921): Lignite in the western part of the Fort Berthold Indian Reservation south of Missouri River, North Dakota. – U. S. Geol. Surv. Bull., 726: 109–172.

Beekly, A. L. (1915): Geology and coal resources of North Park, Colorado. – U. S. Geol. Surv. Bull., 596: 1–121.

Benedict, J. C., Pigg, K. B., DeVore, M. L. (2008): *Hamawilsonia* boglei gen. et sp. nov. (Hamamelidaceae) from the late Paleocene Almont flora of central North Dakota. – Int. J. Plant Sci., 169(5): 687–700. http://dx.doi.org/10.1086/533607

Berry, E. W. (1930): Fossil plants from the Cypress Hills of Alberta and Saskatchewan. – Bull. Nat. Mus. Canada. 63: 15–28.

Bowen, C. F. (1912): The Baker lignite field, Custer County, Montana. – U. S. Geol. Surv. Bull., 340: 202–226.

Bowen, C. F. (1914): The Big Sandy Coal Field, Chouteau County, Montana. – U. S. Geol. Surv. Bull., 541: 356–378.

Brant, R. A. (1953): Lignite resources of North Dakota. USGS Circular, 226: 1–78.

Brown, R. W. (1939a): Some American fossil plants belonging to the Isoetales. – J. Washington Acad. Sci., 29: 261–269.

Brown, R. W. (1939b): Fossil leaves, fruits, and seeds of *Cercidiphyllum*. – J. Paleont., 13(5): 485–499.
Brown, R. W. (1962): Paleocene flora of the Rocky Mountains and Great Plains. – U. S. Geol. Surv. Prof. Pap., 375: 1–119.
Bryson, R. P. (1952): The Coalwood Coal Field Powder River County, Montana. – U. S. Geol. Surv. Bull., 973-B: 23–106.
Budantsev, L. Y., Golovneva, L. B. (2009): Fossil Flora of Arctic II – Palaeogene Flora of Spitsbergen. Russian Academy of Sciences, Komarov Botanical Institute. Marafon, Saint Petersburg, 400 pp.
Catlett, S. R. (2007): Farmlands, Forts, and Country Life. The Story of Southwest Denver. Big Earth Publishing, Boulder, 240 pp.
Chaney, W. W., Sanborn, E. I. 1933. The Goshen flora of west Central Oregon. – Carnegie Inst Wash Pub. 439: 1-1-3
Chen, I., Manchester, S. R. (2007): Seed morphology of modern and fossil *Ampelocissus* (Vitaceae) and implications for phytogeography. – Am. J. Bot., 94: 1534–1553. http://dx.doi.org/10.3732/ajb.94.9.1534
Collier, A. J. (1919): Geology of Northeastern Montana. In: White, D. (ed.), Shorter Contributions to General Geology. – U. S. Geol. Surv. Prof. Paper, 120: 17–39.
Collier, A. J. (1925): The Scobey Lignite Field, Valley, Daniels, and Sheridan Counties, Montana. – U. S. Geol. Surv. Bull., 751: 157–230.
Collier, A. J., Smith, C. D. (1908): The Miles City Coal Field, Montana. - U. S. Geol. Surv. Bull., 341: 36-61.
Collier, A. J., Knechtel, M. M. (1939): The coal resources of McCone County, Montana. – U. S. Geol. Surv. Bull., 905: 1–77.
Collinson, M. E. (2001): Cainozoic ferns and their distribution. – Brittonia, 53(2): 173–235. http://dx.doi.org/10.1007/BF02812700
Crane, P. R. (1984): A re-evaluation of *Cercidiphyllum*-like plant fossils from the British early Tertiary. – Bot. J. Linn. Soc., 89: 199–230. http://dx.doi.org/10.1111/j.1095-8339.1984.tb02196.x
Crane, P. R. (1989): Early fossil history and evolution of the Betulaceae. – in Crane, P.R. and Blackmore, S. [eds.], Evolution, Systematics, and fossil history of the Hamamelidae, Volume 2: 'Higher' Hamamelidae, Syst. Assoc. Spec. Vol. 40B: 87–116, Clarendon Press, Oxford, England.
Crane, P. R., Manchester, S. R., Dilcher, D. L. (1988): Morphology and Phylogenetic significance of the angiosperm *Platanites hebridicus* from the Palaeocene of Scotland. – Palaeontology, 31: 503–517.
Crane, P. R., Stockey, R. A. (1985): Growth and reproductive biology of *Joffrea speirsii* gen. et. sp. nov., a *Cercidiphyllum*-like plant from the Late Paleocene of Alberta, Canada. – Canad. J. Bot., 63: 340–364. http://dx.doi.org/10.1139/b85-041
Crane, P. R., Manchester, S. R., Dilcher, D. L. (1990): A preliminary survey of fossil leaves and well-preserved reproductive structures from the Sentinel Butte Formation (Paleocene) near Almont, North Dakota. – Fieldiana Geol., 1418: 1–63.
Crane, P. R., Manchester, S. R., Dilcher, D. L. (1991): Reproductive and vegetative structure of *Nordenskioldia* (Trochodendraceae), a vesselless dicotyledon from the Early Tertiary of the Northern Hemisphere. – Am. J. Bot., 78: 1311-1334. http://dx.doi.org/10.2307/2445271
Crane, P. R., and Stockey, R. A. (1986): Morphology and development of pistillate inflorescences in extant and fossil Cercidiphyllaceae. – Ann. Missouri Bot. Gard., 73: 382–393. http://dx.doi.org/10.2307/2399118
Crane P. R., Stockey, R. A. (1987): *Betula* leaves and reproductive structures from the Middle Eocene of British Columbia. – Can. J. Bot., 65: 2490-2500. http://dx.doi.org/10.1139/b87-338
Davis, J. A. (1912): The Little Powder River Coal Field, Campbell County, Wyoming. – U. S. Geol. Surv. Bull., 796: 1–64.
Denk, T. Dillhoff, R.M. (2005): *Ulmus* leaves and fruits from the Early-Middle Eocene of northwestern North America: Systematics and implications for character evolution within Ulmaceae. – Can. J. Bot., 83: 1663–1681.
Dobbin, C. E. (1930): The Forsyth Coal Field, Rosebud, Treasure, and Big Horn Counties, Montana. – U. S. Geol. Surv. Bull., 812: 1–55.
Dobbins, C. E., Barnett, V. H. (1928): The Gillette Coal Field, Northeastern Wyoming. – U. S. Geol. Surv. Bull. 796A: 1–50.
Douglas, E. (1908–1909a): Vertebrate fossils from the Fort Union Formation. – Ann. Carnegie Mus., 5: 11–26.
Douglas, E. (1908–1909b). A Geological Reconnaissance in North Dakota, Montana, and Idaho, with Notes on Mesozoic and Cenozoic. – Ann. Carnegie Mus., 5: 211-288.
Earthpoint, accessed 2014. http://www.earthpoint.us/TownshipsSearchByDescription.aspx
Eldridge, G. H. (1896): Economic Coal. Geology of the Denver Basin in Colorado. – U. S. Geol. Surv. Monogr., 27: 317–465.
Ellis, B., Johnson, K. R., Dunn, R. E. (2003): Evidence for an in situ early Paleocene rainforest from Castle Rock, Colorado. – Rocky Mt. Geol., 38(1): 73–100. http://dx.doi.org/10.2113/gsrocky.38.1.173
Emmons, S. F., Cross, W., Eldridge, G. H. (1896): Geology of the Denver Basin in Colorado. – U. S. Geol. Surv. Monogr., 27: 1–278.
Endo, S. (1968): The flora from the Eocene Woodwardia Formation, Ishikari Coalfield, Hokkaido, Japan. – Bull. Natl. Sci. Mus. Tokyo, 11: 411–449.
Erdei, B, Manchester, S. R., Kvaček, Z. (2012): *Dioonopsis* Horiuchi et Kimura leaves from the Eocene of western North America: a cycad shared with the Paleogene of Japan. – Int. J. Plant Sci., 173(1): 81–95. http://dx.doi.org/10.1086/662654
Fedotov, V. V. (1970): New species of aspidiaceous and polypodiaceous ferns with sporangia from the Paleogene of the Zeya-Bureya depression. – Palaeontol. J., 4: 539–546.
Feng, G. P., Ablaev, A. G., Wang, Y. F., Li, C. S. (2002): Paleocene Wuyun flora in northeast China: *Amersinia* and *Beringiaphyllum* of Cornaceae. – Acta Bot. Sinica, 44(4): 481–487.

Feng, G. P., Ablaev, A. G., Wang, Y. F., Li, C. S. (2003): Paleocene Wuyun flora in Northeast China: *Ulmus furcinervis* of Ulmaceae. – Acta Bot. Sinica, 45(2): 146–151.

Feng, G. P., Li, C. S., Zhilin, S.G., Wang, Y. F., Gabrielyan, I. (2000): *Nyssidium jiayinense* sp. nov. (Cercidiphyllaceae) of the Early Tertiary flora from north-east China. – Bot. J. Linn. Soc. 134: 17I–181. http://dx.doi.org/10.1111/j.1095-8339.2000.tb00544.x

Freeman, W. B., Mathers, J. G. (1911): Surface water supply of the United States. 1910. Part VII. Lower Mississippi Basin. – U. S. Geol. Surv. Water-Supply Paper, 287: 1–264

Gardner, J. H. (1909): The coal field between Durango, Colorado, and Monero, New Mexico. – U. S. Geol. Surv. Bull., 341: 352–36.

Gemmill, C. E. C., Johnson, K. R. (1997): Paleoecology of a late Paleocene (Tiffanian) megaflora from the northern Great Divide Basin, Wyoming. – Palaios, 12: 439–448. http://dx.doi.org/10.2307/3515382

GEOLocate. Accessed 2014. Tulane University. www.museum.tulane.edu/geolocate

Gingerich, P. D., Rose, K. D., Krause, D. W. (2006): Early Cenozoic Mammalian Faunas of the Clark's Fork Basin-Polecat Bench Area, Northwestern Wyoming. – Pap. Paleont., 24: 51–68.

Goldman, M. I. (1910): The Colorado Springs Coal Field, Colorado. Contributions to Economic Geology 1908, Part II,-Mineral fuels. – U. S. Geol. Surv. Bull., 381: 317–340.

Golovneva, L. B. (1988): A new genus *Micoconium* (Cupressaceae) from the Late Cretaceous deposits of the north-east of the USSR. – Bot. Zhurn., 73: 1179–1183 (in Russian).

Golovneva, L. B. (1997): Morphology, Systematics and distribution of the genus *Haemanthophyllum* in the Paleogene floras of the Northern Hemisphere. – Paleont. J., 31(2): 197–207. (Orig. Paleont. Zhurn., 31(2): 77–87.)

Golovneva, L. B. (2000): Early Palaeogene floras of Spitsbergen and North Atlantic floristic exchange. – Acta Univ. Carol. Geol., 44(1): 39–50.

Golovneva, L. B. (2002): *Palaeocarpinus* (Betulaceae) from the Paleogene of Spitsbergen and Transatlantic floristic migrations. – Paleont. J., 36(4): 422–428. (Orig. Paleont. Zhurn., 31(4): 97–103.)

Golovneva, L. B. (2010): Variation in Epidermal Characters of *Ginkgo tzagajanica* Samylina (Ginkgoales) from the Paleocene of the Tsagayan Formation (Amur Region) and the taxonomy of Tertiary species of *Ginkgo*. – Paleont. J. 44 (5): 584–594. http://dx.doi.org/10.1134/S003103011005014X

GoogleEarth. Accessed 2014. www.google.com/earth

Guo, S.X., Sun, Z., Li, H., Dou, Y. (1984): Palaeocene flora from Altai in Xinjiang, Northwest China. – Bull. Nanjing Inst. Geol. Palaeont., Academia Sinica, 8: 119–146 (in Chinese with English summary).

Guo, S.-X., Kvaček, Z., Manchester, S. R., Zhou, Z.-K. (2012): *Ditaxocladus* (extinct Cupressaceae, Cupressoideae) from the Upper Cretaceous and Paleocene of the Northern Hemisphere. – Palaeontogr., Abt. B: Palaeobot. Palaeophytol. 288(5-6): 135–159.

Hail, W.J., Leopold E.B. (1960): Paleocene and Eocene age of the Coalmont Formation, North Park, Colorado. US Geol. Surv. Prof. Pap. 400: 260–261.

Hantke, R. (1954): Die fossile Flora der obermiozänen Oehninger-Fundstelle Schrotzburg (Schienerberg, Süd-Baden). – Denkschr. Schweiz. Naturforsch. Gesellsch., 80(3): 1–118.

Hares, C. J. (1928): Geology and lignite resources of the Marmarth Field, southwestern North Dakota. – U. S. Geol. Surv. Bull., 775: 1–110.

Hayden, F. V. (1869): Preliminary field report of the U.S. Geol. Survey of Colorado and New Mexico. – US. Geological Survey, Washington, 35 pp.

Hayden, F. V. (1885): Report of Dr. F. V. Hayden. – In: Powell, J.W. (ed), Fufth Annual Report of the United States Geological Survey 1883–84, pp. 28–30, U.S. Geol. Survey, Washington,

Heer, O. (1869): Contributions to the fossil flora of North Greenland, being a description of the plants collected by Mr. Edward Whymper during the summer of 1867. – Phil. Trans. Royal Soc. London 159: 445–488. http://dx.doi.org/10.1098/rstl.1869.0016

Heer, O. (1871): Die miocene Flora und Fauna Spitzbergens. – Flora Fossilis Arctica, Band 2, Heft 3: Kgl. Svenska vetenskapsakad. handlingar, 8 (7): 1–98.

Herald, F. A. (1912): The Terry Lignite Field, Custer County, Montana. – U. S. Geol. Surv. Bull., 471: 227–270.

Herald, F. A. (1913): The Williston Lignite Field, Williams County, North Dakota. – U. S. Geol. Surv. Bull., 531-E: 91–157.

Herendeen, P. S., Les, D. H., Dilcher, D. L. (1990): *Ceratophyllum* (Ceratophyllaceae) from the Tertiary of North America. – Am. J. Bot. 77: 7–16.

Herrera, F., Manchester, S. R., Hoot, S. B., Wefferling, K. M., Carvalho, M. R., Jaramillo, C. (2011): Phytogeographic implications of fossil endocarps of Menispermaceae from the Paleocene of Colombia. – Am. J. Bot., 98(12): 1–14. http://dx.doi.org/10.3732/ajb.1000461

Hettinger, R. D., Honey, J. G., Ellis, M. S., Barclay C. S. V., East, J. A. (2008): Geologic map of Upper Cretaceous and Tertiary strata and coal stratigraphy of the Paleocene Fort Union Formation, Rawlins-Little Snake River area, South-Central Wyoming. U. S. Geol. Surv., Denver.

Hewett, D. F. (1914): The Shoshone River section, Wyoming. – U. S. Geol. Surv. Bull., 541: 89–113.

Hewett, D. F. (1926): Geology and oil and coal resources of the Oregon Basin, Meeteetse, and Grass Creek Basin quadrangles. – U. S. Geol. Surv. Prof. Paper, 145: 1–10.

Hewett, D. F., Lupton, C. T. (1917): Anticlines in the southern part of the Big Horn Basin. – U. S. Geol. Surv. Bull., 656: 1–192.

Hickey, L. J. (1973): Classification of the architecture of dicotyledonous leaves. Am. – J. Bot., 60(1): 17–33.

Hickey, L. J. (1977): Stratigraphy and paleobotany of the Golden Valley Formation (Early Tertiary) of western North Dakota. – Geol. Soc. Am. Memoir., 150: 1–183.

Hickey, L. J. (1980): Paleocene stratigraphy and flora of the Clark's Fork Basin. Early Cenozoic paleontology and stratigraphy of the Bighorn basin, Wyoming. – Univ. Michigan Papers Paleont., 24: 33–49.

Hickey, L. J. (2001): On the nomenclatural status of the morphogenera, *Quereuxia* and *Trapago*. – Taxon, 50: 1119–1124.
http://dx.doi.org/10.2307/1224729

Hickey, L. J, Peterson, T. R. K. (1978): *Zingiberopsis*, a fossil genus of the ginger family from Late Cretaceous to early Eocene sediments of Western Interior North America. – Can. J. Bot., 56: 1136–1152.
http://dx.doi.org/10.1139/b78-128

Hicks, J. E., Johnson K. R., Obradovich, J. D., Miggins, D. P. (2003): Magnetostratigraphy of Upper Cretaceous (Maastrichtian) to lower Eocene strata of the Denver Basin, Colorado. – Rocky Mountain Geol. 38 (1): 1–27.
http://dx.doi.org/10.2113/gsrocky.38.1.1

Historic MapWorks. Accessed 2014.
www.historicmapworks.com

Hoffman, G. L., Stockey, R. A. (1999): Geological setting and paleobotany of the Joffre Bridge Roadcut fossil locality (Late Paleocene), Red Deer Valley, Alberta. – Can. J. Earth Sci., 36(12): 2073–2084.

Jähnichen, H. (1990): New records of the conifer *Amentotaxus gladifolia* (Ludgwig) Ferguson, Jähnichen and Alvin, 1978, from the Plish and Czechoslovakian Tertiary and its recognition in Canada, North America and Europe. – Tertiary Res., 12: 69–80.

Johnson, K. (1996): Description of seven common fossil leaf species from the Hell Creek Formation. – Proc. Denver Mus. Nat. Hist. Series 3, 12: 1–47.

Johnson, K. (2002): Megaflora of the Hell Creek and lower Fort Union Formations in the western Dakotas: Vegetational response to climate change, the Cretaceous-Tertiary boundary event, and rapid marine transgression. – In: Hartman, J, Johnson, K., Nichols, D. (eds.): The Hell Creek Formation and the Cretaceous-Tertiary boundary in the northern Great Plains: An integrated continental record of the end of the Cretaceous. – Geol. Soc. Am. Spec. Pap., 361: 329–391.

Johnson, K., Reynolds, M. L., Werth, K. W., and Thomasson, J. R. (2003): Overview of the Late Cretaceous, early Paleocene, and early Eocene megafloras of the Denver Basin, Colorado.

Johnson, R. B. (1958): Geology and coal resources of the Walsenburg area, Huerfano County, Colorado. – U. S. Geol. Surv. Bull., 1042-O: 557–583.

Johnson, R. B., Stephens, J. G. (1955): Geologic map of the Walsenburg Area, Huerfano County, Colorado. U. S. Geol. Surv. Oil and Gas Investigations Map OM-161.

Kauffman, E. G., Upchurch Jr, G. R., Nichols, D. J. (1990): The Cretaceous-Tertiary boundary interval at South Table mountain, near Golden, Colorado. – In: anonym (ed): Extinction events in earth history, Lecture notes 30: 365–392.

Knowlton, F. H. (1896): Paleontology. Section I. The fossil plants of the Denver Basin. – US Geol. Surv. Monogr., 27: 466–473.

Knowlton, F. H. (1902): Report on a small collection of fossil plants from the vicinity of Porcupine Butte, Montana. – Bull. Torrey Bot. Club, 29(12): 705–709.
http://dx.doi.org/10.2307/2478699

Knowlton, F. H. (1907): Field Notes #6, unpublished (FK-06-June13, 1907-Aug. 28, 1907.pdf).

Knowlton, F. H. (1908): Field Notes #8, unpublished (FK-08-July10, 1908 to Aug. 25, 1908.pdf).

Knowlton, F. H. (1910): Descriptions of fossil plants from the Mesozoic and Cenozoic of North America. – Smithsonian Misc. Coll. 52, 4: 489–496.

Knowlton, F. H. (1917): Fossil floras of the Vermejo and Raton formations of Colorado and New Mexico. – U. S. Geol. Surv. Prof. Paper, 101: 223–435.

Knowlton, F.H. (1919): A catalogue of the Mesozoic and Cenozoic plants of North America. – U. S. Geol. Surv. Bull., 696: 1–815.

Knowlton, F. H. (1922): The Laramie flora of the Denver Basin; with a review of the Laramie problem. – U. S. Geol. Surv. Prof. Paper, 130: 1–175.

Knowlton, F. H. (1924): Flora of the Animas Formation: – U. S. Geol. Surv. Prof. Paper, 134: 71–117.

Knowlton, F. H. (1930): The flora of the Denver and associated formations of Colorado: – U. S. Geol. Surv. Prof. Paper, 155: 1–142.

Krassilov, V. (1973): Cuticular structure of Cretaceous angiosperms from the Far East of the USSR. Palaeontographica, B, 142: 105–116.

Krassilov, V. (1976): Tsagayanskaya flora Amurskoy oblasti. Nauka, Moskva (in Russian).

Kvaček, Z., Manchester, S.R. (1999): *Eostangeria* Barthel (extinct Cycadales) from the Paleogene of western North America and Europe. – Int. J. Plant Sci., 160: 621–629.
http://dx.doi.org/10.1086/314152

Kvaček, Z., Manum, S.B. (1993): Ferns in the Spitsbergen Palaeogene. – Palaeontographica Abt. B 230: 169–181.

Kvaček, Z., Manchester, S. R., Guo, S.-X. (2001): Trifoliolate leaves of *Platanus bella* (Heer) comb. n. from the Paleocene of North America, Greenland, and Asia and their relationships among extinct and extant Platanaceae. – Int. J. Plant Sci., 162: 441–458.
http://dx.doi.org/10.1086/319574

Kvaček, Z., Manum, S.B., Boulter, M.C. 1994. Angiosperms from the Palaeogene of Spitsbergen, including an unfinished work by A.G. Nathorst. Palaeontographica, B, 232: 103–128.

LeConte, J. L. (1868): Notes on the geology of the survey for the extension of the Union Pacific railway from Smoky Hill, Kansas, to the Rio Grande, Philadelphia. 76 pp.

Lee, W. T. (1917): Geology of the Raton Mesa and other regions in Colorado and New Mexico. – U. S. Geol. Surv. Prof. Paper, 101: 9–221.

LePage, B. A. (2007): The taxonomy and biogeographic history of *Glyptostrobus* Endlicher (Cupressaceae). – Bull. Peabody Mus. Nat. Hist., 48(2): 359–426.

Leonard, A. G. (1906): Field Notes. Courtesy of Curt Hanson, Chester Fritz Library, University of North Dakota, January 2014.

Leonard, A. G. (1908): The geology of southwestern North Dakota with special reference to coal. State Geological Survey of North Dakota Fifth Biennial Report, pp. 27–114.

Lesquereux, L. (1872): Sixth Annual Report of the U.S. Geol. Survey of the Territories. 329 pgs.

Lesquereux, L. (1878): Contributions to the flora of the Western Territories II. The Tertiary flora. – Rept. U. S. Geol. Surv. Terr., 7: 1–366.

Lesquereux, L. (1883): Contributions to the flora of the Western Territories III. The Cretaceous and Tertiary floras. – Rept. U. S. Geol. Surv. Terr., 8: 1–283.

Lloyd, E. R. (1914): The Cannonball River Lignite Field, Morton, Adams, and Hettinger Counties, North Dakota. – U. S. Geol. Surv. Bull., 541: 243–291.

Lord, N. W. (1913): Analyses of coals in the United States with descriptions of mine and field samples collected between July 1, 1904 and June 30, 1910. – Dep. Interior, Bur. Mines Bull., 22: 1–1200.

Lupton, C. T. (1909): The eastern part of the Bull Mountain Coal Field, Montana. – U. S. Geol. Surv. Bull., 481: 163–189.

MacGinitie, H. D. (1974): An early Middle Eocene flora from the Yellowstone-Absaroka Volcanic Province, northwestern Wind River Basin, Wyoming. – Univ. Calif. Pub. Geol. Sci., 108: 1–103.

Manchester, S.R. (1981): Fossil plants of the Eocene Clarno Nut Beds. – Oregon Geol., 43: 75–81.

Manchester, S. R. (1986): Vegetative and reproductive morphology of an extinct plane tree (Platanaceae) from the Eocene of western North America. – Bot. Gaz., 147: 200–226.

Manchester, S. R. (1987): The fossil history of the Juglandaceae. – Missouri Bot. Gard. Monogr., 21: 1–137.

Manchester, S. R. (1989): Systematics and fossil history of the Ulmaceae – In Crane, P. R., Blackmore, S. (eds), Evolution, Systematics, and fossil history of the Hamamelidae, Volume 2: 'Higher' Hamamelidae, Systematics Association Special Volume no. 40B, pp. 221–252, Clarendon Press, Oxford.

Manchester, S. R. (1994): Fruits and seeds of the Middle Eocene Nut Beds flora, Clarno Formation, north central Oregon. Palaeontogr. – Am., 58: 1–205.

Manchester, S. R. (1999): Biogeographical relationships of North American Tertiary floras. – Annals Missouri Bot. Gard., 86: 472–522. http://dx.doi.org/10.2307/2666183

Manchester, S. R. (2001): Leaves and fruits of *Aesculus* (Sapindales) from the Paleocene of North America. – Int. J. Plant Sci., 162(4): 985–998. http://dx.doi.org/10.1086/320783

Manchester, S. R. (2002): Leaves and fruits of *Davidia* (Cornales) from the Paleocene of North America. – Syst. Bot., 27(2): 368–382.

Manchester, S. R., Chen, Z.-D. (1996): *Palaeocarpinus aspinosa* sp. nov. (Betulaceae) from the Paleocene of Wyoming, USA. – Int. J. Plant Sci., 157: 644–655. http://dx.doi.org/10.1086/297386

Manchester, S. R., Chen, Z.-D. (1998): A new genus of Coryloideae (Betulaceae) from the Paleocene of North America. – Int. J. Plant Sci., 159: 522–532. http://dx.doi.org/10.1086/297569

Manchester, S. R., Dilcher, D. L. (1982): Pterocaryoid fruits (Juglandaceae) in the Paleogene of North America and their evolutionary and biogeographic significance. – Am. J. Bot., 69: 275–286. http://dx.doi.org/10.2307/2443015

Manchester, S. R., Dilcher, D. L. (1997): Reproductive and vegetative morphology of *Polyptera* (Juglandaceae) from the Paleocene of Wyoming and Montana. – Am. J. Bot., 84: 649–663. http://dx.doi.org/10.2307/2445902 PMid:21708618

Manchester, S. R., Guo, S.-X. (1996): *Palaeocarpinus* (extinct Betulaceae) from northwestern China: New evidence for Paleocene floristic continuity between Asia, North America and Europe. – Int. J. Plant Sci. – 157: 240–246. http://dx.doi.org/10.1086/297343

Manchester, S. R., Hickey, L. J. (2007): Reproductive and vegetative organs of Browniea gen. n. (Nyssaceae) from the Paleocene of North America. – Int. J. Plant Sci., 168(2): 229–249.

Manchester, S. R., Kodrul, T. M. (2014): Morphology, affinities and phytogeographic history of *Porosia* Hickey in the Cretaceous and Paleocene of North America and Asia. – Acta Palaeobot. 54(1): 77–99. http://dx.doi.org/10.2478/acpa-2014-0002

Manchester, S. R., Kress W. J. (1993): Fossil bananas (Musaceae): *Ensete oregonense* sp. nov. from the Eocene of western North America and its phytogeographic significance. – Am. J. Bot., 80: 1264–1272. http://dx.doi.org/10.2307/2445709

Manchester, S. R., Kvaček, Z. (2009): Fruits of *Sloanea* (Elaeocarpaceae) in the Paleogene of North America and Greenland. – Int. J. Plant Sci., 170(7): 941–950. http://dx.doi.org/10.1086/600148

Manchester, S. R. O'Leary, E. (2010): Distribution and identification of fin-winged fruits. – Bot. Rev., 76: 1–82. http://dx.doi.org/10.1007/s12229-010-9041-0

Manchester, S. R., Akhmetiev, M. A., Kodrul, T. (2002): Leaves and fruits of *Celtis aspera* (Newberry) comb. nov. (Celtidaceae) from the Paleocene of North America and eastern Asia. – Int. J. Plant Sci., 163: 725–736. http://dx.doi.org/10.1086/341513

Manchester, S. R., P. R. Crane, and D.L. Dilcher. (1991): *Nordenskioldia* and *Trochodendron* (Trochodendraceae) from the Miocene of northwestern North America. Bot. Gaz. 152: 357-368. http://dx.doi.org/10.1086/337898

Manchester, S. R., Crane, P. R., Golovneva, L. (1999): An extinct genus with affinities to extant *Davidia* and *Camptotheca* (Cornales) from the Paleocene of North America and Eastern Asia. – Int. J. Plant Sci., 160: 188–207. http://dx.doi.org/10.1086/314114

Manchester S. R., Pigg, K. B., Crane, P. R. (2004): *Palaeocarpinus dakotensis* sp. n. (Betulaceae: Coryloideae) and associated staminate catkins, pollen and leaves from the Paleocene of North Dakota. – Int. J. Plant Sci., 165: 1135–1148. http://dx.doi.org/10.1086/423870

Manchester, S. R., Xiang, Q.-Y. (J.), Kodrul, T. M., Akhmetiev, M. A. (2009): Leaves of *Cornus* (Cornaceae) from the Paleocene of North America and Asia confirmed by trichome characters. – Int. J. Plant Sci., 170(1): 132–142. http://dx.doi.org/10.1086/593040

Manchester, S. R., Xiang, X.-P., Xiang, Q.-Y. (2010): Fruits of Cornelian Cherries (Cornaceae: Cornus Subg. Cornus) in the Paleocene and Eocene of the Northern Hemisphere. – Int. J. Plant Sci., 171(8): 882–891.

Manum, S. (1966): *Ginkgo spitsbergensis* n. sp. from the Paleocene of Spitsbergen and a siscussion of certain Tertiary species of *Ginkgo* from Europe and North America. – Norsk Polarinst. Årb. 1965, 49–58.

Map-It. Accessed 2014. http://woodshole.er.usgs.gov/mapit/.

Maslova, N. P. (2002): A new plant of the family Platanaceae from the early Paleogene, reconstructed on the basis of leaves and inflorescences. – Paleontol. Zh., 2:, 89–101 [Paleontol. J. 36(2): 207–218].

Maslova. N. P. (2008): Association of vegetative and reproductive organs of platanoids (Angiospermae): Significance for systematics and phylogeny. - Paleontol. J., 42 (12): 1393–1404. http://dx.doi.org/10.1134/S0031030108120034

McIver, E. E., Basinger, J. F. (1987): *Mesocyparis borealis* gen et sp. nov.: fossil Cupressaceae from the early Tertiary of Saskatchewan, Canada. – Can. J. Bot., 65: 2338-2351. http://dx.doi.org/10.1139/b87-318

McIver, E. E., Basinger, J. F. (1989): The morphology and relationships of *Thuja polaris* sp. nov. (Cupressaceae) from the early Tertiary, Ellesmere Island, Arctic Canada. – Can. J. Bot., 67: 1903–1915. http://dx.doi.org/10.1139/b89-242

McIver, E. E., Basinger, J. F. (1990): Fossil seed cones of *Fokienia* (Cupressaceae) from the Paleocene Ravenscrag Formation of Saskatchewan, Canada. – Can. J. Bot., 68: 1609–1618. http://dx.doi.org/10.1139/b90-207

McIver, E. E., Basinger, J. F. (1993): Flora of the Ravenscrag Formation (Paleocene), southwestern Saskatchewan, Canada. – Palaeontogr. Can., 10: 1–167.

McNeill, J., Barrie, F. R., Buck, W. R., Demoulin, V., Greuter, W., Hawksworth, D. L., Herendeen, P. S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W. F., Smith, G. F., Wiersema, J. H., Turland, N. J. (2012). International code of nomenclature for Algae, Fungi, and Plants (Melbourne Code). Regnum Vegetabile 154. Koeltz Scientific Books. 208 pp.

Moiseeva, M. G. (2008): New Angiosperms from the Maastrichtian of the Amaam Lagoon Area (Northeastern Russia). – Paleont. J., 42 (3): 313-327. (orig in Russian: Paleont. Zhurn., 2008(3): 92–105.)

Melchoir, R. C., Hall, J. W. (1983): Some megaspores and other small fossils from the Wannagan Creek site (Paleocene), North Dakota. – Palynology, 7: 1, 133–145. http://dx.doi.org/10.1080/01916122.1983.9989255

National Geologic Map Database. Accessed 2014. http://ngmdb.usgs.gov/ngmdb/ngmdb_home.html

Newberry, J. S. (1868): Notes on the later extinct floras of North America, with descriptions of some new species of fossil plants from the Cretaceous and tertiary strata. – Lyceum Nat. Hist. New York Ann., 9: 1–76. http://dx.doi.org/10.1111/j.1749-6632.1870.tb00175.x

Newberry, J. S. (1878): Illustrations of Cretaceous and Tertiary plants of the western Territories of the United States. [publisher not indicated; see A. Hollick's explanation, p. xv in the editor's preface to Newberry (1898)].

Newberry, J. S. (1895): The flora of the Amboy clays. – U. S. Geol. Survey Mon. 26, p. 1–137, 58 pls.

Newberry, J. S. (1898): The later extinct floras of North America. – U. S. Geol. Surv. Monogr., 35: 1–295, 68 pls.

Nichols, D. J., Ott, H. L. (1978): Biostratigraphy and evolution of the Momipites-Caryapollenites lineage in the early Tertiary in the Wind River Basin, Wyoming. – Palynology, 2: 93–112.

Nichols, D. J., Ott, H. L. (2006): Neotypes for Paleocene species in the *Momipites–Caryapollenites* pollen lineage. – Palynology, 30(2006): 33–41. http://dx.doi.org/10.1080/01916122.2006.9989617 http://dx.doi.org/10.2113/gspalynol.30.1.33

Paleobiology Database. Accessed 2014. Fossilworks. http://fossilworks.org.

Peppe, D. J. (2009): A high resolution chronostratigraphic study of the early Paleocene floral record in the northern Great Plains. – PhD dissertation, Yale University, New Haven, Connecticut. 590 pp.

Peppe, D. J. (2010): Megafloral change in the early and middle Paleocene in the Williston Basin, North Dakota, USA. – Palaeogeogr., Palaeoclimatol., Palaeoecol., 298(3-4): 224–234. http://dx.doi.org/10.1016/j.palaeo.2010.09.027

Peppe, D. J., Hickey, L. J. (2014): Fort Union Formation fossil leaves (Paleocene, Williston Basin, North Dakota, USA) indicate evolutionary relationships between Paleocene and Eocene plant species. – Bull. Peabody Mus. Nat. His. 55(2): 171–189. http://dx.doi.org/10.3374/014.055.0209

Peppe, D. J., Evans, D. A. D., & Smirnov, A. V. (2009): Magnetostratigraphy of the Ludlow Member of the Fort Union Formation (Lower Paleocene) in the Williston Basin, North Dakota. Geol. Soc. Amer. Bull., 121(1-2): 65–79.

Pepperberg, L. J. (1910): The Milk River Coal Field, Montana. – U. S. Geol. Surv. Bull., 381: 82–107.

Pepperberg, L. J. (1912): The southern extension of the Milk River Coal Bed, Chouteau County, Montana. – U. S. Geol. Surv. Bull., 471: 359–383.

Pigg, K. B., DeVore, M. L. (2010): Floristic composition and variation in late Paleocene to early Eocene floras in North America. – Bull. Geos., 85(1): 135–154. http://dx.doi.org/10.3140/bull.geosci.1136

Pigg K. B., DeVore, M. L., Wojciechowski, M. F. (2008): *Paleosecuridaca curtisii* gen. et sp. nov., *Securidaca*-like samaras (Polygalaceae) from the Late Paleocene of North Dakota, USA and their significance to the divergence of families within the Fabales. – Int. J. Plant Sci., 169: 1304–1313. http://dx.doi.org/10.1086/591981

Pigg, K. B., Stockey, R. A. (1991): Platanaceous plants from the Paleocene of Alberta, Canada. – Rev. Palaeobot. Palynol., 70: 125–146. http://dx.doi.org/10.1016/0034-6667(91)90082-E

Pigg, K.B., Manchester, S.R. and DeVore, M.L. (2008): Fruits of Icacinaceae (Tribe Iodeae) from the Late Paleocene of western North America. – Am. J. Bot., 95: 824–833. http://dx.doi.org/10.3732/ajb.2007340

Pishel, M. (1912): Lignite in the Fort Berthold Indian Reservation North Dakota, north of the Missouri River. – U. S. Geol. Surv. Bull., 471: 170–186.

Raven, P. H., Axelrod, D. I. (1974): Angiosperm biogeography and past continental movements. – Ann. Missouri Bot. Gard. 61: 539–673.

Read, R. W., Hickey, L. J. (1972): A revised classification of fossil palm and palm-like leaves. – Taxon, 21: 129–137. http://dx.doi.org/10.2307/1219237

Reeside, J. B. Jr. (1924): Upper Cretaceous and Tertiary Formations of the western part of the San Juan Basin of

Colorado and New Mexico. – U. S. Geol. Surv. Prof. Paper, 134: 1–70.
Richardson, G. B. (1910): The Trinidad Coal Fields, Colorado. – U. S. Geol. Surv. Bull., 381: 379–446.
Richardson, G. B. (1911): The Monument Creek Group. – Geol. Soc. Am. Bull., 23: 267–276.
Richardson, G. B. (1915): Description of the Castle Rock quadrangle, Colorado. – U. S. Geol. Surv. Geological Atlas, Castle Rock foilio 198.
Richardson, G. B. (1917): Note on the age of the Scranton Coal, Denver Basin, Colorado. – Am. J. Sci., 43: 243–244. http://dx.doi.org/10.2475/ajs.s4-43.255.243
Rothwell, G. W., Stockey, R. A. (1991): *Onoclea sensibilis* in the Paleocene of North America, a dramatic example of structural and ecological stasis. – Rev. Palaeobot. Palynol., 70(1-2): 113–124. http://dx.doi.org/10.1016/0034-6667(91)90081-D
Saporta, G. (1865): Études sur la végétation du sud-est de la France à l'époque tertiaire. – Ann. sci. nat., Bot., 5th ser., 4: 5-264, pls. 1–13.
Saporta, G. (1868): Prodrome d'une flore fossile des travertine anciens de Sézanne. – Soc. géol. France Mém., 2d ser., 8: 289–436, pls. 1–15.
Schimper WP 1874 Traité de paléontologie végétale ou la flore du monde primitif dans ses rapports avec les Formations Géologiques et la Flora du Monde Actuel. Vol 3. JB Bailliére, Paris.
Schultz, A. R. (1910): The southern part of the Rock Springs Coal Field, Sweetwater County, Wyoming. – U. S. Geol. Surv. Bull., 381: 214–281.
Schweitzer, H.-J. (1974): Die Tertiären Koniferen Spitzbergens. – Palaeontogr. Abt. B Palaeophytol., 149: 1–89.
Secord, R., Gingerich, P. D., Smith, M. E., Clyde, W. C., Wilf, P., & Singer, B. S. (2006): Geochronology and mammalian biostratigraphy of middle and upper Paleocene continental strata, Bighorn Basin, Wyoming. – Amer. J. Sci., 306(4): 211–245. http://dx.doi.org/10.2475/ajs.306.4.211
Smith, C. D. (1910): The Fort Peck Indian Reservation lignite field, Montana. – U. S. Geol. Surv. Bull., 381: 40–59.
Sprain, C. J., Renne, P. R., Wilson, G. P., & Clemens, W. A. (2014): High-resolution chronostratigraphy of the terrestrial Cretaceous-Paleogene transition and recovery interval in the Hell Creek region, Montana. – Geol. Soc. Amer. Bull., 126 (in press).
Stiehler, A. W. (1857): Beiträge zur Kenntniss der vorweltlichen Flora des Kreidegebirges im Harze. II. Die Flora des Langeberges bei Quedlinburg. – Palaeontographica, 5: 71–80.
Stockey, R. A., Manchester, S. R. (1988): A fossil flower with in situ *Pistillipollenites* from the Eocene of British Columbia. – Can. J. Bot., 66: 313–318. http://dx.doi.org/10.1139/b88-051
Stockey, R. A., Rothwell, G. W. (1997): The aquatic angiosperm *Trapago angulata* from the upper Cretaceous (Maastrichtian) St. Mary River Formation of southern Alberta. – Int. J. Plant Sci., 158(1): 83–94. http://dx.doi.org/10.1086/297417
Stockey, R. A., Hoffman, G. L., Rothwell, G. W. (1997): The fossil monocot *Limnobiophyllum scutatum*: Resolving the phylogeny of Lemnaceae. – Am. J. Bot., 84: 355–368. http://dx.doi.org/10.2307/2446009 PMid:21708589
Stockey, R. A., Hoffman, G. L., Rothwell, G. W. (2013): Paleobotany and paleoecology of Gao Mine, a late Paleocene fossil locality near Red Deer, Alberta, Canada. – Can. J. Earth Sci., 50: 235–248. http://dx.doi.org/10.1139/cjes-2012-0073
Stockey, R.A, Hoffman, G.L., Vavrek, M. J. (2014): Paleobotany and Palynology of the Munce's Hill fossil locality near Red Deer, Alberta, Canada. Ch. 13, pp. 367-388 in W.D. Stevens, O. M Montiel and P.H. Raven, eds. Paleobotany and biogeography. Missouri Botanical Garden Press, St. Louis, 404 pp.
Stockey, R. A., Lantz, T. C., Rothwell, G. W. (2006): *Speirseopteris orbiculata* gen. et sp. nov. (Thelypteridaceae), A derived fossil filicalean from the Paleocene of western North America. - Int. J. Plant Sci. 167(3): 729–736. http://dx.doi.org/10.1086/501233
Stockey, R. A., Rothwell, G. W., Falder, A. B. (2001): Diversity among taxodioid conifers: *Metasequoia foxii* sp. nov. from the Paleocene of central Alberta, Canada. – Int. J. Plant Sci., 162(1): 221–234. http://dx.doi.org/10.1086/317914
Stone, R. W., Calvert, W. R. (1910): Stratigraphic relations of the Livingston Formation of Montana. Econ. Geol., 5: 551–557. http://dx.doi.org/10.2113/gsecongeo.5.7.652 http://dx.doi.org/10.2113/gsecongeo.5.8.741 http://dx.doi.org/10.2113/gsecongeo.5.6.551
Stone, R. W., Lupton, C. T. (1910): The Powder River Coal Field, Wyoming, adjacent to the Burlington Railroad. – U. S. Geol. Surv. Bull., 381: 115–136.
Stull, G. W., Herrera, F., Manchester, S. R., Jaramillo, C., Tiffney, B. H. (2012): Fruits of an "Old World" tribe (Phytocreneae; Icacinaceae) from the Paleogene of North and South America. – Syst. Bot., 37 (3): 784–794. http://dx.doi.org/10.1600/036364412X648724
Sun, F., Stockey, R. A. (1992): A new species of *Palaeocarpinus* (Betulaceae) based on infructescences, fruits, and associated staminate inflorescences and leaves from the Paleocene of Alberta, Canada. – Int. J. Plant Sci., 153: 136–146. http://dx.doi.org/10.1086/297015
Tanai, T. (1979): Late Cretaceous floras from the Kuji district, northeastern Honshu, Japan. – Jour. Fac. Sci. Hokkaido Univ. Ser. 4, 19(1-2): 75–136.
Tidwell, W. D., Parker, L. R. (1987): *Aurealcaulis crossii* gen. et sp. nov., An arborescent, osmundaceous trunk from the Fort Union Formation (Paleocene), Wyoming. – Am. J. Bot., 74 (6): 803–812. http://dx.doi.org/10.2307/2443861
Topographic maps. Accessed 2014. U. S. Dept. Int., U. S. Geol. Surv. http://geonames.usgs.gov/pls/topomaps/
Turland, N. (2013): The code decoded. A user's guide to the International Code of Nomenclature for algae, fungi, and plants. Regnum Vegetabile, 155: 1–169.
Unger, F. (1850): Die Gattung *Glyptostrobus* in der Tertiär-Formation. – Sitzungsberichte Kaiserl. Akad. Wissensch. Wein, Math.-Naturwiss., Classe 5: 434–435.
Upchurch, G. R., Jr., Dilcher, D. L. (1990): Cenomanian angiosperm leaf megafossils, Dakota Formation, Rose

Creek Locality, Jefferson County, Southeastern Nebraska. – U.S. Geol. Surv. Bull., 1915: 1–55.
Upchurch, G. R., Jr., Wolfe, J. A. (1987): Extinction patterns in Laurales at the Cretaceous-Tertiary boundary. – Am. J. Bot., 74: 692–693. Abstr.
Veatch, A. C. (1907): Geography and geology of a portion of southwestern Wyoming. – U.S. Geol. Surv. Prof. Paper, 316: 1–178.
Wang, Q. (2012): Nomenclatural notes on *Leguminosites* and several taxonomically relevant names (fossil Leguminosae). – Taxon, 61(4): 871–877.
Wang Yan-Hui, Ferguson D. K., Feng, G.-P., Wang, Y.-F., Zhilin, S.G., Li, C.-S., Popova-Tselenkova, S., Yang, J., Ablaev, A. G. (2009): The Phytogeography of the extinct angiosperm *Nordenskioeldia* (Trochodendraceae) and its response to climate changes. – Palaeogeogr. Palaeoclimat. Palaeoecol., 280: 183–192. http://dx.doi.org/10.1016/j.palaeo.2009.05.019
Ward, L. F. (1885a): Report of Mr. Lester F. Ward. - In: Powell, J.W. et al. (eds), Fifth Annual Report of the United States Geological Survey 1883-84, pp. U.S. Geol. Survey, Washington.
Ward, L. F. (1885b): Synopsis of the flora of the Laramie group. – U. S. Geol. Surv. Ann. Rep., 6: 400–570.
Ward, L. F. (1887): Types of the Laramie flora. – U. S. Geol. Surv. Bull., 37: 1–117.
Washburne, C. W. (1910): The South Park Coal Field, Colorado. – U. S. Geol. Surv. Bull., 381: 307–316.
Watt, A. D. (1971): Validation of names of species of fossil plants described by RW Brown in 1962. – Taxon, 20(4): 639–640. http://dx.doi.org/10.2307/1218282
Watt, A. D. (1975): A new name for *Rhamnus hirsuta* Brown ex Watt. – Taxon, 24(4): 488. http://dx.doi.org/10.2307/1219502
Weber O 1852 Die Tertiärerflora der Niederrheinischen Braunkohlenformation. Palaeontographica 2:115–236, pls 18–25.
Weed, W. H. (1898): Description of the Little Belt Moutains Quadrangle, Montana. – U. S. Geol. Surv. Atlas, Folio 56, 11 p., 4 maps.
Wegemann, C. H. (1912): The Sussex Coal Field, Johnson, Natrona, and Converse Counties, Wyoming. - U. S. Geol. Surv. Bull., 471: 441–471.
Wilf, P. (2002): Late Paleocene-early Eocene climate changes in southwestern Wyoming: Paleobotanical analysis. – Geol. Soc. Am. Bull., 112(2): 292–307.
Wilf, P., Beard, K. C., Davies-Vollum, K. S., Norejko, J. W. (1998). Portrait of a late Paleocene (early Clarkforkian) terrestrial ecosystem; Big Multi Quarry and associated strata, Washakie Basin, southwestern Wyoming. – Palaios, 13(6), 514–532. http://dx.doi.org/10.2307/3515344
Winchester, D. E. (1912): The Lost Springs Coal Field, Converse County, Wyoming. – U. S. Geol. Surv. Bull., 471: 472–515.
Winchester, D. E., Haies, C. J., Lloyd, E. R., Parks, E. M. (1916): The lignite field of northwestern South Dakota. - U. S. Geol. Surv. Bull., 627: 1–178.
Wing, S. L. (1998): Late Paleocene-early Eocene floral and climatic change in the Bighorn Basin, Wyoming. Late Paleocene-Early Eocene climatic and biotic events in the marine and terrestrial records. In: Aubry, M., Lucas S., Berggren W. (eds.): Late Paleocene-Early Eocene Biotic and Climatic Events. pp. 371–391, Columbia University Press, New York.
Wing, S. L, Alroy, J., Hickey, L. J. (1995): Plant and mammal diversity in the Paleocene to early Eocene of the Bighorn Basin. – Palaeogeogr. Palaeoclimat. Palaeoecol., 115: 117–155. http://dx.doi.org/10.1016/0031-0182(94)00109-L
Wing, S. L., Currano, E. D. (2013): Plant response to a global greenhouse event 56 million years ago. – Amer. J. Bot., 100(7): 1234–1254. http://dx.doi.org/10.3732/ajb.1200554
Wolfe, J. A. (1966): Tertiary plants from the Cook Inlet region, Alaska. – U. S. Geol. Surv. Prof. Paper, 398-B: 1–32.
Wolfe, J. A. (1977): Paleogene floras from the Gulf of Alaska region. – Geol. Surv. Prof. Paper, 997: 1–108.
Wolfe, J. A.; Tanai, T. (1987): Systematics, phylogeny, and distribution of *Acer* (maples) in the Cenozoic of western North America. – J. Fac. Sci. Hokkaido Univ. Ser. 4, 22(1): 1–246.
Wolfe, J. A., Wehr, W. C . (1987): Middle Eocene dicotyledonous plants from Republic, Northeastern Washington. – U. S. Geol. Surv. Bull., 1597: 1–25.
Woodruff, E. G. (1909): The Red Lodge Coal Field, Montana. – U. S. Geol. Surv. Bull., 341: 92–107.
Woolsey, L. H., Richards, R. W., Lupton, C. T. (1917): The Bull Mountain Coal Field, Musselshell and Yellowstone Counties, Montana. U.S. Government Printing Office, 218 p.
Yen, T.-G. (1952): Molluscan Fauna of the Morrison Formation. – U. S. Geol. Surv. Prof. Paper, 233-B: 1–51.
Zetter, R., Farabee, M. J., Pigg, K. B., Manchester, S. R., DeVore, M. L., Nowak, M, D. (2011): Palynoflora of the late Paleocene silicified shale at Almont, North Dakota, USA. – Palynology, 35: 1–33. http://dx.doi.org/10.1080/01916122.2010.501164
Zhou, Z., Quan, C., Liu Y.-S. C. (2012): Tertiary *Ginkgo* ovulate organs with associated leaves from North Dakota, USA, and their evolutionary significance. – Int. J. Plant Sci., 173: 67–80. http://dx.doi.org/10.1086/662651

Table 1. Current taxonomic assignments compared with the designations of Brown 1962.

Phylogenetic position	Current assignment[1]	Old name from Brown (1962)
Marchantiaceae	*"Marchantia" lignitica* (Ward) R. W. Brown	*Marchantia lignitica* (Ward) R. W. Brown
Marchantiaceae	*"Marchantia" pealei* Knowlton	*Marchantia pealei* Knowlton
Marchantiaceae	*Preissites wardii* Knowlton	*Preissites wardii* Knowlton
Moss	*"Hypnum" coloradense* R. W. Brown	*Hypnum coloradense* R. W. Brown
Moss	*"Mnium" montanense* R. W. Brown	*Mnium montanense* R. W. Brown
Isoetaceae	*Isoetites horridus* (Dawson) R. W. Brown and *Minerosporites dissimilis*	*Isoetites horridus* (Dawson) R. W. Brown
Selaginellaceae	*Selaginella berthoudii* Lesquereux	*Selaginella berthoudii* Lesquereux
Selaginellaceae	*Selaginella collieri* Knowlton	*Selaginella collieri* Knowlton
Selaginellaceae	*Selaginella monstrosa* (Hollick) R. W. Brown	*Selaginella monstrosa* (Hollick) R. W. Brown
Sphenophyte	*Equisetum* spp.	*Equisetum* spp
Schizaeaceae	*"Anemia" elongata* (Newberry) Knowlton	*Anemia elongata* (Newberry) Knowlton
Schizaeaceae	*Lygodium coloradense* Knowlton	*Lygodium coloradense* Knowlton
Osmundaceae	*Osmunda greenlandica* (Heer) R. W. Brown	*Osmunda greenlandica* (Heer) R. W. Brown
Osmundaceae	*Osmunda macrophylla* Penhallow	*Osmunda macrophylla* Penhallow
Onocleaceae	*Onoclea hesperia* R. W. Brown	*Onoclea hesperia* R. W. Brown
Dennstaedtiaceae	*Dennastra sorimarginata* McIver et Basinger	*Saccoloma gardneri* (Lesquereux) Knowlton
Dennstaedtiaceae	*"Dennstaedtia" americana* Knowlton (possibly *Coniopteris*)	*Dennstaedtia americana* Knowlton
Blechnaceae	*Woodwardia arctica* (Heer) R. W. Brown	*Woodwardia arctica* (Heer) R. W. Brown
Fern	*Allantodiopsis erosa* (Lesquereux) Knowlton et Maxon	*Allantodiopsis erosa* (Lesquereux) Knowlton et Maxon
Fern	*"Blechnum" anceps* (Lesquereux) R. W. Brown	*Blechnum anceps* (Lesquereux) R. W. Brown
Fern	*"Hymenophyllum" confusum* Lesquereux	*Hymenophyllum confusum* Lesquereux
Fern	*"Dryopteris" lakesii* (Lesquereux) Knowlton	*Dryopteris lakesii* (Lesquereux) Knowlton
Fern	*"Dryopteris" meeteetseana* R. W. Brown	*Dryopteris meeteetseana* R. W. Brown
Fern	*"Dryopteris" serrata* R. W. Brown	*Dryopteris serrata* R. W. Brown
Fern	*"Lastrea" goldiana* (Lesquereux) Lesquereux	*Lastrea goldiana* (Lesquereux) Lesquereux
Fern	*"Gleichenia" hesperia* R. W. Brown ex Watt	*Gleichenia hesperia* R. W. Brown ex Watt
cycad	*"Zamia" coloradensis* (Knowlton) R. W. Brown	*Zamia coloradensis* (Knowlton) R. W. Brown
cycad	*"Zamia" wyomingensis* R. W. Brown	*Zamia wyomingensis* R. W. Brown
cycad	*Eostangeria pseudopteris* Kvaček et Manchester	*na*
Ginkgoaceae	*Ginkgo cranei* Zhou, Quan et Liu	*Ginkgo adiantoides* (Unger) Heer
Amentotaxaceae	*Amentotaxus gladifolia* (Ludwig) Ferguson, Jähnichen et Alvin	*Amentotaxus campbellii* (Gardner) Florin
?Araucariaceae	*"Araucaria" longifolia* (Lesquereux) R. W. Brown	*Araucaria longifolia* (Lesquereux) R. W. Brown
Cupressaceae	*Glyptostrobus europaeus* (Brongniart) Unger	*Glyptostrobus nordenskioldii* (Heer) R. W. Brown
Cupressaceae	*Metasequoia occidentalis* (Newberry) Chaney; *Metasequoia foxii* Stockey, Rothwell et Falder	*Metasequoia occidentalis* (Newberry) Chaney
Cupressaceae	*"Taxodium" olrikii* (Heer) R. W. Brown	*Taxodium olrikii* (Heer) R. W. Brown
Cupressaceae	*Ditaxocladus catenulatus* (W.A. Bell) S.X. Guo, Z. Kvažek, Manchester et Z.K. Zhou	*Fokienia catenulata* (Bell) R. W. Brown
Cupressaceae	*Mesocyparis borealis* McIver et Basinger	*Thuja interrupta* Newberry
Nymphaeaceae	*Nymphaea pulchella* (Knowlton) R. W. Brown	*Nymphaea pulchella* (Knowlton) R. W. Brown
Nymphaeaceae	*Paleonuphar hesperium* R. W. Brown	*Paleonuphar hesperium* R. W. Brown
?Nymphaeaceae	*"Nymphaea" leei* (Knowlton) R. W. Brown	*Nymphaea leei* (Knowlton) R. W. Brown
Magnoliaceae	cf. *Liriodendron*. *"Bauhinia" wyomingana* R. W. Brown	*Bauhinia wyomingana* R. W. Brown
Lauraceae	*"Cinnamomum" sezannense* Watelet	*Cinnamomum sezannense* Watelet
Lauraceae	*"Laurus" socialis* Lesquereux	*Laurus socialis* Lesquereux
Lauraceae	*"Lindera" obtusata* (Ward) R. W. Brown	*Lindera obtusata* (Ward) R. W. Brown
Lauraceae	*"Persea" brossiana* Lesquereux	*Persea brossiana* Lesquereux
Lauraceae	*"Sassafras" thermale* (Lesquereux) R. W. Brown	*Sassafras thermale* (Lesquereux) R. W. Brown
Lauraceae	*Laurophyllum caudatum* (Knowlton) R. W. Brown	*Laurophyllum caudatum* (Knowlton) R. W. Brown
Lauraceae	*Laurophyllum perseanum* R. W. Brown ex Watt	*Laurophyllum perseanum* R. W. Brown ex Watt
Lauraceae	*"Melastomites" montanensis* R. W. Brown ex Watt	*Melastomites montanensis* R. W. Brown ex Watt
Lauraceae	*"Artocarpus" lessigiana* (Lesquereux) Knowlton	*Artocarpus lessigiana* (Lesquereux) Knowlton
Chloranthaceae	cf. *Crassidenticulum* Upchurch et Dilcher (1991)	*Myrtophyllum torreyi* (Lesquereux) Dorf
?Gramineae	"Grasslike monocotyledons"	Grasslike monocotyledons
? Alismataceae	*Haemanthophyllum* sp. 3 (Golovneva 1997)	*Alismaphyllites grandifolius* (Penhallow) R. W. Brown
Zingiberales	*Canna? magnifolia* Knowlton	*Canna? magnifolia* Knowlton
Zingiberales	*Zingiberites dubius* Lesquereux	*Zingiberites dubius* Lesquereux
Zingiberales	*Ensete goldianum* (Lesquereux) comb. nov. (seeds)	*Viburnum goldianum* Lesquereux seeds
Araceae	*Limnobiophyllum scutatum* (Dawson) Krassilov	*Hydromystria expansa* (Heer) Hantke
Palmae	*"Chamaedorea" danae* (Lesquereux) Berry	*Chamaedorea danae* (Lesquereux) Berry
Palmae	*Palmacites dorfi* (R. W. Brown) Read et Hickey	*Thrinax dorfii* R. W. Brown

[1] Binomials apply to leaves unless otherwise indicated.

Phylogenetic position	Current assignment	Old name from Brown (1962)
Palmae	*Paloreodoxites plicatus* (Lesquereux) Knowlton	*Paloreodoxites plicatus* (Lesquereux) Knowlton
Palmae	*Sabal imperialis* Dawson	*Sabal imperialis* Dawson
Palmae	*Sabalites grayana* (Lesquereux) Knowlton	*Sabal grayana* Lesquereux
Palmae	*Sabalites powellii* (Newberry) E.W. Berry	*Sabal powellii* Newberry
?Palmae	*"Palmocarpon" commune* Lesquereux (fruit)	*Palmocarpon commune* Lesquereux
?Palmae	*"Palmocarpon" compositum* Lesquereux (fruit)	*Palmocarpon compositum* Lesquereux
?Palmae	*"Palmocarpon" lineatum* Lesquereux (fruit)	*Palmocarpon lineatum* Lesquereux
?Palmae	*"Palmocarpon" subcylindricum* Lesquereux	*Palmocarpon subcylindricum* Lesquereux
?Palmae	*"Palmocarpon" truncatum* Lesquereux	*Palmocarpon truncatum* Lesquereux
Sabiaceae	*Meliosma rostellata* (Lesquereux) Crane, Manchester et Dilcher (fruit)	*Carpites rostellatus* Lesquereux
Nelumbonaceae	*Nelumbago montanum* (R. W. Brown ex Watt) McIver et Basinger (leaf and fruit)	*Nelumbium montanum* R. W. Brown ex Watt leaf and associated fruit
Nelumbonaceae	*Nelumbium tenuifolium* Lesquereux	*Nelumbium tenuifolium* Lesquereux
Nelumbonaceae	*Paleonelumbo macroloba* Knowlton	*Paleonelumbo macroloba* Knowlton
Platanaceae	*Macginitiea gracilis* (Lesquereux) J. Wolfe et Wehr	*Platanus nobilis* Lesquereux (5-lobed laminae) sensu Brown 1962
Platanaceae	*Macginitiea nobilis* (Newberry) comb. nov.	*Platanus nobilis* Newberry (3-lobed laminae) sensu Brown 1962
Platanaceae	*Macginitistemon mikanoides* (MacGinitie) Manchester (stamens)	"Calyx of a flower" (Brown 1962, pl. 68, figs 27–29)
Platanaceae	*Macginicarpa* sp. (infructescences)	*Sparganium antiquum* (Newberry) Berry
Platanaceae	*Platanites raynoldsii* (Newberry) comb. nov.	*Platanus raynoldsii* Newberry
Platanaceae	*Platanites marginata* (Lesquereux) K. Johnson	*Cissus marginata* (Lesquereux) R. W. Brown
?Platanaceae	*Dyrana flexuosa* (Newberry) Golovneva	*Quercus sullyi* Newberry
Trochodendraceae	*Nordenskioeldia borealis* Heer (fruit) and *Ziziphoides flabellum* (Newberry) Crane, Manchester et Dilcher	*Nordenskioldia borealis* Heer (R. W. Brown 1962, pl. 67, figs 13, 45), and "seeds with papillose inner surface" (Pl. 67, figs 9, 10, 14–16, 20, 22, 23)
Cercidiphyllaceae	*Trochodendroides genetrix* (Newberry) comb. nov. + *Nyssidium arcticum* (Heer) Iljinskaya. Brown's concept also included leaves of *Zizyphoides flabellum*	*Cercidiphyllum arcticum* (Heer) R. W. Brown (part).
Cercidiphyllaceae	*Archeampelos acerifolia* (Newberry) McIver et Basinger (1993)	*Ampelopsis acerifolia* (Newberry) R. W. Brown
Cercidiphyllaceae	winged seed probably from a *Nyssidum* fruit	*Liquidambar dakotense* R. W. Brown ex Watt
?Hamamelidaceae	*Hamamelites inaequalis* (Newberry) R. W. Brown	*Hamamelites inaequalis* (Newberry) R. W. Brown
Hamamelidaceae	Hamamelidaceae fruiting raceme	Longitudinal hollow studded with bilobed projections (pl. 65, fig. 44)
Cucurbitaceae	*Cucurbitaciphyllum lobatum* (Knowlton) comb. nov.	*Vitis lobata* (Knowlton) R. W. Brown
Fagaceae	*"Castanea" intermedia* Lesquereux	*Castanea intermedia* Lesquereux
?Fagaceae	*Fagopsiphyllum groenlandicum* (Heer) Manchester	*Quercus greenlandica* Heer
?Fagaceae	*"Quercus" asymmetrica* Trelease	*Quercus asymmetrica* Trelease
?Fagaceae	*"Quercus macneilii"* R. W. Brown	*Quercus macneilii* R. W. Brown
?Fagaceae	*"Quercus" yulensis* R. W. Brown	*Quercus yulensis* R. W. Brown
?Betulaceae	*"Betula" stevensonii* Lesquereux	*Betula stevensonii* Lesquereux
Betulaceae	*Palaeocarpinus joffrense* Sun et Stockey (infructescence and fruit)	Burlike objects
Betulaceae	*Cranea wyomingensis* Manchester et Chen (seeds)	unknown
Juglandaceae	*Cyclocarya brownii* Manchester et Dilcher (fruits), *Cyclocarya hispida* (R. W. Brown) comb. nov.	*Pterocarya hispida* R. W. Brown ex Watt
Juglandaceae	*Juglandicarya simplicarpa* Manchester (fruit)	*Juglandicarya* spp.
Juglandaceae	*Polyptera manningii* Manchester et Dilcher (fruit), *Juglandiphyllites glabra* (R. W. Brown ex Watt) Manchester et Dilcher	*Pterocarya glabra* R. W. Brown ex Watt
Juglandaceae	*"Carya" antiquorum* Newberry	*Carya antiquorum* Newberry
Rhamnaceae	*Rhamnites cleburnii* (Lesquereux) McIver et Basinger	*Rhamnus cleburnii* Lesquereux, and *"Magnolia" regalis* Heer sensu Brown
Rhamnaceae	*"Rhamnus" goldiana* Lesquereux	*Rhamnus goldiana* Lesquereux
Rhamnaceae	*Zizyphus fibrillosus* (Lesquereux) Lesquereux	*Zizyphus fibrillosus* (Lesquereux) Lesquereux
Rhamnaceae	cf. "*Rhamnus*" *goldiana* Lesquereux	*Magnolia regalis* Heer
?Rhamnaceae	*Paliurus*? sp.	*Paliurus*? fruit of Berry (1930)
Malvaceae	*Penosphyllum cordatum* (Ward) Hickey	*Pterospermites cordatus* Ward
Rutaceae?	*Porosia verrucosa* (Lesquereux) Hickey emend. Manchester et Kodrul (fruit)	*Hydromystria expansa* (Heer) Hantke (part)
Sapindaceae	*Acer* sp. fruit	*Acer* spp.
Sapindaceae	*Aesculus hickeyi* Manchester (leaf, leaflets and fruit)	*Carya antiquorum* Newberry (most of the leaflets figured by Brown, but not the type specimens of Newberry)
?Sapindaceae	*Deviacer wolfei* Manchester (fruit)	"Maplelike samaras, but probably of sapindaceous affinity" (Brown 1962, pl. 67, figs 6, 7)

Phylogenetic position	Current assignment	Old name from Brown (1962)
Leguminosae	Indet Leguminosae pods	*Robinia wardii* (Knowlton) R. W. Brown
Leguminosae	Pod of Leguminosae or Bignoniaceae or other plant	*Leguminosites coloradensis* Knowlton
Cannabaceae	*Celtis asperum* (Newberry) Manchester, Akhm. et Kodrul (leaf and fruit)	*Viburnum asperum* (Newberry) R. W. Brown
Ulmaceae	*Ulmites microphylla* (Newberry) comb. nov.	*Planera microphylla* Newberry; *Zelkova planeroides* (Ward) R. W. Brown
?Rosaceae	*Prunites mclearnii* (Berry) McIver et Basinger	*Prunus mclearnii* Berry
?Rosaceae	*"Persea" brossiana* Lesquereux	*Persea brossiana* Lesquereux
?Rosaceae	*"Prunus" careyhurstia* R. W. Brown ex Watt	*Prunus careyhurstia* R. W. Brown ex Watt
?Rosaceae	*"Prunus" coloradensis* Knowlton	*Prunus coloradensis* Knowlton
Vitaceae	*Vitis* or *Ampelocissus* sp. (seed)	*Vitis* sp. seed
Polygonaceae	*Paranymphaea crassifolia* (Newberry) Berry	*Paranymphaea crassifolia* (Newberry) Berry
Polygonaceae	*Podopterus antiqua* Manchester et O'Leary (winged fruit)	*Ulmus rhamnifolia* Ward (Brown 1962, pl. 24, fig. 18, as winged fruit)
Polygonaceae	*Polygonocarpum curtisii* Manchester et O'Leary (winged fruit)	*Ulmus rhamnifolia* Ward in Brown 1962, pl. 24, fig. 17 (winged fruit)
Ericaceae	*"Kalmia" elliptica* R. W. Brown	*Kalmia elliptica* R. W. Brown
Cornaceae	*Cornus swingii* Manchester, Xiang, Kodrul et Akhmetiev	*Cornus hyperborea* Heer (part) and *C. nebrascensis* Schimper (part, non type)
Nyssaceae	*Beringiaphyllum cupanioides* (Newberry) Manchester, Crane et Golovneva	*Viburnum cupanioides* (Newberry) R. W. Brown
Nyssaceae	*Browniea serrata* (Newberry) Manchester et Hickey (leaf, infructescence, fruit, and flowers)	*Eucommia serrata* (Newberry) R. W. Brown leaves and "Probably fruits with remnants of calyces" (Brown 1962, pl. 67, figs 11, 12, 17); "Calyx of a flower" (pl. 67, fig. 46)
Nyssaceae	*Davidia antiqua* (Newberry) Manchester (leaf and fruit)	*Viburnum antiquum* (Newberry) Hollick (leaves) and *Viburnum tilioides* Ward (fruits)
Icacinaceae	*Icacinicaryites linchensis* Pigg, Manchester et DeVore 2008 (fruit)	*Prunus corrugis* R. W. Brown ex Watt (smaller fruits)
Icacinaceae	*Icacinicaryites corruga* (R. W. Brown) Pigg, Manchester et DeVore (fruit)	*Prunus corrugis* R. W. Brown ex Watt (large fruit)
Icacinaceae	*Palaeophytocrene piggae* Stull (fruit)	Impression of a seed showing pits arranged in longitudinal rows (Brown 1962, pl. 67, fig. 26)
Bignoniaceae	Bignoniaceae (seed)	Two-winged seeds (Brown 1962, pl. 68, figs 17–22
Elaeocarpaceae	*Sloanea ungeri* (Heer) Manchester et Z. Kvaček (fruit)	*Carpolithes spinosus* Newberry, "Elliptic fruit with a fringe of hairs or filaments" Brown 1962, pl. 67, fig. 35)
Incertae Sedis	*Dicotylophyllum silberlingi* (R. W. Brown) J. Wolfe et Tanai 1987	*Acer silberlingii* R. W. Brown
Incertae Sedis	*Dicotylophyllum triloba* (Newberry) J. Wolfe et Tanai	*Acer newberryi* R. W. Brown
Incertae Sedis	*Dicotylophyllum hansonium* Peppe et Hickey	*Vitis olrikii* Heer sensu R.W. Brown
Incertae Sedis	*Averrhoites affinis* (Newberry) Hickey	*Sapindus affinis* (Newberry) R. W. Brown
Incertae Sedis	*Quereuxia angulata* (Newberry) Kryshtofovich	*Trapa angulata* (Newberry) R. W. Brown, and *Trapa paulula* (Bell) R. W. Brown, and *Cabomba inermis* (Newberry) Hollick
Incertae Sedis	*"Koelreuteria" annosa* R. W. Brown (fruit)	*Koelreuteria annosa* R. W. Brown
Incertae Sedis	*Leepierceia preartocarpoides* (R. W. Brown) K. Johnson	*Ficus artocarpoides* (Lesquereux) R. W. Brown (just one of Brown's illustrated specimens reassigned (1962, pl. 28, fig. 4) by Johnson (1996)
Incertae Sedis	*Mciveraephyllum nebrascense* (Schimper) comb. nov.	*Ficus artocarpoides* Lesquereux sensu Brown (except one of Brown's figured specimens, pl. 24, fig. 4 = *Leepierceia preartocarpoides* (R. W. Brown) K. Johnson)
Incertae Sedis	*Wardiaphyllum daturaefolium* (Ward) Hickey	*Credneria? daturaefolia* Ward
Incertae Sedis	*Cissites panduratus* Knowlton (according to Wolfe and Tanai 1987)	*Acer fragilis* Knowlton
Incertae Sedis	*Calycites polysepala* Newberry	*Calycites polysepala* Newberry
Incertae sedis	*"Juglans" berryana* (Knowlton) R. W. Brown	*Juglans berryana* (Knowlton) R. W. Brown
Incertae Sedis	*"Juglans" taurina* R. W. Brown ex Watt	*Juglans taurina* R. W. Brown ex Watt
Incertae Sedis	*"Salix" aquilina* R. W. Brown ex Watt	*Salix aquilina* R. W. Brown ex Watt
Incertae Sedis	*"Ficus" minutidens* Knowlton	*Ficus minutidens* Knowlton
Incertae Sedis	*"Ficus" planicostata* Lesquereux	*Ficus planicostata* Lesquereux
Incertae Sedis	*"Ficus" subtruncata* Lesquereux	*Ficus subtruncata* Lesquereux
Incertae Sedis	*"Ficus" uncata* Lesquereux	*Ficus uncata* Lesquereux
Incertae Sedis	*"Morus" montanensis* R. W. Brown	*Morus montanensis* R. W. Brown
Incertae Sedis	*"Asimina" vesperalis* R. W. Brown	*Asimina vesperalis* R. W. Brown
Incertae Sedis	*"Celtis" newberryi* Knowlton et Cockerell	*Celtis newberryi* Knowlton et Cockerell

Phylogenetic position	Current assignment	Old name from Brown (1962)
Incertae Sedis	*"Celtis" peracuminata* R. W. Brown	*Celtis peracuminata* R. W. Brown
Incertae Sedis	*"Ficus" affinis* (Lesquereux) R. W. Brown	*Ficus affinis* (Lesquereux) R. W. Brown
Incertae Sedis	*"Hydrangea" antica* R. W. Brown ex Watt	*Hydrangea antica* R. W. Brown ex Watt
Incertae Sedis	*"Magnolia" borealis* R. W. Brown	*Magnolia borealis* R. W. Brown
Incertae Sedis	*"Magnolia" berryi* (Knowlton) R. W. Brown	*Magnolia berryi* (Knowlton) R. W. Brown
Incertae Sedis	*"Magnolia" magnifolia* Knowlton	*Magnolia magnifolia* Knowlton
Incertae Sedis	*"Magnolia" rotundifolia* Newberry	*Magnolia rotundifolia* Newberry
Incertae Sedis	*"Rhamnus" geowandrewsii* Watt (1975)	*Rhamnus hirsuta* R. W. Brown ex Watt. (Non *Rhamnus hirsuta* Wight and Arnott 1834)
Incertae Sedis	*"Nyssa" alata* (Ward) R. W. Brown	*Nyssa alata* (Ward) R. W. Brown
Incertae Sedis	*"Nyssa" borealis* R. W. Brown	*Nyssa borealis* R. W. Brown
Incertae Sedis	*"Nyssa?" obovata* Knowlton	*Nyssa? obovata* Knowlton
Incertae Sedis	*"Apocynophyllum" lesquereuxi* Ettingshausen	*Apocynophyllum lesquereuxii* Ettingshausen
Incertae Sedis	*"Cercocarpus" ravenscragensis* Berry	*Cercocarpus ravenscragensis* Berry
Incertae Sedis	*"Fraxinus" eocenica* Lesquereux	*Fraxinus eocenica* Lesquereux
Incertae Sedis	*"Magnolia" berryi* (Knowlton) R. W. Brown	*Magnolia berryi* (Knowlton) R. W. Brown
Incertae Sedis	*"Ilex" artocarpidioides* (Lesquereux) R. W. Brown ex Watt	*Ilex artocarpidioides* (Lesquereux) R. W. Brown ex Watt
Incertae Sedis	*"Viburnum" solitarium* Lesquereux	*Viburnum solitarium* Lesquereux (Brown 1962, pl. 67, figs 33, 34)
Incertae Sedis	*"Staphylea" minutidens* (Knowlton) R. W. Brown	*Staphylea minutidens* (Knowlton) R. W. Brown
Incertae Sedis	*Cissites rocklandensis* R. W. Brown	*Cissites rocklandensis* R. W. Brown
Incertae Sedis	*"Dillenites" garfieldensis* R. W. Brown ex Watt	*Dillenites garfieldensis* R. W. Brown ex Watt
Incertae Sedis	*"Parthenocissus" ursina* R. W. Brown ex Watt	*Parthenocissus ursina* R. W. Brown ex Watt
Incertae Sedis	*"Dombeyopsis" magnifica* Knowlton	*Dombeyopsis magnifica* Knowlton

Table 2. Taxonomic determinations Brown 1962, in sequence as he presented them, followed by current name and comments. Numbers in left column indicate the species listed by locality in column 5 of Appendix Table 1. "Pl.", and "fig." refer to specific plates and figures of Brown (1962).

	Name applied by Brown (1962)	Current name, comments
1	*Marchantia lignitica* (Ward) R. W. Brown	accepted; thallus with similar areolation to extant genus
2	*Marchantia pealei* Knowlton	uncontested; thallus lacks areolation. [liverwort]
3	*Preissites wardii* Knowlton	uncontested
4	*Hypnum coloradense* R. W. Brown	questionable genus [moss]
5	*Mnium montanense* R. W. Brown	questionable genus [moss]
6	*Hymenophyllum confusum* Lesquereux	questionable; poorly preserved [fern]
7	*Allantodiopsis erosa* (Lesquereux) Knowlton et Maxon	uncontested, but some specimens may represent the cycad, *Eostangeria pseudopteris*
8	*Blechnum anceps* (Leqsuereux) R. W. Brown	questionable; no fertile material available [fern]
9	*Dennstaedtia americana* Knowlton	Kvaček and Manum (1993: 173, tab. 3) suggested should be transferred to the extinct genus *Coniopteris* of the Dicksoniaceae [fern]
10	*Dryopteris lakesii* (Lesquereux) Knowlton	questionable generic assignment (Collinson 1991) [fern]
11	*Dryopteris meeteetseana* R. W. Brown	questionable " "
12	*Dryopteris serrata* R. W. Brown	questionable " "
13	*Lastrea goldiana* (Lesquereux) Lesquereux	questionable " "
14	*Onoclea hesperia* R. W. Brown	see argument for placement in extant species, *O. sensibilis* (Rothwell and Stockey 1991) [Onocleaceae]
15	*Saccoloma gardneri* (Lesquereux) Knowlton	*Dennastra sorimarginata* McIver et Basinger. [Probably Dennstaedtiaceae (Collinson 2001)].
16	*Woodwardia arctica* (Heer) R. W. Brown	*Woodwardia gravida* Hickey. Another species, *W. maxoni* Knowlton, was included in synonymy by Brown (1962), but considered distinct by McIver and Basinger; (1993); (Collinson 2001) [Blechnaceae]
17	*Gleichenia hesperia* R. W. Brown ex Watt	Questionable generic placement (Brown 1962) [fern]
18	*Anemia elongata* (Newberry) Knowlton	*Anemia*-like sterile foliage (Collinson 2001) [Schizaeaceae]
19	*Lygodium coloradense* Knowlton	OK [Schizaeaceae]
20	*Osmunda greenlandica* (Heer) R. W. Brown	Tidwell and Parker (1987) described permineralized osmundaceous stem remains associated with pinnules of *O. greenlandica.* [Osmundaceae]
21	*Osmunda macrophylla* Penhallow	OK [Osmundaceae]
22	*Equisetum* spp.	OK [Equisetaceae]
23	*Isoetites horridus* (Dawson) R. W. Brown	OK Hickey (1977) recovered *in situ* megaspores similar to the dispersed spores of *Minerosporites dissimilis* [Isoetaceae]
24	*Selaginella berthoudii* Lesquereux	uncontested [Sellaginellaceae]
25	*Selaginella collieri* Knowlton	uncontested [Sellaginellaceae]
26	*Selaginella monstrosa* (Hollick) R. W. Brown	uncontested [Sellaginellaceae]

	Name applied by Brown (1962)	Current name, comments
27	*Zamia coloradensis* (Knowlton) R. W. Brown	lacks well preserved cuticle so it cannot be confirmed whether it represents *Zamia*, or another, perhaps extinct genus [cycad]
28	*Zamia wyomingensis* R. W. Brown	lacks well preserved cuticle so it cannot be confirmed whether it represents *Zamia*, or another, perhaps extinct, genus [cycad]
29	*Ginkgo adiantoides* (Unger) Heer	reassigned to *Ginkgo cranei* Zhou, Quan et Liu based on associated reproductive structures [Ginkgoaceae]
30	*Amentotaxus campbellii* (Gardner) Florin	*Amentotaxus gladifolia* (Ludwig) Ferguson, Jähnichen et Alvin (Jähnichen 1990) [Amentotaxaceae]
31	*Araucaria longifolia* (Lesquereux) R. W. Brown	unchallenged, but in need of closer investigation
32	*Glyptostrobus nordenskioldii* (Heer) R. W. Brown	*Glyptostrobus europaeus* (Brongniart) Heer according to Hickey (1977); authority corrected as *G. europaeus* (Brongniart) Unger (LePage 2007) [Cupressaceae]
33	*Metasequoia occidentalis* (Newberry) Chaney	partially overlapping with Paleocene *Metasequoia foxii* Stockey, Rothwell et Falder [Cupressaceae]
34	*Taxodium olrikii* (Heer) R. W. Brown	genus unconfirmed due to lack of convincing reproductive material [Cupressaceae]
35	*Fokienia catenulata* (Bell) R. W. Brown	*Ditaxocladus catenulatus* (W.A. Bell) S.X. Guo, Z. Kvaček, Manchester et Z.K. Zhou [Cupressaceae]
36	*Thuja interrupta* Newberry	*Mesocyparis borealis* McIver et Basinger (same kind of foliage, with attached cones) [Cupressaceae]
37	*Sparganium antiquum* (Newberry) Berry	Not *Sparganium,* rather it is an infructescence of *Macginicarpa* [Platanaceae]
38	*Alismaphyllites grandifolius* (Penhallow) R. W. Brown	illustrated specimens of Brown (1962) were reassigned to *Haemanthophyllum* sp. 3 (Golovneva 1997)
39	*Sagittaria megasperma* R. W. Brown ex Watt	rejected; well preserved globose infructescence containing winged fruits of uncertain affinities. Reillustrated here, text-fig. 3.1–3.3
40	*Hydromystria expansa* (Heer) Hantke	leaves of *Limnobiophyllum scutatum* (Dawson) Krassilov (1973) [Araceae] + unrelated fruits of Lesqueruex) Hickey emend. Manchester et Kodrul [40a in Appendix Table 1]
41	Grasslike monocotyledons	uncertain [monocot]
42	*Chamaedorea danae* (Lesquereux) Berry	affinity to *Chamaedorea* unconfirmed. [palm]
43	*Paloreodoxites plicatus* (Lesquereux) Knowlton	accepted by Read and Hickey (1972) [palm]
44	*Thrinax dorfii* R. W. Brown	*Palmacites dorfii* (R.W. Brown) Read et Hickey [palm]
45	*Sabal grayana* Lesquereux	*Sabalites grayana* (Lesquereux) Knowlton [palm]
46	*Sabal imperialis* Dawson	uncontested [palm]
47	*Sabal powellii* Newberry	*Sabalites powellii* (Newberry) Berry sensu Read and Hickey. (holotype is from Eocene Green River Fm) [palm]
48	*Canna? magnifolia* Knowlton	Specimen figured by Brown (pl. 15, fig. 2) was transferred to *Zingiberopsis isonervosa* Hickey by Hickey and Petersen (1978) [Zingiberales]
49	*Zingiberites dubius* Lesquereux	uncontested [Zingiberales]
50	*Salix aquilina* R. W. Brown ex Watt	"referred to *Salix* with some hesitation" (Brown 1962) [dicot]
51	*Carya antiquorum* Newberry	original leaflets of Newberry remain as *C. antiquorum* [Juglandaceae], but most leaflets figured by Brown (1962) are *Aesculus hickeyi* Manchester [Sapindaceae]
52	*Juglandicarya* spp.	*Juglandicarya simplicarpa* Manchester
53	*Juglans berryana* (Knowlton) R. W. Brown	questionable generic assignment
54	*Juglans taurina* R. W. Brown ex Watt	questionable generic assignment
55	*Pterocarya glabra* R. W. Brown ex Watt	*Polyptera manningii* Manchester et Dilcher (fruits), *Juglandiphyllites glabra* (R. W. Brown ex Watt) Manchester et Dilcher (leaves)
56	*Pterocarya hispida* R. W. Brown ex Watt	*Cyclocarya brownii* Manchester et Dilcher (fruits), *Cyclocarya hispida* (R. W. Brown) comb. nov. (leaves)
57	*Betula stevensonii* Lesquereux	perhaps Betulaceae, but probably not *Betula*
58	*Corylus insignis* Heer	*Craspedodromophyllum malmgrenii* (Heer) Golovneva [Betulaceae]
59	*Castanea intermedia* Lesquereux	uncontested, although no reproductive structures of this genus have been recovered
60	*Quercus asymmetrica* Trelease	uncontested, although no reproductive structures of this genus have been recovered
61	*Quercus greenlandica* Heer	*Fagopsiphyllum groenlandicum* (Heer) Manchester 1999 [Fagaceae?]
62	*Quercus macneilii* R. W. Brown	no reproductive structures of this genus have been recovered
63	*Quercus sullyi* Newberry	Most specimens that Brown illustrated appear to be *Dyrana flexuosa* (Newberry) Golovneva
64	*Quercus yulensis* R. W. Brown	possibly corresponding to *Fagopsiphyllum*
65	*Celtis newberryi* Knowlton et Cockerell	genus unconfirmed [dicot]
66	*Celtis peracuminata* R. W. Brown	genus unconfirmed [dicot]

	Name applied by Brown (1962)	Current name, comments
67	*Planera microphylla* Newberry	*Ulmites microphylla* (Newberry) comb n. [Ulmaceae]
68	*Ulmus rhamnifolia* Ward	Fruits attributed to this species by Brown were later identified as *Polygonocarpum curtisii* Manchester et O'Leary (Brown 1962, pl. 24, fig. 17) and *Podopterus antiqua* Manchester et O'Leary (Brown 1962, pl. 24, fig. 18) [Polygonaceae]. Leaves are *Ulmites microphylla* (Newberry) comb. nov. [Ulmaceae]
69	*Zelkova planeroides* (Ward) R. W. Brown	*Ulmites microphylla* (Newberry) comb. nov. [Ulmaceae]
70	*"Artocarpus" lessigiana* (Lesquereux) Knowlton	extinct genus of probable lauraceous affinity (Kirk Johnson pers. comm.)
71	*Ficus affinis* (Lesquereux) R. W. Brown	generic and familial assignment rejected
72	*Ficus artocarpoides* Lesquereux	genus rejected; not likely Moraceae; among specimens figured by Brown most are *Mciveraephyllum nebrascense* (Schimper) comb. nov., but one (pl. 24, fig. 4) is *Leepierceia preartocarpoides* (R. W. Brown) K. Johnson
73	*Ficus minutidens* Knowlton	generic and familial assignment rejected
74	*Ficus planicostata* Lesquereux	generic and familial assignment rejected
75	*Ficus subtruncata* Lesquereux	generic and familial assignment rejected
76	*Ficus uncata* Lesquereux	generic and familial assignment rejected
77	*Morus montanensis* R. W. Brown	generic assignment rejected; lacks occasional lobation of *Morus*
78	*Platanus nobilis* Newberry	*Macginitiea nobilis* (Newberry) comb. nov. (3-lobed laminae) + *Macginitiea gracilis* (Lesquereux) J. Wolfe et Wehr (5-lobed laminae) [Platanaceae]
79	*Platanus raynoldsii* Newberry	*Platanites raynoldsii* (Newberry) comb. nov. [Platanaceae]
80	*Credneria? daturaefolia* Ward	*Wardiaphyllum daturaefolium* (Ward) Hickey [Family unknown]
81	*Cinnamomum sezannense* Watelet	familial assignment OK, generic assignment questionable
82	*Laurophyllum caudatum* (Knowlton) R. W. Brown	OK
83	*Laurophyllum perseanum* R. W. Brown ex Watt	OK
84	*Laurus socialis* Lesquereux	*"Laurus" socialis* Lesquereux
85	*Lindera obtusata* (Ward) R. W. Brown	*"Lindera" obtusata* (Ward) R. W. Brown
86	*Persea brossiana* Lesquereux	*"Persea" brossiana* Lesquereux
87	*Sassafras thermale* (Lesquereux) R. W. Brown	*"Sassafras" thermale* (Lesquereux) R. W. Brown; illustrated specimens of Brown are not lobed. Suprabasal acrodromy is OK for Lauraceae. No cuticle.
88	*Cabomba inermis* (Newberry) Hollick	cf. roots of *Quereuxia*.
89	*Nelumbium montanum* R. W. Brown	*Nelumbago montanum* (R. W. Brown ex Watt) McIver et Basinger peltate leaves and fruit similar to *Nelumbo* [Nelumbonaceae]
90	*Nelumbium tenuifolium* Lesquereux	uncontested
91	*Nymphaea leei* (Knowlton) R. W. Brown	uncontested
92	*Nymphaea pulchella* (Knowlton) R. W. Brown	accepted [Nymphaeaceae]
93	*Paleonelumbo macroloba* Knowlton	accepted [Nelumbonaceae]
94	*Paleonuphar·hesperium* R. W. Brown	resembles extant *Nuphar* [Nymphaeaceae]
95	*Paranymphaea crassifolia* (Newberry) Berry	Polygonaceae according to McIver and Basinger (1993)
96	*Cercidiphyllum arcticum* (Heer) R. W. Brown	Heterogeneous taxon: leaves of *Trochodendroides genetrix* (Newberry) comb. nov. and *Zizyphoides flabellum* (Newberry) Crane, Manchester et Dilcher; plus fruits of *Nyssidium,* and *Nordenskioeldia*
97	*Magnolia berryi* (Knowlton) R. W. Brown	*"Magnolia" berryi* (Knowlton) R. W. Brown
98	*Magnolia borealis* R. W. Brown	*"Magnolia" borealis* R. W. Brown
99	*Magnolia magnifolia* Knowlton	*"Magnolia" magnifolia* Knowlton
100	*Magnolia regalis* Heer	*"Magnolia" regalis* Heer
101	*Magnolia rotundifolia* Newberry	*"Magnolia" rotundifolia* Newberry
102	*Hamamelites inaequalis* (Newberry) R. W. Brown	possibly Hamamelidaceae
103	*Liquidambar dakotense* R. W. Brown ex Watt	Not *Liquidambar*; probably the winged seed of *Nyssidium arcticum* (Heer) Iljinskaya
104	*Eucommia serrata* (Newberry) R. W. Brown	*Browniea serrata* (Newberry) Manchester et Hickey [Nyssaceae]
105	*Hydrangea antica* R. W. Brown ex Watt	*"Hydrangea" antica* R. W. Brown ex Watt
106	*Asimina vesperalis* R. W. Brown	*"Asimina"* vesperalis R. W. Brown
107	*Cercocarpus ravenscragensis* Berry	*"Cercocarpus" ravenscragensis* Berry
108	*Prunus careyhurstia* R. W. Brown ex Watt	*"Prunus" careyhurstia* R. W. Brown ex Watt
109	*Prunus coloradensis* Knowlton	*"Prunus" coloradensis* Knowlton
110	*Prunus corrugis* R. W. Brown ex Watt	*Icacinicaryites corruga* (R. W. Brown) Pigg, Manchester et DeVore (large fruit) and *Icacinicaryites linchensis* Pigg, Manchester et DeVore (smaller fruits)
111	*"Prunus" mclearni* Berry	*Prunites maclearnii* (Berry) McIver et Basinger
112	*Prunus perita* R. W. Brown ex Watt	*"Prunus" perita* R. W. Brown ex Watt

	Name applied by Brown (1962)	Current name, comments
113	*Bauhinia wyomingana* R. W. Brown	*"Bauhinia" wyomingana* R. W. Brown Not *Bauhinia*. Magnoliaceae, cf. *Liriodendron*.
114	*Leguminosites coloradensis* Knowlton	Brown (1962) was not sure if this represents Leguminosae or another family such as Bignoniaceae.
115	*Mimosites coloradensis* Knowlton [Coalmont Fm]	not restudied.
116	*Robinia wardii* (Knowlton) R. W. Brown	Leguminosae. These pods differ from the type material of *Robinia wardii*,and therefore require a different specific epithet. Clearly Leguminosae but not *Robinia* (Herendeen pers. comm. 2013)
117	*Staphylea minutidens* (Knowlton) R. W. Brown	*"Staphylea" minutidens* (Knowlton) Brown
118	*Acer fragilis* Knowlton	*Cissites panduratus* Knowlton (according to Wolfe and Tanai 1987)
119	*Acer newberryi* R. W. Brown	*Dicotylophyllum triloba* (Newberry) J. Wolfe et Tanai 1987
120	*Acer silberlingii* R. W. Brown	*Dicotylophyllum silberlingi* (R. W. Brown) J. Wolfe et Tanai 1987
121	*Acer* spp.	some of the fruits represent typical schizocarpic samaras of *Acer*; others are nonschizocarpic, representing the extinct genus *Deviacer* Manchester
122	*Sapindus affinis* (Newberry) R. W. Brown	*Averrhoites affinis* (Newberry) Hickey
123	*Koelreuteria annosa* R. W. Brown	Not *Koelreuteria*. [?Rutaceae]
124	*Ilex artocarpidioides* (Lesquereux) R. W. Brown ex Watt	*"Ilex" artocarpidioides* (Lesquereux) R. W. Brown ex Watt
125	*Paliurus?* sp.	Not rexamined. Published figure is a line drawing.
126	*Rhamnus cleburnii* Lesquereux	*Rhamnites cleburnii* (Lesquereux) McIver et Basinger
127	*Rhamnus goldiana* Lesquereux	*Rhamnus goldiana* Lesquereux
128	*Rhamnus hirsuta* R. W. Brown ex Watt. (Non *Rhamnus hirsuta* Wight et Arnott 1834)	*"Rhamnus" geowandrewsii* Watt (1975) [probably not Rhamnus or Rhamnaceae, however]
129	*Zizyphus fibrillosus* (Lesquereux) Lesquereux	*"Zizyphus" fibrillosus* (Lesquereux) Lesquereux
130	*Zyzyphoides mackayi* Bell	not restudied
131	*Ampelopsis acerifolia* (Newberry) R. W. Brown	*Archeampelos acerifolia* (Newberry) Mclver et Basinger (1993). [Cercidiphyllaceae?]
132	*Cissus marginata* (Lesquereux) R. W. Brown	*Platanites marginata* (Lesquereux) K. Johnson [Platanaceae]
133	*Cissites rocklandensis* R. W. Brown	uncertain familial affinity
134	*Parthenocissus ursina* R. W. Brown ex Watt	*"Parthenocissus" ursina* R. W. Brown ex Watt [uncertain family]
135	*Vitis lobata* (Knowlton) R. W. Brown	*Cucurbitaciphyllum lobatum* (Knowlton) comb. nov. [Cucurbitaceae]
136	*Vitis olrikii* Heer	*Dicotylophyllum hansonium* Peppe et Hickey (2014) [uncertain family]
137	*Vitis* sp.	seed characteristic of Vitaceae. It likely belongs either to *Vitis* or *Ampelocissus*.
138	*Dombeyopsis magnifica* Knowlton	*Dombeyopsis magnifica* Knowlton
139	*Pterospermites cordatus* Ward	*Penosphyllum cordatum* (Ward) Hickey 1977 [Malvaceae sl.]
140	*Dillenites garfieldensis* R. W. Brown ex Watt	*Dillenites garfieldensis* R. W. Brown ex Watt [uncertain family]
141	*Myrtophyllum torreyi* (Lesquereux) Dorf	rejected from Myrtaceae because the leaves are serrate; probably Chloranthaceae (Upchurch and Dilcher 1990)
142	*Trapa angulata* (Newberry) R. W. Brown	*Quereuxia angulata* (Newberry) Kryshtofovich (see Hickey 2001 for nomenclature review). [uncertain family]
143	*Trapa paulula* (Bell) R. W. Brown	*Quereuxia angulata* (Newberry) Kryshtofovich [uncertain family]
144	*Melastomites montanensis* R. W. Brown ex Watt	Likely to be leaves of Lauraceae.
145	*Cornus hyperborea* Heer	Possibly *Cornus swingii* Manchester, Xiang, Kodrul et Akhmetiev but lacking the diagnostic trichomes [Cornaceae?]
146	*Cornus nebrascensis* Schimper (nontype specimens figured under this name by Brown)	*Cornus swingii* Manchester, Xiang, Kodrul et Akhmetiev
147	*Nyssa alata* (Ward) R. W. Brown	*"Nyssa" alata* (Ward) R. W. Brown
148	*Nyssa borealis* R. W. Brown	*"Nyssa" borealis* R. W. Brown
149	*Nyssa? obovata* Knowlton	*"Nyssa"? obovata* Knowlton
150	*Kalmia elliptica* R. W. Brown	*"Kalmia" elliptica* R. W. Brown (entire-margined leaves; family and genus uncertain in my opinion)
151	*Fraxinus eocenica* Lesquereux	*"Fraxinus" eocenica* Lesquereux
152	*Apocynophyllum lesquereuxii* Ettingshausen	*Apocynophyllum lesquereuxii* Ettingshausen [uncertain family]
153	*Viburnum asperum* (Newberry) R. W. Brown	*Celtis asperum* (Newberry) Manchester, Akhmetiev et Kodrul [Cannabaceae]
154	*Viburnum cupanioides* (Newberry) R. W. Brown	*Beringiaphyllum cupanioides* (Newberry) Manchester, Crane et Golovneva [Nyssaceae]
155	*Viburnum tilioides* Ward	*Davidia antiqua* (Newberry) Manchester (fruits) [Nyssaceae]
156	*Viburnum antiquum* (Newberry) Hollick	*Davidia antiqua* (Newberry) Manchester (leaves) [Nyssaceae]
157	*Phyllites demoresi* R. W. Brown	*Phyllites demoresii* R. W. Brown
158	*Phyllites disturbans* R. W. Brown	*Phyllites disturbans* R. W. Brown
159	*Phyllites pagosensis* R. W. Brown	*Phyllites pagosensis* R. W. Brown
160	"Leaf with minute teeth"	not restudied
161	*Calycites hexaphylla* Lesquereux	*Calycites hexaphylla* Lesquereux

	Name applied by Brown (1962)	Current name, comments
162	*Calycites polysepala* Newberry	*Calycites polysepala* Newberry
163	*Carpolithes spinosus* Newberry	*Sloanea ungeri* (Heer) Manchester et Z. Kvaček [Elaeocarpaceae]
164	*Nordenskioldia borealis* Heer	*Nordenskioeldia borealis* Heer [note corrected spelling] [Trochodendraceae]
165	*Palmocarpon commune* Lesquereux	Not restudied
166	*Palmocarpon compositum* Lesquereux	Not restudied
167	*Palmocarpon lineatum* Lesquereux	Not restudied
168	*Palmocarpon subcylindricum* Lesquereux	Not restudied
169	*Palmocarpon truncatum* Lesquereux	Not restudied
170	*Viburnum goldianum* Lesquereux	Seeds of Zingiberales. *Ensete goldianum* (Lesquereux) comb. nov. Reillustrated here, text-fig. 3.4, 3.5.
171	*Viburnum solitarum* Lesquereux	*"Viburnum" solitarum* Lesquereux
172	*Carpites rostellatus* Lesquereux	*Meliosma rostellata* (Lesquereux) Crane, Manchester et Dilcher [Sabiaceae]
173	"Five-loculed fruit" (pl. 67, fig. 5)	Incertae sedis
174	"Maplelike samaras, but probably of sapindaceous affinity" (pl. 67, fig. 6, 7)	*Deviacer wolfei* Manchester [uncertain family]
175	"Seeds with papillose inner surface" (pl. 67, figs 9, 10, 14–16, 20, 22, 23)	*Nordenskioeldia borealis* dispersed seeds. [Trochodendraceae]
176	"Flattened, carbonized fruit with scars" (pl. 67, fig. 10)	Incertae sedis.
177	"Probably fruits with remnants of calyces" (pl. 67, fig. 11, 12, 17):	Fruit of *Browniea serrata* (Newberry) Manchester et Hickey [Nyssaceae]
178	*Nordenskioeldia borealis* Heer (pl. 67, fig. 13, 45)	*Nordenskioeldia borealis* Heer [Trochodendraceae; Crane et al. 1991]
179	"Spike or catkin of seeds" (pl. 67, fig. 21)	Interesting, well preserved, in need of detailed study
180	Impression of a seed showing pits arranged in longitudinal rows (pl. 67, fig. 26)	*Palaeophytocrene piggae* Stull (Stull et al. 2012)
181	Seeds with ridges and scattered glands (pl. 67, fig. 28, 29)	Indet.
182	Heart-shaped fruits or seeds (pl. 67, fig. 32)	Indet.
183	*Viburnum solitarium* Lesquereux (pl. 67, fig. 33, 34)	Indet.
184	"Elliptic fruit with a fringe of hairs or filaments" pl. 67, fig. 35)	*Sloanea ungeri* (Heer) Manchester et Z. Kvaček
185	Oval fruit with several locules (pl. 67, fig. 36)	Indet.
186	Oval seeds like figs 33 and 34 but rounded at the top, not squarish (pl. 67, fig. 38)	Indet.
187	Burlike objects (pl. 67, fig. 39–42, 47)	*Palaeocarpinus joffrense* Sun et Stockey fruits [Betulaceae]
188	Probably the fertile cone of an *Equisetum* (pl. 67, fig. 43)	*Equisetum* strobilus
189	Longitudinal hollow studded with bilobed projections (pl. 67, fig.44)	Hamamelidaceae raceme
190	Calyx of a flower (pl. 67, fig. 46)	Perianth of a *Browniea* fruit [Nyssaceae]
191	Roots with rootlets (pl. 68, figs 2, 7–11)	Indet.
192	"Two-winged seeds" (pl. 68, fig. 17–22)	Seeds of Bignoniaceae
193	"Probably a stone fruit" (pl. 68, fig. 25)	globose fruit, uncertain affinities
194	"Probably the glume of a grass" (pl. 68, fig. 26)	Indet.
195	"Calyx of a flower" (pl. 68, fig. 27–29)	*Macginitistemon mikanoides* (MacGinitie) Manchester [Platanaceae]
196	Spiny fruits, not cited	*Ceratophyllum furcatispinum* Herendeen, Les et Dilcher [Ceratophyllaceae]

Appendix Table 1. USGS localities providing the basis for Brown's (1962) synthesis. Taxon list numbers correspond to those in Table 2 and are based mainly on data provided by Brown (1962).

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
317	South Table Mountain, Golden, CO	39.745933°, -105.199616°	A. Lakes, June 1890, H.C. Beckwith	6, 7, 10, 13, 20, 24, 32, 43, 45, 49, 67, 70, 71, 74, 75, 79, 82, 90, 96, 99, 100, 124, 126, 127, 129, 131, 132, 138, 139, 147, 149, 150, 151, 159, 165, 167, 168, 169, 170, 171, 175	9, 21, 22, 29, 38, 41, 49, 57, 81
318	NW side of Green Mountain, Golden, CO	39.705858°, -105.185932°	A. Lakes, 1890	7, 16, 124	9, 22, 41, 57
320	South Table Mountain, Golden, CO	39.749116°, -105.163397°	A. Lakes, June 1890, H.C. Beckwith	Missing Data	9, 21, 22, 29, 38, 41, 49, 57, 81
321	South Table Mountain, Golden, CO	39.738672°, -105.206820°	A. Lakes, June 1890, H.C. Beckwith	Missing Data	9, 21, 22, 29, 38, 41, 49, 57
322	N face of South Table Mt., Golden, CO	39.761023°, -105.197532°	A. Lakes, 1890	8	9, 22, 57
324	South Table Mountain, Golden, CO	39.746576°, -105.194418°	A. Lakes, June 1890, H.C. Beckwith	Missing Data	9, 21, 22, 29, 38, 41, 49, 57, 81
325	3,000 ft E of Douglas (Lehigh) coal mine, 3 mi W of Sedalia, CO	39.437321°, -105.016653°	A. Lakes, 18 June, 1890	7, 9, 13, 15, 71, 74, 138, 139, 147, 169	9, 41, 49, 57, 64

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
326	Sandstone at coal seam in Laramie at Morrison, CO (Cretaceous)	39.648848°, -105.135235°	A. Lakes, June 1890	6	9, 22, 41, 57
331	1,900 ft E of Douglas (Lehigh) coal mine, Sedalia, CO	39.437124°, -105.020211°	A. Lakes, June 1890	131, 132, 136	9, 22, 41, 57
333, 334, 335, 8788	N side of Potato Hill Gap, 2 mi E of Hot Sulphur Springs, CO	40.085064°, -106.076361°	G.L. Cannon, summer, 1889	13, 16, 18, 22, 27, 96, 131	9, 57
336	Near Sheriff's coal shaft on Sheriff Cr., E of Hot Sulphur Springs, CO	40.088724°, -106.069460°	G.L. Cannon, summer, 1889	8, 87, 114	9, 49, 57
337, 338, 8787	Mount Bross, Hot Sulphur Springs, CO	40.079311°, -106.112206°	G. L. Cannon, summer, 1889	18, 32, 72, 78, 86, 87, 96, 105, 114, 131, 136, 145, 146, 151, 191	9, 57
436	Red Lodge, MT	45.183631°, -109.241900°*	W.H. Weed, 1891	40, 63	9, 57, 78
541	Head of Buck Cr., Niobrara Co., WY	43.173673°, -104.528630°*	J.B. Hatcher, 1892?	51, 59, 110	9, 25, 56, 57
607	Sweetgrass Cr., W of Porcupine Butte, MT	46.148061°, -110.175994°	W.H. Weed, July 5, 1892	14, 153	9, 42, 57, 74
1468	Lightning Cr., 2 mi above mouth of Walker Cr., Lance Cr., WY	43.151833°, -104.869980°	F.H. Knowlton & T.W. Stanton, July 15, 1896	96	9, 57
1471	Almy, WY, Mine no. 6	41.341111°, -111.000000°	T.W. Stanton & F.H. Knowlton, Aug. 14, 1896	161	9, 57, 70
1474	Almy, WY, Mine No. 5	41.331905°, -110.989131°	Stanton & F.H. Knowlton, Aug. 14, 1896	72	9, 57, 70
1502	2½ miles SE of Black Buttes, WY	41.518253°, -108.657314°	F.H. Knowlton, Aug. 4-5, 1896	18, 87, 122	9, 57, 66
2414	Clear Cr., 6 mi N of Yellow-stone R., 15 mi above Glendive, MT	46.984775°, -104.901808°	L.F. Ward, Aug. 1883	22, 58, 63, 68, 69, 78, 79, 136, 155, 156	9, 57, 79
2416, 2426, 8196	6 mi above mouth Sevenmile Cr., 10 mi NE of Glendive, MT	47.257583°, -104.716747°	L.F. Ward, Aug. 9-12, 1883	18, 29, 32, 34, 37, 40a, 45, 58, 69, 72, 78, 80, 83, 85, 96, 102, 104, 122, 139, 147, 156, 157	9, 43, 57, 71, 72, 79
2417, 2418, 2427	Crackerbox Cr., 18 mi NW of Glendive, MT	46.954150°, -104.975531°	C.A. White, July 28, 1882.	6, 22, 41, 153, 187	9, 78
2420	Burns, Montana	47.372667°, -104.399397°	C.A. White, Aug. 17, 1882	1, 3, 23, 25, 33, 34, 40, 79, 85, 96, 98, 104, 119, 131, 142, 154, 178	9, 57, 79
2421	Iron Bluff, 12 mi SW of Glendive, MT	46.956147°, -104.795483°	C.A. White, Aug 3, 1882	18, 40, 104, 142	9, 43, 57, 78
2422	2 mi E of Gladstone, N side of Heart R., ND	46.847440°, -102.528021°	A.C. Peale, Sept. 21, 1883	104, 122, 153	9, 38, 57
2423, 4984	Bull Mountains, 40 mi N of Billings, MT	46.240131°, -108.342221°	F.V. Hayden & A.C. Peale, Aug. 17, 1883	33, 34, 54, 57, 72, 78, 104,110	9, 30, 57, 79
2424	near Medora, ND	46.921803°, -103.540719°	F.V. Hayden & A.C. Peale, 1883	79, 155	9, 57
2432	Iron Bluff, 12 mi SW of Glendive, MT	46.956147°, -104.795483°	L.F. Ward, 15-17 July, 1883	23, 51, 95, 131	8, 9, 43, 57
3563	1 mi N-NE Nugget, WY	41.837286°, -110.816953°	Missing Data	33	9
3653, 5538, 5542	Evanston, WY, RR cut, 1 mi E of RR station	41.268069°, -110.946592°	A.C. Veatch, June 23, 1905	72, 87, 96, 131, 136	9, 57
3658, 5539	Almy, WY, Mine No. 7	41.346311°, -111.000046°	A.C. Veatch, 1905	57, 78, 82, 84, 96, 131, 151	9, 57, 70
3661	Almy, WY	41.345406°, -110.998336°	A.C. Veatch, 6 July, 1905	57, 83, 84, 96	9, 57
3667	Near Evanston, WY	41.318369°, -110.962281°	A.C. Veatch, 6 July, 1905	15	9, 57
3728	Mouth of Cedar Coulee, 4 mi SE of Williston, ND	48.111058°, -103.547936°	M.R. Campbell, 13 July, 1905	122	9, 32, 57
3852	Meeyero Cr., 8 mi SW of Winchester P.O., WY	43.777977°, -108.278140°*	C.A. Fisher, 1905	87, 96, 99, 114, 132	9, 57
3963	~7.3 mi W of Hanna, WY	41.858864°, -106.698117° 1 [SE sec. 24, T. 22 N, R. 83 W]	Missing Data	191	9,
3979, 4325	Signal Butte, 5 mi SE of Miles City, MT	46.390350°, -105.757889°	Leonard, Holgate & Clark, Aug. 28 and Sept. 1, 1906	58, 69, 83, 84	9, 15, 51, 52, 57
3980	Left bank Yellowstone R. across from Miles City, MT	46.422247°, -105.860586°	A.G. Leonard, W.R. Holgate, W.H. Clark, Sept. 3, 1906	89, 142, 146	9, 57
4005	12 mi SW of Glendive, MT	46.956283°, -104.795492°	Campbell, Leonard, Holgate & Clark, July 31, 1906	104	9, 57
4010	4 mi SW of Winchester P.O., WY	43.817897°, -108.217008°*	C.A. Fisher, Sept. 19, 1906	61	9, 57
4028	Turner ranch, 20 mi NW of Jordan, MT	47.508258°, -107.170894°*	A.G. Leonard, W.R. Holgate & W.H. Clark, Sept. 25, 1906	18, 36	9, 51
4029	13 mi N of Jordan, MT	47.498817°, -106.935753°*	A.G. Leonard, W.R. Holgate & W.H. Clark, Sept. 21, 1906	15, 14	9, 51, 57
4031	Kern ranch, 24 mi NW of Jordan, MT	47.583886°, -107.255092°*	A.G. Leonard, W.R. Holgate & W.H. Clark, Sept. 25, 1906	26, 40, 175	9, 51, 57
4032	Alkali Cr., 27 mi NW of Miles City, MT	?	Missing Data	77, 79, 96	9
4035	3 mi S of Griers Ranch, near Miles City, MT	~T. 14 N, R. 42 S	A.G. Leonard & W.R. Holgate, Sept. 11, 1906	69, 79	9, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
4050	3/4 mi E of Florida R. crossing, E of Durango, CO	37.274783°, -107.781053°	C.D. Smith for J.A. Taff 1906	110	9, 25, 57
4256	1½ mi NW of Coleharbor, ND	47.556258°, -101.250153°	F.H. Knowlton & A.C. Peale, June 29, 1907	96	9, 37, 57
4262, 4264	W side of Little Missouri R., 2 mi S of Medora, ND	46.905426°, -103.552291°	F.H. Knowlton, July 8, 1907	33, 51, 54, 67, 96, 156, 157, 158, 180	9, 43, 57
4268	Face of Picket Butte, near Custer Trail Ranch, 4 mi S of Medora, ND	46.859119°, -103.532078°	F.H. Knowlton & A.C. Peale, July 11, 1908	39	9, 25, 57
4272	Custer Trail Ranch ¼ mi SE of mouth of Davis Cr., S of Medora, ND	46.877470°, -103.531483°	F.H. Knowlton & A.C. Peale, July 12, 1907	6, 88	9, 43, 57
4273	Custer Trail Ranch, ¼ mi SE of mouth of Davis Cr., S of Medora, ND	46.866350°, -103.527175°	F.H. Knowlton & A.C. Peale, July 12, 1907	9, 96	9, 43, 47, 57
4280	S side of Yellowstone R., opposite Harpster's Ranch, ~10 mi NE of Glendive, MT	47.219964°, -104.625142°	F.H. Knowlton & A.C. Peale July 22, 1907	132	9, 43, 57
4289	Hedges Coal Mine, N side of Yellowstone R. opposite Miles City, MT	46.431919°, -105.839714°	F.H. Knowlton, A.C. Peale & A.J. Collier, Aug. 3, 1907	63	9, 43
4293	Hedges coal mine, N side of Yellowstone R., 1 mi N of Miles City, MT	46.431919°, -105.839714°	A.C. Peale, A.J. Collier & F.H. Knowlton, Aug. 3, 1907	2	9, 14, 57
4310	3 mi N of Clyde Park, E side of Shields R., MT	45.925758°, -110.613458°	F.H. Knowlton, A.C. Peale & D. White, Sept 4, 1907	58	9, 57
4311	2 mi N of Clyde Park, opposite of crossing of rd to Myersburg, E side of Shields R., MT	45.906169°, -110.605553°	F.H. Knowlton, A.C. Peale & D. White, Sept 4, 1907	72, 131	9, 57
4315	Collier Camp, Klonder Ranch, bluff E of camp, 18 mi E of Miles City, MT	46.439706°, -105.533648°	F.H. Knowlton, July 27, 1907	89, 122	9, 14, 43, 57
4323	7 mi from Miles City, MT	46.437692°, -105.747016°	A.J. Collier & R.W. Howell, July 17, 1907	85	9, 14, 43, 57
4334	Sentinel Butte, ND	46.877178°, -103.848203°	F.H. Knowlton & A.C. Peale, July 15, 1907	9	9, 57
4368	1 mi N of Emerson ranch, 6 mi N of Lay, CO	40.607870°, -107.852624°	Missing Data	Missing Data	9
4369	N side of Separation Cr., WY	41.649275°, -107.557042°	T.W. Stanton, July 16, 1907	18, 72, 79, 104, 132	9, 57
4370, 4457, 8774	S side of Cr. in Rifle Gap, 6 mi N of Rifle, CO	39.616740°, -107.765226°	T.W. Stanton, Gale 1907; R.W. Brown, T.D. Lamar, Sept. 11, 1937; R.W. Brown and C.E.S. June 25, 1940	20, 22, 36, 59, 72, 74, 79, 96, 106, 131, 132, 139, 140, 151, 154, 155, 156, 160, 190	9, 57
4395	20 mi SW of Rawlins, WY	41.584000°, -107.513494°	T.W. Stanton, July 16, 1907	36	9, 57
4404	8 mi NW of Douglas, WY	42.802097°, -105.485672°	Branson, Aug 22, 1907	79	2, 9, 57
4421, 4882, 8666	Inez Mine, SW of Inez, 3 mi E of Careyhurst, 13 mi W of Douglas, WY	42.834075°, -105.618106°	R.W. Brown, C.W. Mumm, June 24, 1938	8, 16, 74, 85, 99, 108, 141	2, 10
4474	~19 mi E SE of Cody, WY	44.375194°, -108.709689° [SW¼ Sec. 24, T. 51 N, R. 99 W]	H.P. Little, Aug. 5, 1907	22	9, 57
4514	6 mi S of Lennep, MT	46.352333°, -110.481333°	F.H. Knowlton & A.C. Peale, Sept. 13, 1907	154	9, 57
4515	Ridge crossing near mouth of Shields R. below Livingston, MT	45.727319°, -110.461351°	Missing Data	Missing Data	9
4565	Musselshell, MT, 600 ft E of P.O.	46.51826°, -108.088240°	Bancroft, 1907	104	9
4570	3 mi from head of Razor Cr., MT	46.163667°, -108.450458°	L.H. Woolsey, 1907	72, 78, 96	9, 57, 79
4571	SE of Roundup, E fork of Razor Cr., 3.5 mi NE of Buckey, MT	46.231930°, -108.421845°	L.H. Woolsey, 1907	32, 79, 81, 84, 96, 122	9, 57, 79
4582	6 mi NE of Buckey, MT	46.227961°, -108.332031°	R.W Richards, Sept. 21, 1907, L.H. Woolsey	33, 63, 74, 86	9, 57, 79
4617	6 mi SE of Lennep, MT	46.352333°, -110.481333°	R.W. Stone, T.W. Stanton & C.A. Fisher, Aug. 27, 1907	104	9, 57
4618	Lebo Cr., MT	[T 6N, R 13 E]	T.W. Stanton & C.A. Fisher, Sept. 15, 1907	180	9, 57, 68
4620	Lebo Cr., MT	[T 6N, R 13 E]	T.W. Stanton & C.A. Fisher, Sept. 15, 1907	68, 69	9, 57, 68
4625	9 mi W of Miles City, MT	46.389689°, -106.036583°*	C.D. Smith & R.W. Howell,1907	32, 71, 72, 79, 95, 96, 104, 131, 139, 154	9, 57
4626	Miles City, MT	46.431844°, -105.841208° [SW¼ Sec. 22, T. 8 N, R. 47 E]	C. Smith, 1907	104, 146, 151, 155, 177	9, 57
4661 6666	near Ilo PO, WY	43.892819°, -108.524697° [SW¼ Sec. 5, T. 45 N, R. 97 W]	E.G. Woodruff, 1907	13, 16, 29, 33, 34–37, 57, 79, 83, 86, 96, 104, 105, 150, 151, 164,	9, 35, 47, 57
4665	2 mi N of Ilo PO, WY	43.940575°, -108.536772°	E.G. Woodruff, Sept. 2, 1907	32, 74, 78, 87, 99, 127, 153, 155	9, 35, 47, 57
4674	On Shoshone R., Cody, WY	44.561028°, -108.996919°	Willard, F.H. Knowlton, E.G. Woodruff, 1907	96	9, 34, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
4676	E side of divide between Red Lodge and Bear Cr., MT	45.183046°, -109.206218°*	T.W. Stanton, C.A. Fisher, & Schranun 1907	72	9, 57
4688	Shoshone R., below Cody, WY	?	F.H. Knowlton et al.	51	9
4694	Roof of Black Diamond Mine, 3 mi N of Meeteetse, WY	44.197581°, -108.895569°	E.G. Woodruff, Aug. 18, 1907	11, 32, 99	9, 57
4696	9 mi SW of Bridger, MT	45.203774°, -109.041110°*	F.H. Knowlton, 1907	30, 84	9, 57
4699	SE corner of Ft Keogh Military Res. on Tongue R., Miles City, MT	46.299142°, -105.776853°*	C.D. Smith, 1907	104, 131	9, 14, 57
4725	near Rock Springs, WY	41.591250°, -108.628692° [S ctr. Sec. 25, T. 19 N, R. 100 W]	Missing Data	81	9, 57
4843	~19 m due N of Rock Springs, WY	41.865475°, -109.160047°* [SW 1/4, sec. 23, T. 22 N, R. 104 W]	Missing Data	Missing Data	9
4860	¾ mi NW of Beckton, WY	44.765181°, -107.141467° [Sec. 2, T. 57 N, R. 85 W]	T.E. Willard & A.W. Thompson, July 17, 1907	72	9, 57
4870	E of Stater Cr., WY	44.928000°, -107.066072°	T.E. Willard July 27, 1907	164	9, 57
4871	~4.2 mi NE of Ranchester, WY	44.942236°, -107.085014°	Missing Data	119, 145, 153	9, 57
4874	~5 ½ mi E of Ranchester, WY	44.913814°, -107.070178°	T.E. Williard, July 27, 1907	87	9, 57
4875	1/2 mi W of 4874	44.915925°, -107.082058°	Missing Data	Missing Data	9
4876	3 mi NW of Monarch, WY	44.923447°, -107.097142°	T.E. Willard, July 30, 1907	52, 72, 74, 87	9, 57
4877	2¼ mi NW of Monarch, WY	44.912061°, -107.086300°	T.E. Willard, July 30, 1907	84, 94, 131	9, 57
4878	near Monarch, WY	44.897861°, -107.035358° [Sec. 19, T. 57 N, R. 84 W]	Missing Data	61	9
4879	Upper Fort Union Formation	?	Missing Data	157, 159	9
4881	1½ mi SE of Monarch, WY	44.896050°, -107.024042°	T.E. Willard, Aug. 2, 1907	96	9, 57
4892	2 mi SE of Carneyville, Big Goose Cr., WY	44.884259°, -106.984403°	T.E. Willard, Aug. 10, 1907	96, 157, 159, 164	9, 57
4896	1 mi SE of Dietz, WY	44.864558°, -106.966586°	T.E. Willard, Aug. 12, 1907	143, 175	9, 57
4897	W side of Tongue R., WY	44.939467°, -106.963150°	T.E. Willard, Aug. 13, 1907	40a, 79, 155	9, 57
4898	3 mi E of Carneyville, WY	44.908406°, -106.944469°	T.E. Willard, Aug. 20, 1907	40a, 51, 67	9, 57
4901	Fort Union Formation	?	Missing Data	168, 175	9
4908	½ mi E of Prairie Dog Cr., WY	44.911525°, -106.847075°	T.E. Willard, Aug. 19, 1907	96, 104	9, 57
4909	¾ mi E of Prairie Dog Cr., WY	44.911556°, -106.844525°	T.E. Willard, Aug. 19, 1907	96	9, 57
4910	Near Decker, MT	45.012633°, -106.858046°*	J.A. Taff & T.E. Willard, Aug. 24, 1907	79	9, 57
4974, 4976, 8563	2 mi E of Widdecombe Brothers Ranch, ~14 mi NE of Melville, MT	46.224506°, -109.721117°	A.C. Silberling, 1908; R.W. Brown, F.S. MacNeil, A.C. Silberling, Aug. 27 1926	40a, 58, 79, 84, 96, 131, 132, 156, 158	9, 19, 20, 68, 57
4975 8567	NW of John Widdecombe Ranch, NE of Melville, MT	46.235831°, -109.742778°	A.C. Silberling, May 14, 1908; R.W. Brown, F.S. MacNeil, & A.C. Silberling, Aug. 27, 1936	38, 78, 80, 96, 131, 146, 154	9, 19, 46, 57
4977	8 mi E NE of Melville, MT	46.152656°, -109.783606°* [Sec. 25, T. 5 N, R. 15 E]	A.C. Silberling, June 16, 1908	102, 184	9, 57
4979	Lower Fort Union Formation	?	Missing Data	79	9
4985, 8568	2.5 mi SE of Buckey P.O., Hwy 87, MT	46.166600°, -108.439203°	T.W. Stanton, R.W. Richards, July 5, 1908; R.W. Brown & F.S. MacNeill, Aug. 25, 1936	36, 37, 57, 72, 78, 104, 110	9, 57, 79
5025, 5582	2 mi E of Black Buttes, 1/3 mi from R.R. track, WY	41.509552°, -108.622821°	F.H. Knowlton, July 29, 1908	63	9, 44
5029	35 mi SW of Black Buttes, SE of Mud Springs, along Brown Park Stage Rd, WY	41.228937°, -108.834700°	F.H. Knowlton, A.C. Veatch, C.A. Fisher, A.R. Schultz & T.W. Stanton, July 25, 1908	10	9, 44, 57, 66
5030	35 mi SW of Black Buttes, SE of Mud Springs, along Brown Park Stage Rd, WY	41.239654°, -108.862300°	T.W. Stanton & C.A. Fisher, July 25, 1908	15, 16, 36	9, 57, 66
5032	Head of Vermillion Cr. on Brown Park Stage Rd, ~47 mi SE of Rock Springs, WY	41.236944°, -108.824969°	A.C. Veatch & A.R. Schultz, July 26, 1908	17	9, 44
5043	Black Buttes, WY	41.584331°, -108.707217° [1/4 mi N of ctr., sec. 32, T. 19 N, R. 100 W]	Missing Data	Missing Data	9
5046, 5122	Gonzales Poison Canyon, 5 mi above Aguilar on Gonzales Cr., CO	37.412650°, -104.738628°	G.C. Broadhead, G.B. Richardson, J.H. Gardner, Sept. 4, 1908	74, 82, 99, 126, 127, 129, 132, 166	9, 45, 50, 57
5063	Bud Kimball mine on Bud Kimball Draw, WY	43.905594°, -107.540433°	E.G. Woodruff, July 19–21, 1908	32, 33, 96, 131	9, 53, 57
5094, 5102	3 mi N of Trinidad, Bowen Mine, near Bowen, CO	37.211881°, -104.514369°	G.B. Richardson, July 17, 1908	30, 45, 46, 74, 99	9, 45, 50, 57
5095	Bear Canyon, SW of Berwind, CO	37.278853°, -104.643850°	Missing Data	99	45, 50
5099	N slope of Raton Mesa, 3 mi SE of Trinidad, 1 ½ mi SW of Engle, floor of Fishers Peak Mine (no. 8), CO	37.132042°, -104.481539°	J.H. Gardner, July 11, 1908	8, 38, 75, 90, 118	9, 57, 45, 50, 62
5100	3 mi further NW of 5697, CO	37.205344°, -104.605206°	Missing Data	51	45, 50
5101	~1 mi N of Bowen, CO	37.249153°, -104.523475°	Missing Data	74, 99	45, 50
5103-5105	Riley Canyon, 2 mi above Cokedale, CO	37.169931°, -104.638256°	Missing Data	18, 45, 70, 99	45, 50

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
5106, 5114	E of Stonewall Gap, ½ mi N of North Fork Purgatoire R., between Virgil's and Wood's ranches, CO	37.191500°, -104.877397°	Missing Data	45, 99	45, 50
5107	1½ mi SW of Berwind, CO	37.292947°, -104.643606°	Missing Data	79, 132	45, 50
5111, 5112, 5695	Powell Arroyo, 5 mi NW of Trinidad, or 3 mi W of Bowen, CO	37.238431°, -104.560117°	W.T. Lee, 1910	45, 99, 141, 152, 159	9, 45, 50
5113	2 mi SE of Dean,Colorado Bowen	37.264144°, -105.036256°	Missing Data	74, 132	45, 50
5118	SW of 5684, 3 mi above Aguilar, CO	37.414070°, -104.696584°	Missing Data	86	45, 50
5120	Mine # 37, 4 mi SW of Berwind, CO	37.282931°, -104.671114°	Missing Data	71	45, 50
5121	Poison Canyon, S of Apishap R., 7 mi SW of Berwind, CO	37.270897°, -104.743078°	J.H. Gardner, Aug. 30, 1908	74, 96	9, 45, 50, 57
5123	4 mi above Aguilar, CO	37.413750°, -104.724364°	Missing Data	79	45, 50
5124	1½ miles NW of 5687, CO	37.365883°, -104.762119°	Missing Data	74	45, 50
5132	Normans Ranch, ~1 mi NE of Yankee, 12 mi E of Raton, S extremity of Barilla Mesa, NM	36.978242°, -104.302767°	W.T. Lee, 1908	74, 79, 99, 152	9, 45, 50, 57
5133	Roof of Raynolds coal mine, NM	36.978944°, -104.321078°	W.T. Lee, 1908	45, 99	9, 45, 50, 57
5134	E wall of gulch near Yankee Mine #5, highest rocks exposed at 5139, near Raton, NM	36.891789°, -104.322046°	W.T. Lee, 1908	78, 79, 84, 127	9, 45, 50, 57
5135	E wall of gulch near Yankee Mine #5, 50 ft higher of 5137, near Raton, NM	36.891789°, -104.322046°	Missing Data	74	9, 45, 50, 57
5137	E wall of gulch near Yankee Mine #5, 50 ft higher of 5138, near Raton, NM	36.891789°, -104.322046°	W.T. Lee, 1908	74, 96, 99	9, 45, 50, 57
5138	E wall of gulch E of Yankee Mine #5. at 5139, near Raton, NM	36.891789°, -104.322046°	Missing Data	79	9, 45, 50, 57
5139	E wall of gulch, near Yankee Mine #5, NM	36.891789°, -104.322046°	W.T. Lee, 1908	45	9, 45, 50, 57
5140	near Yankee, NM, old Honeyfield Mine	36.900311°, -104.334674°	W.T. Lee, 1908	18, 82, 84, 96, 99, 104, 139	9, 45, 50, 57
5141	near Yankee, NM, old Honeyfield Mine, 125-200 ft above 5140	36.944017°, -104.351883°	W.T. Lee, 1908	79	9, 45, 50, 57
5142	Gulch mi SE of Raynolds coal mine, near Yankee, NM	36.977611°, -104.311206°	W.T. Lee, 1908	45, 47, 53, 74, 76, 82, 99, 129, 147, 151	9, 45, 50, 57
5143	Sugarite Mine (Old Wagon Mine), ½ mi W of site 83, 4 mi NE of Raton, NM	36.947344°, -104.378609°	Missing Data	45, 118	45, 50
5144	Above highest coal in Tin Pan Canyon, NW of Raton, NM	36.946818°, -104.548826°	W.T. Lee, 1908	23	9, 45, 50, 57
5146, 5151	Hillside just W of S end of Raton Tunnel, N of Raton, NM	36.983147°, -104.491975°	F.H. Knowlton	45, 46, 51, 74, 79, 86, 99, 104, 126, 132	9, 45, 50
5147	W side of Dillon Canyon, 1 mi N of mouth of Coal Canyon, near Blossburg, NM	36.933133°, -104.509331°	W.T. Lee, 1908	46, 74, 99	9, 45, 50, 57
5148, 5149	N wall of Dillon Canyon, NM, opposite sites 5150 and 5147	36.935031°, -104.507133°	Missing Data	45, 99, 129	45, 50
5150	½ mi NW of mouth of Coal Canyon, Dillon Canyon, near Blossburg, NM	36.930583°, -104.499303°	Missing Data	45	45, 50
5152	Bartlett Mesa, N of Raton, NM	36.938144°, -104.442006°	Missing Data	74, 132, 136	45, 50
5154	Small tributary system, ½ mile N of Brilliant, NM	36.956574°, -104.523966°	Missing Data	53, 99, 132	9, 45, 50
5194	Arid R. Basin, MT	46.240711°, -111.522319°	E.G. Woodriff, Sept. 10, 1908	32, 71, 153, 190	9, 57
5235, 6533	Canadian Canyon, near mouth of Jones Canyon, NM	36.915447°, -104.610650°	Missing Data	46	45, 50
5236	NW extremity of Vermejo Park, S wall of Spring Canyon, NM	36.957192°, -105.038986°	W.T. Lee, 1908	71, 74, 83, 86, 126	9, 45, 50, 57
5239	E of Vermejo Gap, NM	36.969676°, -105.126332°*	W.T. Lee, 1908	79, 132	45, 50
5241	Mouth of York Canyon in Vermejo Valley, NM	36.831619°, -104.902875°	Blair, 1908	74, 79, 84, 132	45, 50
5255	~23 mi SE of Rock Springs, WY	41.382067°, -108.843439°* [On TP line of 46 A.P.N. from corner of sects. 12 & 13, T. 16 N, R. 102 W]	G.E.Burton, Aug. 14, 1908	23	9, 57
5259	~23 mi SE of Rock Springs, WY	41.343411°, -108.873303° [NE ¼ NE ¼, Sec. 27, T. 16 N, R. 102 W]	G.E. Burton, Aug. 17, 1908	51	9, 57
5291	Canadian (Red) Canyon, 1 mi E of Jones Canyon, NM	36.903661°, -104.594675°	W.T. Lee, 1908	79, 99, 127, 132	9, 23, 45, 50, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
5300	Near head of Cow Gulch, ~7 mi SE of Fattig P.O., MT	46.285242°, -108.226811°	R.W. Richards, Aug. 24, 1908	67	9, 57, 79
5321	E side of Little Bitter Cr. Rd, S of Rock Springs, WY	41.367536°, -109.254386° [On section line Sec. 16, T. 16 N, R. 105 W]	A.R. Schultz, Sept. 7, 1908	40a	9, 57
5322	N of rd across Cr. at big bend in rd, S of Rock Springs, WY	41.495984°, -109.228018° [Sec. 35, T. 18 N, R. 105 W]	Bartholomew, 1908	14	9, 57
5324	~19 mi S of Rock Springs, WY	41.311492°, -109.219458° [Sec. 3, T. 15 N, R. 105 W]	J.L. Rich, Sept. 12, 1908	154	9
5332	4 mi E of Parkman, WY	44.957236°, -107.249179°	Missing Data	Missing Data	9
5333	~5 mi E of Parkman, WY	44.958004°, -107.224324°	Pepperburg, V.H. Barnett, 6 Oct. 1908	131	9
5374	E bank of Jimmy Camp Cr., opposite Richfield Spring, CO	38.847772°, -104.663041°	M.Goldman & A.C. A.C. Peale, Sept. 19, 1908	71	9, 57
5385	Fort Peck Indian Res., right bank of Missouri R., SE of Brockton, MT	48.110558°, -104.737747°	E.A. Davis, Sept. 9, 1908	67	9, 57, 67
5387	Fort Peck Indian Res., near mouth of Smoke Cr., MT	48.302197°, -104.682400°	C.D. Smith, Sept. 9, 1908	67	9, 57
5388	Fort Peck Indian Res., 2 mi E of Ralston Ranch, SE of Brockton, MT	?	C.D. Smith, 1908	104, 147	9, 57
5389	Fort Peck Indian Res., Balls Bluff, right bank of Missouri R., SE of Brockton, MT	48.115511°, -104.832783°	C.D. Smith, 1908	104, 146	9, 66, 67
5437, 5438	McCord coal bank, N side of S Fork Cannon Ball R. (Cedar Cr.), ND	46.028525°, -101.719650°	A.L. Beekly, April 26, 1909	23, 96, 131, 141, 142, 175	9, 38, 52, 57,
5455	5.7 mi NE of Bayfield, CO	37.288000°, -107.529686° [E side of Sec. 31, T. 35 N, R. 6 W]	J.H. Gardner, Aug., 7, 1909	53, 79, 85, 97, 99, 127, 132	9, 49, 57
5456	~7.3 mi NE of Bayfield, CO	37.295267°, -107.506514° [SE Corner Sec. 15, T. 35 N, R. 6 W]	J.H. Gardner, Aug., 1909	74	9, 49, 57
5460	~5.5 mi E of Durango, CO	37.285300°, -107.783208° [SE from ctr. of Sec. 19, T. 35 N, R. 8 W]	J.H. Gardner & Heald, July 10, 1909	110	9, 57
5461	110 ft below 5460, near Durango, CO	37.285458°, -107.783464°	Missing Data	191	9
5465	Raton Fm.	?	Missing Data	100	9
5467	Raton Fm.	?	Missing Data	45, 74	9
5469	Bowen mine, 5 mi N of Trinidad, CO	37.239010°, -104.508787°	F.H. Knowlton, June 22, 1909	45	9, 50, 57
5480	Clinker Ballast Quarry, Minturn, WY	44.261906°, -105.351169° [NE ¼ NE ¼, Sec. 2, T. 49 N, R. 71 W,]	C.A. Fisher, T.W. Stanton, R.W. Stone & C. Lupton, Oct. 7, 1908	104	9, 57, 69
5486	½ mile SW of Roundup, MT	46.438071°, -108.555390° [NE ¼, Sec. 23, T. 8 N, R. 25 E]	R.W. Richards, July 7, 1908	29, 33, 79, 96, 156	9, 79
5495	just W of crest of divide, 5 mi E of Hanna, WY	41.877753°, -106.454764° [Near middle of Sec. 18, T. 22 N, R. 80 W]	T.W. Stanton, July 30, 1909	59	9, 57, 70
5509	8 mi NE of Parkman, WY	45.034846°, -107.217497°*	T.W. Stanton & R.W. Stone, Sept. 4, 1909	155, 164	9, 57
5512	7 mi NE of Parkman, WY	45.028008°, -107.231005°*	T.W. Stanton & R.W. Stone, Sept. 5, 1909	40a	9, 57
5526, 9112	E of Ethete, WY	43.049642°, -108.619900° [NE¼ SE¼ Sec. 22, T. 1 N, R. 2 E]	E.G. Woodruff, July 21, 1909	29, 32, 51, 52, 61, 114	9, 57
5551	Mine No. 9, Almy, WY	?	F.H. Knowlton & A.C. Peale, Aug. 8, 1909	61	9, 57
5555	Mine No. 8, Almy, WY	?	F.H. Knowlton & A.C. Peale, Aug. 8, 1909	84, 96	9, 57
5557	Ridge above coal mines No. 1 and 4, Almy, WY	41.320724°, -110.987438°	Missing Data	Missing Data	9
5578	4 mi SE of Black Buttes, on rd to Bitter Cr., WY	41.508794°, -108.640194°	F.H. Knowlton & A.C. Peale, July 27, 1909	87, 122	9, 57, 66
5579	1½ mi E of Black Buttes, WY	41.548748°, -108.670830°	F.H. Knowlton & A.C. Peale, July 26, 1909	32, 98	9, 57, 66
5594, 5595, 5596	SE side of coulee, 14 mi S of ctr. of Chinook, MT	48.416803°, -109.280917° [SW ¼ NW ¼, Sec. 28, T. 31 N, R. 19 E]	L.J. Pepperberg, Sept. 15, 1909; R.W. Brown & D.B. Stewart, Aug. 20, 1949	29, 33, 37, 54, 78, 87, 104, 195	9, 57, 59
5609	2 mi N of Musselshell, MT	46.546028°, -108.093402°	R.W. Stone, B. Kennedy, June 15, 1909	32, 37, 79, 96, 139, 147, 154	9, 57, 79
5611	2½ mi N of Musselshell, MT	46.551441°, -108.104499°	R.W. Stone	79, 152, 156	9, 79
5612	3.5 mi NE of Musselshell, MT	46.549332°, -108.027236° [NW¼ NW¼ Sec. 13, T. 9 N, R. 29 E]	R.W. Stone, B. Kennedy, June 16, 1909	33, 79, 86, 96	9, 57, 79
5613	Alkali Cr. Rd., MT	46.440439°, -107.836400° [SE¼SW¼ Sec. 15, T. 8 N, R. 31 E]	C.F. Lupton, Aug. 10, 1909	69, 78, 96, 153, 156	9, 55, 57, 79
5614	10.8 mi N of Pompeys Pillar, MT	46.144478°, -107.990864° [NE ¼, Sec. 32, T. 5 N, R] 30 E	C.F. Lupton	78, 191	9, 79

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
5618	14 mi N of Gilette, WY, 1.2 mi W of Hwy 59	44.491272°, -105.494458° [Sec. 15, T. 52 N, R. 72 W]	H. Hindus, Oct. 13, 1909	85, 87, 164	9, 57
5619	At mouth of Elk Cr. on Little Powder R., MT	44.793531°, -105.376653°	C.J. Lupton & H. Hindus, Oct. 17, 1909	155	9, 16, 57
5667	Florida R., near Durango, CO	?	J.H. Gardner, Aug., 1909	70, 96, 186	9, 49, 50
5678	S side of Cucharas R., 3 mi SW of Walsenburg, CO	37.598039°, -104.824465°	W.T. Lee, 1910	74, 99	9, 41, 57
5679	N bank of Cuchara R., 1/8 mi NE of Rockland Mine, 3 mi SW of Walsenburg, CO	37.601833°, -104.826338°	W.T. Lee, 1910	42, 46, 53, 70, 71, 74, 79, 91, 97, 99, 132, 133, 136, 147, 151	9, 41, 45, 50, 57
5682	near Strong, CO	37.716950°, -104.901653° [SW ¼ NW ¼, Sec. 9, T. 27 S, R. 67 W]	Missing Data	70	45, 50
5683	Canyon W of Old Rouse, ~4 mi W of Mayne, CO	37.542819°, -104.789617°	W.T. Lee, 1910	71, 79, 84, 86, 132, 147	9, 45, 50, 57
5684	Dump of Green Canyon mines in Gonzales Canyon, near Aguilar, CO	37.425669°, -104.683889°	W.T. Lee, 1910	51, 71, 74, 76, 83, 86, 99, 100, 101, 127, 132, 136, 152	9, 45, 50, 57
5686	Apishapa Canyon, N of Apishapa R., N of wagon rd, ½ mi W of Abeton, CO	37.337572°, -104.726353°	W.T. Lee, 1910	71, 74, 99, 117, 151	9, 45, 50, 57
5687	~1 mi NW of Trujillo Plaza, CO	37.352894°, -104.751281°	W.T. Lee, 1910	70, 74, 99, 101, 126	9, 45, 50, 57
5688	Apishapa Canyon, 3 mi NE of Abeton, CO	37.351906°, -104.707614° [~1 mi NE of 5686]	W.T. Lee, 1910	74, 129	9, 45, 50, 57
5689	N wall of Apishapa Canyon, 3½ mi SW of Aguilar or NE of Abeton, CO	37.363019°, -104.700464° [1 mi NE of 5688]	W.T. Lee, 1910	74, 76, 99, 100	9, 45, 50, 57
5690	Delagua Mine dump, W of Hastings, CO	37.360523°, -104.650159°	W.T. Lee, 1910	70, 79, 82, 84, 99, 129, 132	9, 45, 50, 56, 57
5693	Near Suffield Mine, CO	37.258254°, -104.516028°	Missing Data	74	45, 50
5696	1½ mi SW of mine at Rugby, ~5 mi N of Aguilar, CO	37.455457°, -104.687605°	Missing Data	79, 132	45, 50
5697	Colorado Canyon, W of Trinidad, CO	37.183419°, -104.564589°	W.T. Lee, 1910	18, 43, 46, 53, 74, 76, 99, 151	9, 45, 50, 57
5699, 5702, 5703	Riley Canyon, ½ mi N of Cokedale, CO	37.152950°, -104.622122°	W.T. Lee, 1910	45, 71, 99	9, 45, 50, 57
5700	Riley Canyon, near Cokedale, CO	37.150425°, -104.625661°	W.T. Lee, 1910	79	9, 45, 50, 57
5701	Riley Canyon, near Cokedale, CO	37.155767°, -104.629564°	W.T. Lee, 1910	45, 79, 132, 141, 152	9, 45, 50, 57
5704, 5795	W of Long Canyon, S wall of Purgatoire Canyon, mouth of Riley Canyon, S of Cokedale, CO	37.127205°, -104.607152°	W.T. Lee, 1910	45, 86, 99, 147	9, 45, 50, 57
5711	RR cut, ½ mi N of Wootton, CO	37.007314°, -104.489303°	W.T. Lee, 1910	51, 53, 70, 72–74, 79, 84, 127, 132, 151	9, 25, 45, 50, 57
5712	Hillside W of Wootton, between town and N end of Raton Tunnel, CO	36.997231°, -104.490958°	W.T. Lee, 1910	45, 51, 53, 59, 70, 74, 79, 82, 86, 99, 104, 129, 132, 147, 151	9, 45, 50, 57
5713	RR cut, 165 ft N of 5711, N of Wootton, CO	37.008356°, -104.488633°	W.T. Lee, 1910	79	9, 45, 50, 57
5714	Turner Mine dump, 1½ mi N of Wooten, CO	37.026603°, -104.480669°	W.T. Lee, 1910	53, 76, 82, 99, 109, 117, 126, 132, 151	9, 45, 50, 57
5715	RR cut, 1 mi S of Morley, CO	37.019765°, -104.496606°	W.T. Lee, 1910	79	9, 45, 50, 57
5716	14 mi E of Douglas, 2 mi N of jct of western and middle forks of Shawnee Cr., WY	42.677685°, -105.142530°	D.E. Winchester, July 29, 1910	33, 35, 96, 144	9, 57, 76
5718	Roof of prospect ~2 mi W of Douglas, WY	42.766592°, -105.415125°*	D.E. Winchester, 21 July 1910	131	9, 57
5720	~1 mi NW of Sunset Mine, ~9.5 miles N NW of Lost Springs, WY	42.892106°, -104.999436°	D.E. Winchester, Aug. 20, 1910	85, 87, 146	9, 57, 76
5721	40 ft above coal, at Sunset Mine, WY	42.883756°, -104.982317°	F.H. Knowlton, Aug. 20, 1910	29, 32, 79, 122	9, 57, 76
5738, 8656	Top of a conical hill, 3/4 mi S of a dry hole, 6 mi NW of Ramah, CO	39.218014°, -104.222611°	C.W. Cook, Sept. 7, 1910	4, 14, 15, 18, 19, 83, 109, 132, 141	9, 57
5760	1½ mi E of Old Washakie Station, N side of Muddy Cr., WY	41.480217°, -107.664147°	A.C. Peale, Aug. 5, 1910	72, 104, 151	1, 9, 57
5783	Near Rockville and Coal Cr, CO	38.3631833°,-105.1577333°* [vicinity of secs. 24, 25, 36, T. 19 S, R. 70 W, and secs. 19, 30, 31, T. 19 S, R. 69 W]	W.T. Lee, 1910	132	9, 57, 73
5796, 5797	RR cut, 1½ mi S of Starkville, CO	37.099264°, -104.524708°	W.T. Lee, 1910	71	9, 45, 50, 57
5798	Rock dump, Primero Mine, CO	37.142424°, -104.741093°	W.T. Lee, 1910	10, 53, 79, 82, 99, 122, 152	9, 45, 50, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
5799, 5825	Wet Canyon, ~4-5 mi NW of Weston, CO	37.191406°, -104.883288°	W.T. Lee, 1910	70, 74, 83, 86, 97, 99, 100, 109, 117, 126	9, 45, 50, 57
5801	N of North Fork of Purgatoire R., CO	37.212814°, -105.004225°	Missing Data	99	45, 50
5802	400 ft above 5803, near Terclo, CO	37.066547°, -104.984419°	W.T. Lee, 1910	53, 79, 132, 151	9, 45, 50, 57
5803	near Terclo, CO	37.065397°, -104.983967°	W.T. Lee, 1910	13, 43, 86, 99	9, 45, 50, 57
5826	Vermejo Cr., Vermejo Canyon, 5 mi above Stout Canyon, near Salyers Cr., NM	36.771915°, -104.844568°	W.T. Lee, 1910	7, 8, 45, 46, 71, 74, 78, 79, 82–84, 86, 96, 97, 99, 126, 129, 132	9, 45, 50, 57
5827	Vermejo Cr. Canyon, ~3-4 mi NW of Dawson, near Stout Canyon, NM	36.711403°, -104.800531°	W.T. Lee, 1910	45, 71	9, 45, 50, 57, 59
5830	NW of Ute Park, in canyon on wagon rd from Ute Park to Ponil Cr., NM	36.606889°, -105.127267°	W.T. Lee, 1910	45, 74, 82	9, 50, 57
5831	E bank of Jimmy Camp Cr., 6/10 mi N of Richfield Springs Ranch, 9 mi E of Colorado Springs, CO	38.853028°, -104.659820°	F.H. Knowlton & W.T. Lee, July 11, 1910	15, 71, 74, 81, 92, 127?, 132?, 138, 165	9, 27, 57, 64
5835	1 mi E of Richfield Springs Ranch on E bank of Jimmy Camp Cr., 9 mi E of Colorado Springs, CO	38.855193°, -104.653664°	F.H. Knowlton, July 11, 1910	79, 81, 132	9, 27, 57, 64
5836, 8655	RR cut 3/4 mi SW of Falcon, 10 mi SW of Eastonville, CO	38.927467°, -104.618306°	F.H. Knowlton & G.B. Richardson, July 22, 1910	12, 18, 32, 51, 59, 109, 132	9, 27, 57, 63, 64
5837	Gulch just S of Rice's clay bank, 1 mi SW of Calhan, CO	39.023518°, -104.305727°	F.H. Knowlton, Wood & C.W. Cooke, July 26, 1910	74, 99, 127, 131, 132, 136, 147, 165	9, 27, 57, 63, 64
5838	Dump of Mosby coal mine, Mosby, CO	38.917983°, -104.377647°	Missing Data	6, 22, 109, 126, 132, 147,	9, 65
5839	¼ mi E of Purdons Mine, CO	39.064878°, -104.208040°	G.B. Richardson, C.W. Cooke, & Wood, Aug. 1910	59, 72, 100, 122, 132, 138	9, 47, 53, 57
5840	Red Hill, 4 mi S of Ramah, CO	39.068939°, -104.165939°	Missing Data	19, 43, 46, 74, 96, 131, 136, 141	9, 47, 49
5842	16 mi SW of Baker, MT	46.222706°, -104.417981°	M.A. Peale, Aug. 12, 1910	14	9, 5, 57
5863	Near Belle Fourche R, WY	44.066133°, -105.272408°	J.J. Galloway, July 15, 1910	126	9, 57
5882	O'Fallon Cr., E of Terry, MT	46.753128°, -105.123100°	J.R. Newby, L.E. Trout, F.A. Herald, July 29, 1910	153	9, 31, 57
5885	near Terry, MT	46.624678°, -104.377811° [NE ¼, Sec. 14, T. 10 N, R. 58 E]	J.R. Newby, Aug. 26, 1910	67, 104, 154	9, 31, 57
5886	0.8 mi S of Cap Rock Road, MT	46.622975°, -104.318008° [NE¼ Sec. 17, T. 10 N, R. 59 E]	F.A. Herald, J.R.H. & J.R. Newby, Sept. 2, 1910	31, 46	9, 31, 57
5889	near Terry, MT	46.669511°, -104.322814° [NW ¼ NE ¼, Sec. 32, T. 11 N, R. 59 W]	J.R. Newby, J.R.H., Sept. 5, 1910	104, 154	9, 31, 57
5905	2.3 mi S SW of Weston, WY	44.603212°, -105.357441° [Sec. 2, T. 53 N, R. 71 W]	Missing Data	51, 57	9, 16
5911	~22 mi N of Kaycee, WY	44.013133°, -106.613104° [Sec. 29, T. 47 N, R. 81 W]	C.H. Wegemann, July 19, 1910	28	9, 75
5917, 5918	S of Sussex, WY	[T. 42 N, R. 78 W]	O.B. Hopkins for C.H. Wegemann, Aug. 24, 1910	52, 114, 164, 168	9, 75
5971	Ferris Formation, southern, WY	?	Missing Data	147	9
6050	6 mi SW of Moorcroft, Belle Fourche, WY	44.236578°, -105.080136°	V.H. Barnett, June 14, 1911	154	9, 18, 57
6051	6 mi W of Moorcroft, WY	44.254347°, -105.066475°	V.H. Barnett, June 14, 1911	45	9, 18, 57
6057	30 mi SW of Moorcroft, WY	43.969367°, -105.207336°	A.W.S. & V.H. Barnett, R.P., July 24, 1911	74, 79, 85, 87	9, 57
6083	45 mi S of Moorcroft, WY	43.857883°, -105.168642°	V.H. Barnett, Aug. 3, 1911	87	9, 18, 57
6084	20 mi above Hampshire, WY, on Little Thunder Cr.	43.648969°, -104.889286°	V.H. Barnett, Sept. 9, 1911	9, 18	9, 57
6113	Near head of Wolf Draw, SD	45.418531°, -102.951194°	D.E. Winchester, July 8, 1911	79	9, 57, 77
6114	3.4 mi S of Strool, SD	45.451326°, -102.819197° [Sec. 7, T. 17 N, R. 11 E]	Missing Data	Missing Data	9
6116	Sexton Mine, SD	45.437194°, -102.549275° [Sec. 17, T. 17 N, R. 13 E]	Missing Data	1, 15, 122	9, 77
6117	10.5 mi S of Lemmon, SD	45.781095°, -102.160769°* [Sec. 17, T. 21 N, R. 16 E,	C.B.A., D.E. Winchester, Oct. 9, 1911	72, 96, 104	9, 57, 77
6131	1 mi N of R.R. bridge, near Terry, MT	46.785778°, -105.455761°	G.S. Rogers party, July 8, 1911	96	9, 57
6142	~2¼ miles SE of Monument, CO, 2 mi E of RR	39.077089°, -104.825614°	C.W. Cooke, Sept. 9, 1911	8, 15, 79?, 136	9, 57, 64
6145	Coal Cr., 18 mi E of Denver, Castle Rock Quad., CO	39.693069°, -104.681247°*	J.B. Richardson, Oct. 1911	126	9, 57
6154	7.5 mi SW of Reva, SD	45.466754°, -103.201928° [Sec. 1, T. 17 N, R. 7 E]	E.M. Parks & party, Aug. 23, 1911	32, 39, 69, 95, 96, 131	9, 57, 77
6155	~7.9 mi SE of Reva, SD	45.465906°, -102.961094° [ctr. Sec. 1, T. 17 N, R. 9 E]	Missing Data	Missing Data	9
6156	~8.6 mi SW of Reva, SD	45.449869°, -103.208381° [NE ¼ SW ¼, Sec. 12, T. 17 N, R. 7 E]	E.M. Parks & party, Aug. 19, 1911	32, 39, 104	9, 57, 77
6161	7 mi NW of Reva, SD	45.580689°, -103.214264° [Sec. 25, T. 19 N, R. 7 E]	E.M. Parks & party, Sept. 6, 1911	104	9, 57, 77

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
6171	19.5 mi SE of Cody, WY	44.295328°, -108.825358° [N 1/2 Sec. 24, T. 50 N, R. 100 W.]	D.T. Hewett, July 20, 1911	61	9, 35, 36, 57
6173	Above stage rd opposite Sleepers Ranch, WY	44.262561°, -108.799375°	D.T. Hewett, Aug. 2, 1911	6, 32, 33, 104	9, 35, 36, 57
6176	23.5 mi SE of Cody, WY	44.243714°, -108.797644° [SE ¼ Sec. 6, T. 49 N, R. 99 W]	D.T. Hewett, Aug. 9 1911	33	9, 36, 57
6215	On Little Missouri R. S. of Yule, ND	46.549411°, -103.807272°	Mr. Bauer for C.J. Hares, July 10, 1911	25, 142?, 175	9, 28, 57
6219	W of Little Missouri R., N of mouth of Bullion Cr., 14 mi S of Andiru, ND	46.710717°, -103.599233°	Bauer & Birch for C.J. Hares, 27 July 1911	29, 32	9, 28, 38, 57
6225	20 mi NE of Marmarth, 8 mi S of Dakota National Forest, ND	46.431189°, -103.546142°	Price & Birch, Sept. 9, 1911	67, 69, 122, 145	9, 28, 57
6297	~3 mi N of Craig, CO	40.549039°, -107.534306°*	W.T. Lee, 1912	79, 132,	9, 57
6299	1 mi S of Ducey's ranch, 7 mi NW of Craig, CO	40.564119°, -107.620953°*	W.T. Lee, 1912	51	9, 57
6309	RR cut ½ mi downstream from station at Pagosa Junction, CO	37.034225°, -107.205308°	W.T. Lee, 1912	90, 97, 129, 132, 156	9, 48, 50, 57
6342, 8885	Mackton Coal Mine, 6-7 mi NE of Big Sandy, MT	48.182206°, -109.985564°		54, 158	6, 9, 57, 58
6344	2 mi SW of Inez, WY	42.819394°, -105.609370°	V.H. Barnett, Sept. 24, 1912	59, 79	2, 9, 57
6359	13.7 mi SE of Cody, WY	44.392961°, -108.846058° [Near ctr. Sec. 14, T. 51 N, R. 100 W]	D.F. Hewett & T.W. Stanton, Sept. 4, 1912	32, 36?, 96, 131	9, 36, 57
6360	19.5 mi SE of Cody, WY	44.292264°, -108.830328° [200 ft NW of ctr. of Sec. 24, T. 50 N, R. 100 W]	D.F. Hewett & T.W. Stanton, Sept. 6, 1912	142	9, 35, 36, 57
6376	10 mi S of Bentley, ND	46.206114°, -102.066700°	E.R. Lloyd & B.W. Clark, Aug. 24, 1912	40a	9, 54, 57
6377	1 mi S of Kaiser, ND	46.364261°, -101.788257°	W.T. Thorn & L.M. Newman, Sept., 1912	153	9, 38, 54, 57
6382	3 mi E of Scranton, ND	46.125413°, -103.099307°	C.J. Hares & E.G. Woodruff, July, 1912	176	9, 57
6384, 9125	Opposite Anarchist Butte on Hwy, SD	45.833081°, -103.002106°	R.W. Brown, N Denson & W. Benson, 8 July 1950	3, 29, 32, 34, 37, 78, 79, 96, 156, 164, 174, 178, 195	9, 77
6415	Ferris Formation, SE WY	?	Missing Data	96	9
6416	bank of Big Ditch, WY	41.948829°, -106.828454° [NW ¼ SW ¼, Sec. 24, T. 23 N, R. 84 W]	A.L. Buckly, Sept., 1912	132	9, 70
6417	N bank of Big Ditch, WY	41.942305, -106.830966° [SE ¼ SE ¼, Sec. 23, T. 23 N, R. 84 W]	A.L. Buckly, Sept., 1912	40a, 79	9, 57, 70
6419	bank of Big Ditch, WY	41.931434°, -106.844280° [NW ¼ SW ¼, Sec. 26, T. 23 N, R. 84 W]	A.L. Buckly, Sept., 1912	14	9, 57, 70
6420	10.7 mi W of Hanna, WY	41.882625°, -106.767319° [NW ¼ NW ¼, Sec. 16, T. 22 N, R. 83 W]	A.L. Buckly, Sept., 1912	16, 36, 96, 144	9, 57, 70
6428	Southern arm of Seminoe Reservoir, WY	41.973672°, -106.840467° [SE ¼ SW ¼, Sec. 11, T. 23 N, R. 84 W]	A.L. Buckly, Oct. 14, 1912	59	9, 57, 70
6431	N of Platte R., WY	41.936636°, -106.855497° [SW ¼ NE ¼, Sec. 27, T. 23 N, R. 84 W]	A.L. Buckly, Oct. 16, 1912	87, 126, 132	9, 57, 70
6443	1 mi NE of Pagosa Junction, CO	37.041306°, -107.186047°*	W.T. Lee, 1912	45, 74, 79, 85, 132,	9, 24, 50, 57
6444	1 mi. NW of Pagosa Junction, CO	37.042720°, -107.208311°*	W.T. Lee, 1912	45, 74, 79, 126, 90	9, 24, 50
6530	At foot of Barilla Mesa, in E wall of Sugarite Cayon, in roof of new Sugarite Mine, NM	36.947419°, -104.380389°	Missing Data	99, 141	50
6535	Van Houten, Raton Field, NM	36.794656°, -104.563236°*	W.F. Lee, 1913	79, 97	9, 57
6592	21 mi W NW of Craig, CO	40.587342°, -107.950344°* [Sec. 4, T. 7 N, R. 94 W]	Missing Data	50	9, 57
6594	20.4 mi W NW of Craig, CO	40.593178°, -107.916558°* [N 1/2 Sec. 2, T. 7 N, R. 94 W]	Missing Data	55	9
6598	~6 mi S of St. Gertrude, ND, 1.5 mi E of hwy 31	46.194639°, -101.304403° [SW ¼, Sec. 3, T. 131 N, R. 85 W]	L.M. Neumann, July 31, 1913	75, 104	9, 57
6602	1 mi SE of Leith, ND	46.337381°, -101.617622°	Missing Data	63	9, 54
6625	~11.75 mi W NW of Hanna, WY	41.931628°, -106.775847° [SE¼ Sec. 29, T. 23 N, R. 83 W]	C.F. Bowen, Aug. 15, 1913	51, 79	9, 57, 70
6630	~13.65 mi W NW of Hanna, WY	41.896833°, -106.822317° [NE ¼ NW ¼, Sec. 12, T. 22 N, R. 84 W]	Missing Data	72	9, 70
6652	3 mi S of Old Strain, ND	46.570183°, -101.033517°	Neumann & Mansfield, Sept. 2, 1913	40a	9, 57
6667	N of Ilo PO, WY	43.925739°, -108.516606° [E ½, Sec. 29, T. 46 N, R.97 W]	D.F. Hewett, Oct. 3, 1913	40, 89, 95	9, 35, 46, 57
6668	N of Ilo PO, WY	43.927644°, -108.507022° [NW ¼, Sec. 28, T. 46 N, R. 97 W]	D.F. Hewett, Oct. 3, 1913	72, 156	9, 35

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
6669	Near Ilo PO, WY	43.910731°, -108.502750° [W ½, Sec. 33, T. 46 N, R. 97 W]	D.F. Hewett, Oct. 3, 1913	95	9, 35
6738	~12 mi N of Glenrock, WY	43.017206°, -105.864278°	V.H. Barnett, 1913	31, 51, 52	9, 57
6765	First cut on RR, ¾ mi S of Wilsall, near milepost 22, N of Livingston, MT	45.984250°, -110.655325°	F.H. Knowlton & E.W. Berry, 1913; R.W. Brown, C.E.S., July 17, 1940	29, 32, 58, 98, 145, 191	9, 57
6767	Brackett Cr., ¼ mi W of National Forest Reserve, N of Livingston, 12 mi W of Clyde Park, MT	45.858525°, -110.860317°	E.W. Berry, T.W. Stanton & F.H. Knowlton, 1913	29, 32, 34, 57, 86, 131	9, 57
6839	Conant Cr., about 35 mi E of Lander, WY	42.882833°, -108.014084°	J.B. Reeside, Jr., Aug. 28, 1914	56	9, 57
6845	Coal Cr., 55 mi NW of Rawlins, WY	42.324342°, -107.534808°	C.J. Hares, Oct. 3, 1914	15	9, 57
6892	7.4 mi E of New Salem, ND	46.851361°, -101.253922° [SW ¼ Sec. 14, T. 139 N, R. 84 W]	E.J. Hancock & G. Williams, Oct. 9, 1914	139	9, 57
6905	6.5 mi S of New Salem, ND	46.751186°, -101.401678° [SW ¼ Sec. 22, T. 138 N, R. 85 W]	Missing Data	188	9
6943	½ mi W of Ramah, CO	39.121674°, -104.174611°	W.F. Lee, 1915	71	9, 57
6944	Coal Gulch, 2 mi NW of Ramah, CO	39.143133°, -104.182056°	Missing Data	Missing Data	9
6971	Middle Perc cut, 5 mi E of Dana, WY	41.837619°, -106.631503°	T.W. Stanton & C.F. Bowen, July 9, 1915	32, 51, 72, 79, 85, 96, 104, 156	9, 57, 70
6985	~9 mi NE of Hanna, WY	41.936883°, -106.412250° [NE ¼ Sec. 28, T. 23 N, R. 80 W]	C.F. Bowen, July 1915	40a, 63	9
7004	10.4 mi N NW of Scobey, MT	48.924486°, -105.522031° [NE 1/4 Sec. 33, T. 37 N, R. 47 E]	W.T. Thom, E.C., Aug. 30, 1915	14, 25, 30, 38, 104, 143	9, 57
7005	16.5 mi N NE of Scobey, MT	49.006492°, -105.278181°	A.J. Collier, Sept. 3, 1915	16, 32, 33, 144	9, 12, 57
7371	3 mi SW of Farmington, NM	36.700034°, -108.254058°*	H. Bassler, J.B. Reeside, Jr., July 16, 1917	70, 74, 79, 127	9, 57, 61
7452	1 mi NW of Bayfield, CO	37.233345°, -107.613652°	J.B. Reeside, Jr., Oct. 27 1920	79	24, 48
7463	5 mi E of Durango, CO	37.275523°, -107.785853°	J.B. Reeside, Jr., Oct. 8, 1920	79, 127,	9, 24, 48, 57
7480	600 ft above base, hill top W of Talian Mine, 5 mi N of Pagosa Junction, CO	37.104932°, -107.186555°	Q.D. Singewald, J.B. Reeside, Jr., May 31, 1921	18, 45, 71, 74, 79, 98, 127	9, 24, 48, 57
7481	Loose sloop, hill top W of Talian Mine, 5 mi N of Pagosa Junction, CO	37.104932°, -107.186555°	Q.D. Singewald, J.B. Reeside, Jr., June 1, 1921	19, 45, 71, 74, 98, 99, 127	9, 24, 48, 57
7482	Hill top W of Talian Mine, 5 mi N of Pagosa Junction, CO	37.104932°, -107.186555°	Q.D. Singewald & J.B. Reeside, Jr., June 1921	79	9, 24, 48, 57
7483	1000 ft S of Talian Mine, 4½ mi N of Pagosa Junction, CO	37.102441°, -107.185056°	Q.D. Singewald & J.B. Reeside, Jr., June 1, 1921	71, 75, 135, 141	9, 24, 48, 57
7484	On rd ½ mi S of Talian Mine, 4½ mi N of Pagosa Junction, CO	37.098917°, -107.186600°	Q.D. Singewald & J.B. Reeside, Jr., June 2, 1921	13	9, 24, 48, 57
7485	On rd ½ mi S of Talian Mine, 4½ mi N of Pagosa Junction, CO	37.101278°, -107.188883°	Q.D. Singewald & J.B. Reeside, Jr., June 2, 1921	53, 59, 74, 79, 99, 126, 132	9, 24, 48, 57
7495	1 mi NW of Ojo Alamo, NM	36.337839°, -108.050356°	Wells, Q.D.Singewald & J.B. Reeside, Jr., June 24, 1921	74, 132	9, 57
7496	½ mi W of Pagosa Junction, CO	37.038044°, -107.207448°	Q.D. Singewald, Knickenbacker & J.B. Reeside, Jr., June 4, 1921	8, 53, 70, 73, 84, 86, 97, 99, 109, 127, 129, 155, 157	9, 24, 48, 57
7498	On Cat Cr., ~1 mi N of Pagosa Junction, CO	37.049781°, -107.198219°	Q.D. Singewald, J.B. Reeside, Jr., June 5, 1921	132	9, 48, 57
7538	2.3 mi N NW of Sand Springs School, MT	47.129386°, -107.510631° [SE ¼ Sec. 22, T. 16 N, R. 33 E]	W.T. Thom, Jr., & C.E. Dobbin, May 27, 1921	6, 10, 15, 18, 79, 94, 187	9, 57
7547	14 mi NE of Big Timber, MT	45.992861°, -109.720544°	H.H. Graff, 1922	96	9, 57
7548	~11 mi NE of Big Timber, MT	45.957631°, -109.742431°	H.H. Graff, 1922	34, 35, 78	9, 57
7552, 8540	Clay pit, 1 mi S of Dickinson, ND	46.860969°, -102.813448°	D. White, Sept. 1907	80, 96	9, 37, 57
7623	At Pugh's place, NE of Craig, CO	40.689194°, -107.347112°*	Missing Data	Missing Data	9
7659	10 mi W of Colstrip, MT	45.850558°, -106.805240°	C.E. Dobbin, 1923	131, 158	9, 17, 57
7662	14 mi NNW of Lame Deer, MT	45.790883°, -106.822185° [SE ¼ Sec. 36, T. 1 N, R. 39 E]	C.E. Dobbin, 1923	69, 144	9, 17, 57
7663	4 mi W of Camp Crook, SD	45.552417°, -104.042506°	C.E. Dobbin, 1923	8	9, 57
7685	Hanging Woman Divide, SE of Birney, MT	45.272128°, -106.427672° [NE ¼ Sec. 35, T. 6 S, R. 43 E]	Bass, Aug. 24, 1923	104	9, 57
7688	Valley of Hungry Woman Cr., MT	45.300453°, -106.480795°*	J.B. Stone, Sept. 13 1923	66	9
7695	Valley of Hanging Woman Cr., MT	45.300121°, -106.483405°*	J.B. Stone, Sept. 13, 1923	78	9, 57
7776, 8652	2 mi SE of coal mine at Black Buttes, WY	41.537376°, -108.666702°	T.W. Stanton & J.B. Reeside, Jr., Aug. 3, 1924	16, 81, 139	9, 57, 66
7839, 8249	On little knoll, 2 mi SW of Edwards, MT	47.117158°, -107.350972°	R.W. Brown & J. Murata, Sept., 17, 1931	26, 32, 36, 104	9, 57
7989	Station N 50, Weldon, MT	47.616008°, -105.891536°*	A.J. Collier, June 22, 1929	36	9, 14, 25, 57
8163	Sweeny Cr., MT	46.198964°, -106.294394° [SW ¼ Sec. 12, T. 5 N, R. 43 E]	R.W. Brown, 1929	69, 131	9, 57
8164	~8.4 mi W SW of Garland, MT	45.998056°, -106.098818° [Sec. 23, T. 3 N, R. 45 E]	R.W. Brown, Sept. 16, 1929	6, 22, 80	9, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
8165	Below top of hill at Last Flag, ~10 mi NE of Garland, MT	46.184052°, -105.833706°	R.W. Brown, Sept. 25, 1929	36, 151	9, 57
8166	SE of Colstrip, MT	45.860036°, -106.594856°*	R.W. Brown, July 9, 1929	67, 153, 156	9, 57
8167	27 mi N of Ashland, MT	45.964781°, -106.231061° [SW corner Sec. 35, T. 3 N, R. 44 E]	R.W. Brown, July 1, 1929	96, 164, 185	9, 57
8187	3.5 mi S of Ramah, CO	39.068364°, -104.158881° [NW ¼ Sec. 30, T. 11 S, R. 60 W]	C.H. Dane & party (Pierce), Aug. 24, 1931	132	9, 57
8188	S of Ramah, CO	39.068939°, -104.165939° [NE ¼ Sec. 25, T. 11 S, R. 61 W]	C.H. Dane & party (Pierce), Aug. 26, 1931	18, 43, 46, 74, 96, 122, 131, 141	9, 57
8190	Left bank of Yellowstone R., 1 mi N of Intake, MT	47.306122°, -104.525469°	R.W. Brown & K.J. Murata, Aug. 21, 1931	104, 139, 154	9, 57
8191	Cliffs along left bank of Yellowstone R., 0.5 to 2 mi N of Burns Ranch, MT	47.384561°, -104.405642°	R.W. Brown & K.J. Murata, Aug. 20, 1931	40	9, 57
8192	Right bank of Yellowstone R, E of Sidney, MT	47.708036°, -104.085789°	J. Murata, Aug. 18, 1931	153	9, 57
8193	Right bank of Yellowstone R., E of Sidney, MT	47.711175°, -104.084872°	R.W. Brown & J. Murata, Aug. 18, 1931	32	9, 57
8195	Right bank of Yellowstone R., E of Sidney, MT	47.710833°, -104.084853°	R.W. Brown & J. Murata, Aug. 18, 1931	40a, 51, 146	9, 57
8199	4 mi up Seven Mile Cr. from Stipek, MT	47.258232°, -104.717874°	R.W. Brown & J. Murata, Aug. 22, 1931	79, 196	9, 57
8200	3 mi up Clear Cr., Left bank, W of Glendive, MT	46.981206°, -104.863672°	L.F. Ward, Aug. 1883	22, 67, 78, 155, 156	9, 72
8202	On rd toward Hofflund along left bank of Missouri R., 10 mi N of Sanish, ND	48.079957°, -102.657186°	R.W. Brown, T.W. Stanton & J. Murata, July 24, 1931	2	9, 57
8203	5-6 mi on rd NW of Sanish, toward Hofflund on E side of Missouri R., ND	48.043565°, -102.601066°	R.W. Brown, July 24, 1931	32	9, 57
8204	30 ft above 8203	48.043565°, -102.601066°	R.W. Brown, July 24, 1931	6, 22	9, 57
8205	18.4 mi along river rd from Sanish to Hofflund, ND	48.130729°, -102.759216°	R.W. Brown, July 24, 1931	80	9, 57
8206	6 mi N of Armstrong (underwater), E of trail leading down to river, on rd Sanish to Hoflund, ND	47.582402°, -102.007616°	T.W. Stanton, R.W. Brown & J. Murata, July 22, 1931	30, 32, 38, 51, 67, 69, 104, 122	9, 57, 60
8212	~4 mi N of mouth of Rising Water Cr., N of Elbowoods, ND	47.724465°, -102.172428°	R. W. Brown, T.W. Stanton & J. Murata, July 23, 1931	14, 32, 36, 40a	9, 57, 60
8213	5 mi SE of Elbowoods, ND	47.524998°, -102.089970°	R.W. Brown, July 22, 1931	153	9, 38, 57, 60
8215	9 mi N of Sixmile Cr., Armstrong, ND	47.605435°, -102.062961°	Missing Data	Missing Data	9, 60
8220	Hoffman Mine, W of Sanish, W bluff of Missouri R., ND	47.975256°, -102.593410°*	R.W. Brown, June 25, 1931	21	3, 9, 57
8222	At first of Blue Buttes, S of Keene, ND	47.880278°, -102.850556°	R.W. Brown & J. Murata, June 25, 1931	9, 36, 51, 153	9, 56, 57
8224	At Brittian Mine, 6 mi SE of Mott, ND	46.314546° -102.259102°	R.W. Brown & J. Murata, July 6, 1931	32, 40, 51, 58, 104, 147, 156	7, 9, 56, 57
8225	At Hoffman mine, Right bank of Missouri R., W bluff, across from Sanish, ND	47.975256°, -102.593410°*	R.W. Brown & J. Murata, 25 June 1931	131, 155	3, 9, 57
8227	Erz Mine stripping, 3 mi N of Watauga, SD	45.965996°, -101.540862°	R.W. Brown & J. Murata, July 10, 1931	30, 38, 75, 89, 96, 104, 131	9, 56, 57
8229	Phelan's Ranch on Little Missouri R., ND	46.512745°, -103.840967°	R.W. Brown & J. Murata, Aug. 10, 1931	142	9
8230, 8234	N of rd; ~5 mi W of Grassy Butte, ND	47.414883°, -103.328622°*	R.W. Brown, T.W. Stanton & J. Murata, June 28, 1931	29, 51, 96, 151, 156, 164	9, 57
8231, 8232, 8233	W of Grassy Butte, near Bicycle P.O., ND	47.417545°, -103.373365°*	R.W. Brown, July 28, 1931	10, 58	7, 9, 57
8236	On route 85 just S of Little Missouri R. crossing, ~17 mi S of Watford City, ND	47.583991°, -103.248770°	J. Murata, July 27, 1931	164	9
8238	Near top of Sentinel Butte, ND J. Murata, July 29, 1931	46.877394°, -103.848789°	R.W. Brown, T.W. Stanton & Leonard, Aug. 10, 1908	36	9, 57
8239	Steven's Ranch, left bank of Little Missouri R., 3/4 mi S of Yule, ND	46.548083°, -103.801547°	Stanton, R.W. Brown & J. Murata, July 29, 1931	36, 62–64, 104	9, 28, 57
8240	Bluffs on Little Missouri R., 3 mi S of Yule, ND	46.527512°, -103.845407°	T.W. Stanton, R.W. Brown & J. Murata, July 30, 1931	33, 104, 131, 164	9, 28, 57
8245	0.5 mi N of Ekalaka, MT on left side of rd toward Baker, MT	45.897130°, -104.544803°	R.W. Brown & J. Murata, Aug. 13, 1931	35	9, 57
8246	50 ft above river, right bank of Yellowstone R. opposite Terry, MT	46.803838°, -105.294710°*	R.W. Brown & J. Murata, Aug. 24, 1931	72, 74	9, 31, 57
8247	Halfway up cliff, left bank of Yellowstone R., opposite of Terry, MT	46.810110°, -105.298413°*	R.W. Brown & J. Murata, Aug. 24, 1931	173	9, 31, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
8248	Frank Roberts coal Mine, 3 mi. W of Amidon, ND	46.485647°, -103.390955°	R.W. Brown & J. Murata, Aug. 12 1931	21	9
8250	N face of Signal Butte, S of Miles City, MT	46.388953°, -105.756754°	R.W. Brown & J. Murata, Sept. 5, 1931	147	9
8252	W of Forsyth, MT, 8 mi S of mouth of Armell Cr., E of Cr	46.167147°, -106.803265°	R.W. Brown & J. Murata, Sept. 15, 1931	3	9, 57
8253	2 mi E of Powder R. bridge, Mizpah, on rd to Ekalaka and Ismay, MT	46.239439°, -105.226092°	J. Murata, Sept. 4, 1931	63, 104	9, 15, 57
8255	Colstrip, MT	45.879211°, -106.612783°	R.W. Brown & J. Murata, Sept. 10, 1931	58, 67, 69, 96, 131, 155, 156	9, 57
8256	8 mi S of mouth of Armell Cr., E of Cr, W of Forsyth, MT	46.167352°, -106.802973°	R.W. Brown & J. Murata, Sept. 15, 1931	29, 32, 35, 44	9, 57
8257	Up Harris Cr., ~5 mi NE of Kinsey, MT	46.619993°, -105.632020°	R.W. Brown & J. Murata, Sept. 12, 1931	63, 79, 147	9, 57
8258	1 mi E of Hathaway, MT. Right side of rd toward Miles City, at base of bluffs	46.278262°, -106.170334°	R.W. Brown, Sept. 11, 1931	2, 13, 32, 36, 39, 104	9, 57
8259	1 mi E of Hathaway, MT. Right side of rd toward Miles City, 50 ft from top of bluffs	46.277204°, -106.169493°	R.W. Brown, Sept. 11, 1931	Missing Data	9, 57
8261	2 mi W of Cap Rock, on rd Kinsey to Cap Rock, 18 mi NE of Miles City, MT	46.582305°, -105.743230°	R.W. Brown & J. Murata, Sept. 12, 1931	72	9, 57
8262	At Cap Rock, N side of Yellowstone R., 20 mi E of Miles City, MT	46.594333°, -105.714221°	R.W. Brown & J. Murata, Sept. 12, 1931	89	9, 57
8307[1]	SE of Calhan, CO	39.017943°, -104.269035° [NW¼ Sec. 7, T. 12 S, R. 61 W]	C. Dane & White, Sept. 15, 1931	51, 84, 132,	9, 57
8426	6 mi S and a little E of Como, South Park, CO	39.234679° -105.865260°	J. Harlan Johnson	81	9, 57, 73
8447	6 mi S of Como, CO	39.240071°, -105.886943°	J. Harlan Johnson	8, 17, 131, 136	9, 57
UGS 8493	12 ft above 8447, 6 mi S of Como, CO	39.240071°, -105.886943°	J. Harlan Johnson 1934	32	9, 57
8516	1 mi E of filling station near Dana, on Lincoln Hw y 30, WY	41.793485°, -106.754687°	R.W. Brown & F.S. MacNeill, 10 Sept. 1936	72, 74, 75, 82, 85, 132, 148	9, 57, 70
8517	N of U.S. Hwy 10, right bank of Moon Cr., 10.5 mi W of Miles City, MT	46.321091°, -106.004627°	R.W. Brown, F. S. MacNeill, Aug. 21, 1936	2, 23, 95, 96, 122, 131, 136	9, 57
8519	S and 50 ft above level of U.S. Hwy, 4.5 mi E of Shirley and 25 miles E of Miles City, MT	46.642219°, -105.520181°	R.W. Brown, F.S. MacNeill, Aug.14, 1936	5, 12, 16, 20, 21, 21, 31, 40, 41, 47, 58, 95, 96, 122, 128, 135, 144, 153–155, 175, 179, 182	9, 57
8520	Foley Brothers Pit no.1, Colstrip, MT	45.879211°, -106.612783°	R.W. Brown, F.S. MacNeil, Aug. 20, 1936	153	9, 57
8521	N of George Newlin Ranch, Ashland, MT	45.643339°, -106.264819°	R.W. Brown, Aug. 14 1939	32, 36, 59, 69, 131, 154	9, 57
8522	S side of Dry Cr., S of jct of roads 310 and 20, 5 mi W of Greybull, WY	44.499513°, -108.128939°	R.W. Brown & F. S. MacNeill, Sept. 2, 1936	29, 32, 34, 57, 163, 182	9, 57
8523	Sweetgrass Cr., MT	46.170931°, -110.152794° [Sec. 19, T. 5 N, R. 13 E]	R.W. Brown, F.S. MacNeill, A.C. Silberling & W. Hendekoper, Aug. 28 1936	51, 67, 98, 122, 131, 156	9, 57
8526	near Jepsen mammal quarry on Polecat Bench, W of Frannie, WY	44.893075, -108.752486	R.W. Brown & F.S. MacNeill, Sept. 1, 1936	45	9, 26, 57
8528	¾ mi E of Dana filling station on Hwy 30, WY	41.791070°, -106.757906°	R.W. Brown & F.S. MacNeill, Sept. 2, 1936	132	9, 57, 70
8529	N side of old rd to Musselshell, 10 mi E of Roundup, MT	46.48075, -108.342306	R.W. Brown, Aug. 26, 1936	32	9, 57
8530	Tusler, MT, S of rd at curve and cutbank on Hwy 10, 15 mi E of Miles City	46.558653°, -105.615498°	R.W. Brown & F.S. MacNeill, Aug. 22, 1936 = UF loc. 19013	95, 96, 104, 177	9, 57
8535	Poison Spider Cr., SW of Casper, WY	42.783875°, -106.531261°	C.E. Dobbin, R.W. Brown & F.S. MacNeill, July 13, Sept. 7, 1936	23	9, 57
8542	1 mi E of Intake, MT on conical hill near stone quarry N of Hwy	47.302999°, -104.513182°	R.W. Brown, F.S. MacNeill, Aug. 4, 1936	147	9, 57
8545	E of Hwy from Forsyth to Colstrip, near station on rr branch to Colstrip, MT	46.083967°, -106.721658°	R.W. Brown, F.S. MacNeill, Aug. 20, 1936	45, 96, 131	9, 57
8547	S side of Lebo Cr., at type section of the Lebo Fm., MT	46.257664°, -110.085281°*	F.S. MacNeill, Aug. 29, 1936	104, 134, 177	9, 57, 68
8548	On rd N from US Hwy 30 from point about 2 mi W of Hanna, WY	41.890819°, -106.625464°	R.W. Brown & F.S. MacNeill, Sept. 10, 1936	23	9
8549	1 mi E of Hathaway, halfway up slope of bluff S of Hwy, MT	46.277161°, -106.169569°	R.W. Brown & F.S. MacNeill, Aug. 21, 1936	32, 34	9, 57
8550, 8553	On rd to Cap Rock, 18-18.5 mi NE of Miles City, MT	46.582305°, -105.743230°	R.W. Brown & F.S. MacNeill, Aug. 17, 1936	36, 95, 104, 142	9, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
8551	MC Mine, 0.5 mi E of Sand Cr. Bridge,~7 mi N of Glenrock,WY	42.961450°, -105.837983°	R.W. Brown & F.S. MacNeill, Sept. 5, 1936	8, 27, 32, 51, 57, 58, 72, 75, 84, 87, 96, 114, 132, 141, 180	9, 57
8552	3 mi W of Marsh, near Coulin Station on RR, W of Glendive, MT	46.866000°, -104.991000°	R.W. Brown, F.S. MacNeill & D. Yri, Aug. 3, 1936	32, 58, 63, 72, 104, 108, 112, 131	9, 57
8554	On N side of Yellowstone R., opposite Terry, MT	46.809836°, -105.307483°*	R.W. Brown & F.S. MacNeill, Aug. 12, 1936	155	9, 31, 57
8556	10 mi N of Terry on rd to Crow Rock, ~2 mile W of bridge in a cut bank of Cherry Cr., MT	46.873578°, -105.432589°	R.W. Brown & F.S. MacNeill, Aug. 13, 1936	29, 37, 40, 79, 96	9, 57
8558	On Lebo Cr., Wallis Hende-koper Ranch, 1½ mi S of Buckley, MT	46.256550°, -110.100872°	R.W. Brown & F.S. MacNeill, July 21, 1936	153	9, 57
8566	Wyodak Coal Mine, 4½ mi E of Gillette, WY	44.288336°, -105.399311°	R.W. Brown & F.S. MacNeill, Sept. 4, 1936	51, 177	9, 57
8654	300 ft S of Hwy 30, 7½ mi E of Point of Rocks, WY	41.645577°, -108.665141°	R.W. Brown & C.W. Mumm, July 8, 1938	122, 153, 164	9, 57
8660	1 mi NE of US Hwy 30 at Hadsell, 10 mi W of Rawlins, WY	41.789362°, -107.360664°	R.W. Brown & C.W. Mumm, July 1, 1938	51, 110, 132	9, 33, 57
8662	Near bridge crossing, in bluff on N side of Big Ditch, WY	41.923647°, -106.786100°	R.W. Brown & C.W. Mumm, July 28, 1938	45	9, 57, 70
8668	10 mi S of Rozet, E of Gillette, WY	44.287803°, -105.007197°	R.W. Brown, June 15, 1938	110, 191	9, 57
8669	Dump from large rd cut, 4 mi W of Bayfield, CO	37.224933°, -107.670778°	R.W. Brown & C.W. Mumm, Aug. 31 1938	191	9
8670	Slack pile at mine No. 1, Almy, 2.5 mi NW of Evanston, WY	41.313864°, -110.996395°	R.W. Brown & C.W. Mumm, July 14, 1938	32	9, 57, 70
8672	85 ft below top of hill, in bank of Second Cr., 10 mi E of Derby, CO	39.828911°, -104.721764°	R.W. Brown & Dobbin, May 25, 1938	45, 71, 92, 96, 126, 132, 147	9
8673	In gully S of rd going W from Conoco Camp, W of Lance Cr., WY	43.033397°, -104.773592°	R.W. Brown & C.W. Mumm, June 7, 1938	47, 93, 92, 96, 131, 142, 153	9, 57
8677	Overlooking Thunder Cr. in distance to W, 8 mi W of Clareton, WY	43.671419°, -104.892869°	R.W. Brown & C.W. Mumm, June 6, 1938	32, 82, 104, 128, 141, 142	9, 57
8678	250 ft lower than 8677	43.670692°, -104.893050°	R.W. Brown & C.W. Mumm, June 6, 1938	8, 12, 15, 18, 19, 22, 31, 41, 50, 95, 122, 139, 142, 153, 200	9, 57
8775	1 mi E of DeBeque, CO, N side of U.S. Hwy 6 at curve on hill	39.334133°, -108.195764°	R.W. Brown, T.D. Lamar, & B. Patterson, Sept. 14, 1939	18, 182	9, 57
8776	1½ mi W of Walsenburg, CO, 20 ft above Cucharas R.	37.612246°, -104.801667°	R.W. Brown & T.D. Lamar, July 31, 1939	129	9, 39, 40, 57
8777	W side of Platte R., Denver, CO, near Colfax Pressed Brick Co. & 17th Ave	39.699628°, -105.001419°*	R.W. Brown, June 1, 1939	8, 70, 71, 74, 81, 126	9, 11, 57
8779	S side of Jimmy Camp Cr., ¾ mi E of Richfield Springs Ranch, 9 mi E of Colorado Springs, CO	38.854619°, -104.652958°	R.W. Brown & T.D. Lamar, Aug. 4, 1939	24, 70, 71	9, 57
8780	S side of Beebe-Powderville Rd, 3.8 mi W of Powderville, MT	45.791842°, -105.177939°	R.W. Brown, Aug. 15, 1939	95, 131	9, 10, 57
8781	2 mi up Little Powder R. from jct with Powder R., NE of Broadus, MT	45.454836°, -105.328797°	R.W. Brown, Aug. 10, 1939	32, 96, 146	9, 57
8786	~6 mi SW of Broadus, MT	45.365933°, -105.540850°	R.W. Brown, Aug. 9, 1939	29, 32, 36, 40a, 89	9
8881	½ mi W to NW of Ramah, CO	39.123284°, -104.173451°	R.W. Brown, June 13, 1940	23, 40, 104, 141	9, 57
8882	½ mi E of Purdon Mine, 5 mi SW of Ramah, CO	39.064839°, -104.204025°	R.W. Brown, June 12, 1940	36	9, 53, 57
8884	2 mi E of Hwy 87 on county rd from elevator near Ohlman, 25 mi NW of Sheridan, WY	44.955829°, -107.290256°*	R.W. Brown & C.E.S. Sept. 10, 1940	8, 27, 51, 96, 114, 131	9, 57
8885	Mackton No. 2 coal mine, 6½-7 mi NE of Big Sandy, MT	48.182206°, -109.985564°	R.W. Brown, Aug. 22, 1940	32, 36, 63, 67, 69, 96, 153	6, 9, 57, 58
8886	W of mouth of Cub Cr., on Otter Cr., MT, 50 ft above wall bed	45.218600°, -106.185114°	W. Hass et al., Sept. 6, 1940	63	9, 57
8887	Sayle Rd, MT	45.087182°, -106.082108° [300 ft W of corner between sects 33/34, T. 8 S, R. 46 E	R.P. Bryson & R.W. Brown, Sept. 6, 1940	40a, 87, 164	9, 57
8888	~4.6 mi NE of Otter, MT	45.260147°, -106.141725° [SE ¼/ NE ¼ Sec. 6, T. 7 S, R. 46 E]	R.W. Brown & R.P. Bryson, Sept. 6, 1940	79, 104	9, 57
8893	20 mi N NE of Kaycee, Wy, ¾ mi S of bridge over Crazy Woman Cr., & ~4 mi E to bluffs	43.975842°, -106.682025°*	R.W. Brown, Sept. 17, 1940	27, 57, 96, 131	9, 57
8896	Big Timber, MT; Bluff top, N side of Yellowstone R.	45.855211°, -109.959267°	R.W. Brown, July 19, 1940	18, 57, 79, 96	9, 57
8897	8½ mi NW of Glendive bridge over Yellowstone R., MT, 1 mi E of Hwy 18	47.125900°, -104.890200°	R.W. Brown, Sept. 1, 1940	14, 15, 16, 36, 58, 89, 128, 144	9, 57

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
8899	S of Hwy at Gwynn Ranch, Grass Cr., WY	?	R.W. Brown, July 5, 1940	10, 32, 34, 71, 95, 96, 131, 136, 141	9, 35, 57
8901	E side of Graveyard Coulee, S of Glendive, MT	47.101731°, -104.687421°	R.W. Brown, Aug. 29, 1940	75, 126	9, 57
8910	Bayhorse Cr. (W side), 1½ mi N of Traub Ranch, MT	45.156317°, -105.691544°	R.W. Brown & M.W. Ellis, July 14, 1941	56, 52, 68, 72, 96, 119, 121, 154, 164, 175, 180, 192	9, 57
8913	Sentinel Butte, ND; Small hill to N of rd leading up to the butte	46.884939°, -103.849756°	R.W. Brown, July 28, 1941	9, 16, 40a, 63, 79, 96, 178, 193, 194	9, 57
8917	3 mi E of Black Buttes, WY; ¼ mi S of Hwy, on new rd from Bitter Cr. to Black Buttes	41.516736°, -108.654203°	R.W. Brown, June 18, 1941	14, 35, 57, 164, 177	9, 57, 66
8920	Little Bitter Cr., 1/4 mi N of gate on rd, E of rd on hillside, 20 mi S of Rock Springs, WY	41.286367°, -109.195683°	R.W. Brown, June 20, 1941	40a, 56, 63, 77, 80, 122, 145, 154	9, 57
8921	Little Bitter Cr., SW of Antelope Butte, WY	41.372608°, -109.211536°	R.W. Brown, June 23, 1941	14, 55, 58, 96, 122, 136, 139, 153	9, 57, 66
8922	E side of Bitter Cr., E of Bacon ranch, S of Rock Springs, WY	41.337985°, -109.207567°	R.W. Brown & W.H. Bradley, June 21, 1941	14, 30, 38, 40a, 72, 84, 96, 131, 153	9
8928	~9 mi NW of Craig, CO; bluff in second gulch NE of Allan Mckinison Ranch house	40.588308°, -107.678731°	R.W. Brown, Sept. 16, 1941	8, 18, 35, 59, 87, 96, 129, 131	9, 57
8930	7 mi E of Point of Rocks, WY, 1 mi N of Hwy 30	41.661797°, -108.658742°	R.W. Brown, June 17, 1941	55, 58	9, 57
9056	~17 mi SW of Musselshell, MT	46.300677°, -108.161213°*	R.W. Brown & H. Hadley, Sept. 4, 1944	96, 153	9, 57
9071	~¼ mi E of mouth of Buck Cr., N side of Fish Cr., WY	43.518719°, -110.052080°	Bergquist, & J.D. Love, July 10, 1945	156	9, 57
9072	1.5 mi SE of Coalwood, MT	45.707956°, -105.576319°	R.P. Bryson, July 3, 1946	14, 58, 88, 96	9
9084	17.5 mi N NW of Hebron, ND	47.118339°, -102.225036° [NW ¼ SW ¼ Sec. 16, T. 142 N, R. 91 W]	W.E. Benson, R.W. Brown, July 9, 1947	21	9
9085	NE side of Young Men's Butte, ~2.5 mi E of Richardton, ND	46.873132°, -102.240429°	W.E. Benson, R.W. Brown, July 11, 1947	21, 131	9, 38
9104	Ranous Coal Mine, Daleview, MT	48.906783°, -104.923822°	R.W. Brown, R.B. Colton, Aug. 29, 1949	57, 58, 69, 131, 136	9, 13, 57
9109	12.5 mi E Riverton, WY, 3 mi N 10° W of station on Alkali Butte	42.946569°, -108.198999° [NW1/4 SW1/4 sec. 29, T. 1 S, R. 6 E]	R.W. Brown, G.N. Piperingos, K. Yenne, R. Thompson, et al., July 25–26, 1949	29, 37, 40, 57, 65, 78, 79, 96, 116, 121, 139, 145, 175, 187, 195	9, 57
9111	E of Little Dome, Carter Oil site 2, N of Lander, WY	42.886191°, -108.734164°*	missing data	61, 99	9
9129	Gas Hills, WY	42.957467°, -107.680869° [SE ¼ SE ¼ Sec. 36, T. 35 N, R. 91 W]	J.D. Love, K Yenne, Oct., 1950	31, 40a, 164	9
9130	Gas Hills, WY	42.872014°, -107.911092° [SW ¼ Sec. 31, T. 34 N, R. 92 W]	D. Beardsley, J. Belshe, K. Yenne, R.W. Brown, Aug. 1, 1950	27, 96, 114, 131	9
9132	SW side of Shotgun Butte, WY	43.453164°, -108.727333°	R.W. Brown, Troyer, K. Yenne, W.R. Keefer, Thompson, & Burnside, July 26, 1950	61, 110, 137	9, 57
9134	Blue Pony coal mine, MT	48.234982°, -109.864718° [SW1/4 SW1/4 Sec. 25, T. 29 N, R. 14 E]	missing data	48	9
9180	1 mi W of RR to Reliance, along Killpecker Cr., 3 mi NW of Rock Springs, WY	41.619585°, -109.248113°	R.W. Brown & H.R. Christener, July 21, 1952	36, 57, 79, 122, 142	9
9192	N side of Ekalaka-Mizpah Rd, 11 mi E of Powder R., on Grail (Trail) Cr., MT	46.124858°, -104.957881° [1]	R.W. Brown, Aug. 28, 1946	35	9, 57
9193	Whetstone Falls, on tributary of Pacific Cr, NE of Moran, WY	43.868742°, -110.485229°*	missing data	33, 104	9
9196	45 mi N of Lander, WY	43.493780°, -108.778577° [NE1/4 SE1/4 sec. 17, T. 6 N, R. 1 E.]	missing data	29, 61	9
9198	~1 mi due S of Riner, WY	41.719383°, -107.550117° [SE ¼ Sec. 8, T. 20 N, R. 90 W]	R.B. Nace, 15 March 1941	52	9, 57
9199	17 mi S of Garland, MT	45.795942°, -105.888144° [Sec. 33, T. 1 N, R. 47 E]	R.D. Forester, May 3, 1950	57	9, 57
9200	8 mi S of Taylor, ND	46.776936°, -102.432233°	R.L. Coville	48	9
9201	~4 mi E of Mackton Coal Mine, in Bearpaws, E of Big Sandy, MT	48.166437°, -109.864908°	R.W. Brown & D. Sewart, Sept. 4, 1951	174	6, 9
9202	3 mi E of Fort Stevenson (submerged), N side of Missouri R., ND	47.570129°, -101.414107°	L.F. Ward, Sept. 17, 1883	58	9, 57
9203	1 mi S of Como, CO	41.891669°, -106.365225°	R.W. Brown, June 27, 1938	59	9, 57, 70
9207	W of station on Alkali Butte, 13 mi E of Riverton, WY	42.946164°, -108.200397°*	G.N. Pipiringos & K. Yenne, 1949	68	9, 57
9208	51 mi E of Lander, WY	42.914273°; -107.728382° [S 1/2 Sec. 15, T. 34 N, R. 91 W]	missing data	29, 61	9
9209	N of Medicine Bow R., S side of Hwy, ~directly N of Hanna, WY	42.017261°, -106.525482°*	F.S. MacNeil, Sept. 9, 1936	110	9

Locality number	Brief Description	Latitude, Longitude [and original coordinates]	Collectors, Date	Taxon list	Reference
9210	Black Buttes, WY	41.504053°, -108.640697° [SE ¼ Sec. 26, T. 18 N, R. 100 W]	R.L. Nace 1941	141	9
9235	N side of rd, along LaBarge Cr., ~2 mi E of Viola, WY	42.247417°, -110.337914°	R.W. Brown, Sept. 14, 1946	110	9
9236	Hiawatha Unit well 2, 14 mi E of Diamond Peak, CO	40.990894°, -108.625644° [NW ¼ NW ¼, Sec. 22, T. 12 N, R. 100 W]	Mountain Fuel & Supply Co., 1952	175	9
9237	Above white SS of "Castle Gardens" on Muskrat Creek, S of Moneta, WY.	43.018119°, -107.708968°	missing data	70	9
9239	35 mi SW of Broadus, MT;	45.067281°, -105.944092° [NE1/4 Sec. 10, T. 9 S, R. 47 E]	missing data	104	9
9248	E side of Smoky Butte Cr., 14 mi NW of Jordan, MT	47.399361°, -107.182475°*	Barnum Brown, 1906	161	9, 57
9249	SE corner of Sec. 10, T. 16 N, R. 38 E, MT	47.149569°, -106.890881°	A.K. Cameron, 1924	161	9, 57
9252	1 mi above mouth of Powder R., 6 mi SW of Terry, MT	46.735278°, -105.404033°	J.B. Clough, 1881	132	9, 31
9253	W side of Little Powder R., near Biddle, MT	45.090736°, -105.337442°*	R.W. Brown, July 15, 1941	20, 123	9
9322	Eagle Coal Mine, 1 mi S og Bear Cr., MT	45.149825°, -109.169369°*	A.M.N.H., May 8, 1905	50, 78, 153, 154	9, 57, 78
9334	E side of Smoky Butte Cr., 14 mi NW of Jordan, MT	47.399361°, -107.182475°	A.M.N.H., May 8, 1905	29, 33, 79, 96, 131, 132	9
9344	E of Point of Rocks, WY	41.748178°, -108.676511° [NE ¼ SW ¼ Sec. 36, T. 21 N, R. 100 W]	W.P. Revern, 1957	123	9
9398	18.5 mi SW of Beulah, ND	47.100098°, -102.117576° [SW1/4 Sec. 20, T. 142 N, R. 90 W]		67	9
9402	~5 mi SW of Bridger, MT	45.216793°, -108.976741°	R.W. Brown, Aug. 23, 1944	40	9
9403	N side of Hwy, 5 mi NW of Rock Springs, toward Yellow-stone Park, WY	41.664233°, -109.264633°	R.W. Brown, July 21, 1952	40a	9
9404	~3 mi W of Elk Basin, WY	44.996150°, -108.923533°	R.W. Brown, Aug., 22, 1944	40a	9
9405	~30 Mi N of Riverton, WY	43.451817°, -108.546450° [ctr. Sec. 32, T. 6 N, R. 3 E]	J.D. Love, W.R. Keefer & M.C. Troyer, Oct. 1950	40a	9
9445	~1½ mi NE of Whitely Peak, CO	40.322675°, -106.471906°	D. Kinney & W. Hail, Aug. 26, 1956	116	9
9482	Gas Hills area,WY	42.931052°, -107.617897° [NW1/4 SW1/4 Sec. 10, T. 34 N, R. 90 W]	missing data	61	9
9492	W side of Hwy, 3½ miles N of Pagosa Junction, CO	37.081261°, -107.193786°	R.W. Brown, 19 June 1940	110	9
9501	Along highway on left bank of Colorado R, 4 mi SW of DeBeque, CO	39.277271°, -108.229821° [NW1/4 Sec. 16, T. 9 S., R. 97 W]	missing data	51, 74, 79	9
9532	Sand Draw, WY	42.800979°, -108.183040° [ctr. SW ¼ Sec. 26, T. 33 N, R. 95 W]	W.R. Keefer	35, 121	9
9540	NE of Muskrat Cr. camp at cabin, on rd to Riverton, WY	43.153160°, -108.174892°*	R.W. Brown 28, July 1951	110	9
9544	2 mi N of Hwy 94, 3 mi E of bridge over Jimmy Camp Cr., 9 mi E of Colorado Springs, CO	38.866876°, -104.605017°	Missing Data	71, 81	9
9554	2 mi N of hwy 94, 3 mi east of bridge over Jimmy Camp Cr, 9 mi east of Colorado Springs, CO	38.842058°,-104.619812°	missing data	71, 81	9
9558	5.5 mi SW of Kemmerer, WY	41.759835°, -110.640597° [ctr. of NE 1/4 sec. 36, T. 21 N, R. 117 W]	Missing Data	35	9
9565	1 mi above confluence of Los Pinos & San Juan Rivers, NM	36.852992°, -106.253314°	Missing Data	45, 51, 132	9
9566	3 mi W of Douglas, WY, just N of Hwy 20	42.770076°, -105.422683°	Missing Data	114	9
Woolsey 522	5 mi NW of Buckey, MT	46.234904°, -108.538548°	L.H. Woolsey	19, 104, 122	79
Woolsey 523	6 mi NE of Buckey, MT	46.226553, -108.344949	L.H. Woolsey	96, 122	79

Coordinates marked with asterisk (*) are rough approximations based on limited original data. References consulted: 1. Ball & Stebinger (1910); 2. Barnett (1914); 3. Bauer & Herald (1921); 4. Beekly (1915); 5, 6. Bowen (1912, 1914); 7. Brant (1953); 8, 9. Brown (1939a, 1962); 10. Bryson (1952); 11. Catlett (2007); 12, 13. Collier (1919, 1925); 14. Collier & Knechtel (1939); 15. Collier & Smith (1908); 16. Davis (1912); 17. Dobbins (1930); 18. Dobbins & Barnett (1928); 19, 20. Douglas (1908-1909a, b); 21. Eldridge (1896); 22. Emmons et al. (1896); 23. Freeman & Mathers (1911); 24. Gardner (1909); 25. GEOlocate (accessed 2014); 26. Gingerich et al. (2006); 27. Goldman (1910); 28. Hares (1928); 29, 30. Hayden (1869, 1885); 31, 32. Herald (1912, 1913); 33. Hettinger et al. (2008); 34, 35. Hewett (1914, 1926); 36. Hewett & Lupton (1917); 37. Hickey (1977); 38. Historic MapWorks (accessed 2014); 39. Johnson (1958); 40. Johnson & Stephens (1955); 41, 42, 43, 44, 45, 46, 47, 48, 49. Knowlton (1896, 1902, 1907, 1908, 1917, 1919, 1922, 1924, 1930); 50. Lee (1917); 51, 52. Leonard (1906, 1908); 53. Lord (1913); 54. Lloyd (1914); 55. Lupton (1909); 56. Nat. Geol. Database (accessed 2014); 57. Pal. Database (accessed 2014); 58, 59. Pepperberg (1910, 1912); 60. Pishel (1912); 61. Reeside (1924); 62, 63, 64, 65. Richardson (1910, 1911, 1915, 1917); 66. Schultz (1910); 67. Smith (1910); 68. Stone & Calvert (1910); 69. Stone & Lupton (1910); 70. Veatch (1907). 71, 72. Ward (1885a, b); 73. Washburne (1910); 74. Weed (1898); 75. Wegemann (1912); 76. Winchester (1912); 77. Winchester et al. (1916); 78. Woodruff (1909); 79. Woolsey et al. (1917); 80. Yen (1952). 81. Kaufmann, et al. (1990). **Abbreviations:** AMNH: America Museum of Natural History, Ave: Avenue, CO: Colorado, Cr.: Creek, Ctr: Center, E: East, ft: feet, Hwy: Highway, Jct: Junction, Mi: Mile(s), MT: Montana, N: North, ND: North Dakota, NE: Northeast, NM: New Mexico, NW: Northwest, PO: Post Office, R: Range, S: South, SD: South Dakota, Sec: Section, SW: Southwest, T: Township, W: West, WY: Wyoming.