

dinosaur skull exposed in the Arapahoe basal conglomerate in the 12th Street clay pits at Golden. Examination revealed a number of other bones scattered in the conglomerate nearby. These have been turned over to Mr. Harold Cook of the Colorado Museum of Natural History. It is expected that a description and discussion of them will be ready for publication about October, 1930. This find is of particular interest as it is almost the only one in which the exact geographic and stratigraphic location are definitely known.

Several small collections of plants from localities around Denver have been reported by early writers. Unfortunately, the localities given are vague and it has been demonstrated that these writers had several misconceptions as to stratigraphy, so that it seems more than probable at present that most of these actually came from the Denver. The one collection regarded by Knowlton¹¹ as most probably Arapahoe comes from the Douglas mine near the type locality of the Arapahoe. It comprises the following flora:

Acer sp.
 Allantodiopsis erosa (Lesquereux) Knowlton and Maxon
 Asimina eocenica Lesquereux
 Berchemia multinervis (Al. Braun) Heer
 Cissus coloradensis Knowlton and Cockerell
 Cissus lobato-crenata Lesquereux
 Dennstaedtia crossiana Knowlton
 Diospyros brachysepala A. Braun
 Dombeyopsis obtusa Lesquereux
 Dombeyopsis? sedaliensis Knowlton
 Dryopteris lakesii (Lesquereux) Knowlton
 Dryopteris richardsoni Knowlton
 Ficus? alata Knowlton
 Ficus neoplanicostata Knowlton
 Laurus primigenia Unger
 Nelumbo crossii Knowlton
 Nelumbo lakesiana (Lesquereux) Knowlton
 Phyllites aristolochoides Knowlton
 Platanus haydenii Newberry
 Quercus? sedailensis Knowlton
 Viburnum richardsoni Knowlton
 Woodwardia latiloba Lesquereux

Knowlton makes the following comment:

"It will be seen at once that this is essentially a Denver flora, with only two species that occur in the Laramie—*Dombeyopsis obtusa* and *Ficus planicostata*. Both of these species have already been several times mentioned as passing from Laramie into post-Laramie beds."

¹¹Op. Cit.

It should be noted that all the plants are found in the Denver flora and that all the dinosaurs are also known in the Denver, as can be seen by comparing with the Denver lists given below.

Inasmuch as Eldridge seems to have rather arbitrarily divided the Arapahoe from the Denver, because of a misconception as to its age, and, since Richardson has shown that both grade laterally into the Dawson Arkose of the Castle Rock Quadrangle, it would seem advisable to discard the name Arapahoe altogether.

Denver Formation. Abundant plant fossils are known from the Denver formation. Some are splendidly preserved. Collections totaling hundreds of specimens have been obtained from a number of localities in the vicinity of Golden, and plant remains can be obtained in almost any of the sandy layers.

Most of the described material has been collected along the south sides of South Table Mountain and from the north-western base of Green Mountain. The total known flora includes about 225 species. They are listed below:¹²

Acorus brachystachys Heer
 Allantodiopsis erosa (Lesquereux) Knowlton and Maxon
 Alnus auraria Knowlton and Cockerell
 Amelanchier typica var. Lesquereux
 Andromeda linearifolia Lesquereux
 Aralia notata Lesquereux
 Artocarpus pungens (Lesquereux) Hollick
 Arundo gopperti? Munster
 Arundo? obtusa Lesquereux
 Asimina eocenica Lesquereux
 Asplenium crossii Knowlton

Berchemia multinervis (Al. Braun) Heer
 Berrya racemosa (Knowlton) Knowlton
 Betula gracilis? Ludwig
 Betula schimperii Lesquereux

Carex Berthoudi Lesquereux
 Carpites coffeaeformis Lesquereux
 Carpites costatus Lesquereux
 Carpites alurineus Lesquereux
 Carpites minutulus Lesquereux
 Carpites myricarum Lesquereux

¹²Knowlton, F. H., and Berry, E. W., Flora of the Denver and associated formations of Colorado: U. S. Geol. Survey Prof. Paper 155, 1930.

- Carpites oviformis* Lesquereux
Carpites rostellatus Lesquereux
Carpites triangulatus Lesquereux
Carpolithes corrugatus (Lesquereux) Cockerell
Castanea intermedia Lesquereux
Celastrinites artocarpidioides Lesquereux
Celastrinites populifolius Knowlton
Celastrus gaudini Lesquereux
Chrysobalanus coloradoensis Knowlton
Cinnamomum sp.
Cissus coloradoensis Knowlton and Cockerell
Cissus corylifolia Lesquereux
Cissus duplicato-serrata Lesquereux
Cissus lesquereuxii Knowlton
Cissus lobato-crenata Lesquereux
Cissus obovata Knowlton
Cornus denverensis Knowlton
Cornus holmesii Lesquereux
Cornus impressa Lesquereux
Cornus lakesii Knowlton
Cornus studeri? Heer
Crataegus antiqua Heer
Crataegus betulaefolis Lesquereux
Crataegus englehardti Lesquereux
Crataegus holmesii Lesquereux
Crataegus myricoides Lesquereux
- Daphnogene anglica?* Heer
Diospyros brachysepala Al. Braun
Diplazium crossii (Knowlton) Knowlton
Dombeyopsis grandifolia? Unger
Dombeyopsis obtusa Lesquereux
Dryopteris arguta (Lesquereux) Knowlton
Dryopteris lakesii (Lesquereux) Knowlton
Dryopteris nigricans (Lesquereux) Knowlton
Dryopteris polypodioides (Ettingshausen) Knowlton
- Equisetum*, 2 species
Eriocaulon? *porosum* Lesquereux
- Ficus aguilar* Knowlton
Ficus andraei Lesquereux
Ficus berthoudi Lesquereux
Ficus coloradoensis Cockerell
Ficus eldridgi Knowlton
Ficus denveriana Cockerell
Ficus lakesii Knowlton
Ficus martini Knowlton
Ficus occidentalis (Lesquereux) Lesquereux
Ficus neoplanicostata Knowlton
Ficus planicostata clintoni (Lesquereux) Knowlton
Ficus planicostata goldiana Lesquereux
Ficus planicostata problematica Knowlton
Ficus pseudopopulus Lesquereux
Ficus subtruncata Lesquereux

- Ficus tilioefolia* (Braun) Heer
Ficus zizyphoides Lesquereux (Formation doubtful)
Ficus sp. (2)
Fraxinus praedicta Heer
Fraxinus eocenica Lesquereux

Geonomites goldianus (Lesquereux) Lesquereux
Geonomites graminifolius Lesquereux
Geonomites tenuirachis Lesquereux
Geonomites? sp.
Ginkgo? *truncata* (Lesquereux) Knowlton
Grewiopsis tenuifolia Lesquereux

Hicoria antiquora (Newberry) Knowlton
Hymenophyllum confusum Lesquereux

Ilex? *ovata* Knowlton

Juglans denveriana Knowlton
Juglans rhamnoides Lesquereux
Juglans rugosa Lesquereux
Juglans schimeri Lesquereux
Juglans thermalis Lesquereux

Laurus primigenia Unger
Laurus schmidtiana Heer
Laurus socialis Lesquereux
Leguminosites? *arachioides* (Lesquereux) Lesquereux

Magnolia magnifolia Knowlton

Negundo decurrens Lesquereux
Nelumbo lakesiana (Lesquereux) Knowlton
Nelumbo tenuifolia (Lesquereux) Knowlton
Nyssa denveriana Knowlton
Nyssa europaea Unger
Nyssa lanceolata Lesquereux
Nyssa? *obovata* Knowlton
Nyssa? *racemosa* Knowlton

Paloreodoxites plicatus (Lesquereux) Knowlton
Paliurus coloradoensis Lesquereux
Paliurus zizyphoides Lesquereux
Palmocarpon? *corrugatum* Lesquereux
Palmocarpon lineatum Lesquereux
Palmocarpon palmarum (Lesquereux) Knowlton
Palmocarpon subcylindricum Lesquereux
Palmocarpon truncatum Lesquereux (Formation doubtful)
Palmodyloncannoni stevens
Persea brossiana (Lesquereux) Lesquereux
Phyllites cyclophyllus (Lesquereux) Hollick
Phyllites denverensis Knowlton
Piper heerii Lesquereux
Pisonia chlorophylloides Berry
Platanus aceroides Goppert
Platanus guillelmae Goppert
Platanus haydenii Newberry

- Platanus raynoldsii* Newberry
Platanus raynoldsii integrifolia Lesquereux
Platanus rhomboidea Lesquereux
Populus denverensis Knowlton
Populus nebrascensis Newberry
Populus jacksoni Knowlton
Populus lacoeana Knowlton
Populus nebrascensis acute-dentata Lesquereux
Populus nebrascensis grandidentata Lesquereux
Populus nebrascensis longifolia Lesquereux
Populus nebrascensis rotunda Lesquereux
Populus subrotunda Lesquereux
Populus tenuinervata Lesquereux
Populus ungeri Lesquereux
Populus zeilleri (Lesquereux) Knowlton
Populus sp.
Protoficus zeilleri Lesquereux
Pteris pseudopinnaeformis Lesquereux
Ptericarya americana Lesquereux (Formation doubtful)
Pterocarya retusa Lesquereux
Pterospermites grandidentatus Lesquereux
Pterospermites sp. Lesquereux

Quercus celastrifolia Lesquereux
Quercus coloradoensis Lesquereux
Quercus crossii Lesquereux
Quercus eucalyptifolia Ettingshausen
Quercus haidingeri Ettingshausen (Formation doubtful)
Quercus? *leonis* Knowlton
Quercus viburnifolia Lesquereux
Quercus whitei Lesquereux

Rhamnus alaternoides Heer
Rhamnus cleburni Lesquereux
Rhamnus crenulatus Knowlton and Cockerell
Rhamnus deformatus Lesquereux
Rhamnus goldianus Lesquereux
Rhamnus obovatus Lesquereux (Formation doubtful)
Rhamnus praealaternoides Knowlton
Rhamnus rectinervis Heer

Sabal? *eocenica* (Lesquereux) Knowlton
Sabalites fructifer Lesquereux
Sabalites grayanus Lesquereux
Saccoloma gardneri (Lesquereux) Knowlton
Salpichlaena anceps (Lesquereux) Knowlton
Sapindus caudatus Lesquereux
Sapindus? *obtusifolius* Lesquereux?
Sclerotites rubellus (Lesquereux) Meschinelli
Selaginella berthoudi Lesquereux
Sequoia? sp. Lesquereux
Sterculia saportanea Knowlton
Sterculia libbeyi Knowlton
Styrax ambra Unger
Styrax laraminense Lesquereux

Ulmus antedecens Lesquereux
Ulmus quercifolia Unger

Viburnum goldianum Lesquereux
Viburnum? *heterodontum* Knowlton
Viburnum lakesii Lesquereux
Viburnum richardsoni Knowlton
Viburnum solitarium Lesquereux

Woodwardia latiloba Lesquereux

Zingiberites dubius Lesquereux
Zizyphus beckwithii Lesquereux
Zizyphus daphnogenoides Knowlton
Zizyphus distortus Lesquereux
Zizyphus fibrillosus (Lesquereux) Lesquereux
Zizyphus hesperius Knowlton
Zizyphus resquereuxii Knowlton
Zizyphus meekii Lesquereux

Silicified and more or less carbonized wood is quite common. Some large logs have been noted. Silicified palm stumps, 18 inches to 2 feet in diameter, have been found around the Table Mountains and Green Mountain.

The animal remains reported from the Denver formation include:

Dinosaurs: *Ceratops alticornis* (type)
 Ornithomimus velox Marsh
 Triceratops horridus
 Clasosaurus annectens
 Palaeoscinius latus Marsh
 Turtles: *Compsemys victus*
 Trionyx feveatus
 Crocodile: *Crocodylus humilus*
 Fish: *Lepidotus occidentalis*
 Mammal: Several teeth and fragmentary bones

Cannon¹³ records the finding of a few imperfect fresh water shells near Cheltenham Heights by T. W. Stanton, and names the following species:

Viviparus trochiformis
Goniobasis tenuicarinata
Corbicula sp. ?
Physa sp. ?
Unio sp. ?

It is interesting historically to note that the first ceratopsian dinosaur fragments, collected from the Denver, were identified by Marsh as a dinosaur of typical Jurassic stegosaurian type and a bison of late Pliocene character. Mr.

¹³Cannon, G. L., The geology of Denver and vicinity: Colo. Sci. Soc. Proc., Vol. 4, p. 261, 1893.

Cannon¹⁴ in an early publication of this Society expresses his amazement at such an unholy union.

It should also be noted that the age of the Arapahoe-Denver formation has been a much debated matter among geologists and paleontologists for over fifty years. The combination of typical Cretaceous dinosaurs with an equally typical Tertiary flora has been a perplexing problem. Cope¹⁵ summarized his views on the matter in the statement (p. 16) which has been frequently quoted:

"There is then no alternative but to accept the result that a Tertiary flora was contemporaneous with a Cretaceous fauna."

More recently the suggestion was made of the possibility of a Cretaceous fauna being contemporary with Tertiary flora, and this is the idea which has more or less been adopted by local geologists for the last 15 or 20 years. Then, this fall, Dobbin and Reeside have reopened the question by expressing the opinion, backed by some evidence, that the Arapahoe and at least part of the Denver are equivalent to the Lance, which is considered to be Cretaceous.

Quaternary Formations. The local post-Tertiary deposits have been divided by Cannon into four divisions¹⁶ (p. 51):

- | | |
|---|-----------------|
| 4. Terrace epoch | } Glacial times |
| 3. Loessial epoch-Loess | |
| 2. Loessial epoch-River drift | |
| 1. Erosional epoch-(Late Pliocene to glacial) | |

No fossils of the first division are known.

From the second division numerous teeth and bones have been obtained, especially during excavations for foundations and sewers in Denver. They include elephants of several species, bison, and a camel-like animal.¹⁷ Berthoud¹⁸ and Rockwell¹⁹ describe the discovery of an elephant tusk in Clear

¹⁴Cannon, G. L., On the Tertiary Dinosauria found in the Denver beds: *Colo. Sci. Soc. Proc.*, Vol. 3, pp. 142-143, 1890.

¹⁵Cope, E. D., Review of the vertebrata of the Cretaceous period found west of the Mississippi River: *U. S. Geol. and Geog. Survey Terr. Bull.* 1st Ser., No. 2, pp. 1-51, 1874.

¹⁶Cannon, G. L., The Quaternary of the Denver Basin: *Colo. Sci. Soc. Proc.*, Vol. 3, p. 51, 1890.

¹⁷Cannon, G. L., *Colo. Sci. Soc. Proc.*, Vol. 3, p. 59; Vol. 4, p. 264.

¹⁸Berthoud, Captain, Tusk of an elephant or mastodon found in Colorado: *Amer. Jour. Sci. Ser.* 3, Vol. 3, p. 302, 1872.

¹⁹Rockwell, A. P., Discovery of the tusk of an elephant in Colorado: *Am. Jour. Sci.* 3rd Ser. Vol. 3, pp. 373-374, 1872. (In Clear Creek Valley, 5 miles above Golden.)

Creek Valley about 5 miles above Golden in 1872. It occurred either in division 2 or 4, probably 2.

Emrich²⁰ describes the discovery of bones which he considers mastodon during the excavations for a sewer in Golden during July, 1908. It also probably came from this division.

"The Loess division is poorly adapted for the preservation of organic remains and with the exception of bones, fossils are rare."²¹

The recorded fossils include:

Physa sp.
Planorbis sp.
Succinea sp.
Pupa sp.
Linnea sp.

Bones of several kinds of elephant, camel, horse, and numerous rodents, snakes, and frogs. The last three are probably Recent.

The terrace deposits have yielded some bones, mostly of relatively recent types of animals. As far as known to the writer, no one has made a careful study of material from this horizon.

Vegetal material has been found in all of these Quaternary deposits, but, with the exception of a few carbonized fragments of wood, it was in too fragmentary a condition, or too poorly preserved, to be studied.

²⁰Emrich, Clarence T., Mastodon bones (from Golden, Colorado): Colo. School of Mines Bull., Vol. 5, No. 1, pp. 36-37, Illust., 1909.

In making excavations for a sanitary sewer at Golden, Colorado, July 20, 1908, in Quaternary wash about 15 feet below surface, workmen uncovered some large bones which C. T. Emrich and the civil engineer on the job call Mastodon.

²¹Cannon, G. L., The Geology of Denver and Vicinity: Colo. Sci. Soc. Proc., Vol. 4, pp. 235-270, 1893.

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