H.F. OSBORN

LOXOLOPHODON

AND

UINTATHERIUM

1881

Osborn. Loxolophodon and Uintatherium
accompanied by } 1881
McMaster. Bridger beds in the Washakie basin

Osborn. Mesozoic mammalia 1888.

Rütimeyer. Beziehungen zwischen den Saugethierstämmen alter und neuer welt. 1888.

With Henry F. Osborn's
Compliments.

CONTRIBUTIONS

FROM THE

E.M. MUSEUM OF GEOLOGY AND ARCHÆOLOGY

OF THE

COLLEGE OF NEW JERSEY.

VOLUME I.

PRINCETON, NEW JERSEY.

CONTRIBUTIONS FROM THE E. M. MUSEUM OF GEOLOGY AND ARCHÆOLOGY OF THE COLLEGE OF NEW JERSEY.

The E. M. Museum of Geology and Archæology at Princeton College contains not only an ample collection of specimens for college instruction, but also a large amount of material for more advanced study in the shape of fossils new to science, mainly collected by the college scientific expeditions of 1877 and 1878.

It has seemed desirable for the advancement of science, as well as in justice to the palæontologists and biologists connected with the Museum, that the results of their studies should be placed in a permanent and suitable form before the scientific public.

It is, therefore, no small gratification to the Director of the Museum to be enabled to enlarge the system of publication begun by the bulletins in 1878, under the auspices of the Museum.

The mode of publication will be the same as that adopted by most of the Scientific Institutions, viz.: bulletins in octavo for advanced work and minor notices, and memoirs in quarto for later and more mature researches.

The contributions will be based chiefly upon the study of the palæontological and geological collections made by the past, and those which may be made by the future scientific expeditions from the college. The other portions of the collections, however, contain a considerable amount of new material, both in fossil botany and zoology, for study and publication.

Biological and Geological Memoirs, as well as communications on the Era of Pre-historic man, will be embraced in the field of research covered by the publications of the Museum.

A. GUYOT.

Director of the E. M. Museum.

PRINCETON, NEW JERSEY,
July 10, 1881.

CONTRIBUTIONS FROM THE E. M. MUSEUM OF GEOLOGY AND ARCHÆOLOGY OF THE COLLEGE OF NEW JERSEY.

VOL. I., NO. I.

A MEMOIR

UPON

LOXOLOPHODON AND UINTATHERIUM

TWO GENERA OF THE SUB-ORDER DINOCERATA

BY

HENRY F. OSBORN, Sc.D.
Lecturer on Biology.

ACCOMPANIED BY A

STRATIGRAPHICAL REPORT OF THE BRIDGER BEDS IN THE WASHAKIE BASIN

BY

JOHN BACH McMASTER, C.E.
Instructor in Civil Engineering.

PRINCETON, NEW JERSEY, 1881.

INTRODUCTORY.

THE study of two genera oi the Dinocerata forms the first of a series of Palæontological Memoirs that will be published by the E. M. Museum of Princeton College.

The Museum already contains a very interesting collection of Tertiary fossils, chiefly procured by parties going out from the college. The first of these field-parties was formed in the summer of 1877. After four weeks in Colorado they camped for the remainder of the season in the country lying near Fort Bridger, Wyoming Ter. In 1878 a second party, smaller but better equipped for collecting fossils, returned to the same field, extending their journey into the Loxolophodon beds of the Bitter Creek country, and making their way back to Twin Buttes, and thence to Fort Bridger, after a short trip up Ham's Fork. During both seasons the principal collections were made in the Bridger Beds (Upper Eocene), so that the fauna of this group is finely represented in the Museum.

In the first Bulletin the collections made during the summer of 1877 were described. The writers there stated that they were fully aware they were upon ground already quite familiar to science. The same thought occurs in some measure in connection with this Memoir. Two distinguished palæontologists in this country, with large collections at their command, have been contributing to a general knowledge of the Bridger fauna for years. But many features that have not been brought to light are discovered among our collections, so these studies are offered, in the belief that they contain much that is original. At the outset, the writer acknowledges with pleasure his indebtedness to the works of these authors, to whom full credit is accorded in the text.

The horizon of the genera which are the subject of the present Memoir is the Bridger group, Upper Eocene. They had quite an extensive range in the Tertiary basin in which these beds were formed, and were the largest in size of the many varieties of animals which roamed on the borders of the great Eocene lakes. The sub-order of Dinocerata is of more interest from a consideration of the many varieties which it includes than from a phylogenetic point of view; for its genera possess many characters by which we must consider them as forming an aberrant group which became extinct long before the close of the Tertiary. The indirect relations of these genera with the elephant tribe were apparent from the first, but there is no foundation for a belief that they came in the line of forms ancestral to the Proboscidia.

The Stratigraphical Report by J. B. McMaster, leader of the expedition of 1878, made from his notes and sections of the strata of the Bridger beds as exposed in the Washakie basin, points chiefly to the present condition of the strata as they are left by erosion and denudation. As it indicates the level at which the fossils described in the text were discovered, and embraces an outline of the principal topographical features of the country it is published in connection with this memoir.

The thanks of the writer are gladly expressed to Dr. Arnold Guyot, Director of the Museum, for frequent advice and encouragement, and to Dr. William B. Scott for several suggestions of value. Dr. Franklin C. Hill also rendered much kind assistance in the Museum.

H. F. O.

PRINCETON, *July* 1881.

Loxolophodon and Uintatherium

BY

HENRY F. OSBORN.

GEOLOGICAL INTRODUCTION.

THE testimony of the rocks is nowhere more marvellous than in the central deserts of Wyoming Territory. Even the view obtained in passing rapidly through this barren country cannot fail to arouse interest; for to the thoughtful traveller it seems that Nature here tells her story with peculiar simplicity. The great elevation of the whole desert above the sea, the noble and grotesque forms which centuries of wind and rain have carved out of the sandstone bluffs, the brilliant colors which enable the observer to follow the strata as they appear and disappear in bold outlying buttes and receding curves, are all highly unique characters. The name *Mauvaises Terres* conveys an impression of the singularly forbidding aspect of this country—of the vegetation, sparse from the protracted summer droughts, and of the naked strata over which, in the rare atmosphere, the eye easily ranges from mile to mile. Add to this the discovery that in these rocks are buried many generations of animals whose genealogy can often be clearly followed, and it is undeniable that here, if anywhere, the records of an ancient land are written in characters which cannot be mistaken.

When the relations of the desert plains to the high mountains surrounding them at all quarters became known, and the relative ages of the mountains and the plains were ascertained from the fossils they contained, it was a natural conclusion that these sedimentary beds were formed in inland waters by erosion from the hills freshly emerged from the Secondary seas. The earnest labors of Hayden, King, and Powell have thrown light upon the different aspects of this geological problem. To the early studies and explorations of Dr. Leidy and the persevering efforts of Professors Cope and Marsh are due most of our knowledge of the animals which these rocks entombed. With these researches at hand, and those of Prof. Lesquereux, who has devoted many years of study to the ancient flora, it follows that we now have a considerable knowledge of the condition of animate and inanimate nature of Eocene times in this region.

The ancient geography and ancient fauna should be placed and studied together even more intimately than has been done hitherto, in order to afford the mind a comprehensive view of the whole. For facts of the structural peculiarities of species and genera are of diminished value when isolated from an investigation of their natural and physical environment. We cannot grasp the meaning of the peculiar dentition, of the anomalous features of the skull, or, what is more important, of the modifications of the ankle-joint and feet; in short, of the adaptability of the skeleton to certain functions, unless we first inquire into the nature of the moist and semi-tropical country which formed the habitat of these Eocene animals. However vague and unsatisfactory this inquiry be, it affords a collection of additional facts upon which to advance.

Clarence King in his recent work[1] has given an original and interesting account of the early geological history of this region. And this memoir upon the Dinocerata cannot be more appropriately introduced than by a *résumé* of his narrative, accompanied by several observations of our own.

At the close of the Cretaceous period, the country lying between the present Rocky Mountain system and the Wahsatch range lay open to the sea on all sides. By the elevation of the land which now forms the summit of these ranges, a great area became enclosed on the East and West, and the convergence of the ranges somewhat in crescent shape formed a northern shore. To the South the waters extended into Colorado and New Mexico. The discoveries of Hayden and Marsh have confirmed and increased this southerly extension. Its exact limits are not yet ascertained, nor do they, although interesting, immediately belong to the present subject.

Thus, at the beginning of the Eocene an inland sea was formed, almost as broad as Lake Erie, enclosed on the North by the spurs of the great system of hills which formed the eastern and western barriers. These spurs are represented by the Bear River, Wind River, and Sweet Water mountain systems of to-day. On the southwestern shore was a great island, the Uinta chain, also of Secondary rocks, lying in an east and west direction. This inland lake therefore filled the basin which is at present drained by the head-waters of the Green and Colorado river systems, and the Green River now cuts through the eastern base of the Uinta range, marking the central point of southern outlet probably from the earliest enclosure of the basin. These waters, which King has named the Ute Lake, gradually lost their saltness by the drainage from the hills surrounding them, while the mouth, or southern outlet, was slowly losing its direct communication with the sea. This change from marine to lacustrine conditions was preceded by the extinction of many of the reptilian types of the Cretaceous.

Underlying the waters of the lake, somewhat tilted by the upheavals which formed the shores of the basin, were the upper members of the Cretaceous series, the Laramie beds. Here and there also were islands of earlier Second-

[1] U. S. Geol. Explor. of Fortieth Parallel. Vol. I. Systematic Geology.

ary rock; these had not shared in the general submergence which preceded the deposition of the Laramie. On the flanks of the Wahsatch hills were Mesozoic and Carboniferous beds, and the same strata were exposed on the Uinta slopes.

The degradation of these older strata, if we can judge from the investigations of Major Powell[1] in the Uinta range, taking place *pari passu* with upheaval, was on a grand scale. Vast quantities of water were borne by the winds from the Pacific Ocean, as yet uninterrupted by the Sierra range, and were condensed on the Uinta slopes. The sediments thus collected formed the Vermillion Creek group of rocks—so named from their prevailing red color. They lie unconformably over the Laramie strata, and are highly fossiliferous. The most characteristic mammal at this period was *Coryphodon*, five-toed and with a full dentition. The presence of this with *Hyracotherium*, *Hyopsodus*, *Opisthotomus*, *Amblyctonus*, *Clastes*, and others, has led Prof. Cope[2] to indicate the close parallelism between these beds and the Suessonian or Orthrocene of Europe, in which these genera also abounded.

The middlemost member of the Eocene series, the Green River group, was deposited over a still larger area; for after the Vermillion Creek beds were formed, the western, and in some degree the eastern, borders of the Ute Lake subsided, enlarging the basin to nearly double its former size. This second lake, named the Gosiute Lake, in which the Green River beds were slowly deposited, was an almost uninterrupted sheet of water, extending about three hundred miles on the fortieth parallel, and one hundred and fifty north and south.

While the close of the Vermillion Creek deposition was marked by an expansion of the basin borders, the close of the Green River deposition was marked by contraction; so that the third member of the Eocene series, the Bridger beds, was deposited in a smaller basin. According to Powell, a dry-land period also intervened. It followed that when the limits of the third lake were defined, they were on all but the southern side within the area of the Vermillion Creek beds. The oscillations of level which preceded it and the contour of the present exposures of the beds, formed in this third or Washakie Lake, leave considerable doubt whether it was a continuous sheet of water enclosed in a single basin or several smaller basins, with a common southerly outlet. This question will be resumed further on.

A liberal estimate of the total thickness of these three groups of Eocene rocks is 9500 feet. Powell estimates them at 6000 feet. They form the lower, mid-

[1] Geology of the Uinta Mountains. Washington, 1876.

[2] Ext. Bull. U. S. Geol. and Geog. Survey, Feb. 28th, 1879. The Relations of Horizons of Extinct Vertebrata of Europe and North America.

dle, and upper Eocene. Just south of the Uinta range is another small group of rocks, of about 500 feet in thickness, which caps the Eocene and forms an approach to the Miocene. The age of these beds has been determined by their fauna. Their position and relation to the Uinta chain, as well as that of the other groups, is made clear in the accompanying sketch-map. The history of these Tertiary lakes and the present confines of the various beds can be followed in this map, which affords an admirable idea, also, of the upheavals which formed the great rim of the basin. It will be kept in mind that the country circumscribed has been elevated since Eocene times to 6000 and 7000 feet above the sea by the general uplifting of the continent, and that the mountain ranges of to-day rise to twice this level.

The total thickness of the Bridger beds is about 1500 feet, presented in two or three comparatively contracted exposures. These overspread two main tracts: one in the Bridger basin, lying wholly east of the Green River; a second to the west of the river, situated in the Washakie basin; a third, smaller tract lies southeast of Vermillion Creek. That the Bridger beds were deposited in a much smaller sheet of water than the Green River beds is evident at once from the nature of the rock, and quite apart from a consideration of their extent. The Green River beds are largely calcareous, fine fissile shales, sometimes containing carbonaceous matter. The lower members are limestones. The uppermost strata of the Uinta were Mesozoic rocks; and King suggests that the earlier erosion (forming the Vermillion Creek strata) must have worked these off, exposing the calcareous strata of the Carboniferous rocks, about the inception of the formation of the Green River beds. The presence of lime in these beds is thus ingeniously accounted for. The shales are often of delicate texture, and rival the Solenhofen slates in the exquisite impressions of leaves, fishes, and crustacea which they contain. They indicate that the streams feeding the Gosiute Lake were of a rather sluggish nature, and heavily charged with fine silt. There are occasional calcareous strata among the Bridger beds, but they are essentially a sand formation. The reader is here referred to the stratigraphical section accompanying this memoir. Alternating with the fine clayey and sandy beds are coarse gravelly beds, indicating streams of considerable size and rapidity which were suited to carry such heavy materials far into the centre of the lake. Rarely they contain remnants of leaves, and seldom or never, the remains of fishes. In the coarser beds we usually found only the remains of larger vertebrates, and those considerably dissociated and scattered by violent aqueous and other agencies.

There is for the above reasons no room for doubt that the Bridger beds were formed in a much smaller basin than the Green River. The question remains, were the later beds formed in a single basin or in a number of separate basins which the waters occupied as they slowly retired? King leaves the matter in doubt, expressing however, the opinion that it is improbable that erosion could have totally removed all traces of the Bridger rocks from the country lying between the Washakie and Bridger basins. He therefore rather favors the view that the waters in which the Bridger beds were formed were not continuous. This view, it appears to the writer, may be sustained on two grounds. First, the nature of the rocks in the Washakie and Bridger basins is somewhat different; secondly, the character of the fauna is more dissimilar than we should expect to find it at opposite ends of a continuous shore. The prevailing colors among the Bridger Basin strata are light grays and drabs, with an occasional green. In the Washakie beds the colors are much more brilliant; many of the strata are a very brilliant green, others have a brownish-red hue. The manner of weathering is dissimilar; in the Washakie basin the occasional beds of harder rock form bold cappings for the softer strata beneath, resulting in mushroom-like forms, which are rarely seen in the Bridger basin. More important is the evidence derived from the character of the fauna, found in the deposits of the two basins. During the summer of 1877 the Princeton party collected wholly in the Bridger-basin area. The dominant species were *Palæosyops* and *Hyrachyus*. The remains of *Uintatherium* (Dinoceras) were quite abundant; and two species of the Carnivora, a small rodent, and numerous quadrumanous forms were obtained. A doubtful Artiodactyle form was secured, referred to the camel tribe. A second tour through these beds, in the following summer, resulted in the collection of other individuals belonging to the same orders. In the summer of 1878, the party spent six weeks in the Washakie Basin beds. Here the number of *Loxolophodon* remains was surprising, especially in the upper strata. Not a single specimen of the allied genus, *Uintatherium*, was obtained. Prof. Cope has, however, reported a single species of *Uintatherium* from these beds, on a rather doubtful determination. He found here several species of *Loxolophodon*. It certainly appears that the latter genus ranged exclusively in this region, while it is possible that some species of *Uintatherium* found their way here, but not in great numbers. In the lower Washakie-basin strata, in a matrix quite different from anything found in the Bridger, we discovered the skeleton of an *Achænodon*, one of the Bunodont Artiodactyla, and an unspecialized member of the Rhinoceros family. *Palæosyops* was rarely found. *Hyrachyus* has been obtained by Cope in these beds. It is unfortunate that the localities in which the Bridger-group fossils have been discovered have not been more frequently published, as data of this description would greatly aid in determining the extent of the third Eocene lake, as well as giving a clue to the migrations of these forms. Our own discoveries point to the distribution of several genera over the region of both basins, also to the fact that several genera which are common in one basin are rarely or never found in the other.

The three exposures of the Bridger (Br.) beds are indicated in the map. First, that of the Washakie basin, which has an east and west extension of about twenty-five miles by about sixteen miles north and south. It is surrounded by a narrow band of Green River (Gr.) beds. Passing to the south across Vermillion Creek, is another small exposure of much more contracted dimensions. Much larger than either are the beds lying in the Bridger basin, extending east and west about sixty miles with an expansion to the north which has not been surveyed. These beds are largely surrounded by those of the Green River period. At some points, however, they overlap the Vermillion Creek (V.) beds. On the flanks of the Uinta Mountains they come in contact with the still older Mesozoic rocks. If the view advocated above be adopted, they represent two large sheets of water lying east and west of the present bed of the Green River and draining to the south. A low line of hills made up of Vermillion Creek and Green River rocks separated them, and was sufficient to account for the variations of the fauna observed in the two basins. It is well to add that there may have been some slight differences in the character and date of their deposition which would attract one group of animals rather than another.

The comparison of the Suessonian of Europe with the Vermillion Creek or Wahsatch of the American Eocene has been extended by Prof. Cope, with more restrictions, into a further comparison of the Bridger with the Parisian beds. They possess many genera in common—chief among which are *Hyænodon*, *Adapis*, *Plesiarctomys*, *Hyrachyus*, *Tapirulus*, and *Anaptomorphus*. The Parisian beds have, moreover, a large number of Selenodont Artiodactyla of primitive type, but are distinguished by the absence of the *Tillodonta* and *Dinocerata* which are so characteristic of the Bridger epoch.

Wandering on the shores of the Bridger or Washakie lakes were great herds of *Palæosyops*, the American *Palæotherium*, and other perissodactyle animals more closely allied to the tapir. There were also primitive horses of the size of the modern fox. Many lemurs and small rodents testify to the presence of wooded vegetation. The Carnivora were represented by several genera of formidable proportions. Dominant in size were the huge Dinocerata, *Loxolophodon*, and *Uintatherium*, standing a little lower than the elephant, but equally long in the body. Crocodiles and many smaller saurians were abundant on the shores, and turtles as large as the modern loggerhead floated on the water, and there were many varieties of land and aquatic birds of small size. The fauna was that of a semi-tropical country, and the climate was very moist; for, alternating with the finer clays, are coarse gravelly beds indicating periods of floods when the heavier materials were transported far into the lakes. All these conditions are in striking contrast with the meteorological phenomena of this desert land at the present day.

The flora of the upper Cretaceous period in this region presents an interesting mingling of hardy northern plants with those of a more tropical character. The plants of the Laramie are well known to resemble those of the European Tertiary formations. It is not improbable that they survived the changes accompanying the upheaval of the land and clothed the borders of these lakes, although the manner of sedimentary deposition during the Bridger epoch did not often admit of the preservation even of the littoral plants. Here and there, however, are found the fragmentary remains of reeds and other water-plants. The position of some of these is indicated in the stratigraphical section accompanying this memoir. The abundance of polydactyle forms, or spreading feet, among the mammals adds probability to the natural supposition that the lakes were bordered by wide-stretching marshes.

As to the causes of extinction there is much evidence to show that they were slow and natural, very much such causes as we should observe on the borders of similar lakes in Southern Africa or elsewhere. The manner in which the parts of a skeleton are found widely scattered, the occasional evidence from the position of the limbs in the rock that the animal has been mired, the absence of large numbers of bones in any one locality, all indicate a long period in which the struggle for existence was not intensified by rapid geological changes. The great variety of species which succeed one another and are closely allied in structure afford further proof of a long undisturbed period in which these gradual modifications could arise. The prevalence of weapons of defence, such as the great tusks and cranial protuberances of *Loxolophodon*, the sharp dentition and powerful muscles of *Palæosyops*, indicated by the skull, the tusks of *Achænodon*, and the full dental series of a primitive Rhinoceros, all go to show that the greatest contest was between the animals of different families rather than against unusually violent forces of nature.

Enough has been written to clearly introduce the short study of the Dinocerata which follows. They were a class of animals which present features of great interest, and so numerous and characteristic of this geological period that one writer has chosen to name the whole series of Bridger rocks after them. The two species which will be described represent two of the principal genera of the sub-order; namely, Uintatherium and Loxolophodon. No explanation is needed of the length of this geological sketch with its accompanying maps, further than to say that it is hoped it will also serve to assist the understanding of some of the other Bridger Eocene fossils.

THE DINOCERATA.

The Dinocerata form a Sub-order of the Amblypoda, an Order which Cope[1] has defined as follows: "Mammalia with small cerebral hemispheres which leave the olfactory lobes and cerebellum exposed. The feet short and plantigrade, with numerous (in the known genera, five) digits, terminating in flat, hoof-bearing, ungual phalanges. The seven bones of the carpus distinct, the unciform articulating with both lunar and cuneiform. The astragalus flat, without trochlear surface, and attached to the tibia with very little freedom of movement; its distal extremity divided into two facets, one for the navicular and the other more or less for the cuboid. Molars inserted with enamel, with wide crowns and transverse crests. A post-glenoid process."

The Order Amblypoda falls into two Sub-orders:

I. A third trochanter on the femur, and a fossa for the round ligament; no alisphenoid canal; superior incisors present________________PANTODONTA.

II. No third trochanter, nor fossa for the round ligaments; an alisphenoid canal; no superior incisors________________________DINOCERATA.

The sub-order Pantodonta includes the genera *Coryphodon* and *Bathmodon*. The former is the most characteristic fossil of the Wahsatch group, in the lower Eocene. It has, as the ordinal name indicates, a complete dentition, and is also marked by a very unmodified type of foot. According to Huxley and others, these unspecialized characters and its geological position combine to place it at the bottom of the Perissodactyle scale.

The sub-order Dinocerata includes at present several genera which widely vary in size and seem to have been peculiar to different portions of the great Eocene Rocky Mountain basin in which they lived. A distinctive character common to all is the possession of a number of paired protuberances upon the upper surface of the head. Another general feature is found in the downward projections from the rami of the lower jaw which were opposite the huge upper canines. These projections, or flanges, underwent various modifications. The nasal bones also supported a small pair of knobs. It is chiefly upon the position of the cranial protuberances, the conformation of the lower jaw, the develop-

[1] Cope. Wheeler's Survey, Vol. IV. pp. 178 *et seq.*

ment of the nasal bones, and the relations of the bones forming the hard palate that the following genera have been determined.

Synopsis of the Genera of the Dinocerata.

A. Lower jaw with powerful downward flange, wide diastema between lower canine and incisor series. Three premolars on lower jaw. Premaxillaries send in narrow plate to form forward portion of hard palate. Nasal tuberosities do not overhang nasal tips. Median protuberances anterior to orbit __________ *Uintatherium.*

B. Lower jaw has a slight, narrow, downward convexity opposite upper canine, wide diastema between lower canine and incisor series. Three premolars in lower jaw. Premaxillaries send in a broad plate to form the forward portion of the hard palate. Nasal tuberosities overhang nasal tips. Median protuberances above or anterior to orbit __________ *Loxolophodon.*

C. Ramus of lower jaw is arched downwards from the symphysis to the angle. The incisors, canine, and anterior premolar form a continuous series. Between the anterior premolar and the remainder of premolar series is a diastema. There are four premolars in the lower jaw __________ *Bathyopsis.*[1]

The first of the above genera was *Uintatherium*, discovered and described by Dr. Leidy in the Bridger Beds, in the exposures referred to above as lying wholly in the Bridger basin or west of the Green River of Wyoming. Prof. Marsh, who reached this field soon afterwards, rapidly obtained a large collection of the remains of these huge mammals, the greater part of which he referred to a distinct genus, Dinoceras. This is considered in this report as synonymous with *Uintatherium*, as we find the generic characters nowhere distinctly stated. The second genus, *Loxolophodon*, was discovered by Prof. Cope, in 1872, in the Washakie exposures of the Bridger beds. He gave the generic characters soon after the discovery.[2] The individuality of the genus was strengthened in 1878 by the fortunate discovery of the lower jaw by the Princeton party. The third genus, *Bathyopsis*, has been quite recently obtained in the country surrounding the head-waters of the Wind River. Cope is doubtful whether to place these beds among the Wahsatch or the Bridger Eocene groups. Some of the genera they contain are found in both the lower and the higher groups. At all events, the discovery of this genus gives the sub-order a still wider geographical distribution. A fourth genus, *Eobasileus*, has been based by Cope on some very short cervical vertebræ. This seems of rather uncertain position.

[1] Cope. Bull. U. S. Geol. Survey, Vol. VI. pp. 194, 195.

[2] Proceedings American Philosophical Society, 1872, p. 580.

UINTATHERIUM.

A synopsis of the numerous species of *Uintatherium* (Dinoceras) will not be attempted here. From numerous specimens in our collection the following species has been positively identified:

A. No tubercle at the entrance of the valley between the lobes of the last upper molar. Nasals divided by a deep groove; slender zygomatic arch. Temporal fossa not continued far behind posterior protuberances.——*U. Leidianum.*

These characters distinguish it from *U. robustum*[1] (Leidy). This individual is figured in Plate II.

In the first Bulletin from this Museum was described another species of Uintatherium, which we called *U. princeps.* This species is no longer recognized as being clearly distinct. In the multiplicity of varieties that have been found by different parties, there are at present no means of ascertaining how far the characters upon which species are constantly based are the outcome of differences of age and sex. The development and proportions of the protuberances especially belong to the class of cranial modifications which may have been wholly subject to differences in sex. The following synopsis of the species of Loxolophodon is therefore offered provisionally.

LOXOLOPHODON.

Nasals deeply cleft in front and much produced beyond nasal tips. Frontal protuberances large and placed directly above the orbit. Foramen incisivum widely cleft in front. (Occiput unknown.)——*L. cornutus.*

Nasals wide and less cleft. Frontal protuberances above orbit. Occiput low and broad——*L. galeatus.*

Nasals uncleft and barely produced beyond nasal tips. Frontal protuberances small and anterior to orbit. Occiput high and narrow.——*L. Speirianum, sp. nov.*[2]

The two unusually fine skulls of Uintatherium and Loxolophodon in our museum have afforded an admirable opportunity for a comparison of these two well-determined genera of the Dinocerata. The distinguishing features of

[1] Leidy. Proc. Ac. Nat. Sc., 1872, p. 169.—Cont. Ext. Vert. Faun. of Western Territories, p. 93.

[2] Dedicated to the discoverer of the head, Mr. Francis Speir, Jr., a member of the two expeditions.

the Sub-order have already been pointed out, also the characters distinguishing the genera known to the writer. In this memoir a careful description of the skull of *Loxolophodon Speirianum* will be given, supplemented here and there by details from *Uintatherium Leidianum* wherever the study of the former is interrupted by imperfect preservation. The *U. Leidianum* skull will not be here described in detail, as a careful description of it has already been given in a former publication from this museum. This skull was found by Mr. Speir, a member of the party of 1877. The basi-occipital and sphenoidal regions had been exposed to the weather for some time, and were completely broken away; in other respects it is perfect. As figured in Plate II., the outline of the occiput is restored from the posterior half of another skull which we have assigned to *Uintatherium.* The latter was procured two years later. It happily fills the gap left in the occipital region of the *U. Leidianum* skull, and admits of a close study of the bones and foramina of the two posterior segments of the skull, including the periotic portion. It is regretted that we have not as yet been able to obtain transverse sections of this specimen to study the cavity of the brain and the petrous portion of the periotic. The *L. Speirianum* skull, represented in Plate I., was obtained in the summer of 1878. It is wonderfully preserved, and has been put together with great skill by the Curator of the Princeton museum. Unfortunately there is a wide break at the base, between the palatines and the forward lower margin of the temporals. The pterygoid bones, which form a deep backward continuation of the posterior nares, are thus wanting in all our specimens. All the remaining bones of the skull are represented in the different specimens.

Comparison of the Skulls of Loxolophodon and Uintatherium.

When placed beside each other, the skulls of the two genera offer a wide contrast even under a rapid glance. Seen from above, the latter is one third longer, while it is considerably narrower at the broadest point. This chiefly arises from the forward extension of the skull in front of the orbit, the distance between the orbit and the occipital condyles being approximately the same in both genera. The broadest portion of both skulls is between the parietal and median protuberances. In *Uintatherium* the lateral expansion above the orbits overhangs the zygomatic arches, while the *Loxolophodon* skull is gently rounded at this point and the zygomatic arches project widely. The *Uintatherium* nasals are shorter, and their processes are knobbed and project more upwards. The fossa above the brain-case is deeper in *Uintatherium.* But by far the most conspicuous feature of the skull is the huge size of both pairs of protuberances—they are so out of proportion to the skull as to give it a most grotesque appearance, which must have been heightened, if, according to the questionable theory, they bore horns. The *Loxolophodon* protuberances are of more modest proportions, but still out of keeping with anything at present found in nature. In side view the *Uintatherium* canines are seen to project more backwards, and the premaxillaries are shorter. It is at once noticed that the eye of this genus must have appeared smaller and more sunken from the excessively developed supraorbital ridges. The condyles of *Loxolophodon* are more closely attached; the occiput overhangs them slightly in both genera. The malar and jugal portions of the zygoma unite by suture in *Loxolophodon*, by smooth articular facets in the allied genus. Many of these minor characters are undoubtedly due to variations which would not extend through all the species. At the base of the skull we find characters which seem to be more permanent. The premaxillaries send in a very narrow strip to form the anterior portion of the hard palate in *Uintatherium.* The foramen incisivum is unenclosed, but towards the extremity of the tips two small processes, partly broken in our specimen, show that in the living state this foramen was partly enclosed. In *Loxolophodon* broad plates grow well forwards on the inner sides of the premaxillaries, extending the hard palate much further forwards. It is extended further back also, in *L. cornutus* to a point slightly behind the last molar. In *U. Leidianum* the horizontal palatine and maxillary plates are somewhat shorter, and the posterior nares open opposite the penultimate molar.

LOXOLOPHODON SPEIRIANUM, *sp. nov.*

General Features of the Skull. The skull is long and narrow, with a high occiput, surmounted by a slight ridge. The median protuberances project well outwards, and are placed considerably anterior to the orbits. In front of them the nasals narrow gradually into the snout. The zygoma arches well outwards. The upper surface of the skull between the frontal and occipital protuberances is gently rounded upwards—although the upper outline is somewhat exaggerated in our specimen from lateral crushing. When compared with other species the features just detailed come out very prominently; in fact, this skull breaks down many of the characters which have hitherto been assigned as distinguishing the whole genus.

Comparison with L. cornutus. The median protuberances in *L. Speirianum* are smaller, and their forward position relatively shortens the snout, and gives greater distance between them and the posterior protuberances. The total length of the skull is the same in both species. The nasals are not cleft in front, and the knobs, misnamed protuberances, which they bear, project more upwards. The zygomatic arches are closer to the skull in *L. cornutus*, the post-glenoid processes are longer, the occipital condyles less prominent, canines set wider apart and the canine alveoli more compressed from side to side; the premaxillaries are shorter, and the horizontal plates between them produced further forwards. The hard palate is produced backwards by the horizontal plate of the palatine bone slightly behind the last molar in *L. cornutus*, while it is opposite the last molar in *L. Speirianum*. With the exception of the last features, the base of the skull closely resembles that of *L. cornutus*.

Comparison with L. galeatus.—The shape of the occiput principally distinguishes this species from *L. galeatus*. Judging from a figure of the latter which Prof. Cope has kindly lent us, the occiput of *L. galeatus* was about thirteen inches broad and twelve inches high, while the occiput of *L. Speirianum* is eleven inches broad by thirteen high.

SKULL OF LOXOLOPHODON SPEIRIANUM. *Description in detail.* (see Plate I.). The general contour of the head has already been described. The *Nasals*, which are unusually long, form the upper and all of the anterior portion of the snout, and are produced upwards upon the inside bases of the median protuberances; behind this they pass back beyond the line of the orbits to form a V-shaped suture with the frontals, terminating in a point about half-way between the median and posterior protuberances. The snout, rounded above, narrows gradually. It is not constricted immediately in front of the protuberances as in *L. cornutus*, nor does it taper so rapidly as in *Uintatherium*. At its extremity it is broad and shovel-shaped, and not so deeply notched as in *L. cornutus*. The *Premaxillaries* form the downward projecting tips. They are wholly edentulous, with horizontal palatine plates between them producing the hard palate forwards to within an inch of their extremities. This notch was probably, in the living state, still further produced by a membrane which supported a callous pad, opposing the sharp lower incisors. The premaxillaries could not be described as "deeply furcate," as in the case of *L. cornutus*. Their lines of junction with the nasals above and maxillaries behind are indicated in the plate. The *Maxillaries* rise well on the sides of the snout anteriorly, contributing all of the outer and upper moieties of the forward protuberances, and forming a considerable portion of the zygomatic arch. They contain the wide alveoli for powerful canines; these are wanting in our specimen. The alveoli indicate that they were much compressed laterally. The protuberances are about six inches long, placed upon the sides of the skull, slightly recurved, and with an obliquely placed oval in transverse section. A peculiar feature of the maxillaries is their long suture with the lachrymals and short frontal articulation. Projecting back beneath the malar bones they form the lower anterior third of the zygoma, articulating beneath the orbit with the orbitosphenoids, and on their lower sides forming the greater extent of the hard palate. The infra-orbital foramina are obscured by fracture in each skull. Cope speaks of them as of small size. The hard palate is very long and narrow. The anterior three inches are formed, as stated above, by the horizontal plates of the premaxillaries. The maxillo-premaxillary suture is marked by the anterior palatine foramina, which are quite small. The palatine groove is found about half-way back on the maxillary plates. Here the palate is arched upwards from side to side with a somewhat decided median ridge. The inward shelf of the palatine bones forms the last inch and a half, notched in front by the posterior palatine foramina, and with a small median projection beneath the opening of the posterior nares behind. This opening is slightly anterior to the last molar.

Behind the nasals the *Frontals* extend a short distance backwards, taking a comparatively small share in the upper walls of the cranium. Their connection with the parietals is indistinct. At this point the skull is more rounded than in *U. Leidianum,* where the upper surface is nearly flat, except for the prominent supra-orbital ridges. A broad swelling on each side, just above the orbits of *L. Speirianum,* represents the supra-orbital ridges of *Uintatherium.* At their sides the frontals unite for some distance with the alisphenoids, the line of junction with these bones, as with the lachrymals, being about one-third way down the temporal fossa.

The *Parietals,* uniting broadly with the squamosals and, by a narrow junction, with the alisphenoids, form all the upper posterior portion of the temporal fossa. Above, they form narrow marginal ridges, just behind their articulation with the frontals, which arch rapidly upwards and backwards, bounding the deep supra-cerebral fossa between. The marginal ridges rise into the great parietal protuberances, behind which they slope away for a short distance, then rise again to form the occipital crest. The protuberances are somewhat smaller than in *U. Leidianum.* They are directed outwards, widely expanded at the top, forming in section a fore-and-aft oval at their bases and a transverse oval at their summits. They are admirably represented in the drawing. The occipital crest arches upwards in the centre, thickening into a slightly prominent rim which is most marked at the sides.

The *Occipitals* are comparatively narrow just above the condyles, forming a junction at the sides of the lower third with the mastoid portion of the periotic, if the sutures are correctly interpreted. The occiput, narrow below, rises thirteen inches and spreads to a width of eleven inches in the upper third; it is inclined obliquely backwards over the line of the condyles. The surface is slightly concave from side to side, with a central vertical ridge dividing it. It is quite different from the occiput of *L. galeatus,* which is much lower and broader. It conveys a remote likeness to a half-opened fan. The rim and central ridge are slightly rugose for muscular attachment. The condyles are directed obliquely downwards and set closely to the skull; they are perforated at their bases by the condylar foramina.

The *Basi-occipitals* are bounded at the sides by the mastoid portion of the periotic, and narrow forwards, joining the long narrow *Basi-sphenoids*. The mastoid portion of the periotic is rough and prominent. The external auditory meatus is directed sharply upwards and inwards. The post-glenoid process of the *Squamosal* is very large and projects below the mastoid, while the glenoid cavity is broad and rather shallow. The squamosal portion of the arch springs well up above the level of the orbits. The *Malar* is rather small, forming a sutural connection with the squamosal in *Loxolophodon*, as distinguished from the smooth facet in *Uintatherium*. They overlap the maxillaries, but do not quite extend to the orbit. The zygoma, as a whole, is arched well upwards and somewhat outwards. The *Alisphenoids* are perforated opposite the post-glenoid process by the *foramen ovale*. Their posterior limits are defined by the *foramen lacerum medium*. The study of the skull is here interrupted by a wide break which extends as far forwards as the palatines.

The *Loxolophodon* skull in the basi-occipital region is in fair preservation, but the base of another skull belonging to *U. mirabile* affords an opportunity for still clearer interpretation of this difficult portion. The two skulls placed beside each other are found to bear a close resemblance in this region; the only distinctions which arise are in size and proportion. In the lateral walls of the skull, behind the orbit, the skull of *U. Leidianum* (Plate II.) offers the best opportunity for study. The description which has been given of *L. Speirianum* will accordingly be continued and supplemented in greater detail by a study of the two above-mentioned species of *Uintatherium*, and those portions only will be described which are imperfect or wanting in the *Loxolophodon* skull.

UINTATHERIUM LEIDIANUM.

A full description of the skull of *U. Leidianum* was given in the Bulletin from this Museum published in 1878. It possesses many characters in common with *Loxolophodon*, and those which distinguish it have been outlined in the comparisons given above. They are chiefly in the palatinal region, in the proportions of the nasals, and size and relations of the horn-cores. It is not necessary to detail the lesser variations which can be found in the skull. Many of them can be traced in the excellent figure given in Plate II.

The topography of the lower side walls is one of the most difficult problems met with in the study of these skulls. This is owing in part to the age of the individuals, which has caused most of the sutures to become obliterated. The *U.*

Leidianum skull is in fine preservation, but even here some of the most important points are concealed by age and fracture. Many of the sutures of the bones can, however, be clearly traced.

Partial Description of Skull. The *Squamosals* form a long suture with the parietals, and the latter have only a short connection with the alisphenoids. The *alisphenoids* in turn unite for some distance with the frontals, and form also a short connection with the unusually large *lachrymals*, thus shutting out the orbito-sphenoids from articulation with the frontals. It is difficult to ascertain whether the *orbito-sphenoids* are distinct. Their position is judged of by the foramina. The line between the ali- and orbito-sphenoids seems to be marked by a wide fissure, the *foramen lacerum anterius*, and just above this is a groove extending obliquely downwards and backwards across the alisphenoid and terminating in a foramen. It is not clear whether this is the *foramen rotundum* or not. The exact position of the *foramen opticum* is difficult to ascertain, owing to a slight displacement of the bones by lateral pressure; it seems to be above and slightly anterior to the sphenoidal fissure. The *lachrymals* are perforated on the inner side of the orbit by two foramina; on the outer side, just above the maxillary suture, they are marked by a deep pit.

UINTATHERIUM MIRABILE.

The skull which has, upon conjecture, been referred to *Uintatherium* (*Dinoceras*) *mirabile* (Marsh) is quite distinct in contour from the corresponding portions of the skull of either *U. Leidianum* or *L. galeatus.* It is represented by the posterior half, the break having occurred just in front of the posterior protuberances and extending vertically downwards. The distinctions arise first from the smaller size; it may be the head of a younger animal, but, as the teeth are wholly wanting, there is no means of ascertaining this. A second and more striking variation is in the shape of the posterior protuberances, which are well preserved; they are low and tuberous at the summits, barely rising two inches above the marginal ridge, and presenting the usual transverse oval in section. The marginal ridge of the parietals rises high behind them to a point about level with their summits, so they do not form a conspicuous feature of the skull as in *U. Leidianum.* The backward prolongation of the temporal fossa is also marked. The occiput resembles that of *L. Speirianum* on a smaller scale, except that it is less narrowed above the condyles; it spreads widely above, and is directed obliquely backwards. The surface is slightly concave from side to side, with a median vertical crest for attachment of the *ligamentum nuchæ,* which is less pronounced than in *Loxolophodon.*

Partial Description of Skull.—The base of the skull is in beautiful preservation, affording, as remarked above, an admirable opportunity for the study of the bones and foramina of the base. The condyles projecting downwards and slightly backwards are raised upon a short neck. This is perforated by the condylar foramen. Just above the upper level of the condyles and perforating the rim of the occipital crest is the stylo-mastoid foramen. Immediately in front of the condyles, bounded anteriorly by the post-glenoid process and externally by the periotic mass, is a deep space. Into this projects the paroccipital process, which does not extend below the level of the basi-occipitals. Marking the postero-internal angle of this space is the *foramen-lacerum posterius.* On the antero-internal side is the *foramen-lacerum medius,* and just external to this is the upward-directed external auditory meatus. This has a wide open entrance behind the post-glenoid process, and narrows quickly as it enters the skull. The low paroccipital process is immediately behind this.

A deep groove leads forwards on the inner side of the post-glenoid process, terminating in the *foramen ovale.* Immediately in front and internal to this is the posterior opening of the short alisphenoid canal. This canal pierces the base of the pterygoids; it is one of the characters common to all the Dinocerata, and distinguishing the sub-order from the Pantodonta. It transmits the external carotid artery for part of its course. It is one of the characters which the Dinocerata possess in common with the Proboscidia and Perrissodactyla.

If the sutures and foramina have been correctly interpreted, the *Alisphenoids* extend well around on the inner side of the glenoid fossa, forming a short sutural connection with the *basi-occipitals.* The limits of the *Presphenoids* cannot be positively determined; they are very narrow forwards. The lower portions of the pterygoids are wanting in all our specimens. According to Cope, they form a high backward continuation of the posterior nares.

The *Exoccipitals,* if the suture has been discovered, are found to extend about an inch forwards in front of the condyles. Here is an obscurely marked suture showing their junction with the mastoid portion of the periotic. This is about an inch and a half broad, with a considerable upward extension on the side of the head. Here it is perforated by the stylo-mastoid foramen, which is placed high. This surface is extremely rough for muscular attachments. The *basi-occipitals* narrow rapidly forwards and, terminating opposite the post-glenoid processes, are convex from side to side; they form a narrow suture with the *basi-sphenoids,* which are obscurely marked off from the presphenoids.

COMPARATIVE MEASUREMENTS OF SKULLS.

	Lox. M.	*Uinta.* M.
Head, length over all, (Lox. 37½ inches), estimated for *Uintatherium*	.91	.76
Head, breadth of, above orbits	.195	.22
Bony palate, length	.34	.22
Nasal bones, length	.53	.35
Snout, breadth	.165	.12
Median protuberances, distance between, at summits	.37	.33
Distance between median and posterior protuberances	.45	.37
Distance between anterior protuberances and nasal tips	.35	.25
Width between zygomatic arches	.32	.30
Distance from angle of nares to tips of premaxillaries	.12	.114
Distance from angle of nares to tips of nasals	.18	.162
Anterior protuberance, height from base	.16	.175
Posterior protuberance, height from supra-cerebral fossa	.25	.27
Occipital crest at broadest point	.28	...
Occipital crest, height from base of skull	.31	...

Comparison with Proboscidian Skull. Some of the points which are suggested by a comparison of the skull of *Loxolophodon* with that of the elephant are of considerable value as showing the common origin of the two forms. Others point to a wide divergence and perhaps predominate over those indicating an approximation of structure. These may be placed with the comparisons of the same character which are inserted with the description of the skeleton which follows, before conjecture can be made as to the degree of divergence. The features of agreement are: (1) Both possess an alisphenoid canal; (2) The anterior portion of the zygomatic arch is made up by the maxillaries; (3) The frontals are narrow and do not join the premaxillaries; (4) There are extensive air-cavities in the skull. In the following respects the Dinocerata differ from the Proboscidia: (1) The periotic bones have a considerable exposure at the side of the skull; (2) There is a condylar foramen; (3) There are postglenoid processes; (4) There are no postorbital processes; (5) There are no upper incisors.

Comparison with Rhinocerus. The skulls of the *Dinocerata* agree with those of the *Rhinocerotidæ* in the following particulars: (1) They have no postorbital processes; (2) They possess an alisphenoid canal; (3) The nasals are produced forwards. The points of disagreement in the *Rhinocerotidæ* are: (1) The maxillaries, as in all ungulates, form a small portion only of the zygomatic arch; (2) The external auditory meatus has a more posterior position; (3) The mastoid portion of the temporal bone is not exposed.

Teeth—Upper Jaw.

Dental formula: $I\frac{0}{3}$, $C\frac{1}{1}$, $Pm\frac{3}{3}$, $M\frac{3}{3}$. The narrow premaxillaries are edentulous in all the known genera of the Dinocerata. Behind the maxillo-premaxillary sutures are the strong recurved canines which form a striking feature of these animals. These are not preserved in either of our skulls, although with one of the lower jaws, figured in Plate III., Fig. 1, the tip of a tusk was found and has been figured in the same plate, Fig. 6. It is lanceolate in outline, with a median ridge worn by friction with the pendent process of the lower jaw. This belongs to *Loxolophodon.* Cope describes that of *L. Cornutus* as a tusk of compressed form strongly recurved, and with anterior and posterior cutting edges. According to Marsh, the tusk of *Uintatherium* (*Dinoceras*) *mirabile* has a decidedly lance-shaped extremity. The Museum contains no remains of the canines of *Uintatherium.* In this genus they were protected by the pendent flange of the lower jaw, but projected widely below the short corresponding processes in *Loxolophodon.*

The molar series are peculiar for their small size in proportion to the skull.

Upper Molar-Premolar Series.

The upper molar-premolar series are poorly preserved in *Loxolophodon,* presenting much-worn crowns and broken edges. They agree in essential characters, as far as can be judged from our specimens, with those of *Uintatherium,* a description of which (Plate III., Fig. 5) follows. In the table of measurements the difference in size is seen to be in keeping with the greater dimensions of the *Loxolophodon* head, which is nearly a third larger.

Premolars. The first premolar is not preserved in our specimen. The second and third are subequal and of about the same conformation, implanted by three fangs, one internal and two external. A large basal ridge completely surrounds the sub-circular crown. The crown, somewhat trihedral above, is surmounted by two transverse grinding edges; of these, the anterior is the lower and crescent shaped, while the posterior is straight. Together they form an irregular V opening outwards. The anterior ridges throughout the series are much the most worn.

Molars. The true molars increase in size regularly backwards. The first, worn almost to the basal ridge, is larger than the last premolar, and shows, moreover, an accessory tubercle on the inner side of the posterior ridge. The extremities of the ridges rise into points and their summits are transversely concave. In the last molar there are but two fangs, which are long and wide, extending the whole breadth of the crown. This tooth is much larger and less worn than the preceding, with a strong, slightly serrated posterior basal ridge, which recalls the corresponding ridge in the last lower molar. The crescentic anterior ridge rises into high points at the extremities, giving a tripodal character to the crown; it projects beyond the line of the straight posterior ridge. The accessory tubercle is large and shows a tendency to become double. In this respect the tooth agrees with that of *U. robustum*, but there is no tubercle occupying the entrance of the triangular valley between the lobes.

As a whole the series diverge rapidly, but the distance between the first premolars and posterior molars is about the same, owing to the great breadth of the latter. The molars are distinguished from the premolars by the accessory tubercle. The entire series present the outward opening V, the posterior ridge in all being straight, the anterior curved forwards.

Measurements and Relations of Upper Teeth.

	Lox. M.	*Uinta.* M.
Distance between canine alveoli, inner margins	.11	.08
Length canine-molar diastema	.09	.072
Fang of canine transverse diameter	.04	.039
Fore-and-aft diameter of ditto	.065	.060
Distance from canine to tips of premaxillaries	.070	.09
Length of molar series	.169	.148
Length of premolar series	.074	.062
Fore-and-aft diameter of first premolar	.025	....
Transverse diameter of first premolar	.019	....
Fore-and-aft diameter of second premolar	....	.022
Transverse diameter of second premolar	....	.023
Fore-and-aft diameter of third premolar	.025	.022
Transverse diameter of third premolar	.029	.023
Fore-and-aft diameter of first molar	.029	.023
Transverse diameter of first molar	.030	.023
Fore-and-aft diameter of second molar	.030	.028
Transverse diameter of second molar	.037	.031
Fore-and-aft diameter of third molar	.040	.039
Transverse diameter of third molar	.039	.044
Height, crown of penultimate molar	.021	.019
Distance between molar series in front	.072	.058
Distance between molar series behind	.068	.049

Lower Jaw of Loxolophodon.

The museum has not succeeded in obtaining a complete lower jaw of *Uintatherium*, though a portion of the jaw has been placed in position and figured in Plate II. Marsh, however, at an early day described a jaw belonging to this genus, with its remarkable lower flange opposite the upper canines, and with four canine-incisor sockets. During the summer of 1878 we happily secured a complete lower jaw unquestionably belonging to *Loxolophodon,* for with it was found the lower portion of an upper canine corresponding in appearance to this tooth as described by Professor Cope. It contained the full dentition. The decided difference in the lower outline of the jaw firmly established the position of *Loxolophodon* as an independent genus from *Uintatherium.* This important fossil has already been described in *Silliman's Journal.*[1] The principal characters will be repeated here.

Since that publication the stone has been removed from another jaw of the same genus which is even more complete, especially in the symphysial portion. Both jaws lack the coronoid processes, nor are the condyles complete in either. The teeth belonging to the former jaw are figured in Plate III., the canine, the three incisors, and the complete molar-premolar series. The second, or smaller jaw, has been placed in position beneath the Loxolophodon skull in Plate I. and reduced in a slightly less degree than the head, as it belonged to a smaller individual.

A principal feature is the striking disproportion between the jaw and the head; this is somewhat increased by the upward and backward extension of the head behind the glenoid process. This, with the absence of upper incisors, does away at once with the idea that *Loxolophodon* had any but an herbivorous diet. This question is referred to elsewhere.

Description of the Lower Jaw. (See Plate III., Fig. 1). In general contour the jaw is neither long nor deep. It extends from the well-advanced glenoid cavity barely to the tips of the slender premaxillaries, where it is wholly overhung by the broad and projecting nasals. The coronoid process rises immediately behind the last molar, projecting well up into the temporal fossa, if we can judge by its stout base. The condyles, slightly above the plane of the molar series, are small and decidedly convex, with their transverse axes converging. Below these the posterior border narrows and then projects slightly beyond the line of the condyles, roughened on the inner side for the pterygoid muscles. The lower border arches gently downwards and outwards from the angle to below the first premolar. Here two slight downward processes are formed, homologous with the heavy pendent processes of *Uintatherium,* but in striking contrast with the excessive development of the latter. The under surface at this point is slightly concave, meeting the opposite jaw and forming a long narrow symphysis. The chin narrows into a prow-shaped keel; it is about three and a half inches long. The alveoli for the canine-incisor series converge in almost straight lines, dipping downwards in front. This would throw the teeth out of the hori-

[1] Vol. XVII., April, 1879, p. 304.

zontal line were it not that the median incisor is almost double the size of the canine. The space between the dental series is deeply concave.

MEASUREMENTS OF THE LOWER JAW.

	M.
Extreme length from infra-condylar depression to symphysis (21 inches)	.295
Depth at last molar	.08
Internal depth of jaw at posterior edge of symphysis	.071
Thickness of jaw at angle	.014
Length of symphysis	.15

The *Molar* series (see Plate III., Figs 1 and 2), display three transverse crests, the anterior the most prominent and forming with the second an open angle with the apex directed inward; the posterior crest, less prominent than the other two and appearing like a much-enlarged cingulum, is serrate throughout the series. A cingulum faint elsewhere is quite strongly developed at the edges of the third crest. Just beyond the inner apex of the middle crests is a large accessory tubercle which is constant on the true molars and last premolar inclusive.

More in detail, beginning with the last molar—for it presents the characters of all the others in strongest development—it is much the largest of the series. The posterior crest is highest in the centre. The middle crest divides two valleys, the anterior valley opening outwards, though not completely closed on the inner side. The anterior crest is horizontal, terminating interiorly in a prominent and exteriorly in a lesser tubercle. The second molar presents the same characters, but is greatly reduced in size. The first molar is so much more worn that it fixes three beyond a doubt as the number of true molars.

In the *Premolar* series the anterior crest is relatively more prominent, and its terminal tubercles become equal in size. The third is the only premolar on which the tubercle beyond the apex is found. The second and third premolars have the middle crest comparatively lower, while in the first it rises to form a continuous course with the anterior, giving a crescentic appearance to this portion of the tooth, accompanied by a considerable elevation of the outer marginal tubercle.

The *Canine-incisor* series in *Loxolophodon* (see Plate III. Figs. 1, 3, and 4) are separated by a considerable diastema of about four inches. They are contiguous, and directed upward and forward at such an angle that the two lobes, the larger (which is anterior) and smaller (posterior) lobe, are on a line and divide the attrition. They increase regularly in size from the canine forwards.

The median incisor consists of an outer convex and inner flat surface. The outer portion is divided by a median valley into two convex lobes. Of these the anterior is higher and larger and comes to a pointed apex. The median valley is marked at the top by a very slight ridge. The posterior lobe comes to an obtuse point about two thirds the height of the anterior. The inner surface of the tooth has a flat, slightly raised, and faintly serrate margin. The second and lateral incisors decrease in size regularly with the same characters as the above, except that the posterior lobe of the lateral tooth is relatively higher. In the canine the cleft at the head of the valley has disappeared, and consequently there is a deep single valley. The fangs throughout the series are long, and stout; they arch forwards slightly, and decrease in size with the crowns.

COMPARATIVE MEASUREMENTS OF THE TEETH OF THE LOWER JAW.

	Lox. M.	*Uinta.* M.
Entire length of molar series (6 inches)	.166	....
Length of the molar series	.094	....
Fore-and-aft diameter of last true molar	.047	....
Transverse diameter of same	.036	.026
Heigot of crown of same	.030	.023
Fore-and-aft diameter of first premolar	.023	....
Transverse diameter of same	.019	....
Height of crown of same	.022	....
Length of canine-incisor series	.140	....
Width of median incisor	.019	....
Length of same	.041	....
Height of crown of same	.037	....
Width of external lobe of same	.026	....
Width of internal lobe of same	.015	....
Length of fang of same	.060	....
Width of canine	.015	....
Length of same	.036	....

The measurements of the Uintatherium molars are from specimens which Dr. Leidy kindly lent us, and which have been described in full.[1] They correspond closely, except in size, to those of Loxolophodon.

GENERAL CHARACTERS OF THE TEETH.

The characters of the teeth sustain the inference, drawn from the study of the limbs and skull, of the aberrant position of this group, and of their probable origin from a common stock with the *Coryphodon* group. The latter genus displays a marked divergence towards the Perissodactyle ungulate type, while the *Dinocerata* with marked ungulate characters in their dentition show an advance along an independent line. *Coryphodon* in the premolar series of the lower jaw presents curved inward-opening crests, while the molar series are marked by simple transverse crests, as in the Tapir. The upper teeth, according to Cope, present slight divergence from the ordinary Perissodactyle type.

[1] Cont. from the E. M. Museum; Princeton College, No. 1, Sept. 1st, 1878, page 71.

In the lower jaw of *Loxolophodon* we find in the last molar, which has a structure typical of the whole series, an outward-opening V, formed by two transverse limbs, and behind this a prominent transverse crest. The upper teeth also present an outward-opening V, formed of two limbs, as well as a posterior crest.

Homologies of the Teeth. More in detail, the teeth present a likeness to the Perissodactyle ungulate type in the uniting of the inner and outer tubercles by the transverse limbs of the V. In the lower jaw these crests unite on the inner side, forming a V opening outwards, here distinguished from the inward-opening V of the Perissodactyle type. A more important distinction arises from the fact demonstrated in the posterior molar of the lower jaw, that the posterior tubercle on the inner side of the typical tooth has moved forwards and become placed on the posterior slope of the larger anterior tubercle. This posterior tubercle grows less marked as the teeth are followed forwards. It shows, however, that the posterior limb of the V is homologous with the posterior transverse crest of the Perissodactyle type of tooth, and that the posterior ridge of *Loxolophodon* is an additional structure, probably derived from the basal cingulum and not from any portion of the Bunodont type of tooth. In the Perissodactyle type, represented by *Lophiodon*, the transverse ridges, not uniting on the inner side, form two forward-opening crescents, which grind against the backward opening crescents of the upper molars. In *Loxolophodon* the transverse ridges of the lower jaw are directed obliquely across the tooth without assuming the crescentic pattern. In the upper jaw, however, the anterior limb of the V forms a backward-opening crescent, while the posterior limb is straight. The accessory tubercle on the inner side of the apex of the V in the true upper molars is taken to represent the fifth tubercle occasionally found in the Bunodont type. The posterior ridge of the upper molars seems to be homologous with the same ridge in the lower jaw, but does not attain so great a development. In each jaw it probably represents the upgrowth of the posterior basal cingulum.

Emphasis may be laid upon the presence of the second tubercle on the inner side of the median crest of the lower jaw of *Loxolophodon*. It substantiates the inference that the two limbs of the V are homologous with the two transverse crests of the Perissodactyle type of tooth. If this is true of the lower it is probably also true of the upper jaw, and the objection raised by Cope[1] that the accessory tubercle prevents a comparison of these ridges with those of *Hyrachyus* and *Rhinocerus* is not sustained. This is on the ground that the posterior inner tubercle has probably disappeared, as in the premolars of the lower jaw, and the accessory tubercle of the upper jaw represents the fifth tubercle found in such a form as *Achænodon* among the Bunodont types.

[1] Extinct Vertebrata of New Mexico. Wheeler's Survey, Vol. IV., p. 192.

SKELETON OF LOXOLOPHODON AND UINTATHERIUM.

We fortunately obtained a series of six cervical vertebræ of Loxolophodon, several dorsals, the humerus, ulna, and radius of one individual. The distal end of a femur belonged to another individual; also the tibia and numbers of the foot-bones of others. There were no portions of the head found to positively establish these remains as belonging to Loxolophodon; but numbers of the remains of other individuals of this genus were found on the same level and not far separated from these vertebræ and limbs.

Loxolophodon—Cervical Vertebræ.

Cervical Region. The *Atlas* has a light superior arch, deeply cupped for the occipital condyles, and with sub-oval faces for the axis. There is a shallow groove on the lower arch for the odontoid process, and a perforation of the transverse process close to the centrum. The *Axis* with its bifid spine wears a close resemblance to that of the elephant, save for the shorter upper arches. The centrum is long and is a transverse oval slightly concave behind. The odontoid process is short and stout. As in *Elephas*, the laminæ support throughout the series obliquely divided zygapophysial faces. The centra of the succeeding vertebræ are slightly opisthocœlous, and in our specimen have lost the terminal epiphyses; thus the combined measurements give a shorter neck than the animal shows in the Restoration, Plate IV. The transverse processes are widely perforated, as in the elephant, with a rather pronounced inferior lamella. The spines are low rugosities. The neural canal is a broad oval. The seventh cervical has not been procured.

Measurements of the Cervical Vertebræ.

	Lox. M.	*Uinta.* M.
Atlas, transverse diameter, estimated	.11	....
do. inferior arch fore-and-aft	.088	....
do. height	.135	....
Axis, centrum, fore-and-aft	.11	....
do. do. transverse	.145	....
do. height to top of spine	.195	....
5th cervical, centrum, fore-and-aft	.058	.051
do. do. transverse	.11	.111
do. do. vertical	.09	.079
do. to top of neural spine	.154	....

The figures given in the second column are from a single cervical vertebra belonging to *U. Leidianum.* Cope has described a separate genus, *Eobasileus,* similar to *Loxolophodon* in other respects, but with cervical vertebræ of less than half the length. The neck of this animal resembled that of *Elephas*, or was even shorter.

The description of the skeleton is now continued mostly from the Uintatherium remains. As in the description of the skull, the writer passes from one genus to another, according to the nature of the materials. In the case of the skeleton this course is justified in many instances by the close likeness of structure. Wherever variations exist, they are pointed out.

Uintatherium—Vertebral Column.

The special characters of the cervical region are not known. The neck, judging from a single cervical the measurements of which are given above with those of Loxolophodon, was probably about the same length in each genus. The dorsal vertebræ also agree closely, as far as our material admits of comparing them. It is safe to conjecture, as will be shown in the Restoration, that the general features of the vertebral columns were similar. The following description is in part an extract from the first Bulletin from the Museum. It is based upon nine dorsals and two lumbar vertebræ of Uintatherium.

Dorso-lumbar Series. The *Centra* are large, sub-triangular; slightly opisthocœlous, but less so than in the *Proboscidia.* They compare bone for bone in length, but not in height, with those of a mastodon of medium size in the museum collection; increasing in length regularly backwards, at the same time becoming narrower and higher. The *Costal Surfaces* anteriorly are large and deep; in the middle dorsal region they almost meet, as in *Elephas.* Behind they are reduced to thin lozenge-shaped projections of the centra. The *Neural Spines* are markedly smaller than those in the Proboscidians and Rhinoceros. Those placed about sixth and seventh in the Restoration have about the same angle as in *Mastodon;* in the last dorsals they are wide, straight, and very thin; in the lumbar region short, stout, and tuberous. The metapophyses of the last lumbar vertebræ are very characteristic; they are high, parallel with the column, forming deeply concave pre-zygopophysial faces on their inner sides. Into these are mortised the post-zygapophyses, forming a very close union between the successive vertebræ. This recalls the arrangement of these parts among the primates rather than the loose articulation on the laminæ of mastodon or tapir. The *transverse processes* present unique features. In the anterior region they are long, wide, and rugose, and in the same plane with the laminæ, sending out wide projections curving downwards. In the middle region they lose these projections, assume a sub-trihedral shape, supporting a large facet for the rib. The *pedicles* throughout are deeply notched behind.

Sacral Region. The sacrum is composed of four vertebræ, three true and one pseudo-sacral. The centra rapidly diminish in size from before backwards. The first is shorter than the last lumbar, but much longer than the other sacrals, which are sub-equal. The pre-zygapophyses of the first resemble those of the lumbar region—the metapophysis of the first being large, while it is tuberous and rudimentary in the other three. The transverse processes are long and wide in the first three; widest in the first, but thickest in the second; long and thin in the fourth. The perforations for exit of the sacral nerves are wide and deep. The pleuropophysial segments of the true sacrals are very heavy. The inferior faces of the centra are slightly concave in the first three, and the first and fourth are marked by slight hypophysial keels. The neural canal decreases to a narrow opening in the last.

Caudal Region. We possess the first four caudal vertebræ. The centra of the caudal vertebræ are rather long, narrow, and greatly depressed in the middle; their slow decrease in size, the persistence of the backward-directed neural spines, enclosing a narrow neural arch, point to a somewhat stouter tail than that of the elephant. The transverse processes are wide, thin plates roughened at the ends and projecting directly out; they decrease in size backwards.

MEASUREMENTS OF THE VERTEBRÆ.

	Uinta. M.
Dorsal Region.	
In anterior region: Diameter of centrum, fore-and-aft	.075
do. do., vertical	.062
do. do., transverse	.142
In posterior region: Diameter of last dorsal, vertical	.087
do. do., transverse	.110
Neural canal, average width throughout the series	.097
Lumbar Region.	
Centrum, fore-and-aft diameter	.095
do., transverse diameter of posterior face	.111
do., vertical diameter of posterior face	.078
Extreme width between transverse processes	.214
Width between prezygapophyses	.110
Heighth of neural spine from lamina	.060
Sacral Region.	
Length of sacral series (about 11½ inches)	.264
Transverse extent of sacral series	.298
First vertebra, diameter of anterior face (transverse)	.109
do., vertical diameter of anterior face	.072
do., fore-and-aft diameter of anterior face	.070
Last vertebra, transverse diameter of posterior face	.053
do., vertical diameter of posterior face	.031
do., vertical diameter of neural canal	.018

Caudal Region.

Length of first four vertebræ (9 inches)	.252
First vertebra, fore-and-aft diameter of centrum	.061
do., diameter of neural canal	.035
do., extent of transverse process	.085

Several of these vertebræ were figured in the first Bulletin of the Museum.

Comparison with the Proboscidia. Several comparisons with the spinal column of mastodon have been already commented upon. In summary: the cervical vertebra of *Uintatherium* have longer centra and possess shorter neural spines; in the dorso-lumbar region, anteriorly the neural spines are shorter and lighter; the centra have the same proportionate length; the articular facets for the ribs correspond closely. Posteriorly *Loxolophodon* diverges in the great development of the metapophyses, and consequent closer articulation of the vertebræ. The pleurophysial elements of the sacrum are much more expanded, and present broader attachments with the sacral surfaces of the ilia. The caudal vertebræ are broader, and have more slender spines.

Comparison with Rhinoceros. The vertebræ of Rhinoceros differ widely from those of the Dinocerata. The vertebral artery passed through the superior arch, instead of the transverse process, of the Atlas. Throughout the cervical series the zygapophysial faces are more oblique, the spines longer, the centra more flattened and deeply cupped behind. In the dorso-lumbar region the vertebræ are still decidedly opisthocœlous; the spines are very long in the lumbar and high above the sacral surfaces in the sacral region. The metapophyses differ widely from those of *Loxolophodon.* They are represented in the lumbar region by short, forward-directed spines; they do not therefore support the zygapophysial faces which are found instead upon the laminæ.

Ribs.

The collection contains ribs from several portions of the chest; they bear a general resemblance to those of the elephant, although much lighter, thus in keeping with the narrower chest. The most anterior has a stout head and well-raised tubercle. The shaft arches strongly outwards to the angle beneath the tubercle, and then turns rapidly downwards. The shape of the first rib indicates a narrow opening at the neck. The outer face of the rib is much roughened for the attachment of the muscles which swing the scapula. As in *Elephas*, the head is divided by a median groove. The succeeding ribs are deeply grooved in front and much less so behind. The neck is somewhat longer throughout than in *Elephas;* the angle is more acute, the tubercle more prominent.

Pelvis.

The *Ilia* have a great lateral expansion, with the iliac surfaces concave and the gluteal nearly flat; thin in the middle, they increase in thickness near the borders, which are roughened for the attachment of the heavy oblique and transverse muscles of the abdomen. The supra-iliac borders arch strongly forwards and outwards beyond the line of, and apparently below, the acetabula. The acetabular borders are only slightly concave; the prominence for the attachment of the rectus muscle is low and V-shaped. The sacral surface is very broad and deep, projecting beyond the sacral spines above, and roughened for the attachment of the gluteal muscles. The ischial borders are deeply concave, a muscular ridge passing horizontally across the lower surface of the ilium from the margin of the acetabulum for the attachment of the gemelli muscles. The ilio-lumbar angle is about 110°. The *Ischia* are short; a section of them as they leave the acetabulum is subtriangular. Below they expand, fan-shaped, terminating in a rounded lower border and a small upward-directed *tuber ischii.* They do not show a very strong ridge for the adductor muscles: this is what we should expect from the study of the femur, which is about as rugose as that of the elephant.

The *Pubes* are very light, sub-cylindrical as they leave the acetabula, and after this flattened in the same plane with the ischia. The pubic symphysis is short. The thyroid foramina are large and oval, with their long diameters parallel to the axis of the ischia. The *acetabula* are large, sub-circular, and deep, with prominent borders, especially the iliac, which are produced into a point; on their external extremities the ischiatic are deeply notched. From the wide ligamentous pit in the centre there runs a deep groove part way down the antero-external side of the ischium.

The anterior outlet of the pelvis, when compared with the pelvis of *L. cornutus,* is broader and proportionately shallower. In this respect *Loxolophodon* presents a likeness to *Mastodon.* The thyroid foramen is a wider oval. The ilia have about the same lateral expansion and direction of the crests in both genera.

Comparison with Mastodon. The pelvis of *Mastodon* resembles that of *Uintatherium* only in general features. In an anterior view the likeness is striking, but wide variations exist in the shortness of the sacral surfaces, and in the vertical direction of the pelvis, which reduces the ilio-lumbar angle to about 100°. Finally, the elongation and backward extension of the pubic symphysis contrasts with the narrow symphysis of *Uintatherium.*

Comparison with Rhinoceros. The ilio-lumbar angle of the pelvis of *Rhinoceros* is less than that of *Uintatherium,* the pelvis having a more vertical position, as in

Elephas. The crest of the ilium has about the same contour, but is thickened and bifid where it overhangs the acetabulum. The obturator foramen is more rounded and the symphysis pubis longer. The sacral surfaces are, on the other hand, very short and not raised above the sacral spines.

Fore Limb.

The *Scapula* is strongly proboscidian in outline, with a sub-triangular shape. On the external side the pre-scapular fossa is concave antero-posteriorly. The post-scapular fossa is much the larger and less concave. The spine rises slowly from the supra-scapular border, extending to within an inch of the glenoid cavity; it is antroverted with a rudimentary acromion. The coracoid process is a low, rugose tuberosity. The inner surface of the scapula has a large, smooth median ridge. The supra-scapular border is much thickened.

As indicated in an earlier description, the resemblance to the scapula of the *Proboscidia* is more closely marked than in any other of the corresponding bones. The points of similarity are: (1), the subtriangular shape; (2), the same relative proportions between the fossæ; (3), the antroversion of the spine; (4), the glenoid cavity looking directly downwards. The differences are, (1), in the dissimilar proportion of the glenoid cavity; (2), the great thickening of the spine at each end.

The *Humerus* is stout and twisted upon its axis. As in *Elephas* it contrasts in the greatly projecting tuberosities with the comparatively smooth femur. The head is large, hemispherical, and sessile, placed almost vertically above the axis of the shaft. The great tuberosity is high and heavy, and separated by a shallow bicipital groove from the lesser tuberosity, which is faint. The deltoid ridge is prominent, but not recurved; it is placed about half-way up the shaft. The supinator ridge does not present the development we meet with in the proboscidian humerus; it is a faint rugose line. The trochlear surfaces are subequal in size; above the radial surface is situated a rather deep supra-trochlear fossa, forming the inner limit of the external condylar tuberosity, which is the most prominent. The internal tuberosity is more massive. The anconeal fossa is median in position and quite deep.

The *Radius* is placed directly anterior to the *Ulna* (the position of these bones and the description which follows are partly based upon the complete fore-leg of *Loxolophodon* in our collection). Above, it has an exact median position, the proximal surface divided by a central ridge for the two facets of the trochlea. Below, the shaft, which is slightly twisted and narrowed in its central portion, passes across the ulna to the antero-internal side of the leg. This crossing of the shafts is less marked than in *Elephas*. The distal end of the shaft is perhaps slightly larger than the proximal; it has a sub-trihedral face for the scaphoid and lunar bones, with a narrow facet for the ulna.

The *Ulna*, with a massive olecranon process above, has a stout shaft arching slightly forwards and terminating below in an oblong facet which articulates with the cuneiform, and has a small facet for the lunar. The diameter of the shaft is about one and a half times that of the radius. The latter is evidently in process of reduction, as the weight of the shoulders falls more and more upon the ulna. Still the disproportion in size is not strongly marked. The distal faces of the ulna and radius are sub-equal in size.

Of the bones of the *Manus* the Museum contains the proximal row of the carpus, two of the distal row, and several of the metacarpals. The proximal row, and consequently the entire foot, is directed somewhat outwards, owing to the oblique position of the distal faces of the ulna and radius. The *scaphoid* is long, with a much-rounded proximal face. The *lunar* has a narrow face for the ulna; it is of an irregular quadrilateral shape; with the *cuneiform* it covers the entire lower articular face of the radius. On their lower side both these bones meet the *unciform*. The median metacarpal, III., is placed between the magnum and unciform. Metacarpals IV. and V. articulate with the unciform. Each toe is furnished with a complete number of phalanges, which, according to Marsh, are short and proboscidian in appearance.

Hind Limb.

The *Femur* has a small rounded head, with no pit for the *ligamentum teres*, placed partially out of the line of the shaft. The great trochanter is much thickened fore-and-aft and slightly recurved behind. Below it the shaft narrows to the centre, and then widens rapidly into the broad condylar extremity. The lesser trochanter is a strongly rugose line. There is no third trochanter. The condyles are of nearly equal size, very convex, and divided by a deep popliteal groove. The condylar tuberosities are narrow; each sends a ridge obliquely inwards above the popliteal space for attachment of the great adductor muscle on the internal side and for the heads of the gastrocnemius muscles on either side. The trochlear face for the patella is short.

The *Tibia* is short and stout, contracted at the middle, expanded and very rugose at the extremities. The massive proximal end supports deeply concave articular faces separated by a slight ridge; of these the inner is considerably higher, as in the mastodon. The tuberosity is cupped above for the reception of the ligament of the patella. The popliteal space is shallow; just on its outer margin is the small facet for the fibula. The *Fibula* is a very slender bone placed wholly on the postero-external face of the shaft, with an expanded distal extremity articulating by a narrow facet with the rim of the distal face of the radius, and forming a wide external malleolus. This bone seems to have a narrow articular facet for the astragalus, but does not touch the calcaneum.

Marsh[1] has pointed out clearly the characters of the hind-foot from the fine specimens in his possession. Our collection of foot-bones is not quite complete. The *Astragalus,* with a slightly concave upper surface, showing no groove, articulates below with both the *navicular* and *cuboid.* The *Calcaneum* is small with a short tuber-calcis directed inwards; it has two subquadrate facets for the astragalus. It has a narrow anterior face for the cuboid. Marsh states that it does not meet the navicular. The metatarsals are shorter and stouter than the metacarpals. The hallux is complete, but very small; the remaining digits are well developed.

Proboscidian and Perissodactyle Affinities of the Appendicular Skeleton.

The Fore-limb. The proboscidian characters of the axial skeleton of *Uintatherium* have been considered above. In the appendicular skeleton the following distinctions and homologies are observed. The *fore-limb:* (1) The upper borders of the scapulæ resemble each other; the spine is less recurved. (2) The supinator ridge of *Uintatherium* is a low rugose line; in *Elephas* it is a stout crest. (3) The radius of *Uintatherium* is proportionally much larger and crosses the ulna less obliquely and the distal ends of the ulna and radius are sub-equal in size, while in *Elephas* that of the ulna is much greater. In both the ulna has a narrow articulation with the lunar. The arrangement of the *manus* is similar in the two genera, with the exception that in Uintatherium (4) the unciform articulates broadly both with the lunar and cuneiform. In the reduction of the radius, which is evidently advancing in the Dinocerata, is seen a divergence towards the proboscidian rather than the perissodactyle, type of fore-arm; for in the latter group, where there is a reduction of either bone, it is the radius which develops at the expense of the ulna, the distal end of the latter bone being reduced in the tapir and disappearing entirely in the horse.

The fore-limb of *Rhinocerus* differs in the narrow, high ungulate type of scapula. The humerus offers contrast with that of Uintatherium in its salient deltoid ridge. The ulna is in process of reduction at its lower end, but, as in the Dinocerata, covers the entire proximal surface of the cuneiform. The two ends of the radius are sub-equal, the lower occupying a postero-external position in relation to the ulna. The unciform articulates, as in the Dinocerata, with both lunar and cuneiform.

[1] Am. Journ. Science and Arts, 3d series, Vol. XI. p. 168.

The Hind-limb. Above the tarsus, the hind-limb of *Uintatherium* closely resembles that of *Elephas;* the shape of the femur, the angle of the knee, the relations of the tibia and fibula and the two malleoli formed by them offer close points of likeness. (1) The astragalus of *Uintatherium,* unlike that of *Elephas* articulates with both the navicular and cuboid bones. (2) The calcaneum of *Uintatherium* does not articulate with the navicular as in *Elephas.* (3) The reduction of the lateral toes in *Elephas,* hallux and minimus, has its parallel merely in the advancing reduction of the hallux in *Uintatherium.*

Flower suggests that the reduction of the lateral toes in *Elephas* is an approach to the odd-toed type of foot. The full-sized minimus and slightly reduced hallux of *Uintatherium* present us with a simpler type of foot than that of the elephant.

Points of likeness in the hind-limb of *Uintatherium* and *Rhinocerus* are that in both genera (1) the astragalus articulates with navicular and cuboid; (2) the tibia and fibula are of same relative size and position. The Rhinoceros differs (1) in the possession of a grooved astragalus; (2) in the articulation of the calcaneum with the cuboid; (3) in the possession of a third trochanter on the femur.

RESTORATION.

The restoration of the animal attempted in Plate IV. has been carefully based upon the very considerable portions of the skeletons of *Loxolophodon* and *Uintatherium* in the Princeton collection. In outlining the feet the excellent drawings of Prof. Marsh[1] have been consulted. Recourse has also been had to the suggestions of Prof. Cope made in 1872,[2] although the material at his command at that time was quite incomplete. The head is that of *L. Speirianum,* figured also in Plate I., the incisor teeth being added. The remainder of the axial skeleton is represented by the six anterior cervicals of *Loxolophodon,* and several dorsals of the same, two of which have been placed as sixth and seventh. Of *Uintatherium* there are a number of dorsal vertebræ, two lumbar, the complete sacrum, and the four anterior caudals. Some of these agree so closely with the corresponding vertebræ of the allied genus as to induce the belief that in general outline the spinal columns were closely similar. There was not such a wide difference in the length of the neck as has been asserted. At all events, the *Uintatherium* vertebræ can be placed and drawn with some assurance, in the *Loxolophodon* skeleton. The neck was considerably longer than that of the Mastodon; allowing for the intervertebral discs it is estimated at two feet. The oblique bevelling of the vertebræ below indicates that the neck arched upwards

[1] Am. Journ. Science and Arts, Vol. XI. p. 168.

[2] Hayden's Survey of the Territories, 3d Series, Vol. XI.

and was set well down between the shoulders. The dorsal series, which increase in size backwards, have the same approximate lengths in different parts of the back as in the Mastodon. The laminæ of the anterior dorsal region indicate lighter spines than in Mastodon, still somewhat produced to support the elongated and inclined head. The lumbar spines are rather short and bifid, the sacrum consisting of four vertebræ. The four anterior caudal vertebræ have unusually broad transverse processes and a slight neural arch, indicating quite a long tail. In summary, the back was as long as that of the Mastodon, and the neck was considerably longer.

We have more or less complete ribs from every portion of the trunk. Several of them have been figured, placed in their approximate positions. The most anterior indicates a narrow opening at the neck; those behind arch widely from the tubercle outwards, indicating a capacious chest. The number of ribs was either nineteen or twenty.

In the appendicular skeleton we have complete limb-bones of both genera. The fore-shoulder is restored from a scapula of *Uintatherinm* found with the vertebræ and pelvis. The outline is drawn from a plate, kindly lent us by Prof. Cope, of a Loxolophodon scapula. The humerus and fore-arm belong to the same individual as the cervical vertebræ. The foot-bones are from other individuals. We possess the scaphoid, lunar, cuneiform, magnum, and unciform; also two metacarpals. The outlines of the toes are after Marsh's drawings. The pelvis is from the Uintatherium skeleton which, according to Cope's figure closely resembles that of *Loxolophodon*. The hind-limb is from a perfect femur of *Uintatherium*, and tibia and fibula of the same genus. In drawing these a slight allowance has been made for the larger size of the Washakie-basin genus. The feet are from different individuals, the outlines from the same sources as the fore-foot. The bones in our possession are the calcaneum, astragalus, navicular, cuboid, and others which cannot be positively placed.

The angle of the limbs at the elbow and knee has been decided by the character of the hind-limb, which except in length bears a close resemblance to that of the elephant. It is improbable that this limb was more flexed in the Eocene than in the modern genus. A greater flexure at the elbow would lower the head and enable us to account more readily for the manner of feeding, but this is not sustained by the character of the limbs.

The body was nearer the ground than in the elephant, while more elevated than in the modern rhinoceros. The animal stood about six and a half feet high at the withers, and very little lower at the rump. The head, which measures about two and a half feet, was probably carried so that the occiput was vertical. From snout to rump, therefore, the animal measured fully twelve feet. The forward projection of the lower teeth, abutting against a callous pad on the premaxillaries above, points to the fact that the animal fed close to the ground, but the projecting snout would have prevented his cropping the grass. It is probable that the head could reach within a foot or two of the ground. The limb-bones as a whole indicate a less muscular animal than either the rhinoceros or the elephant.

Anatomy, Muscles and Brain. The muscles at the back of the neck were stout in order to raise the much elongated head. The brain-cavity, which Marsh called attention to at an early date, is situated between the posterior protuberances and indicates a brain so small that it could have been readily pulled through the neural arches of the vertebræ. The forward extension of the head beyond the brain region is enormous. It was accompanied by the development of large sinuses in the sphenoidal and ethmoidal regions. The solid appearance of the skull exterior is rather deceptive, the anterior nares being very large and the nasals excavated on their lower sides. The protuberances are solid above, but hollow at their bases. Altogether the skull was, like that of the elephant, much lighter than it appears at first sight.

The rounded upper crest of the occiput is swollen for the attachment of the sterno-cleido-mastoid, the complexus and rectus-capitis muscles. From the vertical ridge dividing the occiput in the median line rose the powerful *ligamentum nuchæ*, which was attached to the spines of the cervicals and anterior dorsals. These muscles and ligaments probably filled completely the space behind the occiput. The inner angle of the jaw is roughened for the attachment of the pterygoid muscles; these were inserted in the large pterygoid bones above, and were employed in grinding the food. The large temporal fossa and stout zygomatic arch gave origin to the temporal and masseter muscles. The lower jaw, although undersized, must have had considerable power. Above the orbits in *Uintatherium* are strong ridges for the muscles of the eyebrow and scalp. The tips of the nasals in the same genus are deeply pitted for the levator labii and other muscles of the lip. The animal did not need a proboscis; the indications point to a stout prehensile upper lip like that of the tapir. This would have been of use in bending the reeds and grasses so that they could be cropped off by the sharp lower incisors.

Taken altogether, the long body, wide thorax, and comparatively short limbs with spreading toes indicate an animal rather of the habits of the Rhinoceros than of the Elephant. The lighter limbs indicate some speed. For many reasons it is improbable that the frontal and parietal protuberances bore horns. In many of the genera they are wider at the top than at the base. Their bony structure differs from that of true horn-cores. Horns upon the parietal processes would have been useless for purposes of defence. The presence of the long canine tusks are features seldom found in animals provided with horns. It is more likely that they gave support to masses of callous epidermis. However covered they gave the animal a very formidable appearance.

There are many evidences that may be derived from the study of the skulls of the wide variations in form and size which this remarkable genus attained. The median protuberances in the *L. Speirianum* skull figured measure about six inches from the tip to the inner side, and three and a half inches in the fore-and-aft diameter at their bases. Of the same shape is a corresponding protuberance which has been broken from the skull to which it belonged. It is only three and a half inches long, with a transverse diameter of two inches. Showing the enormous size which these animals sometimes attained, we have the forward portion of a skull bearing protuberances which measure nine inches from base to tip, found in the Loxolophodon beds. If these were in the same proportion as those borne upon *L. cornutus* or *L. Speirianum*, they would indicate a head over four feet long. From present data it is of course difficult to form any conjecture regarding the influences of age and sex upon the strange outlines of these skulls, and there is little doubt that purely sexual or immature characters have been employed in fixing species and perhaps genera. Evidence is, however, wanting that the sexes varied in their dentition, as no exceptions to the dental formula given above have, as far as is known, appeared.

General conclusions. In the upper Cretaceous or early Eocene, lived a group of animals which were the common ancestors of the Dinocerata and Pantodonta With the Dinocerata arose on a common branch the ancestors of the Proboscidia, the two groups remaining united for some time, and then separating. The Dinocerata branched off as an aberrant group, gradually losing the characters of the main stem, and, as far as we know, becoming extinct at the close of the Eocene. They are related to the Proboscidia in numerous points of structure which are detailed in the preceding pages. On the other hand, it follows from their common origin that the Dinocerata are related to the Perissodactyle Ungulates through *Coryphodon*, presenting several points of likeness with Rhinoceros. These resemblances are also pointed out in this memoir.

Stratigraphical Report

upon the

Bridger Beds in the Washakie Basin

WYOMING TERRITORY

ACCOMPANIED BY PROFILES OF THREE SECTIONS

BY

JOHN BACH McMASTER.

STRATIGRAPHICAL REPORT.

A QUARTER of a century ago, when the overland journey to California was made in the mail-coach, one of the many stopping-places in Wyoming Territory was a small station called Leclede. The completion of the Union Pacific Railroad ruined the business of the stage company; Leclede was abandoned, and nothing is now left to mark the spot where it stood but the roofless walls of the stables and tavern and the broken piers of an old bridge that spanned a stream hard by.

Almost due West, and not more than eighteen or twenty miles away, is Black Butte station, on the Union Pacific Railroad, and just back of it the high butte from which it takes its name. To the southwest is Pine Bluffs, a long mountain rising more than two thousand feet above the plain, and clearly visible from Leclede. Close about the station, which is still a camping-place for emigrants, are low hills, and winding between them is a narrow stream. The water is very strongly alkaline, and bordered at some places by steep and high banks, at others by meadows covered with coarse grass, and not seldom by alkali bogs. This creek flows southward from Leclede across a wide plain which stretches away to the South and Southeast for several miles and ends abruptly at the Bad Lands. The country from Leclede to the Bad Lands is not, strictly speaking, a plain, but a series of broad benches lying one over the other and sloping southward at an angle of about four degrees. This bench-formation is, indeed, the most peculiar geological feature of the region, and is best seen from the summit of Black Butte, or from the steep hills that border the railroad at Black Butte station. Standing at either of these places and looking off to the East and South, the variegated strata are visible for many hundred feet in thickness, and as they crop out, one under the other, suggest to the mind the idea of a pack of cards carelessly thrown upon a table.

The beds exposed at Black Butte station belong to the Lignitic coal-measures, and contain a seam of coal that has in times past been very extensively mined. Over these, some two miles to the eastward, is a bed of sandstone, at the foot of which were observed many slabs covered with deep ripple-marks and fragments of large palms. Still above this lies a thick, dark, lead-colored deposit of what was once fine mud, and full of remarkably well-preserved specimens of leaves and seeds. These beds are almost the highest point between Black Butte and Bitter Creek stations, and due East from the former; for at that place the railroad begins a great bend to the South, which again turns northward to Bitter Creek. For three or four miles the old overland stage-road runs parallel to the railroad from Black Butte, with the deep bed of Bitter Creek between them and high hills on either side. Then the road turns southeasterly, still following the creek, and begins a long series of ascents over bench after bench of sandstone and shale, till the plains at Leclede are reached. None of these outcrops were measured.

At Leclede the road bends, runs almost due East, and is skirted a mile to the South by a high and steep bench. Here the passage is made from the Cretaceous into some of the outlying Green River beds (Middle Eocene). The bench was carefully measured with a tape-line, and the character and thickness of the beds forming it, noted. Nine strata were distinctly visible. The thickness of the lowest was 27 feet; the color was brown; the structure shale-like, and the material apparently a fine mud. This was overlaid by 21.5 feet of true shale of many colors, some bands being light pink, some bluish-green, and some white. Then came 20 feet of white sandstone in which was a very considerable quantity of clay, forming with the sand a hard cement. The fourth stratum resembled the third in structure, but was of a rusty-iron color, and 17 feet thick. Capping this came a layer of white, fine-grained sandstone 18 inches in thickness. It was very hard, and, resisting the wearing power of rain and snow better than the beds of softer material that lay above and beneath it, stood out some feet from the face of the bench. Immediately over this ledge were 15 feet of white shale; then came a bed, 24 feet thick, of grayish, fine-grained sandstone full of great lumps of tough white clay; then 4 feet of sand and clay weathering into lumps, and finally 30 feet of clay very shale-like in appearance. This was the uppermost stratum of the bluff, which measured from top to bottom 161 feet. A careful search was made among the sand-heaps at its foot for fossils, and a few fragments of the carapace and plastron of a small turtle were found, but nothing more. None of the upper beds were examined; for the face of the bench was very steep, could indeed be climbed at but a few places, and at those with difficulty. When, however, the ascent was made, a plain, apparently as level as a floor, was reached which extended southward six or seven miles to the base of Haystack Mountain and the borders of the Bad Lands of Leclede. The beds last described were probably transition from the Green River to the Bridger group.

The aspect of the country at this place is most peculiar. The plains support a scanty growth of sage-brush and grease-wood, and are covered here and there with deposits of sand and gravel, mingled with quartz pebbles, bits of smooth sandstone, and water-rolled fragments of jasper and flint. The streams flow between steep banks. The low buttes that lie along the foot of the mountains are weathered into fantastic shapes, while the excavations, whose bottoms are many feet below the plains, wear the usual features of erosion: deep cañons, ravines, smoothed mounds, and tall columns of sandstone.

The description hereafter and the section which follows relate wholly to the Bridger beds as they are exposed in the Washakie basin. The position of this basin and the relation of these groups of rocks, the Vermillion Creek, the Green River, and the Bridger, can be clearly understood by referring to the sketch-map. At this point the Bridger beds form a central island surrounded by a ring of Green River beds, widest towards the South, and these beds are flanked by the Vermillion Creek (lower Eocene) beds. This map is from King's survey. All the stratigraphical sections and measurements of this report were the work of the Princeton party.

Standing on the plain at the edge of one of these excavations and looking down, the scene that presented itself cannot well be described. The eroded area was in three immense basins, each succeeding one smaller and lower than the other, so that, seen from a distance, the Bad Lands had much the appearance of a great amphitheatre. The bottom of the lowest basin, stretching away until it was lost to sight, was the arena. The two benches separating the three basins were the tiers of seats.

From the plain to the bed of the first basin the face of the rock was almost vertical, yet very irregular and broken. At places long thin masses jutted out. At others the wall was cut into deep recesses or broken through by narrow cañons that wound and twisted, crossed and recrossed, and finally ended in a well-shaped excavation. On the bottom of such wells was to be seen every form of erosion—pyramids, cones, mounds, and table-like platforms—while here and there stood up isolated, or in clusters of two or three, tall columns of sandstone, each capped by a slab of hard, coarse brown sandstone to whose protection it owed existence. Out from the walls stood small buttes; some had steep sides and broad flat tops, but most of them were broad at the base and ended, a hundred or more feet above, in a sharp edge not two feet wide.

While searching in the Leclede Bad Lands for fossils a careful examination of the beds was made and two geological sections taken. The profiles of these, drawn to a scale of three feet horizontally to one foot vertically, are shown in the accompanying plate. That marked No. 3 was run by prismatic compass due East across the Bad Lands from a point some five miles to the South of Haystack Mountain. The eastern direction was chosen because, in general, the cañons, and therefore the ridges of rock between them, ran North and South.

At the particular place where the section was begun the surface of the plain was 36 feet above the bed of the first cañon. Almost everywhere else the descent was too precipitous to admit of climbing down, but at that point a bank of débris joined the edge of the plain with the bed of the cañon. Two hundred and fifty feet from the foot of this rose the first ridge. It was 40 feet thick at the base, 19 feet on the west side and 24 on the east, and made up of two strata of sandstone. The lower was of very hard, coarse brown sandstone, a foot thick. The upper was of fine grayish sandstone easily cut and scratched with a knife. The brown stratum was one of the most marked and peculiar of the beds, and wherever it was found its presence has been indicated on the profiles by cross-lining. The color was not superficial and therefore not due to exposure, but was the same throughout. Its hardness was very great, and where at all affected by the weather, split up into large slabs and flakes. The gray strata were composed of a mixture of feldspar, clay, and coarse or fine quartz sand. The relative proportion of these ingredients was not the same in all the beds. In some the feldspar was wanting and the clay much more abundant than the sand. In others the quartz sand was of a very decided green color, which made all such strata very marked. It happened almost invariably that the green beds immediately underlay the brown, and were, so far as known, the only fossiliferous ones. Yet even these yielded little that was of enough value to bring away. Often in clambering over the boulders and sandstone slabs that covered the bottoms of the cañons, bits of bones, easily recognized by their pink tint, were observed, and beyond them other and still other fragments forming a long line of bone chips leading to some elevated spot on a bank where was the carapace or plastron of a turtle completely weathered to pieces, or the broken remains of a crocodile jaw. Some parts of femurs and ribs, odd foot-bones, and a few teeth were, indeed, picked up. But it was not till the Bad Lands close to the foot of Haystack Mountain were searched that fossils of any value were obtained.

The position of the mountain is shown on the geological map of southern Wyoming which accompanies the report of Mr. Clarence King. Yet it was thought advisable to determine as carefully as possible the precise location of that portion of Haystack where the best "finds" were made. For this purpose compass-bearings[1] and sextant angles were taken both to and from Black Buttes, Pine Bluffs, and such other prominent points as the country afforded, and from the data so collected the spot has been marked by a cross, as accurately as the scale will permit, on the sketch-map already referred to. As there indicated the beds are believed to be on the northern edge of an exposure of

[1] The compass-bearing of the summit was N. 38° E. from Pine Bluffs, and S. 83° E. from Black Buttes.

the Green River group. The deposits are very different in character from those further to the north. As stated, the beds along the Union Pacific Railroad are shaly, contain many seams of coal and rich beds of fish, leaves, and palms. Passing south the coal-measures disappear, the shale becomes less marked and sandstone more abundant, until, as at Haystack, not a particle of shale is to be seen. In this connection two facts are worthy of notice. Close to the road leading from Leclede to Black Buttes Station, and scarce three miles from the former, is a most remarkable butte of Green River rocks. Its measured height is 338 feet; its sides are entirely without any kind of vegetation and marked with 48 bands of brilliantly colored shale. Beginning at bottom the order of the beds and colors is dark Indian-red shale, blue slate-color, Indian red, neutral tint, Indian red, purple, and brown shale containing seams of selenite, soft brown sandstone; then purple, yellow, gray, Indian-red shale, and so on to the top. The blue slate-color, neutral tint, and purple proved on examination to be differences produced by weathering. The beds of shale were clearly alike in material, and diminished in thickness as the summit was approached. Thus the lowest of the purple bands measured 18 feet; the next of the same color, 14 feet; the next, 10 feet; the next, 12 feet; the next, 9; while the topmost one was but 2 feet thick. Nothing like this was seen until the members of the party reached Twin Buttes. At this place, thirty miles south of Bryan Station on the Union Pacific Railroad, and fully eighty miles southwest of Leclede, a series of shale-beds, precisely similar in color and order of the colors, was seen. They were in the Bad Lands at the north end of the butte.[1]

Section number 2 was taken five miles north of number 3, at a place singularly rich in fossil remains. All the strata shown in the profile lay beneath the surrounding plain, and therefore under the beds of Haystack Mountain, which was not more than a mile distant. They have accordingly been numbered on the drawing from the bottom to the top of the profile. Those of number 1, which is a section through the plain and the mountain, have been numbered in like manner. So that where the two are joined, a continuous section is afforded from the highest point on Haystack to the lowest exposure in the Bad Lands at its foot, a vertical distance of 700 feet.

I. A bed of hard, fine-grained, light green sandstone weathering to a pale pink. The thickness was 27 feet.

II. Over this was 24.5 feet of very soft sandstone containing a great deal of fine clay. The color was a pale green, and at distances of from five to seven

[1] This butte on Major Powell's map of "Green River," is called Cameo Mountain. On Mr. King's map it is put down as Twin Buttes.

feet were six-inch layers of very hard sandstone. The character of these two strata and the manner of weathering is rudely shown in the sketch in the upper left-hand corner of the plate. It is designed to represent one of a cluster of tall columns that stood out a hundred feet or more from the wall of the cañon. The lower half was made up of the rock of stratum I. The upper half of that of stratum II. Capping it was a huge block of very coarse brown sandstone, which clearly belonged to III.

III. This was in three layers. The lower six feet was fine green sandstone, streaked with bands of darker green, but weathering brown. Over this was a layer one foot thick of very hard dark green clay, and over this in turn 17 feet of coarse green sandstone that weathered brown. The grains of quartz composing it were at least an eighth of an inch in diameter. The whole stratum was full of fossils; but the richest part was the band of green clay. Scattered through this in every direction were leaves, reeds, water-grasses, and the skulls of some carnivorous animals. No less than six heads or jaws were at one spot in plain sight. But the clay matrix was exceedingly hard, the bones tender, and the difficulty of getting them from the rock so great that, after repeated trials, the attempt was given up. A number were, however, cut from the brown layer and have since, by the skill of Franklin C. Hill, Curator of the Museum been entirely removed from the stone. This stratum formed the top of a bench as shown on the profile.

IV. Nineteen feet of soft sandstone weathering pink.

V. Two and a half feet of fine light green sandstone weathering brown and full of concretions. Over this lay a bed 11.5 feet thick of green sandstone like I. and weathering pink.

VI. Six inches of bright green sandstone very coarse in grain. Four feet of moderately coarse brown sandstone which broke up, under the influence of the weather, into slabs. The brown color was not confined to the surface, but extended through the rock.

VII. On top of this was 8½ feet of sandstone similar to that of stratum I., but coarser. The surface color was light pink. Two feet of dark green sandstone, coarse in grain, streaked with bands of darker green clay and weathering brown, completed the second bench.

VIII. Seven feet of sandstone like that of II.

IX. Twenty-two feet of soft sandstone like I.

X. Two feet of coarse green sandstone similar to that of stratum VI., but turning brown where exposed to the weather. Nine feet of soft clayey sandstone like II.

XI. One foot of fine soft sandstone. On the surface the color was almost white. But when wet, it turned green. Seven feet of sandstone like the lower bed of X.

XII. Twenty-one feet of exceedingly coarse green sandstone weathering into brown slabs.

XIII. Twelve feet of clayey sandstone.

XIV. Forty-eight feet of sandstone, fine, hard, and green. Of all the strata examined this was the most remarkable for the quantity, variety, and excellent state of preservation of the fossils it contained. From it were taken several fine heads and almost an entire skeleton of Loxolophodon, a great number of leg and foot bones, jaws, teeth, and vertebræ. Just at the place where the section was made the face of the bed was very steep, and from it, twenty feet above the plain, projected the distal end of a femur. The bone measured some thirteen inches across the exposed end, and, when cut out of the rock, was found to be four feet in length. A little further to the east in the same stratum lay a thick bed of Unios, while turtles, pieces of crocodile jaws, and bits of silicified wood were scattered in every direction along the whole face of the outcrop.

XV. Eighteen feet of sandstone full of iron-stained concretions of peculiar form.

XVI. Twelve feet of gray sandstone. Over this was a bed of gravel and sand, 7 feet in thickness, which sloped gently down to the base of Haystack Mountain.

XVII. Sixteen feet of argillaceous sandstone.

XVIII. Sixteen feet of fine green sandstone. Two feet of very bright green sandstone.

XIX. Thirty-four feet of clayey sandstone, green within, but pink on the surface.

XX. Thirty-two feet of sandstone similar to XIX., but coarser.

XXI. This was in three layers. First came 2 feet of green clayey sandstone; then 16 feet of a like material weathering pink; and finally 6 feet of very coarse sandstone bright green in color.

XXII. Similar to XIX. Eight feet thick.

XXIII. Like the lowest layer of XXI. Forty-seven feet thick.

XXIV. A bed of argillaceous sandstone thirty-five feet thick, and weathering pink, purple, and brown.

XXV. Six feet of coarse green sandstone like the top layer of XXI. On this was a stratum 17 feet thick and similar to XIX.

XXVI. Another bed, 6 feet thick, of coarse green sandstone like the lower one of XXV.; 4 feet of clayey sandstone like XIX.; and 2 feet of fine sandstone, white when dry, but green when wet.

XXVII. Forty-one feet of clayey sandstone weathering to a rusty brown color.

XXVIII. Very coarse sandstone, green in color, but turning pink on exposure,

XXIX. A bed like XIX. Thirty-three feet thick. This was capped by a stratum, 6 feet thick, of very coarse sandstone, composed of green quartz sand that turned brown under the influence of the weather. The summit of the mountain, and indeed the side for a hundred feet or more, was strewn with large boulders of the same green sandstone.

Search was made up and down Haystack at several places for fossils, with ill success. Nothing but the remains of two varieties of turtles were seen. These, however, were abundant: plastrons projected from every stratum; leg-bones covered every bench.

Profiles

THREE SE

THROUGH

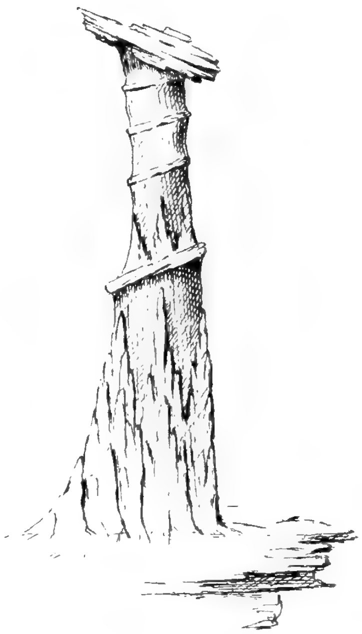
LECLEDE B

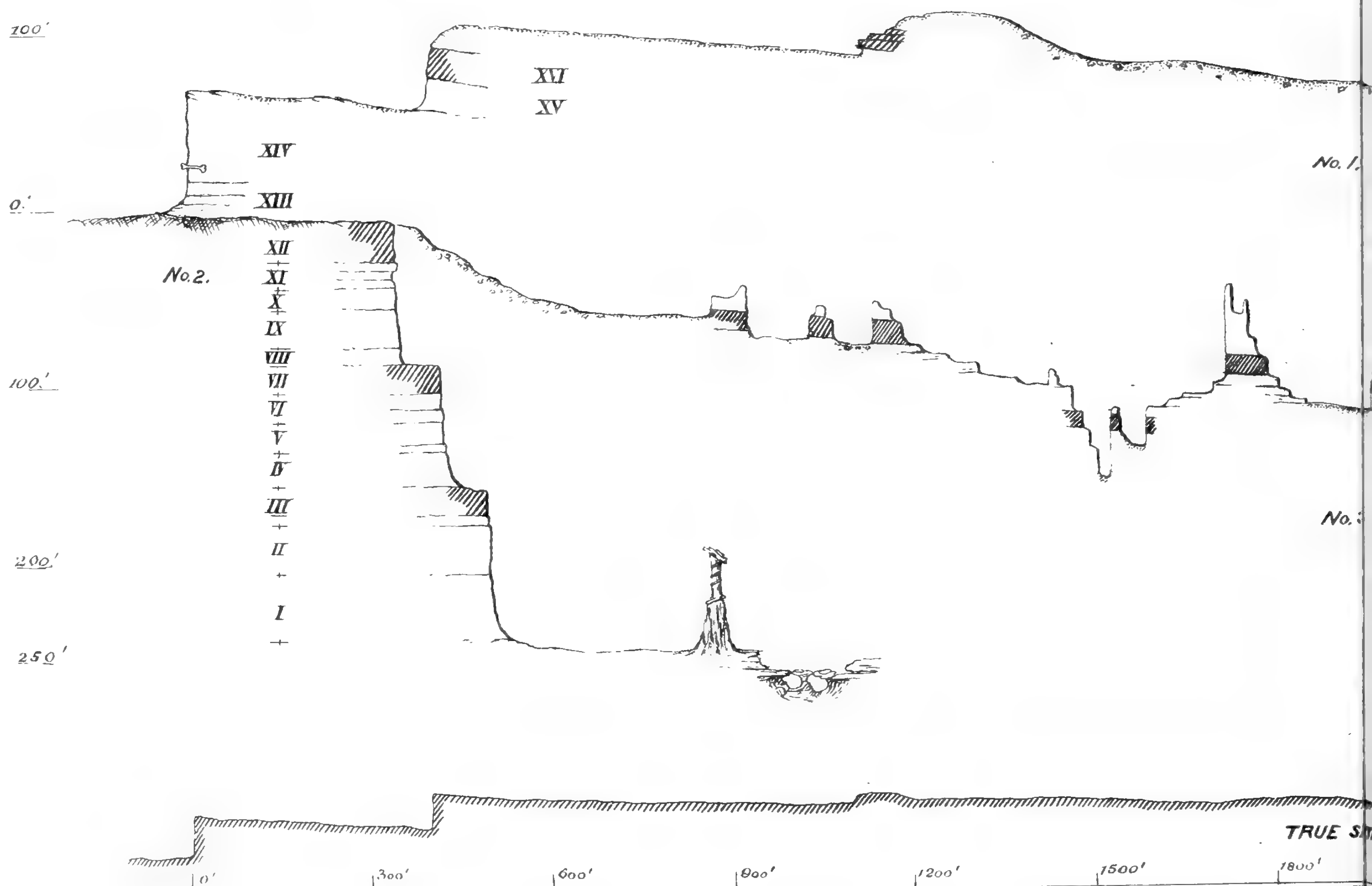
IN

WYOMING TE

187

Scale,





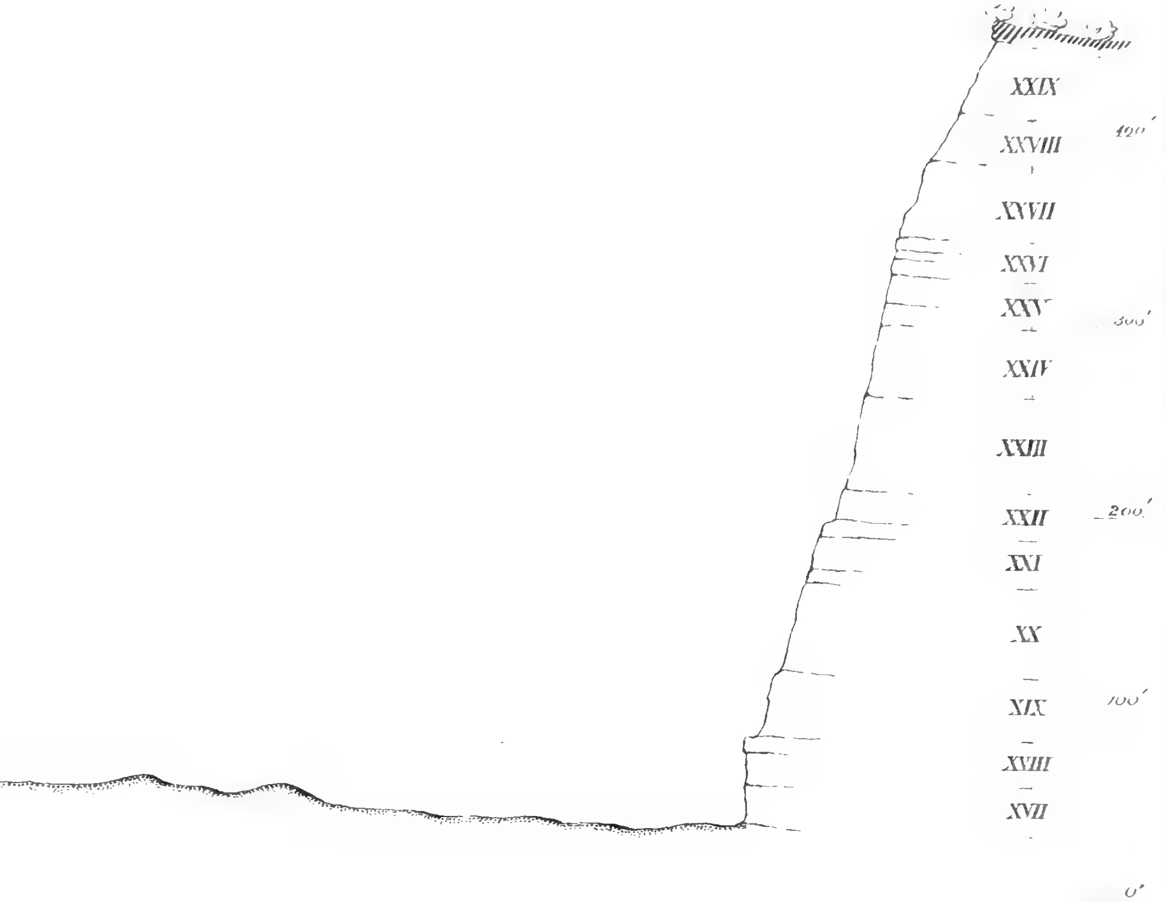
TIONS

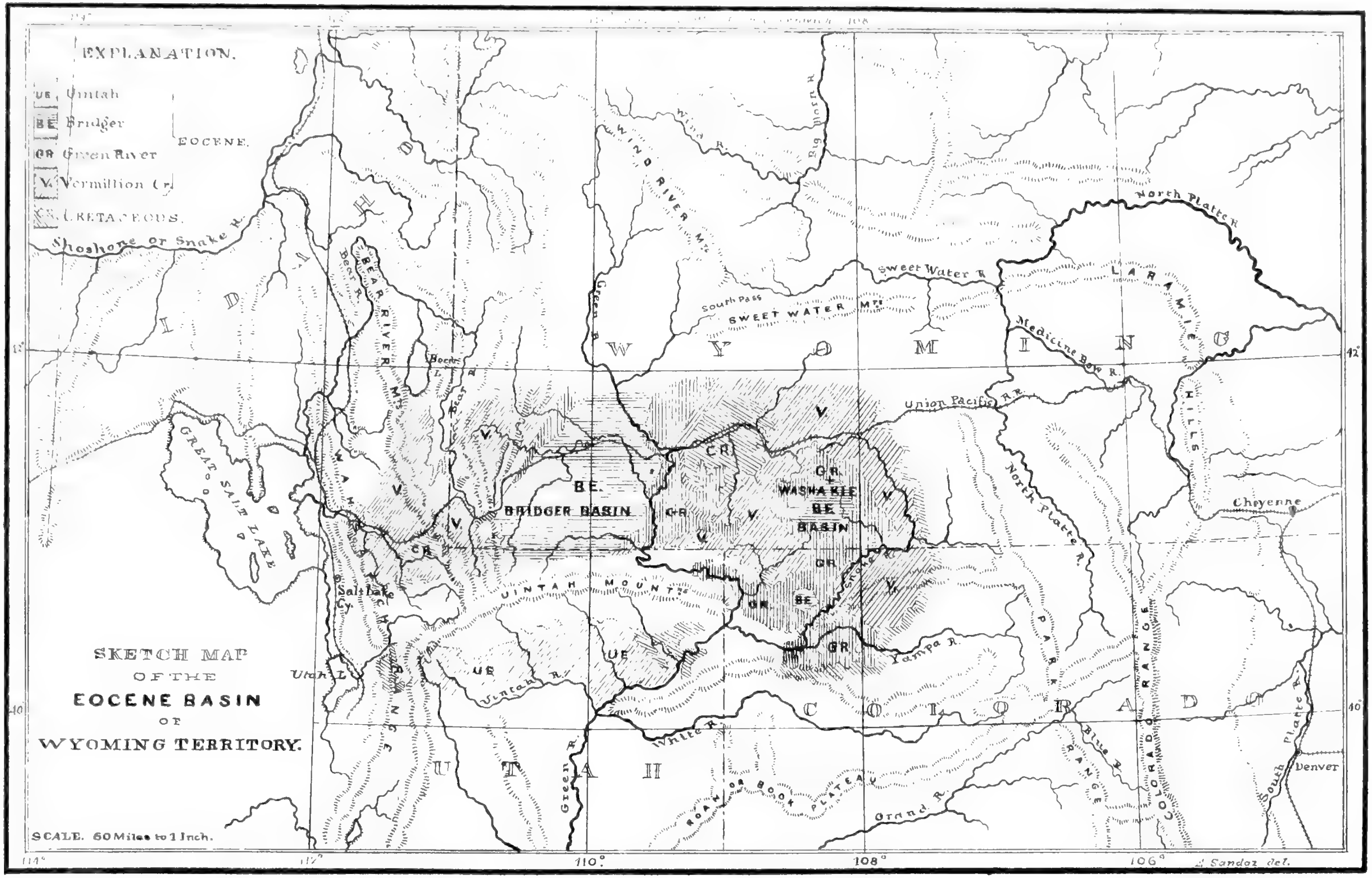
HE

AD LANDS

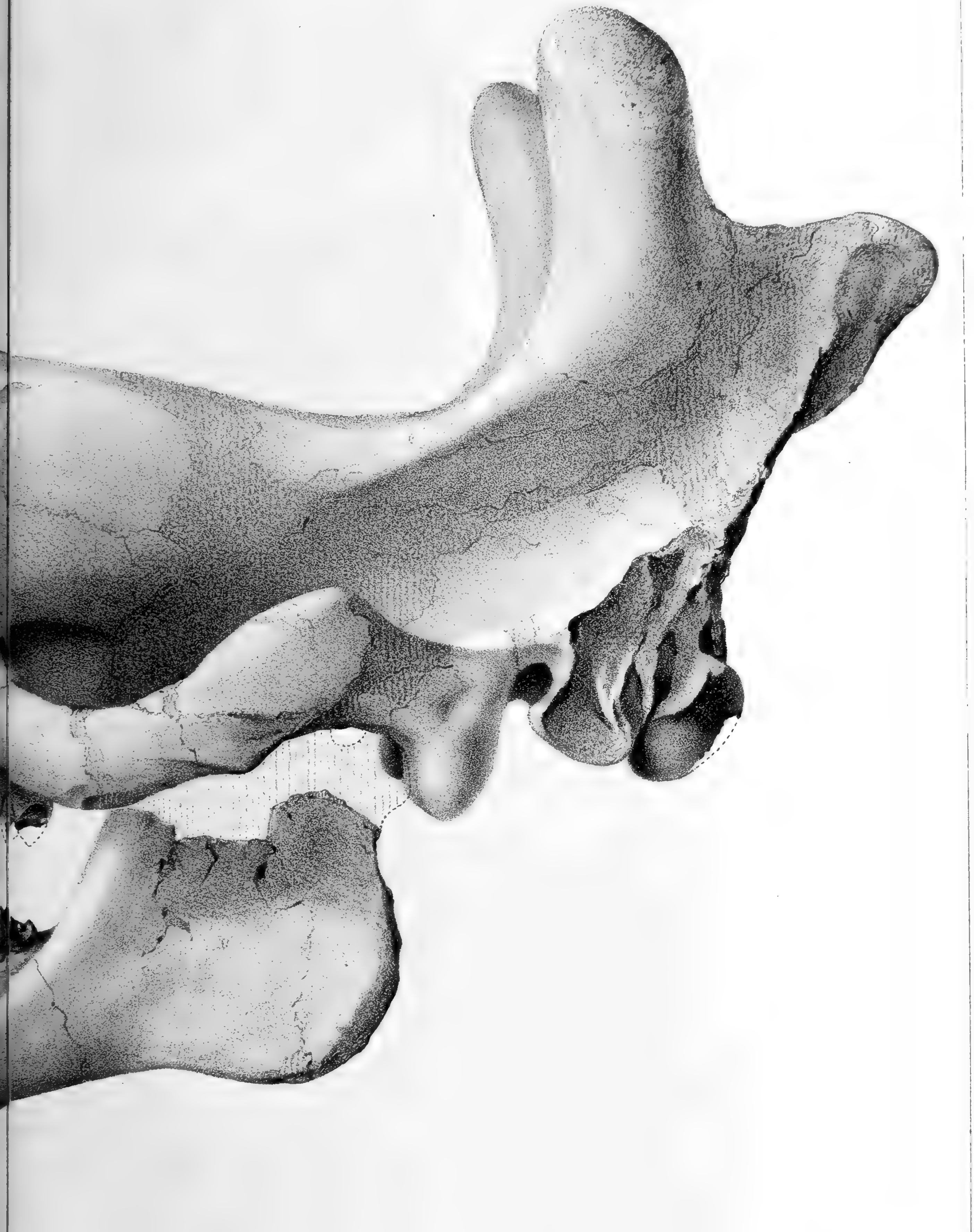
RITORY.

3. to 1.





EXPLANATION.
UE Uintah
BE Bridger
GR Green River
V Vermillion Cr.
EOCENE.
CR CRETACEOUS.
SKETCH MAP
OF THE
EOCENE BASIN
OF
WYOMING TERRITORY.
SCALE. 60 Miles to 1 Inch.
Sandoz del.
BRIDGER BASIN
WASHAKIE BASIN
UINTAH MOUNTS.
WIND RIVER MTS.
SWEET WATER MTS.
BEAR RIVER MTS.
LARAMIE HILLS
PARK RANGE
COLORADO RANGE
ROAN OR BOOK PLATEAU
GREAT SALT LAKE
Salt Lake Cy.
Utah L.
Cheyenne
Denver
South Pass
Union Pacific R.R.
Shoshone or Snake R.
Green R.
North Platte R.
South Platte R.
Sweet Water R.
Medicine Bow R.
White R.
Yampa R.
Grand R.
Blue R.
Uintah R.
Bear R.
Wind R.
Big Horn R.
IDAHO
WYOMING
UTAH
COLORADO
110°
108°
106°
112°
114°
42°
40°



…IPHANUM,

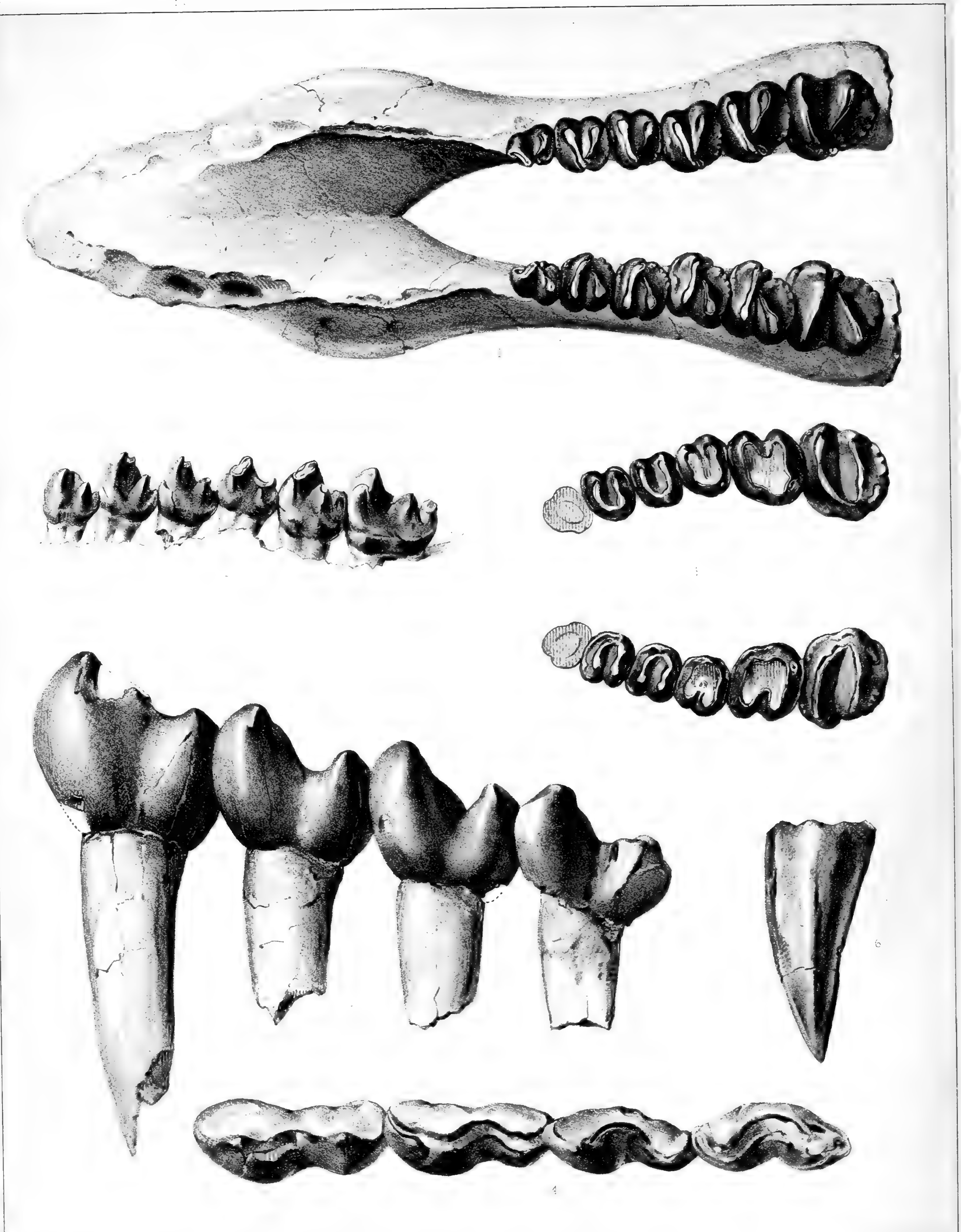
EXPLANATION OF PLATE I.

SKULL OF LOXOLOPHODON SPEIRIANUM (one-third natural size), with lower jaw belonging to another individual placed beneath.

EXPLANATION OF PLATE II.

Skull of Uintatherium Leidianum (one-third natural size).

UINTATHERIUM LEIDIANUM, ⅓



EXPLANATION OF PLATE III.

TEETH OF LOXOLOPHODON AND UINTATHERIUM.

Fig. 1. Forward portion of lower jaw of *Loxolophodon*, viewed from above, (one-half natural size).

Fig. 2. Lower premolar-molar series of *Loxolophodon*, (one-half natural size).

Fig. 3. Side view of canine-incisor series of lower jaw of *Loxolophodon* of left side, (natural size).

Fig. 4. Upper view of same.

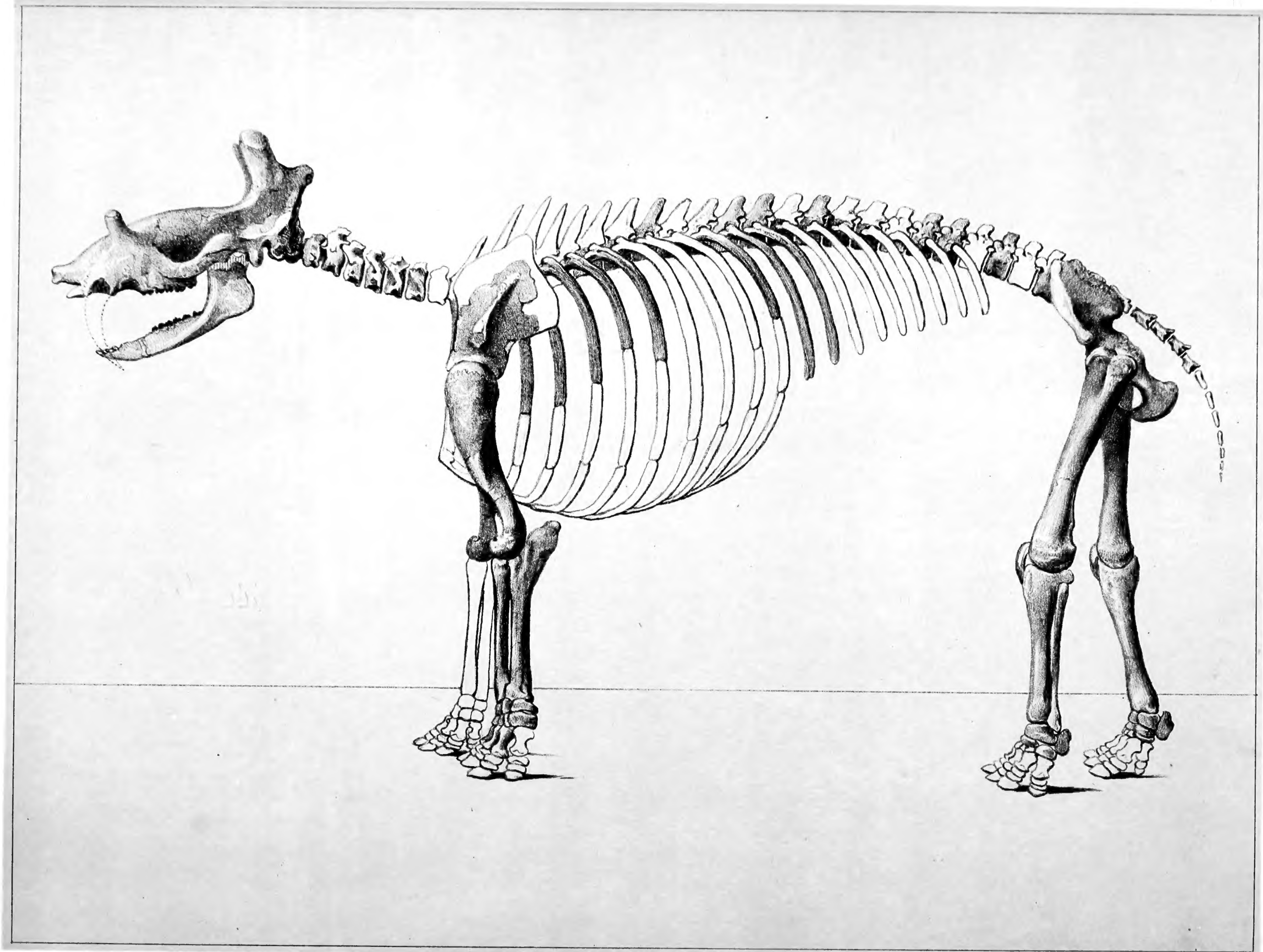
Fig. 5. Upper premolar-molar series of *Uintatherium Leidianum*, (one-half natural size).

Fig. 6. Tip of right canine of *Loxolophodon*, internal face, (natural size).

EXPLANATION OF PLATE IV.

RESTORATION OF LOXOLOPHODON (one-fifteenth natural size).

The shaded portions are drawn from specimens in the Princeton Museum. The parts restored in outline are partly from conjecture, partly from the drawings of Cope and Marsh. The skull is the same as that figured in Plate I.



RESTORATION OF LOXOLOPHODON 1/15