

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

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MEMOIR

ON THE

EXTINCT SPECIES OF AMERICAN OX.

BY

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COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

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## INTRODUCTION.

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Fossil remains of the ox tribe have been frequently discovered in the United States, of which descriptions, scattered through various works, have been given; but no approach to a correct view has been obtained of the number and character of the extinct species. The author, having the best opportunity of inspecting most of the specimens which have been described, has availed himself of it to give in this Memoir as clear a history of the animals as the remains would justify. In this endeavor, he has been very much assisted by the examination of additional specimens, in the cabinets of the American Philosophical Society and Academy of Natural Sciences of Philadelphia; and others, loaned with the utmost liberality by the Boston Natural History Society; Prof. Samuel St. John, of Hudson, Ohio; Mr. J. W. Foster, and Mr. Thomas Kite, of Cincinnati; to all of whom he now expresses his sincere thanks.

The ox tribe is surpassed by no other in economical importance to man, and it is also one of peculiar interest to the naturalist and geologist. The existing species are numerous, and are indigenous to all the continents excepting South America and Australia.

America, at the period of its discovery by Europeans, possessed no indigenous species of horse; although the New World presented such favorable conditions to the existence of this animal, that, a few years after its introduction, it formed large herds, now found in a wild state. This is a remarkable fact, especially as recent researches have proved the former existence of at least two species in North and South America.

The non-existence of any species of ox indigenous to the latter continent is, however, still more remarkable; for, not only are the conditions so favorable to its development at the present time, that the Domestic Ox introduced by Europeans exists in immense herds upon the extensive pampas in a wild state, but there are also found two species indigenous to North America. Nor have any remains of extinct species of ox been found in South America, while such have been discovered in North America, indicating the former existence of three and probably four

species; and it really appears as if circumstances had always been absent upon the former continent, which have been at least coincident with the primitive origin of the ox tribe in other countries.

Of Australia, we know too little to say positively no species of the ox tribe has ever existed there *ab origine*; and it would probably even be unsafe to infer from a view of its recent fauna that there did not.

The two recent species of ox of North America are the *Bison Americanus*, Gray, and the *Ovibos moschatus*, Blainville.

When North America was first colonized by Europeans, the *Bison Americanus*, or Buffalo, ranged over nearly the whole continent; but it has gradually retired westward in advance of the migrating column of the white race of man, until it has entirely disappeared west of the Mississippi. To find it now, in large numbers, it is necessary to travel far west of the latter, even to the foot of the Rocky Mountains; and the day is not far distant when it will become quite extinct, unless protected by a munificent republic, as has been done by the Emperor of Russia in the case of the Aurochs, or European Bison, now kept in great herds in certain forests of Lithuania.

The *Ovibos moschatus*, or Musk Ox, is rarely seen by travellers and naturalists, being confined to that part of America west of Hudson's Bay, and north of 65° of latitude, to which climate it is peculiarly adapted by its thick long fleece.

A fine specimen of this animal, preserved in the British Museum, we are informed is the only one contained in any collection of Europe or this country.

## CHAPTER I.

### GENERAL REMARKS.

#### § 1. FOSSIL REMAINS OF THE AMERICAN BUFFALO, BISON AMERICANUS.

REMAINS of the American Buffalo are frequently discovered within the circuit of its former habitation east of the Mississippi, more especially at that remarkable cemetery of mammalia, Big-bone Lick, Kentucky. Mr. Lyell, in the description of a recent visit to this locality,<sup>1</sup> remarks that, within the memory of persons now living, the Buffaloes crowded to the springs of Big-bone Lick; but they have retreated for many years, and are now as little known to the inhabitants as the Mastodon itself. In reference to the same place, he observes he saw remains of the Buffalo in great number in a superficial stratum cut open in the bank of the river.<sup>2</sup>

In the Museum of the Academy of Natural Sciences there is a collection of bones from Big-bone Lick, which I do not hesitate to attribute to the Buffalo; although, from no recent skeleton, excepting crania, of this animal being accessible for comparison, I cannot positively ascertain their identity.

The specimens are as follow:—

1. Fragment of the left side of the lower jaw, containing the last molar tooth.
2. Fragment of the left side of the lower jaw containing four teeth, from an old individual.
3. The occipito-parietal and temporal bones of a young individual.

These three specimens were presented to the Academy by Dr. Richard Harlan.

4. Two superior molar teeth; presented by Thomas Fisher, Esq.

Besides the foregoing, there are numerous bones from Big-bone Lick, presented by Thomas Jefferson to the American Philosophical Society, and now on deposit in the museum of the Academy. The specimens are dark-brown or black in color, with a lustrous surface, and are dense and unaltered in their texture. The interior of the long bones is filled with a hard, dry, pulverulent, chalk-like adipocire. (= native paraffin)

They are as follow:—

1. A dorsal and a lumbar vertebra, and a sacrum of five pieces belonging to an individual not quite adult. They are about the size of those of the Domestic Ox. The epiphyses are separated from the bodies of the two vertebræ and lost. The pieces of the sacrum are firmly anchylosed together, but the first piece has lost its anterior epiphysis.

<sup>1</sup> Travels in North America (1845), vol. ii. p. 55.

<sup>2</sup> Ibid. p. 56.

= Hatchett's.

## 2. A radius about as large as in the common ox.

Length internally . . . . .	11½ inches.
Breadth of proximal articulation . . . . .	3½ "
"    distal    "    . . . . .	3¼ "
Circumference at middle . . . . .	4½ "

## 3. Two metacarpals of the right and left foot of two different individuals, about as long as, but broader than in the common ox.

Length . . . . .	8 inches and 8 inches 3 lines.
Breadth of proximal articulation . . . . .	2 " 11 lines and 3 inches 1 line.
"    distal    "    . . . . .	3 " and 3 inches 3 lines.
Circumference at middle . . . . .	5 " 2 lines and 5 inches 7 lines.

## 4. Three metatarsals about as long as in the common ox, but narrower.

Length . . . . .	9 inches 3 lines.
Breadth of proximal articulation . . . . .	1 inch 10" "
"    distal    "    . . . . .	2 inches 3 " "
Circumference at middle . . . . .	3 " 11 " "

## 5. Six first phalanges about 2½ inches long.

## 6. Five second phalanges measuring from 1¼ to 1½ inches in length.

✓ § 2. GENERAL HISTORY OF THE REMAINS OF EXTINCT SPECIES OF AMERICAN OX, WHICH  
HAVE BEEN PREVIOUSLY DESCRIBED.

Remains of extinct species of ox are also quite abundant in the post pliocene deposits of North America.

The first distinct species of extinct American ox was announced to the world by Mr. Rembrandt Peale.<sup>1</sup> It was established upon a fragment of a cranium with a portion of one horn-core attached, which was discovered in the bed of a creek falling into the Ohio River, twelve or fourteen miles north of Big-bone Lick, and was presented to the American Philosophical Society by Dr. Samuel Brown, of Kentucky, and is now deposited in the museum of the Academy of Natural Sciences.

Notwithstanding the greater size of the specimen as compared with the corresponding part of the skull of the Aurochs, Cuvier, who subsequently described a cast of it sent to the museum at Paris by Mr. Peale, considered it as having belonged to the same species,<sup>2</sup> and in this view he has been generally supported by succeeding writers on the subject. It is, however, exceedingly doubtful, abstractly, whether the same species of Aurochs was ever common to the eastern and western world; and in the absence of any correct evidence to favor such a view, Dr. Harlan

<sup>1</sup> Account of some Remains of a Species of gigantic Oxen found in America and other parts of the World, by Mr. Rembrandt Peale. Philosophical Magazine (1803), vol. xv. p. 325, pl. vi. The latter is a good representation of a posterior view of the specimen, *but reversed*

<sup>2</sup> Ossem. Foss. ed. 4, t. vi. p. 287.

was quite justifiable in proposing for the animal to which the fragment under consideration belonged, the name of *Bos latifrons*.<sup>1</sup>

In the *American Journal of Science* for 1846,<sup>2</sup> Dr. W. M. Carpenter described a portion of a fossil ox skull, and a molar tooth of an old individual, found on the banks of the Brasos River, near San Felipe, Texas, which appear to belong to the same species as that just indicated.

A second species of extinct ox was established, by Dr. Wistar, in the year 1814, upon part of a skull with both horn-cores nearly entire, found at Big-bone Lick.<sup>3</sup> This specimen, and many other remains of mammalia, were obtained through the exertions of Thomas Jefferson, in his zeal for the advancement of science, and presented by him to the American Philosophical Society, which subsequently deposited them in the museum of the Academy of Natural Sciences, that they might be accessible to the inspection of all persons visiting Philadelphia.

To the species indicated by Wistar, Dr. Harlan afterwards gave the name of *Bos bombifrons*.<sup>4</sup>

Mr. William Cooper, in a communication entitled "Notices of Big-bone Lick,"<sup>5</sup> observes, that he found a second head of this species among a collection of bones discovered by Mr. Finnell at Big-bone Lick, much in the same state as that figured by Dr. Wistar.

A third extinct species of ox found in North America was first indicated by Dr. De Kay, from a fragment of a skull with portions of both horn-cores attached, which was ejected by the shock of an earthquake in 1812, at New Madrid, on the banks of the Mississippi, and was presented to the Lyceum of Natural History of New York by Dr. S. L. Mitchell.<sup>6</sup>

Under the impression that the specimen belonged to the same species of ox as two crania described by Pallas,<sup>7</sup> and a third by Ozeretskovsky,<sup>8</sup> for which no name had been proposed, Dr. De Kay designated this as the *Bos Pallasii*, and provisionally referred his specimen to the same species;<sup>9</sup> which is, however, without doubt, incorrect, as will be seen hereafter.

Mr. Cooper states that, during his stay at Big-bone Lick in 1828, a mutilated skull of this species was found at that place and brought to him, and is now deposited in the collection of the Lyceum of Natural History. He also adds he saw another specimen of the same species from Ohio.<sup>10</sup>

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<sup>1</sup> Fauna Americana, p. 273.

<sup>2</sup> Trans. Amer. Philos. Soc. n. s. vol. i. p. 381.

<sup>3</sup> Am. Month. Journ. of Geol. vol. i. p. 173.

<sup>4</sup> Nov. Comment. Petrop. vol. xvii. p. 606.

<sup>5</sup> An. Lyc. Nat. Hist. vol. ii. p. 291.

<sup>6</sup> N. S. vol. i. p. 245.

<sup>7</sup> Fauna Americana, p. 271.

<sup>8</sup> An. Lyc. Nat. Hist. vol. ii. p. 280.

<sup>9</sup> Mém. Acad. de St. Petersb. vol. iii. p. 215.

<sup>10</sup> Am. Month. Journ. of Geol. vol. i. pp. 173, 174.

## CHAPTER II.

## ✓ DESCRIPTIONS OF EXTINCT SPECIES OF AMERICAN OXEN.

**BISON**, HAM. SMITH.

IN the skeleton of the genus *Bison*, the skull presents the most important characters, by which it may be distinguished from *Bos* and extinct species may be recognized. As in *Bos*, the horn-cores are on a level with the orbits behind, but they come off an inch or more in advance of the inion. In *Bison*, the forehead is broad, quadrate, and slightly convex. It has no trace of lachrymal fossæ.

## BISON LATIFRONS, LEIDY.

- Great Indian Buffalo*, PEALE: Philos. Mag. Vol. XV. p. 325, Pl. VI.; Hist. Disq. on the Mammoth, p. 84.  
 ———, FAUJAS-SAINT-FOND: Essai de Geol. I. 347; An. du Mus. II. p. 192.  
*Aurochs*, CUVIER: An. du Mus. Vol. XII. p. 382, Pl. 34, Fig. 2; Ossem. Fos. IV. p. 50, Pl. III. Fig. 2;  
 Ed. 4, t. 6, p. 287, Pl. CLXXIII. Fig. 2.  
*Bos latifrons*, HARLAN: Fauna Americana, p. 273; Med. and Phys. Researches, p. 276; Edinb. New  
 Philos. Journ. XVII. 359; COOPER: Amer. Month. Journ. of Geol. Vol. I. p. 174; DE KAY: An. Lyc.  
 Nat. Hist. of New York, Vol. II. p. 286; New York Fauna, Zool. Pt. 1, p. 110.  
*Urus priscus*, BOJANUS: Nov. Act. Acad. Nat. Cur. XIII. 427.  
*Great fossil ox*, GODMAN: Amer. Nat. Hist. Vol. III. p. 243, Pl.  
*Bos priscus*, H. v. MEYER: Nov. Act. Acad. Nat. Cur. XVII. p. 141; GIEBEL: Fauna d. Vorwelt, I. p. 153.  
 — *Fossil ox*, CARPENTER: Am. Journ. of Science, n. s. Vol. I. p. 245.  
*Bison latifrons*, LEIDY: Proc. Acad. Nat. Sci. Vol. VI. p. 117.

The *Bison latifrons* is established upon the fragment of cranium before referred to, presented by Dr. Samuel Brown to the American Philosophical Society.

The specimen consists of the hinder portion of the cranium with a fragment fourteen inches in length of the left horn-core (Plate I.), and indicates a species as large as the existing Arnee, or Buffalo (*Bubalus buffelus*, GRAY), of India and Java.

The sutures of the remaining bones of the specimen are anchylosed; but the positions of the frontal and fronto-parietal sutures are yet distinguishable as slightly elevated zigzag lines (Fig. 1).

The form of the cranial fragment with its attached portion of horn-core is almost a repetition of the corresponding part of the skull of the Buffalo.

The base of the horn-core is situated five inches in a curved line outwards and forwards, or two inches and a half in a straight line, in advance of the position of the occipito-parietal crest.

The forehead is slightly more flat antero-posteriorly than in the Buffalo, arising from the occipito-parietal crest, being a little less below its level.

The lateral margins of the inion are broken away in the specimen; but the



remaining portion exhibits the same appearances in detail as in the Buffalo, though in an exaggerated degree corresponding to its much greater size (Fig. 2).

The base of the specimen is very much broken, but that which is preserved indicates the form to have been the same as in the last-mentioned animal.

The occipital condyles are alike in both, and, at their anterior part, advance in a concave manner to the posterior muscular protuberances of the basilar process. Between the condyles and paramastoid, a large deep fossa exists, having at its inner side the foramen condyloideum.

The foramen magnum occipitis is slightly wider than high, being two inches one line by one inch eleven lines.

The basilar process in the fossil, at its posterior muscular protuberances, is four inches wide and two inches and a quarter at those joining the body of the sphenoid.

The os tympanica has been large and inflated, as in the Buffalo, and a portion of one glenoid articulation remaining in the specimen presents the same form as in the latter.

#### *Admeasurements.*

Breadth of forehead between the bases of the horn-cores	. 15 inches.
Height of theinion from the upper edge of the occipital foramen	. 5½ “
Circumference of the horn-core at its base	. 20½ “
Circumference of the horn-core ten inches from its base	. 17½ “

As before observed, the fragment of a fossil ox head and molar tooth, described by Dr. W. M. Carpenter, also belong to the *Bison latifrons*. —

The cranial specimen, Dr. Carpenter states, consists of the frontal bone with portions of the horn-cores. From one broken extremity of the latter to the other, the measurement is fifty-six inches; the right portion being two feet, the left eighteen inches in length. The base of the horn-cores is seventeen inches in circumference, and at the distance of eighteen inches from the head fourteen and a half inches. The frontal bone is nearly plane, and between the horn-cores, which arise laterally from the same level, is fourteen inches in breadth. The horn-cores are nearly cylindrical; and from the wood-cut representing the specimen, are directed outwards, a little backwards, and slightly upwards.<sup>1</sup>

The tooth found with the above specimen, Dr. Carpenter observes, is a second true molar of the upper jaw of the left side. The crown is worn down nearly to the fangs, and the characteristic ruminant triturating surface is nearly obliterated. The antero-posterior diameter of the crown is a little over an inch and a half, and the transverse diameter is an inch and a sixth.

In the cabinet of the Academy of Natural Sciences there are preserved five molar teeth, about one-third larger than those of the Buffalo, which I am disposed to consider as having belonged to the *Bison latifrons* (Plate II., Figs. 2—7).

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<sup>1</sup> Dr. Carpenter says “forwards,” but, from the cut, he evidently means upwards.—*Am. Journ. of Sci.* vol. i. 1846, p. 245.

All the specimens are from the vicinity of Natchez, Mississippi. Two of them were found by Dr. M. W. Dickeson in association with remains of *Mastodon*, *Equus*, *Ursus*, *Cervus*, *Megalonyx*, and *Mylodon*; the others belong to the American Philosophical Society, to which they were presented by W. H. Huntington, Esq., who discovered them in association with remains of *Mastodon*, *Equus Americanus*, and the jaw of *Felis atrox*, described by me in the Transactions of the latter Society.

Three of the teeth are superior molars; one, the last of the series (Plate II., Fig. 4), is unworn, the others are moderately so. The inferior molars are both the last of the series; and one is unworn, while the other is worn down within half an inch of the fangs, which are elongated, as is ordinarily the case in the teeth of old ruminating animals.

In the upper molars the external side exhibits six folds relatively not more prominent than in the common ox. Internally between the principal lobes, the accessory column is very well developed and robust (Figs. 2, 4). The crescentic enamel pits or islands of the grinding surface are more simple than in the ox, and appear relatively more capacious as a result of their greater simplicity or less degree of inversion of the sides of the pits (Fig. 3).

The last lower molar (Fig. 5) also presents a well-developed accessory column between the anterior pair of principal lobes externally, and in the worn down specimen (Figs. 6, 7), upon the triturating surface forms a correspondingly larger fold. In the unworn specimen, the summit of the posterior lobe bifurcates anteriorly, one portion joining the postero-internal fold of the middle lobe, the other the postero-external angle of the same lobe.

#### *Admeasurements of the Teeth.*

##### Unworn superior last molar :

Length . . . . .	36 lines.
Antero-posterior diameter externally . . . . .	20½ "
Transverse diameter at the middle of the tooth anteriorly . . . . .	14 "
Transverse diameter at bottom . . . . .	17 "

##### Two superior true molars, probably first and second :

Length . . . . .	30 and 33 "
Antero-posterior diameter . . . . .	18 "
Transverse at middle . . . . .	13 "

##### Unworn inferior last molar :

Length . . . . .	36 "
Antero-posterior diameter . . . . .	25 "
Transverse . . . . .	9½ "

##### Worn inferior last molar :

Length of crown . . . . .	6 "
Antero-posterior diameter of triturating surface . . . . .	25 "

This last specimen appears somewhat water-worn and rolled. A portion of the anterior fangs are broken off, and the posterior, which is now fourteen lines long, is partially worn away.

J. Hamilton Couper, Esq., of Darien, Georgia, presented to the Academy of Natural Sciences an os humeri and a tibia found in excavating the Brunswick Canal, in Georgia. The specimens are well preserved in their texture, are hard and lustrous, and brown in color. The former has its upper extremity broken off, and the head of the tibia is somewhat mutilated. They belonged to a species of ox considerably larger than the Buffalo, and probably belong to the *Bison latifrons*.

The os humeri is of the right side, and measures nine and a half inches in circumference at the middle of its shaft, and four and a half inches in breadth at the condyles.

The tibia, also of the right side, anteriorly, from the summit of the spinous process of its proximal articulation, is eighteen inches in length, and the distal articulation is three and a half inches in breadth.

Mr. Couper also presented to the Natural History Society of Boston, an atlas and a metatarsus of an extinct ox found in the same locality as the preceding specimens. They have been kindly loaned to me by the Society, for examination. They are perfect, are dense and heavy, and black in color, and if they do not belong to the same individual as those just described, they, at least, probably belonged to the same species.

The atlas is about one-fifth larger than in the common ox, but it does not fit the condyles of the specimen, which has been described, of the cranium of *Bison latifrons*, being a little too small. Its exact measurements are as follow:—

Breadth transversely . . . . .	9½ inches.
Breadth of transverse processes; greatest, obliquely and antero-posteriorly . . . . .	6 “
Diameter of the spinal canal posteriorly, nearly . . . . .	2½ “
Depth from spinous process to front tuberosity of the body . . . . .	4½ “

The metatarsus is of the right foot, and is about an inch longer than those attributed to the Buffalo from Big-bone Lick, and is one-third more robust. Its measurements are as follow:—

Length . . . . .	10½ inches.
Breadth of proximal articulation . . . . .	2½ “
“ distal “ . . . . .	3 “
Circumference at middle . . . . .	5½ “

BISON ANTIQUUS, LEIDY.

Proc. Acad. Nat. Sci. Vol. VI. p. 117.

This species is proposed with some hesitation upon the greater portion of a right horn-core, with a small fragment of the os frontis attached (Plate V., Fig. 1). The specimen indicates an animal intermediate in size to the recent *Bison Americanus* and the *Bison latifrons*, as characterized in the preceding pages. It was found at Big-bone Lick in association with remains of the recent Buffalo, and belongs

to the Jefferson collection deposited by the American Philosophical Society in the cabinet of the Academy.

The specimen is rather too small to determine positively whether it is a distinct species or not from *Bison latifrons*. It did not belong to an aged individual, as the suture is still open between the frontal bone and that portion of the parietal which forms the upper boundary of the temporal fossa. It belonged to a species of *Bison*, as indicated by the advanced position of the horn-core, and resembles more the corresponding part in the *Bison priscus* of Europe, as represented by Cuvier and others, than it does that of *Bison latifrons*. The horn-core is more abruptly conoidal, and relatively more curved than in the latter. It is not improbable, however, that the fragment may have belonged to a female of *Bison latifrons*. The only characteristic measurements to be obtained from it are as follow:—

Length of the fragment of horn-core . . . . .	10 inches.
Circumference on a line with the basal margin inferiorly	14½ “
do. five inches from the basal margin superiorly	10 “

#### BOOTHERIUM, LEIDY.

This is a new genus proposed in the Proceedings of the Academy of Natural Sciences, upon two species of extinct ox of North America. Its diagnostic characters, so far as they have been ascertained, are distinct, and briefly as follow:—

1. The os frontis rises into a hump, or forms a prominent process, from the sides of which arise the horn-cores.

2. The latter arise above and posterior to the orbits, but considerably in advance of the inion, and curve downwards in their course, but do not turn up at the tips, as in *Ovibos*.

3. The species possess lachrymal depressions, or larmiers, as well developed as in cervine animals.

*Bootherium* is closely allied to the Musk Ox, *Ovibos moschatus*, Blainv.; and probably, like the latter, the species were clothed in a long fleece, and inhabited the great valley of the Mississippi, just anterior to the drift period. The genus occupies a position intermediate to *Bos* and *Ovis*.

#### BOOTHERIUM CAVIFRONS, LEIDY.

*Bos Pallasii*, DE KAY: An. Lyc. Nat. Hist. of New York, Vol. II. p. 280, Pl. VI.; New York Fauna, Pt. I., Zool. p. 110; COOPER: Amer. Month. Journ. of Geology, Vol. I. p. 173; HARLAN: Med. and Phys. Researches, p. 276; Edinb. New Phil. Journ. XVII. 359; H. v. MEYER: Nov. Act. Acad. Nat. Cur. XVII. 1835, p. 155; GIEBEL: Fauna d. Vorwelt, I. p. 154.

*Bos bombifrons*: Proc. Am. Assoc. Cincinnati, 1851, pp. 179, 235.

*Bootherium cavifrons*, LEIDY: Proc. Acad. Nat. Sci. Vol. VI. p. 71.

Through the kind recommendations of several friends, Professors Baird and Agassiz, and Mr. W. S. Vaux, Mr. Thomas Kite, of Cincinnati, Ohio, brought with him to Philadelphia for my inspection, in the spring of 1852, an excellent specimen of the cranium proper of an extinct species of ox, to which I have given

the above name. It is well preserved, compact, heavy, and brown in color from the infiltration of oxide of iron (Plate III., Figs. 1, 2; Plate IV., Fig. 1). Mr. Kite discovered the specimen in the hut of an Indian, in which it was used as a seat, and he was informed it was found in a neighboring gravelly bluff, near Fort Gibson, on the Arkansas River.

Compared to the cranium proper of the American Buffalo, it is relatively higher and narrower. The inion is also relatively higher and narrower (Plate III., Fig. 2).

The bases of the horn-cores, instead of being placed on a line with the orbits posteriorly, as in the Bison and Domestic Ox, are elevated above them, as in the Musk Ox. They are also united together on the top of the head, forming a very remarkable process, covering the os frontis like a huge exostosis (Plate III., Fig. 1). This process extends from within ten lines of the inion the entire length of the os frontis, or four inches anterior to the bases of the horn-cores, and two inches posterior to them. Its length is ten and a half inches, and between the horn-cores it is five and a half inches wide, and anterior to them five inches. At its posterior extremity (Fig. 2), it is one and three-quarter inches thick, and at its anterior border about half an inch. The whole process is remarkably rough and tuberculated, and presents, in some degree, the appearance of an exostosis, the result of disease. Its upper surface is depressed into a concavity, deepest between the horn-cores and divided at bottom by a prominent median ridge. Laterally, the frontal process is continuous with an elevated rough ridge curving in a sigmoid manner beneath the base of the horn-cores. About the middle of its course this ridge comes in contact with the post-orbital ridge proceeding backwards from the post-orbital arch.

The horn-cores project outwards, downwards, and forwards. They are demiconoidal; being flattened on their antero-superior surface the whole length, but in a most marked degree at the basal and distal third. The latter portion of the horn-core has a slight twist directing the flat surface more upwards. The under or convex surface of the horn-cores is marked by deep vascular grooves, and others corresponding to ridges of the inner parietes of the horns. The flat surface is relatively smooth except near the tip, where it is also marked, though in a less degree, by grooves corresponding to ridges of the horns.

The inion (Plate III., Fig. 2) is seven and a quarter inches in height from the upper margin of the occipital foramen to the top of the frontal process, or four inches five lines to the parieto-occipital crest. The middle of the latter is constituted by a quadrilateral rough protuberance for the attachment of the ligamentum nuchæ. On each side below the crest is a deep oval muscular impression.

The supra-orbital margin is situated three inches below the line of the highest part of the horn-cores, which commence above the position of the posterior fifth of the orbital entrance. It is notched at its junction with the lachrymal bone. The latter, one and three-quarter inches antero-internal to the notch just mentioned, forms a deep lenticular depression, or larmier, such as exists in the Deer and Sheep (Plate IV., Fig. 1).

The occipital condyles in the specimen appear to have suffered in some degree

from the wearing influence of running water; but they appear originally to have been more uniformly convex than in the Bison, or they have not been so abruptly bent about their middle. The inferior portion also is very much less inclined outwards from a level than in the latter.

The occipital foramen is absolutely a little less in size than in the Bison, and is almost one inch and a half in diameter.

The base of the paramastoids is thick and pyramidal, and between these and the condyles is a broad shallow concave surface not more than three fourths of an inch deep from the level of the lowest part of the condyles, while in a corresponding position in the Bison a fossa exists at least two inches in depth from the same points of measurement.

The basilar process is three and a half inches wide posteriorly, and is strongly marked by the attachment of the anterior cervical muscles. The prominences just in advance of the condyles are one and a half inches wide, and to their outer side, about ten lines in advance of the condyles, is the foramen condyloideum. Just anterior to the latter, and separated from it by a simple transverse ridge, is the jugular foramen, and in advance of this is the os tympanica, not at all inflated, but presenting an irregular crest continuous from the base of the paramastoid inwards and forwards to the side of the basilar process, and there terminating in a short compressed conoidal apophysis. Immediately internal to the latter is the foramen lacerum, and from this the groove is continuous to the inner side of the pterygoid processes, for accommodating the Eustachian tube.

The stylal depression is a cylindrical pit half an inch deep and in diameter.

The auditory process commences in a vaginal apophysis, continuous with the os tympanica, forms the anterior wall of the stylal depression, and has an oblique position outwards, backwards, and upwards. Its anterior surface is concave, and its lower margin presents a groove, passing outwards from the stylal depression, bounded on each side by a ridge, the anterior of which is acute and continuous with the margin of the vaginal process. Between the paramastoids, stylal pit, and auditory process is the stylo-mastoid foramen.

The meatus auditorius externus is longitudinally oval, and is situated about twenty lines above the level of the lowest part of the basilar process.

The glenoid articulation is, in a trifling degree, less convex than in the Bison, is about two and a half inches in breadth, and one and a half antero-posteriorly, and is on a level with the upper part of the meatus auditorius externus.

The post-glenoid tubercle is compressed conoidal, with a slight twist, and is longer than in the Bison.

The glenoid foramen is circular, about two lines in diameter, and occupies a position immediately outside of the post-glenoid tubercle.

The root of the zygoma, at its outer margin, projects considerably external to the position of the base of the horns. Its upper surface above the glenoid articulation presents a large deep concavity, above which, posteriorly, are two large foramina.

The space between the glenoid articulation and the root of the zygoma is much narrower than in the Bison, and the foramen rotundum is less advanced, being on a line with the anterior face of the post-glenoid tubercle.

The process formed by the conjunction of the temporal, sphenoidal, and frontal bones, at the inferior limit of the temporal fossa, is very much larger and more prominent than in the Bison.

The supra-orbital foramen is placed about twenty lines within the supra-orbital margin.

The temporal fossa (Plate IV., Fig. 1), is relatively more superficial than in the Bison, but is more oblique in its course forwards and downwards, and has a greater breadth from the base of the horn-core to the root of the zygoma.

*Admeasurements.*

From middle line of os frontis to the tip of the horn-core above . . . . .	16 inches, 6 lines.
Length of posterior curve of horn-core . . . . .	15 " 6 "
Greatest distance between the bases of the horn-cores above . . . . .	5 " 6 "
Antero-posterior diameter of base of horn-cores . . . . .	4 " 6 "
Vertical " " " . . . . .	3 " "
Circumference at base . . . . .	12 " 6 "
" three inches from the base above . . . . .	10 " "
Greatest breadth of head at the supra-orbital margins . . . . .	9 " 6 "
From occipital condyle to the lachrymal margin of the orbit . . . . .	11 " "
Height from basilar process to summit of frontal process at the inion . . . . .	9 " "
Breadth at the glenoid articulations . . . . .	8 " 6 "
Length of temporal fossa . . . . .	6 " 6 "

The specimen of the cranium of an extinct ox, described by Dr. De Kay, before referred to, without doubt belongs to the *Bootherium cavifrons*. From its mutilated condition, the concavity of the frontal process was suspected as being the result of the removal of the whole of the external plate of the os frontis, and the species was supposed to be the same as that indicated by two heads described by Pallas,<sup>1</sup> and one by Ozeretskovsky.<sup>2</sup>

One of the specimens of Pallas was discovered on the shores of the Ob, immediately under the arctic circle; the other was found more northerly in the region of Tundra. That described by Ozeretskovsky was obtained at the mouth of the Yana, between the Lena and Indigirska.

In the better specimen of those indicated by Pallas, Cuvier<sup>3</sup> says the forehead is flat; and the bases of the horn-cores occupy all the space from the orbits to the occipital crest, and approach on a straight line, leaving not more than a finger's

<sup>1</sup> Nov. Com. Petrop. xvii. p. 601; Nov. Aet. Petrop. i. 2, p. 243.

<sup>2</sup> Mém. de l'Acad. de St. Petersburg (1810), iii. p. 215, tab. 6.

<sup>3</sup> Ossem. Fos. ed. 4, t. vi. p. 313.

breadth between them, and adds that it would be difficult to distinguish this cranium from that of the recent Musk Ox.

Of the specimen described by Ozeretskovsky, Cuvier is undecided whether to consider it as belonging to the same species of the latter or not, but a simple inspection of Ozeretskovsky's figures, reproduced in Cuvier (Plate CLXXII., Figs. 6 and 7), proves a very close relationship with the recent Musk Ox, and indicates a very distinct animal from *Bootherium cavifrons*, as represented in the figures of the cranium, in Plates III., IV. of this memoir. At a glance, it will be observed that in the former, the horn-cores approach very near each other along their bases, and turn up at their tips like in the Musk Ox, while in the latter, the horn-cores are widely separated at base, and do not turn up at the tip.

Among a large collection of bones and teeth of the Mastodon from Benton County, Missouri, purchased by the American Philosophical Society, and deposited in the Academy of Natural Sciences, I have observed the cranial portion proper of the head of three individuals of *Bootherium cavifrons*, agreeing in all the details with the specimen just described. With them, also, there are fragments of five horn-cores of the same species.

All these Missouri specimens are much decomposed, being exceedingly friable, white, and chalk-like. They are much mutilated, but all the cranial fragments still possess the remains of the remarkable frontal process, and, in one specimen, this verges close upon the inion, and in that position is two and a half inches in thickness.

In the collection of the Boston Natural History Society, I observed a specimen consisting of the posterior part of the cranium with portions of both horn-cores of *Bootherium cavifrons*, which was discovered in the alluvium of the Kentucky River, a tributary of the Ohio River, in Kentucky, and was deposited with the Society by Mr. J. W. Foster.

Through the kindness of Professor Baird, I have received, for inspection, from Professor Samuel St. John, of Hudson, Ohio, a much water-worn fragment of a cranium with one horn-core attached, of the same species, which was found in Trumbull County, Ohio.

Thus have been indicated portions of the crania, of at least twelve individuals of *Bootherium cavifrons*, all found in the great valley through which flows the Mississippi with its tributaries. And from the number of remains, it is probable that this animal, at a former period, fed in vast flocks upon the rich prairies of the valley and the fertile banks of its streams.

Accompanying the fragments of crania and horn-cores of *Bootherium cavifrons*, from Missouri, above described, were two astragali and a metacarpal bone in the same condition of preservation as the former specimens, and no doubt belonging to the same animal.

The astragali have their surface much disintegrated, and, in their present state, measure about three and a quarter inches in their long diameter, and two inches in their breadth.

The metacarpal bone is also much injured upon the surface.

Its measurements are as follow :—



Length . . . . .	9 inches, 7 lines.
Breadth at the proximal articulation . . . . .	3 " 4 "
"    distal    " . . . . .	3 " 5 "
Circumference at middle . . . . .	6 " 3 "

Among the collection of Jefferson from Big-bone Lick, there is a specimen of a right metacarpal in perfect condition, which may also probably belong to *Bootherium cavifrons*, although it is a little larger than that last described. It is not improbable that it might belong to *Bison latifrons*.

Its measurements are as follow :—

Length . . . . .	10 inches, 3 lines.
Breadth at proximal end . . . . .	3 " 9 "
"    distal    " . . . . .	3 " 7 "
Circumference at middle . . . . .	6 " 4 "

A metatarsal bone and a first phalanx, in the collection of Jefferson, probably also belong to this species. The former is of the left foot, and is a little shorter and considerably less robust than the corresponding bone from Georgia, attributed to the *Bison latifrons*.

Its measurements are as follow :—

Length . . . . .	10 inches.
Breadth of proximal articulation . . . . .	2 " 3 lines.
"    distal    " . . . . .	2 " 7 "
Circumference at middle . . . . .	4 " 9 "

The phalanx measures three and a quarter inches in length.

#### BOOTHERIUM BOMBIFRONS, LEIDY.

——, WISTAR: Trans. Amer. Phil. Soc. n. s. Vol. I. p. 359.

*Bos bombifrons*, HARLAN: Fauna Americana, p. 271; Med. and Phys. Res. p. 275; Edinb. New Phil. Journ. XVII. 359; COOPER, SMITH, and DE KAY: Amer. Journ. Sci. XX. 370; COOPER: Am. Month. Journ. of Geol. Vol. I. p. 173; DE KAY: An. Lyc. Nat. Hist. II. 286; New York Fauna, Zool. Pt. 1, p. 110; MEYER: N. A. A. Nat. Cur. XVII. p. 143.

*Bootherium bombifrons*, LEIDY: Proc. Acad. Nat. Sci. Vol. VI. p. 71.

The only characteristic specimen which I have seen of the *Bootherium bombifrons*, is that first described and figured by Dr. Wistar from the collection of Jefferson. It consists of the cranium proper, with both horn-cores attached, and presents the ordinary condition of preservation of all the preceding bones described from the morasses of Big-bone Lick (Plate IV., Fig. 2; Plate V.).

The upper outline of the head of *Bootherium bombifrons*, when viewed laterally (Plate V., Fig. 1), resembles in its posterior rise from theinion and its abrupt declination forward that of the Sheep. The os frontis, instead of forming an exostosis-like process, as in *Bootherium cavifrons*, rises gradually from its commencement anteriorly, and forms a sort of hump, from the sides of which, like

in the last-mentioned species postero-superiorly to the orbits, the horn-cores arise. The highest portion of the os frontis is between the posterior part of the bases of the horn-cores, and in this position is elevated over two inches above the line of the supra-orbital margin. Anteriorly to this most elevated part, the os frontis inclines at an angle of about  $45^{\circ}$ , but posteriorly has a less degree of inclination. The apex is transverse, obtuse, and impressed at the middle. The parieto-frontal surface is quadrilateral, about four inches square, moderately convex, and presents a broad shallow impression at its central part.

The horn-cores curve outwards, downwards, and slightly forwards. They arise about three and a half inches in a curved line from the inion, or about two and a half in a straight line. They are elongated, conical, curved, and longitudinally furrowed.

The inion (Plate V., Fig. 2) is about four inches in height above the occipital foramen, and in its details corresponds pretty closely with *Bootherium cavifrons*.

The relative position of the orbits to the horn-cores is the same as in the species just mentioned. The supra-orbital margin is about two inches below the highest part of the base of the horn-cores, and these commence anteriorly about the posterior sixth of the entrance of the orbits. At its anterior third, the supra-orbital margin is deeply notched, and the supra-orbital process upon the upper or frontal surface, about an inch and a half from the margin, is pierced by three foramina arranged in an antero-posterior row.

In advance of the orbit, the lachrymal bone is depressed into a remarkably deep fossa, or larmier, which appears to have been hemispherical, but, in the specimen, the lower portion is broken away (Plate IV., Fig. 2). At the orbital margin, below the larmier, a deep, broad, lachrymal groove exists, as in *Bootherium cavifrons*.

The temporal fossa presents nearly the same degree of inclination as in the latter, and also has the same relative degree of shallowness and length and breadth of surface which this has in comparison with that of the Buffalo.

The ridge, which in *Bootherium cavifrons* proceeds from the frontal process laterally, beneath the base of the horn-core, is but very feebly developed in *Bootherium bombifrons*.

The base of the cranium, though much mutilated, is sufficiently well preserved to exhibit the peculiarities which associate it in the same genus with *Bootherium cavifrons*. The foramina and processes have the same relation of position and form. Like in the latter, the occipital condyles appear to have been less bent than in the Buffalo, the paramastoids have been large and robust, and the fossæ between them and the condyles have been superficial also, as in *Bootherium cavifrons*.

The basilar process is broad and strongly marked by processes for muscular attachment.

The form of the os petrosa, auditory process, and relative position of the meatus auditorius are the same as in *Bootherium cavifrons*.

The post-glenoid tubercle is relatively larger than in the latter, and between it and the auditory process is a pit, into which opens a large foramen, piercing the root of the zygoma, from the temporal surface. Both the pit and foramen exist, but are much smaller, in *Bootherium cavifrons*.

*Admeasurements.*

From middle line of os frontis to tip of horn-core	12 inches, 6 lines.
Length of horn-core . . . . .	9 "
Distance between the bases of the horn-cores . . . . .	6 "
Circumference at base of " . . . . .	8 " 6 "
Greatest breadth of head at the supra-orbital margins	6 " 4 "
From occipital condyle to lachrymal margin of orbit	8 " 6 "
Greatest height from basilar process to summit of os frontis . . . . .	7 "
Length of temporal fossa . . . . .	6 "

With the same collection of bones which contained the specimen just described, there is preserved a small metacarpal bone, which I suspect to belong to the same species. It is of the right foot, is an adult specimen, and has the following measurements:—

Length anteriorly . . . . .	7 inches.
Breadth of proximal articulation . . . . .	2 " 4 lines.
" distal " . . . . .	2 " 5 "
Circumference at middle . . . . .	3 " 11 "

## REFERENCES TO THE PLATES.

## PLATE I.

Figs. 1, 2. A portion of the cranium and left horn-core of *Bison latifrons*, one-fourth the diameter of nature.

Fig. 1. Upper view of the specimen.

Fig. 2. Posterior view of the specimen.

## PLATE II.

Fig. 1. Posterior view of the right horn-core of *Bison antiquus*, one-third the diameter of nature.

Figs. 2—7. Molar teeth of *Bison latifrons*, the size of nature.

Fig. 2. Inner view of the second superior true molar of the left side.

Fig. 3. View of the masticating surface of the same tooth as the last.

Fig. 4. Inner view of the last superior true molar of the left side.

Fig. 5. Outer view of the last inferior true molar of the left side.

Fig. 6. Outer view of a much worn last inferior molar of the left side.

Fig. 7. Masticating surface of the same specimen as the last.

## PLATE III.

Figs. 1, 2. Cranium with both horn-cores of *Bootherium cavifrons*, one-fourth the diameter of nature.

Fig. 1. Superior view of the specimen.

Fig. 2. Posterior view of the specimen.

## PLATE IV.

Fig. 1. Lateral view of the same specimen of the cranium of *Bootherium cavifrons*, represented in Plate III., also one-fourth the diameter of nature.

Fig. 2. Upper view of the cranium with both horn-cores of *Bootherium bombifrons*, one-third the diameter of nature.

## PLATE V.

Figs. 1, 2. Views of the same specimen of *Bootherium bombifrons*, represented in Fig. 2, Plate IV., also one-third the diameter of nature.

Fig. 1. Lateral view of the cranium.

Fig. 2. Posterior view of the cranium.

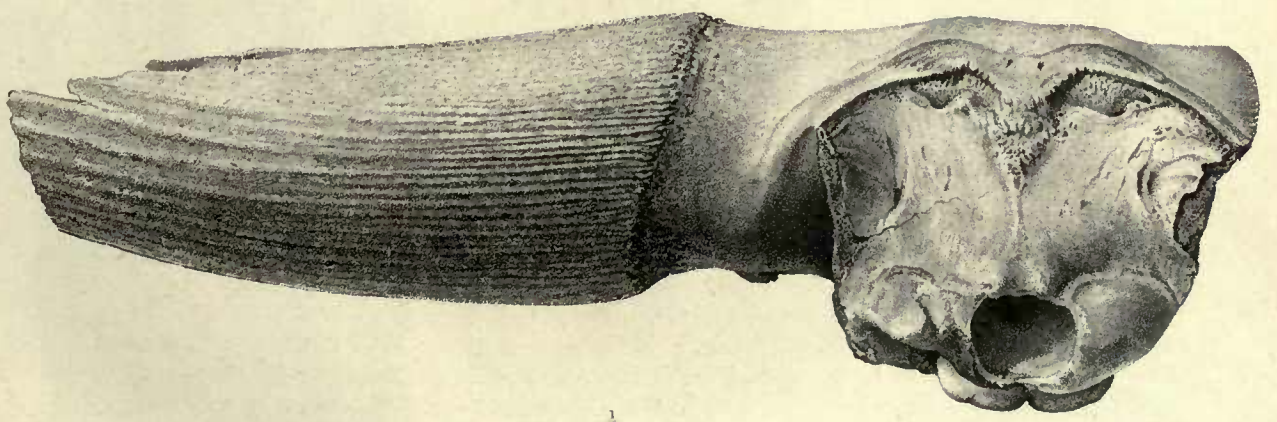
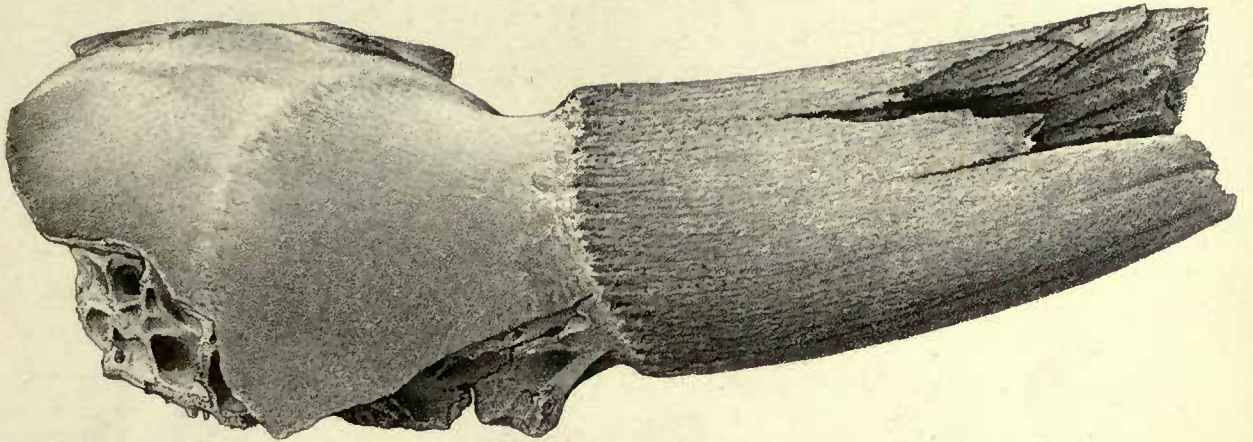
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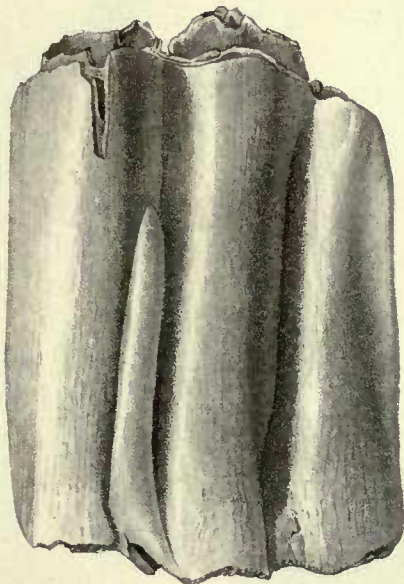
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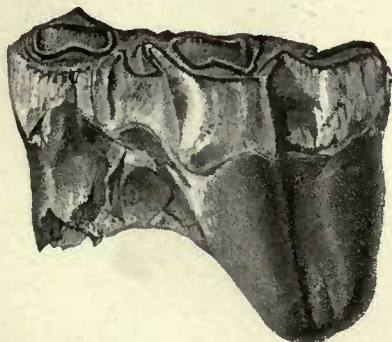
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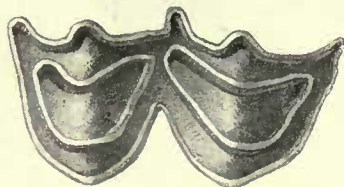
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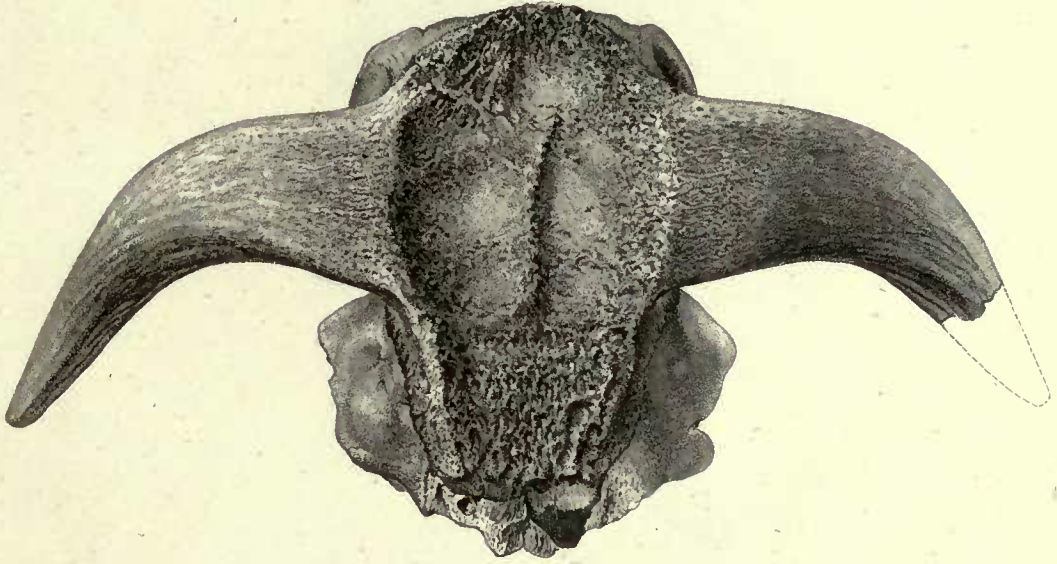
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 2-7. BISON LATIFRONS. *Leidy.*

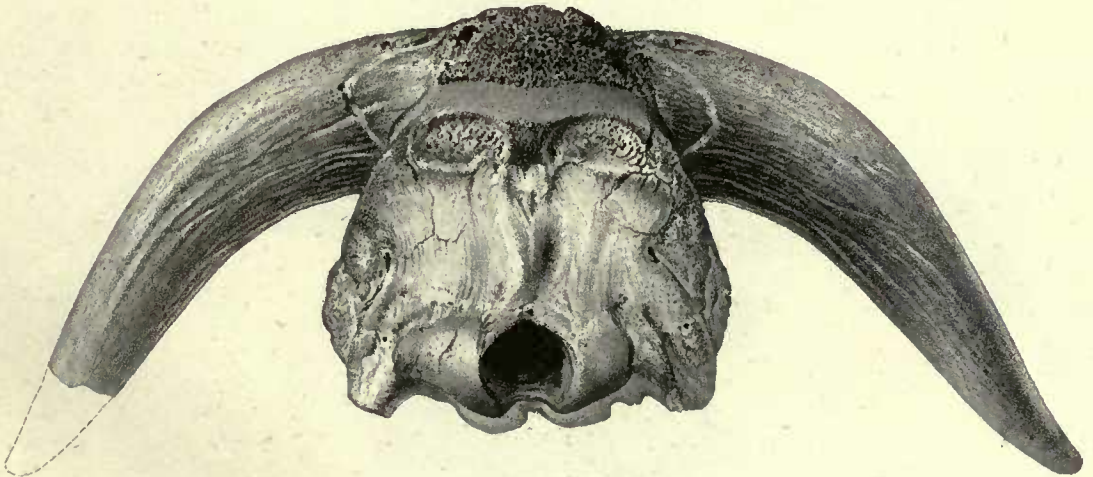




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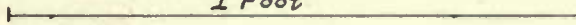


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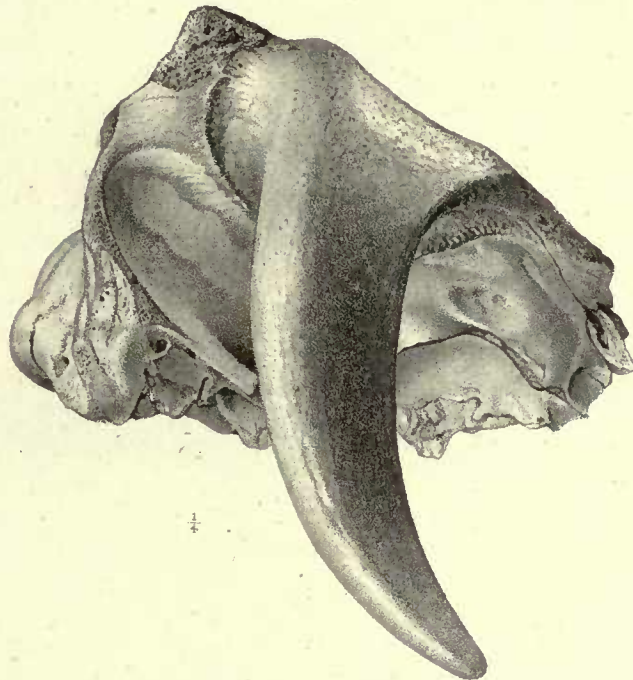
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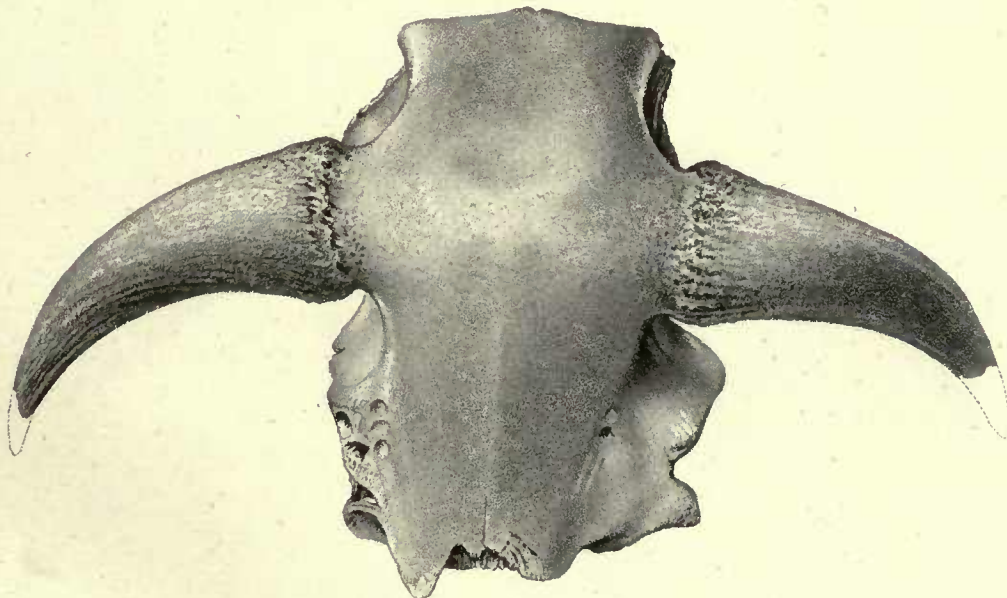


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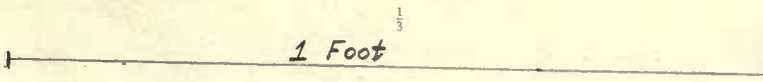


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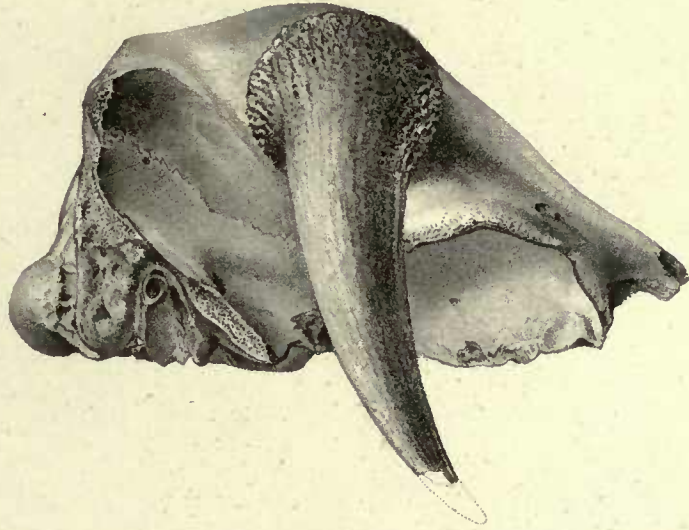
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BOOTHERIUM CAVIFRONS *Leidy*

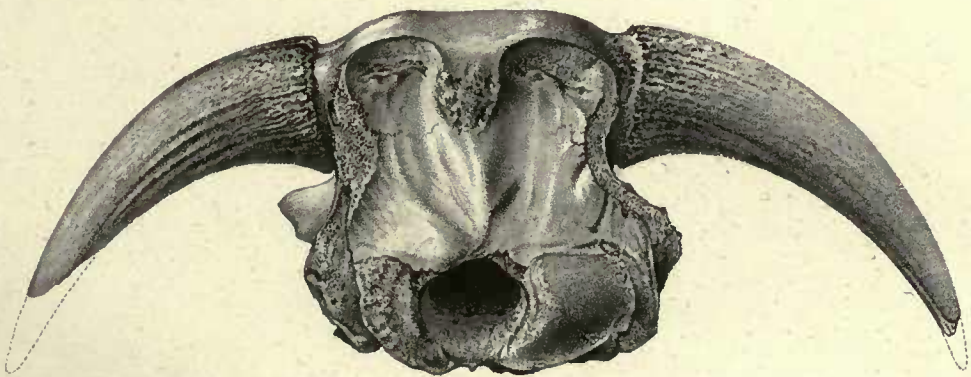
BOOTHERIUM BOMBIFRONS *Leidy*



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1 Foot

