in this soil, with parts of the limbs still attached. The trunk of the tree, of which we present a section, with portions of the limbs adhering, is flattened and almost turned to lignite by pressure and lapse of time. But what is still more interesting are the cones or fruit which the tree bore. These cones are about an inch in length and somewhat resemble those of a species of conifer, different, however, from any known species. We place before you other remains of this ancient vegetation."

Judge Holmes, in commenting upon the specimens, stated that marine deposits had been found in a peculiar stratum which was supposed by geologists to extend as far south as the mouth of the Ohio River, and that the tusks referred to in the paper would be a valuable discovery if they proved to be those of a walrus.—*Globe Democrat*.

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RESTORATION OF BRONTOSAURUS

By Professor O. C. MARSH.

NEARLY all the bones here represented belonged to a single individual, which, when alive, was nearly or quite fifty feet in length. The position here given was mainly determined by a careful adjustment of these remains. That the animal at times assumed a more erect position than here represented is probable, but locomotion on the posterior limbs alone was hardly possible.

The head was remarkably small. The neck was long, and, considering its proportions, flexible, and was the lightest portion of the vertebral column. The body was quite short, and the abdominal cavity of moderate size. The legs and feet were massive and the bones all solid. The feet were plantigrade, and each footprint must have been about a square yard in extent. The tail was large, and nearly all the bones solid.

The diminutive head will first attract attention, as it is smaller in proportion to the body than in any vertebrate hitherto known. The entire skull is less in diameter or actual weight than the fourth or fifth cervical vertebra.

A careful estimate of the size of *Brontosaurus*, as here restored, shows that when living the animal must have weighed more than twenty tons. The very small head and brain, and slender neural cord, indicate a stupid, slow moving reptile. The beast was wholly without offensive or defensive weapons, or dermal armature.

In habits, *Brontosaurus* was more or less amphibious, and its food was probably aquatic plants or other succulent vegetation. The remains are usually found in localities where the animals had evidently become mired.

bones were found in position and the other bones at the base of the skull were undisturbed, a careful search was made for the stapes, but no indication of it was found. Its absence in this specimen, so well preserved, would indicate that it was wanting in this genus if not in the other Sauropoda.

COLUMELLA PRESENT.

In a skull of *Brontosaurus* in which the bones, although displaced, were in very perfect preservation, a pair of bones were found which apparently are the columellæ. They are elongated, flattened bones, with the shaft somewhat constricted in the middle, and twisted. Their length corresponds to the elevated posterior part of the skull in this genus.

HYOID BONES.

There are two pairs of hyoid bones in the Sauropoda. They are elongated, rodlike, and somewhat curved. In *Brontosaurus excelsus*, they are 210 and 130 mm. in length respectively.

Among the other points of interest in the skull of the *Sauropoda* are the following:

The parietal bones are very short, and form but a small portion of the brain case. They are composed chiefly of the flattened arched processes, which meet with the squamosals at their outer ends. There is no parietal foramen. The squamosals lie upon the par-occipital processes. They have a short deep groove for the reception of the post-frontal. On their lower part, which descends in front of the par-occipital process, they expand into a thin, spoon-shaped form, which fits over the head of the quadrate. The quadrate has an oval, rounded head, and slender shaft. Below, it is firmly united to the pterygoids. On the outer side, the quadrato-jugals are attached. These bones are elongate, and slightly sigmoid in shape. The lower end is rodlike, and curved forward, descending below the articular surface of the quadrate. The pterygoids are tri-radiate bones, with the posterior ends cup-shaped, resembling the partially closed human hand. This cavity, somewhat restricted by a thumb-like process, receives the basi-ptyergoid process.

THE VERTEBRÆ.

There are twenty-seven precaudal vertebræ in *Brontosaurus*, of which the first twelve bear pleurapophyses, or hatchet bones, united to the centra, and may hence be called true cervicals. Of the remaining twelve which bear free ribs, the thirteenth, fourteenth, and fifteenth have the surface for the articulation of the head of the rib on the centrum, below the neural suture.

All the precaudal vertebræ have large cavities in the cen-

ORDER SAUROPODA. Herbivorous.

Feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified. Pubes projecting in front, and united distally by cartilage; no post-pubis. Fore and hind limbs nearly equal; limb bones solid. Sternal bones parial. Premaxillary bones with teeth. Precaudal vertebræ hollow. Each sacral vertebra supports its own transverse processes.

Family *Atlantosauridae*. Anterior vertebræ opisthocœlian. Ischia directed downward, with extremities meeting on median line. Anterior caudals with lateral cavities. A pituitary canal.

Family *Morosauridae*. Anterior vertebræ opisthocœlian. Ischia directed backward, with sides meeting on median line. Anterior caudals solid. Pituitary fossa only. Yale College, New Haven, July 12, 1883.

THE MUSK CATTLE OF AMERICA.

By DR. G. A. STOCKWELL.

DURING the earlier days of our continent, and just prior to the "drift period," the plains and valleys of that which is now the central portion of the United States nourished considerable herds of dwarfed cattle, clothed in long, hairy fleece—the *Bos bombrifrons* and *Bos latriformis*, described by Leidy. Possibly, also, the remains of oxen found in upper Siberia and the Lachoo Island may have been of the same or a kindred race, as well as the *Bos pullasi* of De Kay; while the fossil relics of Eschscholtz Bay, Greenland, and the valley of Treetholt River, of Alaska, are almost identical with an existing form. To-day, however, the Old World exhibits no representatives of the race, while in the New the immediate descendants, if such they are, are confined to the extreme and most dreary portions of North America, and to a range that is gradually becoming more and more restricted in its southern and western limits.

Evidences are not wanting that musk oxen ranged at a comparatively recent date far into the borders of the wooded belt, descending as low as the southern shores of Hudson's Bay, to the west reaching the valley of the Yukon and sterile shores of West Georgia, Alaska, non-fossilized remains being frequently brought to light. Scarce a century since, Samuel Hearne observed their fresh tracks within two miles of Prince of Wales Fort, now Churchill House, and every autumn brought hundreds about the north shores of Athabasca Lake; but now many a weary mile must be traversed from either point ere a single individual of the species is encountered, few descending below latitude 65° N. Indeed, the limits of the race are almost exclusively those of

RESTORATION OF BRONTOSAURUS EXCELSUS, MARSH. (One-eightieth natural size.)

Among the new points in the skull of the Sauropoda recently determined, are the following:

PITUITARY FOSSA.

In *Morosaurus*, the pituitary fossa is comparatively shallow, much like that in the crocodile and many birds, being connected with the under surface of the skull by the two usual divergent foramina for the passage of the internal carotid arteries. In *Apatosaurus*, however, it is remarkably different. Here the fossa becomes enlarged into a vertical canal, which, expanding below, communicates by a wide transverse orifice with the pharyngeal cavity. The arterial foramina are here canals thinly covered over with bone, and open just within the rim of the lower orifice. The pituitary cavity itself has a firm, smooth wall throughout. The openings are both transverse, and oval in shape. The upper one is eighteen by six millimeters in its diameters; the lower opening thirty by twelve.

This remarkable connection of the cerebral cavity with the alimentary canal is an embryonic character, and corresponds to the condition observed in the chick at the fifth day of incubation. This peculiar feature appears to be a family character of the *Atlantosauridae*.

POST-OCCIPITAL BONES.

In two genera of the *Sauropoda* (*Morosaurus* and *Brontosaurus*), and probably in all members of this order, there is a pair of small bones connected with the skull which have not hitherto been observed in any vertebrates. These bones, which may be called the *post-occipital* bones, were found in position in one specimen, and with the skull in several others. When in place, they are attached to the occiput just above the foramen magnum, and extend backward and outward, overlapping the lateral pieces of the atlas, thus protecting the spinal cord at this point, which would otherwise be much exposed.

These bones are short, flattened, and slightly curved, resembling somewhat a riblet. The anterior end is thickened and rugose for an attachment to a roughened surface on the exoccipital just above and outside the foramen magnum. The shaft is flattened from above downward, and gradually converges to a thin posterior end. In *Morosaurus grandis*, these bones are about 65 mm. in length, and 30 along the surface which joins the occiput. They correspond in position to the muscle in mammals known as the *rectus capitis posterior minor*.

In the existing Cormorants (*Graculus*) a single slender bone is articulated to the occiput on the median line. This, however, does not correspond to the bones here described. To distinguish it from the post-occipitals, it may be called the *nuchal* bone.

STAPES WANTING.

In the skull of *Morosaurus* in which the post-occipital

trum, communicating exteriorly with the surface by means of large lateral foramina. This cavernous structure of the vertebræ gradually decreases posteriorly, until in the anterior caudal vertebræ it is confined to a small pocket above the transverse process. The neural arches of the presacral vertebræ contain numerous deep cavities. The pleurapophyses of the cervical vertebræ are also reticulate in their structure, and some of the anterior ribs have small but deep fossæ below the tubercle.

POST-METAPOPHYSES.

On the last two or three cervical vertebræ of *Brontosaurus* there is a convoluted ridge of bone over the posterior zygapophyses. In the anterior dorsals, this ridge becomes stronger and more elongated, forming a distinct protuberance. These processes have not hitherto been described. As they are analogous to the processes in mammals known as metapophyses, they may bear the same general name, being distinguished as the post-metapophyses. The term pre-metapophyses should then be applied to the processes in mammals.

The post metapophyses probably serve for the attachment of ligaments in the place of the neural spine, which is here wholly wanting.—These processes, which are at first oblique in position, gradually become more vertical and stouter, and, coalescing at their bases, finally become united throughout, and are thus converted into the neural spine.

FETAL DINOSAURUS.

Remains of a very small dinosaur were found in immediate relation with the type specimen of *Morosaurus grandis*. These remains, which consist of a complete femur, the larger portion of both humeri, and several vertebræ, show no essential differences from the large specimens except in size, and indicate an animal of perhaps seven feet in length, and little more than two feet in height. The imperfect ossification of these bones indicates that the animal was very young, and it seems probable that it was fetal. The only other similar case known in the *Dinosauria* is the apparent embryo observed by the writer in *Compsognathus*.

CLASSIFICATION.

The various genera of the *Sauropoda*, and in fact of the *Dinosauria* in general, cannot at present be distinguished by the detached teeth. In one form, however, the teeth are quite peculiar and the dentition appears to offer generic characters. The maxillary teeth of this form have been referred to *Stegosaurus*, as they were first found in connection with the remains of that genus. Later investigations indicate that they belong to the *Sauropoda*, and there is some evidence that they are the teeth of *Diplodocus*.

The main characters of the order *Sauropoda*, and of the two families now known to belong to it, are as follows:

the Barren Grounds—that practically treeless and barren waste that stretches from Great Slave and Bear Lakes, east to the extreme verge of Melville Peninsula, and north to the shores of the Polar Sea, embracing its bewildering maze of islands.

On the hither side of the Atlantic we are accustomed to speak of the animals as *oxen*, out of deference to certain osteological characteristics, merely adding the prefix of *musk* as a specific indication, bestowed in consequence of the effluvia always given off by all members of the race, old and young, male or female, though most marked in summer, particularly with old bulls in August, which is the wooing season. Our insular brethren, the English sportsmen more particularly, insists upon the title of *musk sheep*, basing upon certain characteristics of the hair with which they are clothed, a faint ovine contour of head and horns, the small round extremity like that of the sheep or hare, and the modest stature, which is more than exceeded by the famous Kyle kine, or dwarfed Highland cattle. The horns, however, are smooth and round, lacking the three-cornered, wrinkled appearance and peculiar symmetrical curve of the ram, while the nose and muzzle, the flat forehead, the peculiar character of hoof, and general anatomical outlines are unmistakably bovine. Nevertheless, the similarities, especially under cursory inspection, are sufficiently marked to lead to many curious and interesting muddles, more particularly as science has assumed a middle or neutral position and denominates it the *musk sheep-ox—Oribos moschatrus*.

Taking all circumstances into consideration, including habits, form, and range, the musk-ox is a somewhat remarkable as well as anomalous animal. Imagine, if possible, a creature scarce five feet long from tip of its outstretched nose to the root of tail, but a yard high, or, at most, three feet six at the withers, and weighing but four or five hundred pounds when in prime condition; a small body set low on its legs and appearing considerably larger than it really is in consequence of its heavy fleece of hair that on the neck, brisket, flanks, and under parts attains a length of half a yard, hanging considerably below the knee; a pair of small, intensely wicked blue eyes, set well forward; a soft, downy muzzle, with two enormous nostrils that seem almost blended into one; pointed ears, three inches long and of equal breadth in their middle, but nearly hidden by the surrounding hair; trim, deer-like legs, set in hoofs of prodigious size, and a pair of huge horns falling down on each side of the head with a forward curvature; imagine all this, and you have a faint perception of the *tout ensemble*.

The most astonishing features, perhaps, are the horns, hoofs, and fleece, the first and last having no parallels among existing forms of life. The horns of an old male are ponderous affairs, weighing perhaps fifty pounds, joined at their bases, where they have a circumference of two feet, then fall over the sides of the head with an outward ten-