

Ann Arbor, and the following year was transferred to that of Geology, Zoology and Botany. From 1873 to 1879 he was first Chancellor of the University at Syracuse, N. Y., and afterward Professor of Geology and the Natural Sciences in the same University and in the Vanderbilt University of Tennessee. In 1879 he returned to Ann Arbor, taking again the chair he had left, and there remained in active service until his decease.

The subjects of Professor Winchell's publications were various; but his scientific investigations were confined to the departments of Geology and Paleontology. In 1859 he was appointed Director of the Geological Survey of the State of Michigan; and in 1860 he sent to the Legislature his "First Biennial Report," which was published in 1861. The survey was soon after suspended in consequence of the civil war. It was resumed under his charge again in 1869, but two years after he resigned the position. He however published, before this and later, occasional papers bearing on the geology of the State and its mineral resources, besides a geological map of Michigan, and also the results of some observations in other States.

During the later years of Professor Winchell's life his geological work was largely among the Archæan rocks, and especially those of Minnesota, in connection with the survey which was in progress under his brother, Prof. N. H. Winchell, and his reports appear in the annual volumes of the survey. These important contributions to Archæan geology are collected in a volume of more than 500 pages issued by him in 1889, entitled "Field Studies of the Archæan Rocks." "A last word with the Huronian" is the title of a paper read by him before the American Geological Society on the 30th of last December. "The Origin of the Earth's features" was another subject on which he wrote at some length; and in 1885 he presented to the American Association for the Advancement of Science a valuable paper on "The sources of trend and crustal surplusage in mountain structures," the substance of which is published in vol. xxx (1885) of this Journal. In 1886 appeared a Geological Text Book under the title of "Geological Studies," or Elements of Geology, which contains many of his personal observations.

Professor N. H. Winchell's tribute to his brother in the American Geologist for March, rightly says: "He was a man of indomitable will, unremitting industry, with an insatiable love for work in his profession; of broad philanthropy, of penetrating reason, of fearless pursuit of the truth; at home in any realm of nature's handiwork,—which he considered permeated with the essence and will of its Creator; a geologist who embraced geology in all its ramifications, ambitious to serve the world by contributing to its fund of advanced knowledge."

HENRY BOWMAN BRADY.—Dr. Brady, the eminent British authority on the Foraminifera, died on January 10th. He was born at Gateshead-on-Tyne, February, 1835.

APPENDIX.

ART. XXXIX.—*Restoration of Triceratops*; by O. C. MARSH.
(With Plates XV and XVI.) (+ Brontosaurus)

IN previous numbers of this Journal, the writer has given the principal characters of the gigantic *Ceratopsidae*, or horned Dinosaurs, from the Laramie, with figures of the more important parts of the skull and skeleton.* The abundant material now available for examination makes it possible to attempt a restoration of one characteristic form, and the result is given in Plate XV. This figure, about one-fortieth of natural size, is reduced from a large outline plate of a memoir on this group, now in preparation by the writer for the United States Geological Survey.

This restoration is mainly based on two specimens. One of these is the type of *Triceratops prorsus*, Marsh, in which the skull, lower jaw, and cervical vertebræ are in remarkable preservation. The other specimen, although somewhat larger, is referred to the same species. It consists of parts of the skull, of vertebræ, the pelvic arch, and nearly all the important limb bones. The remaining portions are mostly taken from other remains found in the same horizon and localities, and at present are not to be distinguished specifically from the two specimens above mentioned. The skull as here represented corresponds in scale to the skeleton of the larger individual.

In this restoration, the animal is represented as walking, and the enormous head is in a position adapted to that motion. The

* This Journal (3), vol. xxxvi, p. 477, December, 1888; vol. xxxvii, p. 334, April, 1889; vol. xxxviii, p. 173, August, 1889, p. 501, December, 1889; vol. xxxix, p. 81, January, 1890, p. 418, May, 1890; and vol. xli, p. 167, February, 1891.

massive fore limbs, proportionally the largest in any known Dinosaur, correspond to the head, and indicate slow locomotion on all four feet.

The skull is, of course, without its strong horny covering on the beak, horn-cores, and posterior crest, and hence appears much smaller than in life. The neck seems short, but the first six cervical vertebræ are entirely concealed by the crest of the skull, which in its complete armature would extend over one or two vertebræ more. The posterior dorsals with their double headed ribs continue back to the sacrum itself, there being no true lumbar, although two vertebræ, apparently once lumbar, are now sacral, as their transverse processes meet the ilia, and their centra are coössified with the true sacrum. The four original sacral vertebræ have their neural spines fused into a single plate, while the posterior sacral, once caudal, have separate spines directed backward.

No attempt is made, in this restoration, to represent the dermal armor of the body, although in life the latter was more or less protected. Various spines, bosses, and plates, indicating such dermal armature, have been found with remains of this group, but the exact position of these specimens can, at present, be only a matter of conjecture.

This restoration gives a correct idea of the general proportions of the entire skeleton in the genus *Triceratops*. The size, in life, would be about twenty-five feet in length, and ten feet in height. The genus *Ceratops* so far as at present known is represented by individuals of smaller size, and in some instances, at least, of quite different proportions. A third genus, which may be called *Sterrholophus*, can be readily distinguished from the other two by the parietal crest, which had its entire posterior surface covered with the ligaments and muscles supporting the head. In *Ceratops* and *Triceratops*, a wide margin of this surface was free, and protected by a thick, horny covering. The type of the new genus is the specimen described and figured by the writer, as *Triceratops flabellatus*, which in future may be known as *Sterrholophus flabellatus*, Marsh. There is some evidence that other forms, quite distinct, left their remains in essentially the same horizon of the Laramie, but their true relation to the above genera cannot be settled without further discoveries.

This group so far as at present investigated is very distinct from all other known Dinosaurs, and whether it should be regarded as a family, *Ceratopsidae*, as first described by the writer, or as a sub-order, *Ceratopsia*, as later defined by him, will depend upon the interpretation and value of the peculiar characters manifested in its typical forms.

The main characters which separate the group from all other known families of the *Dinosauria* are as follows:

- (1) A rostral bone, forming a sharp, cutting beak.
- (2) The skull surmounted by massive horn-cores.
- (3) The expanded parietal crest, with its marginal armature.
- (4) A pineal foramen.
- (5) The teeth with two distinct roots.
- (6) The anterior cervical vertebræ coössified with each other.
- (7) The dorsal vertebræ supporting, on the diapophysis, both the head and tubercle of the rib.
- (8) The lumbar vertebræ wanting.

The animals of this group were all herbivorous, and their food was probably the soft succulent vegetation that flourished during the Cretaceous period. The remains here figured are from the *Ceratops* beds of the Laramie, and were found by Mr. J. B. Hatcher, in Wyoming, on the eastern slope of the Rocky Mountains.

RESTORATION OF BRONTOSAURUS.

On Plate XVI is a restoration, one-ninetieth natural size, of another large Dinosaur, the gigantic *Brontosaurus* of the Jurassic. This differs so widely from *Triceratops* of the Cretaceous that a comparison of the two is most instructive. Each represents the dominant reptilian type of the period in which it lived, and each belongs to a distinct order of the *Dinosauria*. The older form, *Brontosaurus*, was more than double the size of the later *Triceratops*. The former represents a more primitive type, and the latter, one highly specialized. Both show the early character of locomotion on all four feet, which many allied forms of each appear to have nearly or quite lost before their extinction.

In the restoration of *Brontosaurus*, the diminutive head will first attract attention, as it is smaller in proportion to the body than in any reptile hitherto known. The neck was very long and flexible. The body was rather short. The legs and feet were massive, and the bones all solid. The tail was very long and powerful. The animal during life must have been nearly sixty feet in length, and about fifteen feet in height. Its probable weight was more than twenty tons.

Brontosaurus was herbivorous in habit, and its food was probably aquatic plants or other succulent vegetation. The skeleton here represented was found in the *Atlantosaurus* beds of the upper Jurassic, in Wyoming, west of the Rocky Mountain range.

342 O. C. Marsh—Restoration of *Brontosaurus*.

The figure on Plate XVI, one-ninetieth natural size, is reduced from a large restoration, one-twenty-fourth natural size, on a lithographic plate accompanying the monograph of the *Sauropoda*, prepared by the writer for the U. S. Geological Survey. In previous numbers of this Journal will be found various papers by the writer on this group of Dinosauria, and among them, published in August, 1883, is a preliminary outline sketch of the present restoration.

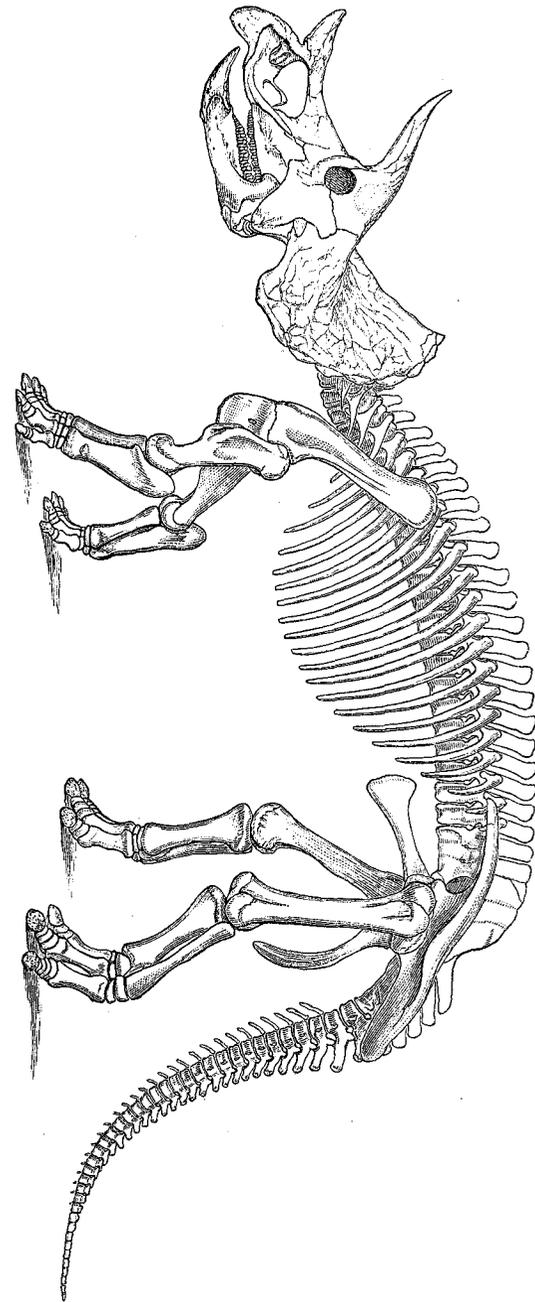
New Haven, Conn., March 18th, 1891.

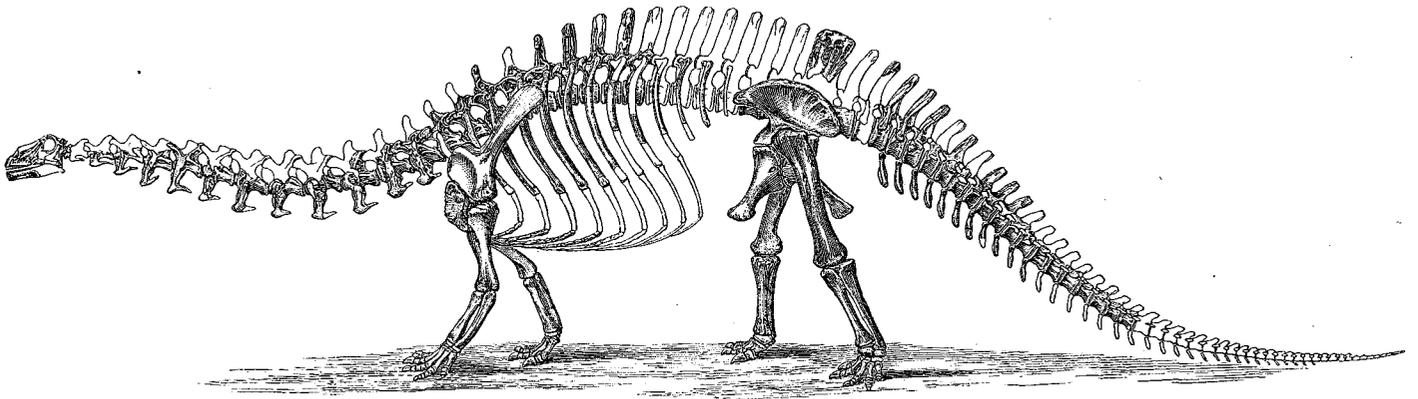
EXPLANATION OF PLATES.

Plate XV.—Restoration of *Triceratops prorsus*, Marsh; one-fortieth natural size. (Cretaceous.)

Plate XVI.—Restoration of *Brontosaurus excelsus*, Marsh; one-ninetieth natural size. (Jurassic.)

Restoration of *TRICERATOPS PRORSUS*, Marsh. One-fortieth natural size.





Restoration of BRONTOSAURUS EXCELSUS, Marsh. One-ninetieth natural size.