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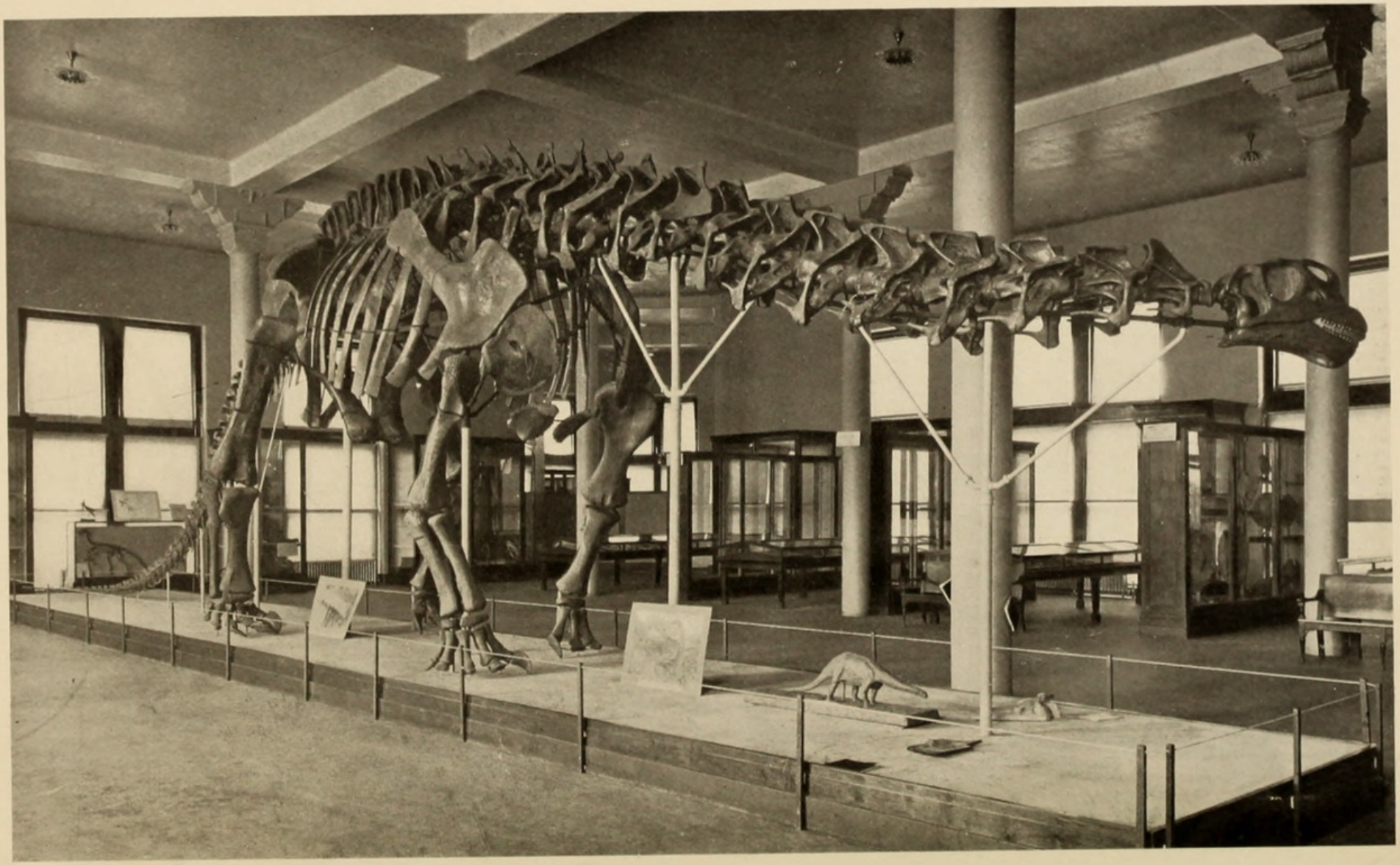

FIG. 1. MOUNTED SKELETON OF BRONTOSAURUS IN THE AMERICAN MUSEUM OF NATURAL HISTORY

The Mounted Skeleton of Brontosaurus

in the American Museum of Natural History.

A Guide Leaflet to the Collections

in the

Department of Vertebrate Palæontology.

By

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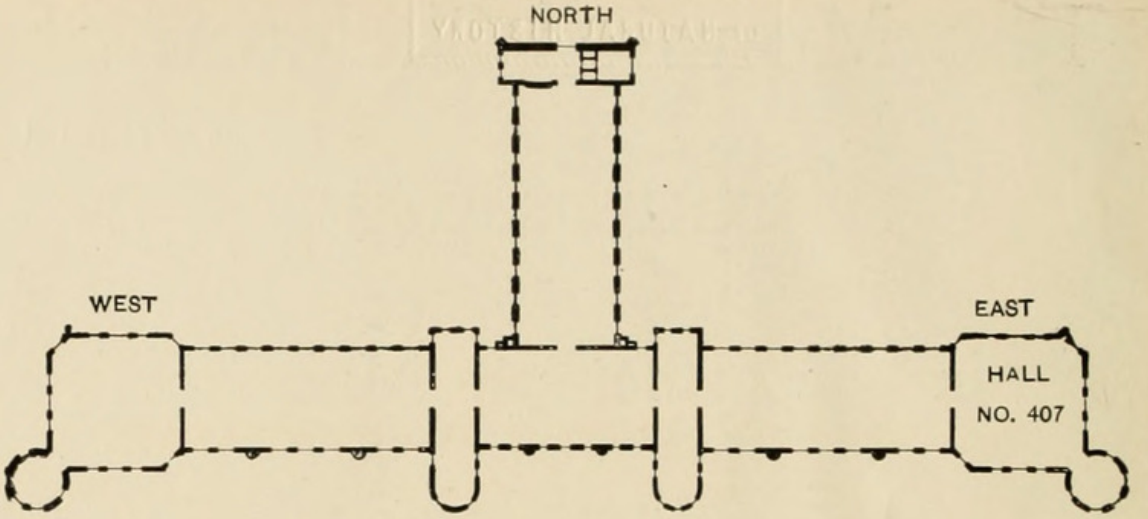

FOURTH FLOOR.

The Mounted Skeleton of Brontosaurus described in this Guide Leaflet is exhibited in Hall No. 407, the Dinosaur Hall, South-East Wing, fourth floor of the Museum.

PREFATORY NOTE

THE collections in the Dinosaur Hall were gathered together and prepared for exhibition under direction of Professor Henry Fairfield Osborn, Curator of the Department, Vice-President and Trustee of the Museum. They include the Cope Collection of Fossil Reptiles and Amphibians, presented in 1902 by Morris K. Jesup, and the collections brought together by Museum Expeditions to the various Rocky Mountain States where the richest localities for such specimens are found. The funds for these expeditions are provided by the generosity of the Trustees of the Museum.

Besides the general guide to the Collection of Fossil Vertebrates, re-issued in October, 1903, a series of special guides is in course of preparation. Each of these treats of one or more important groups of animals, their evolution, and the various problems and theories illustrated by the specimens in the hall, more fully than could be done in the general guide. Two of these special guides have been published, one dealing with the evolution of the Horse, the other with the Fossil Carnivores, Marsupials and Small Mammals. A special guide to the Dinosaurs is planned, to be issued in three or more sections, which will be prepared as soon as the collections are more permanently and completely installed.

EDITOR.

THE MOUNTED SKELETON OF BRONTOSAURUS.

By W. D. Matthew.

EIGHT years ago the American Museum began a search for fossil reptiles in the Rocky Mountain States. The prime object of the search was to obtain skeletons of the Dinosaurs, those gigantic extinct animals whose fragmentary remains, discovered in that region and studied and described especially by the late Professor Marsh, have excited the greatest interest among men of science. In order to place these marvels of an antique world before the public in tangible form, a Dinosaur Hall was planned, in which should be exhibited mounted skeletons of the principal kinds of Dinosaurs. To obtain these, a series of expeditions into the regions of the arid West, where such fossils are to be found, was inaugurated and carried on under direction of Professor Osborn, and the collections of the late Professor Cope, containing three splendid skeletons of Dinosaurs, were purchased through the liberality of President Jesup.

This programme involved an amount of work hardly to be appreciated by outsiders, and it is as yet far from being complete. Nevertheless, the mounting of the largest skeleton, the Amphibious Dinosaur Brontosaurus, has been finished, the skeleton of a remarkable dwarf Dinosaur, the "Bird-Catcher," has been mounted and placed on exhibition, the preparation and mounting of entire skeletons of three other large and very extraordinary types (the Carnivorous, Duck-billed and Armored Dinosaurs) are well under way, and diligent search is being made for complete and mountable skeletons of other important kinds. Many other more fragmentary specimens have been found, some of which are exhibited in the wall-cases around the hall.

Visitors see here the largest fossil skeleton that has ever been mounted, and may obtain some idea of the variety and the extraordinary character of the animals which populated the earth during the Age of Reptiles, millions of years ago, before the Age of Mammals had begun or the various races of quadrupeds which now inhabit the world had commenced their evolution.

The Brontosaurus skeleton, the principal feature of the hall, is sixty-six feet eight inches in length, and stands fifteen feet two inches high. Its petrified thigh-bone weighs 570 lbs. The weight of the animal when alive is estimated at not less than ninety tons. About one-third of the skeleton, including the skull, is restored in plaster, modeled or cast from other incomplete skeletons. The remaining two-thirds belong to one individual, except for a part of the tail, one shoulder-blade and one hind limb, supplied from another skeleton of the same species.

The skeleton was discovered by Mr. Walter Granger, of the Museum expedition of 1898, about nine miles north of Medicine Bow, Wyoming. It took the whole of the succeeding summer to extract it from the rock, pack it and ship it to the Musuem. Nearly two years were consumed in removing the matrix, piecing together and cementing the brittle and shattered petrified bone, strengthening it so that it would bear handling, and restoring the missing parts of the bones in tinted plaster. The articulation and mounting of the skeleton and modeling of the missing bones took an even longer time, so that it was not until February, 1905, that the Brontosaurus was at last ready for exhibition.

It will appear, therefore, that the collection, preparation and mounting of this gigantic fossil has been a task of extraordinary difficulty. No museum has ever before attempted to mount so large a fossil skeleton, and the great weight and fragile character of the bones made it necessary to devise especial methods to give each bone a rigid and complete support, as otherwise it would soon break in pieces from its own weight. The proper articulating of the bones and the posing of the limbs were equally difficult problems, for the Amphibious Dinosaurs, to which this animal belongs, disappeared from the earth long before the dawn of the Age of Mammals, and their nearest relatives, the living

lizards, crocodiles, etc., are so remote from them in either proportions or habits that they are unsatisfactory guides in determining how the bones were articulated, and are of but little use in posing the limbs and other parts of the body in positions that they must have taken during life. Nor among the higher

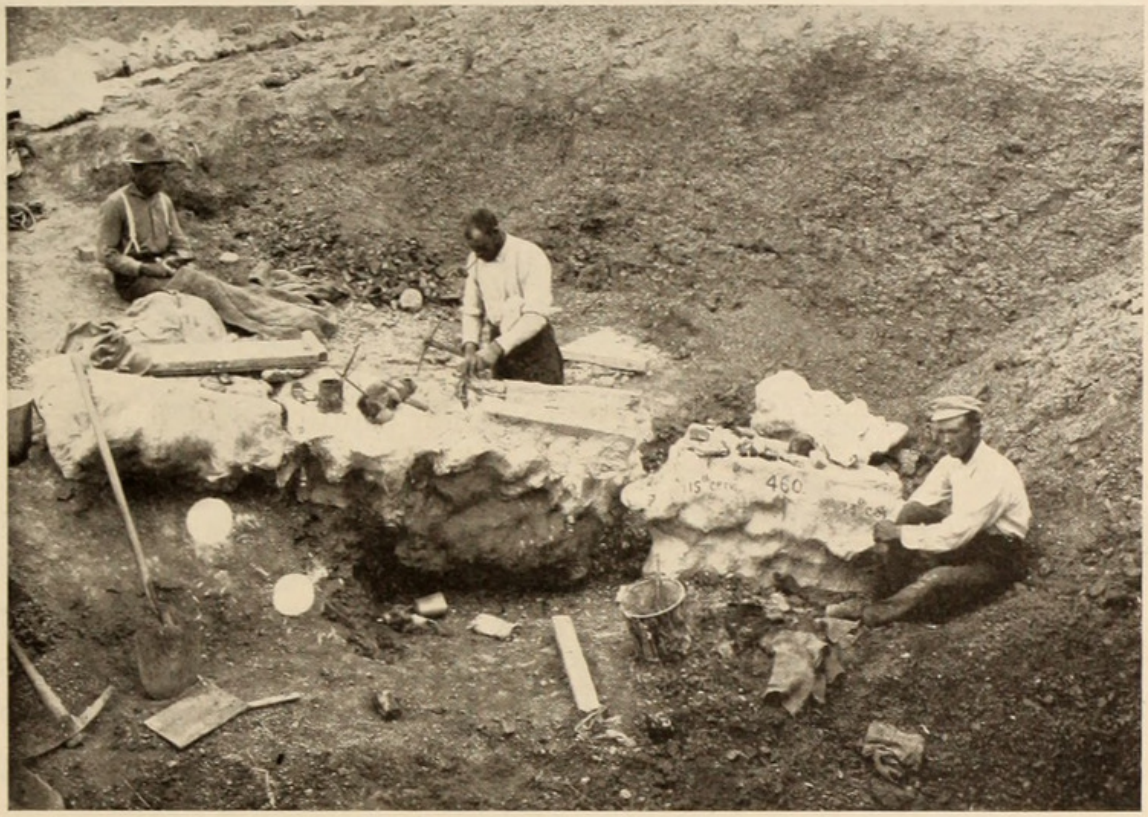

FIG. 2. SKELETON OF BRONTOSAURUS IN THE QUARRY

Showing three sections of the backbone partly covered with plaster bandages for transportation to the Museum. The ribs have already been removed from the near side of the backbone. Tools used in the work lie scattered about the quarry.

animals of modern time is there one which has any analogy in appearance or habits of life to those which we have been obliged by the study of the skeleton to ascribe to the Brontosaurus.

As far as the backbone and ribs were concerned, the articulating surfaces of the bones were a sufficient guide to enable us to pose this part of the skeleton properly. The limb-joints, however, are so imperfect, that we could not in this way make sure of having the bones in a correct position. The following method, therefore, was adopted:

A dissection and thorough study was made by the writer, with the assistance of Mr. Granger, of the limbs of alligators and

other reptiles, and the position, size and action of the principal muscles were carefully worked out. Then the corresponding bones of the Brontosaurus were studied and the position and size of the attachments of the corresponding muscles were marked out, so far as they could be recognized from the scars and processes preserved on the bone. The Brontosaurus limbs were then provisionally articulated and posed, and the position and size of each muscle were represented by a broad strip of paper extending from its origin to its insertion. The action and play of the muscles on the limb of the Brontosaurus could then be studied, and the bones adjusted until a proper and mechanically correct pose was reached. The limbs were then permanently mounted in these poses, and the skeleton as it stands is believed to represent, as nearly as study of the fossil enables us to know, a characteristic position that the animal actually assumed during life.

The Brontosaurus was one of the largest of the Amphibious Dinosaurs or Sauropoda, a race of gigantic reptiles which flourished during the Jurassic or Middle Period of the Age of Reptiles, —some eight millions of years ago by a moderate estimate of geological time. These Amphibious Dinosaurs are more ancient than any of the extinct mammals in the adjoining hall (No. 406), except for a few tiny jaws in the Small Mammal Alcove. They were the largest animals that ever lived, excepting some of the whales, and certainly were the largest animals that ever walked on four legs.

In proportions and appearance the Brontosaurus was quite unlike any living animal. It had a long thick tail like the lizards and crocodiles, a long flexible neck like an ostrich, a thick, short, slab-sided body and straight, massive, post-like limbs suggesting the elephant, and a remarkably small head for the size of the beast. The ribs, limb-bones and tail-bones are exceptionally solid and heavy; the vertebræ of the back and neck, and the skull, on the contrary, are constructed so as to combine the minimum of weight with the large surface necessary for attachment of the huge muscles, the largest possible articulating surfaces, and the necessary strength at all points of strain. For this purpose they are constructed with an elaborate system of

braces and buttresses of thin bony plates connecting the broad articulating surfaces and muscular attachments, all the bone between these thin plates being hollowed into a complicated

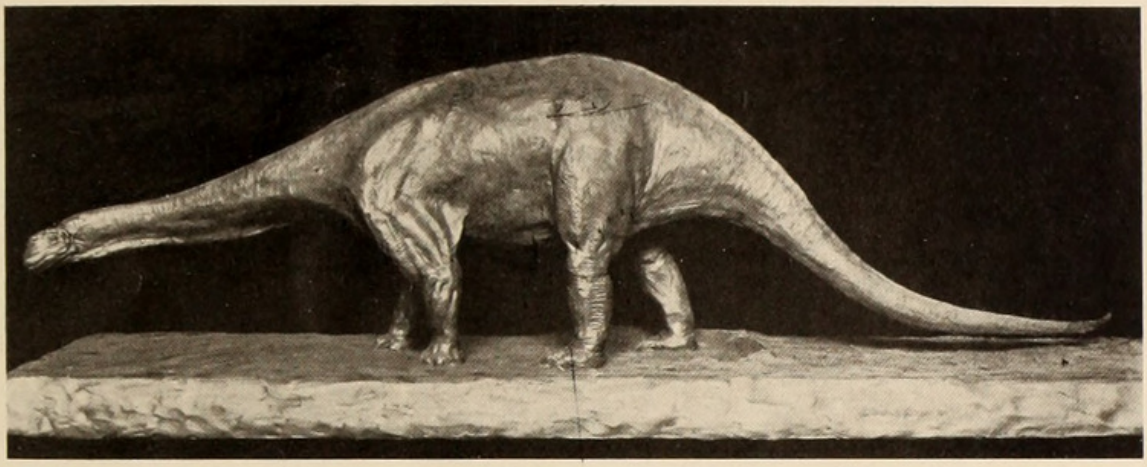

FIG. 3. MODEL OF BRONTOSAURUS. BY CHARLES R. KNIGHT, 1905
Executed from the mounted skeleton, under direction of Professor H. F. Osborn

system of air-cavities. This remarkable construction can be best seen in the unmounted skeleton of Camarasaurus, another Amphibious Dinosaur.

The teeth of the Brontosaurus indicate that it was an herbivorous animal feeding on soft vegetable food. Three opinions as to the habitat of Amphibious Dinosaurs have been held by scientific authorities. The first, advocated by Professor Owen, who described the first specimens found forty years ago, and supported especially by Professor Cope, has been most generally adopted. This regards the animals as spending their lives entirely in shallow water, partly immersed, wading about on the bottom or, perhaps, occasionally swimming, but unable to emerge entirely upon dry land. More recently Professor Osborn has advocated the view that they resorted occasionally to the land for egg-laying or other purposes, and still more recently the view has been taken by Mr. Riggs and the late Mr. Hatcher that they were chiefly terrestrial animals. The writer inclines to the view of Owen and Cope, whose unequaled knowledge of comparative anatomy renders their opinion on this doubtful question especially authoritative.

The contrast between the massive structure of the limb-bones, ribs and tail, and the light construction of the backbone, neck

and skull, suggests that the animal was amphibious, living chiefly in shallow water, where it could wade about on the bottom, feeding on the abundant vegetation of the coastal swamps and marshes, and pretty much out of reach of the powerful and active Carnivorous Dinosaurs which were its principal enemies.

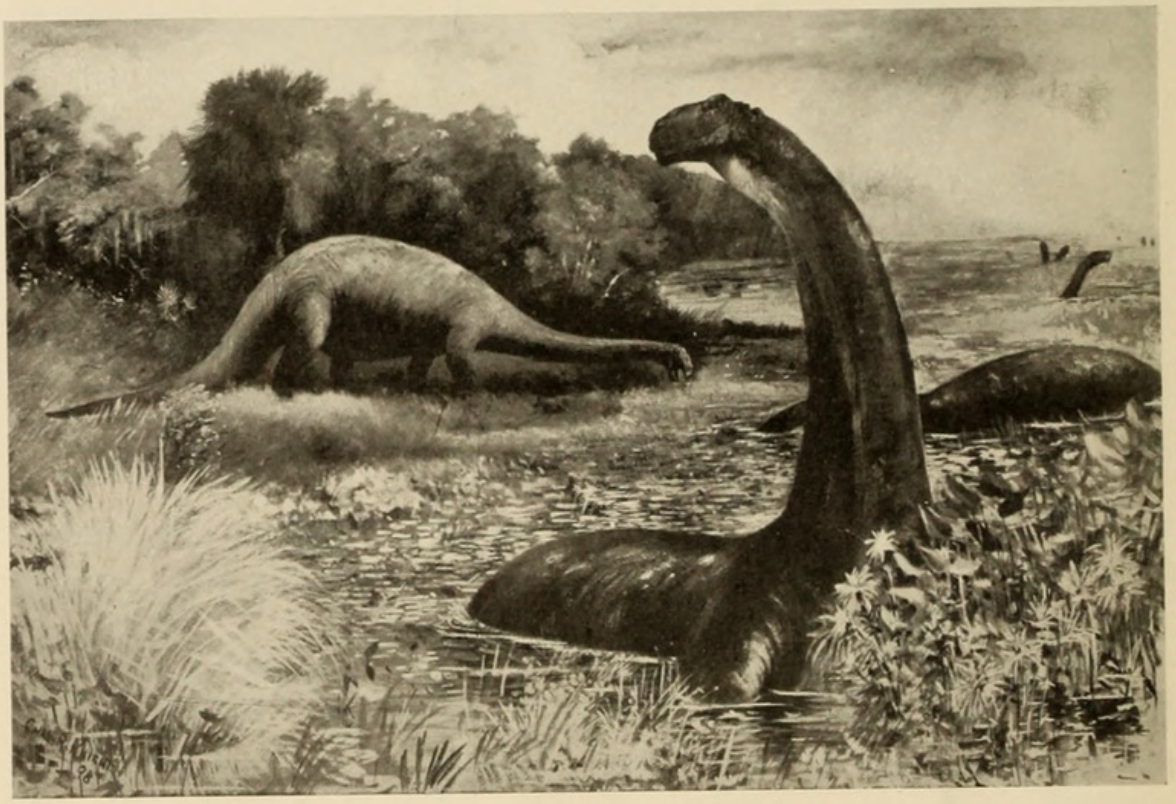

FIG. 4. RESTORATION OF BRONTOSAURUS. BY CHARLES R. KNIGHT
This restoration represents Professor Osborn's view of the habits of the animal

The water would buoy up the massive body and prevent its weight from pressing too heavily on the imperfect joints of the limb- and foot-bones, which were covered during life with thick cartilage, like the joints of whales, seals and other aquatic animals. If the full weight of the animal came on these imperfect joints, the cartilage would yield and the ends of the bones would grind against each other, thus preventing the limb from moving without tearing the joint to pieces. The massive, solid limb- and foot-bones weighted the limbs while immersed in water, and served the same purpose as the lead in a diver's shoes, enabling the Brontosaurus to walk about firmly and securely under water. On the other hand, the joints of the neck and back are exceptionally broad, well-fitting and covered with a much thinner

surface of cartilage. The pressure was thus much better distributed over the joint, and the full weight of the part of the animal above water (reduced as it was by the cellular construction of the bones) might be borne on these joints without the cartilage giving away.

Looking at the mounted skeleton we may see that if a line be drawn from the hip-joint to the shoulder-blade, all the bones below this are massive, all above (including neck and head) are lightly constructed. This line then may be taken to indicate the average water-line, so to speak, of this Leviathan of the Shallows. The long neck, however, would enable the animal to wade to a considerable depth, and it might forage for food either in the branches or the tops of trees or, more probably, among the soft succulent water-plants of the bottom. The row of short, spoon-shaped, stubby teeth around the front of the mouth would serve to bite or pull off soft leaves and water-plants, but the animal evidently could not masticate its food, and must have swallowed it without chewing, as do modern reptiles and birds.

The brain-case occupies only a small part of the back of the skull, so that the brain must have been small even for a reptile, and its organization (as inferred from the form of the brain-cast) indicates a very low grade of intelligence. Much larger than the brain proper was the spinal cord, especially in the region of the sacrum, controlling most of the reflex and involuntary actions of the huge organism. Hence we can best regard the Brontosaurus as a great, slow-moving animal-automaton, a vast storehouse of organized matter directed chiefly or solely by instinct and to a very limited degree, if at all, by conscious intelligence. Its huge size and its imperfect organization, as compared with the great quadrupeds of to-day, rendered its movements slow and clumsy; its small and low brain shows that it must have been automatic, instinctive and unintelligent.

COMPOSITION OF THIS SKELETON.

The principal specimen, No. 460, is from the Nine Mile Crossing of the Little Medicine Bow River, Wyoming. It consists of the 5th, 6th and 8th to 13th cervical vertebræ, 1st to 9th dorsal and 3d to 19th caudal vertebræ, all the ribs, both coracoids, parts of sacrum and ilia, both ischia and pubes, left femur

and astragalus and part of left fibula. The backbone and most of the neck of this specimen were found articulated together in the quarry, the ribs of one side in position, the remainder of the bones scattered around them, and some of the tail-bones weathered out on the surface.

From No. 222, found at Como Bluffs, Wyo., were supplied the right scapula, 10th dorsal vertebra, and right femur and tibia.

No. 339, from Bone Cabin Quarry, Wyo., supplied the 20th to 40th caudal vertebræ; No. 592, from the same locality, the metatarsals of the right hind foot, and a few toe-bones are supplied from other specimens.

The remainder of the skeleton is modeled in plaster, the scapula, humerus, radius and ulna from the skeleton in the Yale Museum, the rest principally from specimens in our own collections. The modeling of the skull is based in part upon a smaller incomplete skull in the Yale Museum, but principally upon the complete skull of *Morosaurus* shown in Case 42.

Mounted by A. Hermann; completed Feb. 10, 1905.