### A PECULIAR RAILROAD ACCIDENT.

Unfortunately, railroad accidents are not of great rarity in the United States. One of the most peculiar accidents which has occurred in some time took place at White Pigeon, Mich., February 23, on an embankment on the main line of the Lake Shore and Michigan Southern Railway, close to a junction. An engine pushing a snow-plow came into collision with a freight engine standing still, and the snow-plow ran under the locomotive of the freight train, which rose in the air and landed on top of the other engine pushing the plow, as shown in our engraving. Two trainmen riding on the top of the plow were killed, and the engineer of the engine which landed on top escaped unhurt. The fireman also jumped, and escaped with slight bruises.


WRECK OF TWO ENGINES AND A SNOW-PLOW, WHITE PIGEON, MICH.

### THREE CHARACTERISTIC TYPES OF AMERICAN DINOSAURS.

BY J. CARTER BEARD.

THEIR EVOLUTION.

Modifications in the structure of animals, fitting them to procure with the least possible difficulty the food upon which they subsist, afford unfailing keys to the history of the development and character of their environments.

Selecting an extreme case for illustration, the tardigrades, the gradual change in the surroundings of the tribe can be readily enough reasoned out in the transformation of one branch of the phyllophagous bruta, the enormous megatheriods, with their peculiar conformation, allowing them to sit upright, kangaroo-like, and reach from the earth, pull down and devour the foliage of the trees, to animals measuring less than three feet in length, the sloths, with radically different methods of procuring the same kind of food. So perfectly have the latter become fitted to a leaf-eating, arboreal life; so complete is the adaptation of the sloth to the nature and habit of growth in the trees in which it lives, that its organism, in its entirety and in every least part, demands a vast primeval forest of many-branched trees where the animal can pass its whole life, migrating from one contiguous bough to another, in search of fresh food supplies, without having any more cause to feel its deficiency in not being able to progress over the ground, to which it need never descend, than the seal or the dolphin in not being able to range over field and forest.

The reverse of this rule is obviously true. The more perfectly we become acquainted with the nature of the food supplies of any species or of any race of animals, the more unfailingly we can trace the evolution and describe the development of the type which forms the subject of investigation. A remarkable uniformity is observable in the conformation of the great terrestrial reptiles of the Mesozoic era. Its character reminds us, in a general way, of the plan of structure of the megatherium, insomuch as the comparative weight and strength and development of the hind quarters of the great reptiles afford absolute proof that they also must have sat upright, tripod fashion, supported by their hind legs and powerful and massive tails.

In the case of the megatherium, it is quite possible that the peculiarities of its structure point to the selection of some particular sort of vegetation. Mr. Woodbine Parish thought it was the agave, or American aloe, upon which it fed, but in the case of the dinosaurs there was no alternative.

The sparsely-branched and columnar forms of vegetable growth which afford little accommodation to arboreal animals consisted principally of Gymnosperms, especially of Cyads, which at this period reached their highest development, mingled with palms, tree ferns, many species of Filicinæ of lesser size, giant equisetums, liverworts, club mosses, and some herbaceous and some aquatic plants. The straight, upright shafts of the larger forms of plant life arose from the naked soil, for grasses had not yet clothed the earth.

Almost the only food supply the vegetable world afforded was the leaves, shoots, and young twigs of such trees as then grew, and to reach these required the great stature and peculiar build of the herbivorous dinosaurs.

The bipedal habit acquired by browsing upon the tall vegetation also gave them an extended range of vision, and to some extent insured their safety against the stealthy and undetected approach of enemies, principal among which was probably the large carnivorous dinosaur shown in our illustration, Ceratosaurus nasicornus, which reached a length of twenty-two feet. By assuming an upright position, this and other dinosaurs were, it is likely, sometimes able to elude their prey.

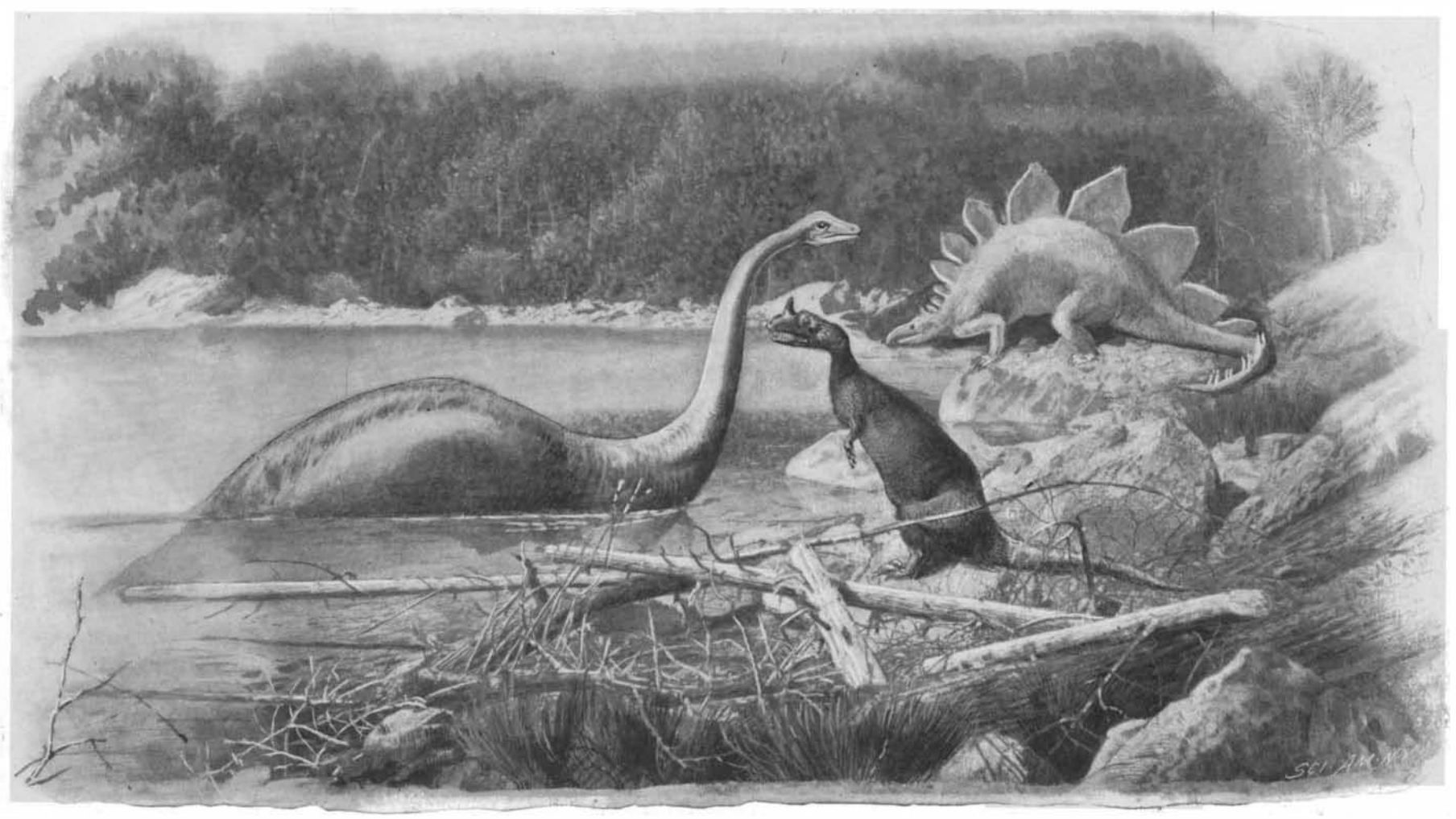
DESCRIPTION OF THE THREE TYPES.

Largest of all quadrupeds that ever trod the earth, the enormous brontosaurus, which reached the length of from sixty to perhaps seventy feet, and certainly weighed more than twenty tons, presents one of the most perplexing problems ever offered the paleontologist. How such an immense mass of almost brainless living flesh, with, so far as is known, no means of defense or refuge of escape, except taking to the water, in which he could be followed by powerful, agile, and more intelligent foes, escaped almost immediate extinction passes conjecture. How such an animal could stand upright upon dry land, under the terrible stress and pull of gravitation, which would put to the severest test the strength of cohesion of the mere flesh, muscle and bone of which he was built, is a question not easily answered. Paleontologists have lately been inclined to believe that the brontosaurus never came ashore, but an animal with four well-developed legs and feet formed for walking seems scarcely built for an exclusively aquatic life, and nothing that is known in natural history affords a parallel for such a state of things. The great beast, with its great body, long neck and disproportionately small head, is in the water at the left of the illustration.

Nearer to the foreground on shore is seen the great horned dinosaur, Ceratosaurus nascicornus, dwarfed in appearance here by comparison with the much larger brontosaurus beyond him. Small as he looks, however—and must look, to be in proper proportion to his companion—he measures no less than twenty-two feet, a rather formidable size for such a beast of prey. In addition to the large and trenchant array of teeth with which his massive jaws are furnished, he bears a stout horn, like that of a rhinoceros, projecting from a space just above his nostrils, and which must have added materially to his powers of offense and of defense.

The fore limbs are extremely small, it will be noticed, in proportion to the rest of the animal, and could never have been used for support, though they might have been of assistance to the ceratosarus in retaining a hold upon his prey. The animal must, in progressing, have always walked upright, dragging his massive tail behind him.

But, without doubt, the strangest animal ever known to have existed upon the face of the earth is the gigantic armored dinosaur shown somewhat in the distance upon the bank of the lake in our picture. This is the



THREE CHARACTERISTIC TYPES OF AMERICAN DINOSAURS.

Stegosaurus ungulatus. The entire length of this dinosaur was thirty feet or more. The stegosaurus, instead of being entirely defenseless like the immense brontosaur described above, was provided not only with a complete osseous dermal covering, but with a series of large, erect, bony plates, protected by a thick, horny covering, extending along the back and part of the tail, and further to the end of the tail by four pairs of spines of great size and power.

We are, in this animal, confronted with a strange reversal of the first and governing principle of construction common to all modern vertebrates. An enlargement of the spinal cord in the pelvic region, giving a reinforcement of nervous power to the generally disproportionately large hinder half of dinosaurs, is in a number of species quite apparent, but in the stegosaurs the development of the lumbar region takes complete precedence of the fore part of the animal. The head—so diminutive in proportion to the entire bulk of this colossal reptile that it becomes a problem how a sufficient amount of food to sustain and nourish the enormous body could have passed through the jaws—contained a brain which, taking the proportional size of the two creatures into consideration, was one hundred times smaller than that of an alligator; but, as is well known, a second brain, twenty times greater than that contained in the skull, found place in the sacral cavity, and governed and intelligently directed the movements of the hind limbs and the armed tail of the monster.

## THE NEW STREET RAILWAY TUNNEL UNDER BOSTON HARBOR.

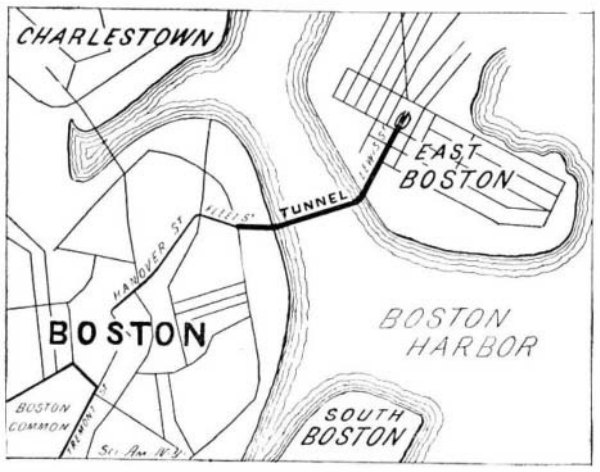
BY J. A. STEWART.

Street railway expansion has been going on rapidly in Boston by underground, elevated, and surface lines. Its latest and most interesting development is the new tunnel under the harbor from the South Ferry, on Atlantic Avenue, to the peninsular district known as East Boston.

When the Boston subway was built a few years ago, it was suggested that it would prove but the beginning of a network of subterranean avenues which would underlie the entire city—a statement which recent movements seem to have justified.

The legislative act of 1894, which authorized the people of Boston to appoint a Transit Commission to construct a subway under Boylston, Tremont and various streets in the north part of the city to the Union Station, also empowered that body to build the tunnel under the harbor to East Boston.

Work on the construction was begun May 5, 1900. The portion of the work then commenced—in Maverick Square and Lewis Street, East Boston—was not difficult of construction. The engineering problems, as the work could be in open cut, were of an ordinary nature. The excavating for the incline in Maverick Square was done without timbering the trench, and the earth was shoveled into carts. The sidewalls of the incline are of concrete, faced with granite and surmounted by a granite coping. Granite also surrounds the portal. The subway or covered portion of this section is a concrete monolith. Nuts and washers are embedded in the masonry to admit of the use of steel tie-rods for increasing the strength of the roof, if deemed desirable. The grade is 5 per cent, and the bottom of the masonry invert is about 39 feet below the surface of the street.




MAP OF BOSTON, SHOWING LOCATION OF TUNNEL.

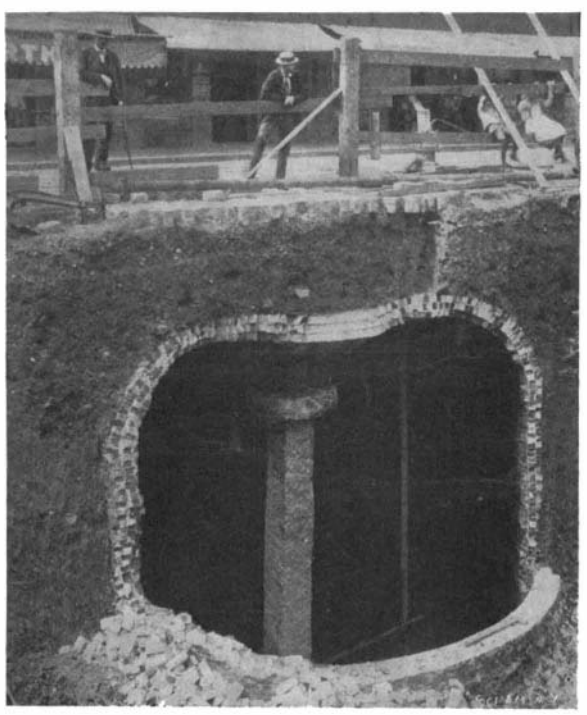
In preparing to put in place the masonry for the covered portion, the bottom of the excavation was graded, and three thicknesses of tarred felt were laid. They were thoroughly pitched together, and when the pitch had hardened, the concrete invert was put in and 6-inch back walls were carried up a convenient distance, the sheeting being removed and the trench rebraced as was necessary. The back walls were plastered with a rich Portland cement plaster, and against this the main wall was built. Wooden centers were used, and work on each section of the concrete arch was carried on continuously until its completion. Beginning in Maverick Square, the East Boston tunnel runs under Lewis Street, Boston Harbor, and, on the Boston side, under Eastern Avenue, Fleet and Hanover Streets, to Friend Street, where it connects with the subway system. The tunnel proper lies between the two South Ferry slips, a distance of about 2,250 feet.

In considering the important question of construction, the Commission was greatly aided by the experience of foreign cities as personally investigated by Chief Engineer Carson. Cast-iron twin tubes, of 10 to 12 feet in diameter, are used in the Glasgow street railway tunnels and in the London Underground Road, which passes under the Thames. Comparing the relative merits of twin tubes or a single wider tube, the Commission came to the conclusion that, although a wide tube would be more costly and would have less favorable grades than twin narrow ones, the wide tunnel would conduce more to the comfort of passengers, would be much more satisfactory to the public, and would be more in accordance with the work previously done by the city.

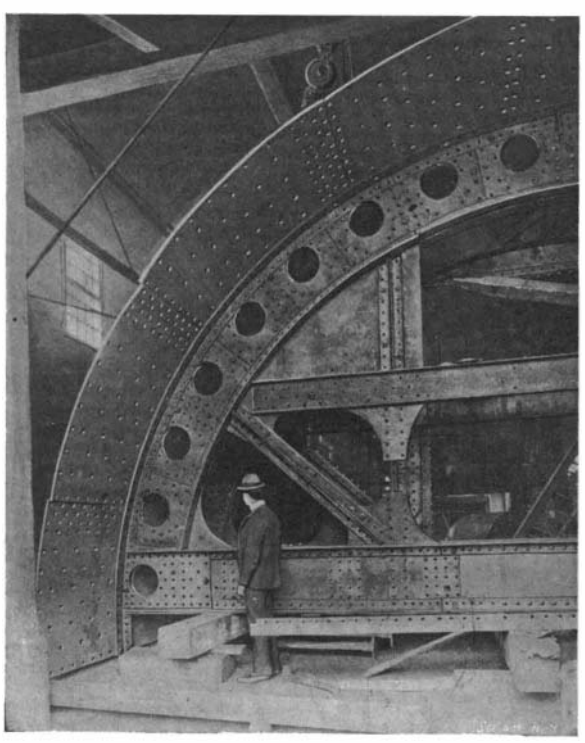
The Boston Harbor tunnel is an arched structure for two electric railway tracks. The thickness of the roof of earth over the outside of the arch of the tunnel under the harbor is from 16 to 18 feet. Above this, in the deepest part of the harbor, is 35½ feet of water at mean low tide. The tunnel under the harbor is about 20½ feet high inside; about 23 feet wide, and about 2,250 feet long. Its walls are 33 inches thick at minimum measurement.

The tunnel, on the East Boston side, has grades from 4.7 to 5 per cent. At a point 250 feet southwesterly from the Harbor Commissioners' line it is about 100 feet lower than in Maverick Square. A length of about 1,350 feet in mid harbor is nearly level. Short-length grades of 5 per cent occur on the Boston side, caused by the intervention of Commercial Street, where the east-bound platform is immediately below that for the west-bound cars, their depths below the street being respectively 66½ and 50 feet. There are pumpwells and chambers under the harbor.

In constructing the tunnel the shaft in Lewis Street was sunk to grade, and sidewalls were commenced in small tunnel drifts. A steel roof-shield spans these sidewalls and is pushed forward on them by means of hydraulic jacks. As the roof-shield is advanced step by step the arch is put in place inside. An air lock is built at a distance of 100 feet within the tunnel, by means of which air may be compressed to the degree necessary to prevent any objectionable flow of water into the working portion of the tunnel. A most interesting and important feature of the tunnel is its arrangement as to ventilation. In respect to good air, it is well known that the Boston underground system cannot be rivaled by any of its contemporaries. The City and South London Railway, 3½ miles long, consists of two cast iron tubes about 11 feet in diameter.



OLD RESERVOIR, UNEARTHED IN MAVERICK SQUARE.



A QUARTER SECTION OF THE EXCAVATING SHIELD.

APPROACH TO THE BOSTON TUNNEL, MAVERICK SQUARE.

THE MONOLITHIC, CONCRETE, ROOF OF THE TUNNEL.