THE PLEISTOCENE OF NORTH AMERICA AND ITS VERTEBRATED ANIMALS FROM THE STATES EAST OF THE MISSISSIPPI RIVER AND FROM THE CANADIAN PROVINCES EAST OF LONGITUDE 95°.

BY

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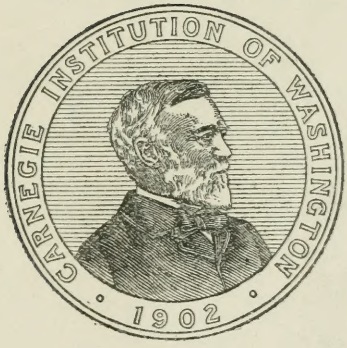

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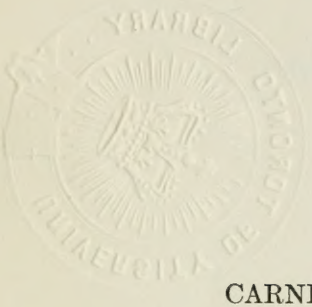

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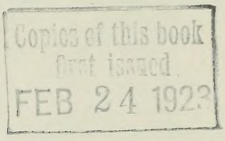

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PREFACE.

The writer has been engaged for several years on an investigation of the Pleistocene geology of North America and of the Vertebrata which have been discovered in the deposits of this epoch. It had been his expectation to publish the results of all his studies at the same date. However, on consultation with Dr. John C. Merriam, it was agreed that it would be better to publish immediately that part which pertains to the region lying east of the Mississippi River and, as to the country further north, that east of longitude 95°.

At the outset the writer was convinced that, before just conclusions could be reached, it was necessary to know what fossil materials had been collected and under what geological and geographical conditions. He therefore made as thorough a search as possible of the literature for reports of discoveries of fossil vertebrates. Also, when in scientific journals or in newspapers the finding of fossils was recorded, recourse was had to correspondence, thus securing much exact information as to locality, kind of matrix, depth, and other important data. Often photographs have been obtained and even the materials themselves. The writer has also visited many museums and colleges throughout the country and examined their collections. Even in the smaller institutions, where perhaps only a few objects have been secured and preserved, some of these have furnished important information. Regret may be expressed that in the larger museums and colleges, as well as the smaller ones, too often there have been preserved only meager or no records regarding the history of what would otherwise be valuable specimens.

In order to show the geographical distribution of the most important species that occur in considerable numbers, a series of maps has been prepared, pertaining to the following:

Whales and porpoises.	Mastodons, mostly Mammut.	Cervus.
Seals and walruses.	Horses, mostly Equus.	Rangifer.
The edentates.	Tapirs.	Musk-oxen.
Elephas primigenius.	Peccaries.	Bisons, extinct.
E. columbi.	Camels.	Bison bison.
E. imperator.	Odocoileus.	Giant beavers.
E. species undetermined.		

Where the map of a State has become too crowded with numerals, a special map of that State for that species or genus has been prepared. There are maps of the edentates in Florida; mastodons of Indiana, of New York, of Ohio, of Michigan, of Florida; *Elephas columbi* in Florida; *Elephas imperator* in Florida; horses in Florida.

Other maps and figures for illustration of the Pleistocene geology will be found in their proper places.

The first part of the present volume is occupied by a consideration of the specimens recorded on the maps. Such information is noted as could be secured, often satisfactory, little enough sometimes; but it has been found that one can not foresee what important information a given fossil

may furnish. At least, the presence of the fossil at a locality indicates the existence there of Pleistocene deposits of some kind. In cases where other species have been associated with the one mapped and described, these are noted.

When the consideration of these mapped species and genera is completed, the Pleistocene geology of the various States and provinces is taken up, so far as it is related to the vertebrate palæontology. This involved an examination of much of the literature of the Glacial period; and here one soon finds himself in face of huge tomes and endless articles and detailed maps. Only somewhat less in amount is the literature of the States beyond the glaciated area. The opportunity to misunderstand and to commit errors is unlimited, and the writer can only hope for lenient criticism.

An attempt has been made in the case of all vertebrate fossils to determine their geological relations and to derive some general conclusions regarding the history of our Pleistocene vertebrates and their relation to the divisions of the Pleistocene epoch. The conclusions reached are embodied in the immediately succeeding pages.

Not much attention has been given to the fossil invertebrates and plants. It is evident that neither the mollusks nor the plants have undergone any considerable change during Pleistocene times and are therefore not available as indicators of geological stages, though often useful for determining local climatic conditions. Their value can be better utilized by the palæomalacologists and palæobotanists.

To the officers of museums and colleges and to the private individuals who have so freely offered the use of their materials and in other ways aided the writer, he takes pleasure in expressing his sincere thanks. Most of all, however, he is indebted to the Carnegie Institution of Washington for the generous support extended during the years of this investigation.

JUNE 1, 1922. OLIVER P. HAY.

THE PLEISTOCENE OF NORTH AMERICA AND ITS VERTEBRATED ANIMALS.

CONCLUSIONS REGARDING THE DIVISIONS OF THE PLEISTOCENE.

I. Limits of the Pleistocene.

The Pleistocene is regarded as being equivalent to what is known as the Glacial period. It began with the deployment of the ice-sheets which, proceeding from their centers of accumulation in British America, laid down in the East the Jerseyan drift and in the West the Nebraskan. The more the Glacial period is studied the more one becomes impressed with the significance of its physical effects on the northern hemisphere and with its influence on the vertebrate life. Doubtless its effects on the world in general are only beginning to be comprehended. The writer knows of no other phenomena, geological or biological, which so well characterize the Pleistocene period as do those comprehended under the term Glacial. They constitute the key to the determination of the subdivisions of the epoch and of their succession and to the history of the vertebrates which during this time occupied the continent.

II. The Blanco Pliocene.

The Blanco is held to belong to the upper, or to the uppermost, Pliocene. It is at present assigned to the Middle Pliocene (Osborn, Bull. U. S. Geol. Surv. No. 361, p. 81; Matthew, ibid., p. 120). Until recently the oldest known Pleistocene vertebrates appeared to be represented by the collections which long ago were made at Fossil Lake, Oregon, and at Grayson (Hay Springs), Nebraska. These assemblages had formerly been referred to the Pliocene, and the belief that they belong there is not yet wholly without supporters. It seemed, therefore, proper to retire the Blanco somewhat. The discovery that the Fossil Lake and Grayson faunas were represented in the Aftonian deposits of Iowa, and belonged probably to the first interglacial stage, reveals the fact that the geological interval between the Blanco and the Aftonian is at least partly filled by the first glacial stage, the Nebraskan. Naturally, it is to be expected that the breach between the earlier and the later faunas will be occupied, in part at least, by the vertebrates of the Nebraskan. What these are is not yet well determined; but the writer believes that as the Blanco and its equivalent and closely related formations and faunas become better known, they will be attracted close to the Pleistocene.

Aside from the facts just mentioned, the Blanco fauna seems to the writer to be more closely related to the Aftonian than has been supposed. The genera which occur in the Blanco are the following:

Megalonyx.	Protohippus.	Stegomastodon.
Mylodon.	Platygonus.	Felis.
Glyptotherium.	Pliauchenia.	Amphicyon?
Hipparion.	Anancus.	Borophagus.
Pliohippus.	Gomphotherium.	Canimartes.

Of these, *Megalonyx, Mylodon, Hipparion, Platygonus, Anancus, Gomphotherium?, Stegomastodon,* and *Felis* are known from the first interglacial stage. *Anancus* includes mastodons with short, tuskless lower jaws and trefoiled molars. *Gomphotherium,* having long lower jaws with tusks, upper tusks with enamel band, and with trefoiled molars, may be represented by some of the early Pleistocene species. The same species of *Stegomastodon* appears to be present in the Blanco as in the Pleistocene, *S. mirificus.* The edentate *Glyptotherium* is not far removed from *Glyptodon* of the early Pleistocene. The Blanco genera of horses are so close to *Equus* that Cope regarded them as belonging to this genus.

The matter may be looked at from another point of view. If *Mylodon, Megalonyx,* and *Glyptotherium* are referred to the Middle Pliocene, we shall probably have them recorded as living in Texas before they existed in South America. It is true that Santiago Roth (Neues Jahrb., Min. Beil., Bd., vol. xxvi, table opposite p. 144) states that *Glyptodon* occurs in the Lower Pampas beds, and these he refers to the Upper Miocene; but the writer believes that Wilckens (Neues Jahrb. Min. Beil., Bd., vol. xxi, p. 193) is more nearly correct in placing them in the Pliocene. While the opinion may be correct that, when no obstacles intervene, the time required for mammals to spread over even a continent constitutes but a small part of a geological age, yet in making their way from South America, especially from Argentina, along the narrow bridge that appears to have been offered them, probably over mountain ranges, and across rivers and gorges, and in the face of the competing fauna advancing from the north, some of which were wolves and saber-tooth tigers, the slowly plodding and inoffensive edentates would have encountered too many hindrances to be able to make the journey in a short time.

The writer, therefore, ventures to range the Blanco immediately below the Pleistocene. On about the same level may be placed the Tulare-Etchegoin and the Thousand Creek formations of Merriam (Bull. Dept. Geol. Univ. Calif., vol. x, pp. 425, 429).

III. The Historical Divisions of the Pleistocene.

The writer accepts the divisions of the Pleistocene which the geologists appear to have established. Formerly it was believed that North America had been subjected to a single glacial epoch; now it seems to be proved that there have occurred five such glacial epochs, or stages, and that there have intervened four interglacial stages of mild climate. The interglacial stages are italicized. The Nebraskan stage is the earliest, the Wisconsin the latest: Wisconsin, *Peorian,* Iowan, *Sangamon,* Illinoian, *Yarmouth,* Kansan, *Aftonian,* Nebraskan.

The characteristics of the various stages will be briefly discussed. The stages are not equally well understood and at present do not seem to be of equal importance in their relation to vertebrate paleontology.

IV. Elevations of the Continent Immediately Preceding or Accompanying the Opening of the Pleistocene.

In pursuing the study of the Pleistocene, one soon realizes that this period was one of great geological activity. Ranges of mountains, if not begun anew, were at least raised to greater altitudes. The Cascade Range appears to have begun to rear its head at the beginning of the epoch, or even a little later. Here and there the crust of the earth was ruptured and great sheets of lava were poured out over the land. Ice caps repeatedly accumulated over large areas in North America and Europe, and in their movements southward transported vast amounts of earthy débris and turned the courses of great streams. Apparently at times the rainfall was greatly increased. The rivers, quickened by greater slope and the increased volume of water, cut their channels deeper and in the mountains excavated profound gorges. Through elevation of the land North America was, late in the Pliocene or early in the Pleistocene, put into easy communication with Asia and South America, so that vertebrated animals passed freely to and fro. A part of these activities probably belonged to the latter part of the Pliocene. In the more elevated regions of the eastern United States, through the chemical, rupturing, and transporting properties of water, rocks were dissolved and their disintegrated materials produced what has been designated the Lafayette formation; but it is possible that this belongs to the early Pleistocene.

V. Connections with Asia and South America.

Mention has just been made of a land connection with Asia at some time about the beginning of the Pleistocene. The evidence for this may be called circumstantial rather than direct. The geological evidence has not been developed. If any deposits containing marine fossils had been laid down along the Asiatic and Alaskan coasts during a time of elevation, they would now be covered by the sea. Our evidence for the connection is derived from the distribution of the vertebrate animals. During the early Pleistocene our country was invaded by a host of mammals whose home was originally in Asia. These included elephants, bisons, elk, goats, bears, wolves, and foxes, besides many mammals of smaller size. It is the presence in America of the smaller animals, many genera of rodents of Asiatic origin, that shows that there must have been a land connection. These could not have made their passage across Bering Strait on the ice, as it might be imagined the larger animals did.

The way between the two continents had more than once before been open, but it was during the early Pleistocene that modern Asiatic genera entered North America in great numbers. Exactly where the land bridge between the two countries was situated is not certain; it may be that a large part of the area now occupied by Bering Sea was then dry land. Arldt (Entwicklung der Kontinente, plate 21) represents a connection

extending from the northern border of Alaska southward to include the Aleutian Islands. Where narrowest, this bridge, as represented by the author named, extended from latitude 60° to 70°, a distance of about 700 miles. In such case the cold currents from the Arctic Ocean would have been prevented from entering the Pacific, while the Japan Current would have warmed up the southern side of the bridge. The route was then open on the north for the boreal animals of Asia to enter Alaska; while on the south the genera inhabiting the more temperate part of eastern Asia would have had free access to the American shore. Once on the continent, the boreal mammals might have spread along the shores of the Arctic Ocean and those of the temperate parts of Asia have made their way up the Yukon Valley, or possibly along the Pacific coast, to the warmer regions toward the south. We do not need to suppose that even during the first glacial, or Nebraskan, stage the climate of that part of North America was as inclement as now.

At the other end of our continent a train of events not wholly dissimilar was in motion. Even in the latter part of the Pliocene some South American edentates, such as *Megalonyx, Mylodon,* and *Glyptotherium,* had reached Texas. Probably a little later the bridge had become widened so that other edentates and a few genera of South American hystricine rodents swarmed into our southern borders. At the same time a host of carnivores, tapirs, horses, camels, peccaries, deer, and cricetine and sciurine rodents made their way into South America. It is now certain that the land bridge over which the interchange took place did not include the West Indies. Possibly there yet remained along the western coast of Central America some of the border, now submerged, which Schuchert (Bull. Geol. Soc. Amer., vol. xx, plates 96 to 100) represents as being present during the Tertiary.

VI. The Sources of the Vertebrates of the Pleistocene.

The Pleistocene vertebrate fauna of North America has been derived from three sources. One component had descended from the animals which occupied the continent during the late Tertiary, but even these were of mixed derivation. A few appear to have filtered in from South America during the Pliocene; others had come from Asia during Tertiary invasions; but a large element was native to the country. As such may be taken the camels, the peccaries, the three-toed horses, the prong-horn antelope, the deer of the genus *Odocoileus.*

Upon a continent of vast extent and great fertility, possessing unbounded variety of climate and habitat, all these animals were thrown together to struggle for their existence. We must depend upon the imagination to picture what the result would have been if nature had pursued a course which might have been predicted. What the result in reality was, we shall see.

VII. The Richness of the Pleistocene Vertebrate Life.

It will be profitable to consider briefly the character of the Pleistocene vertebrate fauna. The writer has compiled a list of the species which have, so far as he knows, been collected and described up to this time. There are in all 637 species; of these, 387 belong to the mammals, 154 to the birds,

26 only to the reptiles, 7 to the amphibians, 56 to the bony fishes, and 7 to the group of sharks and rays. Certainly these form only a part of the species which existed. At present there are known in our existing fauna north of Mexico 693 species of mammals, excluding the cetaceans—somewhat more than twice the number of known Pleistocene species. It is, however, rather in the great variety of forms that the Pleistocene excelled. Following Gerrit S. Miller's Land Mammals of North America, 1912, we find in our present fauna north of Mexico 29 families; in the Pleistocene there are now known 37 families, not including the cetaceans. In our existing mammalian fauna there are recognized 111 genera; in the Pleistocene, with hardly half as many species recorded, 138 genera are counted. In order to realize more vividly the variety of Pleistocene forms, we have only to recall the animals then present, now absent, namely, the great ground-sloths, the glyptodons, the numerous species of horses, tapirs, numerous peccaries, camels, the extinct relatives of the musk-oxen, extinct bisons, elephants, mastodons of three or four genera, the giant beaver, and the saber-tooth tigers. Among the birds, reptiles, batrachians, and fishes, there were few striking forms, and these were mostly among the birds and the tortoises.

The above account shows the great richness of the vertebrate life during the Pleistocene; furthermore, this abundance evidently existed during the early stages of the epoch. It constituted the materials on which that combination of conditions which we call environment had to work during Pleistocene times. The comparison shows that the result was an impoverishment of the vertebrate fauna. Genera and families, even orders, were wiped out of existence, and these included some of the noblest animals that have graced the face of the earth, the elephants, the mastodons, tapirs, many species of bison, horses, saber-tooth cats, huge tigers, and gigantic wolves. The following nine or ten families became either wholly extinct or continued to exist only in other more hospitable lands: the Megatheriidæ, including several genera of ground-sloths; the Hoplophoridæ or glyptodons; the Caviidæ, which embraced one or more species of huge capybaras; the Elephantidæ, under which are arranged three or four species of elephants and three genera of mastodons; the Equidæ, represented by a dozen or more species of horses; the Camelidæ, of which there were several Pleistocene species and probably three or four genera; the Hyænidæ, of which there appears to have been at least one genus, with one species; the Tapiridæ, including three or four species; and probably the Rhinocerotidæ. Besides these, the subfamily of Felidæ known as Machairodontinæ, embracing those wonderful carnivores the saber-tooth tigers, was suppressed. The Dasypodidæ, which included some armadillos 5 or 6 feet long, are now represented by only one small species in Texas. Of the Tagassuidæ, to which belonged several genera and stately species of peccaries, there exists now in North America north of Mexico but one species, an animal of only moderate size.

VIII. On Evolution During the Pleistocene.

We have seen that the Pleistocene fauna was very different from that which existed when white men first entered the country; also that the

difference has in large part been due to the destruction of species, genera, and families. We may now inquire whether or not the loss has been to any considerable extent compensated by the development of new forms. Many of our existing genera and species have been found in the collections that represent the earliest Pleistocene known to us. The writer believes it would be unsafe to say that any living species that one might select may not hereafter be discovered in early Pleistocene collections. It is probably true, however, that some of those small changes by which we distinguish one species from another have been produced. Some small but persistent differences might, for example, have arisen in the teeth or in the form of the skull of a group of muskrats which would justify us in regarding it as forming a new species. It is extremely doubtful that any new genus of vertebrates has been developed since the first interglacial stage. Matthew has concluded (Science, n. s., vol. XL, pp. 232–235) that the evolution of the mammals during the Pleistocene amounts to about one-tenth of that achieved during the Pliocene. The present writer regards this as a liberal estimate.

This failure to evolve new genera and species is not necessarily to be attributed to the shortness of the Pleistocene period; it may have been due rather to the unfavorable conditions. In what direction could an animal make progress when, after being subjected for some thousands of years to one set of conditions, it was compelled for some other thousands to endure just the opposite conditions? If life in front of a glacier for some centuries led to the development of a coat of hair on an elephant, that coat would probably disappear during the succeeding interglacial stage, and in the end, if the elephant had not perished, he would be where he began.

Too much stress must not, however, be placed on this suggestion. It may yet be possible to show that nowhere in the world was any considerable progress made by mammals during the Pleistocene, in the modification of their forms and structure. On the other hand, it is also possible that all over the world climatic conditions were at intervals unfavorably affected by the development of the great glaciers and that all life was retarded in its evolution. The writer believes, therefore, that it can not be shown with certainty that new forms of living things, especially vertebrates, were developed in North America during the Pleistocene. It may be quite as difficult to prove that any genera or species of importance entered from other lands after the first invasion. Under these conditions there appears to be no means for determining successive faunas other than through recording the time of the disappearance of genera and species.

IX. Did the Extinction of Species Take Place Mostly at the End of the Pleistocene?

At the beginning of the Pleistocene there existed, as has been shown, an abundant and highly varied mammalian fauna; at the close of the epoch this fauna had become relatively impoverished. Did all those families and genera and species, that in the end were missing, perish during or after the last glacial stage, the Wisconsin? This opinion has been expressed by some. The writer believes that this view is wholly improbable.

A glacial sheet, stretched across the continent or a large part of it, was not local in its effects; it was not a cap of ice merely concealing a part of the land and covered possibly by forests and allowing occupation by certain hardy animals, while beyond, up to its foot, the country was pleasantly cool, wooded, and abounding with animated creatures. In the Sierra Nevada Mountains of California (Lindgren, Folio 66, U. S. Geol. Surv.) and of Nevada (Knopf, Prof. Pap., U. S. Geol. Surv., 110, pp. 92–105) and in the San Juan Mountains of Colorado (Atwood and Mather, Jour. Geol., vol. xx, p. 385), at distances of approximately 600 or 700 miles from the glacial front, there existed, during more than one stage, extensive local glaciers. Along the Atlantic coast during at least one glacial stage the walrus was driven as far south as Charleston, South Carolina. One can hardly doubt that the whole continent was chilled during each of the glacial stages.

To mammals, which for perhaps various reasons had been with difficulty enduring the stress of existence, the glacial climates would give the final stroke; perhaps to others the interglacial climates would have been quite as fatal. We can not doubt that each glacial and each interglacial stage swept away a few of the less hardy genera and species. Nevertheless, several remarkable animals passed through the vicissitudes of all the glacial and interglacial times and left their bones in the deposits overlying the last, or Wisconsin, drift. Such are two species of elephants, the American mastodon, the giant beaver, and one or more species of peccaries. Why they succumbed at last is difficult to say. Possibly the return of a fifth warm era proved too much for their endurance.

A reason for believing that the genera and species missing from the fauna found here when white men arrived, called sometimes the Columbian fauna, were exterminated gradually and not at one epoch is that certain ones are found in deposits overlying the earlier glacial drift sheets, but are not found in deposits on later drifts. Camels occur in Aftonian beds overlying the Nebraskan drift, but have not been collected in later interglacial deposits. Horses grow scarcer as the Pleistocene advances. They are known from deposits overlying the Illinoian drift, but do not appear after the Wisconsin.

X. The Stratigraphical and Time Limits of the Earliest Pleistocene.

It is necessary to determine, if possible, where the boundary-line shall be drawn between the Pliocene and the Pleistocene. Room must be made for the first interglacial, the Nebraskan, and its fauna. How long this first glacial stage continued we do not know. Chamberlin and Salisbury have indicated (Geology, vol. III, p. 420) that in a rough way the dates from the present of the culmination of the various glacial stages, except the Nebraskan, taken in order backward, may be represented by the geometrical series 1, 2, 4, 8, 16. That is, if the Illinoian stage had its culmination 150,000 years ago, that of the Kansan occurred 300,000 years ago; if the Nebraskan should fall in the same series, it culminated 600,000 years ago; and it and the succeeding Aftonian interglacial held sway as long as all the rest of the Pleistocene put together. It would be rash to assert that this first glacial did last so long; but we see the possibilities. In a personal

communication Professor Frank Leverett writes that he estimates that the Kansan culmination took place at not less than 400,000 years ago and the Nebraskan at 500,000. This, as the present writer estimates, would leave for the Nebraskan itself somewhere near 40,000 or 50,000 years. Some changes in the life of the Pleistocene must have been wrought during those years.

The glacial deposits of the Nebraskan stage are not as well known as one might wish. They appear to be in general overlain by the later drifts and are observed mostly where streams have cut through both the overlying drift and the Nebraskan. The old drift found in New Jersey is thin and of no great extent. Moreover, we can hardly expect to find fossil vertebrates in the drift itself. We must therefore depend on studies of supposed Nebraskan fossils found mostly outside of the glaciated area and make comparison of them with earlier and later faunas. If we shall discover collections of Nebraskan vertebrate animals, we may be sure that they will differ from those of the first interglacial, the Aftonian. We may be pretty certain that they will include autochthonous genera of the late Tertiary, which may be missing from the Aftonian, together with at least a few genera from South America and others from Asia.

Now, have any formations and included fossil vertebrates been found which may be fitted into the Nebraskan interval?

In this stage the writer places the beds which Cope designated the Idaho formation (Cope, Proc. Acad. Nat. Sci. Phil., 1883, p. 135). Since Cope's time several new species have been added to his list from this formation. In 1917 (Bull. Dept. Geol. Univ. Calif., vol. x, p. 432), Dr. J. C. Merriam published a list of the fossils, except fishes, which had been secured up to that time. The list of species referred to the Idaho formation is as follows:

Equus idahoensis.
E. excelsus?
Protohippus?
Rhinoceros, probably Aphelops (Teleoceras) fossiger.
Mastodon mirificus.
Cervus, possibly new. Smaller and more slender than C. canadensis.
Procamelus, size of P. major.
Tragocerus? horn-core of antelope.
Ischyrosmilus n. sp.
Morotherium leptonyx.
Castor, possibly n. sp.
Olor, size of O. paloregonus.
Graculus idahoensis.

In this collection the presence of horses of the genus *Equus*, of *Cervus*, *Morotherium*, and *Castor*, is strongly suggestive of the Pleistocene. The type of *Mastodon mirificus* was found in Pleistocene deposits of probably Aftonian age. Although rhinoceroses are supposed to have become extinct before the end of the Pliocene, this supposition may be an error. The list of Blanco vertebrates is a short one, and the absence of a genus from it is not decisive. One drawing of a seine in the sea-waters of Florida would furnish inadequate materials for conclusions about the fish fauna of that coast.

The Thousand Creek fauna (Merriam, Bull. Dept. Geol. Univ. Calif., vol. x, p. 429), which to the present writer appears of about the same age as the Blanco, contains a species of *Teleoceras*. The genera *Protohippus* and *Procamelus* might be supposed to have continued their existence and evolution until interrupted by an age of ice and by competitors from Asia.

In 1917 (Bull. cit., vol. x, pp. 255–266) Merriam and Buwalda published a short list of fossils which they had collected along the Columbia River in Washington State. A horse was found which was referred to *Equus* or *Pliohippus;* also two camelids, one of which was thought to be near *Pliauchenia.* Merriam concluded that the evidence on the whole favored the Pleistocene. The list will fit into the Nebraskan without difficulty.

In 1889 (Amer. Naturalist, vol. xxiii, p. 253), Professor E. D. Cope published a list of fossil mammals collected in the "Oregon desert," apparently somewhere in the region of Silver Lake or Summer Lake. The list is as follows:

Canis sp. indet.	Holomeniscus or Auchenia.	Hippotherium relictum.
Elephas or Mastodon.	Aphelops sp. indet.	Equus sp. indet.

Cope looked upon this collection as remarkable in that it showed the presence of true horses and camels associated with a rhinoceros. He concluded that the fossils belonged to his Idaho formation. Dr. W. D. Matthew thought that the collection was a mixture of fossils from two formations (Bull. Amer. Mus. Nat. Hist., vol. xvi, p. 321). It may, however, have been made in Nebraskan deposits.

In 1921 (Proc. U. S. Nat. Mus., vol. lix, pp. 617–638), the writer described a collection of vertebrate remains from Anita, Coconino County, Arizona. These remains were found in a cave in making explorations for copper ore. The list follows:

Equus occidentalis.	Antilocapra americana?	Brachylagus browni.
E. giganteus?	Marmota arizonæ.	Taxidea robusta.
Mylohyus? sp. indet.	Citellus tuitus.	Canis nubilus?
Procamelus coconinensis.	Neotoma cinerea.	C. latrans?
P. longurio.	Lepus benjamini.	Chasmaporthetes ossifragus.

The writer believes that this assemblage of mammals must be referred to the Pleistocene. It will be noted, however, that there are two species of the genus *Procamelus.* These resemble so much two species, *P. major* and *P. minimus,* described by Leidy and Lucas (Trans. Wagner Free Inst., vol. iv, pp. i-xiv, 15-61) from the Alachua clays of Florida, that it seemed at first necessary to identify them as such. The genus *Procamelus* seems, therefore, to be brought definitely into the early Pleistocene, probably the Nebraskan.

The collections made in the Alachua clays in Florida were obtained in Alachua and Levy counties. On pages 195 and 375 will be found an account of the geological conditions under which the fossils were found, and lists of the species. The essential features are that such supposed Miocene or Pliocene genera as *Gomphotherium, Procamelus, Teleoceras,* and *Aphelops* were found associated with the Pleistocene genera *Odocoileus, Tapirus, Megatherium,* and *Equus.* This has been explained on the theory that the clays are of Tertiary age and that the Pleistocene species had become mingled with those of an earlier time. At a number of places in Florida where phosphate rock has been mined there have been secured similar associations of early camels, rhinoceroses, horses (*Hipparion, Parahippus*) with genera belonging undoubtedly to the Pleistocene. This has occurred so often that the writer doubts the correctness of the explanation given.

He ventures, therefore, to include in the Pleistocene of the Nebraskan stage the various deposits that have received the names Alachua clays, the Dunnellon formation, and Bone Valley formation. The latter, called also the land-pebble phosphates, is believed by Sellards to be contemporaneous in age with the Dunnellon or hard phosphates, but to have accumulated under different conditions. Both the Alachuan and the Bone Valley formations were referred by Sellards to either the late Miocene or the early Pliocene, with an evident preference for the latter. It seems to have been the presence of the rhinoceroses that most influenced him in his assignment of the deposits; but there were naturally other considerations. He wrote:

> The presence of rhinoceroses in the formation is believed to establish definitely the fact that the beds can not be later than the early Pliocene, since rhinoceroses in America apparently did not survive beyond that time (Fla. Geol. Surv., vol. VII, p. 73).

According to Sellards the hard phosphate, belonging to the Alachua (Dunnellon) formation (Fla. Geol. Surv., vol. v, p. 37) resulted from a disintegration of underlying Upper Oligocene deposits and probably the Vicksburg limestone. Through chemical action these rocks were partly dissolved and the residual materials were mixed by local subsidence and by action of streams and later modified by chemical changes.

The land-pebble phosphate of the Bone Valley formation had, Sellards concluded (Fla. Geol. Surv., vol. VII, p. 55), resulted from underlying phosphate marls of Upper Oligocene age. This occurred during a time of general subsidence of sufficient extent to permit marine waters to reach the area covered by the Bone Valley phosphates. The presence of sea-water is indicated by the occurrence of bones of cetaceans.

With regard to the effects of streams and of the chemical action of the water on the rocks, which contributed to the formation of the hard rock-phosphate and the production of sinks and caves, it may be remarked that we know of no time when rocks were dissolved and caves formed to the extent that they were during the Pleistocene.

As shown on page 15, various deposits of marine marls along the Atlantic coast are referred by the writer to the Nebraskan. Among these marls are the coquina rock found at St. Augustine and the marine marl underlying the bed at Vero, which contained early Pleistocene vertebrate fossils. These marls are known to extend well inland, being found at Kissimmee, 50 miles from the coast. In some places they are met with at depths of 70 feet (Sellards, Fla. Geol. Surv., vol. VIII, pp. 105–106). Marls of probably the same age occur on the western coast of Florida (Dall, Bull. 84, U. S. Geol. Surv., p. 152). The writer believes that some of these marls may yet be connected with the phosphate beds of the Bone Valley formation.

A figure taken from Sellards (Geol. Surv. Fla., vol. VII, opp. p. 53) may be found on page 377. This illustrates the relation of the Dunnellon and Bone Valley formations to the underlying deposits.

XI. The First Interglacial, or Aftonian, Stage.

Mention has been made of collections of fossil vertebrates which long ago were secured at Fossil Lake, Oregon, and of others along Niobrara

River, near Grayson, Nebraska. Lists of the species found at each locality were given by Dr. W. D. Matthew in 1902 (Bull. Amer. Mus. Nat. Hist., vol. XVI, pp. 317–320). These deposits and animals were regarded by Cope and Marsh as belonging to the Pliocene, until G. K. Gilbert, in his work on Lake Bonneville (Monogr. I, U. S. Geol. Surv., pp. 393–402) showed that the Oregon fossils must belong to the Glacial epoch, but he referred them to a late time in this epoch, that of the last glaciation. It thus became quite impossible to determine the age of any collection of fossil vertebrates.

In 1887 (Univ. Geol. Surv. Kansas vol. II, pp. 299–308), Williston wrote:

> Every fact furnished from Kansas seems to substantiate Cope's conclusion that the *Megalonyx* fauna of the East and the *Equus* fauna of the West were contemporaneous and that both occurred during the period of depression; that is, during late Pleistocene time.

This paragraph was quoted by Osborn in 1910 ("Age of Mammals," p. 453), who appears to agree in part with Williston, although he expressed the opinion that some of the deposits were earlier than the others. Osborn supported the view of the existence of two faunas, that of the "*Equus* zone" and that of the "*Megalonyx* zone." The former fauna was regarded as the older, but overlapping somewhat during the "mid-Pleistocene" the *Megalonyx* fauna. He presented a catalogue of deposits belonging to his *Equus* zone (his page 453) and another of those of the *Megalonyx* zone (p. 467). In the latter he included deposits that he would now doubtless refer to the earliest Pleistocene, for example, the Ashley River beds.

It was necessary for the geologists to come again to the rescue of the palæontologists. They established the fact that there had passed, not a single glacial stage, but a series, and that these had been separated by corresponding interglacial stages. They were able to show also that between the drift sheets there were to be found remnants of old gravels and fossil-bearing soils. In Iowa, through the careful researches of Calvin and Shimek, numerous remains of fossil mammals were discovered in gravels lying between the earliest drift, the Nebraskan, and the second drift, the Kansan. Among these mammals were identified horses, camels, elephants (*E. columbi, E. imperator*), *Mylodon, Megalonyx,* and a large ruminant which is certainly a species of bison. This fauna, known as the Aftonian, was correlated by Calvin with that of the Sheridan beds of Nebraska (Bull. Geol. Soc. Amer., vol. XX, p. 354). The writer has had the opportunity to study this Aftonian material (Iowa Geol. Surv., vol. XXIII), and, although it is not as abundant as might be desired, he agrees with Calvin's correlation.

Making due allowances for environment and the hazards attending preservation and collection, the Aftonian and Sheridan fauna is practically the same as that found at Fossil Lake, Oregon. Furthermore, it may be traced along the plains into Texas and to the shores of the Gulf. Here, at or near tide-level, or not far away, may be found horses, camels, elephants (*E. columbi* and *E. imperator*), *Mammut americanum,* and mastodons with teeth presenting trefoils. In Texas, within a mile of the Louisiana line, *Elephas imperator* has been collected. The fauna reappears on the west coast of Florida; also on Peace Creek; on the east coast at Vero; at Brunswick and Savannah, Georgia; along Ashley River, near Charleston; prob-

ably also on the banks of Neuse River, 16 miles below New Bern, North Carolina; and again probably at Long Branch, New Jersey, where *Megatherium* has been found; and finally at Port Kennedy, on Schuylkill River, about 25 miles above Philadelphia. All along the coast, apparently from the Rio Grande to Long Branch, the localities which furnish Aftonian fossils are within a few feet of sea-level.

XII. The Yarmouth Interglacial Stage.

Up to the present time the interglacial soils found in a few localities between the Kansan and the Illinoian drifts have furnished only scanty remains of vertebrate fossils—a rabbit and a skunk at the type locality in Iowa. Certainly, however, the same animals were living then that were found at later stages.

XIII. The Illinoian Glacial Stage.

To the Illinoian glacial stage the writer refers the collection of fossil vertebrates which was described in 1908 by Barnum Brown (Mem. Amer. Mus. Nat. Hist., vol. IX, pp. 157–208) and which had been obtained in the Conard fissure near Willcockson, Newton County, Arkansas. It is placed here rather than in the Sangamon stage, because of the number of species present which suggest a rather cold climate. A list of these species will be found on pages 31–32 of volume XXIII, of the Iowa Geological Survey.

XIV. The Sangamon Interglacial Stage.

This was the warm stage which succeeded the glacial Illinoian. Between the Illinoian and the Wisconsin there passed a long period of time. It is now believed that it was interrupted by the Iowan ice-sheet, but this appears not to have lasted long nor to have occupied any considerable area. Associated with it in some way was the accumulation of much loess. This was formerly supposed to have been deposited to a large extent at least during the Sangamon; but, as Leverett informs me, it appears to have been laid down at a time nearer the Wisconsin than the Illinoian. This Iowan drift and the loess has been the subject of a special investigation by Alden and Leighton (Iowa Geol. Surv., vol. XXVI, pp. 49–212). Few vertebrate fossils have been found in the loess. Their bones may have been dissolved out by the percolating rain-water, and yet the delicate shells of land mollusks are abundant. A collection which the writer regards as belonging rightfully to the Sangamon was made at Alton, Illinois, many years ago, by William McAdams. A list of the species and an account of the geological conditions connected with it are presented on page 339. The remains appear to have accumulated in a pond on the Illinoian drift and to have been covered by loess. The horse was yet in existence, as well as the deer *Sangamona* and the antelope *Taurotragus americanus*. Two-thirds of the 15 species are extinct. A smaller number of species have been collected near Kimmswick, just below St. Louis, Missouri. The remains found in a cave in Bexar County, Texas, are believed to belong here (Hay, Proc. U. S. Nat. Mus., vol. LVIII, p. 129). It is, however, in the Alleghany Mountains that most of the vertebrates have been collected which the writer refers to the Sanga-

mon stage. These have been found in caves and fissures from northern Pennsylvania to northern Alabama. Unfortunately, although mostly discovered several years ago, some of these collections have not yet been well studied and have not been accessible to the writer. They contain two or three species of horses, two or three genera of peccaries, tapirs, the deer *Sangamona*, the antelope *Taurotragus*, and one or more species of sabertooth tigers. Half or more of the species are extinct. To the writer these assemblages seem to fit into the history nowhere so well as into the Sangamon stage.

Another assemblage that probably belongs here is that made at Toronto (p. 282). This indicates a warm climate, since the papaw and the osage orange grew there.

XV. The Peorian Interglacial Stage.

This is the interglacial interval between the Iowan glacial and the Wisconsin. It was probably not of long continuance and is chiefly remarkable for the deposition of loess. This has not furnished any important collections of vertebrate fossils. The type locality for the Peorian stage is a locality east of Peoria, Illinois. Leverett (Monogr. xxxviii, U. S. Geol. Surv.) mentions several cases in which old soils believed to belong to the Peorian were observed in Illinois. None of these has furnished vertebrate fossils. It is usually difficult to distinguish the Sangamon from the Peorian soils.

XVI. The Wisconsin Glacial Stage and the Wabash Beds.

The next stage which furnishes abundant vertebrate fossils is the Wisconsin. These remains are found most abundantly in the old soils and mucks which accumulated in the swamps, ponds, and lakes left on the uneven surface of the Wisconsin drift as the ice retired. To such deposits the writer has given the name Wabash beds. They are often called postglacial deposits; but that term ought in strictness to be applied only to deposits of the present epoch. They may be called Late Glacial, but that expression has been used for the drift and moraines produced by the second half of the Wisconsin glaciation. It might be better to use for the divisions of the Wisconsin the terms Lower and Upper.

In the late Wisconsin, or the Wabash, deposits there may be found remains of any of the existing animals of the region; also often the bones and teeth of mammals now living in more northern regions. Besides these, there may occur the relics of animals which were able to endure the rigors, changes, and competitions of the Glacial period, but succumbed at its end. These are, especially, two species of elephants, one or two species of mastodons, four or more species of musk-oxen, the moose *Cervalces*, one or more species of peccary, and the giant beaver.

XVII. On the Theory of the Pleistocene Terraces of the Coastal Plain.

The writer will discuss briefly the widely accepted theory that along the sea-coast from New Jersey to southwestern Texas there occurs a series of

terraces and corresponding escarpments, three or more in number, representing successive emergences of the borders of the continent from the sea. The theory was first proposed by Dr. W J McGee (Amer. Jour. Sci., ser. 3, vol. xxv, 1888, p. 367; 12th Ann. Rep. U. S. Geol. Surv., pt. 1, 1891, pp. 353–521). He included in the initial submergence not only the area occupied by the supposed Pleistocene terraces, but also the borders of the coasts to an elevation corresponding to the Lafayette (Appomattox) formation, which he

Conspectus of the Geology and Vertebrate Paleontology of the Pleistocene.

1 Drift-sheets and other deposits.	2 Representative collections.	3 Disappearance of genera and species.	4 Characteristic genera.
Wisconsin Stage.			
Atlantic to Pacific in Wisconsin, Illinois, Iowa, Indiana, Ohio, New York, New Jersey (Cape May, Trenton gravels), Ontario, Quebec, etc., Maine, Massachusetts.	Made in swamps and old lakes on Wisconsin drift (Wabash beds) from Illinois to Massachusetts and Cape Breton Island. Leda clays, Canada.	Megalonyx, Elephas, Mammut, Cervalces, Symbos, Boötherium, Mylohyus, Platygonus Bison occidentalis, Castoroides.	Existing mammals, plus those of column 3.
Peorian Stage.			
Old soils between the Iowan and the Wisconsin drifts where the former is present. Reported by Leverett (Mon. U. S. Geol. Surv., vol. xxxviii) from localities in Illinois. Usually hard to distinguish from Sangamon. Abundant loess in Mississippi Valley.	Fossil mammals rarely found.	None certainly known.	Few recognized. In general, those of the Wisconsin.
Iowan Stage.			
Known certainly only from Iowa and Wisconsin. Supposed to be present along New England coast, Gay Head to Maine.	None.	Mylodon, Tapirus, Equus, Taurotragus, Sangamona, Bison latifrons, B. antiquus, Ænocyon, Dinobastis, Smilodon, Smilodontopsis.	None known; but in general those of the later stages.
Sangamon Stage.			
Sangamon River, Illinois. Old soils just above the Illinoian drift. Some loess of this stage. Cave deposits in Texas and in the Alleghany Mountains.	Alton, Illinois; Kimmswick, Missouri; cave in Bexar County, Texas; bluffs at Natchez, Mississippi; salt mine at Petite Anse, Louisiana; Cavetown and Corriganville, Maryland; Ivanhoe, Virginia; Whitesburg, Tennessee; interglacial beds at Toronto, Ontario.	None known to have become extinct during this stage.	Mylodon, a few horses, tapirs, peccaries, Sangamona, Taurotragus, Symbos, Bison latifrons, B. antiquus, Elephas and Mammut.
Illinoian Stage.			
In Illinois, Wisconsin, eastern Iowa, Indiana, Ohio. Supposed glacial drift from Long Island to Massachusetts (Montauk till, etc.).	Conard fissure, Newton County, Arkansas. Otherwise none recognized.	May include some accredited to the Kansan.	Equus, Mylohyus, Symbos, Felis, Smilodontopsis, Dinobastis.
Yarmouth Stage.			
Interglacial soils and mucks between the Kansan and Illinoian in Iowa and Illinois. Gardner clay and Sankaty from Long Island to Boston.	Few vertebrates yet recognized. Skunk and rabbit at Yarmouth, Iowa.	Not known.	Few known. Doubtless those which became extinct during Illinoian and Iowan and later.
Kansan Stage.			
Iowa, Missouri, Kansas, and northwestward. Loess overlying the drift; Jerseyan drift, New Jersey (may be Nebraskan); Pensauken. Jameco gravels on Long Island, New York, and Cape Cod, Massachusetts.	Fossil vertebrates rarely found.	Megatherium, Glyptodon, Stegomastodon, Anancus, Gomphotherium?, Elephas imperator, Eschatius, Camelops, Camelus, Hydrochœrus, Aftonius, Leptochœrus, Trucifelis.	Doubtless those in the later stages of this column and some of those of this stage in column 3.

referred provisionally to the late Pliocene. This submergence required a depression of the eastern half of the continent amounting to 500 feet or more. The theory was accepted especially by the geologists of Maryland in their excellent reports (Shattuck, Maryland Geol. Surv., Pliocene and Pleistocene volume, pp. 62–137, with maps). It has likewise been applied to the geology of Virginia (Clark and Miller, Va. Geol. Surv. Bull. No. IV, pp. 48–56, 179–189), North Carolina (Stephenson, N. C. Geol. Econom. Surv., vol. III, 1912, pp. 266–290), Georgia (Veatch, Geol. Surv. Ga., Bull. No. 26, 1911, pp. 35–50), as Okefenokee and Satilla; (Stephenson, ibid., pp. 425–445), Florida (Matson and Clapp, Fla. Geol. Surv., vol. II, 1909), and to Texas (Deussen, Water Supply Pap. U. S. Geol. Surv. 335, pp. 78–83).

Conspectus of the Geology ond Vertebrate of the Pleistocene—Continued.

1 Drift-sheets and other deposits.	2 Representative collections.	3 Disappearance of genera and species.	4 Characteristic genera.
Aftonian Stage. Gravels and soils between the Kansan and the Nebraskan in Iowa, Missouri, Nebraska, and Kansas. Lake and river deposits in Nebraska and Oregon; river deposits, Pittbridge, Texas; asphalt beds near Los Angeles, California. Sands, etc. bearing vertebrate remains at or near sea-level from mouth of the Rio Grande to Sandy Hook, New Jersey.	Along Missouri River in Iowa; Fossil Lake, Oregon; Grayson, Sheridan County, Nebraska; La Brea, California; Lake Lahontan and Walker River, Nevada; Lavaca and Galveston Bays, Texas; Peace Creek, Caloosahatchee River, and Vero, Florida; Brunswick and Savannah, Georgia; Beaufort and Ashley River, South Carolina; Neuse River, North Carolina; Fish House clay near Camden, New Jersey; Long Branch, New Jersey; Port Kennedy, Pennsylvania.	None recognized. Probably some of those cited under the Kansan.	Mylodon, Megalonyx, Megatherium, Glyptodon Chlamytherium, Elephas imperator, Anancus, Gomphotherium. Tapirus, Equus, Hipparion, Camelops, Camelus, Bison regius, Hydrochœrus.
Nebraskan Stage. Drift in Iowa and Nebraska beneath more recent drifts; Idaho formation, Idaho; New Jerseyan? and Bridgeton, New Jersey; Mannetto gravels, New York, Long Island, and Cape Cod, Massachusetts; "First Glacial" at Marthas Vineyard; Arcadia marls, on Peace Creek; Alachuan clays and phosphates, and Bone Valley phosphates; marine marl bed at Vero; Coquina at St. Augustine, Florida; Quarantine Station, Southport, New Hanover County, North Carolina; Dismal Swamp, North Carolina and Virginia.	Collections made in southwestern Idaho; "Oregon Desert," Oregon; Anita, Coconino County, Arizona; Ringgold, Yakima County, Washington. In clays in Alachua and Levy counties; Dunnellon, Ocala, Brewster, and Mulberry, Florida. Horse at Marthas Vineyard?.	Gomphotherium floridanum, Protohippus, Parahippus, Procamelus, Teleoceras, Aphelops.	Megatherium, Elephas imperator, Mammut, Gomphotherium floridanum, Protohippus, Parahippus, Hipparion, Equus, Tapirus, Teleoceras, Aphelops, Procamelus, Agriotherium, Canis, Trucifelis floridanus, Chasmaporthetes.
UPPER PLIOCENE—BLANCO, TEXAS; THOUSAND CREEK, NEVADA; ETCHEGOIN-TULARE, CALIF.			
Upper Pliocene Stage. Texas, Nevada, and California.	Lists published by J. C. Merriam in Bulletin of Department Geology, University of California, vol. x, p. 425 (Etchegoin-Tulare); p. 425 (Thousand Creek); p. 434 (Blanco).	Glyptotherium, Pliohippus, Tephrocyon, Hyænognathus, Ilingoceros.	Glyptotherium, Megalonyx, Gomphotherium, Pliohippus, Hipparion, Teleoceras, Platygonus, Pliauchenia, Procamelus, Ilingoceros, Tephrocyon, Hyænognathus.

In Maryland and the District of Columbia there have been recognized three Pleistocene terraces (Shattuck, as cited above). The uppermost is the Sunderland, the next the Wicomico, the lowest the Talbot. These are not correlated by Shattuck definitely with glacial divisions of the Pleistocene, but the Sunderland is the oldest, while the Talbot is regarded the most recent, probably about the age of the last glacial stage, the Wisconsin.

When the writer began his study of the Pleistocene he accepted the theory proposed by McGee and the Maryland geologists, and traces of this acceptance may be found in this work; but he is now convinced of its falsity. It is hardly to be believed that the coastal region could have been occupied, even at intervals, since the late Pliocene, when the depression is supposed to have been at least 500 feet, and 200 feet during the Sunderland, down to the end of the Wicomico and even the Talbot, without its having left other traces of marine occupation than the supposed terraces and escarpments. There ought to appear somewhere in the long border from New Jersey to Mexico abundant and extensive deposits of stratified materials, clays, sands, and gravels. Such deposits appear to be relatively rare.

A still more serious objection to the theory of submergence beneath marine waters is the absence of marine fossils. In the materials forming these terraces one might with confidence expect to find at least marine mollusks, mussels, clams, and beds of oysters; probably also remains of fishes, of porpoises, and of whales. Leaving out of consideration the Talbot terrace, which is near sea-level (Shattuck, op. cit., p. 10), the supporters of the theory under consideration admit that not in the Lafayette, nor the Sunderland, nor the Wicomico, have any traces of such fossils been met with. On the other hand, all over these terraces are found remains of land animals and plants. Mastodons, elephants, and horses are by no means rare. Conditions favorable for the preservation of teeth of proboscideans must have been quite as well adapted to preserve shells of oysters. In the Sunderland and Wicomico a few land plants have been secured, an abundance of them in the Talbot. Map No. 39 shows the distribution of Pleistocene mammals, mollusks, and plants on the Coastal Plain of North Carolina.

It seems evident, therefore, that the sea has had nothing to do with the formation of the Lafayette, the Sunderland, and the Wicomico terraces, and little with that of the Talbot. It was natural that the advocates of this theory of the formation of these terraces during the Pleistocene should distribute them somewhat impartially over the time of this epoch, assigning the Talbot to a late interval. On page 11 the writer has called attention to the fact that in many places along the coast from southeastern Texas to New Jersey, at or near sea-level, there are beds which contain a vertebrate fauna of the Aftonian or first interglacial stage. Probably nowhere do these beds have any large amount of later materials overlying them; it is often extremely little. So far as the writer can judge, this means that all the terraces and escarpments were produced before the time of the first interglacial; not since that distant time has there occurred along the Gulf or Atlantic coasts south of New Jersey any considerable elevation or depression of the Coastal Plain.

FINDS OF PLEISTOCENE CETACEANS IN EASTERN NORTH AMERICA.

(Map 1.)

ONTARIO.

1. *Nepean Township, Carleton County.*—In 1914, Mr. L. M. Lambe, of the Canadian Geological Survey, stated (Summ. Rep. for 1913, p. 299) that Walter Billings, of Ottawa, had presented to the Survey a caudal vertebra of *Delphinapterus leucas*, found in Pleistocene gravel on lot 15, concession 5, of Nepean township. The locality is near Jock River, a stream which flows northeasterly and enters Rideau River about 11 miles south of Ottawa. With it was sent the lower end of a femur, supposed to belong to the bison.

2. *Ottawa East, Carleton County.*—In 1910, Mr. L. M. Lambe reported (Summ. Rep. Geol. Surv. Can. for 1909, p. 273) that Mr. A. Penfold had presented to the Survey a caudal vertebra of *Delphinapterus leucas*, which he had found at Ottawa East, at a depth of 25 feet, while digging a well.

3. *Smith's Falls, Lanark County.*—In 1883 (Amer. Jour. Sci., ser. 3, vol. xxv, p. 200) Dr. J. W. Dawson announced the finding of two vertebræ, a part of another, and a fragment of a rib of a large whale, in a ballast pit at Welshe's, 3 miles north of Smith's Falls. This whale he identified as *Megaptera longimana* (*M. boöps*). The bones were found in gravel at a depth of 30 feet and about 50 feet from the original face of the pit. The elevation of the place is given as about 440 feet above sea-level. Dawson stated that this corresponds exactly with the height of one of the sea-terraces on Royal Mountain at Montreal. He added that this animal might have sailed past that mountain, then only a rocky islet, when a wide sea, 400 feet above the lower levels of Montreal, covered all the plain of the lower St. Lawrence. Inasmuch as the highest terrace containing marine fossils at Montreal stands at a height of about 625 feet (Stansfield, Mem. 73, Canad. Geol. Surv., 1915) above sea-level, the region had apparently risen about 160 feet at least above its lowest submergence when the whale was buried. The discovery of this whale is mentioned by Dawson in his "Canadian Ice Age," 1894, page 268; also by Professor G. H. Perkins in his Report of the State Geologist of Vermont, 1907–8, page 83.

4. *Pakenham, Lanark County.*—This locality is about 42 miles north-northwest from Welshe's, where the whale remains just discussed were found. At Pakenham, in 1906, there were discovered bones, including a nearly perfect skull, of a white whale. The discovery was reported in 1906 and 1907 by Dr. J. F. Whiteaves (Summ. Rep. Geol. Surv. Can. for 1908, p. 171; Ottawa Naturalist, vol. xx, pp. 214–216). The remains were found by a well-digger on a farm (lot 21, 11th concession), and were embedded in blue clay at a depth of 14 feet. Immediately about the bones was a mixture of clay and shells. The animal has been referred to *Delphinapterus leucas*. As one of the ear-bones was secured, the determination of the species would appear to be possible. According to Perkins, the ear-bone in the type of *D. vermontanus* differs from that of the existing white whale, *D. leucas*. The writer is unable to say more than that the whale found at Pakenham belongs to the Late Wisconsin.

5. *Cornwall, Stormont County.*—In 1870 (Canad. Naturalist and Quart. Jour. Sci., vol. v, pp. 438–439), E. Billings gave an account of the discovery of remains of a white whale at Cornwall. Considerable parts of the skull were secured, including the lower jaws. Besides many vertebræ and some other parts, 8 teeth were saved, but the ear-bones were missing. The animal had been about 15 feet long. Whether it belonged to *Delphinapterus leucas* or *D. vermontanus* may be regarded as doubtful. Extracts from Billings's description are to be found in Professor Perkins's paper (Rep. State Geologist Vermont, 1907–8, pp. 81–82).

6. *Williamstown, Glengarry County.*—This place is about 10 miles northeast of Cornwall. In Professor Perkins's paper just cited it is stated that Edward Ardley, assistant curator at Redpath Museum, McGill University, Montreal, had found here a few bones of a white whale, the hyoid, a few phalanges, and rib fragments. It is impossible from such limited materials to determine whether the animal was *Delphinapterus vermontanus* or *D. leucas*. From Mr. Ardley, through Mr. Arthur Willey, curator of Redpath Museum, the present writer has learned that these bones were dug up from a depth of 14 feet, in a well sunken in the Leda clay. Under the surface soil was a band of sandy clay containing shells of *Saxicava* and *Mya*. Beneath this was a stiff blue clay showing stratification and containing shells of *Leda*.

QUEBEC.

7. *Montreal.*—In 1863 (Rep. Geol. Surv. Canada, p. 919), W. E. Logan announced the finding of some bones of a whale at the Mile-End quarries, Montreal, on a slight ridge, "where are found stratified sand and gravel holding boulders and shells in the lower part." In corresponding clays in a neighboring brickyard was found a pelvis of a seal, *Phoca grœndlandica*. In 1895 (Canad. Rec. Sci., vol VI, p. 351), Dr. J. W. Dawson reported the discovery of a nearly complete skeleton of another white whale at Montreal. This was found in brick-clay, near Papineau Road. The locality is said by Dawson to be about 100 feet above the St. Lawrence; the bones were in the clay at a depth of 22 feet. The clay itself was probably deposited at a depth of 50 to 80 fathoms. This is said by Dawson to correspond approximately with a well-marked shore-line at Montreal, found at a height of about 470 feet above the sea and with the old sea-beach at Smith's Falls as related on page 17. In 1916, Mr. Edward Ardley, assistant curator of Redpath Museum, reported (Canad. Rec. Sci., vol. IX, pp. 490–493) the discovery of a large part of the skeleton of a white whale, supposed to belong to *Delphinapterus leucas*, at Montreal East. The skeleton was buried in Leda clay about 15 feet above St. Lawrence River. It was 10.5 feet long. The cranium and lower jaw were secured, besides parts of the trunk and limbs.

8. *Rivière du Loup, Temiscouata County.*—In his work, "Canadian Ice Age," 1894, on page 268, Dr. J. W. Dawson reported that bones of *Beluga catodon* (*Delphinapterus leucas*) had been found at the place mentioned. It is not probable that parts sufficient for making a definite determination were secured, nor did Dawson give any details regarding the geological

conditions connected with the discovery. Doubtless the remains were found in marine deposits of one of the terraces.

9. *Metis, Rimouski County.*—In the work just cited (p. 269), Dawson stated that in the summer of 1891 he secured a large jawbone of a whale which had been found in digging a cellar in the shelly marl of the lower terrace at Metis. He did not identify the species, but appears to imply that it belonged to either the "humpback" (*Megaptera boops*) or to one of the finner whales (*Balænoptera*).

NEW BRUNSWICK.

10. *Jaquet River, Restigouche County.*—In 1874 (Trans. Nova Scotia Inst. Sci., vol. III, pp. 400–404), Dr. J. B. Gilpin gave an account of the discovery of some cetacean bones in a railroad cut at the place named, but did not identify the bones otherwise than as those of a small cetacean. In the same year (Amer. Jour. Sci., ser. 3, vol. VII, p. 597), in a short, unsigned communication, this discovery was mentioned and the whale was identified as *Beluga vermontana*. In volume VIII of the same journal (1874, p. 219), Dr. D. Honeyman described the deposit and gave a list of the shells found in it. Dawson (Canad. Ice Age, p. 268) refers the bones to *Beluga catodon*. The locality is a cut of the International Railway, on the north side of the Jaquet River, about 0.25 mile from the sea. Gilpin gives the elevation as 40 feet above the sea; the writer of the unsigned communication just mentioned gives it as 25 feet.

Professor G. H. Perkins (Rep. State Geologist Vermont, 1907–8, pp. 102–112) studied the bones described by Gilpin. They consisted of 18 vertebræ, some fragments of the skull, one of the ear-bones, a part of the lower jaw, some fragments of ribs, and some arm-bones. He identified the animal as belonging to the genus *Monodon* and probably *M. monoceros*, the existing narwhal.

11. *Mace's Bay, Charlotte County.*—In 1879 (Geol. Survey of Canada, 1877–78, EE, p. 23), Mr. G. F. Matthew reported the discovery of a ramus of the lower jaw of a whale, possibly a species of *Delphinapterus*, at the mouth of the Popologan (or Pocologan) River. It is now in the Mechanics' Institute at St. John. It had fallen from a bank of Leda clay. It probably belongs to the late Pleistocene.

VERMONT.

12. *Charlotte, Chittenden County.*—At this place were discovered considerable parts of a whale, described in 1850 (Amer. Jour. Sci., ser. 2, vol. IX, pp. 256–263) by Zadock Thompson, under the name *Beluga vermontana*. The animal has by many been regarded as identical with the white whale, *Delphinapterus leucas*, now appearing sometimes as far up as Montreal. A more extended description of it was given in 1853 (Hist. Vermont, Append., p. 15, figs. 1–13). This was reproduced in Edward Hitchcock's Report on the Geology of Vermont, 1861, page 164, and was followed by remarks on the specimen by Edward Hitchcock jr. In the second volume of the work just cited (p. 938) Hager furnished a figure of the skeleton as mounted. In

1908 (Rep. State Geologist Vermont, 1907–8, pp. 76–112, plates x–xix), Professor G. H. Perkins gave an extended description of the remains and reached the conclusion that *D. vermontanus* is distinct from *D. leucas*. Since Perkins's article gives a full history of the discovery and the literature pertaining to the specimen, this account will be much abridged. The bones were found in making a cut for the Rutland and Burlington Railroad, at the town of Charlotte, about a mile east of the shore of Lake Champlain. The bones were 8 or 9 feet below the surface and "were very completely bedded in fine adhesive blue clay." The locality is 60 feet above the mean level of the lake and 150 feet above the sea. The deposits were laid down in the marine waters which took possession of Lake Champlain and the St. Lawrence Valley when the Wisconsin glacial ice had withdrawn north of St. Lawrence River. The geological age of the animal is therefore late Pleistocene.

NORTH CAROLINA.

13. *Below New Bern.*—In 1842 (Amer. Jour. Sci., vol. xliii, p. 143), Richard Harlan reported regarding the species of fossil vertebrates found 16 miles below New Bern. His list, which was long and consisted mainly of vernacular names, included "cetaceans."

SOUTH CAROLINA.

14. *Charleston.*—In 1860 (Holmes's Post-Pliocene Foss. South Carolina, p. 117, plate xxiv, fig. 9), Leidy described a cetacean tooth which he called *Physeter antiquus*. Later the specific name was changed to *vetus*. At the same time he figured a tooth (fig. 8) found in the Ashley River deposits. He further stated that teeth apparently of the same species had been taken from the Miocene formations of Virginia, but found no characters by which they could be distinguished from those of the recent sperm whale.

GEORGIA.

15. *Brunswick.*—In 1911 (Bull. No. 26, Geol. Surv. Georgia, p. 436), Gidley reported from here, among other vertebrates, some teeth which he regarded as those of *Physeter vetus;* but this may not be correct and they may not belong to the Pleistocene.

FLORIDA.

16. *Daytona, Volusia County.*—In 1916 (Florida Geol. Surv., vol. viii, p. 105), Doctor Sellards stated that he had obtained from marl-pits worked at this place for road materials a proboscidean tusk and a rib of a whale, probably of the genus *Balænoptera*. At the same place had been found a tooth of *Elephas columbi*.

17. *De Land, Volusia County.*—At this place was obtained the dolphin skull which Sellards described as *Globicephalus bœreckeii* (Florida Geol. Surv., vol. viii, p. 107, plate xiv). It was found embedded in sand at a depth of 10 feet. This sand overlies marls which are regarded as Pliocene or Miocene. Sellards believed that the sands belonged to the Pleistocene. It is not improbable that the marls pertain to the Pleistocene of the first glacial time.

FINDS OF PLEISTOCENE PINNIPEDIA IN EASTERN NORTH AMERICA.

(Map 2.)

GRINNELL LAND.

Dumbbell Harbor.—In 1877 (Ann. Mag. Nat. Hist., ser. 4, vol. xx, p. 488), Fielden published a paper on the Post-Tertiary beds of Grinnell Land and north Greenland. Fielden and De Rance reported on the same subject in 1878 (Quart. Jour. Geol. Soc. Lond., vol. xxxiv, p. 566). In beds having an elevation of 400 feet, in latitude 82° 30′, there were obtained meager remains of *Phoca hispida* and *Ovibos moschatus*. In latitude 82° 25′ were secured remains of *Rangifer tarandus, Ovibos moschatus,* and *Phoca barbata*. The invertebrate fauna was found to be identical with that existing there to-day. If the beds are of Pleistocene age, as the elevation appears to indicate, they may be referred to the Late Wisconsin.

NOVA SCOTIA.

1. *Sable Island.*—In the collection of the Philadelphia Academy there is a walrus skull which was sent to the Academy from Sable Island about 1871. According to Rhoads (Proc. Phila. Acad., 1898, p. 197), Leidy regarded this skull as that of a recent individual; but Rhoads states that "the specimen is of precisely the same nature in color, texture, and specific gravity as the larger fossil specimen which Leidy described and figured in the Philosophical Transactions and which came from the beach at Long Branch, New Jersey." He thinks that it had been derived from an ancient raised sea-beach. This does not appear to be at all improbable.

NEW BRUNSWICK.

2. *Fairville, Charlotte County.*—In 1879 (Geol. Surv. Canada, Rep. for 1877–8, ee, p. 23), Dr. G. F. Matthew reported the discovery of a skeleton of *Phoca grœnlandica* near Fairville, at the mouth of St. John River, New Brunswick. The fore limbs and several vertebræ were missing. The skeleton was afterwards destroyed in a fire at St. John. The bones were found at a depth of about 25 feet, in the lower Leda clay.

QUEBEC.

3. *Bic, Rimouski County.*—In Le Naturaliste Canadien (vol. xxxvi, 1908, p. 51), the editor, V. A. Huard, in commenting on a letter written to him and announcing the capture of a walrus somewhere on the northern coast of the Gulf of St. Lawrence, recalled an article contributed in 1869 by the former editor, a priest named Provancher (Le Naturaliste Canad., vol. ii, p. 19). This writer stated that some workmen employed in the construction of the International Railway had discovered at Bic, Rimouski County, Quebec, on the southern shore of the St. Lawrence, a complete skeleton of a walrus. This skeleton had a length of 13 feet. It was found at a depth of 14 feet, in a compact clay, and at a height of more than 100

feet above sea-level. The skeleton was deposited in the museum of the Rimouski Seminary, but was destroyed in a fire in 1881.

It is evident that when that animal died and was buried in the clay the land in that region stood at a level at least 100 feet lower than at present.

Through the late Mr. L. M. Lambe, of the Canada Geological Survey, the writer has received from Mr. W. A. Johnston, who made a special study of the Pleistocene, information regarding the age of the clays at Bic. He says that little can be said definitely regarding the age of the clays in which the walrus skeleton was found. Clays belonging to the Champlain submergence stand now at an elevation of 311 feet in that vicinity; and marine shells occur in clays, supposed to belong to the Champlain, at an altitude of 120 feet. There is a possibility that some of the clays in that region are earlier than the time of the Wisconsin. Mr. Johnston cites Guide Book No. 1, part I, pp. 77–78, of the Canada Survey, and Dawson's Ice Age, 1893, pp. 186–195. The first article was written by J. W. Goldthwait. On page 921 of Logan's Geology of Canada, 1863, it is stated that bones of whales and of the morse have been found partially embedded in the Leda clay in several places between Bic and Matanne, about 60 miles farther down the river.

4. *Montreal, Quebec.*—In 1863, Logan (Geol. Surv. Canada, p. 920) told of the discovery of a skeleton of *Phoca grœndlandica* near Montreal. The exact locality appears to be about 0.75 mile east of what was then known as the Mile-end quarries. These quarries were about 100 feet above sea-level, and the spot where the skeleton was found was about 40 feet lower down. At a nearby brickyard some bones of a young seal were discovered which belonged probably to the same species. One of the pelvic bones of a seal was found also at the Mile-end quarries. Dr. J. W. Dawson ("Canadian Ice Age," 1844, p. 267) stated that the skeleton was found in the Leda clay; that it is in the collection of the Geological Survey, at Ottawa; and that detached bones are in the Peter Redpath Museum of McGill University at Montreal. The Leda clay, at least that of the upper portion of the St. Lawrence Valley, is now referred to the Champlain epoch, a time when the sea had invaded this valley and even Lake Ontario.

5. *Tétreauville, Ottawa County.*—In 1897 H. M. Ami (Ottawa Naturalist, vol. XI, p. 24) announced that he and Ruggles Wright had found some bones which were probably those of a young harbor seal, *Phoca vitulina*. They were collected in 1888, in a sandy layer about 30 feet below the surface, on a hillside, at Wright's brick-clay pits, on Aylmer Road, Tétreauville, Quebec. This place is about 5 miles west of Hull, and within 10 miles of Ottawa. These bones are in the Victoria Museum at Ottawa. Besides the left half of the lower jaw with teeth, there are both ear-bones, one exoccipital, the greater portion of the backbone, scapula, part of the pelvis, and some of the larger limb-bones. This species is abundant in the Gulf of St. Lawrence, and also ascends the larger rivers to a great distance. Doubtless great numbers inhabited the inland sea which, during Champlain times, is believed to have occupied the valley of the St. Lawrence, Lake Ontario, and the valley of the Ottawa River nearly as far up as the city of Ottawa.

ONTARIO.

6. *Ottawa.*—Remains believed to belong to *Phoca grœnlandica* have been found near Ottawa, Ontario. In 1856 (Proc. Phila. Acad. Nat. Sci., vol. VIII, p. 90, plate III), Doctor Leidy described and figured the hinder limbs of a young aquatic animal which he regarded as a seal, but did not more exactly identify. He expressed the opinion that its descendants were yet sporting in the sea-borders of Canada. This specimen was found in Gloucester Township, Carleton County, about 9 miles east of Ottawa. The locality is on Green's Creek, a tributary of the Ottawa River, the bank of the creek being about 30 feet high and composed of clay. This is regarded as being of Champlain age, the close of the Wisconsin stage. Out of this clay were washed numerous nodules of hardened clay, many of which contained organic remains, such as marine shells and fishes. Among the latter are two species, the capelin (*Mallotus villosus*) and the lump-sucker (*Cyclopterus lumpus*).

Later, at the same locality, a lower jawbone of a young seal was found, which was identified as the harp seal; and it was even thought that it might have belonged with the hinder limbs figured by Leidy. A figure of this jaw, with some of the teeth, was published by Dawson in his "Canadian Ice Age."

MAINE.

7. *Addison Point, Washington County.*—From the curator of the Portland Society of Natural History, Arthur H. Norton, the information is received that some portions of the skeleton of a walrus, several ribs, parts of two limbs, and a phalanx of a digit, had been found at Reef Point, near Addison Point, Maine. These remains are now in the collection of the society just named. They had been collected in 1881 by C. H. Boyd, who published an account of them (Proc. U. S. Nat. Mus., vol. IV, p. 234). They had washed out of the bank on the eastern side of Pleasant River, about 3 miles below Addison. They had been buried in a stiff blue clay, about 2 feet above high-water. Above them there was 6 feet of the clay, and above this gravel and soil. Mr. Boyd stated that he had seen a tusk, with a part of the socket, which had been washed out at the same place.

8. *Andrews Island, Knox County.*—The American Museum Journal for 1912 (vol. XII, pp. 269–270) contains an article which calls attention to a walrus skull preserved in the American Museum of Natural History in New York. It is reported as having been found by Sidney Norton, in December 1912, in 50 fathoms of water, near Andrews Island, off Owl's Head, Penobscot Bay. One of the tusks is complete, the other is gone; also the occiput and zygomatic arches are missing. The bone is said to be quite well petrified, which shows that the skull is not a recent one.

9. *Gardiner, Kennebec County.*—In 1845 Charles Lyell visited ("Second Visit to the United States," vol I, p. 44) Gardiner, Maine, and examined a collection of fossil shells and crustacea which had been made by Mrs. Frederic Allen from the glacial deposits of that vicinity. He recognized the tooth of a walrus, which he stated was similar to the one procured by him on Martha's Vineyard. This tooth is said by Packard (Mem. Bost.

Soc. Nat. Hist., vol. I, 1867, p. 246) to have been a tusk; and he was informed that it had been taken by Lyell to London and had been identified by Professor Richard Owen. Inasmuch as Owen regarded the specimen found on Martha's Vineyard as a species distinct from the one now living on the Atlantic coast, it is to be supposed that the Gardiner specimen also was thought to be different from the latter. Packard, in another communication (Amer. Naturalist, vol. I, 1868, p. 268), states that the tooth of the walrus and some teeth of a supposed bison were discovered in the claybeds at Gardiner by Lyell, or at least during his visit, but it is evident that they had been collected before his arrival.

In his discussion of the supposed bison teeth found in clay at Gardiner, Dr. J. A. Allen (The American Bisons, 1876, pp. 89, 91) gives us some information about the fate of Mrs. Frederic Allen's collection. At her death it passed into the possession of her daughter, by whom the greater part of it was presented to Bowdoin College, Brunswick, Maine. Professor Manton Copeland, of this college, informs the writer that the walrus tusk is in their collection and bears the number FM20. It is badly shattered. The length is about 75 mm.

The important matter concerning the remains of the walrus found at Gardiner is to determine when the animal lived there. It is to be assumed that the tusk had been buried in the Pleistocene clay at that locality. This appears to belong to the closing period of the Wisconsin stage, but there has been some dispute about its age.

Packard (Mem. Bost. Soc. Nat. Hist., vol. I, pp. 245–246) gives a list of the species which had been found in the clay at Gardiner. These are nearly all invertebrates and indicate a climate somewhat colder than that now existing there. Whether the time when the walrus lived at Gardiner was before or after the culmination of the Wisconsin ice period, it was so long ago that those deposits of clay, made in sea-water of considerable depth, have since been lifted above sea-level to a height of perhaps 200 feet.

10. *Portland, Cumberland County.*—In the American Naturalist, volume XII, 1878, page 633, it is recorded that the larger part of the skeleton of a walrus, including the skull, with tusks over 5 inches long, had lately been found in the Quaternary clays at Portland. It had been discovered by workmen excavating for the foundation of the transfer station of the Boston and Maine Railroad. The remains were partially embedded in a layer of blue clay a foot thick, itself overlain by 2 feet 2 inches of a lighter clay. The latter contained casts and shells of 11 species of mollusks. J. A. Allen, in his work already quoted, states that the skeleton was found at a depth of 7 feet. It was placed in the museum of the Portland Society of Natural History, and is still there, as reported by the curator, Arthur H. Norton.

Mr. Norton has sent the writer an extract from the report of the committee which investigated this discovery. The bed of blue clay in which the greater part of the skeleton was buried contained the following species of mollusks: *Mya arenaria, Macoma sabulosa* (*calcarea*), *Mytilus edulis, Cardium* (*Serripes*) *grœndlandicum, Saxicava distorta, Nucula antiqua, Leda tenuisulcata, L. truncata* (*Yoldia glacialis*), *Natica clausa, N. pusilla,* and *Astarte striata.* The lighter-colored clay above the blue clay was more

sandy and adhered strongly to the bones. This clay contained *Mya arenaria, Mytilus edulis, Serripes grœndlandicus, Astarte striata, Macoma calcarea, Nucula antiqua, Natica,* and *Balanus.*

Above the lighter-colored clay just mentioned was a foot of a clay which contained wood and roots, the unused portion of the brick-clay that once existed there, but which had been removed for the manufacture of bricks.

Inasmuch as the clay overlying the bed in which the remains were found contains marine shells, it is certain that since their deposition the land has been considerably elevated.

George N. Stone (Monogr. xxxiv, U. S. Geol. Surv., pp. 286–291) has discussed the age of the glacial deposits at Portland. Professor M. L. Fuller has written to the author that on the Maine coast the chief clay is known as the Leda and is found at Portland and Gardiner, and that it probably antedates the Wisconsin. This is not to be correlated with the Leda clay of the St. Lawrence Valley. It corresponds rather to Clapp's "high-level clays" (Bull. Geol. Soc. Amer., vol. xviii, p. 505, seq.).

NEW HAMPSHIRE.

11. *Jeffries Reef, off Portsmouth.*—The specimen from this place consists of the greater part of the left side of the skull of a large individual. The occipital and the exoccipitals are missing. The bone and especially the tusk have suffered some decay. The fragment is labeled as having been dredged from a depth of 50 to 75 fathoms on Eastern Jeffries Reef. The bottom was hard. Jeffries Reef lies 5 or more miles off the southernmost part of the Maine coast and extends from the Isle of Shoals to Boon Island. The skull belonged to an old individual. The length from the rear of the mastoid process to the front of the premaxilla is 360 mm. The exserted part of the tusk measures 225 mm. in length. At its base the diameters are 65 mm. and 42 mm. There are 4 large grinding teeth. There is no reason for supposing that the species represented is not *O. rosmarus.*

MASSACHUSETTS.

12. *Gay Head, Martha's Vineyard.*—In his "Travels in North America," volume i, 1845, page 257, plate v, figure 1, Lyell announced the finding of a part of a skull of a walrus at Gay Head. This he had purchased from a fisherman who lived there and who said it had fallen out of a conglomerate found at that place and which contains bones of cetaceans. The skull retained but a small portion of its animal matter. Richard Owen, to whom the skull was shown, regarded it as belonging to a species distinct from *O. rosmarus.* The upper jaw contained the base of one tusk, the socket for the other, and 3 molar teeth on each side. The reduced number of molars furnishes no distinctive character, for existing individuals sometimes present this number. The base of the tusk has its transverse diameter greater than usual relatively to the fore-and-aft diameter. According to Lyell's illustration of the specimen, the greater diameter was 70 mm., the shorter 53 mm. The writer has seen no tusk of *O. rosmarus* as thick as this; but the thickness is variable and may possibly attain to two-thirds of the greater diameter.

Inasmuch as the Tertiary deposits at Gay Head, rising above the sea to a height of about 150 feet, are capped by a sheet of glacial drift and clays, it is probable that the skull in question had fallen from some of these drift deposits. According to Professor J. B. Woodworth (17th Ann. Rept. U. S. Geol. Surv., pt. I, p. 982), there are at Gay Head deposits of drift which represent some of the older glacial stages as well as the last one, the Wisconsin. It is possible, therefore, that this walrus lived there as far back as the middle of the glacial epoch or even earlier. For additional information on the geology of that island consult Woodworth's paper, in which the literature is cited; also the important paper by N. S. Shaler (7th Ann. Rept. U. S. Geol. Surv., 1888, pp. 303-363.)

The hooded seal, *Cystophora cristata*, has probably been found fossil at Gay Head. The only reason for this supposition is found in a statement made by Charles Lyell (Proc. Geol. Soc. London, vol. IV, p. 32; Amer. Jour. Sci., vol. XLVI, 1844, p. 319). He says that with other remains on Martha's Vineyard he found a tooth having the crown fractured. Lyell submitted the tooth to Richard Owen, who pronounced it to be that of a seal which seemed to be nearly allied to the modern *Cystophora proboscidea* (*C. cristata*). It seems quite probable that this species lived there at the time when the walrus haunted the region. It is of course possible that the remains reported belonged to an animal that lived in that region as far back as the Miocene. The tooth was not described or figured.

NEW JERSEY.

13. *Long Branch.*—Portions of several walrus skulls have been found on the beach at Long Branch. Two of these were described and figured by Leidy in 1867 (Trans. Amer. Philos. Soc., vol. XI, p. 83, plate IV, figs. 1, 2, plate V, fig. 1). One skull, lacking the lower jaw, some of the right hinder part of the cranium, and the exserted portion of one tusk, was discovered in 1853. The other specimen, discovered about 1856, furnished the front of the skull as far back as the middle of the palate. Both belonged to old individuals. Leidy concluded that the animals which had possessed these skulls belonged to the existing species *Odobenus rosmarus*. He surmised that they had been floated to the New Jersey coast on fields of ice or perhaps had lived there during the Glacial period. The skull which was found in 1853 is now in the collection of the Philadelphia Academy; the other is in the collection of the New Jersey Geological Survey. Recently, Mr. Samuel N. Rhoads has studied these skulls. He had also for examination the skull from Sable Island, which has been mentioned. He concluded that these skulls belonged to a species distinct from *O. rosmarus* and which might bear DeKay's name, *O. virginianus*.

It does not appear to the present writer that Rhoads has successfully maintained his proposition. He did not have at hand a sufficient number of skulls of the existing Atlantic walrus to present all the variations that occur in that species. Of course, the number of fossil specimens was very limited. In discussing Rhoads's conclusion, it will be of advantage to consider a part of a skull which belongs to the Marsh collection in Yale University. This specimen consists of the anterior half of the skull, without

the tusks and without the other teeth. It was found at Kitty Hawk, at the mouth of Albemarle Sound, just north of latitude 36°. It is thoroughly fossilized; and, having been found so far south, it may be safely regarded as having belonged to the species which inhabited the New Jersey coast during the Pleistocene.

For purposes of comparison, such measurements are here given as can be obtained from the skull; likewise the corresponding measurements of a specimen from Sable Island, No. 199528 of the U. S. National Museum, and of another, No. 22014 of the National Museum, brought from Ungava Bay. Unfortunately, the basilar length of the fossil can not be determined, nor the width of the mastoids.

Measurements of skulls of walruses, in millimeters.

	Kitty Hawk.	Sable Island.	Ungava Bay.
From front of premaxillæ to rear of vomer	183	167	205
From front of tusk to optic foramen	188	177	195
From oral border of premaxilla to upper border of nasal opening	110	96	100
Greatest width across maxillæ	160	136	177
Least width at front of orbits	105	106	146
Least width at temporal fossæ	75	62	70
Width between the sockets for tusks	75	75	85
Length of row of teeth	82	60	83
Space between incisors	40	36	32
Space between last molars	62	60	53
Long diameter of tusk at base	34	26	38

The nasal bones of the fossil are so thoroughly consolidated with each other and with the adjoining bones that their dimensions can not be determined. There is no reason, however, for supposing that the length was greater than 70 mm.

The grinding teeth of the fossil do not show the larger size that we might expect from Rhoads's determinations and from comparison with Leidy's illustrations. The second socket was almost exactly the diameter of the same socket in the Sable Island specimen measured. The third socket is larger than that of the skull from Sable Island. The sockets for the first molars are very small and shallow; the socket for the left incisor is still smaller, while that for the right incisor is wholly effaced. The diameter of the socket for the second molar is much shorter than that of the corresponding socket in the Ungava Bay specimen. In the latter, the left incisor is present and large, but the other is missing and the socket is nearly filled up. It is evident that the teeth are extremely variable in both size and the number present.

Rhoads has found that the incisive foramina of the fossil skulls in his hands are placed high above the alveolar borders. In the North Carolina specimen this height is 32 mm.; in the Sable Island specimen in the U. S. National Museum, 30 mm.; in the Ungava Bay specimen, about 22 mm. Nor does the distance between the sockets for the incisors in the fossil from North Carolina agree with that dimension in the two specimens from Long Branch.

Despite the differences shown in the measurements in the table given above, the writer must conclude that there are not as yet sufficient reasons for regarding the Pleistocene walrus of the Atlantic coast as specifically different from the existing form.

Dr. Albert Reid Ledoux, mining engineer, of New York City, when a young man bathing at low tide at Long Branch, found a skull of a walrus. This was given to Professor John S. Newberry and is now probably at either Columbia University or the American Museum of Natural History. At the same time and at the same spot was a heel-bone of *Megatherium*, now in the American Museum (p. 31). It is very improbable that these two animals lived there at the same time.

According to recent publications of the Geological Survey of New Jersey (Salisbury, Report for 1897, p. 19, pl. 1; Lewis and Kümmel, Bull. No. 14, p. 120, with Geologic Map of New Jersey, 1910–1912), Long Branch is situated on the Cape May formation. This is regarded by the geologists just quoted as corresponding in age, in great part at least, to the Wisconsin stage. When this deposit was laid down, the New Jersey coast was depressed from 35 to 50 feet below its present level. It seems very probable that at that time the walrus was living there and that the skulls found have been washed out of this deposit by the waves during storms. Nevertheless, the finding of *Megatherium* at Long Branch shows that there are deposits present which belong probably to early Pleistocene.

Dr. H. B. Kümmel, State Geologist of New Jersey, has informed the writer that a strip 0.25 to 0.75 mile back from the ocean in the region about Long Branch probably belongs to the Recent time. He states that one would be safe in concluding that the skulls of the walrus were found in deposits not older than the Cape May and that they may have occurred in more recent beds. Against the view that the walruses found along this coast lived there during the Recent period is their well-fossilized condition.

14. *Ocean Grove, Monmouth County.*—In 1910, after a storm, a part of a skull of a walrus was found on the beach at Ocean Grove, New Jersey. This is still in the possession of the finder, Mr. W. S. Hidden, who furnished the writer with photographs of the specimen. It consists of the front of the skull extending back to the bases of the zygomatic arches, and containing portions of both tusks and most of the teeth. There is no likelihood that this specimen belonged to any other species than *Odobenus rosmarus*, and it was probably washed out of the same deposits as those which furnished the specimen found at Long Branch.

VIRGINIA.

15. *Accomac County.*—In the Annals of the Lyceum of Natural History of New York, volume II, 1828, page 271, Messrs. Mitchill, Smith, and Cooper made a report on a fossil walrus skull found along the Virginia coast somewhere in Accomac County. Only the anterior half of the skull was secured. According to this report, portions of the tusks were preserved, but were much mutilated. There were present also 4 of the grinding teeth. The skull was described as being remarkably hard and heavy and the tusks were almost agatized. The sutures of the skull had mostly closed up; hence the animal

was evidently an old one. The specimen bore the marks of having been in salt water, and was said to have been found on the beach.

This is the specimen which DeKay, in 1842 (Zool. of N. Y., pt. I, p. 56, plate XIX, fig. 1), made the type of his *Trichechus virginianus*. Newberry, in 1873 (Proc. Lyc. Nat. Hist. New York, p. 71), identified the specimen as belonging to the existing Atlantic species. Cope (Proc. Amer. Philos. Soc., vol. XIV, 1874, p. 17) does not mention the presence of tusks. He supposed that there was, at that part of the coast, glacial drift, out of which the skull had been washed. There are, however, no such deposits in that region. This specimen was placed in the collection of the Lyceum of Natural History of New York, but according to Rhoads, was afterward destroyed in a fire.

On examination of G. B. Shattuck's work on the Pleistocene of Maryland (Maryland Geol. Surv., Pliocene and Pleistocene volume, p. 95, plate I), it seems that the coast of Virginia in Accomac County is occupied by the Talbot formation. This, according to his theory, corresponds, at least the part nearest the coast, with the Cape May formation of New Jersey. Hence we might conclude that the walrus skull in question had become buried, probably during the Wisconsin glacial stage. The present writer regards the principal part of the Talbot terrace as being much older.

Messrs. W. B. Clark and B. L. Miller (Virginia Geol. Surv. Bull., No. IV, p. 187) recognize the presence of the Talbot formation in Accomac County, where it seems to reach a thickness of 100 feet; but the authors add that part of this may belong to earlier Pleistocene formations.

NORTH CAROLINA.

16. *Kitty Hawk, Currituck County.*—In the Marsh collection of fossils belonging to Yale University is a part of a skull found somewhere near Kitty Hawk. No particulars regarding the exact place of discovery accompany the specimen. It has already been described on page 27; and, while there are some differences between it and the recent skulls used for comparison, it is not believed that a distinct species is indicated.

According to L. W. Stephenson's map of the Coastal Plain of North Carolina (North Carolina Geol. and Econom. Surv., vol. III, plate XIII), the coast at Kitty Hawk and for about 50 miles back of this is occupied by the Pamlico formation. This corresponds to the upper part of the Talbot of Maryland, and it, or part of it, may have been deposited at the close of the Pleistocene. So far as the present writer knows, there is nothing to show the character of the climate then prevailing. As this Pamlico nowhere rises more than 25 feet above sea-level, and as the thickness is usually only from 15 to 20 feet, it is possible that the walrus skull found at Kitty Hawk had been unearthed by the waves from the Chowan formation or some still earlier deposit.

SOUTH CAROLINA.

17. *Charleston.*—In 1876 Leidy announced (Proc. Phila. Acad., 1876, p. 80) that a complete tusk of a walrus had been found in the Ashley River,

near Charleston. This tusk Leidy described and figured in 1877 (Jour. Phila. Acad., vol. VIII, fig. 6). It had evidently been dredged from the river in collecting phosphate rock, as have been most of the fossils of that region. The tusk was 13 inches long. Near the base it measured 3.62 inches and transversely 1.75 inches. Leidy especially noticed the shortness of the tusk as compared with the diameter, but concluded that the tusk might, during the life of the individual, have been broken off and worn obliquely at the end.

In the collection of the Charleston Museum are some fragments of tusks of a species of walrus, probably *O. rosmarus*. One of these, No. 1028, furnishes 184 mm. of the distal end. The width at the fracture is 60 mm., the thickness 29 mm. The distal end is worn off somewhat obliquely, but not so much as in the tusk figured by Leidy; also, the tusk appears to have been less curved than the one which he described. The original length can not be determined.

Another fragment, No. 1029, was given to the Charleston Museum by Major E. Willis and was no doubt found in the region about Charleston. This gentleman has sent a fossil horse tooth and a part of a sirenian to the U. S. National Museum from Wando River. The fragment is short, but belonged to a large tusk, its long diameter being 81 mm., the shorter one 51 mm. It was therefore a larger tusk and one whose thickness was relatively greater than that of the imperfect specimen found at Long Branch and figured by Leidy.

Mr. Earle Sloan's collection at the Charleston Museum has two other fragments of tusks. One, No. 13497, is 113 mm. long, 60 mm. wide, and 25 mm. thick; the other, No. 13296, is 140 mm. long, 60 mm. wide, and 31 mm. thick.

Considering that all of the remains of the walrus found about Charleston have been picked out of great quantities of phosphate rock collected for commercial purposes, and that no records of the exact locality where obtained have been kept, it is impossible to determine their exact geological age. It is to be supposed that this animal inhabited the region about Charleston at the time it frequented the coasts of North Carolina and New Jersey. This appears to have been during the Wisconsin stage; but it is possible that the walrus extended its range far southward during more than one of the glacial stages. All of the specimens appear to be thoroughly fossilized.

FINDS OF XENARTHRA IN EASTERN NORTH AMERICA.

NEW JERSEY.

(Map 3.)

1. *Long Branch, Monmouth County.*—In the American Museum of Natural History, New York, there is a large heel-bone which was found at the place named and identified as having belonged to a species of *Megatherium,* most probably to *M. mirabile.* It was presented by Dr. A. R. Ledoux, of New York, who wrote that he found it about 40 years ago while bathing at Long Branch. With this bone were found a skull of a walrus and a tooth of a mastodon. The heel-bone is somewhat more than 15 inches long. It was incrusted with barnacles and small oyster shells.

While one can not at present be certain that this animal did not live up to a late stage of the Pleistocene, it is improbable that it did so. It is also quite improbable that the megatherium and walrus lived at Long Branch at the same time. It is more likely that the megatherium had its existence there at the time when horses lived in the same region and when the Port Kennedy fauna existed; that is, at some time during the early Pleistocene, about the Aftonian stage.

PENNSYLVANIA.

(Map 3.)

1. *Port Kennedy, Montgomery County.*—From the noted bone cave at Port Kennedy a number of species of *Megalonyx* have been described. The presence of this genus was first announced by Wheatley (Amer. Jour. Sci., ser. 3, vol. I, p. 384). Cope, in 1899 (Jour. Acad. Nat. Sci., Phila. vol. XI, pp. 211-219), admitted the occurrence of 4 species, *Megalonyx wheatleyi, M. loxodon, M. tortulus,* and *M. scalper.* It must be left to future investigations to determine the status of these species. *M. jeffersonii* was not recognized by Cope in the materials found in the cave. Of *M. loxodon,* only a single upper canine molar was found. Of *M. wheatleyi,* numerous specimens were secured, including considerable parts of crushed and decayed skulls. *M. tortulus* was represented by a considerable number of teeth; M. *scalper* by only a single "canine-molar." On page 312 will be found a list of the species of vertebrates associated with these sloths. Of *Mylodon,* Wheatley (op. cit., p. 384) had a single ungual phalanx which Cope (op. cit., p. 210) thought belonged probably to *M. harlani.*

2. *Frankstown, Blair County.*—Remains of an undetermined species of *Megalonyx* have been reported from a bone cave at this place by Dr. W. J. Holland (Ann. Carnegie Mus., vol. IV, 1908, p. 231). The associated species are listed on pages 321–322.

OHIO.

(Map 3.)

1. *North Fairfield, Huron County.*—In the Norwalk, Huron County, Museum there are various bones of *Megalonyx jeffersonii* which were obtained about 7 miles from North Fairfield. The writer learned of the discovery of this skeleton from Mr. Roe Niver, a student of the University

of Illinois. Unfortunately Mr. Niver died before the writer could obtain all the desired information. A part of the skeleton was in his possession and is probably in the possession of his family, but the writer has been unable to secure any information from them. The bones were found at a depth of a few feet in a hackberry swamp and were considerably scattered. In the search for these the bones which form the type of *Bison sylvestris* Hay were found. The locality is within the area of the Wisconsin drift-sheet and evidently the animal lived there after the ice had retired from the region.

2. *Millersburg, Holmes County.*—In the University of Ohio there is a mounted specimen of *Megalonyx jeffersonii* containing a considerable part of the skeleton; the missing portions are replaced artificially. The remains were found in the eastern part of Holmes County just north of the terminal moraine of the Wisconsin drift-sheet. This moraine had led to the formation of a marsh, and in this the animal ended his life. The place was said by Orton to be 6 miles east and a mile north of Millersburg. The skeleton lay on shell marl beneath 6 feet of peat. The remains have been described by Claypole (Amer. Geologist, vol. VII, 1891, pp. 122–132, 149–153) and by Hay (Geol. Surv. Indiana, vol. XXXVI, 1913, p. 558; Geol. Surv. Iowa, vol. XXIII, 1914, p. 110).

INDIANA.

(Map 3.)

The only member of the order of Xenarthra that has yet been found in this State is *Megalonyx jeffersonii*, and this in only one place, viz, Evansville.

1. *Evansville, Vanderburg County.*—In 1854 (Proc. Acad. Nat. Sci. Phila., vol. VII, pp. 199–200), Leidy described a collection of vertebrate fossils secured by Mr. Francis A. Lincke from the banks of the Ohio River, near the mouth of Pigeon Creek, a short distance below Evansville. At that time and locality bones were usually found sticking out of the bank when the water in the river was low. The bones sent to Leidy were thoroughly impregnated with oxide of iron, which served as a cement to adhering pebbles, sand, and fragments of Unios and shells of other fresh-water mollusks. The remains of the megalonyx consisted of parts of two tibiæ of young individuals, an atlas, a fragment of a heel-bone, a metacarpal and a metatarsal bone, and a claw phalanx. With these were discovered a fragment of a cervical vertebra of a species of bison, various bones of the Virginia deer, a vertebra of a horse, probably *Equus complicatus*, a tooth of the tapir *Tapirus haysii*, and a part of the upper jaw of the wolf now known as *Ænocyon dirus*, but at that time called by Leidy *Canis primævus*.

The principal interest in these remains is to determine at what time during the Pleistocene the megalonyx lived. Some indications may be obtained from a study of its companions. From a part of a cervical vertebra Leidy could not name the bison, but it belonged probably to one of the extinct species. The deer is yet living, but appears to have existed through most of the Pleistocene. The species of horse represented is extinct, and there is no evidence that it lived after the Wisconsin glacial stage. Its latest representatives probably lived during the Sangamon stage. No tapir is known to have lived after the Wisconsin stage. The wolf, *Ænocyon*

dirus, is believed to be represented in the numerous individuals found in the asphalt beds of Los Angeles, California, probably equivalent in age to the Aftonian.

Mr. Arthur C. Veatch (Jour. Geology, vol. VI, pp. 257–272) has given an account of changes which have occurred along the Ohio River in Spencer County, Indiana, about 25 miles above Evansville, since late Pliocene times. According to his investigations, the valley of the river was deeply excavated into the Carboniferous rocks during the Ozarkian uplift. Since that time, during the Pleistocene epoch, that great valley has been, to a large extent, filled up by alluvial deposits. While the greater part of these deposits were laid down during glacial stages, it is not improbable that some were made during the Aftonian stage and that a part of these yet exist along the borders of the river. It is still more probable that Sangamon beds yet exist there and that the bones Leidy described were found here.

Many bones of the megalonyx were described by Leidy (Smithson. Contrib. Knowl., vol. VII, article V) from a locality 5 or 6 miles below Henderson, Kentucky, not much more than 10 miles in a straight line from the mouth of Pigeon Creek. The bone-bed was said by Dr. D. D. Owen (op. cit., p. 7) to be about 5 feet above ordinary low-water. In the same bed Owen found abundant remains of the deer. He seemed to regard this bone-bed as a continuation of that existing at Pigeon Creek.

Megalonyx has been found at Bigbone Lick, between Cincinnati and Louisville, associated with *Equus complicatus*, two species of extinct bisons, and the Virginia deer, in deposits overlying Illinoian drift and hence belonging, in part at least, to the Sangamon. These deposits are, however, at a higher level, being now submerged only at times of very high water in the Ohio River. If these and the Pigeon Creek beds are of the same age, we may suppose that the animals entombed at the latter place were buried low down in the deep valley along the river banks, while those at Bigbone became covered up around salt springs at a higher level.

ILLINOIS.

(Map 3.)

1. *Urbana, Champaign County.*—In the fall of 1909 a claw phalange of *Megalonyx jeffersonii* was found near Urbana by Mr. Lindley, of Urbana. An excavation was being made at the eastern end of Crystal Lake, and the tooth, as reported to the writer by Professor C. C. Adams, was discovered in a blue clay. The writer has seen the tooth. The extreme length in a straight line had been close to 145 mm. The greatest thickness was 42 mm. This has been figured by the writer (Iowa. Geol. Surv., vol XXIII, plate III, figs. 5, 6, text-figs. 28–29).

Inasmuch as all this region is covered by Wisconsin drift and this tooth was found in a deposit lying on the top of this drift, there can be no reason for denying that this species lived after, probably long after, the withdrawal of the Wisconsin ice. Two occurrences of the same species in Ohio confirm the conclusion.

2. *Alton, Madison County.*—The U. S. National Museum contains a fragment of a molar of apparently *Megalonyx jeffersonii*, from a collection

made long ago by William McAdams, at Alton, Illinois. It has on it McAdams's number 21. This collection, which was long in the hands of Professor O. C. Marsh, as vertebrate palæontologist of the U. S. Geological Survey, is said to have been made in the loess at Alton. Most of the teeth, with occasional bones, are inclosed in nodules of extremely fine sand and carbonate of calcium so hard that the teeth can not be removed without injury. They have been, however, partly exposed by weathering. The nodules which contained the fossils were found between the loess and the underlying Illinoian drift.

The fragment of a megalonyx tooth has the diameters respectively 16 mm. and 24 mm. It is thinner fore and aft than other specimens, but this may be an individual variation.

It is believed that this loess belongs to the Sangamon interglacial stage. The geology of the locality and the species found there are discussed on page 339. Also, the fossils were described by the writer in 1920 (Proc. U. S. Nat. Mus., vol. LVIII, pp. 109–117). The presence of this sloth-like beast appears to indicate that the climate was at that time mild.

3. *Galena, Jo Daviess County.*—In 1870 (Proc. Acad. Nat. Sci. Phila., 1870, p. 13), Dr. Leidy brought to the notice of the Academy the fossil remains of two species of much interest. These had been presented to the Academy by Henry Green, of Elizabeth, Jo Daviess County, and were reported as having been found in a narrow crevice of the lead-bearing rocks in the vicinity of Galena, at a depth of 130 feet. One fossil was a metacarpal bone of *Megalonyx jeffersonii,* the other was identified as a last lower molar of *Bison antiquus.* Leidy mentioned three other species, *Platygonus compressus, Procyon priscus,* and *Anomodon snyderi* as having been found about Galena in similar situations. The geological age of the Vertebrata found in the lead crevices about Galena has not been well determined, but the present writer has regarded them as being probably of late Wisconsin time. The *Bison* tooth may have been that of the yet existing species. However, the possibility is that these fossils are pre-Wisconsin.

VIRGINIA.

(Map 3.)

1. *Saltville, Smyth County.*—Mr. O. A. Peterson, in 1917 (Ann. Carnegie Mus., vol. XI, p. 472, figs. 4, 5), reported the discovery of the symphyseal portion of the lower jaw of *Megalonyx* at Saltville. It was referred with some doubt to *M. dissimilis* Leidy. Further mention of the specimen will be made on page 352.

2. *Ivanhoe, Wythe County.*—On a page devoted to the consideration of a considerable number of species found by Cope near Ivanhoe, in Wythe County, mention will be made of *Megalonyx jeffersonii.* Only fragments of teeth were secured by Cope.

WEST VIRGINIA.

(Map 3.)

1. *Green Brier County.*—In a cave situated somewhere in this county were found the bones described in 1799 by President Thomas Jefferson

(Trans. Amer. Philos. Soc., vol. IV, pp. 246–260) under the name *Megalonyx*. Colonel John Stewart became interested and saved some of the bones from being carried away by curious inhabitants of the region.

The bones, a distal end of a femur, a complete radius, a complete ulna, three claws, and some other foot-bones were secured and presented to the American Philosophical Society of Philadelphia, from which they passed into the possession of the Academy of Natural Sciences, where they are still preserved. Some of these were described by Dr. Caspar Wistar (Trans. Amer. Philos. Soc., vol. IV, 1899, p. 526, plates I, II).

Inasmuch as this species may have existed during a large part of the Pleistocene and certainly after the passing of the Wisconsin epoch, and inasmuch as no other species were found associated with the megalonyx bones, it is impossible to say to what part of the Pleistocene that particular animal is to be assigned.

SOUTH CAROLINA.

(Map 3.)

1. *Beaufort, Beaufort County.*—In the Charleston Museum the writer has seen a left lower canine tooth of *Megalonyx jeffersonii*. The fore-and-aft diameter is 34 mm., the transverse 18 mm. It is recorded as found in dredging in Coosaw River. Tuomey (Rep. Geol. South Carolina, 1848, p. 203) found fragments of bones, probably belonging to *Megatherium*, on Eddings Island, about 10 miles south of Beaufort.

2. *Charleston, Charleston County.*—In 1855, Doctor Leidy (Smithson. Contrib. Knowl., vol. VII, p. 55) stated that Professor F. S. Holmes, of Charleston, had loaned him fragments of two very small teeth of *Megatherium* found on the shores of Ashley River. These were figured by Leidy in 1860 (Holmes, Post-Pl. Foss. South Carolina, p. 111, plate XX, figs. 8, 8*a*). In a collection belonging to Rev. Robert Wilson, in Charleston, the writer has seen a tooth of *Megatherium* found by the Charleston Mining Company in Ashley River. G. E. Manigault (Proc. Elliott Soc. Nat. Hist., 1886, p. 91) reported the finding of a claw phalanx of *Megalonyx* at Cainhoy, 12 miles from Charleston, on Wando River.

In the Charleston Museum is a part of the right side of the upper jaw of *Megatherium*, with the second and third teeth and parts of the sockets of the first and fourth. It is recorded as having been found in the Bolton phosphate mine on or in Stono River. There is in the same museum a fragment of the left side of the lower jaw of the same animal. This jaw contains the second and third molars and parts of the socket of the first and fourth. It is recorded as having been found in the Kiawah phosphate mine, Cooper River.

The Charleston Museum contains considerable parts of the skeleton of a megatherium of which no record has been preserved. In Holmes's "Post-Pleiocene Fossils of South Carolina," page 111, plate XX, figures 7 to 7*b*, Leidy mentioned briefly and figured two small fragments of lower teeth of *Mylodon harlani*, which had been obtained from the Pleistocene beds of Ashley River. The tooth figured was originally described as *Eubradys*

antiquus. Figures of it are found also in the seventh volume of the Smithsonian Contributions to Knowledge, plate XVI, figures 21*a* to 21*c*.

The Pleistocene geology of South Carolina is discussed on pp. 361 to 368.

GEORGIA.

(Map 3.)

1. *Brunswick, Glynn County.*—In 1842 (Proc. Acad. Nat. Sci. Phila., vol. I, p. 189), Richard Harlan gave to the Academy of Natural Sciences a number of bones which had been collected in the Brunswick Canal by Mr. J. H. Couper and sent to the Academy. Among these was a number of bones of *Megatherium*. A part of a lower jaw contained 4 teeth. A list of the bones is presented by Couper on page 44 of William B. Hodgson's memoir on *Megatherium* published in 1846. There were, besides the part of a mandible, parts of 2 maxillæ without teeth, parts of 6 or 7 femora, a part of an ilium, several dorsal vertebræ, and several teeth. Lyell (Second Visit, ed. 2, 1850, vol. I, p. 347) stated that a part of a skeleton of a *Megatherium*, dug out in cutting the canal, was so near the surface that it was penetrated by the roots of a pine tree. Most of this material was sent to the Academy of Natural Sciences at Philadelphia (Leidy, Smithson. Contrib. Knowl., vol. VII, art. 5, p. 54).

The accompanying fossils will be named on page 370.

2. *Skidaway Island, near Savannah, Chatham County.*—The earliest announcement of the discovery of *Megatherium* in North America was made by Dr. Samuel L. Mitchill in 1824 (Ann. Lyc. Nat. Hist. N. Y., vol. I, pp. 58–61, plate VI). The announcement was based on a number of teeth which had been sent to him from Skidaway Island. In the same volume, on pages 114 to 124, plate VIII, William Cooper described teeth and bones which had been sent to him from the same locality by Joseph E. Habersham. Cooper had some reason to conclude that all the bones and teeth found up to that time had come from the same individual. In 1828 (Annals cited, vol. II, pp. 267–270) Cooper described additional materials which he had received from Skidaway Island.

In 1846 (Hodgson's Mem. Megath., p. 25), Habersham gave a list of the fossil bones and teeth found at the island mentioned. Lyell (op. cit., p. 313) gave a brief account of a visit to Skidaway Island and stated that *Megatherium, Mylodon, Mastodon, Elephas primigenius*, and a species of the ox tribe had been found there. In 1855 (Smithson. Contrib. Knowl., vol. VII, art. 5, p. 50) Leidy enumerated the specimens of *Megatherium* which had been found at Skidaway Island, and he gave an excellent figure (plate XV) of a ramus of the lower jaw containing all its teeth, which had been sent to the National Institute at Washington. These bones ought to be now in the National Museum, but the writer has not been able to find them. They may never have been transferred and may be lost. On the other hand, Leidy did not mention other specimens from Skidaway Island, given by Scriven, and now in the National Museum. One of these is the hinder part of a skull figured in Hodgson's memoir. Also, the same plate contains what is almost certainly the astragalus; its greatest diameter is 9

inches. Furthermore, there is present the distal end of a right humerus presented by Doctor Scriven. It is probably one of the two mentioned on page 27 of Hodgson's memoir. As in the one there measured, the distance across the condyles is 14 inches and that across the articular surfaces is 7.75 inches. The Scriven collection also contains several teeth and fragments of others. A piece of the maxilla bears the small hindermost upper molar, no doubt the fragment mentioned by Habersham in his memorandum, page 26. Many of the bones sent from the island show by the presence of barnacles and bryozoa that at one time they lay in salt water; but this was probably not long before they were discovered.

Lyell stated that among other animals which had been found at Skidaway Island was *Mylodon*. *Mylodon* was reported by Lyell ("Travels in North America," vol. I, p. 164) as having been found at Heyner's Bridge. This is or was situated about 7 miles south of Savannah and about 5 miles northwest from the locality on Skidaway Island where the *Megatherium* and *Mylodon* remains were found. The map accompanying Hodgson's memoir is here reproduced as map 40.

FLORIDA.

(Maps 3, 4.)

1. *Archer, Alachua County.*—Leidy mentioned (Proc. Acad. Nat. Sci. Phila., 1886, pp. 11, 12) the fact that an astragalus of *Megatherium* had been found at Archer. Several other species of vertebrates have been found there, among them *Teleoceras fossiger, Gomphotherium floridanum, Hipparion plicatile,* three species of *Procamelus,* and a species of *Tapirus.* The deposits are assigned to the Pliocene, but it is doubtful whether the megatherium and the tapir belonged among the others. The geology of the locality is discussed on page 375. The megatherium, as an undetermined species, is included in the list of fossils which is recorded by Leidy in Bulletin 84 of the United States Geological Survey, page 129. It may be referred provisionally to Leidy's *Megatherium mirabile.*

2. *Almero Farm, St. John County.*—In the collection of Mr. Fred Allen, at St. Augustine, the writer has seen a right tibia of a mylodon found in the Inland Waterway Canal about 28 miles south of St. Augustine. The bone is complete, except that a sliver has been split off the upper half of the outer border. The total length of the bone is 290 mm.; the greatest width of the upper end 208 mm.; width at middle of length 105 mm.; width of surface for astragalus 130 mm. This appears to be a relatively stouter bone than the larger one described by Harlan (Amer. Jour. Sci., vol. XLIV, 1842, p. 77). It is also larger and relatively stouter than a tibia found at Labelle, Lee County, described on page 40. It is referred to *Mylodon harlani.*

11. *Williston, Levy County.*—In the U. S. National Museum there are some foot-bones of a large ground-sloth, which are labeled as having been collected in 1887 by the U. S. Geological Survey, in the county named. The collector was probably J. B. Hatcher. The astragalus had evidently been studied by Leidy. This bone was described by the writer in 1919 (Proc. U. S. Nat. Mus., vol. LVI, p. 104, plate XXVII) as *Thinobadistes segnis.*

Later, other parts of the foot were found in the museum and described (Proc. U. S. Nat. Mus., vol. LIX, p. 638, plate CXIX, figs. 6–11).

3. *Ocala, Marion County.*—In 1888, in a fissure in a limestone quarry, probably Phillip's quarry, near Ocala, Mr. Joseph Willcox discovered some vertebrate remains which were later described by Leidy (Trans. Wagner Free Inst., vol. II, pp. 13–17, plate III, figs. 1, 5, 6 to 9). The species as determined by Leidy were *Elephas columbi, Equus fraternus, Auchenia minima,* and *Machairodus floridanus.* They were regarded as belonging to the Quaternary, but in Dall's paper of 1892 (Bull. 84, U. S. Geol. Surv., p. 129) they are referred to the age of the Alachua clays; that is, to the Pliocene. Sellards, in 1916 (8th Ann. Rep. Florida Geol. Surv., p. 103), regards the fossils as belonging to the Pleistocene, and he adds representatives of 4 genera to the list. These are undetermined species of *Bison, Odocoileus, Dasypus,* and *Sylvilagus.* The genus *Dasypus* is the one to which attention is especially called at this time. A list of the vertebrate animals found at this place is presented on page 378.

4. *Dunnellon, Marion County.*—In Sellards's report just referred to, he prints a list of the Pleistocene vertebrates found in Withlacoochee River. Among these is the xenarthrid animal *Chlamytherium septentrionale.* What parts were secured and exactly at what place the writer does not know.

In the collection of the Florida Geological Survey is a foot-bone, No. 1307, which appears to be the second right metacarpal of *Megalonyx.* It is smaller than the one figured by Leidy. The extreme length is 60 mm., the greatest diameter of the proximal end 27 mm., that of the distal end 36 mm. It was found in the mine of the Dunnellon Phosphate Company. For a list of the associated species the reader is referred to page 376.

5. *Hillsboro River, Hillsboro County.*—In 1915 (Amer. Jour. Sci., vol. XL, p. 139), Sellards stated that the Jarman collection at Vanderbilt University, at Nashville, contains several dermal plates of *Chlamytherium septentrionale,* found in Hillsboro River.

6. *Sarasota Bay, Sarasota County.*—In 1915, Sellards (op. cit., p. 143) reported that the collection of Wagner Free Institute at Philadelphia contains one dermal plate of *Chlamytherium septentrionale* found by Joseph Willcox at White Beach, on Sarasota Bay.

The American Museum of Natural History, New York, possesses a dermal plate of a xenarthrid, collected by Barnum Brown 8 miles southeast of Sarasota. This probably belonged to the animal mentioned above.

7. *Zolfo, Hardee County.*—Dr. W. D. Matthew has informed the writer that there are in the American Museum of Natural History some bones of a very large individual of *Megatherium,* reported as having been found near Zolfo. An astragalus, the proximal part of a humerus, the distal part of a radius, and the proximal part of a femur were mentioned. These bones may be referred provisionally to *Megatherium mirabile* Leidy.

8. *Vero, St. Lucie County.*—At this place there have been found remains representing 4 genera of xenarthrids, as follows: *Megalonyx, Mylodon, Chlamytherium,* and *Dasypus.*

Megalonyx jeffersonii is represented by a part of a lower jaw, a right

upper canine tooth, a molar tooth, a part of a hyoid bone, an axis, an astragalus, a median phalanx, and a claw (Sellards, 8th Ann. Rep. Florida Geol. Surv., p. 148, plate xxv, fig. 2; plate xxx, fig. 6). These were all found in the stratum denominated No. 2 in the report just cited.

Mylodon harlani? is known from a single claw, but from which stratum it was derived is not known.

Chlamytherium is represented by a part of the right side of the lower jaw, a part of the left side, a foot-bone, and numerous dermal plates (Sellards, op. cit., p. 148, plate xxviii, figs. 4 to 6; plate xxx, fig. 7). Most of these remains have been taken from stratum No. 2, but some finely preserved dermal plates have been collected from No. 3.

Dasypus remains, consisting of dermal scutes, have been found in both No. 2 and No. 3.

In the collection of the Florida Geological Survey (No. 1795) is a bone, apparently the right parietal of an undetermined xenarthrid. It was found in the canal of the Indian River Farms Company, east of the railway and near Indian River. The length of the bone at the midline is 70 mm. and here the thickness is 22 mm. There appears to have been no median crest and only a feebly indicated occipital crest. There is no rough surface for the temporal muscles, as in *Nothrotherium,* and the bone is thicker than in that genus.

For complete lists of the fossil vertebrates found at Vero, see page 382.

9. *Arcadia, De Soto County.*—The *Xenarthra* are represented in the Pleistocene deposits about Arcadia by the genera *Megalonyx, Glyptodon,* and *Chlamytherium.* If these were not found at Arcadia they were collected along Peace Creek, not far from the town. A list of the species found in the vicinity of Arcadia is given on page 380.

Leidy (Trans. Wagner Free Inst., vol. ii, p. 27) stated that a first phalanx of *Megalonyx jeffersonii* was among the fossils collected along Peace Creek. It was probably found on the sand-bar at Arcadia. Among the fossil vertebrates described by Leidy, the paper just cited included some dermal plates which he referred to the genus *Glyptodon.* Two of these plates were figured (op. cit., plate iv, fig. 9; plate vi, fig. 1) as those of *G. petaliferus,* a species based on half of a dermal scute described by Cope from southwestern Texas. The dermal scute shown on Leidy's plate iv appears to be indistinguishable from similar plates which have been referred by the present writer to Cope's *G. petaliferus* (Proc. U. S. Nat. Mus., vol. li, 1916, p. 107, plates iii to v). The scute represented by Leidy on his plate vi appears to be far less extensively pitted than any of those of the specimen just referred to. On Leidy's plate v are two views of a scute which he thought might have belonged on the tail of a glyptodon. It will be observed that this scute has a beak distinctly set off from the body of the scute. Among the few caudal scutes of the specimen which the writer described none presents such a beak, but such may have existed. It seems probable, however, that there was a single species of *Glyptodon* found on Peace Creek and that it was different from *G. petaliferus.* Leidy thought that these caudal scutes resembled those on the tail of the South American *G. asper;* but Burmeister's figures do not indicate exactly such keeled scutes. It is most probable that the

Florida species requires a new name. It is to be called *Glyptodon rivipacis* Hay.

Leidy referred another dermal scute to some glyptodont animal (op. cit., plate VI, figs. 2, 3), but its nature is doubtful; it may even belong to one of the large species of *Testudo*. A conical bone (plate III, figs. 10, 11) belonged pretty certainly to *Testudo*.

In the paper cited Leidy described and figured (p. 24, plate III, figs. 3 to 6) plates of an armadillo-like animal to which he gave the name *Glyptodon septentrionalis*. It is now known as *Chlamytherium septentrionale*. Leidy had over 30 of these dermal scutes which had been found at Arcadia. They are now in the Wagner Free Institute at Philadelphia.

Sellards (Amer. Jour. Sci., vol. XL, 1915, p. 143) states that there are 3 dermal plates of this animal in the U. S. National Museum. In 1915 (Florida Geol. Surv., vol. VII, pp. 77, 78, plate on p. 114) he described a lower jaw, a tooth, and 2 dermal plates of the same animal.

10. *Labelle, Lee County.*—In the Florida Geological Survey is a right tibia of a mylodon, found on the bank of Caloosahatchee River, near Labelle, presented by Capt. F. H. Hendry. The total length is 266 mm.; on the inner border 236 mm. The width across the articulatory surface for the femur is 164 mm. The width at the middle of the length is 84 mm.; fore-and-aft diameter at the same place 38 mm. The side-to-side diameter of the surface for the astragalus is 57 mm. The bone is referred to *Mylodon harlani*.

11. See page 37.

ALABAMA.

(Map 3.)

1. *Tuscumbia, Colbert County.*—In his work on the "Extinct Sloth Tribe" in North America (Smithson. Contrib. Knowl., vol. VII, art. v, p. 6, plate XVI, fig. 13), Leidy, in recording the materials belonging to *Megalonyx jeffersonii* at his disposal, mentioned a supposed third upper molar, said to have come "from Tuscumbia County, Alabama." This was an error, as the name of the town is Tuscumbia. The tooth had been loaned to him by Dr. Jeffries Wyman. Nothing more is known about its history. Mercer (Proc. Amer. Philos. Soc., vol. XXXVI, p. 38) stated that a well-preserved series of bones of *Megalonyx* had been sent to the Academy of Natural Sciences at Philadelphia by Mr. Tuomey. They had been obtained in a cave somewhere in northern Alabama. Leidy does not mention this collection in his work just cited.

MISSISSIPPI.

(Map 3.)

1. *Natchez, Adams County.*—Dr. M. W. Dickeson (Proc. Acad. Nat. Sci. Phila., 1846, p. 106) exhibited before the Academy a large series of fossil bones secured by him near Natchez. Among these were noted especially what was described as an entire head with part of the lower jaw, and many parts of the skeleton of *Megalonyx jeffersonii*. This skull is still in the

collection of the Academy. The lower jaw is missing. It appears that several skeletons were represented in Dickeson's collection. These, as Dickeson stated, had been found in a tenacious blue clay which underlies what he called diluvial drift, but now regarded as being at least principally loess. Associated with this animal were remains of *Ursus, Bos* (*Bison*), *Cervus* (*Odocoileus*), *Equus,* and some other but undetermined genera.

In his "Second Visit to the United States of North America," edition 2, 1850, volume II, p. 196, Lyell mentions the *Megalonyx* among other fossils found at Natchez. He states that the fossils found by Doctor Dickeson were obtained in the "Mammoth Ravine" 6 miles from Natchez.

In Southall's "Recent Origin of Man," 1875, page 552, is a statement made by Professor C. G. Forshey (as quoted from Foster's "Prehistoric Races of the United States," p. 61) in which he says that he visited the locality where the human pelvis was found and that it was situated in Bernard's Bayou, 2.5 miles from Natchez.

In his memoir of 1853 on "Extinct Species of American Ox" (Smithson. Contrib. Knowl., vol. v, art. III, p. 10), Doctor Leidy included *Mylodon* among the genera found at Natchez. In his memoir of 1855 on the "Extinct Sloth Tribe of North America" (Smithson Contrib. Knowl., vol. VII, art. v, p. 48) he gave a list of the bones and brief descriptions of them. They all belonged to one individual, which was about half-grown.

In a list furnished to B. C. L. Wailles by Doctor Leidy (Wailles, Agric. Geol., Mississippi, 1854, p. 286), 4 species of *Xenarthra* are included among the mammals found fossil in the Pleistocene of Mississippi. These are *Megalonyx jeffersonii, M. dissimilis, Mylodon harlani,* and *Ereptodon priscus.* Cope regarded *M. dissimilis* as the same as *M. jeffersonii,* and Leidy was disposed to consider his *Ereptodon priscus* as identical with one of the species of *Megalonyx.*

A list of the fossil vertebrates found in the vicinity of Natchez will be given on page 392.

TENNESSEE.

(Map 3.)

1. *Elroy, Van Buren County.*—In 1831 (Jour. Acad. Nat. Sci. Phila., ser. I, vol. VI, pp. 269–286, plates XII to XIV; 1835, Med. Phys. Res., pp. 319–331, plates XII to XV), Richard Harlan described a number of bones of *Megalonyx jeffersonii* which had been purchased for the Academy of Natural Sciences, Philadelphia, and which he reported had been found in "White Cave," Kentucky. This was supposed to be situated near Mammoth Cave. It was ascertained later that the bones had been found in Bigbone Cave, Van Buren County, Tennessee.

The bones mentioned by Harlan had belonged to a young animal and consisted of 5 vertebræ, a few fore-limb bones, a few hinder-limb bones, a scapula, a rib, and a part of a molar tooth. Some of the articulating surfaces still retained their cartilage. In the same cave were found bones of *"Bos"* (*Bison*), *"Cervus"* (*Odocoileus?*), *Ursus,* and a human metacarpal. These were said to have been found on the surface, while the megalonyx bones were buried at a depth of 2 or 3 feet. The mandible of the bear

(Harlan, op. cit., p. 283) was described as displaying appearances of antiquity equal to that of the megalonyx bones. The sloth bones were made the basis of the name *Megalonyx laqueatus*. In 1855 (Smithson. Contrib. Knowl., vol. VII, art. 5, p. 4), Leidy determined that these bones belonged to *M. jeffersonii*. He wrote that the collection consisted of one molar tooth, four dorsal vertebræ, one lumbar, a left humerus lacking the upper epiphysis, the proximal two-thirds of the right ulna, the right radius, the left scapula, the distal epiphysis of the right femur, the left tibia, and the distal epiphysis of the right tibia, a right calcaneum, two claws of a hinder foot, and some fragments of ribs. Leidy appears to have concluded that these bones had been those of a young animal, but that other bones in the collection had belonged to adult individuals. He stated that they had come from Bigbone Cave, White County. This adjoins Van Buren on the north and possibly at that time included the latter; or Leidy may have been mistaken. Besides the bones above mentioned, Harlan described from this cave an ilium of *Megalonyx* (Med. and Phys. Res., p. 334).

In 1892 (Bull. Geol. Soc. Amer., vol. III, pp. 121–123), Professor J. M. Safford reported the discovery of some bones of a megalonyx in Bigbone Cave. They had been met with in the bat manure at a depth of about 3 feet. The parts received by Professor Safford, and which are all probably in Vanderbilt University, were the skull, 17 vertebræ (including 5 sacrals), a fragment of a rib, a right scapula, a right humerus, the two ilia, a part of the right pubis, a part of the right ischium, and a left tibia. Safford concluded that these bones formed a part of the same young animal that Harlan had described.

In 1897 (Proc. Amer. Philos. Soc., vol. XXXVI, pp. 36–70), Dr. H. C. Mercer gave a detailed account of his explorations in this cave. It is situated about a mile from the left bank of Caney Fork River, a mile above the mouth of a confluent called Dry Branch, and at an elevation of about 1,000 feet above sea-level. It is excavated in Carboniferous limestone and opens into what is known as "Beech Cove." Thomas L. Bailey ("Resources of Tennessee," vol. VIII, pp. 131–132) described it as being situated 3.5 miles south of Quebeck, near the head of a hollow or cove extending south from McElroy's store. The latter is probably the locality put down on the topographic sheet of the quadrangle as Elroy. It is further said to be one branch of an extensive cave whose other branch is known as Arch Cave. Bigbone Cave is known to extend a distance of 3 miles. It appears that the cave had been exploited for saltpeter in the wars of 1776, 1812, and 1863 and immense amounts of the nitrous earth had been removed. Mercer found no bones until he had reached a small passage at a distance of 900 feet from the entrance. Here he found an epiphysis of a left humerus, 6 vertebræ, an astragalus, and a calcaneum of a sloth, evidently a young animal; and he concluded that they were probably parts of the same animal that Harlan had described many years before; also a part of a skeleton that had been found there in 1884, which is the one described by Safford. A remarkable feature of the bones of the young animal found in this cave, as noted by Harlan, Leidy, and Mercer, is the presence of some of the cartilage, some shreds of ligaments, and a part of the horny sheath of one claw.

2. *Lookout Mountain, Hamilton County.*—In 1894 (Amer. Naturalist, vol. XXVIII, pp. 355–357), Dr. H. C. Mercer reported his work, done in 1893, in a cave situated on Lookout Mountain, near Chattanooga, Tennessee. In a brief report made June 4, 1896 (Dept. Amer. and Prehist. Archaeol. Univ. Penn.), Mercer stated that this cave is on the left bank of Tennessee River, 0.25 mile below Chattanooga Creek. According to the report last quoted, the cave earth, "with its culture layer," was removed by him to a distance of 58 feet from the entrance. According to the report of 1894, this was effected by digging 4 trenches, 6 feet 10 inches wide and with a depth of 3 feet, in two cases to rock bottom. Near the bottom of the deposit were found a jaw of *Tapirus haysii* with teeth, and a jaw of a small *Mylodon*, identified as such by Professor E. D. Cope. A bone of the extinct peccary appears to have been found higher up in the layer of refuse. In a letter received by the writer in 1919, Doctor Mercer stated that later Cope expressed some doubt regarding the identity of the bone supposed to belong to *Mylodon*.

A further reference to this cave and its contents will be found on page 396.

3. *Memphis, Shelby County.*—In 1850 (Proc. Bost. Soc. Nat. Hist., vol. III, p. 280; Amer. Jour. Sci., ser. 2, vol. X, p. 58), Jeffries Wyman reported that a tooth and a claw of *Megalonyx jeffersonii* had been found in the "diluvium" of Mississippi River at Memphis. The tooth is a first upper molar of large size; the claw is that of the median digit. With these were found remains of mastodon, beaver, and *Castoroides ohioensis*.

4. *Nashville, Davidson County.*—From Mr. William Edward Myer, Nashville, Tennessee, the writer has received for examination a fragment of a tooth of a mylodon which was found near Nashville, in sand or gravel, along Cumberland River, beneath 30 feet of gravel. This tooth appears to be the left lower penultimate molar of *Mylodon harlani*, but it is in some ways different. The antero-inner face has a broad, shallow groove, while the outer face makes a smaller angle with the inner hinder face than in the tooth figured by Leidy.

The transverse section resembles that of the lower penultimate molar of *M. sulcidens* Cope (Proc. Amer. Philos. Soc., vol. XXXIV, plate X, fig. 4*a*), and somewhat the tooth regarded by Cope as the upper fourth molar of *M. sulcidens* (op. cit., plate XI, fig. 7). It is probable that *M. sulcidens* and *M. renidens* of Cope are synonyms of *M. harlani*, as Stock (Bull. Geol. Soc. Amer., vol. VIII, p. 331) is inclined to believe.

The greatest length of a cross-section of the tooth found at Nashville is 27 mm.; the greatest width 14 mm. The tooth is the property of Mr. H. L. Ridge, of Nashville.

At the same locality have been found remains of *Equus leidyi, E. complicatus, Mammut americanum*, a camel (*Camelops?*), a species of deer, and some turtle bones. The deposit seems to belong to a stage not far removed from the Aftonian.

KENTUCKY.

(Map 3.)

1. *Bigbone Lick, Boone County.*—In 1831, Dr. Richard Harlan (Monthly Amer. Jour. Geol., vol. I, p. 77, plate III, figs. 1 to 3) described a left ramus

of the lower jaw of a ground-sloth which had been brought to New York. This jaw he referred to his *Megalonyx laqueatus* (*M. jeffersonii*); but it was later shown by Owen (Zool. Beagle, 1840, p. 68) to belong to *Mylodon,* and he named it *M. harlani* in honor of Dr. Harlan. From Cooper (Monthly Amer. Jour. Geol., vol. I, p. 172) it is learned that this bone had formed part of the Finnell collection at Cincinnati. So far as the present writer sees, there was nothing in Harlan's article to show where the jaw was discovered. In 1855 (Smithson. Contrib. Knowl., vol. VII, p. 47, plate XIV, figs. 1, 2), Leidy further described and illustrated the specimen and stated that it was found at Bigbone Lick. In 1903, Barnum Brown (Bull. Amer. Mus. Nat. Hist., vol. XIX, p. 511) stated that Harlan's specimen ought to be in Columbia University, but it could not be found. It is more probable that it was destroyed in a fire in the old American Museum of Natural History.

In his report on Bigbone Lick (op. cit., p. 171), Cooper stated that he had seen in the "Western Museum," Cincinnati, a large humerus of a megalonyx. Cooper further wrote that he and a companion had found at the lick a metacarpal bone which he supposed belonged to the same animal. The humerus was described and figured by Harlan (Jour. Acad. Nat. Sci., Phila., ser. 1, vol. VI, p. 277, plate XIII, fig. 10). Cooper (op. cit., p. 172) mentions other bones of *Megalonyx* found at Bigbone Lick, but some may have belonged to *Mylodon.* This is the case with the fragment of lower jaw with 4 teeth which became the type of *Mylodon harlani,* as above mentioned. In Princeton University there is an ungual phalanx 167 mm. long, 66 mm. high, and 43 mm. thick at the middle of the height. This is labeled as having been found at Bigbone Lick. A list of the species discovered at this place will be found on page 403.

2. *Bluelick Springs, Nicholas County.*—In the collection made by Mr. Thomas W. Hunter, in the sulphur spring at the place mentioned, the writer has seen two ungual phalanges which were identified as those of *Megalonyx jeffersonii.*

3. *Henderson, Henderson County.*—A considerable part of a skeleton of *Megalonyx jeffersonii* was found at different times extending through some years, about 5 or 6 miles below Henderson, in the bank of Ohio River. This skeleton is now in the University of Indiana and was described by Leidy in 1855 (Smithson. Contrib. Knowl., vol. VII, art. 3). This collection furnished a fine skull and lower jaw. In the same deposits were found many horns and bones of deer. The geology of the locality and the age of the bones will be discussed on page 405.

FINDS OF PLEISTOCENE MASTODONS IN EASTERN NORTH AMERICA

ONTARIO.

(Map 5.)

1. *Essex County.*—In 1898 (Science, n. s., vol. VII, p. 80), Dr. H. M. Ami reported that he had exhumed some mastodon remains in this county. The exact locality was not given. It was north of the west end of Lake Erie. The section dug up was from 6 to 8 feet deep. At the bottom were clay and boulders; above this were found gravel and the bones, and above these sand, shell marl, peat, and other sands of various colors. The remains were fragmentary.

2. *Morpeth and Highgate, Elgin County.*—In 1858 (Canad. Jour. Indust. Sci. Art, ser. 2, vol. III, p. 356), E. J. Chapman announced the discovery of a tooth of mastodon at or near this place. He had seen a drawing of the tooth. It appears that another man also had sent to the journal an account of the discovery, accompanied by drawings. These showed 5 distinct crown-ridges.

In 1891 (Geol. Mag. London, ser. 3, vol. VIII, p. 504; Brit. Assoc. Adv. Sci., 64th meeting, 1892, p. 654), Professor J. Hoyes Panton gave an account of the discovery of mammoth and mastodon bones at Highgate, only a few miles north of Morpeth. These were found in a bed of marl. Some measurements of the mastodon were given.

3. *St. Thomas, Elgin County.*—In a private museum at Niagara Falls, owned at the time by Davis Brothers, the writer saw a quite complete lower jaw and a tusk, labeled as having been found at this place in 1856, on the farm of Isaac Barnard. The jaw had the last 3 teeth on the right side and the last 2 on the left side. In front was a tusk about 6 inches long which appeared to be in the middle of the jaw. The upper tusk is curved in a semicircle. Dr. J. W. Dawson (Geol. Mag. London, ser. 1, vol. VI, 1869, p. 39) mentions this find. He stated that there were 2 lower tusks. If this was the case the species *M. progenium* is indicated.

4. *London, Middlesex County.*—In the article quoted above from the Geological Magazine of London, Dr. J. W. Dawson stated that there were in the Provincial Museum 3 mastodon molars which had been found at London.

5. *Marburg, Norfolk County.*—In 1898 (Science, n. s., vol. VII, p. 80), Dr. H. M. Ami reported the exhumation of remains of a mastodon at some place in this county. The skull, 25 ribs, 40 foot-bones, 2 tusks, and many vertebræ were recovered. The remains were buried at a depth of from only 3 to 4.5 feet. At the bottom was clay; above this, shell marl, and sands of different colors; and above all was peat.

The writer has seen this skull in Victoria Museum, Ottawa. It is to a considerable extent restored. It appears to have been found at or near Marburg. A small label, somewhat injured, has the record: "West half lot 15, R V, Tp. of [?]dhouse, Norfolk Co., Ont. Ami, 1897." The penultimate and ultimate molars are in place. The former is 113 mm. long; the latter is 174 mm. long, and has 4 crests and a talon. The tusks are present

and the right one is 2,230 mm. long. The skull is a large one. The width across the rear is 760 mm.

6. *Dunnville, Haldimand County.*—In 1869 (Geol. Mag. London, dec. 1, vol. VI, pp. 38, 39), Dr. J. W. Dawson gave an account of the finding of a mastodon, in 1868, at the place named, situated at the east end of Lake Erie. When he reached the place a large part of the animal had disappeared, especially the tusks. He found 7 teeth, a few vertebræ, a few fragments of ribs, and part of the right ramus of the lower jaw. These remains were buried in a swamp, partly embedded in a layer of fine sand. This contained fresh-water shells of species yet living in that region. The sand was 2.5 feet thick and rested on boulder clay. Over the sand was 1.5 feet of black vegetable mold. He regarded it as clear that the animal lived long after the close of the Glacial period.

7. *St. Catharines and Welland Port, Lincoln County.*—At Rochester University, New York, the writer has seen a cast of a lower jaw, labeled as having come from the place named above. On the left side the second and third molars are present, the former slightly worn, the hindermost not at all. On the right side the hindermost molar is not to be seen. The second molar is tilted up behind and lowered in front. The little wear of the tooth is on the hinder end. It is possible that the hindermost molar was yet in the bone and somewhat under the second one. The ramus has a length of 400 mm.

8. *Toronto, York County.*—It does not appear to be wholly certain that the mastodon has been found at Toronto; but its occurrence there is probable. In some of his papers Coleman has reported that its presence was believed to be determined.

9. *Junction of Missinaibi and Moose Rivers, Algoma County.*—In 1898 (Science, n. s., vol. VII, p. 80), Robert Bell reported a mastodon tooth from the locality mentioned. It had been chopped out of a skull by an Indian. Later Bell attempted to obtain the skull, but could not, because of high water. A further account was given of this tooth by Bell in 1898 (Bull. Geol. Soc. Amer., vol. IX, p. 383).

CAPE BRETON ISLAND.

1. *Middle River, Victoria County.*—In 1912 (Proc. Trans. Nova Scotia Inst. Sci., vol. XIII, pp. 163–174), Mr. Harry Piers, curator of the Provincial Museum, Halifax, presented a paper in which he detailed the history of mastodon remains found on Cape Breton Island. At the place above named, in a meadow, at a depth of only 5 inches, was found a right femur. According to Piers's account, this was discovered about the year 1834, possibly a few years earlier. It came into the possession of the Mechanics' Institute, at Halifax, and later of the Provincial Museum of Halifax, where it is now preserved. It was noticed and figured by J. W. Dawson in the four editions of his "Acadian Geology."

2. *Baddeck, Victoria County.*—According to Piers's account, a molar tooth of a mastodon, now in the Provincial Museum, was found in 1859, at the place named. This tooth is figured by Dawson, with the femur. Piers states that Dawson was in error in crediting Honeyman with the discovery. Details regarding this are wanting. The molar has 3 crests.

In the same museum is a part of a proboscidean tusk, but it is not certain where it was found. It is quite certain that all of these remains are of animals which lived there after the Wisconsin ice had retired.

These localities are not indicated on the map.

MASSACHUSETTS.

(Maps 5, 6.)

1. *Coleraine, Franklin County.*—In 1872 (Amer. Jour. Sci., vol. III, p. 146), Dr. Edward Hitchcock, in a letter to one of the editors, reported the discovery of a tooth of a mastodon at or near this place. It had been shoveled out of a muck-bed, on the farm of Elias Bardwell. Nothing more is known about the matter. This tooth was mentioned by B. K. Emerson in 1917 (Bull. U. S. Geol. Surv. 597, p. 149).

2. *Shrewsbury, Worcester County.*—In 1885 (Trans. N. Y. Acad. Sci., vol. v, pp. 14, 15), N. L. Britton read before the Academy an extract from the New York Times, copied from the Worcester Spy of October 14, 1885, relating to the finding of a human skull near Shrewsbury, close to the spot where mastodon remains had been found the year before. In Science (vol. VI, 1885), Professor F. W. Putnam gave an account of the investigations of the case made by himself and others. The conditions under which the mastodon was buried were incidentally described. In the same year Franklin P. Rice, a member of the Worcester Natural History Society, published a pamphlet of 8 pages, in which the discovery and exhumation of the remains were set forth; one molar, an upper penultimate, was well figured. A trench was being made in a meadow of a farmer, W. U. Maynard, about 2 miles from the center of Shrewsbury, on the road to Northborough. The teeth and some bones of the mastodon were met at a depth of 8 feet. Putnam stated that these remains, as well as the human skull, were resting on blue clay beneath a bed of peat. Rice reported that the mastodon bones and teeth were resting on bed-rock. Putnam believed that both skulls had been transported thither by water before the peat was laid down. From Mrs. Ella Horr, custodian of the Natural History Museum of Worcester, the writer has learned that the mastodon remains are preserved there. Mention was made of these remains by B. K. Emerson in 1917 (Bull. U. S. Geol. Surv. 597, p. 149).

There is no reason to suppose that the mastodon in question lived before the Wisconsin stage, but at its close. The ice must already have retired beyond the State, and the land, which, according to Dr. Fairchild, was depressed at the latitude of Shrewsbury about 350 feet, must have been elevated enough to reduce considerably the area covered by water before conditions would have favored the presence of mastodon. It is possible, however, that the depression was not so great.

CONNECTICUT.

(Maps 5, 6.)

1. *Cheshire, New Haven County.*—In 1828 (Amer. Jour. Sci., vol. XIV, p. 187), a note appeared which stated that in the summer of the preceding year 3 or 4 large molar teeth of a "mammoth" had been found near Cheshire. From the description it is evident that they were teeth of a

mastodon. They were in fine condition but were immediately destroyed in a frolic of the workmen. The teeth had been found in gravel only a few feet under ground. Warren ("Monogr. on *Mastodon giganteus*," p. 3) stated that the mastodon teeth had been found in making a canal at Cheshire. He undoubtedly referred to the teeth mentioned above. Schuchert (Amer. Jour. Sci., ser. 4, vol. XIV, p. 321) states that one tooth was preserved and is now in the Yale University collection.

2. *New Britain, Hartford County.*—In 1835 (Amer. Jour. Sci., vol. XXVII, p. 165), a report was published about the finding of a vertebra of a mastodon in digging a canal for a factory in Berlin, not far from New Britain. It appears to have been met with in a deposit of marl. Schuchert (op. cit., p. 322) mentions this find and says that the locality was not in Berlin, but in New Britain. The depth is given as 3 feet and the material as mud or clay.

Schuchert, as cited, gave an account of the discovery, in 1852, of another mastodon in New Britain. Two or three teeth and some bones were found in a soft swampy soil.

3. *Farmington, Hartford County.*—In 1914 (Amer. Jour. Sci., vol. XXXVII, pp. 321–330), Schuchert and Lull described the exhumation of a mastodon near the town named. All of the principal bones of the skeleton were secured. One tusk and most of the foot-bones were missing. The account ought to be taken by collectors as a model for their reports. The exact position of the skeleton is given. A topographic map of the surrounding region is furnished, as well as the details concerning the materials occurring above and below the bones. These lay on boulder clay of Wisconsin age and were covered by materials washed in from the surrounding higher grounds. No mollusks were found in the excavation, and little vegetation. The bones, as shown by Lull's map, were remarkably little disturbed, not more than one might expect from the activities of wolves. One of the tusks was, however, removed from the skull a distance of 23 feet and left on ground 2 feet higher. Schuchert regarded this as being hard to explain. The other tusk was not found at all.

4. *Bristol, Hartford County.*—In 1885 (Trans. N. Y. Acad. Sci., vol. V, p. 14), O. P. Hubbard stated that the remains of a mastodon had been found at Bristol, but no further information was furnished.

5. *Sharon, Litchfield County.*—In 1828 (Amer. Jour. Sci., vol. XIV, p. 187), in a footnote, it was reported that, a good many years before that time, some remains of mastodon had been found near Sharon. In 1835 (ibid., vol. XXVII, p. 166) it was stated that a mastodon bone, found probably at Sharon, had been presented to the museum of Yale College. There seems to be no certainty that the bone was correctly identified.

NEW YORK.

(Maps 5, 6, 34.)

1. *New Dorp, Richmond County.*—In 1901 (Ann. N. Y. Acad. Sci., vol. XIV, p. 67), Dr. Arthur Hollick reported the discovery of some fragments of a molar of a mastodon in a swamp deposit in the Moravian cemetery immediately north of New Dorp, Staten Island. The molar was found at

a depth of 23 feet. The swamp, now drained, was located immediately on the moraine of the Wisconsin ice-sheet (Folio 157, U. S. Geol. Sur.). It had evidently at first been a pond about 25 feet deep; later it had become filled up with sandy silt, muck, and vegetable débris. At a depth of about 8 feet Hollick found a stratum approximately 2 feet thick, in which were cones of white spruce (*Picea canadensis*), a tree now found not farther south than northern New England and the Adirondacks. Evidently the mastodon had lived there not long after the retirement of the ice, for the tooth appears to have been only about 2 feet above the bottom of the old pond. The spot is probably at an altitude above the submergence described by Fairchild (Bull. Geol. Soc. Amer., vol. XXVIII, p. 279).

2. *Ridgewood, Kings County.*—In 1885 (Trans. N. Y. Acad. Sci., vol. v, p. 15), Mr. D. S. Martin stated that some 15 or 20 years before that time a mastodon skeleton had been exhumed in excavating for the Ridgewood, Long Island, reservoirs. No details were furnished.

3. *Jamaica, Queens County.*—In 1859 (Proc. Amer. Assoc. Adv. Sci., 12th meeting, 1858, p. 232), J. C. Brevoort reported the finding of 5 molar teeth and fragments of bones in removing pond-muck in the valley of a small stream which flowed into Baisley's pond, near Jamaica. In the pond itself was a deposit of mud, in some places 6 feet deep, which rested on gravel. This deposit of mud, mixed with vegetable matter, is continued up the valley mentioned. The bones and teeth were found about 20 yards from the channel of the stream, resting on the gravel and covered by about 4 feet of the muck.

According to Folio 83, of the U. S. Geological Survey, Jamaica and vicinity is situated on stratified drift which was laid down while the foot of the glacial ice was immediately north of the town. The mastodon must have lived there after the retreat of the ice from the island; it may have been a long time afterward. According to Fairchild, as above cited, this locality was submerged by the sea while the stratified materials were being laid down.

4. *Inwood, Nassau County.*—In 1891 (Science, vol. XVIII, p. 342), Professor R. P. Whitfield noted the finding near Inwood of a fragment of what he regarded as a mastodon tusk. It was met in cutting a ditch in a peat-swamp. While the probability is that the tusk was that of a mastodon, it might have been that of one of the elephants.

5. *Riverhead, Suffolk County.*—In 1842 (Zool. of New York, Mamm., p. 103), DeKay stated that in the year 1823 more than half of a lower jaw, with the teeth, of a mastodon had been found on the south beach, about 4 miles east of Riverhead, between high and low water. This fossil was mentioned by Dr. John M. Clarke in 1904 (N. Y. State Mus., Bull. 69, p. 923); also by J. C. Brevoort in 1859 (Proc. Amer. Assoc. Adv. Sci., vol. XII, p. 233). This vicinity was evidently submerged while the foot of the glacier was in Long Island. Only after the emergence of the island did the animal probably have its existence.

6. *Morrisania, New York County.*—In 1885, Dr. N. L. Britton (Trans. N. Y. Acad. Sci., vol. v, p. 15) reported the discovery of a large portion of a mastodon's tusk in a cellar excavation in Morrisania 3 years previously.

Here, as in similar cases, one can not be certain that the tusk was not that of an elephant.

7. *New York City.*—In 1891 (Science, vol. XVIII, p. 342), Professor R. P. Whitfield recorded the finding of a supposed mastodon tusk at the upper end of New York Island. It was found at a depth of 16 feet below mean low-water mark, embedded in peat, with the socket end downward. It was met with in excavating the Harlem ship-canal and at the mouth of Dyckman's Creek, an artificial waterway. The location is given as 15 feet from the north side of the canal and 10 feet west of the center of Broadway. At this particular spot there was found at the surface from 4 to 6 feet of meadow sod, with roots, etc. Below this was 12 feet of incipient pure peat, lying on 18 to 20 inches of sandy clay, which itself reposed on limestone. The tusk was in the peat, with its base in the sand. It appeared to have settled from above through the peat.

8. *Hartsdale, Westchester County.*—In 1908, Dr. John M. Clarke (60th Ann. Rep. New York State Mus., for 1906, p. 60), reported that a tooth and some small fragments of bone of a mastodon had been found on the property of W. H. Fish of Hartsdale. No other information was given.

9. *New Antrim, Rockland County.*—In 1818 (Cuvier's Essay Orig. Earth, p. 390, plate VI, figs. 1 to 4), Samuel L. Mitchill stated that he had received a set of grinding-teeth which had been found at the place named. It is described as being 11 miles west of the Hudson River and 32 miles from New York. The teeth had been found in mud at a depth of 3 feet. They are mentioned in J. D. Godman's "American Natural History."

10. *Arden, Orange County.*—In 1903 (New York State Mus. Bull. 69, p. 926), Dr. John M. Clarke stated that a tusk and a few other bones of a mastodon had been found at this place. In 1908 (66th Ann. Rep. New York State Mus., vol. I, p. 61), he gives the further information that the locality was on lands of Mr. E. H. Harriman. Only 2 teeth, some ribs, and a few fragments were secured. The soil was a peat or vegetable mold.

11. *Monroe, Orange County.*—In 1903 (op. cit., p. 926), Clarke reported that about the year 1888 mastodon bones were found on land of Martin Konnight. Clarke himself continued excavations in 1901. About half of the skeleton was secured in all. These bones are now in the New York State Museum at Albany. They lay beneath 3 feet of clayey muck, at the bottom of a pond from 3 to 10 feet deep.

12. *Chester, Orange County.*—In 1818 (Cuvier's Essay, etc., p. 376, plate VII, figs. 1 to 4), Samuel L. Mitchill presented an account of the exhumation in 1817 of a part of a mastodon skeleton at Chester. This had been originally discovered in a ditch made through a wet meadow. The surface soil was underlain by about 6 feet of black peat, and the bones lay in this at a depth of about 4 feet; beneath was a stratum of coarse vegetation. No marl underlay this muck. The upper jaw with teeth and tusks, lower jaw with teeth, shoulder-blade, vertebræ, and parts of the limbs were secured. An account of this discovery is to be found in Godman's "American Natural History." J. C. Warren, in the second edition of his monograph on the mastodon, has some remarks on the food of this mastodon. In 1909 (Trans. N. Y. Acad. Sci., vol. XVIII, p. 147, plate), Dr. E. O. Hovey made

a contribution to the history of this specimen. What became of the bones is not known.

13. *Salisbury Mills, Orange County.*—In 1903 (op. cit., p. 926), Clarke gives a brief account of a part of a mastodon skeleton which, in 1879, was found at this place, 9 miles southwest of Newburgh. It now forms the larger part of a mount in the American Museum of Natural History, New York. The present writer has no further information regarding this specimen.

14. *New Windsor, Orange County.*—In the Kansas City Review of Science and Industry, volume III, 1879, page 241, is an item concerning the finding of a mastodon at this place. Nearly all the bones were secured. It was stated that a black vein of muck about 20 feet thick rested on a bed of blue clay. The bones lay at depths varying from 2 to nearly 5 feet from the surface.

15. *Newburgh, Orange County.*—A considerable number of mastodons, some of them well preserved, have been discovered in the vicinity of Newburgh. The earliest one found was exhumed by Charles Wilson Peale, father of the artist Rembrandt Peale, in 1801. An account of the unearthing of this specimen is given by Rembrandt Peale in his "Historical Disquisition on the Mastodon," London, 1803. The locality was probably south or southwest of Newburgh, for in another paper (Tilloch's Philos. Mag., London, vol. XIV, 1802, p. 163) he states that it was in the neighborhood of New Windsor. Peale wrote that the specimen was found on the farm of John Masten. Peale's account is reprinted in the second volume of Godman's "American Natural History." The whole of that part of the country is spoken of as abounding in morasses, solid enough for cattle to walk upon, and containing peat underlain by a shell marl. The mastodon remains had been found in an effort to get at the marl. It appears that the bones were met with at a depth of 6 or 7 feet, and were lying on the marl. Although the spring of 1801 was an unusually dry one, the digging was greatly hindered by the incoming water, and the work was finally abandoned. A considerable part of the skeleton was secured and sent to Philadelphia.

What is known as the Warren mastodon was discovered in 1845, on the farm of N. Brewster, somewhere in the vicinity of Newburgh. It is an unusually complete and well-preserved skeleton, and gave occasion to the writing of Dr. John C. Warren's monograph entitled "Description of a skeleton of the Mastodon giganteus." Of this work there was an edition printed in 1852, a second in 1855.

The spot where this skeleton was buried is described as being situated in a small valley 300 or 400 feet in length, in which was a pond of water 30 or 40 feet in diameter. Around this the ground was wet and swampy. The summer of 1845 being unusually dry and the pond desiccated, a search was being made for marl. At a depth of about 4 feet the summit of the animal's head was encountered. For many years this skeleton was in Cambridge, but is now the property of the American Museum of Natural History in New York.

According to Warren's description (Monograph, 1st ed., pp. 5, 211, vignette), there was a deposit of about 2 feet of bog-peat, then about a

foot of peat of a reddish color. This was underlain by a bed of shell-marl of a thickness not given, but probably about 2 or 3 feet, while below this was mud changing downward into clay. Some parts of the skeleton were in this mud; but the head, the right fore-leg, the spinal column, part of the ribs, the pelvis, and the tail were embedded in the marl. However, Dr. Charles A. Lee (21st Ann. Rep. State Cabinet, New York, p. 108) affirmed that these bones were not in the marl, but were wholly embedded in the muck or peat.

Dr. F. A. Lucas, of the American Museum of Natural History, New York, stated in 1902 (Science, vol. xvi, p. 169) that there is in Vassar College a skeleton of a mastodon which is supposed to have been found at Newburgh.

In the collection of the Brooklyn Institute, New York, is a partial skeleton which was found in 1899 on the farm of F. W. Schaeffer, 3 miles west of Newburgh. According to Dr. J. M. Clarke (Bull. 69, N. Y. State Mus., p. 926), the bones were found lying on a stony pavement under muck and marl. Osborn (Science, vol. x, 1899, p. 539) stated that the deposit is mostly dark and contains thoroughly decomposed vegetable matter mingled with a few stones and numerous remains of trees, some of which retain marks of beavers' teeth. The deposit appeared to consist of three layers, indicating, as supposed, the building of three distinct beaver-dams.

Dr. John Mickleborough (Brooklyn Eagle, Mar. 9, 1901) stated that he had collected in this peat-swamp species of mollusks belonging to *Limnæa, Physa, Planorbis,* and *Sphærium.* He regarded it as certain that the swamp had been for a long time a fresh-water lake.

Eager (op. cit., p. 73) wrote that in 1838 a mastodon tooth had been found near Newburgh, on a farm owned by Samuel Dixon. No details.

Clarke (Bull. 69, N. Y. State Mus., p. 926) stated that in 1902 a cranium and some other parts of a mastodon had been found at Balmville, just north of Newburgh. The bones lay at a depth of from 2 to 8 feet, some in the muck and some in the marl below. Under the marl was found a boulder pavement.

In 1902 (Science, vol. xvi, pp. 594, 1033), Reginald Gordon gave accounts of the exhumation of a mastodon skeleton 1 mile north of the northern limit of Newburgh and 0.75 mile away from the Hudson. This certainly refers to the same mastodon as that reported by Clarke. The place is a swamp of about 2 acres and at a height of 180 feet above the level of the river. The bones were found 2 to 8 feet below the surface, a few of them inclosed in the muck, most of them in an underlying shell-marl. The muck averages 2 feet in thickness; the marl varies from a few inches to 12 feet in thickness. Beneath the marl a solid bottom is formed of pebbles and boulders.

16. *Northeast of Coldenham, Orange County.*—In 1847 (op. cit., p. 73), Eager wrote that in 1800 remains of a mastodon were found about 7 miles northeast from Montgomery, on or near a farm owned by Dr. George Graham. This statement was based on Dr. J. G. Graham's letter (Med. Repos., vol. iv, p. 213). This must have been in the vicinity of the town named. Dr. J. G. Graham stated that a vertebra had been found here. This may have been in the marshes along Bushfield Creek.

17. *East Coldenham, Orange County.*—Dr. James G. Graham (op. cit., p. 213) states that about 7 miles east of Montgomery (apparently about 5 miles west of Newburgh), a grinding-tooth and some hair of a dun color had been found at a depth of 4 or 5 feet. Possibly the supposed hair was some sort of vegetable matter. The place may have been on Bushfield Creek. Gordon (Science, n. s., vol. XVI, p. 1033) reported further the finding of large numbers of tree-trunks both in the muck and in the marl. Some mastodon bones were found resting on the trees. Red cedar and spruce were recognized. Some trees showed marks of the teeth of beavers.

18. *Montgomery, Orange County.*—Several more or less well-represented skeletons of mastodons have been discovered in the vicinity of Montgomery. So far as the writer knows, the first were met with in 1782. An account of the discovery was given by Rev. Robert Annan in 1793 (Mem. Amer. Acad. Arts, Sci., vol. II, pp. 160–164). The town was not named, but Mather (Geol. N. Y., 1st Dist., pt. 1, 1843, p. 202), on the authority of Dr. James G. Graham (Med. Repos., vol. IV, p. 213), stated that the place was 3 miles south of Ward's Bridge, an old name of Montgomery. This would be near the village of Neelytown, and probably in the swamps along Beaver Creek. A ditch was being made in a deep and wet swamp, and some large teeth were thrown out. The description of these shows that they belonged to a mastodon. Bones were present, but mostly so far decayed that few could be saved.

Eager (op. cit., p. 73) stated that in 1803 mastodon remains had been found on a farm a mile east of Montgomery. These bones were dug out by Peale in 1805 or 1806, and Eager, then a boy, observed the work from day to day. Nothing was said about what remains were secured, or about the geological conditions; but Graham wrote that 3 or 4 ribs were found in a swamp at a depth of 8 feet.

R. Peale, writing in 1803 ("Disquisition on Mammoth," pp. 27–29), reported that his father exhumed mastodon bones on a farm belonging to T. Barber, where 8 years before 4 ribs had been found in digging a pit. One may suppose that only one place is in question and that Eager was wrong in his date. Peale secured almost an entire set of ribs, two rotten tusks, 3 or 4 small teeth, and some other parts. At the bottom of the excavation there was a shell marl; above this there was probably peat or muck.

Dr. Graham further stated that about 3 miles east of Ward's Bridge (now Montgomery) some other bones had been discovered. This was quite certainly near the village of Berea, where swamps are indicated on the topographical map of that quadrangle.

19. *Hamptonburg, Orange County.*—Eager (op. cit., p. 73) states that in 1845 mastodon remains had been found in this town on the farm of Jesse C. Cleve, but no further information was furnished.

20. *Bullville, Orange County.*—Eager (op. cit., p. 73) says that in 1794 remains of a mastodon had been found about 5 miles west of Montgomery, just east of the residence of Archibald Crawford, and near the line of the Cochecton turnpike. It appears probable that the place was east of Bullville on the Dwaar Kill. What was found was not stated.

In 1830 (Trans. Amer. Philos. Soc., vol. III, p. 478, plate XVII), J. D. Godman described a skull of a mastodon which, he said, had been disinterred

a short time previously by Archibald Crawford, about 12 miles from Newburgh. Besides the head, some bones from the trunk and limbs were secured. Whether or not two discoveries had been made, and whether, if two, the localities were near each other, it is now impossible to say with confidence.

Somewhere about Bullville, possibly farther north or northeast, the elder Peale (R. Peale, Hist. Disquis., p. 30) secured some mastodon bones. In arriving at the place, he crossed Wallkill River at the falls (Walden) and "ascended into a rudely cultivated country about 20 miles from the Hudson." The bones were found in a morass on the farm of Peter Millspaw. The lower jaw found there was mentioned and figured by Hays (Trans. Amer. Philos. Soc., vol. IV, 1834, p. 321).

21. *Scotchtown, Orange County.*—On the page just quoted, Eager reported that in 1844 some part of a mastodon had been found at the place named. In his work on *Mastodon giganteus* (first edition, pages 110–117, plates XVI, XVIII, XIX), Dr. J. C. Warren described a very complete skull which had been found at this place. He stated that the magnificent head is remarkable for its size, whiteness, and the distinctness of its sutures. It is known as the "Shawangunk head." Warren wrote that the strata covering it were: first, gravel; second, marl; third, a layer of peat hard enough to be turned in a lathe.

Eager, in his "History of Orange County," on page 348, stated that remains of *Mastodon maximus* were, in 1843, dug up from a marl-bed on the farm of William Connor, about 0.25 mile from Scotchtown, and were then in the cabinet of Professor Emmons, of Albany. This was quite certainly the "Shawangunk mastodon."

22. *Otisville, Orange County.*—In Yale University there is a nearly complete skeleton of a mastodon which was described and figured by Professor O. C. Marsh in 1892 (Amer. Jour. Sci., vol. XLIV, p. 350, plate VIII), but no statement was made as to its origin. Clarke (Bull. 69, New York State Museum, p. 925) stated that a mastodon found in 1874 was purchased by Professor Marsh. Professor R. S. Lull (Amer. Jour. Sci., vol. XXV, 1908, p. 193) refers to a mastodon at Yale which came from Otisville. In 1914 (Amer. Jour. Sci., vol. XXXVII, p. 330) he presented some notes on the anatomy.

A newspaper account of the discovery of this skeleton stated that the region of the stomach contained very fresh-looking, large leaves of odd form, and blades of strange grass of extreme length, and from 1 to 3 inches in width. It seems probable that a good deal of this was pure imagination. The vegetation which flourished there at the time the mastodon was living was certainly not different from that of to-day.

23. *Shawangunk, near Wallkill, Ulster County.*—Dr. James G. Graham, writing in 1801 (Med. Repos. New York, vol. IV, p. 213), reported that "a skeleton of a mastodon had been discovered about 3 miles east of his house, in the town of Shawangunk." The bones lay about 10 feet from the surface and were in a very sound state. Some parts of the head, much broken, were among the parts secured.

24. *Ellenville, Ulster County.*—In 1861 (14th Ann. Rep. State Cabinet, pp. 7, 15) the discovery at this place of some mastodon remains was briefly

reported. A large tusk and parts of the skull, with teeth, were secured. The swamp is composed of about 2 feet of peat and 3 feet of marl, resting on a base of clay. The bones were lying in the marl. In 1871 (21st Ann. Rep., etc., p. 128) further mention of these bones was made. Clarke (Bull. 69, State Mus., p. 927) mentions these remains and adds that there is also a smaller tusk in the museum.

In Rutgers College, New Brunswick, New Jersey, the writer has seen a tusk about 10 feet long, with a considerably spiral form, which is said to have been found at Ellenville. It may, however, be the tusk of an elephant.

25. *Poughkeepsie, Dutchess County.*—In 1854 (Amer. Jour. Sci., vol. XVIII, p. 447), an editorial paragraph stated that a skeleton of a mastodon had been found buried in a marsh about 2 miles east of Poughkeepsie. It had then been only partly exhumed. Clarke (Bull. 69, State Mus., p. 927) quotes from a letter written by Professor W. B. Dwight, who stated that about 40, perhaps 45, years previously mastodon bones had been found in a small pond on the "Creek Road," from 2 to 3 miles northeast of the city named. Probably the same skeleton was referred to by both writers. Clarke stated further that there is in the State Museum a vertebra of a mastodon from Poughkeepsie.

26. *Between Red Bridge and Wurtsboro, Sullivan County.*—In 1828 (Amer. Jour. Sci., vol. XIV, p. 31), J. Van Rensselaer reported that remains of a mastodon had been found by workmen digging the Delaware and Hudson Canal, near the point named. A considerable part of the skeleton had been secured. Mather (Geol. 1st Dist., p. 233) adds that this was found in a peat bog.

27. *Claverack, Columbia County.*—Somewhere near this place, not improbably on the opposite side of the river, in Greene County, were found apparently the first mastodon remains discovered in this country. In his "History of Orange County, New York," Eager published a letter addressed in 1706 by Governor Joseph Dudley to Cotton Mather. In this he told of having secured a tooth which was probably a penultimate molar of a mastodon. Dudley regarded it as the eye-tooth of a giant who had been destroyed by the flood. The locality was given as about 30 miles below Albany and was mentioned as Claverack. It appears that another tooth had been presented the year before to Lord Cornbury. In the account of this, found in a letter by Lord Cornbury, the locality is given as 20 miles below Albany. Clarke (op. cit., p. 928) thinks that this was probably near the present New Baltimore; but a letter from Abeel, recorder of Albany County, published by Clarke, shows that a man was sent to Claverack to make further search. It appears as if 2 teeth had been discovered at the same place near the town. Abeel stated that the tooth had been found near the bank of the river, and that other bones were met with 15 feet below the surface. It appears not improbable that these bones were buried in clays laid down during the Late Wisconsin submergence or in deposits overlying these clays.

28. *Freehold, Greene County.*—Clarke (op. cit., p. 927) stated that there is in the American Museum of Natural History, New York, an atlas of a mastodon which was found at Freehold.

29. *Greeneville, Greene County.*—In 1843 (Geol. 4th Dist., p. 367), James Hall stated that he had visited this locality, where mastodon bones had been found embedded in a fresh-water marl. Lyell (Ann. Mag. Nat. Hist., vol. XII, 1843, p. 127) visited the locality with Hall and stated that the mastodon bones occurred in swamps at a depth of 4 or 5 feet.

In 1843, Mather (Geol. 1st Dist., p. 44) wrote that bones supposed to belong to an elephant had been found at this place. It is doubtful whether the remains reported by Mather and Hall are those of an elephant or of a mastodon.

30. *Coeymans, Albany County.*—Mather (Geol. 4th Dist., 1843, p. 44) recorded the finding of mastodon remains on Helderberg Mountain, on the farm of a Mr. Shear, 4 or 5 miles west of Hudson River, in the township of Coeymans. The remains were discovered in a bed of shell-marl, in the bank of a marsh. A tusk was taken to Albany. It was supposed that most of the skeleton was left in the ground.

31. *Cohoes, Albany County.*—In the collection of the State Museum, at Albany, there is a mounted skeleton of a mastodon discovered in 1866. It was first announced by Robert Safely (Amer. Jour. Sci., vol. XLII, 1866, p. 426) and soon afterward noticed by Marsh (Amer. Jour. Sci., vol. XLIII, 1866, p. 115). It formed the subject of an essay by James Hall (21st Ann. Rep. New York State Cabinet, 1871, pp. 98–148, plates III–VII) and was further mentioned by Clarke in 1903 (op. cit., pp. 929–930). Portions of it were found in two large potholes on the shore of Mohawk River. For the facts, and for Hall's and Clarke's conclusions, the reader must consult the publications cited. G. K. Gilbert (21st Ann. Rep. State Cabinet, 1871, pp. 129–148) discussed the geological conditions at Cohoes. He concluded (p. 140) that the potholes were not made during a glacial period, but were of pre-glacial age. Dr. H. L. Fairchild, who has studied the history of the Mohawk Valley more thoroughly than anyone else, has expressed in a letter to the present writer the opinion that the potholes are post-glacial formations. The matter is further discussed on page 297. Inasmuch as the glacial ice was not far away, it appears to the present writer that the geological stage may better be regarded as Late Wisconsin.

Professor Fairchild's plate 16 of Bulletin No. 160 of the State Museum of New York gives the position of the Wisconsin ice-sheet in New York at the time that it had just withdrawn from the region about Cohoes. His plate 17 presents a later stage, when the upper part of the Hudson Valley was occupied by Lake Albany.

Unfortunately, no evidences of other animal life, excepting the beaver, were found with the mastodon at Cohoes. Marsh, in his notice of the discovery, gave a list of the trees recognized in the potholes. There were white pine, hemlock, black spruce, larch, swamp maple, and white birch.

In the American Museum of Natural History, New York, there is a lower jaw of a mastodon with second and third true molars, right and left, which is said to have come from Cohoes.

32. *Copenhagen, Lewis County.*—In 1884 (Trans. Linn. Soc. N. Y., p. 47), Dr. C. Hart Merriam stated that there had been found in 1877, in a marl bed about a mile west of Copenhagen, a tusk measuring 5 feet 9

inches in length. It was purchased for the State Cabinet. It could not be determined whether this had belonged to an elephant or a mastodon.

33. *Center Lisle, Broome County.*—In the Watkins Glen–Catatonk folio No. 169 of the U. S. Geological Survey, on page 28, Dr. Ralph S. Tarr stated that remains of a mastodon had been found a few hundred yards north of this town, in a boggy place where a spring emerges from the base of a gravel terrace. He did not tell what parts had been found. He remarked that one could not be certain whether the bones had been washed out of the gravel or had come from an animal which had mired there. In geological age it must be referred to the last half of the Wisconsin stage.

34. *Brookton, Tompkins County.*—In the American Naturalist, volume v, 1871, page 314, C. Fred Hartt gave an account of the discovery of mastodon bones at Mott's Corners, on Six-mile Creek. This is the former name of the present village of Brookton. Only 2 teeth and some fragments of bones were secured. The locality is situated in a deep valley of the creek, which had once been filled with drift, and through this the creek had cut down to solid rock. Where the bones were found was a small peat-bog consisting of a layer of peat varying from a few inches to 2 feet. This was full of sticks, pine knots, bark, etc., more or less decayed. Below this peat was a layer, a few inches thick, composed of clay mixed with pebbles and pieces of shale. In this were the teeth and decayed bones. The whole was underlain by drift materials. Tarr, as cited above, stated that mastodon remains had been found in a swamp in the valley bottom at Brookton. He did not say when the discovery was made, nor what was found. It is not unlikely that the two cases are the same.

In 1871 (Amer. Jour. Sci., vol. II, p. 58), Dr. Burt G. Wilder reported that 5 teeth and many fragmentary bones had been found near Ithaca, in a deposit of modified drift. The writer has been informed by Miss Pearl Sheldon, of Cornell University, that these are the same remains as those reported by Professor Hartt.

The mastodon found at Brookton could hardly have lived there before the stage when the waters that gathered at the southern edge of the retreating ice were reaching the sea by way of Mohawk and Hudson Rivers.

35. *Pony Hollow, Tompkins County.*—In 1915 (Science, vol. XLI, pp. 98-99), Pearl Sheldon, of the Department of Geology in Cornell University, reported that a tusk, probably of a mastodon, had been found at Pony Hollow, 12 miles southwest of Ithaca, on the farm of Bert Drake. This place, as shown on the Ithaca Quadrangle topographical sheet, is in the southwest corner of the county. As the writer is informed by Miss Sheldon, it is on Cantor Creek, near its junction with West Branch. The tusk was met with in a gravel pit at a depth of 24 feet. The radius of curvature was between 2 and 3 feet, the circumference from 10 to 13 inches. It may have been the tusk of an elephant. The pit was in the base of an extensive terrace which follows the valley-wall high above the outwash gravel-plain occupying the floor of the valley. The reporter thought that the terrace was not later in origin than the end of the ice occupation of the valley, and might be earlier.

Miss Sheldon informed the writer that the terrace which contained the mastodon tusk is too high in the valley to have been formed by water backed up against the retreating ice-front. Furthermore, the locality is south of the divide. It was suggested that during the retreat of the ice the southward-flowing water in the Pony Hollow basin was backed up somewhat by the ice in the Seneca basin. At any rate, the terrace and the mastodon contained in it belong to the latter part of the Wisconsin ice stage.

36. *Elmira, Chemung County.*—Dr. John M. Clarke (60th Ann. Rep. New York State Mus., p. 59) referred to reports of the eighteenth century to the effect that tusks of proboscideans had been found in Chemung River, one of them just below Elmira. It is very probable that some or all of these had belonged to the mastodon.

Apparently all that can be said about the geological age of these proboscideans is that they lived during or after the last half of the Wisconsin drift stage.

37. *Lodi, Seneca County.*—In the American Museum of Natural History, New York, there are second and third upper mastodon molars, recorded as having been found at Lodi. The town is on the eastern shore of Seneca Lake. This animal belonged to the last half of the Wisconsin stage, or to a later one. Possibly it was living there at the early period when the impounded waters of the Finger Lake region were discharging through Susquehanna River.

38. *Macedon, Wayne County.*—Dr. J. M. Clarke, in 1903 (Bull. 69, N. Y. State Mus., p. 930) reported for Professor H. L. Fairchild, that there are in the University of Rochester a few mastodon teeth from this place. There is no information on record about the geology of the place where they were found. The animal belonged to a relatively late stage of the Pleistocene and may have lived close to the beginning of the Recent. The glacier had withdrawn near to or within the basin of Lake Ontario.

39. *Seneca Castle, Ontario County.*—Professor Edward Hitchcock jr., in 1885 (Science, vol. VI, p. 450), announced the discovery of what was supposed to be remains of mastodon at the bottom of a peat morass, lately drained, at the town named. This place is near Flint Creek. No teeth and no part of the skull were found. The remains were taken to Amherst College. With these bones was found also an antler of an elk. In a letter written December 21, 1918, Dr. F. B. Loomis, of Amherst, states that he regards these bones as those of an elephant.

In Dr. J. M. Clarke's report of 1903, on page 931, Mr. H. J. Peck gave an account of this mastodon, together with a plate representing the way in which the bones were scattered. They were found at a depth of about 3 feet and are shown to have been lying in a deposit of clay and marl, above which came in succession clay and sand, sand, peat, and muck. Beneath the bones were, in order, sand, blue clay, sandy clay, and a thin layer of sand resting on boulder clay.

The stage at or after which this mastodon or elephant lived was probably that represented by Fairchild's plate 38.

40. *Perkinsville (Portway), Steuben County.*—Dr. John M. Clarke, in 1908 (61st Ann. Rep. New York State Mus., vol. 1, p. 44), reported the discovery of a part of a skeleton of a mastodon in a large swamp 0.75 mile north of Portway railroad station. The swamp occupies a depression in a mass of morainic drift. At the surface is from 6 to 12 inches of black muck, beneath which is a bed of nearly white marl from 6 inches to 6 feet in thickness. The bones were lying 4 or 5 rods from the border of the swamp. Those found were in a fine state of preservation. Among them was one ramus of the lower jaw with teeth.

This and the following specimen lived after the Wisconsin glacier had withdrawn about half-way from its terminal moraine to the shore of Lake Ontario.

41. *Wayland, Steuben County.*—In 1874 (Proc. Bost. Soc. Nat. Hist., vol. xvii, p. 91), a report by Dr. J. G. Hunt, of Philadelphia, was presented, which dealt with the contents of the stomach of a mastodon said to have been found at Wayland. No statement was made as to the skeleton of the animal, or the exact place where it had been discovered. No remains of trees of any kind were detected, but stems and leaves of mosses, confervoid filaments, a fragment supposed to belong to a rush, woody tissue, and bark of herbaceous plants.

42. *Pittsford, Monroe County.*—In 1831 (Amer. Jour. Sci., vol. xix, p. 358), Mr. J. A. Guernsey, of Pittsford, wrote that a part of a tusk, supposed to belong to a mastodon, had been found on the bank of Irondequoit Creek, 2. 5 miles east of the town. The part secured was 7.5 feet long, and the whole tusk was thought to have been about 9 feet long. The figure accompanying the description seems to indicate a mastodon tusk rather than that of an elephant, but one can not be certain about the matter. A much-decayed cervical vertebra also was found.

James Hall, in 1843 (Geol. 4th Dist., p. 364), reported that in the town of Perinton there had been found in the bank of a small stream, in gravel and sand, a tusk and several teeth. This place appears to be, or to have been, very near Pittsford. At Perinton, too, was found a tooth of the elephant *Elephas primigenius,* as mentioned on another page. It was near here probably that there were found parts of two skeletons of the peccary *Platygonus compressus,* as noted in its proper place.

Inasmuch as all these animals, as well as those found nearer Rochester, were buried in deposits overlying Wisconsin drift, they must have lived after the withdrawal of the ice beyond Rochester, and at a time when the region had taken the present aspect or nearly so.

43. *Rochester, Monroe County.*—In 1842 (Nat. Hist. N. Y. Mamm., p. 103), J. E. De Kay stated that in 1817 remains of mastodon had been found in Rochester, 4 feet below the surface, in a hollow or water-course. He did not give his authority for this statement. James Hall, in 1843 (Geol. 4th Dist., p. 364), reported that in 1838, during the excavation of the Genesee Valley Canal, at its junction with Sophia street, various bones of a mastodon had been discovered. They are said to have been intermingled with gravel and covered by clay and loam, above which was a deposit of shell marl. The bones were placed in the State Museum at

Albany. C. D. (Amer. Jour. Sci., vol. XXXIII, 1837, p. 201) says that these bones were lying on and in a hard body of blue clay and about 2 feet above the limestone, which itself was polished. Clarke (Bull. 69, New York State Mus., p. 931) reported, on the authority of H. L. Ward, that a few remains of mastodon had been found at Mount Hope cemetery. In the collection of the University of Rochester is a proboscidean rib 837 mm. long, which is labeled as having been found January 27, 1913, at the corner of Charlotte boulevard and Miller street. It lay in gravel 12 feet below the surface. It seems to the writer to belong to *Mammut americanum*.

44. *Scottsburg, Livingston County.*—Clarke (Bull. 69, etc., p. 932) reported that 20 bones and various fragments of bones of a mastodon had been collected here by F. H. Bradley and H. A. Green, and presented to the Yale collection by R. S. Fellows. No additional information was furnished. These remains include a hindermost lower molar (Cat. No. 11714) that had not yet come into use. The animal may be supposed to have lived during or after the last half of the Wisconsin stage.

45. *Fowlerville, Livingston County.*—Dr. John M. Clarke (Bull. 69, etc., p. 932) stated, on the authority of Mr. H. J. Peck, that 3 or 4 teeth, tusks, and other bones, badly broken, had been found, in 1886, in an excavation on the bank of Genesee River, 80 feet above the water. No further information has been recorded.

From Dr. I. Edward Line, Rochester, N. Y., the writer has received a photograph of an upper right penultimate molar, little worn, which he reports as having been found in 1887, near Genesee River, on the road from Avon to Fowlerville. It was discovered in a marshy part of the farm of Robert Boyd and was exhumed by the late Dr. William Nishet, of Avon. Other teeth, a tusk, and fragments of bone were found, some of which, Dr. Line states, were taken to Harvard University by Professor F. W. Putnam. Quite certainly this was the same mastodon as that reported by Mr. Peck. The animal could not have lived here until after a stage represented by Fairchild's plate 37 (Bull. 127, New York State Mus.).

46. *Geneseo, Livingston County.*—In 1827 (Amer. Jour. Sci., vol. XII, p. 380), Jeremiah Van Rensselaer reported that, in 1826, the skull, tusks, lower jaws with teeth, pelvis, and many other bones had been found at Geneseo. Later (1841) Lyell and James Hall made excavations at the same place, but discovered only some fragments of the skull and of other bones. These were at a depth of about 5 feet and were mixed with marl and yet-existing fresh-water shells. Over all was a layer of muck (Lyell, "Travels in North America," vol. I, p. 55). Hall (Geol. 4th Dist., p. 363, fig. 173) published a figure of one of the teeth, a hindermost molar. The remark as to the geological age of the Fowlerville specimen applies to this one.

47. *Nunda, Livingston County.*—Clarke (Bull. 69, p. 932) stated, on the authority of Charles E. Beecher, that 10 bones and fragments of a mastodon had been secured here, and presented to Yale University collection. No exact locality and no geological information were furnished. The geological age is quite certainly late Wisconsin or still later.

48. *Belvidere, Allegany County.*—In the American Geologist, vol. XXXIII, 1904, page 60, an anonymous note states that some mastodon remains, 3

ribs and 4 vertebræ, had been unearthed at this place by James Johnson, of Bradford, and Alban Stewart, of the Smithsonian Institution. Nothing was said as to the exact locality and geological conditions. The time of the animal's life could hardly have been earlier than the last half of the Wisconsin stage.

49. *Pike, Wyoming County.*—In 1876 (Guide to Genesee Valley Mus., Letchworth Park, Castile, N. Y., 1907, pp. 5-6), a part of a skull, the tusks, a few vertebræ, and some foot-bones were found on the farm of Charles Dennis, on the outskirts of the village of Pike. They were met with in making a ditch and hence were probably in a marsh. Their geological age is that of the last half of the Wisconsin stage or later.

50. *Attica, Wyoming County.*—In 1887 (6th Ann. Rep. State Geologist, for 1886, p. 34), J. M. Clarke described briefly the finding of supposed mastodon bones at this place. A tusk had been encountered while a trench for a water-main was being dug on Genesee street. In 1888 (41st Ann. Rep. State Mus., for 1887, pp. 388-390, plate), Clarke reported the results of further digging. The tusk was exhumed, as well as two ribs and a fragment of the zygomatic arch. Nothing was found that distinguished the remains from those of an elephant. The fragments were in a bog-hole and scattered over a space about 20 by 25 feet. Under the made ground was first a layer of loam 5 inches thick, then came in succession 1 foot 2 inches of clayey muck and 1 foot 5 inches of unlaminated clay and an undetermined thickness of laminated clay. The bones lay in the unlaminated clay, at a depth of 2 feet 6 inches from the natural surface. With the bones was what was thought to be an ankle-bone of an elk. At a distance of 75 feet was another bog-hole, 75 feet in diameter, which was filled with muck lying on compact laminated clay. The muck had a maximum thickness of 4 feet. At the deepest place was found a piece of pottery and, beneath and around it, about 30 fragments of thoroughly burned charcoal.

The proboscidean remains here described must have been buried after (how long after one can not say) the Wisconsin glacier had retired about two-thirds the way from its southward limit to the shore of Lake Ontario.

51. *Leroy, Genesee County.*—J. E. De Kay, in 1842 (Zool. N. Y., Mamm., p. 104), stated that in 1841 a mastodon tooth weighing 2 pounds had been found in a bed of marl 3 miles south of Leroy. No other information appears to have been recorded.

The mastodons found here and at Stafford and Batavia could have lived only after the ice-sheet had retired beyond these places. About this time the waters of the Finger Lake region found an outlet westward to the Mississippi by way of lakes Warren and Chicago.

52. *Stafford, Genesee County.*—James Hall, in 1843 (Geol. 4th Dist., p. 364), reported that some years previously a small molar tooth had been found at this place. It was beneath muck and upon a deposit of clay and sand. There was found also a quantity of hair-like confervæ, of a dun-brown color, which resembled hair so closely that a close examination was necessary to determine its real nature.

53. *Batavia, Genesee County.*—In 1904 (Bull. 69, New York State Museum, p. 932), Clarke reported for H. L. Ward, that in 1897 two tusks,

a part of a skull with teeth, several vertebræ, and ribs had been found here. Nothing more is known about this case.

54. *Holley, Orleans County.*—In 1843, James Hall (Geol. 4th Dist., p. 364) reported that during the excavation of the Erie Canal, a large molar tooth was found in a swamp near Holley. This, according to Clarke, was about 1820. At the earliest time assignable, this mastodon lived after the Wisconsin glacier had withdrawn nearly into the basin of Lake Ontario. It may have had its existence nearly up to the Recent epoch.

55. *Medina, Orleans County.*—In the Buffalo Society of Natural History is a part of the left ramus of the lower jaw of a mastodon, labeled as having been found in a swamp near Medina. It contains the second and third true molars. The remark about the geological age of the Holley mastodon is applicable to this one.

56. *Niagara, Niagara County.*—In 1842 (Zool. N. Y., Mamm., p. 104), De Kay stated that a mastodon tooth had been found in digging a mill-race on Goat Island, 12 or 13 feet below the surface. Lyell, in 1843 (Ann. Mag. Nat. Hist., vol. XII, p. 127), alluded to the occurrence of remains of mastodon in a fresh-water formation on the right bank of the Niagara River at the Falls. The formation appears to have consisted of gravel. These are possibly the same remains as those mentioned by De Kay. Hall (Geol. 4th Dist., p. 364) stated that the deposit was a fine gravel and loam containing fresh-water shells, and evidently of fluviatile origin. These deposits were noted by W. E. Logan (Geol. Canada, 1863, pp. 913–914). On the Canadian side of the gorge below the Falls, 16 species of fresh-water mollusks were found in the sand, evidently where they had lived.

At the museum of Davis Brothers, at Niagara Falls, Mr. B. U. Davis told the writer that he owned 2 mastodon teeth which had been found in digging for the foundations of the Tower Hotel, which faces the Falls park.

Mastodons could have lived where Niagara Falls is now located only after the Wisconsin ice-sheet had retired far enough to permit the waters of Lake Iroquois to fall somewhat below those of Lake Erie, the shrinkage of the latter to its present basin, and the formation of dry land or land not too swampy around the present Niagara Falls.

57. *Hinsdale, Cattaraugus County.*—Hall (op. cit., p. 364) stated that at this place a tusk, with some horns of deer, had been found in gravel and sand, 16 feet below the surface. Clarke (Bull. 69, etc., p. 933) mentions this case and suggests that the antlers were possibly those of the elk. The tusk may quite as well have been that of an elephant.

Lyell (Ann. Mag. Nat. Hist., vol. XII, 1843, p. 127) referred to this discovery as showing mastodon bones at the highest elevation known at that time, 1,500 feet above the sea.

58. *Conewango, Cattaraugus County.*—In 1908 (60th Ann. Rep. State Mus., p. 60), Clarke reported that part of a mastodon skeleton, consisting of from 40 to 50 bones, mostly vertebræ and foot-bones, had been unearthed in 1906 from the bank of the State ditch along Conewango Creek, close to the boundary between Cattaraugus and Chautauqua Counties. The remains lay on a shelf of hard clay. They were discovered and reported by C. N. Hoard and W. H. Hoard. The locality was probably not far from the town

indicated. This animal is to be referred to the last half of the Wisconsin glacial stage; that is, to the Wabash stage.

59. *Buffalo, Erie County.*—In 1809 (Phila. Med. and Phys. Jour., vol. II, p. 157), Dr. B. S. Barton reported that a tooth of a mastodon had been found on Buffalo Creek, near its mouth. Of this mastodon one can only say that it lived late in Wisconsin times, not earlier probably than when Lake Iroquois became the immediate predecessor of Lake Ontario.

60. *Jamestown, Chautauqua County.*—In 1872 (Amer. Naturalist, vol. VI, p. 178), Mr. T. A. Cheney announced the finding of parts of 2 skeletons of the mastodon, in a swamp about a mile north of Jamestown. One was a small animal, probably a young one, the larger one an adult. Of the latter, 6 teeth in the lower jaw, the tusks, and various other bones were secured. The remains were lying in a soil composed of peat and marl, at a depth of 4 feet. A great mass, 8 or 9 bushels, of broken twigs was found and taken to be the contents of the animal's stomach. This mastodon belonged to the last half of the Wisconsin glacial stage.

61. *Westfield, Chautauqua County.*—Dr. J. M. Clarke, in 1903 (Bull. 69, etc., p. 933), reported the discovery of a part of a skeleton at Westfield. It was on the property of Mrs. Alice Peacock, alongside the Nickel Plate Railroad. A tusk, 6 feet 2 inches long and highly curved, 17 ribs, 8 pelvic and lumbar vertebræ, a patella, and parts of the scapula and pelvis were secured. The bones lay on a pavement of heavy boulders and under several feet of black clayey muck. This animal could have lived here only after the Wisconsin ice-sheet had withdrawn within, or nearly within, the basin of Lake Erie.

NEW JERSEY.

(Maps 5, 6-A.)

1. *Mannington Township, Salem County.*—In Rutgers College, New Brunswick, New Jersey, is a mounted mastodon said to have been found on the Hackett farm, Chestnut Hill, in Mannington. This township is northwest of the town of Salem. It is stated that about 75 per cent of the bones are present in the mounted skeleton; the missing parts are restored in plaster or some other material. Rhoads (Mamm. Penn. N. J., 1903, p. 235) was informed by Professor Valiant that this skeleton was excavated from a bed of gray marl, at a depth of from 6 to 8 feet below the surface. According to Lewis and Kümmel's geological map of New Jersey, 1912, this region appears to be overlain by the Cape May formation (see also Salisbury and Knapp, vol. VIII, Final Rep. Geol. Surv. New Jersey, p. 194).

2. *Harrisonville, Gloucester County.*—In 1869, Cope (Cook's Geol. New Jersey, p. 740) stated that a mastodon had been found at this place, but no details were furnished. Harrisonville is on Oldman's Creek, and along this are distributed, according to the map above cited, materials belonging to the Pensauken formation. Bridgeton, Pensauken, and Cape May deposits are, however, not far away (Salisbury and Knapp, op. cit., pp. 31, 96, 97, 194, 198).

3. *Mullica Hill, Gloucester County.*—In Cook's "Geology of New Jersey," Cope reported also that mastodon remains had been found at Mullica Hill, on Raccoon Creek, but here again no details were given. Following the map cited, and Salisbury and Knapp, page 194, we find Cape May deposits at the town, but Pensauken is not far away, and it is not known exactly where the mastodon remains were met with.

4. *Woodbury, Gloucester County.*—Mr. Samuel N. Rhoads (Mamm. Penn. N. J., 1903, p. 235) recorded the discovery of a mastodon near Woodbury. It was found on Mantua Creek and was in the possession of Dr. J. C. Curry, of Woodbury. Mantua Creek flows south of Woodbury, about 2.5 miles distant. On the map cited the region is indicated as being covered mostly by Pensauken materials, but there is some Cape May (Salisbury and Knapp, pp. 100, 191). The Cape May is on a lower level along the streams.

From Dr. Curry the writer learns that the remains of this mastodon passed into the possession of Mr. Herbert Twells, of Woodbury, New Jersey. Neither of these gentlemen is able to furnish any further information.

5. *Pemberton, Burlington County.*—Professor E. D. Cope (Cook's Geol. New Jersey, 1869, p. 740) stated that mastodon remains had been found at Pemberton. Previously, Conrad (Proc. Acad. Nat. Sci., Phila. vol. 1, 1832, p. 11) had reported that bones and teeth of this species had been found here. In the collection of the Academy at Philadelphia are a part of a skull and some bones and teeth which were collected at Pemberton in 1887 by J. C. Saltar and E. McConnell. Rhoads (Mamm. Penn. N. J., p. 234) mentioned this skeleton and said that it was exposed in the bed of a small stream. Mr. J. Coleman Saltar, now of Milford, Delaware, has kindly replied to the present writer's inquiries. He says that the skeleton was found about 1.5 miles northwest of Pemberton, in the bank of a small stream lying partly in the water, partly embedded in the bank. The flood-plain is perhaps about 10 feet below the tilled land along the stream. On the flood-plain is Recent silt. Below this appears to be a Pleistocene deposit which contains vegetable débris, including pine cones. The skeleton was in this layer, about 3 feet below the surface. Professor Valiant informed Mr. Rhoads that another skull was found, a good many years ago, in a swamp near Pemberton, and for a long time was used as a door-step before its real nature was discovered. Mr. Saltar, in the letter referred to above, stated that his understanding has been that this skull was found along the same stream and was used as a stepping-stone in crossing, until some progressive person sought to change its position.

In the collection of the Academy, at Philadelphia, are 2 good teeth and parts of 2 others which are said to have been found at Pemberton. They are credited to G. C. Forsyth. At Princeton University is a nearly complete lower jaw, No. 8173, of a mastodon which was collected at Pemberton.

Pemberton is on Rancocas River. In Salisbury and Knapp's work of 1917, on page 184, it is stated that sands which seem to belong to the Cape May are found along the North branch of the Rancocas near Pemberton.

6. *Trenton, Mercer County.*—Mr. S. N. Rhoads, in 1903 (Mamm. Penn. N. J., p. 235) stated that there is in Rutgers College Museum a specimen of

tusk of mastodon which was reported to have been found in 1878 associated with stone implements in the Trenton gravels, 12 feet below the surface. Cook (Rep. Stat. Geol. New Jersey, for 1878, p. 15) stated that the tusk was found at a depth of 14 feet, with the gravel and stones partly stratified over it. There may be a question whether the tusk belonged to a mastodon or to an elephant. Professor S. Lockwood (Pop. Sci. Monthly, vol. XXLI, p. 344) wrote that he had seen a tusk, doubtless the one mentioned above, taken from the Trenton gravels. Whether or not this tusk was found immediately at Trenton was not stated, but Cook reported that it was found at Trenton.

7. *Freehold, Monmouth County.*—Several mastodons have been reported from this place. Professor Samuel Lockwood, in 1882 (Amer. Jour. Sci., vol. XXIV, p. 291; Pop. Sci. Monthly, vol. XXII, p. 341; Proc. Amer. Assoc. Adv. Sci., vol. XXXI, 1883, p. 365) reported that he had exhumed a skeleton of a mastodon in a peat swamp 2 miles west of the town. It rested on hard-pan, beneath the peat. Over the neck were sticks which had been cut by beavers. Lockwood's complete account was published in the Popular Science Monthly, as quoted. The skeleton was in very bad condition. The lower jaw is not mentioned. According to the New Jersey map cited, the region about Freehold is occupied by the Pensauken formation; according to Salisbury and Knapp the identity of this is not wholly certain. It is impossible to say when the skeleton had fallen there. Some one, probably G. H. Cook (Geol. New Jersey, 1868, p. 741), stated that bones of mastodon had been found near Freehold by O. R. Willis. Professor Valiant has told the writer of a milk-tooth of a mastodon found at "Hartshorne's mills" (Cook's Geol. New Jersey, 1868, p. 781).

8. *Englishtown, Monmouth County.*—Mr. S. N. Rhoads (Mamm. Penn., N. J., p. 235) stated that Professor Valiant had informed him that remains of mastodon had been found in marl at Englishtown. The relations of the remains to the marl one can not now learn. According to the New Jersey geologists, the region about the place is occupied by Pensauken; but one can not be certain about the geological age of the mastodon.

9. *Marlboro, Monmouth County.*—George H. Cook (Geol. New Jersey, 1868, p. 741) reported that a portion of a jaw of a mastodon had been found in a mill-race at Marlboro; but when this happened we are not told. Rhoads, as cited, probably refers to the same specimen, where he mentions a ramus of a young mastodon containing the milk dentition. This is in Rutgers College. The gravels on the hills about Marlboro are referred by the New Jersey geologists to the Pensauken. It is not unlikely, however, that Cape May deposits are to be met with at lower levels.

10. *Long Branch, Monmouth County.*—A number of mastodons have been found in the vicinity of Long Branch. In 1824 (Ann. Lyc. Nat. Hist., N. Y., vol. I, pp. 143–147), De Kay, Van Rensselaer, and Cooper gave a detailed account of the exhumation of a mastodon skeleton on a farm called "Poplar," 3 miles southwest of Long Branch, and 2 miles from the sea-beach. The skeleton was found near the border of a marsh and so close to the surface that it was discovered by a molar sticking out of the turf. The vertebral column lay only about 8 or 10 inches below the surface. These bones,

including the skull, which lay near the surface, were more or less decayed. The tusks were not found at all. The bones were all buried in a stratum of black earth about 8 feet thick. Below this was a bed of sand, with rolled pebbles, of unequal thickness, but generally thicker than the bed of muck. Under this again was found a bed of marl of undetermined age. The impression received by the investigators was that the animal had sunken into the marsh and died in a standing position. In such a case, the bog had been formed before the animal was mired in it. There is an account by Van Rensselaer in the American Journal of Science, volume XI, 1826, page 246, of the finding of this skeleton. Godman (Amer. Nat. Hist., vol. II) gave an account of the same discovery. Cook (Geol. New Jersey, 1868, p. 741) thought that the bones had become exposed to view through subsidence of the peaty layer, due to its having been drained.

James Hall (Geol. 4th Dist., N. Y., p. 365) states that he had assisted in exhuming a mastodon at Long Branch which was in a natural vertical position, his body supported by the turf soil or black earth and his feet resting upon a gravelly bottom.

Lockwood (Amer. Jour. Sci., vol. XXIV, 1882, p. 294; Pop. Sci. Monthly, vol. XXII, p. 344) reported that he had known of 2 teeth of the mastodon which at distant times had been taken up at sea off Long Branch.

While it is very natural to refer to the latest Pleistocene these mastodons which lie so near the surface, it must not be concluded with too much assurance that they do belong to the Late Wisconsin. The discovery of horse-teeth in the Navesink Hills and of *Megatherium* at Long Branch shows that the older Pleistocene deposits are present in this region.

11. *Navesink Hills, Monmouth County.*—In 1869 (Jour. Acad. Nat. Sci. Phila., vol VII, p. 261), Leidy reported that remains of the mastodon had been found in this region, associated with a vertebra and some teeth of a fossil horse. This was based on Mitchill's statement (Cat. Organ. Remains, p. 7) that he had a part of a tibia of a mastodon.

12. *Manasquan Inlet, Monmouth County.*—In 1882 (Amer. Jour. Sci., vol. XXIV, p. 294), Lockwood stated that he had known of a tusk and some other bones of a mastodon which had been uncovered by sea-waves in a storm about 15 miles south of Long Branch. In another place (Pop. Sci. Monthly, vol. XXII, p. 344) he spoke of a tusk which had been thus unearthed in Monmouth County. The place was evidently north of Manasquan Inlet.

Salisbury and Knapp (Geol. Surv. New Jersey, vol. VIII) describe the region along the coast from Manasquan River to Long Branch as presenting Cape May deposits at elevations below 40 or 45 feet, while modern beach deposits occupy some areas below this level. It seems, however, that some of these supposed Recent materials contain extinct vertebrates and are older than they appear to be.

13. *Verona, Essex County.*—George H. Cook (Geol. New Jersey, 1868, p. 741) stated that a very perfect tooth of a mastodon had been picked up near Verona. This town is on Peckman Brook, and in the valley of this stream there is some stratified drift which is referred to the Wisconsin. Too little is known about the history of the tooth to enable one to determine with confidence its geological age.

14. *Rockport, Warren County (Schooley's Mountain).*—In 1828 (Amer. Jour. Sci., vol. XIV, p. 188), Thomas P. Stewart reported the discovery of what he called a mammoth on Schooley's Mountain. It was met with in 1827, in excavating the Morris Canal. The locality must therefore be west of Musconetcong River and probably not far from Rockport. The bones lay at a depth of about 3 feet. The animal was evidently a mastodon. A tooth, a lower last molar, measured 3.5 inches in width and 7 inches in length. The enamel was well preserved. Other bones were found.

15. *Hackettstown, Warren County.*—In the fourth volume of the Proceedings of the American Philosophical Society, 1844, on pages 118 to 121, there is an account, by J. B. Maxwell, of the discovery of the remains of 5 mastodons near Hackettstown, about halfway on the road to Vienna. In this vicinity is a ridge of gneiss which runs in a northeast-and-southwest direction. On this ridge is a pond-like depression about 40 yards in length by 25 yards in width, which at one time was a marsh. After it was drained the owner began digging in it and discovered the mastodon skeletons. They are described as consisting of one animal pretty large, three of smaller size, and one a calf. From these were obtained a skeleton which became the property of Harvard University and has since been known as the Cambridge skeleton. It is described by Warren in both editions of his "Monograph on the Mastodon." Jackson (Proc. Bost. Soc. Nat. Hist., vol. II, p. 60) described these skeletons. A lower jaw of a young individual had two alveoli for lower tusks, 0.75 inch in diameter.

Asa Gray (Proc. Bost. Soc. Nat. Hist., vol. II, 1848, p. 92) examined wood which had been taken in the place occupied by the stomach of the skeleton referred to. He found no differences between it and that of the common hemlock spruce. While Gray speaks of this mastodon as being found on Schooley's Mountain, he evidently meant the ones found at Hackettstown.

According to Maxwell's account there was at the surface 6 inches of vegetable deposit; below this was found about 6 inches of whitish sand; while below this came a bed of pure muck from 4 to 6 feet in depth. In this were buried the mastodon bones.

Lyell (Second Visit to U. S., ed. 3, vol. II, p. 363) mentions the skeletons found at Hackettstown. Between the ribs had been found about 7 bushels of vegetable matter supposed to have been contained in the stomach. He took some of it to London and had it examined microscopically. It appeared to belong to the white cedar, *Thuja occidentalis.*

By consulting Lewis and Kümmel's geological map of New Jersey, it will be seen that the locality where these mastodons were found is on the Wisconsin moraine. Plates XLV and XLV *a* of Salisbury's report (vol. V, Geol. Surv. New Jersey) present the topographical and geological details of this region. A "mastodon pond" is there mapped which is doubtless the one referred to above. We may be quite certain, therefore, that these mastodons lived after the retirement of the Wisconsin ice-sheet.

A note, apparently by George Cook (Geol. New Jersey, 1868, p. 741), stated that some years previously a mastodon tooth had been found 0.5 mile east of Vienna, 4 miles west of Hackettstown.

16. *Hope, Warren County.*—A note, probably by George H. Cook, in his "Geology of New Jersey," 1868, page 741, stated that a part of a mastodon skeleton had been found about 2 miles from Hope, on the road leading to Johnsonsburg and on the farm of Charles Howell. This would be northeast from Hope. On the New Jersey map referred to there is some Wisconsin drift indicated near this place. The remains are probably of late Wisconsin age.

17. *Greendell, Sussex County.*—In Warren's "Monograph on the Mastodon" (first edition, page 174; second edition, page 200) is an extract taken from the Sussex Register, of September 27, 1851, giving an account of the finding of bones, jaws, and teeth of a mastodon on the farm of Timothy H. Cook, near Greenville. This town was later called Cuttoff and this name has recently been changed to Greendell. In Cook's "Geology of New Jersey," 1868, page 741, the farm was said to belong to Jacob Voss. In a bog which had been drained a fire was made on a stump of a tree. The fire burned the roots, and the bones of the animal became exposed. The bones of the head especially were apparently very near the surface. The town is on the Lackawanna Railroad, about 3 miles northeast of Johnsonsburg, Warren County.

PENNSYLVANIA.

(Map 5.)

1. *Tunkhannock, Wyoming County.*—In 1883 (2d Geol. Surv. Pennsylvania, G^7, p. 20), Dr. I. C. White reported that the tusks and the teeth of a mastodon had been found at Tunkhannock. At the mouth of Tunkhannock Creek a large gravel deposit rises to a height of 125 feet above Susquehanna River and then spreads out into a wide plain. In the valley of the creek mentioned it takes the form of a sharp, low kame-like ridge of gravel and boulders. In such deposits the mastodon remains were found. According to White, these gravels and boulders were laid down in the waters which came from the retreating glacier and which deeply flooded all the streams. In case this explanation is the correct one, this mastodon lived there after the beginning of the retreat of the Wisconsin ice-sheet. Possibly, however, those gravels, at a height of 125 feet, belong to an older glacial stage.

White, on page 123 of his report quoted above, referred to a tusk which had been dug up in one of the streets of Tunkhannock. This was probably the one mentioned in connection with the teeth.

2. *Pittston, Luzerne County.*—Dr. Joseph Leidy, in 1873 (Ext. Vert. Fauna West. Terrs., p. 238, plate XXVIII, fig. 9), reported that there was in the Academy of Natural Sciences at Philadelphia 3 first premolars of apparently as many individuals of *Mammut americanum,* which had been found at Pittston, associated with *Equus major* (*E. complicatus*) and *Symbos* sp. indet. (*"Bison latifrons"* of Leidy). One of these he figured. The present writer has examined these teeth. Two are upper antepenultimate milk molars (pm^2), right and left; another is an upper penultimate milk-molar, whose length is 45 mm. and whose width is nearly as much. They probably did not all belong to one individual. The geological age of these mastodons will be discussed on page 308.

3. *Berwick, Columbia County.*—The U. S. National Museum has a cast of a mastodon tooth sent there in 1904 by Professor A. U. Lesher. The tooth was an upper right last molar and only slightly worn. There were 4 crests and a very strongly developed talon. No details were furnished regarding the conditions under which it was discovered.

4. *Reading, Berks County.*—The collection of the Academy of Natural Sciences of Philadelphia contains a lower left hindermost tooth of a mastodon and some fragments of one or two other teeth, said to have been found on Schuylkill River at Reading. These remains appear not to have been accompanied by any details regarding the manner of their burial.

5. *Port Kennedy, Montgomery County.*—Many remains of the mastodon have been found in the famous cave, or fissure, discovered at this place. The first accounts of these fossils were published in 1871 (Cope, Proc. Amer. Philos. Soc., vol. XII, pp. 15, 95; Wheatley, Amer. Jour. Sci., ser. 3, vol. I, pp. 235–237, 384–385). Cope (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. XI, pp. 193–267) presented the results of a thorough exploitation of the cave. For the nature of the remains of mastodon found there the papers mentioned may be consulted. A list of the associated fossils and a discussion of the geological features of the case will be found in its proper place on page 312.

6. *Jackson Township, York County.*—In the collection of the Academy at Philadelphia there is a lower left hindermost molar of a mastodon which is labeled as having been found in the township mentioned, but no details regarding the exact locality and kind of deposit were furnished. Jackson Township is situated in the west and northwestern part of York County.

7. *Kishacoquillas Station, near Reedsville, Mifflin County.*—In 1858 Professor H. D. Rogers (Geol. Pennsylvania, vol. I, p. 480) wrote that 4 grinders of a mastodon and a part of the skull had been found 3 miles southwest of Brown's Mills on Kishacoquillas Creek. The remains rested on rounded pebbles and were covered with a few feet of alluvium. Professor Mosheim Swartzell, of Washington, D. C., informs the present writer that Brown's Mills is located at the station Reedsville, and that the tooth must have been found near the station.

8. *Chambersburg, Franklin County.*—In 1806, Dr. B. S. Barton (Phila. Med. and Phys. Jour., vol. II, p. 157) recorded that a large grinder of *Elephas americanus* of Cuvier had been found in a field a few miles from Chambersburg. The tooth was evidently that of a mastodon.

9. *Frankstown, Blair County.*—Dr. W. J. Holland, in 1908 (Ann. Carnegie Mus., vol IV, p. 233), reported remains of young mastodons from a cave at the place named. They were associated with many other species of mammals, a list of which will be presented on pages 321, 322.

10. *Bedford, Bedford County.*—According to Cuvier (Oss. Foss., 4th ed., 1834, vol. II, p. 274), Mitchill mentioned that remains of a mastodon had been found at or near this place. The present writer has not seen Mitchill's statement.

11. *Pittsburgh, Allegheny County.*—In 1876, Professor J. J. Stevenson (2d Geol. Surv. Pennsylvania, K, p. 22), reported that numerous fragments of bones and teeth had been found in the river bank at the junction of

Monongahela and Allegheny Rivers. They were said to have been presented to a Pittsburgh high school.

12. *Hickory, Washington County.*—In 1875, Professor J. J. Stevenson (2d Geol. Surv. Pennsylvania, K, p. 22) reported that a mastodon tooth had been found in Mount Pleasant Township, in the county named. It was said to have been discovered on the high divide between Raccoon and Chartiers Creeks. The tooth is preserved at Washington and Jefferson College, at Washington, in the county of the same name. Professor Edwin Linton has informed the writer that the tooth was found about 1 or 1.5 miles southeast of Hickory. This indicates that it was found along Westland Run, probably about halfway down to the village of Westland. The geological position and possible age will be discussed on page 323.

13. *Erie, Erie County.*—In the Erie Public Museum the writer has seen a part of a lower right hindermost molar of a mastodon which is labeled as having been found long ago on what was called Frontier farm, about 2 miles west of the Public Library, below Eighth street and toward the lake. The discovery is credited to W. F. Leutzer. The locality would apparently be on Chase Creek, at an elevation of about 600 feet above sea-level, unless it had possibly been buried along the creek in some pre-Wisconsin formation. In lack of the information that ought to have been preserved it may be impossible to arrive at any certain conclusion. Mr. Clyde C. Hill, civil engineer, North East, Erie County, has informed the writer that Chase Creek flows through the old Frontier farm.

OHIO.

(Maps 5, 7.)

In Unglaciated Region.

1. *Pike County.*—In 1875 (Cincinnati Quart. Jour. Sci., vol. II, p. 154), J. H. Klippart wrote that the upper jaw of a mastodon, with a considerable part of the cranium, had been found somewhere in this county and had been on exhibition in the State Agricultural rooms. It was owned by a Mr. Faust, of Galion or Crestline. Nothing more appears to be known about this specimen.

2. *Nashport, Muskingum County.*—In 1837 (Amer. Jour. Sci., vol. XXXI, p. 79), S. P. Hildreth, in an unsigned article, stated that mastodon remains had been found 2 miles north of this place, during the excavation of a canal. He recognized large portions of tusks and some molar teeth. At the same place were found the skull which became the type of *Castoroides ohioensis,* as well as a skull which Hildreth described and named *Ovis mamillaris,* but which probably belonged to a domestic sheep.

47. *Lisbon, Columbiana County.*—In the Ohio University Department of Archæology and History there are some remains of a peccary which, as reported by Professor W. C. Mills, was found associated with remains of a mastodon. The locality is said to be in the northwest quarter of the northeast quarter of section 24, township 18 north, range 3 west. This would be in the south edge of the town of Lisbon and probably on the south side of the Middle Fork of Little Beaver River. It would be just outside of the moraine of the Wisconsin drift sheet.

In Illinoian Drift Area.

3. *Cincinnati, Hamilton County.*—In the first edition of his "Ossemens Fossiles," in 1812 (vol. II, Mastodons, p. 12), Cuvier mentioned the discovery of a tooth of a mastodon on the right bank of Ohio River, between the two Miamis. In 1843 (Ann. Mag. Nat. Hist., ser. 1, vol. XII, p. 127), Lyell reported that teeth of the mastodon and of an elephant had been found 4 miles north of Cincinnati, in gravel beds of the higher terrace.

In his "Travels in North America," volume II, page 60, Lyell wrote that several teeth of mastodons had been discovered on Mill Creek, and on what he indicated as the upper terrace. He presented a list of the genera of mollusks that had been found at the same place. He added that mastodon remains had been found in the strata of the upper terrace, both above and below Cincinnati. Professor Fenneman writes that in Mill Creek valley the Illinoian is distinctly terrace-like and composed of interbedded sheets of outwash and till, as though made during repeated advances of the ice. The teeth mentioned may belong, therefore, to the Illinoian or Sangamon.

The most important discovery of mastodon remains is that recorded by Seth Hayes (Jour. Cin. Soc. Nat. Hist., vol. XVII, 1895, p. 217) and by E. W. Claypole (Amer. Geol., vol. XV, 1895, p. 325). These remains form what is known as the "Shaw mastodon." They were discovered in Hyde Park, in the northeastern part of Cincinnati, in section 27 of Columbia Township. The spot is 1.4 miles away from the river, and just south of the upper part of Crawfish Creek. Remains of at least three mastodons were exhumed, including 3 tusks, a lower jaw with teeth, and many other bones. There were found also a tooth and a vertebra of a horse. An interesting matter regarding the lower jaw is the presence of 2 mandibular tusks of considerable size (Hayes, as cited, plates XI, XII). The diameter of each is given as 1.5 inches. One projected beyond the jaw 9.75 inches; the other, 7.4 inches. They were curved rather strongly downward. The specimen is to be referred to *Mammut progenium* Hay. The geology of the locality will be described on page 328.

Under this number may be recorded the discovery of mastodon teeth in a well sunk at Mount Washington, about 8 miles east of the central part of Cincinnati (Fuller and Clapp, Water-Supply Paper 259, 1912, p. 27). The teeth were found in coarse gravel, which lies only 15 feet from the surface, and is overlain by old till and loess. The indications are that the age of the mastodon is early Pleistocene.

In Area of Wisconsin Drift.

4. *Amanda, Butler County.*—In the collection of the Philadelphia Academy of Sciences the writer has seen 2 teeth of a mastodon, probably of the same individual, which are labeled as having been found on Dick's Creek, Butler County. This creek is in Lemon Township, and flowing westward, empties into the Miami near Amanda. The teeth are credited to W. S. Vaux. No details regarding the circumstances of discovery are recorded. The locality is south of the Germantown moraine.

5. *Germantown, Montgomery County.*—In 1875 (Cin. Quart. Jour. Sci., vol. II, p. 154), Mr. J. H. Klippart reported that some years before that time

an account had been published in the Dayton Journal of the finding of teeth, tusks, and some other parts of the skeleton of a mastodon near Germantown. It is not known whether any competent person identified these remains, nor what has become of them.

In 1870 (Amer. Jour. Sci., ser. 2, vol. L, pp. 54–57), Edward Orton described a geological section which was exposed along Twin Creek, a mile east of Germantown. Here were found precipitous walls of clay and gravel from 50 to 100 feet in thickness and extending 0.25 mile in each direction from a point. Beneath this was a bed of peat along 40 rods of the east bank of the creek, varying from 12 to 20 feet in thickness. In the peat-bed were found mosses, grasses, sedges, and wood and berries of red cedar. Orton reported that in 1870 there were taken from this bed two mastodon tusks each 8 feet in length; also a tooth which afterwards was shown to belong to *Castoroides*. Whether or not these tusks were those mentioned by Klippart is uncertain.

This section is discussed by Leverett (Monogr. U. S. Geol. Surv., XLI, p. 363, plate XIV) and by G. F. Wright ("Ice age in North America," 5th ed., p. 592, fig. 151). The latter regards the peat-bed as having come into existence during a temporary recession of the Wisconsin ice and as having been covered up during another advance of it. Leverett thinks that there is good reason to believe that the peat-bed indicates a considerable interval of deglaciation, but that it remains to be determined whether this preceded the formation of the early Wisconsin moraine or succeeded it. Considering the great thickness of the overlying Wisconsin drift and the almost certainty that Illinoian drift underlies the Wisconsin, it seems probable that this peat-bed belongs to an interglacial deposit, probably the Sangamon.

6. *Dayton, Montgomery County.*—In 1820 (Amer. Jour. Sci., ser. I, vol. II, p. 245), Caleb Atwater wrote that teeth of the mastodon had been found at Dayton. No details were given and the case is not illuminating. The weights given for some of the teeth make it doubtful whether or not he distinguished mastodon teeth from those of elephants.

About the first of April 1921, Mr. C. E. Pickering, of Lake View, Ohio, sent to the Smithsonian Institution for identification a well-preserved upper right second molar of a mastodon. This had been found 4 miles east of Dayton in an excavation, 30 feet below the surface. The tooth is 130 mm. long and 95 mm. wide. The surfaces of the cones are furnished with welt-like ridges which descend from the summit to the bases.

This whole region is occupied by Wisconsin drift. It is probable that the tooth was found in some river deposit, not in the drift itself.

7. *New Paris, Preble County.*—Professor Joseph Moore (Proc. Ind. Acad. Sci. for 1886, p. 277) reported that many bones of a mastodon had been discovered by a farmer living 2 or 3 miles from New Paris. Two grinding-teeth and one tusk nearly 11 feet long were part of the remains. The bones became the property of Earlham College. Nothing was said regarding the circumstances of the discovery, but the bones were probably found in one of the marshes so common in that region. New Paris itself appears to be situated on the Germantown moraine.

8. *West Sonora, Preble County.*—In 1893 (Amer. Geologist, vol. XII, p. 73) Professor Joseph Moore reported that mastodon remains had been found near Sonora, Preble County, in company with a fragment of a tooth of *Castoroides*. He probably meant West Sonora, as there is, at present at least, no town by the name of Sonora in the county. He furnished no details as to topography or geology. West Sonora is on the Englewood glacial moraine.

9. *New Madison, Darke County.*—The museum connected with the public library in Greenville, Darke County, contains a large lower jaw of a mastodon with the second and third molars, right and left, found near the headwaters of Mud Creek, on the farm of Elias Harter. The place was evidently near the village of New Madison. The township is number 10 north, range 1 east, and is named Harrison. In the same collection is a part, about 4 feet long, of a tusk found on the farm of Daniel Ruh, about 2 miles north of New Madison. It was met with at a depth of 3 feet in digging a ditch. For the geology of the region see page 326. New Madison is on the Englewood moraine.

10. *Fort Jefferson, Darke County.*—In the collection at the public library in Greenville is a nearly complete mounted skeleton of a mastodon found about 1908, in Neave Township, 11 north, range 2 east, near the village named. The spot is on the Delaplaine farm and near the headwaters of Bridge Creek. The region is very flat and was originally swampy.

11. *Six miles west of Greenville, Darke County.*—The writer has been informed by Mr. Calvin Young, living west of Greenville, that, a good many years ago, a considerable part of a skeleton of a mastodon had been exhumed on Kraut Creek, on the farm of Absalom Shade, in the southeast quarter of section 34, township 12 north, range 1 east. One tusk was broken up by the workmen in order to discover what kind of wood it was. A lower jawbone, containing large molars, was 3 feet 2 inches long. The remains were sold to John Collett, sent to a museum in Terre Haute, and finally destroyed in a fire. The remains were originally found at a depth of 5 feet and scattered about in sand and overlain by vegetable mold and peat.

In a letter of March 9, 1915, Mr. Young wrote that another mastodon had been found 6 miles west of Greenville. The remains were buried at a depth of 2.5 feet and lay on a bed of sand and gravel. Teeth and a tusk 10 feet long were observed, but the skeleton was not exhumed. These fossils were found on or near the Sidney moraine.

12. *Greenville, Darke County.*—The collection at Greenville contains an upper left hindermost molar of a mastodon said to have been found in Greenville Creek, about 0.75 mile west of the town. Another tooth, an upper left second molar, was found nearly northeast of the town, but how far is not stated. Mastodon remains were said by Joseph Moore (Amer. Geologist, vol. XII, p. 73) to have been found associated with the giant beaver, somewhere near Greenville.

These remains also must have been buried near the Sidney moraine, probably in swamps along its border.

13. *Ansonia, Darke County.*—In the collection at Greenville nearly complete ossa innominata, right and left, and some vertebræ are preserved, all found on the farm of Hezekiah Woods, in section 9 of township 13 north, range 2 east, at the headwaters of Stillwater Creek. A considerable part of the south of this section is occupied by a swamp. Around this runs the contour line of 1,000 feet above sea-level.

14. *Troy, Miami County.*—Mr. H. C. Shetrone, of the Ohio Archæological Museum, at Columbus, reported in 1914 that remains of a mastodon had been found in a depression about 3 miles from Troy. A company engaged in draining the pond and in digging found the bones. A lower jaw containing teeth was secured, as well as an upper tooth. The tusks had not been found. Troy is on the Loramie River, situated between the Englewood and Sidney moraines. The remains certainly belong to the latter part of the Wisconsin stage or later. Professor W. C. Mills writes that the remains were found on the farm of Mr. Wheeler, 3 miles southeast of Troy. A swampy kettlehole was being drained.

15. *Catawba, Clark County.*—In 1875 (Cin. Quart. Jour. Sci., vol. II, p. 154), J. H. Klippart wrote that a considerable part of a skeleton of a mastodon had been found in Clark County and had been placed in Wittenberg College, at Springfield. No details were furnished.

From Mr. C. G. Shatzer, of Wittenberg College, in reply to an inquiry, the present writer has received the information that this mastodon is now mounted and in the collection of the Ohio State University at Columbus. It was found at the edge of a small marsh, on the farm of Mr. N. S. Conway, on or close to the line between Clark and Champaign counties, and about 4.5 miles southwest of Mechanicsburg. This would be apparently about a mile northwest of Catawba and in the hills east of Buck Creek. Mr. Shatzer stated that it is in a rather strong knob-and-kettle country. This is shown, too, by the topographical sheet of the region.

The writer has examined this mastodon. The tusks measure, following the curve, 9 feet 8 inches in length. At the base of one of them one diameter is 162 mm.; the other, 184 mm. The tusks are somewhat spirally curved. The animal was not aged, inasmuch as the second true molar is worn only on the first crest, and the third molar is not at all worn.

49. *Brighton, Clark County.*—Mr. Shatzer reports that in 1905 or 1906 he excavated a mastodon at a point about 5 miles southeast of the place where the other was found and about a mile due north of the village of Brighton. This skeleton was met in a marsh and lay at a depth of about 18 inches, but one foreleg went straight down into the blue clay. The tusks were badly decayed, but many of the bones were well preserved.

16. *Urbana, Champaign County.*—In 1908 (Amer. Jour. Sci., ser. 4, vol. XXV, p. 193), Professor R. S. Lull wrote that the Yale University collection has a fairly complete skeleton of a young mastodon from Urbana. The present writer made a note on this specimen to the effect that it was found on a farm 5 miles north of Urbana. This would seem to be not far from Mad River.

50. *Woodstock, Champaign County.*—Mr. J. H. Klippart (Cin. Quart. Jour. Sci., vol. II, p. 153) reported that in 1869 a farmer, W. A. Howard, of

Woodstock, while ditching in his meadow, dug up a finely preserved femur of a mastodon. For several years this was on exhibition in the State agricultural rooms at Columbus. Unfortunately one can not be sure that the bone was not that of one of the elephants.

30. *Fayette County, near New Holland, Pickaway County.*—In 1875 (Cin. Quart. Jour. Sci., vol. II, p. 154), J. H. Klippart reported that portions of a skeleton of a mastodon had been discovered in a bog near New Holland. There appears to be no certainty that the remains were not those of an elephant. They had not been exhumed.

17. *South Bloomfield, Pickaway County.*—In 1834 (Amer. Jour. Sci., ser. 1, vol. XXV, p. 256), in an unsigned article, S. P. Hildreth reported the discovery of mastodon teeth and ribs in an excavation for a culvert in a small stream, a mile east of Bloomfield, now called South Bloomfield, where a canal was being constructed. The teeth were in a fine state of preservation. At the same place was found the tooth of an elephant. These remains are said to have been embedded in a black boggy earth.

18. *Circleville, Pickaway County.*—In 1820 (Amer. Jour. Sci., vol. II, p. 245), Caleb Atwater stated that a large thigh bone of a mastodon had a short time before been found near the town in digging a mill-race. Here again there must be doubt regarding the identification of the animal.

19. *Pickaway Plains, Pickaway County.*—This name is given to a level tract lying about 5 miles southwest of Circleville and east of Scioto River. In the article cited above, Caleb Atwater stated that he had 2 teeth of a mastodon, one of which had been found in a small rivulet near the "Pickaway Plains." This tooth is illustrated by figures 1 and 2 B, of plate II, of the paper cited. It is evidently a tooth of *Mammut americanum*. The locality would be not far from the broad terminal Wisconsin moraine.

20. *Salt Creek Township, Pickaway County.*—The writer just quoted reported that the other mastodon tooth which he owned had been found in the bed of Salt Creek, 22 feet 9 inches below the surface. This tooth is figured on plate II of Atwater's paper above cited.

21. *Shadeville, Franklin County.*—In the collection of the University of Ohio, the writer has seen a tooth of a mastodon which was found at Shadeville. This place is on Scioto River, a few miles below Columbus. It is probably of Late Wisconsin age.

51. *Granville, Licking County.*—In 1873 (Amer. Jour. Sci., ser. 3, vol. V, p. 79), L. E. Hicks reported that he had examined the left side of the pelvis of a mastodon found in the bank of Raccoon Creek, near Granville, along the route of the Atlantic and Lake Erie Railway. This place is on the west border of the Grand River moraine.

22. *Mount Gilead, Morrow County.*—In Ward's Natural History Establishment, at Rochester, New York, the writer has seen an upper left third molar of a mastodon, labeled as having been found at this place. No details accompanied the specimen. The tooth is 158 mm. long and 95 mm. wide, and has a large pulp cavity. Mount Gilead is on the moraine which forms the eastern limb of the Scioto lobe. The tooth may be with safety regarded as of Late Wisconsin age.

23. *Harper, Logan County.*—In Earlham College, Richmond, Indiana, are 2 molars of a mastodon, the lower second and the third, which were found somewhere in the vicinity of Harper.

24. *Roundhead, Hardin County.*—In 1875 (Cin. Quart. Jour. Sci., vol. II, p. 153), J. H. Klippart reported that considerable parts of the skeleton of a mastodon had been exhumed at Fort McArthur, in Hardin County, having evidently drifted out to the Scioto marsh and being widely scattered. Fort McArthur does not appear on recent maps; a gazetteer of 1835 locates the place in Logan County, 24 miles north of Urbana. The locality appears to be in the neighborhood of Roundhead and in the marshes in which Scioto and Miami Rivers take their rise.

25. *Washington Township, Auglaize County.*—In Bulletin No. 16 of the Geological Survey of Ohio, 1912, page 38, Mr. Alfred Dachnowski, quoting from C. W. Williamson, stated that in 1878 Mr. S. Craig, while engaged in surveying section 19 of Washington Township (Tp. 6 S., R. 5 E.) discovered a mastodon skeleton. No further search had been made in 1905 (Williamson's Hist. West. Ohio and Auglaize County, p. 336). While doubtless a proboscidean was buried there, one can not be sure that it was not an elephant. This place is not far from New Knoxville.

26. *Pusheta Township, Auglaize County.*—From the same authorities it is learned that in 1894 a mastodon calf was discovered in section 29 of the township named (Tp. 6 S., R. 6 E.), embedded in a layer of muck at the bottom of a circular pond. The skeleton is reported as having been quite complete, but it went to pieces as it dried. The tusks were about 1 foot long. At this place the waters flow into Clear Creek, a branch of Auglaize River.

27. *Wapakoneta, Auglaize County.*—The authorities quoted reported that a mastodon had been discovered in a ditch excavation in section 33 of Duchouquet Township (Tp. 5 S., R. 6 E.), not far from Wapakoneta. The remains crumbled on exposure and drying. They may have been those of an elephant.

28. *Duchouquet Township, Auglaize County.*—The authorities on whom reliance is here put state that in 1891 a mastodon was discovered by some laborers who were deepening and widening the bed of a creek which extends through section 22 of the township mentioned. This creek must have been either Auglaize River or a branch of it, so unimportant that it is not down on the topographical sheet of that quadrangle. The tusks extended across the creek and were cut off by the workmen and carried away.

29. *St. Johns, Auglaize County.*—Mastodons have been reported from two localities near the village of St. Johns and along the headwaters of Willow Creek. The one nearest the village is mentioned in Dachnowski's work "Peat Deposits of Ohio" (Bull. 16, Geol. Surv. Ohio, 1912, p. 38). It was found in section 4 of Clay Township (Tp. 6 S., R. 7 E.), some time about 1870. There is no certainty that the bone did not belong to an elephant. The other mastodon was found in 1870 and accounts of the discovery were given by Dr. G. K. Gilbert (Proc. Lyc. Nat. Hist., N. Y., vol. I, 1871, p. 220; Rep. Geol. Surv. Ohio, vol. I, pt. 1, 1873, p. 556); and by C. W. Williamson (Hist. West. Ohio and Auglaize County, 1905, pp. 334–336).

The locality is 2.5 miles east of St. Johns, in section 3, Clay Township. Farmers were engaged in running a broad ditch through a swamp. The depth of the swamp deposit at that point was 8 feet, of which the upper third was peat, the remainder, so far as shown, of marl or marly clay. The bones were in their natural relations and it was evident to Gilbert that the animal had mired there. The lower limb-bones were directed downward and well preserved, but the bones nearer the surface were badly decomposed. The presence of the teeth enabled Gilbert to identify the animal as the mastodon. The peat had evidently been deposited after the death of the animal, which had occurred after the deposit of the drift. Klippart (Cin. Quart. Jour. Sci., vol. II, p. 153) stated that a part of the remains had been placed in the Wapakoneta High School. The remains must have been buried near the Loramie moraine.

In Heidelberg University, Tiffin, Ohio, the writer examined teeth and bones of two mastodons which had been found in Auglaize County, but the exact localities were not known.

30. See page 75.

31. *Ohio City, Van Wert County.*—In 1848 (Amer. Jour. Sci., ser. 2, vol. v, p. 215), Whittlesey stated that a mastodon tooth had been found at this place, and further, that it had been mentioned by Charles Lyell. It was found in alluvium and rested on a blue marl. The locality is in the vicinity of the Lima moraine.

32. *Columbus Grove, Putnam County.*—In 1913, Mr. H. B. Maple, of this town, sent to the U. S. National Museum for identification a lower left first molar, found in gravel 3 miles north of the town, near the border of ancient Lake Maumee.

33. *Liberty Township, Putnam County.*—In 1874, Professor N. H. Winchell (Geol. Surv. Ohio, vol. II, pt. 1, p. 392) told of the finding of large bones, supposed to belong to a mastodon, just southeast of the center of section 6, in draining the Medary marsh, in the township named (Tp. 2 N., R. 7 E.) The bones were in a sandy loam along the north side of the Leipsic ridge, a part of the Defiance moraine. Another was found in section 8 of the same township. The remains consisted of two teeth, bones of the posterior extremities, and a fragment of a tusk. The limb-bone was removed 23 feet from the tusk. These remains lay at a depth of about 3 feet from the surface. Other large bones, mastodon or elephant, were found in section 7, Ottawa Township (Tp. 1 N., R. 7 E.). This was evidently on the south side of the ridge mentioned, but yet probably north of Blanchard River.

34. *Springfield Township, Lucas County.*—In 1873 (Geol. Surv. Ohio, vol. I, pt. 1, p. 556), Dr. G. K. Gilbert wrote that Dr. J. B. Trembley, of Toledo, had informed him that a tooth of a mastodon had been obtained from a marsh in Springfield, Lucas County. It is probable that Gilbert meant Springfield Township. He could not ascertain the exact locality, but he remarked that all the marshes of that township date from the formation of the lowest and most recent of the raised beaches and that it was almost certain that the tooth is not less recent than they. Springfield Township is nearly in the center of this county.

In 1886 (Proc. Davenport Acad. Sci., vol. IV, p. 309), Dr. E. Sterling, of Cleveland, wrote that about 15 years previously a mastodon skeleton had been found in a cranberry swamp in Lucas County; but no more exact location was given. A large ditch was being made where the muck of the bog was about 8 feet deep and rested on a layer of "hard pan." The skeleton was badly decayed. What proof the writer had that the remains belonged to the mastodon is not stated.

35. *Jackson Township, Wood County.*—From a clipping taken from the Toledo Blade of January 15, 1919, with 2 illustrations, it is learned that Mr. John Welsh, of the township named, while digging a trench on his farm, unearthed a tooth of a mastodon. The pictures show that it was a considerably worn, lower right hindermost molar. Jackson Township (Tp. 3 N., R. 9 E.) is in the southwestern corner of the county. From Mr. Welsh the writer learns that the locality is 3.5 miles northeast of Deshler and in section 17. The tooth was buried at a depth of 4 feet. The locality is well within the area covered by old Lake Maumee.

36. *Carey, Wyandot County.*—In April, 1911, Mr. O. N. Copley, Cary, sent to the Smithsonian Institution a much-worn lower left first true molar, found at Cary, in muck, at a depth of 3 feet. With it was found also a canine tooth of a bear, apparently *Ursus americanus*. These were buried near the Defiance moraine.

37. *Old Fort, Seneca County.*—At Heidelberg University, Tiffin, Ohio, the writer was told of a mastodon which had been found at Old Fort, and was in the possession of Mr. J. A. Gillmor, of Fremont, Ohio. Upon inquiry Mr. Gillmor stated that the tooth, of which he sent a sketch, had been found in 1909 in a low and marshy piece of tiled ground which lies east of Sandusky River, opposite Old Fort. The tooth was very superficially buried, for it was turned up by the plow. Mr. Gillmor stated that in constructing the Nickel Plate Railroad, not far from where the tooth was found, some large bones had been discovered. The locality is north of Defiance moraine and on the old bed of Lake Maumee.

38. *Bucyrus, Crawford County.*—In 1838, as told by the geologists C. Briggs (Second Ann. Rep. Geol. Surv. Ohio, pp. 127–129) and J. W. Foster (Amer. Jour. Sci., ser. 1, vol. XXXVI, 1839, p. 189, fig. 1), a nearly perfect skull and various parts of the skeleton were found near Bucyrus, on the land of a Mr. Hahn, during the excavation of a mill-race, and in a bed of fresh-water shell marl about 4 feet thick. Both tusks were, however, missing. There were secured also 6 cervical vertebræ, 6 dorsals, 1 lumbar, 5 caudals, 28 ribs, most of the pelvis, and several limb-bones. The fine skull was sent to the American Philosophical Society in Philadelphia, and is now preserved in the Academy of Natural Sciences of that city. What was done with the remainder of the skeleton the present writer does not know. This specimen has been referred to by several authors. N. H. Winchell (Geol. Surv. Ohio, vol. II, pt. 1, 1874, p. 247) stated that the skeleton was embedded in the muck and marl of a swamp and that what remained of it was then in possession of the Ohio Agricultural and Mechanical College. The locality was probably near Celina moraine.

39. *Sandusky, Erie County.*—In 1848 (Amer. Jour. Sci., ser. 2, vol. V, p. 215), Whittlesey wrote that a tusk and a few bones of mastodon or

elephant had been uncovered at the deep cut of the Mansfield Railroad, a few miles from Sandusky, in a Recent bog of muck. J. H. Klippart (Cin. Jour. Nat. Hist., vol. II, 1875, p. 153) referred to the tusk and said that a part of it was preserved in the Homœopathic College at Sandusky. It is impossible now to say whether this belonged to a mastodon or an elephant. If still preserved it may be possible to determine the genus from the microscopical structure of the ivory.

40. *Brownhelm Township, Lorain County.*—In the collection of Oberlin College are many bones of a mastodon, some jaws and teeth, and a part of the skull, collected about 1898, on the farm of a Mr. French, in the township named, not far from the shore of Lake Erie. Professor Lynds Jones, of Oberlin College, has sent the information that this mastodon was found in a county ditch in township 6 N., range 19 W., about where the ditch crosses from lot 29 to 30, on what is known as the North Ridge road. This ridge is mentioned by J. S. Newberry (Geol. Surv. Ohio, vol. II, 1874, p. 207, map opp. p. 58), and has an elevation of from 100 to 118 feet above Lake Erie. It represents the beach of old Lake Warren. According to Professor Lynds Jones, the mastodon had been buried in a morass between two branches of the North Ridge or old beach. This was of course well along toward the close of the Pleistocene period.

41. *Pittsfield Township, Lorain County.*—In the collection at Oberlin College are some fragments of mastodon teeth, found somewhere in Pittsfield township (Tp. 4 N., R. 18 W.) at a depth of about 2 or 3 feet, in a ditch. No further details have been secured.

In the American Museum of Natural History, at New York, is a lower right second molar which had been received from Mr. J. J. Crook. It had probably been found somewhere about Lagrange, but this is not certain.

42. *Cleveland, Cuyahoga County.*—The geologist Charles Whittlesey (Smithson. Contrib. Knowl., vol. XV, art. 3, p. 15) stated that, many years before he wrote, a grinder of a mastodon had been found on the west side of Cuyahoga River, in the valley alluvium, resting on drift clay near the lake level. This might indicate one of three things: The mastodon belonged to some pre-Wisconsin stage; or the tooth had, after the retirement of the lake to its present level, been washed down from above; or the animal had lived there after the lake had reached about its present level.

Newberry (Geol. Surv. Ohio, vol. I, pt. 1, 1873, p. 183) stated that his "Delta Sand Deposit," which forms the surface of the Cleveland plateau, had yielded numerous portions of the skeletons of elephant and mastodon. These could hardly have existed before the retirement of the lake within the Warren beach.

Klippart (Cin. Quart. Jour. Nat. Sci., vol. II, 1875, p. 153) says that a nearly complete skeleton of a mastodon was dug up in the immediate vicinity of Cleveland, but had been broken into pieces at once by the workmen. The identity of this specimen is doubtful and the exact locality is unknown.

43. *Medina County.*—In 1875 (op. cit., p. 153), Klippart reported that nearly 50 years before he wrote tusks, said to have been 12 feet long, and some parts of the skeleton of a mastodon had been taken out of a marl pit

in this county. As in other cases, there is uncertainty about the locality and the identity of the animal.

44. *Green Township, Summit County.*—Professor William C. Mills, of the State University of Ohio, has informed the writer that he had secured remains of a young mastodon in section 13 of this township (Tp. 2 N., R. 9 W.). The bones were found at a depth of about 30 inches and were badly decayed. The region is flat and lies in a bend of the headwaters of Tuscarawas River.

45. *Massillon, Stark County.*—S. P. Hildreth, in 1837 (Amer. Jour. Sci., ser. 1, vol. XXXI, p. 56), reported that a year or two before he wrote some very large bones and tusks of a mastodon had been brought to light in excavating a mill-race near Massillon through a swamp or wet prairie. This city is situated on the Tuscarawas River.

46. *Canton, Stark County.*—In the Cincinnati Inquirer of November 11, 1910, a paragraph announced that some boys, while digging in the east end of the city, had found 2 mastodon teeth. On November 26 the writer received a letter from Mr. N. D. Bush, of Canton, who described the teeth, so that it is certain that they were those of the mastodon. Both Massillon and Canton are situated on the broad Grand River moraine.

47. See page 70.

48. *Trumbull County.*—Mr. John T. Plummer, in 1843 (Amer. Jour. Sci., ser. 1, vol. XLIV, p. 302, footnote), stated that he owned a grinder with 10 prominences which had been found in this county. Evidently the tooth was that of a mastodon, but the locality is somewhat vague.

For 49 and 50 see page 74; for 51 see page 75.

MICHIGAN.

(Maps 5, 8.)

1. *Church, Hillsdale County.*—In 1901 there was found, on the farm of Mr. Levi Wood, near Church, the greater part of the skeleton of a small mastodon. This was exhumed by an agent of the U. S. National Museum and is exhibited there. The animal is small and probably a female. The bones were found in a peat swamp, not far from the surface. Those most deeply buried were only 4 feet from the surface, while others were down only about 2.5 feet.

The whole of the township in which Church is situated is occupied by a part of the Mississinawa moraine, the outermost one formed by the Erie lobe of the Wisconsin ice. So far as the ground is concerned, the mastodon might have lived there long before the close of the Wisconsin stage at any time after the exposure of the moraine.

This mastodon was described and figured by Mr. C. W. Gilmore in 1906 (Proc. U. S. Nat. Mus., vol. XXX, p. 610, plate XXXV).

2. *Adrian, Lenawee County.*—In the American Journal of Science (vol. XXXVIII, 1864, p. 223), Dr. Alexander Winchell reported the discovery of remains of a mastodon on section 7 of the township of Adrian, Lenawee County. The locality is said to have been about 7 miles northwest of the town of Adrian. The township must therefore be that designated as 6 south, 4 east. Winchell gave a list of the bones, and this comprises probably

about half of the skeleton, including the skull. According to Winchell, these remains were found at a depth of only about 2 feet in a peat-bog; beneath this peat, which was 2.5 feet thick, was marly clay, passing at the depth of 4 feet into loose sand.

According to the glacial map of Leverett and Taylor, the locality would lie well outside the limits of Lake Maumee and would be on the Fort Wayne moraine. Probably a long while after the Wisconsin glacial sheet had retired from Michigan, this mastodon died there and became covered by the thin deposit of peat, as found. Here may be noted likewise some remains of a mastodon which Winchell, in the same paper, says had been found in Adrian.

In the U. S. National Museum (No. 188) there is a lower jaw of a mastodon, reported to have been found in a lacustrine marsh in this county, in the "same locality as the Decker mastodon in Adrian College." A note states that with this were found bones of deer, elk, and castoroides. (See further, under the account of the skull of *Castoroides* found at Adrian.)

In the annual report of the Michigan Geological Survey for 1901, page 253, A. C. Lane mentioned that at Clinton, Lenawee County, Mr. P. B. Gragg had found several teeth and bones of mastodon. These seem to have been buried in the same glacial drainway as those found in Adrian township.

27. *Clayton, Lenawee County.*—Mr. George Townsend, of Clayton, Michigan, has informed the writer that he has the lower jaw of a mastodon which he found while digging a posthole on his farm near that town. The locality is described as the middle of the line between the southeast and northeast quarters of southeast quarter of section 7, T. 7. S., R. 2 E., and near a creek. The township is Dover. According to Leverett and Taylor the immediate region is covered by glacial ground moraine.

3. *Howell, Livingston County.*—Dr. A. C. Lane (op. cit., p. 252) reported that a lower tooth and a part of a pelvis had been obtained in dredging the Shiawassee River, in 1900. Mr. C. W. Gilmore, of the U. S. National Museum, tells the writer that he saw a mastodon tooth which had been found in a swamp 2 miles southwest of Howell. Alexander Winchell, in 1864 (Amer. Jour. Sci., vol. xxxviii, p. 224), reported mastodon remains from Green Oak, in Livingston County. No details were furnished. Most of this county is occupied by the Charlotte moraine system, formed by the ice-lobe which extended out from Saginaw Bay.

4. *Bellevue, Eaton County.*—The writer has learned from Mr. N. A. Wood, of the University of Michigan, that mastodon remains had been described from near Bellevue by Mr. E. A. Foote, in the third volume of the Report of the Pioneer Society of Michigan, on pages 402–403. The animal was found on the farm of Mr. Charles Cummings. It was a large one, the femur having a length of 3 feet 10 inches and one tusk was over 12 feet in length. Four teeth belonged to the upper jaw. The remains must have been found before 1879.

Bellevue is situated on the Kalamazoo River, which here traverses the Kalamazoo moraine. As in other cases in the central regions of the State, mastodons may have lived at a rather early stage after the Wisconsin ice began to withdraw; but they may have kept farther from the glacial front.

5. *Olivet, Eaton County.*—Dr. A. C. Lane (Ann. Rept. Board of Geol. Surv. Michigan for 1901, p. 253) reported the finding of mastodon bones near Olivet. A letter from Professor Samuel Rittenhouse, of Olivet College, gives the information that many of the bones of the skeleton had been secured. These were exhumed from a marsh on the northwest quarter of section 11, township 1 north, range 5 west. Following Leverett and Taylor's map, the locality seems to be on an esker through which flows Battle Creek. The country in this region is covered by the Kalamazoo morainic system of the Saginaw lobe. The mastodon must have been buried after the ice receded from that moraine.

6. *Stanton, Montcalm County.*—Mr. N. A. Wood, preparator in the University of Michigan, informed the writer that Mr. L. C. Hodges, of Stanton, in 1911 found some mastodon teeth. Nothing more is known about these remains. Stanton is situated between the West Branch morainic system and the Charlotte system.

7. *Buchanan, Berrien County.*—Mr. William Hillis Smith, of Niles, Michigan, informed the writer that many remains of mastodons were found in a large ditch made to drain the Bakerstown marsh. This ditch began south and west of Buchanan and emptied into Lake Michigan. It was 16 feet wide and 8 to 10 feet deep. In the course of the work bones and teeth were frequently thrown out by the steam shovel, especially bones of mastodons. One skull was badly crushed, but was repaired by Mr. E. H. Crane, of Kalamazoo, and sold to the Ward Establishment, of Rochester, New York. Exact statements as to localities are wanting, but the ditch was evidently located on and within the Valparaiso moraine. It is this moraine which runs around the southern end of Lake Michigan and separates the St. Lawrence drainage from that of the Mississippi; east of the lake it extends far north into Michigan. Naturally, this moraine was formed before the withdrawal of the Lake Michigan lobe of the Wisconsin glacier into that lake, and the mastodons might have lived, died, and been buried there at any time after the exposure of the moraine and the development of climatal conditions that permitted their existence.

Mr. Hillis Smith stated that a tooth of an elephant had been thrown out in making the ditch above mentioned. This tooth was in the possession of Mr. E. H. Crane, of Kalamazoo. The species is not known.

The mastodons referred to above were mentioned by Lane in his report of 1901, page 253. He also called attention to a list of the mollusks found in the muck beneath one of the mastodons, prepared by Bryant Walker (Nautilus, vol. XI, 1898, p. 121), in which 36 species were named.

8. *Eau Claire, Berrien County.*—In the Joint Documents of the House of Representatives of Michigan, session 1841, page 559, Bela Hubbard stated that remains of a mastodon had been found on Paw Paw Creek, Berrien County. Lane (Rep. Geol. Surv. Michigan for 1901, p. 252) stated that there are in the Agricultural College at East Lansing, 6 teeth and half of a lower jaw, found near Eau Claire, and which may be the remains referred to by Hubbard. This appears, however, to be an error. On these teeth are the label: "Found at Eau Claire, Berrien Co., Mich. Found

beneath several feet of muck while digging a ditch. B. L. Comstock, Aug. 17, 1896." The teeth are extraordinarily large; M^3 right is 222 mm. long.

The exact places where the remains mentioned were found have not been recorded. For an account of the small glacial lakes which occupied the depressions that existed between the Valparaiso moraine and the shore of Lake Michigan while the latter was yet filled with ice, see Leverett and Taylor's Monograph No. LIII, pages 225–227. In the deposits of these lakes, but probably long after the glacial ice had retired, were buried the bones of the mastodon and other animals.

From Mr. N. A. Wood, of the University of Michigan, the information has been received that a part of a skull of a mastodon was found in making a public ditch about 2 or 3 miles south of Barada.

25. *Galien, Berrien County.*—In 1885 (Proc. Bost. Soc. Nat. Hist., vol. v, p. 133), I. A. Lapham reported the discovery of the right ramus of the lower jaw of a mastodon at Terre Coupée. This place has disappeared from the maps; but it is said to have been situated on the railroad, 11 miles west of Niles, not far east of Galien. The jaw was found by Mr. A. H. Taylor, at a depth of 6 feet. It was peculiar in having a supernumerary molar, a seventh. The jaw was again described by Dr. J. C. Warren in 1855 (Amer. Jour. Sci. (2), vol. XIX, pp. 348–353).

9. *Dorr, Allegan County.*—A. C. Lane (Rep. Geol. Surv. Michigan for 1901, p. 253) stated that Frank Fleser and others had secured a jawbone of mastodon and several teeth. The place is stated to be 4 miles west of Dorr, probably in the valley of Rabbit River, where it cuts through the Valparaiso moraine.

10. *Cannonsburg, Kent County.*—In the Kent Scientific Museum at Grand Rapids is a lower left last molar, labeled as having been found at Cannonsburg, by Henry Detmer. The exact locality of the place where the tooth was found is unknown to the writer. The tooth is only slightly worn and is of a white color. Cannonsburg is on a great expansion of what Leverett and Taylor call the Charlotte morainic system, a system produced by the Saginaw lobe of the Wisconsin glacier. Being one of the more distant moraines of the Saginaw lobe, it was one of the earliest to be freed from ice and to offer itself to animal occupancy; but it may not have been invaded by mastodons until the glacial wall had moved much farther away.

11. *Moorland, Muskegon County.*—In the Kent Scientific Museum at Grand Rapids, Michigan, is a mounted mastodon, the bones of which, except the limbs, belong to a specimen found about 1905 in a swamp north of Moorland. The exact locality, as given by Mr. C. L. McKay, the finder, is the northwest quarter of the northeast quarter, section 16, township 10 north, range 14 west. The skull and the tusks are in good condition. Beneath the skeleton was found the skull which was made the type of *Boötherium sargenti* Gidley.

The Moorland swamp forms part of a great plain about 25 miles wide lying between the "Lake border morainic system" (Leverett and Taylor, p. 222) and the present eastern shore of Lake Michigan. This plain appears to have been occupied by either ice or the waters of old glacial lakes until well near the close of the Wisconsin stage. The animal must have been one

of the latest of his tribe to inhabit the State of Michigan. It may have lived long after the time of the musk-ox on whose skull the mastodon's pelvis was lying.

12. *Williams Township, Bay County.*—In the annual reports of the Geological Survey of Michigan (1901, p. 253; 1905, p. 354), the discovery of the skeleton of a mastodon in Bay County was announced. It had been found in a depression called a pot-hole. The locality more accurately given is in the southwest corner of section 3, township 14 north, range 3 east. There was a fragment of a tusk 8.75 feet long and but little curved, a femur and its socket 9.5 inches across, one vertebra, and one tooth. These were found 3 or 4 feet from the surface. The remains were sent to Ypsilanti. An examination of Leverett and Taylor's plate XVII (Monograph LIII) indicates that the mastodon could not probably have lived there until after the time of Lake Warren. At that time the ice sheet occupied most of Lake Huron and a part of Saginaw Bay, but the climate of that region was probably, for a long time after the passing of Lake Warren, too raw and cold to please the mastodon, so that it was long afterward that this individual left his skeleton in the boggy hole.

13. *Near Saginaw, Saginaw County.*—Dr. A. C. Lane has reported (Ann. Rep. Geol. Surv. Michigan for 1901, p. 252) that he had found in the possession of farmers in Tittabawassee Township, Saginaw County, parts of a tusk, said to have come from a ditch near the course of the Parker drain, about 0.25 mile north of the south line of section 20, township 13 north, range 3 east, according to Mr. D. E. Williamson, of Saginaw. Dr. Lane also reported remains of a mastodon, including the lower jaw, found in digging a tile ditch on the "Willis farm."

14. See page 85.

15. *Saginaw County.*—In October 1910, Mr. Ralph McQuiston sent to the writer photographs of three mastodon teeth found on a farm about 8 miles east of north of Elsie, Clinton County. He has since given this locality as being in the southeast quarter of the southwest quarter of section 4, township 9 north, range 1 east. According to Leverett and Taylor's glacial map of Michigan, this would be about 6 miles within the old Lake Warren beach-line and in sandy deposits laid down in water. The teeth were found at a depth of 3 feet. It may be that the animal died at that spot after the waters of Lake Warren had retired. If so, it would be interesting to determine the origin of the materials which covered the mastodon. On the other hand, the mastodon remains were possibly deposited there after the withdrawal of Lake Wayne and that the overlying materials were laid down by the water of Lake Warren, for this lake appears to have stood at a higher level than its predecessor. If the latter supposition is correct, mastodons could live not far away from the glacial front.

Further correspondence with Mr. McQuiston makes it appear improbable that the overlying materials were deposited by lake waters. Professor Leverett suggests that the animal had died in an old swale and had afterwards been buried under fine material washed in from the somewhat higher ground in the neighborhood. In that case the mastodon may have lived at any time after the lake waters had retired from the locality.

14. *Alma, Gratiot County.*—In Alma College, at Alma, Gratiot County, are some remains of a mastodon, found about 6.5 miles southeast of Alma, on the farm of Mr. Albert Smith. These remains were exhumed under the direction of Professor H. M. MacCurdy, of Alma College (Mich. Acad. Sci., Rep. xxi, p. 119). Various parts of the skull are preserved, one part showing beautifully the air-cells; also a fragment of a tooth, axis, three dorsal vertebræ, a few ribs, and a part of the pelvis. From Mr. Albert Smith it is learned that the remains were found on the southwest quarter of section 17, township 11 north, range 2 west. This, following Leverett and Taylor's map, would be on the Owosso moraine, which here runs north from Ithaca, Gratiot County. A ditch was being dug through a peat-bog and the bones were met with at a depth of 4 feet or less from the surface. Professor MacCurdy wrote that the bones were lying on a bed of gravelly sand and were covered by a thin layer of mixed sand and vegetation, while over this was about 3 or 4 feet of well-decayed peat. The locality is about 2 miles from the shore-line of the glacial Lake Maumee, as mapped by Leverett and Taylor.

In the collection at Alma College is a left ramus of the jaw of a mastodon, which contains the second and the third true molars and the socket for the first molar. This jaw is reported to have been found on the William Pitt farm, about 7 miles from Alma and in Seville Township. The exact locality is given the writer by Professor MacCurdy as being in the south half of the northeast quarter of section 22, township 12 north, range 4 west. Professor C. A. Davis contributed for the writer the information that these bones were discovered in constructing ditches from 18 inches to probably 3 feet in depth.

In the Alma College collections are some mastodon remains, including three fine upper teeth, which were found in the southeast part of the village of Alma. The locality is described as being in the northeast quarter of the northeast quarter of section 3, township 11 north, range 3 west. Professor Charles A. Davis, deceased, formerly professor at Alma College, later connected with the Bureau of Mines at Washington, D. C., as peat expert, informed the writer that many years ago he exhumed parts of two skeletons of mastodons. Part of the bones lay in a small deposit of marl and were well preserved; the others lay on the edge of the marl-bed and above it and were not so well preserved. It appears that the locality had been covered permanently with water in which peat was growing. Associated with the bones in the marl were the fruits of the tamarack (*Larix laricina*) and of the black spruce (*Picea mariana*). These trees are growing there to-day, and extend far north into British America; hence, when those mastodons were living in the region about Alma the climate may have been as warm as it is to-day or much cooler.

Professor C. A. Davis informed the writer that a large number of mastodon bones were found about 1885 by a farmer who lived half a mile west of Riverdale. This was in Seville Township, No. 12 north, range 4 west, apparently in section 31. The discovery was made by the owner of the land, who found a number of teeth of a mastodon attached to the roots of a small elm tree which he pulled out of a swale on his farm. The bones

were not more than 18 inches below the surface. Professor Davis regarded it as remarkable that remains of the mastodon should be so near the surface in ponds and swales where peat is growing.

16. *Bancroft, Shiawassee County.*—Dr. A. C. Lane (7th Ann. Rep. Geol. Surv. Michigan, 1905, p. 553) reported that some ribs, tusks, teeth, and many bones of a mastodon had been found near Bancroft, at a depth of 4 feet, in marl, above which were muck, marl, and sand. Lane gives the locality as being on the line between sections 36 and 25, township 6 north, range 5 east, but this would be about 12 miles east of Bancroft. The range is probably 3 east. The locality appears to be on the Fowler moraine.

17. *Venice, Shiawassee County.*—In the agricultural school at East Lansing is a lower right hindermost molar, catalog No. 3392, which is said to have been found at Venice by Mr. Hiram Johnson. There are also parts of one or two tusks from the same place, probably of mastodon. Venice is just north of the Owosso moraine, and the mastodon must have lived there at a rather late time in the Wisconsin stage. A letter from Mr. Fayette Johnson, of Washington, D. C., son of Mr. Hiram Johnson, informs the writer that he saw the bones taken up about the year 1884. The place was about the center of section 21, township 7 north, range 4 east. This would be apparently on the Owosso moraine.

18. *Fenton, Genesee County.*—Alexander Winchell (Amer. Jour. Sci., vol. XXXVIII, 1864, p. 224) reported mastodon remains from this place. No details were given. Fenton is located on the Portland moraine, one of those built up by the Saginaw lobe.

19. *Davison, Genesee County.*—In the museum of the Michigan Agricultural School, at East Lansing, Michigan, is a large left femur, found near Davison, Genesee County. It was presented by Mr. A. B. Cullen, but no more exact information was furnished. A comparison of this femur with those of the mastodon and of a specimen of *E. primigenius* from Siberia indicates that the bone belonged to the American mastodon. The length is 40.5 inches. Davison is situated on the border of an old lake which lay along the front of the ice which built up St. Johns moraine (Taylor, Monogr. LIII, p. 241). At this stage the earliest of the glacial lakes, Lake Maumee, had not yet come into existence; but it must have been long after this time that the mastodon lived in the region about Davison.

20. *Utica, Macomb County.*—In 1864, Alexander Winchell (Amer. Jour. Sci., vol. XXXVIII, p. 224) reported mastodon remains from near this town. A mention of this discovery is given in volume XVII, page 425, of the "Collections and Researches made by the Michigan Pioneer and Historical Society," by George H. Cannon. It is here stated that remains had been unearthed on the farm of Hon. P. K. Leech, and that specimens of the jawbone and several teeth were in the cabinet of Hon. W. W. Andrus. A letter to the present writer from Mr. A. F. Leech, son of Mr. P. K. Leech, states that the remains had been found on the east half of the northeast quarter of section 31, township 3 north, range 12 east, in a swale which runs across the land described. These teeth and bones were destroyed in a fire many years ago. According to Leverett and Taylor's Glacial Map of the Southern Peninsula of Michigan, the locality where these remains were

discovered is near the outer border of the glacial Lake Maumee, at a point where there was a delta. This delta is mentioned by Leverett and Taylor (Monogr. LIII, U. S. Geol. Surv., p. 383). It is where Clinton River entered old Lake Maumee. It is evident that the animal did not live before the time of this lake; it probably existed long after this time, when the climate had much moderated.

21. *Plymouth, Wayne County.*—Alexander Winchell (First Bienn. Rep. State Geologist, 1861, p. 132) stated that a Mr. Shattuck had exhumed nearly an entire set of teeth of a mastodon, with a part of a tusk 7 feet in length. Winchell saw five of the teeth; the other bones appear to have been destroyed. The exact location of this place is not known, but Plymouth is within the border of the glacial Lake Maumee; and the existence of the mastodon was possible only well toward the close of the Wisconsin stage.

22. *Wyandotte, Wayne County.*—In the collection of the University of Michigan are many bones, including jaws with teeth, of a mastodon found in Monguegon Township, about 6 miles southwest of Wyandotte and about 2 miles northwest of Sibley. The locality more accurately given is the northwest quarter of the northeast quarter of section 12, township 4 south, range 10 east. This was on the farm of Mr. James H. Vreeland. A county ditch was being made to drain what is known as the Big Marsh. As reported to the writer by Mr. R. A. Smith, Assistant State Geologist of Michigan, on a very coarse limestone gravel are 30 inches of blue clay and over this about 30 inches of muck. The bones were mostly in the blue clay; those lying in the muck were much decayed. Some teeth and an atlas are in the possession of Mr. Vreeland.

According to Leverett and Taylor's map, this mastodon was buried within the borders of glacial Lake Lundy, just outside of that of Lake Rouge, a contemporary of Lake Algonquin. On page 442 of Leverett and Taylor's monograph it is stated that the altitude of the beach of Rouge Lake is 589 feet. On the map just referred to the 600-foot contour-line runs at a considerable distance west of the locality of the mastodon find. The latter appears, then, to have been somewhere between the altitude of 589 and 600 feet above sea-level, without considering the depth the skeleton may have lain below the surface. The altitude of Lake Erie is 573 feet. It is evident that the lake had attained nearly, if not quite, its present level when this mastodon lived.

Dr. E. C. Case, who superintended the excavation of this specimen, informed the writer that the bones were found 4 feet from the surface.

23. See page 88.

24. *Petersburg, Monroe County.*—Alexander Winchell (Amer. Jour. Sci., vol. XXXVIII, 1864, p. 224) reported mastodon remains from this place. The town is in township 7 south, range 6 east. According to Leverett and Taylor's map, Petersburg is within the beach which marks the old glacial Lake Warren. Probably, therefore, this mastodon lived after the retirement of this lake, unless it had lived during the time of Lake Wayne and been covered over by the deposits of Lake Warren when the waters of the latter made their advance on the land. The time of the mastodon was more probably after both lakes had ceased to exist.

23. *Saline, Washtenaw County.*—Mr. N. A. Wood, of the University of Michigan, informed the writer that he had seen some mastodon remains which had been found here in 1880. No exact statements were given regarding the place. Saline is very close to the beach of old Lake Maumee, where this beach is crossed by Saline River and on the Defiance moraine.

25. See page 83.

26. *Seven miles southeast of Ypsilanti, Washtenaw County.*—In 1908 (Folio 155, U. S. Geol. Surv., p. 9), Russell and Leverett stated that remains of a mastodon had been found a few years previously on the farm of Albert Darling, about 7 miles southeast of Ypsilanti, where laborers were digging a ditch across a swampy field. The lower jaw with molar teeth in place, the left tusk, teeth of the upper jaw, portions of the cranium, some vertebræ and ribs, and some of the larger bones of the limbs were found. With considerable restoration these parts were mounted and placed in the museum of Michigan University. The locality must be not far away from Huron River and within the beach of old Arkona Lake, a predecessor of the present Lake Erie.

27. See page 81.

INDIANA.

(Maps 5, 9.)

Mastodons Found in the Unglaciated Region.

1. *Posey County.*—On page 341 of Blainville's "Ostéographie des Mammifères," volume III, it is stated that Lesueur had shown Blainville drawings of a fine vertebra and a femur, with its epiphyses, of a mastodon which had been found along the Wabash River. His language indicates that this was somewhere below New Harmony. He stated that these bones were in the library at Vincennes, Indiana. In answer to my inquiry about these bones, President Horace Ellis, of Vincennes University, informed me that some bones which appear to be those mentioned are in his university.

These remains were found in digging a well, at a depth of 60 feet. One of the curators of the library at Vincennes, Mr. Badollet, states that with these bones were some skin and hair. We may suppose that there was some mistake about this.

Unfortunately, as in so many other cases, it is now impossible to determine just where these remains were found. New Harmony is situated on the border of the Illinoian drift, and this continues nearly 10 miles farther south. This drift is covered by loess. A well sunk here would, at a depth of 60 feet, be in probably Iowan loess. Nearer the river, in the low-lands, the depth given would probably be in Wisconsin outwash.

2. *Dubois County.*—Some details regarding the specimen found here are given in the author's paper on the "Pleistocene of Indiana" (36th Ann. Rep. Geol. Surv. Indiana, p. 702). A part of a mastodon was found long ago near the mouth of Wolf Creek, at the Rock House Ford of White River. This appears to be in Harrison Township (1 north, range 4 west). The valley of White River is here occupied by alluvial terraces older than the Wisconsin drift (Leverett, Monogr. XXXVII, U. S. Geol. Surv., plate VI). There is here too, no doubt, much outwash from the Wisconsin glacier itself.

The writer has received a photograph of a mastodon tooth which Mr. Marshall Roberts, of Jasper, Indiana, found in 1912 in East White River, in the northwest part of Harrison Township. The tooth is 195 mm. long and 87 mm. wide and has four crests and a large talon.

In Samuel L. Mitchill's "Observations on the Geology of North America," page 363, it is stated that a part of a mastodon had been found, in July 1817, "near the falls of the east branch" of White River. No exact conclusion can be drawn from the facts known.

3. *Hindostan, Martin County.*—Mastodon remains (36th Rep. Geol. Surv. Indiana, p. 707) have been found at Hindostan, on the east bank of White River, about 4.5 miles directly southwest of Shoals. A mastodon tooth was found in White River at Shoals (op. cit., p. 709). It appears to be impossible to determine the age of this material.

4. *Orange County, west of Orleans.*—The writer has given an account (36th Rep. Geol. Surv. Indiana, p. 710) of mastodon remains found here, on the farm of Mr. Marion F. Mathers, apparently near the line between the townships of ranges 1 and 2 west and 3 north, and about 2 miles south of the line between Orange and Lawrence Counties. The remains appear to have been found in a valley and about 4.5 feet below the surface. Being found thus in an unglaciated region, they might have been deposited at any time during the Pleistocene.

5. *Sparksville, Jackson County.*—Some years ago teeth and ribs of a mastodon were found on the bank of White River, at Sparksville. The valley here is filled with outwash from the Wisconsin drift, but there is possibly some outwash from the Illinoian.

6. *Jackson County, 7 miles west of Tampico.*—(See 36th Ann. Rep. State Geologist of Indiana, vol. xxxvi, p. 706.) A mastodon tooth was reported found on the bank of Judah Creek, a branch of Mill Creek, in section 9, township 4 north, range 4 east, not far from Muscatatuk River. This is at some distance outside of the border of the Illinoian drift. Along Mill Creek are alluvial deposits, but nearby is Chestnut ridge of probably Wisconsin age (32d Ann. Rep. Geol. Surv. Indiana, p. 192).

7. *New Albany, Floyd County.*—In the Fifth Annual Report of the Geological Survey of Indiana, page 176, Mr. William W. Borden stated that mastodon remains had been frequently found on the bank of the Ohio River, at New Albany. As too often, there are lacking details as to localities and levels. It is quite probable that there is some outwash at this place from the Illinoian drift, and there is much from the Wisconsin.

Mastodons Found Within Area Covered by Illinoian Drift.

8. *Princeton, Gibson County.*—In 1910, three teeth of a mastodon were found in this village, at a depth of 6 feet, in a sewer which was being constructed in West Chestnut street. This region is covered by Illinoian drift. According to Leverett's map (Monogr. liii, 1914), Princeton is situated on Illinoian ground moraine covered by loess. Dr. E. W. Shaw, of the U. S. Geological Survey, who is familiar with the region in question, informs the writer that these teeth were almost certainly found in Iowan loess, deposited at some time between the Illinoian and the Wisconsin glacial stages.

52. *Vincennes, Knox County.*—At the State University of Colorado, at Boulder, there is an atlas of a mastodon which was taken there by Professor M. M. Ellis, formerly of Vincennes, who stated that this, with other bones, had been found at Vincennes, associated with a skull of a fossil bison.

9. *Knox or Gibson County.*—In Blainville's "Ostéographie des Mammifères," page 340, it was stated that the lower jaw of a mastodon had been found at some place between Vincennes and New Harmony. The locality would be in either Knox or Gibson County. The valley of the Wabash in all this region is filled with outwash from the Wisconsin glacier, and most probably the animal represented lived during the Wisconsin stage; but our lack of knowledge of the conditions in which the jaw was found forbids any assumption of certainty in our conclusion.

10. *Parke County.*—In the Forty-first Annual Report of the State Museum of New York it is reported that there was received, about 1888, the tooth of a mastodon, found in this county, at the junction of Raccoon and Little Raccoon Creeks. These creeks unite on section 23 of township 14 north, range 8 west. The political name of the township is Florida. The region is covered by Illinoian drift; hence the tooth is quite certainly more recent than that epoch. The valleys of the creeks named are occupied by outwash from Wisconsin drift, and probably the teeth found lodgment there during the Wisconsin stage.

11. *Brookville, Franklin County.*—The writer has given an account of the remains of mastodons found near Brookville (36th Ann. Rep. Geol. Surv. Indiana, 1912, p. 704). The information is derived from a report by Dr. Rufus Haymond, made in the First Annual Report, 1869, page 199. Two of these were found 8 or 9 feet below the surface, in the gravel of the upper terrace, along Whitewater River. One was discovered about half a mile below Brookville, the other about 3.5 miles below the village. According to Mr. A. E. Taylor's account of this region (34th Ann. Rep. Geol. Surv. Indiana), the terrace in which the mastodon bones were buried is 100 feet above the present bed of Whitewater River. As Haymond speaks of skeletons being found at these localities, it is probable that something more than isolated teeth or bones were buried there. If so, the bones were in their original place of interment, and since that interment the terrace was built up higher by about 8 feet. According to Leverett (Monogr. LIII, p. 118), these terraces were made from the outwash of the Wisconsin glacier while it was forming the moraines which cross Wayne and the southern part of Randolph Counties. If this is true, these mastodons lived shortly after the culmination of the Wisconsin stage. This interpretation would imply that mastodons could live in very close proximity to the glacial front. However, not too much importance must be attached to this case, for it is possible that the animals were not correctly identified.

According to Haymond, another skeleton was found about 3.5 miles northeast of Brookville, in a piece of marshy ground which the owner was ditching. This discovery must have been made either on the outer (Hartwell) moraine of the Wisconsin glacier or along East Honnas Creek, where it breaks through the moraine. In either case, the animal must have been buried there after the retirement of the ice from that moraine.

12. *Dearborn County.*—In 1872 (3d and 4th Ann. Rep. Geol. Surv. Indiana, p. 402), Professor R. B. Warder mentioned briefly that some remains of mastodon had been met with in this county. A part of a large pelvis was found at a salt spring on Tanner's Creek, below Guilford. This may have belonged to either a mastodon or an elephant. A mastodon's tooth is said to have been found on high ground on George Randall's farm, 5 miles west of southwest of Aurora, lying on a stratum of blue clay 8 or 9 feet below the surface. This region is occupied by Illinoian drift and the mastodon probably lived there at some time after the Illinoian stage and before the Wisconsin. However, we can not be certain that the animal was not a mammoth, for no description was given of the tooth and it has almost certainly been destroyed.

According to L. C. Ward's report on the soils of Dearborn County (32d Ann. Rep. Geol. Surv. Indiana, p. 232), this immediate region is occupied by what he calls limestone upland soil, which has resulted from the decay of Silurian limestones and shales. Nothing is said about Illinoian drift there. Nevertheless, by some means, this proboscidean was buried there during the Pleistocene period.

Warder mentioned other remains of proboscideans reported from Ohio County, adjoining Dearborn on the south, a piece of a tusk found near Patriot, a tusk on Laughery Creek above Hartford, and a tooth at Rising Sun, in the river bank; but these may have belonged to elephants. To an elephant may have belonged the tusks which Warder reported as having been found in the river bottom 5 miles below Vevay, in Switzerland County.

54. *Lawrenceburg, Dearborn County.*—Mr. M. G. Mock, of Houston, Texas, formerly of Muncie, Indiana, a careful collector of mastodon and elephant teeth, in a letter informed the writer that in August 1887 a large mastodon tooth was found near Lawrenceburg, but the exact locality was not given.

20. *Charleston, Clark County.*—In the Fifth Annual Report of the Geological Survey of Indiana, 1874, page 176, Mr. William W. Borden reported the discovery of a skeleton of a mastodon on tract 55 of the "Illinois Grant," about 2 miles southwest of Charleston Landing and about the same distance from the Ohio River. A part of the bones was sent to the old Louisville Museum; the others were, in 1874, in the possession of Mr. J. Coons, one of the finders. Probably the bones have long been lost or destroyed. According to Borden, they were found in a sand-bank. This region is occupied by Illinoian drift.

According to R. W. Ellis's soil survey of this region (32d Ann. Rep. Geol. Surv. Indiana, p. 245, map), this area is occupied by what is called New Washington clay loam. This is regarded as the residual soil of the disintegrated limestone of the Jeffersonville and Niagara formations. Nothing is said about any glacial drift here, but the sand of the sand-pit mentioned must have been deposited during the Pleistocene.

Mastodons Found Between the Shelbyville and the Bloomington Moraines.

13. *Greencastle, Putnam County.*—The State collection at Indianapolis contains a last molar of a mastodon found somewhere near Greencastle.

It is not known whether it was found on Wisconsin drift or on Illinoian, or in Wisconsin outwash along Eel River.

50. *Greensburg, Decatur County.*—From Dr. W. D. Matthew, American Museum Natural History, New York City, the writer has received information, accompanied by drawings, that teeth and part of the jaw of a mastodon were found near Greensburg, by Mr. Roscoe Humphrey. The drawings show two teeth, one having a length of 102 mm., the other of 135 mm. Mr. Humphrey states that the jaw and the teeth were found in a branch of Sand Creek, about 4.5 miles southeast of Greensburg. This is evidently on the Shelbyville moraine.

14. *Danville, Hendricks County.*—The collection of the State Museum at Indianapolis contains a lower second true molar labeled as having been found near Danville. The specimen is credited to Dr. Vinnage. As this region is covered by Wisconsin drift, it is probable that the animal lived after the Wisconsin ice had retired.

15. *Attica, Fountain County.*—Mr. J. E. Walker, of Attica, Indiana, has informed the writer that about October 1, 1895, a mastodon jaw was found near Newtown, in that county. Mr. Charles B. McKinney, of Newtown, wrote that the jaw was discovered in the bank of Coal Creek, about 4 rods from where the creek crosses into Montgomery County, in the northeast quarter of section 9, township 20 north, range 6 west. The bank rose 3 feet above the bed of the creek and was composed of a black loam; higher ground is found about 20 rods away. This jaw must have been buried originally where it was found or near-by and after the ice which formed the Champaign moraine had withdrawn further north. It may have been long after this withdrawal. The description of the jaw and teeth leaves no doubt as to the correct identification of the animal.

Former State Geologist John Collett, in 1880 (2nd Rep. Bur. Stat. Geol. Indiana, p. 386), stated that in digging a canal a few miles north of Covington a skeleton of a mastodon had been found embedded in wet peat. Collett reported that the bones yet contained their marrow. The identity of the species and the details as to location and depths are not given. Doubtless the age of the animal was Late Wisconsin.

Mastodons Found North of the Bloomington Morainic System and South of the Wabash River and the Mississinawa Moraine.

The whole region is occupied by deposits from the Wisconsin glacial sheet.

16. *Bowers, Montgomery County.*—Professor Donaldson Bodine of Wabash College, has informed the writer that about 1885 some remains of a mastodon were unearthed on the farm of Milton N. Waugh, near Bowers. The exact locality is said to be in section 12, township 20 north, range 3 west. This must be close to a stream named on the map Potato Creek. This lies north of the Bloomington morainic system or on its northern edge. The epoch of the animal is not earlier than Wisconsin.

According to Jones and Orahood's soil survey of this county (37th Ann. Rep. Geol. Surv. Indiana, p. 149), the glacial drift is almost everywhere overlain by loess, varying in thickness from a few inches to nearly 3 feet. This loess was deposited after the ice had retired from that region.

17. *Indianapolis, Marion County.*—In the State Museum at Indianapolis there is a lower right last molar labeled as having been found in Indian-

apolis, at Pennsylvania and Thirtieth streets, by workmen who were digging a sewer. This was probably in outwash materials brought down by Fall Creek from the northeast during the withdrawal of the Wisconsin ice from the Bloomington moraine to the one which passes through Union City and Muncie, called the Union City moraine.

18. *Anderson, Madison County.*—In the Indianapolis Star of July 30, 1911, is an account of the finding of jawbones, with teeth, of a mastodon. The account was accompanied by reproductions of photographs, which make the identification certain. The remains were found on the farm of Louis Webb, but the exact location was not indicated. The animal certainly lived after the culmination of the Wisconsin stage.

Leverett (Monogr. U. S. Geol. Surv. LIII, p. 99) states that in parts of central Indiana the Wisconsin drift may be relatively thin, as little as from 15 to 20 feet. In western Tipton and southern Clinton Counties a buried soil about 20 feet below the surface seems to represent the land surface previous to the Wisconsin invasion. In southern Madison County a black mucky soil, carrying pieces of wood large enough to be called logs, underlies the till at from 15 to 40 feet. Such a soil would be the product of the interval between the Illinoian glacial stage and the Wisconsin, probably either Sangamon or Peorian. In such deposits there might be found vertebrate remains, possibly even of horses.

19. *Fairmount Township, Grant County.*—In 1883, A. J. Phinney, M. D., in describing the geology of Grant County (13th Ann. Rep. Geol. Surv. Indiana, p. 143), reported that some years previously the tooth of a mastodon was found in one of the marshes south of the lake in Fairmount Township, number 23 north, range 8 east. In another part of the report it is stated that the lake was in section 14. It covered at the time of writing about 10 acres, but had formerly covered about 30 acres. The drainage is now north into the Mississinawa River; but, before the Wisconsin ice had withdrawn to where the Mississinawa moraine now is, the drainage was toward the south into White River. At some time after the retirement of the ice from this region it became occupied by mastodons, elephants, giant beavers, and doubtless many other species of animals.

For 20 see page 91.

21. *Muncie, Delaware County.*—A. J. Phinney, in 1882 (11th Ann. Rep. Geol. Surv. Indiana, p. 131), reported that a mastodon tooth was found 4.5 miles west of Muncie, on the farm of Edward McKinley. No details as to depth or kind of soil were given. The tooth is said to have measured 4 by 5.5 inches, with a depth of 7 inches. Unless the roots were present and large it seems not unlikely that the tooth was that of an elephant. Phinney did not say that he saw the tooth. He reported other supposed mastodon remains which had been found in this county, but there is no assurance that they were correctly identified. Whatever proboscideans they were, they lived after the Wisconsin ice had retreated from that region.

Mr. M. G. Mock, of Houston, Texas, formerly of Muncie, Indiana, has been interested in making collections of fossils and curiosities. He has kept a note-book of his finds and has illustrated it with sketches. He has a lower right last mastodon molar which was found near Muncie. It is 8.5 inches long, and has 4 crests and 5 roots.

He reports having seen a mastodon tooth with 3 crests, which was found June 1887, about 1.75 miles east of Muncie, at the mouth of Hog Creek.

Two teeth, of which Mr. Mock still owns one, were found August 8, 1894, 2.5 miles south of Muncie, in a ditch near Buck Creek, on the farm owned by Oliver McConnell.

53. *Royerton, Delaware County.*—Mr. M. G. Mock, above referred to, showed the writer a drawing of a mastodon tooth which was found May 24, 1890, near Royerton, 6 miles north of Muncie. With this were two other teeth; one 7 inches long and weighed nearly 4 pounds. These were discovered in excavating tile clay at a depth of about 3.5 feet.

22. *Henry County.*—In the collection of Princeton University are two lower true molars, apparently the first of each side. The length of each is 95 mm. They are labeled as having come from Henry County, Indiana, but there is nothing to indicate from what part of the county.

23. *Losantville, Randolph County.*—Losantville is, according to Leverett (Monogr. U. S. Geol. Surv. LIII, plate VI), on the Bloomington moraine of the Wisconsin. As indicated on the map, the drift is covered with silt formed in local ice-border pools. Hence the mastodon in question left his bones in a depression on the top of the Wisconsin drift sheet, and later they were covered by a deposit of peat.

In Nautilus, volume IV, page 131, Elwood Pleas, of Dunreith, Indiana, gave a list of six species of mollusks found associated with the mastodon. All are yet living.

Dr. A. J. Phinney (Twelfth Ann. Rep. Ind. Geol. Surv., p. 181) stated that mastodon bones had been met in this county, but no details were furnished.

24. *Dalton, Wayne County.*—In the Earlham College collection there is a lower jaw found in Nettle Creek, near Dalton. It contains the last two molars. The last one has five crests and a talon. The front of the symphysis is rough, but there are no alveoles for tusks. Dalton is in the northwestern corner of the county and on the southern border of the Shelbyville moraine, where this joins the Bloomington moraine.

25. *Jacksonburg, Wayne County.*—Dr. John T. Plummer (Amer. Jour. Sci., ser. I, vol. XLIV, 1843, p. 302) stated that he had obtained near Jacksonburg, 18 miles west of Richmond, a tooth. It had four cross-ridges and was so well preserved that a dentist attempted to make artificial human teeth from it. According to Leverett's map, the tooth was probably on the surface of Wisconsin drift. It could not, therefore, have lived until after the Shelbyville moraine had been cleared of ice.

26. *Richmond, Wayne County.*—In the twelfth volume of the American Geologist, page 73, Professor Joseph Moore, then of Earlham College, stated that some sound teeth and decayed bones of a mastodon had been found 2 miles east of Richmond, in scooping out a fish-pond. A label on a lower last molar states that the remains were found on the Floyd farm. With them were found a fragment of an incisor of *Castoroides*. According to Leverett (Monogr. LIII, plate VI), the locality would be outside of the Bloomington moraine of the Wisconsin drift.

MASTODONS FOUND WITHIN THE MISSISSINAWA MORAINE.

27. *Penn Township, Jay County.*—Mr. David McCaslin (12th Ann. Rep. Geol. Surv. Indiana, p. 169) stated that various remains of mastodon had been found in Jay County. He mentioned in particular fragments found in Penn Township (township 24 north, range 8 east) and which seemed to indicate the presence of an entire skeleton. It is, however, possible that this skeleton was that of an elephant. The Salamonie moraine passes diagonally through this township.

28. *Fort Wayne, Allen County.*—Richard Lydekker (Foss. Mamm. Brit. Mus., pt. IV, p. 17) stated that there is in the British Museum of Natural History a cast of the left half of the brain of an immature specimen of mastodon which had been found at Fort Wayne. The cast had been sent to that museum by the Chicago Academy of Science.

Professor C. R. Dryer (16th Ann. Rep. Geol. Surv. Indiana, p. 129) reported five skeletons of mastodons found in Allen County. No particulars were given. A note from Professor Dryer to the present writer states that he had been unable to obtain additional information. It is not unlikely that some of these remains belonged to elephants, but doubtless some were those of mastodons. It is to be regretted that so little of value is secured from such discoveries.

29. *DeKalb County, 5 miles west of Waterloo.*—In the Carnegie Museum at Pittsburgh there is a quite complete skeleton of a mastodon which was found in 1897, in a peat-bog about 5 miles west of Waterloo. Dr. W. J. Holland gave a brief account of this skeleton in 1905 (Ann. Carnegie Mus., vol. III, p. 464). The exact location of the place has not been ascertained by the writer. According to Leverett's map (Monograph LIII, U. S. Geological Survey) this mastodon was buried on the eastern border of the Salamonie moraine, and it could not have lived there until well along in the latter part of the Wisconsin stage.

55. *DeKalb County, 5 miles northeast of Waterloo.*—Dr. W. J. Holand (Popular Science, New York, vol. XXXIII, 1899, p. 233) described the finding and disinterment of three mastodons and had a figure of one skeleton. One of the nearly complete skeletons was found resting on "hard-pan," partly embedded in a thin layer of shell marl and muck under the peat, at points not more than 3 feet below the surface.

56. *Noble County.*—Under this number may be mentioned the following discovery of mastodon remains: In the American Naturalist, volume II, 1868, page 56, was reported a communication made to the Chicago Academy of Science by Dr. Meyers, of Fort Wayne. He announced that he and Dr. Stimpson, of Chicago, had unearthed the skeletons of three mastodons somewhere in Noble County, in a basin-shaped depression in the middle of a corn-field, formerly a willow swamp. One of the animals was a young one. Some of the bones had been found by Mr. Thrush, in digging a ditch through his land.

The skeletons lay at a depth of 4 or 5 feet, in a stratum of peat which overlay blue clay containing lacustrine shells. In the peat were found fragments of boughs and branches of several kinds of wood in a good state of preservation, and some fragments had been gnawed by beavers.

30. *Ashley, Steuben County.*—The American Museum of Natural History, New York, contains the fine skull of a mastodon, found in Steuben Township not far from Ashley. The finder of the skull, Mr. Walter F. Deller, of Ashley, informed the writer that it was discovered in a swamp which was being drained, about 5 feet from the surface. He states that the bones lay in a marl, itself overlain by muck, and on top of all some soil which had been washed in. So far as can be determined, the animal was buried between the Mississinawa and the Salamonie moraines. With the skull were found other parts of the skeleton, which shows that the remains were in their original place of burial.

Mastodons Found Outside of Mississinawa Moraine and Between Wabash and Kankakee Rivers.

31. *Beaver Lake, Newton County.*—In 1870 (Geol. Surv. Illinois, vol. IV, p. 229), Frank H. Bradley reported that in draining Beaver Lake, in Newton County, mastodon remains had been found, in company with *Boötherium*. No details were furnished, and it is not known what was done with the specimens. It is probable that the musk-ox belonged to the species *Symbos cavifrons*. It occurs over the country much more abundantly than any other musk-ox.

Beaver Lake has disappeared from the maps, but it is shown on the geological map of Indiana, published in the Eighteenth Annual Report of the Geological Survey of Indiana. The lake occupied a part of the present township of McClellan (township 30 north, range 9 west). Doubtless this lake existed ever since the retirement of the ice from that region. The mastodon was probably found in making the ditch from the lake in a northwesterly direction into the Kankakee River.

32. *Jasper County.*—John Collett, at that time State geologist, reported in 1882 (12th Ann. Rep. Geol. Surv. Indiana, p. 73) that remains of a mastodon had been found in this county, but no particulars were furnished. He stated that remains of this species, as well as those of the mammoth, were buried in deposits of peat. A portion of the county is occupied by the Marseilles morainic system, the remainder by the Kankakee marsh, perhaps largely a lake during the latter part of the Wisconsin stage. On the maps the number 32 is placed arbitrarily.

33. *Denham, Pulaski County.*—In 1915 the U. S. National Museum secured a large part of the skeleton of a mastodon found about 2 miles west of Denham. The locality is described to the writer by Mr. W. D. Pattison, of Winamac, as being on the half-section line between the southeast quarter of the northwest quarter and the northeast quarter of the southwest quarter of section 9, township 31 north, range 3 west. This would be not far west from the center of the section. The skeleton was thrown out by the shovel of the ditching machine, but most of the bones, including the skull, were obtained in quite good condition. They were found at a depth of about 9 feet, in a marly deposit, itself overlain by sandy materials.

On consulting Leverett's glacial map of Indiana it is seen that this skeleton was found in a marshy tract, in which Monon River rises. It is represented by Leverett as a ground moraine plain, surrounded by plains

covered by sand and displaying sand dunes. It forms a part of what has been called Kankakee Lake, but which, as Leverett says, may have been in late Pleistocene times not greatly unlike what it has been within Recent times. It must have been well along in the afternoon of the Wisconsin stage when this mastodon tempted the insecure footing of these swamps.

This skeleton has been mounted and is now on exhibition at the U. S. National Museum.

34. *Rich Grove Township, Pulaski County.*—Mr. J. W. Gidley, of the National Museum, and Mr. F. M. Williams, of Winamac, Indiana, in 1915, saw some mastodon bones which had been found here. No details have been reported.

49. *Indian Creek Township, Pulaski County.*—From Dr. E. S. Riggs, of Field Museum of Natural History, it has been learned that in June 1914, about half of the skeleton of a mastodon was found on the farm of Mr. William Battie, 5 miles west of Oak, Pulaski County. This would be in township 29 north, range 2 west. The skeleton was encountered by ditchers at a depth of 3 feet, in black loam. It was not secured for the Field Museum of Natural History.

35. *Royal Center, Cass County.*—Mr. Gidley and Mr. Williams, as mentioned under No. 34, saw also some mastodon remains which were from about 2 miles west of Royal Center.

48. *Fulton, Fulton County.*—The American Museum of Natural History, New York, contains several mastodon bones secured by Mr. Barnum Brown in 1915, but which had been found by Mr. Arthur Fry, in July 1913. These remains were met with in excavating for abutments for a bridge and had been thrown out of a drainage ditch. The bones were disassociated and scattered over a considerable area. They were all in black muck overlying compact quicksand and about 4 feet below the black loam surface-soil. From Mr. Fry it is learned that the locality is 2 miles southeast of Fulton. This is in township 29 north, range 2 east, and quite certainly in section 36. Mr. Fry wrote that in digging up these bones logs were found that had been gnawed by beavers.

Dr. W. D. Matthew informs the writer that on cleaning up the materials there proved to be present at least four individuals. One was represented by a very complete skull with portions of the tusks. There was another skull; also two lower jaws which appeared not to belong to either of the skulls. From the shortness and the diameter of the tusks it is believed that all the individuals were females. Besides the skulls there were many bones belonging to the trunk and the limbs.

36. *Macy, Miami County.*—Near this place was found the fine skeleton of a mastodon which is mounted and on exhibition in the Public Museum at Milwaukee, Wisconsin. A figure of this has been published by the writer (36th Ann. Rep. Geol. Surv. Indiana, p. 659).

This skeleton was found, according to Mr. H. L. Ward, director of the museum mentioned, in 1907, in the northwest quarter of section 29, township 29, range 4 east, between Macy and Deedsville. This locality is on the great moraine which lies north of Eel River and was produced by the ice fronts of the Michigan, the Saginaw, and the Lake Erie lobes. Accord-

ing to a sketch and some notes furnished to Mr. Ward by Mr. C. F. Fite, who secured the skeleton, it was lying at the lower end of an 8-shaped area of low muck land surrounded by rather high sandy land. The skeleton was buried at a depth of 4 or 5 feet, and the surface was miry and covered with water. Mr. Fite concluded from the position of the bones that the animal had become mired. He says in a letter to the present writer that the contents of the stomach had been preserved, but on exposure to the air became powdery like ashes.

Mr. Fite writes that he took up portions of another mastodon in the southwest quarter of section 26, township 29 north, range 5 east (Perry Township), and that he has the lower jaw and teeth. This animal was found in an old pond which had a growth of buttonwood. The bones were in a blue clay, itself overlain by a rich black soil.

Still another mastodon is reported by Mr. Fite from this region. This was found in the fall of 1915, in the northwest quarter of section 12, township 29 north, range 3 east. The remains were found at a depth of 4 feet and were in a pretty fair state of preservation, except the skull. The animal had been a large one.

37. *Peru, Miami County.*—In the collection of Yale University is a lower left last molar, No. 11689, labeled as having come from Peru, but there is no other information. Peru is on the Wabash River, a few miles south of Denver.

51. *Jackson Township, Miami County.*—Mr. Fite reports having found another mastodon in the southeast quarter of section 11, Jackson Township, Miami County (T. 25 N., R. 5 E.). This would be not far from Pipe Creek, between Somerset and Amboy, and some miles outside of the Mississinawa moraine. The writer has seen these bones, mostly vertebræ, and agrees with the identification.

38. *Laketon, Wabash County.*—Elrod and Benedict state (17th Ann. Rep. Geol. Surv. Indiana, p. 240) that in 1872 a nearly complete skeleton of a mastodon was found about 2 miles west of this place, in digging a ditch at the roadside. The exact location is in section 8, township 29 north, range 6 east, near the bank of Silver Creek. The political name of the township is Pleasant. This would be on the southern border of the great moraine already mentioned as running northeastward and southwestward, north of Eel River. After some litigation the skeleton was put on exhibition at Fort Wayne.

In throwing up an embankment for a bridge across Silver Creek, workmen found in the same township, as reported by Elrod and Benedict, bones of *Elephas primigenius*. They were under 5 feet of muck.

39. *North Manchester, Wabash County.*—Elrod and Benedict, as cited above, reported that a jawbone with two teeth in it had been found on the northwest quarter of the northeast quarter of section 1, township 29, range 7 east. This is about 3 miles east of North Manchester. The description given of these teeth shows that the jaw was that of a mastodon. It was found beneath 2.5 feet of solid blue clay. According to Leverett's map, the locality is not far west of the outer border of the Mississinawa moraine.

40. *Lagrange, Lagrange County.*—Professor Donaldson Bodine, now deceased, formerly of Wabash College, Crawfordsville, Indiana, informed the writer that there are in Wabash College some teeth and other parts of a mastodon, which were found in 1910 in some dredging operations near Lagrange.

H. Pohlig (Bull. Soc. Belge Géol., etc., vol. xxvi, 1912, p. 187) described a lower jaw, found somewhere about Lagrange, which he referred to *Tetracaulodon ohioticum*. It contained a small tusk 230 mm. long and 40 mm. in diameter. There was present also an alveolus for the other tusk. He accepts the genus *Tetracaulodon* for mastodons "a quatre défenses permanentes sans émail représenté par le *Mastodon ohioticum*." Individuals without lower tusks are regarded by him as females.

In Ward's Natural Science Establishment, Rochester, New York, there is, or was, a lower jaw of a mastodon from Lagrange County.

The writer has received a photograph showing the right fore-leg, two ribs, two tusks, and a lower jaw of a mastodon found in 1884, in a swamp, 4 miles northwest of Lagrange. The remains were embedded in a clayey marl deposit, at a depth of from 4 to 10 feet. They are said to have been exhumed by Dr. H. M. Betts. The hindermost lower molar shows five crests and a heel. On the right side is a small lower tusk.

Lagrange is situated at the junction of moraines formed by the Saginaw and the Huron-Erie lobes of the Wisconsin glacier. From this the Lagrange moraine runs off northwestward (Leverett, Monogr. U. S. Geol. Surv., liii, p. 143). Parts of the county are occupied by till plains and others by sand and gravel plains and channels of glacial drainage. At the time these mastodons lived in Steuben and Lagrange Counties, the Wisconsin ice must have retired quite beyond the limits of the State.

Mastodons Found North of Kankakee River.

41. *Lowell, Lake County.*—Mr. M. W. Ponto, Lowell, Indiana, has sent to the U. S. National Museum a photograph of a lower right hinder molar (apparently not yet having come into use) of a mastodon. This was found at a depth of 2 feet 9 inches in a trench for a tile drain. The locality is in the southwest quarter of the northeast quarter of section 36, township 33 north, range 9 west. This is on the southern border of what Leverett (Monogr. liii, p. 175) regards as possibly the westward continuation of the Kalamazoo morainic system of the Lake Michigan glacial lobe.

42 to 44. *Porter County.*—In 1898 (22d Rep. Geol. Surv. Ind.), Professor W. S. Blatchley reported mastodons from various localities in this county; he probably did not see these remains, and the identifications must be regarded as somewhat doubtful. Nevertheless it is more probable that the bones and teeth belonged to the mastodon than to any of the elephants. The latter, however, have been found in this same county. It is rather remarkable that so little definite knowledge has been preserved regarding the proboscideans found in this corner of Indiana.

42. *Hebron, Porter County.*—One of the localities just mentioned is in section 25, township 33 north, range 7 west, about 3 miles southeast of

Hebron. No other information has been obtained about this specimen. Other remains are said to have been found in a marsh, by the side of Cobb's Creek, just east of Hebron.

43. *Kouts, Porter County.*—Another find of mastodon remains, as reported by Professor Blatchley, was near Sandyhook, northwest of Kouts. Mr. C. H. Wolbrandt, of Kouts, has informed the writer that a tooth, probably that referred to by Professor Blatchley, was found some years ago in a ditch being made in the Sandyhook marsh. The tooth was found in a mucky soil at a depth of about 2 feet.

The remains which were found east of Hebron and the tooth found near Kouts were buried near the northern border of the Kankakee marsh, which probably was, since the passing of the Wisconsin ice, no less a marsh than within historical times, and perhaps during some of the time a lake.

44. *Valparaiso, Porter County.*—Professor Blatchley, as quoted above, reported that some remains of a mastodon were found about 2 miles southwest of Valparaiso. The locality is in the southwest quarter of section 27, township 35 north, range 6 west. This would be on the Valparaiso moraine.

45. *Valparaiso, Porter County.*—The writer has learned from Mr. Jacob Davis, of Hebron, that in dredging at a point about 5 miles southeast of Valparaiso he met with a skeleton of a mastodon and secured a large number of bones at a depth of 8 feet; but some of them were carried off by curiosity hunters. It is depressing to think that such remains should be preserved for thousands of years only to be put to such trivial uses. This locality would be in the Kankakee marshes.

46. *Olive Township, St. Joseph County.*—In the museum at Notre Dame University are considerable remains of a mastodon, found about 1902 in Olive Township, about 12 miles west or southwest of Notre Dame. Professor Kirsch has sent a photograph of a tooth of *Elephas primigenius* which was found in Olive Township. Apparently the mastodon and the elephant were living together late in the Wisconsin stage.

47. *Notre Dame, St. Joseph County.*—From Rev. A. M. Kirsch the writer learns that remains of two mastodons have been found in the region about Notre Dame, within a few feet of the surface. All these localities are within the area of Kankakee marsh. These specimens are now in the fine collection of that university.

For 48, 49 see page 97; for 50 see page 92; for 51 see page 98; for 52 see page 90; for 53 see page 94; for 54 see page 91; for 55 and 56 see page 95.

ILLINOIS.

(Maps 5, 38.)

Outside of Area of Illinoian Drift.

1. *Shawneetown, Gallatin County.*—In 1875 (vol. VI, Geol. Surv. Illinois, p. 214), Professor E. T. Cox reported that teeth of a mastodon had been found the preceding summer close to the water's edge in front of Shawneetown. They were embedded in a shallow deposit of bluish clay which rested upon yellow clay and gravel. Michael Robinson, of Shawneetown, states

in a letter that he has in his cabinet teeth of mastodon and mammoth, found about that town. The bluffs bordering the Ohio River at Shawneetown were regarded by Leverett (Monogr. U. S. Geol. Surv., xxxviii, plate vi) as of Wisconsin age, consisting of outwash from the ice-sheet lying farther north.

A. H. Worthen (vol. vi, Geol. Surv. Illinois, p. 39) stated that a fine tooth of a mastodon, found in Gallatin County, had been presented to the State cabinet, but no exact history of it was known.

2. *Chester, Randolph County.*—A note in the Kansas City Review of Science and Industry, volume vii, 1883, page 351, taken apparently from a newspaper at Chester, states that a mastodon's tusk and skull had been discovered in Chester. It was expected that Professor A. H. Worthen, State geologist of Illinois at that time, would arrive and conduct the exhumation. Later (Geol. Surv. Illinois, vol. viii, p. 8) Worthen stated that a mastodon had been found at Chester; but no details were added. With so little knowledge as to exact locality and the surroundings the discovery is of little value.

Within Area Covered by Illinoian Drift.

3. *Beaucoup, Washington County.*—In 1857, the geologist J. W. Foster reported (Proc. Amer. Assoc. Adv. Science, vol. x, Nat. Hist., p. 163) that remains of a mastodon had been discovered by workmen in making an excavation along the Illinois Central Railroad, near the town of Beaucoup. The bones were at a depth of 18 feet in the prairie drift, below the yellow clay and in the older or reddish clay. No details were given as to what bones were found or what was done with them.

Most of this county is covered by Illinoian drift. Leverett (Monogr. U. S. Geol. Surv., xxxviii, p. 770) states that on the higher lands this has a depth of from 10 to 20 feet. One might suppose that at a depth of 18 feet some pre-Illinoian interglacial deposit had been encountered. It is not at all probable that the bones of the mastodon were inclosed in the drift itself.

4. *East St. Louis, St. Clair County.*—Dr. F. V. Hayden (Proc. Acad. Nat. Sci. Phila., 1866, p. 316) announced the finding of a tooth of a mastodon in the bluffs opposite St. Louis. This was probably in St. Clair County.

In the American Museum of Natural History, New York, is a lower right last molar of a mastodon, labeled as having been found in St. Clair County, but there is no other information.

In the collection of the St. Louis Academy of Science there are two teeth of a mastodon, right and left last upper molars, which had been brought in by a boy and presented to the Academy. He said that they had been found in East St. Louis and had been in the possession of the family for some time. The length of the left molar is 175 mm., the width 102 mm. While the valley of the Mississippi River is here filled by deposits laid down during the Wisconsin stage (Leverett, op cit., plate vi) and by later-formed alluvium, Illinoian drift enters into the bluffs, and perhaps pre-Illinoian interglacial soils. It is, therefore, of interest that there should be an exact record made of the place of discovery of every bone and tooth found, the

character of the deposit, and the depth of burial. In all the cases here recorded no such records have been kept.

5. *Alton, Madison County.*—In 1866 (Geol. Surv. Illinois, vol. I, p. 315; 1871, Amer. Naturalist, vol. v, p. 607), A. H. Worthen reported that a part of a jawbone of a mastodon, with two teeth in it, had been found in the lower part of the loess, 30 feet below the surface, at some point just above Alton. The jaw was separated from the limestone by 2 or 3 feet of local drift. The bone was of a chalky whiteness and in a fine state of preservation. Worthen wrote that the loess on the bluffs in this region is from 40 to 80 feet in thickness, but appears in places to have been removed by erosion, so that it comes down to the rock.

Reference is made by Worthen later (Geol. Surv. Illinois, vol. VIII, p. 8) to the discoveries of vertebrate fossils in the drift and loess of this region. He mentions that Hon. William McAdams found, at Alton and Chester, remains of mastodon, mammoth, megalonyx, castoroides, and *"Bos primigenius."* McAdams's collection is now in the U. S. National Museum and a list of the species is presented on page 339. These species were described by the writer in 1920 (Proc. U. S. Nat. Mus., vol LVIII, pp. 109–117). In it are only two fragments of molars of this species.

In the collection at Yale University (No. 11713) is an upper left last molar of a mastodon, obtained from Mr. McAdams. The enamel is very white. There is on the label the date "Feb. 21, 1888." This may be one of the teeth referred to above, and the date may refer to the date of purchase.

6. *Sandoval, Marion County.*—Before the American Association for the Advancement of Science, at its meeting in 1856 (Proc. Amer. Assoc. Adv. Sci., vol. x, 1857, p. 163), the geologist J. W. Foster stated that at Sandoval, on the Illinois Central Railroad, mastodon remains had been found at a depth of 12 feet, under conditions similar to those existing near Beaucoup, in Washington County. Here again there is a poverty of information. In this county there is, in many places, a very compact white clay overlying the Illinoian drift. The relations of this to the drift are not well understood. At a depth of 12 feet in this clay the Illinoian drift might not be reached in some places, while at this depth in the drift a pre-Illinoian deposit might be encountered.

7. *Near Niantic, Macon County.*—In 1873 (Geol. Surv. Illinois, vol. v, p. 308), A. H. Worthen gave an account of finding some remains of a mastodon in this county, near the line between it and Sangamon County and between Illiopolis and Niantic, on a farm then owned by Mr. William F. Correll. The American Journal of Science, volume 50, page 422, in a note regarding the discovery, states that the place is 1.5 miles southeast of Illiopolis. A well was being sunk in a low, spongy piece of ground, which had evidently been a pond filled up by wash from the surrounding higher ground. At a depth of 4 feet two tusks were found, one measuring 7 feet in length and about 8 inches in circumference, the lower jaw containing the teeth, the teeth of the upper jaw, and some small bones. Besides these remains of the mastodon, there were found some bones of the buffalo and deer, and two antlers of an elk. The bones of these yet existing species

are said to have been found at the same depth as the mastodon bones, but were of a lighter color and less decayed.

The bones were partly embedded in a light-gray quicksand, filled with small fresh-water shells. Above this was 4 feet of black peaty soil.

In the eighth volume of the Geological Survey of Illinois, on page 23, Worthen wrote that some of the smaller bones of the mastodon and those of the other animals, except the antlers of the elk, were preserved in the State Museum of Natural History, at Springfield.

In the museum of the Chicago Academy of Science are, as reported by the curator, Frank C. Baker, to Netta C. Anderson (Augustana Lib. Pubs. No. 5, p. 14), two rami of the lower jaw and several molars of a mastodon, all well preserved. They are labeled as having been found in Macon County, "6 miles from Abraham Lincoln's first home" and as having been presented by C. F. Günther. With these is an upper tooth which probably belonged with the same lot as the lower jaw. There can hardly be a doubt that this jaw and these teeth are those described by Worthen. The finder had probably sold them to Mr. Günther, of Chicago, who had a private collection.

The region about Niantic is within the area of the Illinoian drift, so that the bones must have been deposited in the pond after the passing away of the Illinoian ice-sheet.

Dr. F. C. Baker (Bull. Univ. Illinois, vol. XVII, p. 300), in speaking of this case, says that the deposit rests on Illinoian drift and hence it appears referable to the Sangamon interval. It seems to the present writer that these animals belong to a later time, possibly the Late Wisconsin. The locality is about 5 miles from Sangamon River. One might suppose that time enough had elapsed after the Illinoian for the drainage of the pond that must once have been there. Also, Worthen in his account states the uplands are covered by loess from 6 to 20 feet in thickness. One might expect that the pond would have been filled up with the loess which had blown into it and which had been washed into it from the surrounding higher land. These considerations are of course not final. The Wisconsin moraine is not far away, and it is possible that outwash from this was responsible for the pond and that the animals lived after the glacier had passed away.

8. *Warsaw, Hancock County.*—In Netta C. Anderson's "Preliminary List of Fossil Mastodon and Mammoth Remains in Illinois and Iowa" (Augustana Lib. Pubs. No. 5) it was reported by Mr. C. K. Worthen, of Warsaw, that a part of a mastodon tooth had been found sticking out of a bank of a creek 5 miles below the town mentioned.

The writer has seen in the collection of the Philadelphia Academy, from near Warsaw, a part of a lower second molar, labeled as having been found at a depth of 10 feet, 3 miles east of the Mississippi River. It was presented by G. W. Hall.

9. *Manito, Mason County.*—In the U. S. National Museum is a large upper right second molar, No. 7801, presented in 1913 by Mr. John Wiedmer, of St. Louis. This was found by his workmen near Manito, in a peat deposit, at a depth of 5 feet, embedded in the top of a layer of sand which

underlies the peat. At about the same depth was found a part of the skull of *Symbos cavifrons*, also presented to the U. S. National Museum. The place of discovery more exactly given is in section 22, township 23, range 6.

This locality is within the area of the Illinoian drift. On the east, a few miles away, is the foot of the great Shelbyville moraine; while very near, toward the west, there are, according to Leverett (op. cit., plate VI) widely spread deposits brought down by the Illinois River from the Wisconsin ice-sheet. The geological conditions here seem to make it probable that both animals lived near the close of the Wisconsin stage. There may, however, have been a considerable interval between the times of the two animals; for peat, sometimes at least, accumulates very slowly. In proof of this may be cited the case of mastodons found near the surface of peat-swamps in Michigan. In the same peat-swamp at Manito were found at depths of 3 or 4 feet some Indian flint implements. These are in the collection of the U. S. National Museum.

10. *Knox County.*—On page 14 of Netta C. Anderson's list, already mentioned, Professor Albert Hurd, curator of the museum of Knox College, Galesburg, reported that there was in the collection a well-preserved tooth of a mastodon found in the bed of Spoon River, which runs across the southeastern part of the county. Exactly where along this stream the tooth was discovered is not on record.

11. *Cambridge, Henry County.*—In Netta C. Anderson's list, on page 12, Professor Frank C. Baker, then curator of the Chicago Academy of Science, reported that there is in the collection a part of a tusk of a mastodon, found at Cambridge, in digging a well, at a depth of 16 feet.

In this case one can not be certain that the tusk did not belong to one of the elephants. From information accompanying the specimen one can determine little about the exact geological age of the animal. It is probably post-Illinoian.

12. *Rural Township, Rock Island County.*—Dr. J. A. Udden (in Netta C. Anderson's list, p. 18) reported that there is in the collection of Augustana College, Rock Island, a well-preserved tooth of a mastodon, found in 1900, in a creek in the township named, in the southeastern corner of the county. Udden gives the locality as being in section 19, township 16 north, range 1 west.

In the same institution (J. A. Udden, Augustana Coll., Pub. No. v, p. 12) is a part of a proboscidean tusk, referred to the mastodon, which Dr. Udden states was found near Milan, at the base of the loess, in the red oxidized layer of the Illinoian boulder clay. The locality is on the north side of Rock River and on the east side of the Milan road south of Rock Island. The conditions would seem to indicate that the animal had lived about the close of the Illinoian drift stage.

About June 15, 1916, Mr. A. Daxon, of Omaha, Nebraska, sent photographs of two mastodon teeth to the U. S. National Museum for identification. These teeth were found in Bowling Township, Rock Island County, 10 or 12 miles south of Rock Island, but no further information about them has been secured.

Professor J. A. Paarmann, curator of the Davenport, Iowa, Academy of Sciences, has written that he had seen a finely preserved mastodon tooth

which had been picked up on the surface of the ground a mile west of Milan. The land around about is swampy. The tooth was in the possession of Edward Herbert, Rock Island, Illinois, but the present writer has not been able to get any information from him.

13. *Sterling, Whiteside County.*—In the U. S. National Museum (No. 4222) is a mastodon molar, recorded as found near the town named. It was transmitted through the U. S. Geological Survey and credited to T. A. Schroder. It is said to have been found with other teeth and parts of the skeleton, so that there is little probability that the skeleton was disturbed after its original interment. It is to be regretted that so little information was allowed to come with the specimen.

Sterling is in a region of very complicated Pleistocene geology. South of it is an extensive region of swamps and deposits referred by Leverett (op. cit., plate VI) to "sand and gravel plains of Wisconsin age." North of the town is drift mapped by Leverett as Iowan, but which is now regarded as Illinoian. As to the age of the tooth in question, no probable conclusion can be formed, except that it is of post-Illinoian time.

27. *Walnut, Bureau County.*—In the American Museum of Natural History, in New York City, there are three molars (No. 10666), belonging to each side of the upper jaw of a mastodon which was found somewhere near Walnut, in Bureau County.

14. *New Milford, Winnebago County.*—According to S. P. Lathrop (Amer. Jour. Sci., vol. XII, 1851, p. 439), a large tooth of a mastodon, in a fine state of preservation, was found in the Kishwaukee River, being brought up in a seine.

The geology about New Milford is not well worked out. The deposits along the Kishwaukee were probably laid down during or shortly after the Wisconsin stage.

15. *Byron, Ogle County.*—In 1873 (Geol. Surv. Illinois, vol. v, p. 110), James Shaw reported that a tooth identified as that of a mastodon had been found, in 1858, in a tributary of Stillman's Run, somewhere in the region about Byron. The locality is low and marshy. The tooth is described as having been a ponderous grinder, weighing 7.5 pounds, and to have been covered with a black and shining enamel. A large mastodon tooth, just out of the water, might attain such a weight. The statement regarding the enamel confirms the identification.

Shaw reported further that a large leg bone, supposed to belong to a mastodon, had been found 2 or 3 miles above Byron, along the bank of Rock River, 5 feet below the surface and about 15 feet above ordinary water-level. It was sent to the State Museum at Springfield. This may have belonged to one of the elephants.

Harper, Ogle County.—In Netta C. Anderson's list, on page 15, is a report from Miss Abba Fager, of Forreston, concerning a tooth of a mastodon found on the farm of Mr. Gross, in Forreston Township, about a mile south of Harper, in the bed of a small stream. Another tooth had been found there a short time before.

Byron is on Rock River, and the tooth was probably in alluvial deposits laid down after the recession of the Wisconsin ice. Harper is near the western border of the county and Illinoian drift covers the country. All

that can be said in the case of the teeth found is that the possessors lived after the Illinoian stage.

16. *Urbana, Champaign County.*—In the collection of the Illinois State University the writer saw a lower right last molar of a mastodon, found June 1, 1911, at Crystal Lake park, 1.5 miles northeast of the university.

Pesotum, Champaign County.—In 1909, Mr. Rufus M. Bagg (Univ. Ill. Bull., vol. VI, No. 17, p. 49) recorded the fact that a mastodon tooth with some bones had been found near Pesotum, on the farm of Mr. Pfeffer, at a depth of 3.5 feet, in digging a ditch.

Inasmuch as this whole region is covered by Wisconsin drift, the animal could not have lived there before the ice which deposited the Champaign moraine had withdrawn. It probably lived there long after the ice had retreated, possibly about the time when the megalonyx, whose claw alone is left as a memorial of his former existence, lived in that region.

17. *Edgar County.*—In 1870 (Geol. Surv. Illinois, vol. IV, p. 266), Frank H. Bradley, in describing the topography of Edgar County, stated that a nearly perfect skeleton of a mastodon had been found in one of the sloughs of the prairie region which prevails in the western part of the county. It was said that after having been exhibited over that region it was sold to some museum in Philadelphia, but the writer has been unable to obtain further information.

In 1857 (Proc. Amer. Assoc. Adv. Science, vol. X, Nat. Hist., p. 10), J. W. Foster reported that a jaw and three teeth of a mastodon had been found in yellow clay, about 3 feet from the surface, at Bloomfield, in this county. This name has disappeared from the maps and gazetteers.

A little of the southern border of the county is occupied by Illinoian drift, but the greater part is covered by drift of Wisconsin age. The mastodons reported probably lived after the retirement of the last ice of the Glacial period.

18. *Fairmount, Vermillion County.*—In 1870, Frank H. Bradley (Geol. Surv. Illinois, vol. IV, p. 242) stated that in September 1868 remains of a mastodon were found 2 miles southeast of Fairmount. He described the locality as having a black soil, from 1 to 2 feet deep, and underlain by a light-brown tenacious clay, filled with the shells of *Lymnea, Physa, Planorbis, Sphœrium,* etc. The bones of the mastodon lay partly in this marly clay, but the tip of one tusk rose to within 13 inches of the surface. The bones were considerably decayed, but Bradley thought this had resulted from the previous draining of the land and the accession of air to the bones. Some fragments of this skeleton are in the collection of the Chicago Academy of Science. The locality is very close to the northern edge of the Champaign moraine.

19. *Iroquois and Vermillion Counties.*—Under this number must be recorded 3 mastodons found at as many different places. Hoopeston is in Vermillion County, but evidently the mastodon credited to this place was found in Iroquois County.

Six miles northwest of Hoopeston.—In 1881 (2d Ann. Rep. Dept. Statist. and Geol. Indiana, p. 18; of complete report, p. 386), John Collett gave an account of the discovery of a nearly complete skeleton of a masto-

don about 6 miles northwest of Hoopeston. The locality is evidently in the southwestern corner of township 24 north, range 11 east. Each tusk formed a full quarter of a circle, was 9 feet long, 22 inches in circumference at the base, and weighed, while yet wet, 175 pounds. The lower jaw was well preserved, nearly 3 feet long, and contained a magnificent set of teeth. The leg-bones, when joined at the knee, made a length of 5.5 feet. What was supposed to be remains of herbs and grasses which the animal had eaten were found between the ribs.

The following mollusks are reported as being found in the same clay as that which contained the bones: *Pisidium abditum?, Valvata tricarinata, Valvata striata?, Planorbis parvus.* It is stated that these shells live at present all over the States of Illinois, Indiana, and Michigan, and indicate that the climate of the mastodon's day was greatly like that of the present in that region.

Dr. John M. Clarke (56th Ann. Rep. New York State Museum, published in 1904, p. 926) states that the tusks of this mastodon are now in the American Museum of Natural History and form a part of a mounted mastodon. The lower jaw is also in that museum. The writer has seen this jaw, No. 14345, and there are in it 2 tusks of considerable size, such as the writer has supposed characterized *Mammut progenium.* In case this species shall prove to be a natural one it continued from the first interglacial or even earlier to the close of the Wisconsin. This is the mastodon to which Blatchley refers (22d Rep. Indiana Geol. Surv., p. 90).

East Lynn, Vermillion County.—The writer has a note to the effect that some mastodon remains were found near this place in 1881, but the authority can not be cited. East Lynn is 7 miles west of Hoopeston.

Rossville.—Dr. Rufus M. Bagg, jr. (Univ. Ill. Bulletin, vol. VI, No. 17, 1909, p. 49, plate IV, figs. 2, 3) reported the finding of a mastodon's tooth near Rossville, on the banks of the North fork of Vermillion River, about 7 miles south of Hoopeston. The figures indicate that the tooth is the lower right first molar, 127 mm. long and 85 mm. wide.

All three of the mastodons mentioned were evidently buried in pond and swamp deposits which lie on or near the Bloomington moraine of the Wisconsin drift. They lived, therefore, after the disappearance of the last glacial ice-sheet and probably long after that disappearance.

20. *Beecher, Will County.*—At Hebron, Indiana, the writer has seen various bones of mastodons which had been unearthed in the region about Beecher by Mr. Jacob Davis, in dredging large ditches. He described these bones as amounting to "about two wagonloads."

Mr. George Langford, of Joliet, Illinois, stated in a letter that it is reported that over a dozen mastodons have been found on one farm near Beecher in the last 10 years. Mr. Langford sent also a geological section (fig. 1) taken along Trim Creek. Besides the mastodon remains found there, he obtained a large part of an antler of *Cervalces.* The locality is given as the northwest quarter of the southwest quarter of section 11, township 33 north, range 14 east, 3 miles north of east of Beecher.

This locality is on the Valparaiso moraine, the last formed before the Wisconsin ice withdrew into Lake Michigan. It was, however, probably long after this that the mastodons lived and died there.

Mr. Langford's account seems to indicate that, after the deposition of the Valparaiso moraine and the withdrawal of the ice-sheet, there was left along what is now Trim Creek a shallow lake, which became gradually filled by washings from the moraine. This at length became a marsh and produced peat and other vegetable muck. At one stage the surface appears to have been occupied by a forest, which later became covered by about 4 feet of sandy soil. Over this is 2 feet of black peat, itself overlain by probably Recent deposits.

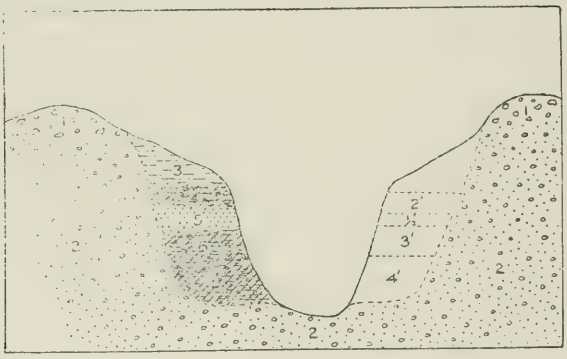


FIG. 1.—Geological section of Trim Creek. Beecher, Will County, Illinois.

1. Moraine.
2. Wisconsin drift.
3. Alluvium.
4. Black peat.
5. Sandy soil, with bones.
6. Peat, sand, vegetable matter.
7. Same stained brown; with gravel.

Mr. Langford has written that all the mastodon bones were found above the gravel, some of them 5 or 6 feet below the surface. Antlers of the elk occurred only above the mastodon bones.

21. *Morris, Grundy County.*—In 1870, Frank H. Bradley (Geol. Surv. Illinois, vol. IV, p. 193) stated that in 1868 the remains of a mastodon were found at Turner's "strippings," about 3 miles east of Morris. These bones lay under 18 inches of black mucky soil and about 4 feet of yellowish loam, and rested on about a foot of hard blue clay, which itself covered the coal. The bones were mostly badly decayed and the greater part were broken and thrown away by the miners; but some, including a part of a lower jaw and 3 teeth, were sent to the State Cabinet at Springfield. The locality was regarded by Bradley as part of an old river bottom.

In 1871, Worthen referred to the same or another mastodon which had been found in the vicinity of Morris. He stated that it had been found in undisturbed drift, 8 feet below the surface. The blue clay on which lay the mastodon described by Bradley may have been brought down from the ice which deposited the Valparaiso moraine. The loam and muck were probably deposits of considerably later date. It is not probable that the Worthen mastodon was buried in undisturbed drift.

22. *Whitewillow, Kendall County.*—At a locality in this county, near Whitewillow, have been found many mastodon bones and those of various other animals. The place is 5 miles west by north of Minooka and 15 miles west of Joliet. Collections have been made there by Dr. E. S. Riggs, of the Field Museum of Natural History, Chicago, and by Mr. George Langford, of Joliet. Mr. Langford wrote that his collection was made in township 35 north, range 8 east, and probably section 27. The farm belonged to John Bamford. Apparently Dr. Riggs's collection was made at the same place. Further details will be found on page 337.

Dr. Riggs reported in Netta C. Anderson's list, already referred to several times, that in 1902 at least six skulls and numerous other bones had been found in a well 10 feet in diameter. Above these were bones of bison, deer, and elk.

23. *Yorkville, Kendall County.*—In the Field Museum of Natural History is a composite skull of a mastodon, part of which was found somewhere about Yorkville; but the writer knows nothing more definite.

Yorkville is situated on Fox River, near the northwestern border of the Marseilles moraine.

24. *Aurora, Kane County.*—H. M. Bannister, in 1870 (Geol. Surv. Illinois, vol. IV, p. 113) wrote as follows: "A portion of the remains of a mastodon, consisting of the tusks and several teeth, was obtained in excavating the track for the Chicago, Burlington, and Quincy Railroad near the city of Aurora, and are now preserved in the museum of Clark Seminary at that place."

These same remains were described by the geologist C. D. Wilbur (Trans. Ill. Nat. Hist. Soc., vol. I, p. 59, figs. 1 to 3). He stated that both tusks and seven teeth were found, all well preserved. The tusks were 10 feet long and 10 inches in diameter at the base; they were curved upward and considerably worn at the ends on the underside. Charles Whittlesey (Smithson. Contrib. Knowl., vol. XV, art. 3, p. 16) probably referred to these remains. He stated that they were found in a swamp.

Probably one of these teeth was sent to Dr. J. C. Warren, of Boston, the author of "The *Mastodon giganteus* of North America." It is described in the second edition of this monograph, on page 76. In the Proceedings of the Boston Society of Natural History, volume IV, page 376, Warren described a tooth, probably the same, which had been found 40 miles west of Chicago, at a depth of 8 feet. He said it was the largest mastodon tooth then known.

In Netta C. Anderson's list, page 10, it is reported that in 1875 some mastodon remains were found about 8 miles southwest of Naperville, which is in Du Page County. The locality would be not far from the common meeting-point of Kane, Kendall, Will, and Du Page Counties; also probably within 8 miles of Aurora. The remains, whatever they were, were donated to the museum of Jennings Seminary, Aurora.

In Netta C. Anderson's list it is stated that teeth and a tusk of a mastodon were found, in 1853, by workmen extending the Burlington Railroad south of Aurora. They were in a swamp near Fox River, where the Burlington

shops are situated. These remains, probably the same as those above described, were presented to Jennings Seminary.

25. *Batavia, Kane County.*—This town is in Kane County, about 9 miles north of Aurora. In Netta C. Anderson's list, on page 13, Dr. E. S. Riggs, of the Field Museum of Natural History, reported that, somewhere in this vicinity, in cutting a ditch to drain a marshy lake of about 200 acres, some leg-bones and vertebræ of mastodon were found in a sticky clay from about 5 to 7 feet from the surface. Dr. Riggs writes that along the same ditch he picked up a jaw of the existing species of elk and some bison bones.

Maple Park, Kane County.—Doctor Rufus M. Bagg recorded in 1909 (Bull. Univ. Ill. vol. VI, No. 17, p. 50, plate IV) the discovery of a large part of the skeleton of a mastodon. It was found at a depth of 6 feet. The exact location was not given.

The whole of Kane County lies between or is covered by the Bloomington and Marseilles moraines, and the mastodons found there must have lived after the retirement of the ice which produced those moraines.

26. *Glencoe, Cook County.*—In Netta C. Anderson's list, on page 9, Professor James G. Needham, of Lake Forest University, reported that a fragment of a mastodon's tooth had been dug up while a ditch in glacial drift was being made.

Glencoe is situated on the eastern till ridge, as described by Leverett (Monogr. U. S. Geol. Surv. XXXVIII, p. 381), the one nearest the western shore of Lake Michigan. If the tooth mentioned really occurred in undisturbed drift, it is possible that it was redeposited from some earlier interglacial deposit.

In 1891, W. K. Higley (Bull. Chicago Acad. Sci., vol. II, pt. 1, p. XV) reported the finding of some bones of a mastodon, about 6 years previously, on the south side of Wicker Park, near Milwaukee Avenue, Evanston. The bones were in a layer of fine sand in which were trunks of oak trees. The depth was 13 feet. The remark was made that the level marked the upper or late limit of the mastodon.

27. See page 105.

WISCONSIN.

(Map 5.)

1. *Dover, Racine County.*—In the Milwaukee Public Museum is a tusk, identified as that of a mastodon, exhumed from a peat-bog at Dover, in 1878. Both tusks and some fragments of a scapula, some ribs, and vertebræ were found, but apparently no teeth. Only one tusk was saved; 4 feet 8 inches long and moderately curved, the middle of the concave surface being about 6 inches below a line joining the base and the tip of the tusk.

Dover is situated near the southern border of Racine County, in the southwestern corner of township 3 north, range 20 east. It is, therefore, within the great composite moraine which runs along the western side of Lake Michigan. According to Alden's map (Prof. Paper 106, U. S. Geol. Surv., plate III) the town is on a tract covered by ground moraine of the Lake Michigan glacier.

2. *Waukesha, Waukesha County.*—In the Milwaukee Public Museum is a slightly worn upper hindermost molar of a mastodon, No. 3867, labeled as having been found at Waukesha. There is no other history. The geological age is probably practically the same as that of the tooth found at Dover, Late Wisconsin.

3. *Madison, Dane County.*—The records for mastodons at Madison are not very satisfactory.

Professor Eliot Blackwelder informs the writer that there is in the collection at the State University of Wisconsin a large vertebra, supposed to be that of a mastodon, brought up out of Lake Monona, in 1906.

Professor C. A. Davis informed the author that in 1908 he visited the fill in one of the city parks made by pumping mud from Lake Monona and found fragments of ivory and parts of proboscidean bones. It is possible that these fragments belonged to an elephant.

4. *Bluemounds, Dane County.*—In 1862 J. D. Whitney, in his "Report on the Geological Survey of the Upper Mississippi Land Region," page 132, mentions having found, at Bluemounds, the first 3 deciduous molars of the mastodon, exquisitely preserved and not at all discolored. Dr. Jeffries Wyman, in Whitney's report, on pages 421, 422, referred to these milk molars. Whitney in 1866 (Geol. Surv. Illinois, vol. 1, p. 162) stated that he had found in a crevice near Bluemounds bones and teeth of mastodon, peccary, buffalo, and wolf.

5. *Lone Rock, Richland County.*—Professor Eliot Blackwelder, of the Wisconsin State University, informs the writer that there is in their collection a pair of tusks, supposed to be of a mastodon. They were found somewhere about Lone Rock in 1901, which is on the northern bank of the Wisconsin River, in the southeastern corner of Richland County.

6. *Sinsinawa, Grant County.*—In his report on the geology of the lead region, already referred to, J. D. Whitney stated, on his page 133, that the greatest quantity of bones of the mastodon found in that region seems to have been near Sinsinnewa mound, but he had no exact particulars of depth or position. Some were preserved at the locality for several years; others, to the amount of several bushels, were carried off or destroyed.

7. *Wauzeka, Crawford County.*—In the collection of the Public Museum of Milwaukee is an upper last molar, found at the place named. It is only slightly worn and nearly white in color. Nothing is known about the exact place or under what conditions it was found.

8. *Richland Center, Richland County.*—Professor George Wagner of the Wisconsin State University, has informed the writer that there is in that university an almost complete skeleton of a mastodon, found at the place named. No particulars are known to the present writer regarding the history of the specimen.

9. *Menomonie, Dunn County.*—Professor S. Weidman, of the Wisconsin Geological and Natural History Survey, informed the writer that in the brick clays used at Menominee had been found a part of a leg-bone of a mastodon. Dr. Weidman was kind enough to send the bone for examination. It proved to be the distal end of the right humerus, including the epiphysial part. The interior of the bone had been neatly excavated, as if by a tool of some kind, the marks of which remained, which proved to be

the jaws of a wolf. He had evidently been after the marrow and had scraped out all of the part filled by cancellated bone. The explanation appears to be that the mastodon had in some way broken an arm and had died. The wolves then proceeded to devour him; they could not have broken the limb themselves.

The finding of the bone shows that these clays belong to the Pleistocene. In a sand formation underlying the clays a caribou antler and bones of the Mackinaw trout, *Cristivomer namaycush*, have been found. Professor Weidman regards the clays as being of pre-Iowan age.

MARYLAND.

(Map 5.)

1. *St. Mary's City, St. Mary's County.*—The U. S. National Museum (No. 200) contains a fine upper left hindermost molar of *Mammut americanum*, labeled as presented by Mr. J. Varden and as found many years ago in a marl-bed at or near the town named. It was probably met in digging for Miocene marl, but was doubtless inclosed in overlying Pleistocene materials. According to Shattuck's Pleistocene map of Maryland (Pleistocene volume, plate 1), St. Mary's City is situated on the Wicomico terrace; but because of absence of exact information whether the tooth was in the body of this deposit, or below it, or possibly in later materials above the Wicomico, its exact age can not be determined. Teeth from the locality were mentioned by Lucas on page 162 of the volume just cited. The geology of the county is described in a special volume of the Maryland Survey, 1907

2. *St. Clements, St. Mary's County.*—The U. S. National Museum contains a lower right hindermost molar, found long ago, apparently 1837, and presented by A. McWilliams. It is recorded as having been discovered in digging a mill-race at or above St. Clements. This race must quite certainly have been located along St. Clements Creek. The place is situated in the Wicomico plain; but possibly Talbot deposits extended up the creek farther than mapped.

3. *Towson, Baltimore County.*—Professor F. A. Lucas (Maryland Pliocene, Pleistocene vol., p. 163) stated that the collection of the Maryland Geological Survey contains a fine upper last molar of a mastodon found on the Ridgeley estate, at Hampton, near Towson, about 10 miles north of Baltimore. At present one can not determine the time during the Pleistocene when this tooth was part of a living creature.

4. *Lane's Creek?, Washington County.*—The writer received, in 1912, a letter from Professor A. F. Bechdolt, of Bellingham, State of Washington, in which he stated that somewhat more than 37 years before, while teaching school in Washington County, Maryland, he saw the remains of a skull of a mastodon which some negroes had unearthed in making a mill-race, but they had broken it in pieces with sledgehammers. Professor Bechdolt recollected plainly the "mammillary face" of the tooth. The locality is described as being near the Pennsylvania line, south and somewhat west of Mercersberg, Pennsylvania, among the foot-hills of North Mountain, at a place locally known as "The Corner." It appears probable that the locality was somewhere along Lane's Creek.

4. *Clear Spring, Washington County.*—In circular No. 109, volume XIII, Johns Hopkins University, 1893, pages 26, 27, is an account of the finding of a mastodon tooth in 1863. It was discovered after a storm, lying on a pile of driftwood, in Conococheague Creek, at a point 2.5 miles south of Clear Spring, and a mile north of the entry of the creek into Potomac River. The tooth is in the collection of Johns Hopkins University.

VIRGINIA.

(Map 5.)

1. *Six miles east of Williamsburg, York County.*—In Godman's Natural History (3d ed., 1860, vol. II, p. 77) mention is made of the discovery, in 1811, of remains of a mastodon along the banks of the York River, 6 miles east of Williamsburg. The account was derived from Dr. S. L. Mitchill (Med. Repos., New York, vol. XV, p. 388; Cuvier's "Theory of the Earth," p. 399). He had received his information from Bishop James Madison, then president of College of William and Mary, at Williamsburg. The parts found consisted of the bones of the pelvis, a thigh bone, 2 vertebræ, 2 ribs, 2 tusks, and 7 molar teeth, 4 of which were yet in a part of the jaw, probably the lower. The largest tooth is reported as weighing 7.25 pounds; the smallest between 3 and 4 pounds. It is probable that mastodon teeth in a wet condition would weigh the amount stated. Clark and Miller (Bull. IV, Virginia Geol. Surv., 1912, p. 20) refer this animal to the Pleistocene of the Talbot formation.

Dr. Lyon G. Tyler, president of College of William and Mary, informs the writer that the fossils above mentioned were doubtless destroyed in a fire which consumed the main building in 1859.

2. *City Point, Prince George County.*—The U. S. National Museum (No. 539) contains a part of the upper second true molar of *Mammut americanum,* sent there in 1888 by Mr. John S. Webb. The tooth is silicified. Mr. Webb reported that the fragment had been unearthed by laborers in making a ditch through some lowland which abounded in shells and blue marl. In a letter dated September 2, 1918, Mr. Webb informed the writer that his recollection is that the tooth was found about 12 miles north of Disputanta and near James River.

3. *Abingdon, Washington County.*—An upper right second true molar in the U. S. National Museum (No. 8807) is recorded as having been received in January 1869 from Mr. Wyndham Robinson, but there is no information as to the exact locality, depth, and kind of soil inclosing it. With it were found some vertebræ and fragments of ribs and of tusks.

4. *Saltville, Smyth County.*—In the U. S. National Museum is the horizontal part of the right ramus of the lower jaw of a young mastodon, found at the place named. This, with some remains of an undetermined species of *Bison* and some teeth of *Elephas primigenius,* were presented to the museum in 1914 by Mr. H. D. Mount. They had been found about 1896, in making an excavation for the water reservoir of the town. It is said that within less than a century the valley at Saltville was at times a lake. The reservoir is situated at the edge of this former lake. The bones were found at a depth of not more than 8 feet. Mr. O. A. Peterson (Ann. Carnegie Mus., vol. XI, 1917, p. 474) records the finding of mastodon remains

in the Saltville deposit. He states that fragmentary remains of mastodon have for many years been picked up in that valley. A list of the species of vertebrates found at this place is given on page 353.

About 100 years ago (Med. and Physic. Jour., Phila., xv, 1806, 1st Supp., p. 388) an account of the discovery of mastodon remains in Wythe County, Virginia, was published by B. S. Barton. The details had been communicated to him by Bishop James Madison, president of William and Mary College, Williamsburg, Virginia. According to the bishop, not only were bones discovered but also the stomach of the animal in a state of perfect preservation, and containing a large quantity of half-masticated food (Godman's Amer. Nat. Hist., 3d ed., 1860, vol. II, p. 74). Later, the bishop admitted that he had been misinformed. It is probable that something was found there, at least some bones. Bishop Madison had made arrangements to have the bones sent to Williamsburg; but if they reached there they were doubtless destroyed by a fire in 1859. The supposed discovery is mentioned in Cuvier's "Ossemens Fossiles," volume II, page 270, and is discussed in Barton's "Archæologia Americana," 1814, page 41.

Wythe County at that time occupied far more territory than at present, and possibly the bones described by Madison had really been found in Washington or Smyth Counties; but Saltville, as the writer is informed by Mr. E. C. Hutton, suryevor, never was in Wythe County.

5. *Covington, Alleghany County.*—In 1901 there was sent to the U. S. National Museum by Dr. A. C. Jones, of Covington, a lower last molar of a mastodon found at that place. This tooth differs from the ordinary teeth of *Mammut americanum* in having the crown more depressed. The writer has observed similar teeth which have been found elsewhere. It is possible that they belonged to a species distinct from *M. americanum.* Dr. Jones informed the writer that the tooth was found within the city limits of Covington, about 300 yards from Jackson River, at a depth of 12 feet, in brick clay.

6. *Hot Springs, Bath County.*—In the U. S. National Museum is a part of an upper left second true molar, recorded as having been found about a mile from the Hot Springs Hotel. The tooth is silicified. It was presented by Mr. J. F. McAllister. Hot Springs is at the head of Wilson Creek, a tributary of Jackson River. In the folio of Monterey Quadrangle coming down nearly to Hot Springs, no mention is made of any Pleistocene; but the presence of occasional deposits of soils along some of the streams is recorded. Evidently some of these deposits were laid down in Pleistocene times.

7. *Edom, Rockingham County.*—The American Geologist in 1891 (vol. VII, p. 335), contains an account of the finding at this place of bones of what was called a mammoth, but which was more probably a mastodon. It was said to have been discovered on the land of a Mr. Frank. The information was furnished by Dr. Zirkle, who stated that a nearly complete skull had been found.

In the U. S. National Museum is the symphysis of the lower jaw of a mastodon, recorded only as having been found in Virginia. The specimen (No. 210) would not be worth mentioning were it not that it presents in

front two sockets for tusks of considerable size. The bases of the tusks are retained at the bottom of the sockets. The left socket has a diameter of about 35 mm.; the other is slightly smaller. From the outside of one socket to the outside of the other is 94 mm. The front of the symphsis is damaged, so that its length can not be determined. Its lower face is quite flat. The height of the jaw at the front of the tooth which was present is about 150 mm. It seems to the writer that this jaw belonged to the species *Mammut progenium*.

WEST VIRGINIA.

(Map 5.)

1. *Stewartstown, Monongalia County.*—Dr. G. F. Wright in his "Ice Age in Northern America," fifth edition, page 378, wrote that Dr. I. C. White had reported (Amer. Jour. Sci., ser. 3, vol. xxxiv, pp. 378–379) the finding of a tooth of a mastodon at this place; but in the article quoted nothing is said about a mastodon. Evidently White published this article elsewhere.

The tooth is said to have been dug up on the fifth and highest terrace along Monongahela River. In White's article, page 378, it is stated that in the region of Morgantown the high-terrace deposits are about 275 feet above low-water in the Monongahela and 1,065 feet above tide. It is probable that the mastodon lived there during the early Pleistocene.

2. *Parkersburg, Wood County.*—In 1902 the present writer received from Mr. J. W. Miller, of the High School of Williamstown, West Virginia, a letter inclosing photographs of a mastodon tooth, found on Neal Island, 3 miles above Parkersburg. The tooth appears to be the upper left second molar and is furnished with all of its roots. The writer does not know under what conditions the tooth was found. Its perfect state of preservation shows that it could not have been carried far by the stream. For a discussion of the Pleistocene of some parts of West Virginia the reader may consult the paragraphs on pages 354–355.

NORTH CAROLINA.

(Maps 5, 39.)

1. *New Hanover County.*—Under this number must be mentioned that a tooth of *Mammut americanum* has been found about 10 miles below Wilmington, near the Fort Fisher road. This tooth is in the possession of Captain E. D. Williams, of Wilmington.

2. *Pender County.*—Professor H. H. Brimley, of the State Museum at Raleigh, North Carolina, has informed the writer that there are in that museum some remains of mastodon from Pender County; but nothing more is known to the present writer about the nature of these remains or about the locality where they were found.

3. *Duplin County.*—From the same source it is learned that there are in the collection at Raleigh teeth of mastodon which had been found in Duplin County.

4. *Goldsboro, Wayne County.*—In the State Museum at Raleigh is a left ramus of a mastodon, collected near Goldsboro. The writer has examined this important specimen and has also received a photograph of it, sent by

Professor H. H. Brimley. This is evidently the jaw described by Leidy (Proc. Acad. Nat. Sci. Phila., 1871, p. 113) from photographs received from Professor W. C. Kerr, then State geologist of North Carolina. This jaw was recorded as having been obtained from gravel overlying Miocene marl, near Goldsboro.

This specimen presents the peculiarity of having two tusks at the front of the symphysis. The diameter of these is 45 mm. How long they were originally can not be determined. The form of this jaw and presence of two large incisor tusks indicates that this specimen belongs to *Mammut progenium*. The front molar present, M_2, has a length of 122 mm. and a width of 88 mm. Leidy regarded this jaw as having belonged to a male animal. Professor E. Emmons (Geol. Surv. North Carolina, 1858, p. 199) mentions that a large number of bones had been found in a marl pit near Goldsboro.

5. *Jacksonville, Onslow County.*—In the collection of the State Museum at Raleigh the writer has seen a part of a skeleton of a mastodon, found near Jacksonville and exhumed by Mr. T. W. Adicks. A considerable part of the skull, including upper teeth, both upper tusks, lower jaw, and some limb-bones, were secured. The animal was evidently a fully mature one, as there were present in the jaws the last and the next to the last molars; but these were not greatly worn. In the lower jaw there were no tusks, but the tip of the jaw seemed to indicate that earlier in life these might have been present. The upper tusks are unusually short. One is 33 inches (841 mm.) long, 94 mm. in diameter at the base, and 120 mm. about the middle of the length. At the base is a pulp-cavity whose depth is 230 mm. The distal end of this tusk is much worn, evidently during the life of the animal. On one side is a flat surface 120 mm. long and 75 mm. wide which is directed obliquely to the plane of the curvature of the tusk. Opposite this surface is another whose plane is parallel with that of the curvature of the tusk. About 50 mm. from its tip the tusk is crossed by a groove nearly 20 mm. wide and 42 mm. deep, which appears to have been produced by the drawing of branches or roots across the tusk. About 60 mm. further back there is another groove, broader and shallower. The other tusk is 940 mm. long. Near its extremity it is crossed by three grooves, one of which, about 55 mm. behind the tip, runs two-thirds of the way around the tusk.

The small size of the tusks makes it pretty certain that this animal was a female. The jaw does not differ especially from that of a Late Wisconsin mastodon, apparently about one-sixth taller, found near Winamac, Indiana, and now mounted in the U. S. National Museum.

6. *Maysville, Jones County.*—From Professor H. H. Brimley, of the State Museum, at Raleigh, the writer has learned that tusks and teeth of *Mammut americanum* had been secured for that museum at Maysville. This is situated on White Oak River. Photographs show the teeth are lower hindermost molars, right and left. The writer has seen these teeth; likewise upper second and third molars and the tusks. The latter are of medium size, having a diameter of 120 mm. at the base. The pulp-cavity is 190 mm. deep. The enamel of all the teeth is rather rough and corrugated.

7. *Sixteen miles southeast of Newbern, Pamlico County.*—On the left bank of Neuse River, at a point said to be 16 miles below Newbern, several

vertebrate fossils were collected many years ago. The collection appears to have been made by the botanist Nuttall; but the first mention found by the writer is a paper by H. B. Croom, in 1835 (Amer. Jour. Sci., ser. 1, vol. XXVII, pp. 168–171. He stated that the locality was on the north bank of Neuse River, on the land of Mr. Benners, who had dug several pits in order to obtain marl. In these pits, some reaching a depth of 25 feet, many fossil shells, sharks' teeth, and bones of marine fishes were found. These marls appear to belong to the Pleistocene (Stephenson, North Carolina Geol. and Econom. Surv., vol. III, p. 289). In the same pits were found teeth and bones of various Pleistocene mammals. A few of the fossils, as the great shark tooth, certainly belonged to Tertiary deposits. Croom states that there were fragments of the horns of a fossil elk; also a mastodon tooth which had a breadth of 7 inches and a depth of 9.5 inches. It is not improbable that this was a tooth of an elephant. Teeth, supposed to belong to a fossil elk and which had a breadth of 3 inches and a depth of 4.5 inches, were probably hindermost milk molars of *Mammut americanum*. Harlan (Amer. Jour. Sci., vol. XLIII, 1842, p. 143) indicated that he had seen in the collection made by Nuttall remains of the mastodon; also of a supposed *Sus*, an elephant, elk, deer, horse, seal, cetaceans, a tortoise, shark, skate, snake, and fish. This collection apparently passed into the hands of T. A. Conrad. J. W. Foster (Proc. Amer. Assoc. Adv. Sci., vol. x, p. 166) stated that Conrad had many years previously obtained these animals near Newbern. Besides those mentioned he included a hippopotamus. This identification was probably based on milk tusks or lower tusks of the mastodon.

8. *Harlowe, Carteret County.*—In 1828 (Amer. Jour. Sci., vol. XIII, p. 348), Elisha Mitchell wrote that in digging the Clubfoot and Harlowe Canal, remains of both the elephant and the mastodon had been found. Under this number may be mentioned the finding of a jaw of a mastodon in the Inland Waterway Canal, which appears to run some miles east of the old Clubfoot and Harlowe Canal. This specimen is, or was recently, in the laboratory of the U. S. Fish Commission at Beaufort.

9. *Pitt County.*—In 1871 (Proc. Acad. Nat. Sci. Phila., p. 113), Leidy reported that an isolated lower last molar tooth of *Mammut americanum*, but accompanied by the jaw, had been obtained in Pitt County. No more exact locality was mentioned. In the U. S. National Museum (No. 202) is a lower right hindermost molar which was found in Pitt County.

10. *Wilson County.*—From Professor H. H. Brimley the writer learned that there are in the museum at Raleigh some remains of mastodon from Wilson County. The writer has seen at Raleigh a lower second left molar, from Wilson County.

11. *Tarboro, Edgecombe County.*—In the U. S. National Museum (No. 205) is a lower right last molar of *Mammut americanum*, recorded as having been sent by Dr. Pitman, of Tarboro. It is black and very heavy.

12. *Rocky Mount, Nash County.*—Professor E. Emmons (Geol. Surv. North Carolina, 1852, p. 56) mentioned the finding of mastodon bones in marl-pits, on the farm of Mr. Knight, on the bank of Tar River, 3 miles west of Rocky Mount. The Pleistocene is here supposed to belong prin-

cipally to the Sunderland, but partly to the Wicomico formation. Emmons, in 1858 (Rep. North Carolina Geol. Surv., Agric. East Cos., p. 199), figured and briefly described a molar of a mastodon which he referred to *Mastodon giganteus*. This was found in a Miocene marl-pit in Halifax County; but so many Pleistocene species have been reported from such marls that it is possible that the tooth belonged to a Pleistocene animal.

Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, 1869, p. 396) referred this tooth with doubt to his *Mastodon obscurus;* but the type of the latter, a lower molar (Leidy op. cit., plate XXVII, fig. 13), presents no such double series of trefoils.

Leidy (op. cit., p. 247, plate XVII, fig. 16) referred some fragments of mastodon teeth found at Tarboro to his *Mastodon obscurus;* but these seem to the writer to belong to *Gomphotherium rugosidens*. We do not know that *G. obscurum* is a Pleistocene species, nor is it certain that it has been found in North Carolina.

SOUTH CAROLINA.

(Map 5.)

1. *Beaufort, Beaufort County.*—In the region about Beaufort numerous remains of mastodons have been found, most of which are to be referred to *Mammut americanum*. In the Academy of Natural Sciences of Philadelphia the writer has seen a fine left lower last molar of this species. The collection of Rutgers College contains a part of a tooth from Coosaw River. At Princeton University there is an upper second true molar from somewhere about Beaufort. Field Natural History Museum has 3 teeth of *Mammut,* recorded as having been found in the phosphate bed at Beaufort.

Leidy (Proc. Acad. Nat. Sci. Phila., 1870, p. 98) stated he had seen, in the collection of C. N. Shepard at Amherst College, bones, fragments of jaws, and teeth of mastodon from the marl at the head of Hilton Harbor, on St. Helena Island, on which Beaufort is situated. Among these were 2 inferior tusks about 10 inches long and 2 inches in diameter at the base. If the molars which accompanied them had differed from those of *Mammut americanum,* Leidy would have been quick to note the fact. Evidently the bones and teeth mentioned by Leidy are those now in the mounted skeleton at Amherst College, described by Professor F. B. Loomis (Amer. Jour. Sci., ser. 3, vol. XLV, p. 437, figs. 1, 3, 4) as *Mastodon americanus*. This was a very large animal and the two large lower tusks show that it belonged to *Mammut progenium*.

In the Academy's collection at Philadelphia is a large hindermost molar, 180 mm. long and 96 mm. wide, which had been sent to the Academy in company with the type of *Gomphotherium rugosidens*.

2. *Ashley River, above Charleston, Charleston County.*—In 1860 (Holmes's Post-Pl. Foss. South Carolina, p. 109), Leidy stated that fragments of teeth and bones had been found in the Post-Pliocene deposits of Ashley River, apparently referable to *Mastodon ohioticus* (*Mammut americanum*). In a footnote to this statement, F. S. Holmes says that since Leidy's statement was written several perfect teeth have been discovered, and referred to plate XIX, figures 1, 2, 3. These figures illustrate the teeth

which belonged to Dr. L. F. Klipstein, Christ Church. In the preface to Holmes's work he refers to the teeth on this plate as being those associated with teeth of a horse, remains of a deer, and a piece of pottery. On page III of the introduction there is further explanation of the discovery. Exactly where the swamp which Klipstein was draining was situated seems not to have been stated, but the context appears to indicate that it was somewhere along Ashley River.

In 1918 (Amer. Jour. Sci., ser. 3, vol. XLV, p. 438, fig. 2, not "fig. 3") Professor Loomis described and figured 2 lower tusks, found in Nine Mile Bottom, 9 miles above Charleston, probably along Ashley River. On page 441 Loomis correctly described these, except that what he called enamel is only a dense outer layer of dentine. Evidently these tusks had been used for punching against hard objects. One may surmise that the animal had been accustomed to bark trees with them.

Leidy (Proc. Acad. Nat. Sci. Phila., 1870, p. 98) states that he saw in the collection of C. N. Shepard, at Amherst College, remains of mastodons, etc., which had been found on Ashley River.

In the collections at Charleston, both the private ones and that of the Charleston Museum, there are teeth of *Mammut americanum*, but records of exact localities are usually wanting.

3. *Head of Cooper River, Berkeley County.*—John Drayton, in his "View of South Carolina," in 1802, page 39, plate, figure 4, mentions the discovery of fossil bones in Biggin Swamp, made in digging a canal between Santee and Cooper Rivers. It appears probable that this swamp is not far from Monks Corner. Drayton's figure shows that the tooth was one of *Mammut americanum*. It is said to have been buried at a depth of 8 or 9 feet. B. S. Barton (Archæologia Amer., 1814, pp. 22–23) stated that he had examined teeth of both mastodon and elephant from this swamp. George Turner (Trans. Amer. Philos. Soc., vol. IV, 1899, p. 511) speaks of the discovery of bones of what is called the mammoth in the construction of the Santee and Cooper River Canal. Cuvier (Oss. Foss, ed. 4, vol. II, p. 275) stated that the naturalist M. Bosc had witnessed the exhumation of 5 molars of mastodon during the excavation of the "canal de Caroline," 15 miles from Charleston. They were found in pure sand at a depth of 3 feet. It is possible that there is here an error in the distance from Charleston.

4. *Lee County.*—Tuomey (Rep. Geol. Surv. South Carolina, 1848, p. 178) states that between Lynch's Creek and Black River, "near Concord church," he found a bed of Pliocene marl about 4 feet thick, which, like the Darlington deposit, rests on black shale. In an excavation made in this marl, he found a portion of a tusk of a mastodon. This might, indeed, have belonged to an elephant, but more probably to *Mammut americanum*.

5. *Darlington County.*—In 1848 (Rep. Geol. Surv. South Carolina, 1848, pp. 177–180), Tuomey reported that 2 perfect molars of *Mastodon maximus* (=*Mammut americanum*) had been found on land of G. W. Dargan, somewhere near Darlington. They were found in a swamp and covered with 3 or 4 feet of mud, but lying in a marl which he regarded as belonging to the Pliocene. One was sent to the college at Columbia. In a note to the geologist J. W. Foster (Proc. Amer. Assoc. Adv. Sci., vol. X, 1856, p. 167),

Tuomey stated that he had placed in the cabinet of South Carolina College a fine tooth of mastodon, found in Darlington district. At an earlier date Robert W. Gibbes (same Proceedings, vol. III, 1850, p. 67) exhibited before the association teeth of a horse found at Darlington, associated with bones of *Mastodon.*

GEORGIA.

(Map 5.)

1. *Brunswick, Glynn County.*—In Richard Harlan's list (Proc. Acad. Nat. Sci., vol. I, 1841–43, p. 189) of fossil vertebrates which had been exhumed in making the Brunswick Canal were mentioned teeth of *Mastodon giganteum* (=*Mammut americanum*). About this time J. H. Couper (Proc. Geol. Soc. Lond., vol. IV, p. 33) read a paper in which he mentioned the occurrence of the same species in the canal referred to. Lyell (Second Visit, etc., p. 348) included the mastodon among the species discovered here. Richard Owen (Proc. Acad. Nat. Sci. Phila., 1846, p. 93) reported the result of an examination of a collection submitted to him through Lyell. Hippopotamus had been recognized in a supposed incisor; but Owen showed that it was a small tusk of a proboscidean, probably of *Mammut americanum.* Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 248) stated that he had examined in the collection of the Academy the hinder part of a tooth of the American mastodon.

Gidley (Bull. 26, Geol. Surv. Georgia, p. 436) recognized *Gomphotherium floridanum* and *Mammut americanum* in a collection which had been made some years ago at Brunswick, probably in dredging in the harbor. Inasmuch as only fragments of these teeth were present, the identification was difficult. The writer has, through the kindness of Professor S. W. McCallie, had the opportunity to examine these fragments. They appear all to belong to *Gomphotherium rugosidens,* a species rather common in that region. This species probably does not belong to the Pleistocene, but to the upper Miocene or the Lower Pliocene. It is possible, however, that it belongs to the lowermost Pleistocene, the Nebraskan.

2. *Skidaway Island, near Savannah, Chatham County.*—Remains of *Mammut americanum* have been found at two places in Chatham County, Heyner's Bridge and Skidaway Island. Lyell (Travels in N. A., 1845, vol. I, p. 163) records his visit to Heyner's Bridge, on White Bluff Creek, about 7 miles south of Savannah. In Hodgson's memoir this locality is said to be on Vernon Creek (map 40). Lyell had learned from Dr. Habersham that bones of mastodons and other extinct mammals had already been found there. Lyell himself secured a grinder of a mastodon. It was found in a bed of clay about 6 feet thick exposed only at low water. The tooth referred to may be the one mentioned by Lydekker (Cat. Foss. Mamm. Brit. Mus., pt. IV, p. 23). Hodgson ("Memoir on Megatherium," p. 12) reported the discovery of mastodon remains at this place, specifying a section of a tusk 3.25 feet long and nearly 11 inches in circumference; also a femur, which was sent to Paris. Reference is made to the mastodon remains on page 42 of the memoir mentioned. For the geology of this locality and a list of the species found there the reader is referred to page 371.

FLORIDA.

(Maps 5, 10.)

It has not been practicable to arrange the figures on the map of mastodons in Florida in an orderly manner. Below, the localities are described by beginning at the northern end of the State and ending at the southern end.

1. *Marianna, Jackson County.*—In the U. S. National Museum (No. 324) is a tooth of *Mammut americanum,* recorded as having been sent to the National Institute, September 25, 1847, by Walter Yonge, from Marianna. No additional information has been preserved. It is a large upper right last molar, with 5 cross-crests, a hinder talon, and nearly complete roots. Marianna is situated on Chipola River.

12. *Little River, Gadsden County.*—Dr. E. H. Sellards (8th Ann. Rep. Florida Geol. Surv., 1916, p. 104) reported that a tooth of *Mammut americanum* had been obtained from Little River.

2. *Fort White, Columbia County.*—Dr. E. H. Sellards reported to the writer the discovery of a tooth of *Mammut americanum* at a point 3 miles northwest of Fort White. No details have been received. The town is on Santa Fé River.

3. *Citra, Marion County.*—In Ward's Natural History Establishment, at Rochester, New York, the writer saw in January 1914, 2 cross-crests of a probably hindermost upper molar of *Mammut americanum.* There had been present a large pulp-cavity. Nothing definite about the history of the specimen could be obtained, except that it had been found at Citra.

15. *Neals, Alachua County.*—From this locality Sellards (5th Ann. Rep. Florida Geol. Surv., p. 58) reported the discovery of a mastodon, probably *Gomphotherium floridanum.* Associated with this species was an undetermined species of *Hipparion.* At the same place has been found *Tapirus terrestris?* On his plates IV and V of the same volume, Sellards has figured teeth belonging to two undetermined species of mastodons. All of these fossils came from the phosphate deposits at Neals.

16. *Archer, Alachua County.*—Dr. Joseph Leidy (Proc. Acad. Nat. Sci. Phila., 1886, p. 11) reported that Dr. W. H. Dall had discovered at Archer remains of a mastodon to which Leidy gave the name *Mastodon floridanus.* It is here referred to the genus *Gomphotherium.* It was associated in the Alachua clays with a species of *Hipparion,* three species of *Procamelus,* and a rhinoceros; also an astragalus of *Megatherium.* All of these, except the last, are usually referred to the Lower Pliocene or the Upper Miocene. The writer believes that they belong to the lowest Pleistocene, the Nebraskan.

17. *Williston, Levy County.*—Leidy (Proc. Acad. Nat. Sci. Phila., 1887, p. 309) reported the finding of several species of fossil vertebrates in the Mixon bone-bed, at or near Williston. The species were *Gomphotherium floridanum, Hipparion plicatile, Procamelus major,* and *Telecoceras proterus.* These were found in the Alachua clays at depths from 2.5 to 6 feet. In Dall's list of 1892 (Bull. U. S. Geol. Surv. No. 84, p. 129) *Hipparion ingenuum* is included.

18. *Juliette, Marion County.*—Sellards, in 1913 (5th Ann. Rep. Florida Geol. Surv., p. 58), stated that *Gomphotherium floridanum* had been found

in hard phosphate in a mine at this place. As in other such cases, he referred the species to the Upper Miocene or the Lower Pliocene.

5. *Dunnellon, Marion County.*—In the collection of the Florida Geological Survey is a fragment of a molar of *Mammut americanum* which was dredged up from Withlacoochee River during operations by the Schilman and Bene Phosphate Company. It was presented by John D. Robertson.

In the possession of Mr. J. D. Robertson of Ocala, Florida, is a part of a skull of *Mammut americanum,* reported by him to have been found in the northeast quarter of the southeast quarter of section 1, township 17 south, range 19 east. This would be about 6 miles east of Dunnellon and not far from Withlacoochee River.

In the region about Dunnellon the mastodon *Gomphotherium floridanum* has been collected. For the list of species found at Dunnellon and in Withlacoochee River the reader may consult page 376.

19. *Near San Pablo Beach, Duval County.*—From station 120, on the Inland Waterway, near San Pablo Beach, Sellards (8th Ann. Rep. Florida Geol. Surv., p. 106) reported the discovery of a tooth of *Mammut americanum* in place in the bank of the canal. Remains of *Elephas columbi* and undetermined species of *Bison* and *Odocoileus* had been thrown out by the dredge.

4. *Almero Farm, St. John County.*—At the residence of Mr. Fred R. Allen, 113 King street, St. Augustine, Florida, the writer had the privilege of examining seven teeth of *Mammut americanum* which had been found near Mr. Allen's farm, 28 miles south of St. Augustine, in the Inland Waterway Canal. At the same place Mr. Allen had found remains of a fossil horse, a mylodon, alligator, and a part of the plastron of *Terrapene antipex.* The deposits are to be regarded as belonging to some part of the first half of the Pleistocene, probably the first interglacial.

6. *Daytona, Volusia County.*—In the U. S. National Museum (No. 2150) is an upper left last molar of *Mammut americanum,* sent in August 1901 from Daytona by E. T. Conrad & Company. It had been found at a depth of 5 feet in an old oyster-bed which was being dug up for surfacing the streets. The locality is within the limits of the town and about 2 miles from the Atlantic coast. The senders reported a little later that they had found four other teeth, a piece of tusk 40 inches long and 7 inches in diameter, and about a bushel of bones and fragments. There appeared to be other bones in the pit, but nothing more is on record. Since that mastodon died there, the land appears to have been depressed beneath the sea, permitting the growth of the oyster-bed, after which there was again an elevation.

13. *Fellsmere, St. Lucie County.*—Dr. E. H. Sellards (8th Ann. Rep. Florida Geol. Surv., p. 105) stated that *Mammut americanum,* represented by a tooth or teeth, had been found at Fellsmere in connection with the construction of drainage canals.

7. *Vero, St. Lucie County.*—At this place have been found well-preserved remains of *Mammut americanum.* Besides a part of a lower jaw, there are some parts of tusks and fragments of other parts. The right side of a palate containing the second and the third true molars, found in what has been called stratum No. 2, has been figured by Sellards (8th Ann. Rep.

Florida Geol. Surv., plate XXXI). The age of these will be discussed on pages 381–384.

14. *Palm Beach, Palm Beach County.*—In his report of 1916, already cited, Dr. Sellards noted the fact, on page 105, that several teeth of *Mammut americanum* had been obtained by him, 8 miles west of the Florida East Coast Railroad, in the canal constructed to drain the Everglades. From the same canal had been secured *Elephas columbi, Equus complicatus,* and a femur of a species of *Bison.* Sellards informs us that the vertebrate fossils here, as at Vero and many other localities, are embedded in the sand and muck beds which lie above the Pleistocene marls.

8. *Hillsboro County.*—Remains of mastodon have been reported from various places in this county, but the localities have not been very exactly defined.

In the National Museum (No. 6726) is a lower left hindermost molar of *Mammut americanum* which was sent by Mr. W. L. Spitler, of Tampa. Exactly where it was found is not recorded. The tooth is white and well preserved. There are five cross-crests. The cones are unusually low, and such teeth may possibly represent an undescribed species.

At Heidelberg University, Tiffin, Ohio, the writer has seen a mastodon tooth, labeled as having come from Tampa Bay. The tooth is heavy and rock-like. A part of an atlas of the mastodon is from the same place.

In the collection of Oberlin College, Oberlin, Ohio, is a lower right last molar of a mastodon, labeled as having been found at Sulphur Springs, Hillsboro County. The writer has not found where this place is situated. All of the specimens mentioned belong to *Mammut americanum.*

9. *Alafia River, Hillsboro County.*—Dr. E. H. Sellards (7th Ann. Rep. Florida Geol. Surv., p. 112, fig. 45) records the finding of an upper right last molar of *Mammut americanum* in this river. The tooth is unworn and has four cross-crests and a large talon. It was preserved in the collection of S. A. Robinson. With a collection of teeth of *Equus* found in Alafia River and preserved in the American Museum of Natural History, New York, is a single cross-crest of *Mammut americanum.*

20. *Brewster, Polk County.*—In his report of 1915 (p. 106, fig. 36) Dr. E. H. Sellards figured a fragment of a tusk, found in a phosphate mine, which he supposed might belong to *Gomphotherium floridanum.* He figured also a tooth (p. 104, fig. 34) which he definitely referred to this species, but it is not clear that it was found at Brewster. A list of the species found associated with the tusk will be found on page 380. Among these species is *Mammut progenium,* a species ranging from the Aftonian to the Late Wisconsin. While all the species of the list are referred by Sellards to the Upper Miocene or Lower Pliocene, *M. progenium* appears to favor a later reference.

10. *Pains Creek, Polk? County.*—In the collection of the Academy of Natural Sciences, Philadelphia, is a tooth of *Mammut americanum* recorded as having been found on Pains Creek, 50 miles from Tampa. It appears to be a second milk molar; the length is 43 mm., the width at the second crest likewise 43 mm.

There is a Big Pains Creek in the northwestern corner of Polk County, which empties into Peace Creek. A little further south is Little Pains

Creek, which empties into Peace Creek in De Soto County, near Bowling Green. On which of these the tooth was found can not be determined.

11. *Peace Creek, De Soto County.*—In the U. S. National Museum (No. 1990) is an upper right hindermost molar recorded as having been found on Peace River. It was a part of the exhibit of the Plant System at the Centennial Exposition at Atlanta, Georgia. It is credited also to the Peace River Phosphate Company. Probably the tooth was found somewhere not far from Arcadia. Leidy (Bull. 84, U. S. Geol. Surv., p. 129) does not record the species from Arcadia, but his undetermined species of the genus may have been *M. americanum.*

The tooth mentioned above has five cross-crests and a conical talon. At the ends of the transverse valleys are large tubercles.

ALABAMA.

(Map 5.)

1. *Bogue Chitto, Dallas County.*—The U. S. National Museum contains 3 or 4 fragments of large molars of *Mammut americanum* found not far from the town named. One fragment is labeled as having been found in section 10, township 17 north, range 7 east. This would probably be 6 or 7 miles west of north from the town named. Another fragment is said to have been found in the bed of Bogue Chitto. The teeth were sent to the U. S. Geological Survey by Crawford P. Lewis. From this same region there have been collected remains of *Elephas imperator* and *Equus leidyi.*

MISSISSIPPI.

(Map 5.)

1. *Perthshire, Bolivar County.*—In the U. S. National Museum is a fragment, the rear end, of an upper left hindermost molar of *Mammut americanum,* received from Pertshire in August 1914. It is the gift of Mr. S. D. Knowlton and was reported as having been sucked up with gravel from the bed of Mississippi River. This place is in the northern part of Bolivar County and immediately south of latitude 34°.

2. *Caseilla, Tallahatchie County.*—The writer has seen a lower left last molar of a mastodon, found in 1915, near this place. It was sent to the U. S. National Museum for identification by Dr. B. Franklin, of Caseilla. He stated that the tooth had been found in Avant Creek, about 3 miles above its entrance into Yalobusha River, apparently in the southeastern corner of Tallahatchie County, in township 23 north, range 7 west. The tooth had been buried in joint clay. The banks of the creek are usually about 10 feet high, but where the tooth was found, on the south side of the creek, the bluff is about 50 feet high.

3. *Jackson, Hinds County.*—In the collection of the Academy of Natural Sciences of Philadelphia is a lower left last milk molar, presented by Dr. Isaac Lea and reported to have been found near Jackson, Mississippi. No additional information was furnished. The tooth is but slightly worn and has complete roots.

4. *Vicksburg, Warren County.*—In the U. S. National Museum (No. 344) is a fragment of an upper right last molar, said to have been found at Vicks-

burg. The fragment consists of the hindermost crest and the talon. In Wailles's report on the geology of Mississippi, 1854, page 284, there is a statement to the effect that mastodon remains had been found in the deep cut of the railroad at Vicksburg.

5. *Bovina?, Warren County.*—In Wailles's report, just cited, it is stated that mastodon bones had been found in the vicinity of Big Black River, near the eastern line of Warren County. While the statement is rather indefinite, the locality is probably somewhere in the region about Bovina, on the railway from Vicksburg to Jackson.

6. *Claiborne County.*—According to Dr. Leidy (Proc. Acad. Nat. Sci. Phila., 1859, p. 111), portions of jaws with teeth of mastodons have been found in this county, associated with a skull of a bear which he could not distinguish from that of *Ursus americanus.*

7. *Jefferson County.*—In Wailles's report of 1854 (p. 284), already cited, it is stated that remains of the mastodon had been found in this county, near the former town of Greenville. The writer has not been able to learn more exactly where this town was situated.

8. *Natchez, Adams County.*—The region about Natchez is a fertile one for remains of mastodons and various other fossil vertebrates. The first mention of the finding of fossils here appears to be a note by S. L. Mitchill in 1826 (Cat. Organ. Remains, p. 10), who presented two teeth to the Lyceum of Natural History, New York. G. Troost, in 1835 (Trans. Geol. Soc. Penn., vol. I, p. 143), stated that he had in his cabinet a tooth of a mastodon, found near Natchez.

In 1845 (Proc. 6th Meet. Assoc. Amer. Geologists and Naturalists, pp. 77–79), M. W. Dickeson read a paper on the geology of the Natchez bluffs, in which he mentioned the occurrence of mastodons.

In 1846 (Proc. Acad. Nat. Sci. Phila., 1846, p. 106), the same writer exhibited at the Academy a large collection of fossil bones which had been made near Natchez. His account treats especially of the remains of *Megalonyx jeffersonii* and a human pelvis; but it is mentioned that the deposit abounds in bones and teeth of the mastodon. Dickeson stated that the stratum which contained these organic remains is a tenacious blue clay which underlies what he called the diluvial drift east of Natchez. This "drift" is now regarded as being mostly loess.

Lyell, in 1846 (Second Visit to U. S. N. A., ed. 2, vol. II, p. 195), wrote that mastodon remains had been found in the loam (loess) which contained land-shells at different depths.

Hilgard in 1860 (Geol. Agric. Mississippi, p. 196) gives a list, furnished by Dr. Leidy, of the mammalian fossils which had been found "in a solid blue clay said to belong to this formation" (the Bluff formation). Mastodons are said to be by far the most common. At Pine Ridge, 6 miles north of Natchez, in townships 7 and 8 north, range 3 west, mastodons and other mammals occurred at a depth of about 20 feet from the surface, in a ravine. The list referred to was quoted from Wailles's report of 1854 (Agric. Geol. Mississippi, pp. 285, 286).

Leidy, in 1889 (Trans. Wagner Inst., vol. II, p. 9), in speaking of the occurrence of human remains at Natchez, referred to the occurrence of the mastodon at this place. McGee, in 1891 (12th Ann. Rep. U. S. Geol. Surv.,

pt. 1, p. 399), in discussing the geological conditions at Natchez, stated that several nearly perfect skulls of the mastodon and at least one of the American elephant had been discovered at Natchez. His idea was that some of these remains had been found in the brown loam and some in the gravelly beds well down toward the Port Hudson clays.

In his discussion of the loess at Natchez, Shimek, in 1904 (Bull. Labs. Nat. Hist., Univ. Iowa, p. 305), expressed doubt about the occurrence of mastodons and other vertebrates in the loess.

In the collection at Yale University is a large lower jaw of *Mammut americanum*, labeled as found at Natchez. Both rami are represented and each has in it the second and third molars. The hindermost molar is but little worn. The second molar is 115 mm. long and 87 mm. wide, the third molar 188 mm. long and 93 mm. wide. The spout at the front of the jaw is cut off square and is rough, but there are no sockets for tusks.

For further consideration of the Pleistocene geology at Natchez and a list of the species of vertebrates found there, the reader is referred to pages 389 to 393.

9. *Pinckneyville, Wilkinson County.*—On page 284 of Wailles's report of 1854 he stated that mastodon bones had been obtained in Bayou Sara, near Pinckneyville.

10. *Between Zeiglerville and Pearce, Yazoo County.*—In the U. S. National Museum (No. 10275) is a right ramus of the lower jaw of a mastodon, found on the farm of Mr. R. L. Fisher, about 8 miles northwest of Vaughan. This jaw was sent to the U. S. National Museum by Mr. R. H. Douthat, secretary of the Yazoo Commercial Club, of Yazoo City. The specimen had been washed out of its place of burial along a creek. From Mr. Fisher the writer has received the information that the jaw was found along Teshacah Creek, in section 9, township 12 north, range 1 east. It appears to have been buried at a depth of about 15 feet.

The length of the jaw from the rear to the front of the penultimate molar is 630 mm., to the front of the beak 808 mm. A part of the front of the jaw has been broken off during exhumation, as shown by the photographs. The height at the middle of the length is 195 mm. The coronoid process rises 400 mm. above the lower border of the jaw. There are present the hindermost and the penultimate molars. The hindermost is 220 mm. long and has five crests and a low rough talon. In the front of the jaw is a part of the socket for an incisor tusk which had a diameter of about 40 mm. Apparently the jaw is to be referred to *Mammut progenium.*

11. *Woodville, Wilkinson County.*—From Mr. W. L. Ferguson, of Woodville, the writer has received a letter, with a photograph showing jaw-bones, with teeth, of one or more mastodons found near Woodville. Some fragments of tusks, a part of a skull, and some vertebræ were also found. The information is sent that these remains were buried under 30 feet of deposit. They were found on the bank of Dunbar Creek, a tributary of Bayou Sara, in township 1, range 3, section 24.

On pages 385 to 389 will be treated the geology of this region; but at the present it would be unsafe to refer these mastodons to any particular stage of the Pleistocene.

TENNESSEE.

(Map 5. Fig. 23.)

1. *Kingsport, Sullivan County.*—The writer was informed by Mr. George P. Torbett, a newspaper man, that D. M. Lafitte, of Bristol, Tennessee, had a tooth of a mastodon, found near Kingsport. Mr. Torbett had seen the tooth and recognized its similarity to a mastodon tooth shown him.

2. *St. Clair, Hawkins County.*—Dr. S. W. McCallie, State Geologist of Georgia, writing in 1892 (Science, vol. xx, p. 333), reported that a mastodon tooth had been found somewhere in that county. On making inquiry of Dr. McCallie the writer received the information that the tooth was found about 3.5 miles nearly due east from St. Clair and about 7 or 8 miles south of Rogersville. The tooth was presented to the University of Tennessee.

3. *Mossy Creek, Jefferson County.*—The writer has received from Mr. W. C. Bayless the information that a mastodon tooth had been found 3 miles south of the place named. The more exact locality is given as the farm of John Silver, 0.75 mile north of Bays Mountain. The tooth was discovered under a white oak stump, at a depth of 6 feet. It was 7.5 inches long and had 5 cross-crests.

4. *Dandridge, Jefferson County.*—The geologist G. Troost, writing in 1835 (Trans. Geol. Soc. Pa., vol. 1, p. 142), stated that he had in his cabinet a tooth of a mastodon from the locality named.

5. *Neuberts Springs, 7 miles Southeast of Knoxville.*—Doctor McCallie, as cited above, reported the discovery of four molars of a mastodon in a fair state of preservation at a point 7 miles southeast of Knoxville. They were found beneath 30 inches of a yellow tenacious clay, in which occurred water-worn stones. In a communication to the writer, Dr. McCallie indicates that the remains had been buried at a time when Tennessee River flowed at a higher level than at present.

6. *Eleven miles West of Nashville, Davidson County.*—From Mr. William A. Nelson, a member of the Tennessee Geological Survey, the information has been received that some mastodon remains, including teeth, had been found 11 miles west of Nashville, just west of Mill Creek and about 200 yards from Cumberland River. The remains occurred in a very tough yellowish clay which occupied a solution channel in the Carter Creek limestone. This was at a depth of about 15 feet from the surface.

Under this number may be recorded the finding of a part of a lower molar of a young mastodon near Nashville, sent to the writer for examination by Mr. W. E. Myer, of Nashville, in 1920. It had been found in the north bank of Cumberland River, about 300 yards upstream from Lock A, in a bed of sand beneath nearly 30 feet of gravel. With it were found a calcaneum of a camel and some fragments of a shell of a turtle. In a thin bed of gravel just below this were discovered a tooth of *Equus leidyi*, a femur of a probably larger horse, and an antler of a small probably undescribed deer. Apparently these fossil-bearing deposits belong somewhere near the Aftonian interglacial stage. Remarks on the geology of this locality will be found on page 399.

7. *Williamson County, 11 miles Southeast of Nashville.*—The geologist Troost (vol. cit., p. 139) recorded the finding of mastodon bones and teeth

in the region noted. The locality was said to be about 0.5 mile from Liberty meeting-house. It must be in the extreme northeastern corner of Williamson County. In another spot not far away were found a tusk and a part of a tooth.

8. *Fayetteville, Lincoln County.*—From Mr. Wilbur A. Nelson, above mentioned, the writer learned in 1913 that Mr. W. F. Myer, of Carthage, had dug up, near Fayetteville, about two-thirds of the skeleton of a mastodon. Nothing more has been learned about this.

9. *Memphis, Shelby County.*—In 1850 (Amer. Jour. Sci., ser. 2, vol. x, p. 57), Dr. Jeffries Wyman reported that teeth of a mastodon had been found somewhere about Memphis. They were supposed to have been obtained from the diluvium of Mississippi River, and were found associated with *Castoroides, Castor,* and *Megalonyx.*

KENTUCKY.

(Map 5.)

1. *Ludlow, Kenton County.*—In the Sunday Star of Washington, D. C., for January 3, 1919, there appeared a reproduction of a photograph of a tusk, believed to belong to a mastodon, which had been found at Ludlow, opposite the lower end of Cincinnati. It was unearthed by the steam shovel in the course of excavating for the Southern Railroad, at a depth of 35 feet, in a gravel bank. It is reported to have a length of 6 feet 10 inches and a diameter of 7 inches. A part of the distal end is missing. According to the photograph, the tusk forms somewhat more than half the circumference of a circle whose radius is about 23.5 inches. The curvature and the thickness, as compared with the length, appear to indicate that it belonged to a mastodon, but the identity is not certain.

2. *Bigbone Lick, Boone County.*—At this place there have been collected an almost incredible number of teeth, skulls, and other bones of *Mammut americanum;* and these have been sent to many museums of this country and Europe. While skulls are said to have been found, no complete skeletons have ever been collected. In 1805, Dr. B. S. Barton (Med. Phys. Jour. Phila., vol. I, pp. 154–159) wrote of bones he had seen from this place. He quoted from a letter written by John Bartram to James Logan. Some Shawanese Indians had brought to Pittsburgh a tooth and a piece of tusk. They described a head as having a long nose and a mouth on the underside. They reported that there were at the Lick five whole skeletons; also a shoulder-blade which, when stood on end, came to the shoulders of a tall man. What they regarded as the long nose may be interpreted as a tusk. Probably some tons of mastodon bones have been collected at this place, but it is quite certain that nearly the whole of this important material has been lost. Further reference to the locality, its geology, and the species collected there will be made on pages 401 to 404, map 41.

3. *Bluelick Springs, Nicholas County.*—From an excavation made at this place by Mr. Thomas W. Hunter, in an attempt to restore the springs which supplied the once popular watering-place, there were taken a large quantity of bones of various animals, perhaps as much as two farm-wagon loads. The greater number of these bones belonged to the mastodon. Portions

of skulls were found, but no complete skull. There were in the collection perhaps 100 mastodon teeth and many tusks, but some of these may have belonged to elephants. In some cases the tusks show at the distal end evidences of abrasion by use. Several tusks are planed off on opposite sides, as if they had lain buried in the bottom of a stream, had been worn down flat by sand and gravel, and had then been turned over and planed on the other side. In Mr. Hunter's collection, seen by the writer, there are small tusks, probably deciduous upper or lower ones, which vary from 87 mm. to 115 mm. in length. Each one is slightly flattened, and has an outer layer of hard dentine or possibly enamel, which is smooth. When this has peeled off the underlying dentine is grooved and ridged longitudinally. The transverse diameters vary from 20 to about 27 mm. Some of these small tusks are straight, others are slightly curved. On page 405 will be given a list of the associated animals and remarks on the geology.

4. *Harrisonville, Harrison County.*—In the U. S. National Museum is a lower left penultimate molar of a mastodon said to have been found somewhere near this place. It was presented by Hon. M. L. Ross, through Mr. R. L. Garner. No details are known. The village mentioned is said to be near Cynthiana, but it is not on the maps at hand.

5. *Fayette County.*—In Kentucky University there is a lower left hindermost molar of a mastodon, labeled as having been found somewhere in the county.

6. *Drennon Springs, Henry County.*—In 1881, Mr. G. K. Greene, (2d Ann. Rep. Bur. Statist. and Geol. Indiana, 1880, p. 428) stated that the collection of the State University of Indiana contains a remarkably fine half of a lower jaw of a mastodon, found at the place named. Nothing more is known about it. In 1831, C. S. Rafinesque (Monthly Amer. Jour. Geol., vol. 1, p. 354) wrote that "Drennon's Licks had bones and mounds," indicating that at that early time fossil bones had been found there.

7. *Louisville, Jefferson County.*—In 1835, Dr. Richard Harlan (Med. and Phys. Res., p. 256) referred to statements made to the effect that several mastodon skeletons had been found in digging the canal around the falls of the Ohio, at Louisville. They were taken from the river banks, at a depth of several feet beneath the present soil. It was added that several pairs of tusks were arranged in a circle within which were remains of a fire and Indian tools. The authority for this story is hardly what one could desire.

8. *Smithland?, Livingston County.*—In the Academy of Natural Sciences at Philadelphia is a part of a lower left hindermost mastodon molar, labeled as having been found at the mouth of Cumberland River. It is credited to Dr. P. B. Goddard. No details have been preserved. Smithland is at the mouth of Cumberland River, but how far away from this town the tooth was found is not known.

FINDS OF ELEPHAS PRIMIGENIUS IN EASTERN NORTH AMERICA.

ONTARIO.

(Map 11.)

1. *Toronto, York County.*—In 1863 (Canad. Naturalist and Geol., vol. VIII, p. 399), Professor Alex. Winchell wrote that he had a cast of a tooth found at Toronto, and thought by him to belong to *Elephas primigenius*. The writer saw this cast at Ann Arbor, Michigan. It is evidently a lower right penultimate molar of the species mentioned. It is to be regretted that more information was not furnished as to the exact locality and the beds; it would be of interest to know whether it had been found in the interglacial deposits that occur about Toronto.

2. *Amaranth, Dufferin County.*—In 1908 (Bull. Geol. Soc. Amer., vol. IX, p. 387), Dr. Robert Bell reported the finding of the greater part of the skeleton of an elephant in a swamp in lot 9, range 7, of the township of Amaranth. The tusk was said to be 14 feet long and 8 inches in diameter. The context indicates that the remains were found at a moderate depth in shell marl.

In 1891 (Geol. Mag., dec. 3, vol. VIII, p. 504), Professor J. Hoyes Panton reported the discovery, in 1890, of bones of a mammoth at this place, impliedly in a bed of marl. There were 31 ribs, several vertebræ, a tusk 12.66 feet long, with a portion broken off; also a tooth weighing 16.75 pounds. From Mr. Simon Jelly, of Shelburne, the writer learns that the bones reported to have been found at Shelburne are the same as those reported from Amaranth. They had been exhumed by his brother, John Jelly, and were taken to Owen Sound and from there exhibited at county fairs for several years.

These bones, or a part of them, are at present in possession of Mr. Alexander Duke, of San Diego, California. A photograph of the tusk shows it has quite the length given for it. It is relatively slender, the base having a diameter said to be 9.5 inches. It is spirally twisted in the distal half. The atlas is present and stated to measure 16 by 9 inches. There is a small but distinct photograph of a hindermost molar, apparently an upper one. The tooth is 16 inches long, 7 inches high, and 3 inches wide. This is the length from the front of the grinding-surface to the base behind. The plates are not worn to the base in front. There appear to be 22 ridge-plates present, and 6 in a 4-inch line. The base of the tooth is straight; the ridge plates curve forward slightly as they ascend. The hyoid arch is preserved. The writer regards the specimen as being a large individual of *Elephas primigenius*.

This elephant lived after the Wisconsin ice-sheet had begun to withdraw. According to Taylor's map (Monogr. U. S. Geol. Surv., LIII, plate XIX), this region had become cleared of ice while the basin of Lake Ontario was still fully occupied by the glacier; but it is doubtful that the animal could have lived there at that time.

NEW YORK.

(Map 11.)

1. *Minoa, Onondaga County.*—Dr. Burnett Smith, of Syracuse University, sent the writer photographs of a lower hindermost molar of an elephant which, associated with a tusk, was found at this place, 8 miles east of Syracuse. Dr. Smith has ascertained that the tooth and the tusk were dug up during the construction of the West Shore Railroad. The tooth is quite certainly that of *Elephas primigenius*. It is worn down to the base in front, but retains a part of its large posterior root.

2. *Williamson, Wayne County.*—In the collection of Rochester University is a lower left hindermost molar tooth found at this place. Professor H. L. Fairchild informed the writer that the tooth was found on the Iroquois beach, but whether on the northern or southern side is not known.

3. *Pittsford, Monroe County.*—In 1842 (Zool. New York Mamm., p. 101, plate XXXII, fig. 2), J. E. De Kay described, under the name *Elephas americanus*, a tooth found at Perinton, about 10 miles east of Rochester and near Irondequoit River. A description of the discovery and of the locality had been given in 1837 (Amer. Jour. Sci., vol. XXXII, p. 377) by an anonymous writer. Two teeth and a tusk had been found in a sandy bank on the stream mentioned while a race was being made for a saw-mill. The tusk, and probably the teeth also, lay at a depth of 4 feet. The exact locality was described as being 2 miles north of the crossing of Erie Canal. This is in reality southeast of Rochester and near Pittsford. On page 59 is described a tusk of a supposed mastodon found at Pittsford in 1830.

De Kay regarded the animal as belonging to an undescribed species, but his name *Elephas americanus* had been applied to the mastodon by Cuvier in 1799.

On examining Fairchild's plates showing the recession of the Wisconsin ice-sheet (Bull. 127, State Mus. New York) it will be seen that the localities where the three specimens of *Elephas primigenius* have been found are close to the south shore of the ancient Lake Iroquois. The animals could not, therefore, have lived before the ice had nearly or quite withdrawn into the basin of the present Lake Ontario. They may have lived long after this, possibly up to, or near to, the beginning of the Recent. It is to be noted further that the locality of the molar tooth found at Williamson, Wayne County, is closer to the shore of Iroquois Lake than is that of any of the mastodons; so possibly this species existed somewhat longer than did the mastodon.

4. *Buffalo, Erie County.*—From the director of the Buffalo Society of Natural History, Dr. William L. Bryant, the writer has received photographs of a right upper hindermost molar of *Elephas primigenius* dredged from near the middle of Niagara River, opposite Buffalo. The tooth is 275 mm. long and 100 mm. wide on the worn surface. It is worn to near the base in front, but probably no plates are wholly lost. There appear to be about 24 present. It appears probable that the tooth had not been carried far after being washed from its resting-place. Although it probably belongs to the Wisconsin stage, there is a possibility that it was washed out of some older Pleistocene deposit.

5. *Queensbury, Warren County.*—Mr. C. A. Hartnagel, assistant State geologist of New York, informed the writer of the discovery, some 60 years ago, of a tooth of an elephant near Queensbury, situated near the southern end of Lake George. The tooth is labeled as found on the John Harris farm. The nature of the deposit in which it was buried is not known. It was found during the excavation of a cellar, therefore at no great depth.

The tooth is a lower right hindermost molar, worn on only about 8 plates and not to the base in front. About 7 plates are missing from the rear. There are present 17 ridge-plates. The length along the base is 250 mm.; originally it must have been close to 350 mm. On a lateral face there are only about 7 of the plates in a 100-mm. line. Nevertheless, the writer regards the tooth as belonging to *E. primigenius*. It is unusually long for the species; hence the plates are thicker, quite as thick as some specimens of *E. columbi*. However, the enamel, as shown on the worn face, is much thinner than that of *E. columbi* and comparatively little folded. The plates are only moderately concave on the hinder face. The height of the tooth at the ninth plate is 140 mm.

6. *Lewiston, Niagara County.*—From Mr. C. A. Hartnagel the writer received information of the finding of a tooth of an elephant at Lewiston; and later the tooth was sent for examination. It proved to belong to *E. primigenius* and to be the upper right hindermost molar. Inasmuch as it is worn to the base in front and as the large anterior root is missing, some plates, probably at least two, are missing. There are 22 present. The tooth is worn back to the tenth from the rear. The length, as the tooth is preserved, is 275 mm. The height at the tenth plate from the rear is 160 mm., not including the base of the roots. The greatest thickness is 85 mm. On the lateral face are 9 plates in a 100-mm. line. The base of the tooth is straight; the hinder border of the crown, arched.

Mr. Hartnagel stated that besides the tooth some fragments of other teeth and two atlases were found at the same place. Evidently more than one animal was present. The remains here described were discovered at least 20 feet below the gravel-bed at that place and 80 feet below the level top of the terrace at points where it was not eroded. The bones and teeth appear to have been scattered through a bed of sediments at least 6 feet in thickness. The remains described above were mentioned by Kindle and Taylor on page 13 of Folio 190 of the U. S. Geological Survey, but were referred to a mastodon. The writers described the deposit in which the tooth was found. The geological age was believed to be that of the Iroquois episode of the Wisconsin.

NEW JERSEY.

(Map 11.)

1. *Trenton, Mercer County.*—In the collection at Princeton University is an upper right last molar of this species recorded as having been found at Trenton. It was discovered in the bluff of Delaware River, just outside the fence of the Riverview cemetery, about 12 feet from the surface. The tooth was given to Dr. Marcus S. Farr by Dr. C. C. Abbott, and to him

by Dr. Ward, of Trenton. Dr. Abbott was certain that it was found in the Trenton gravels. Further mention will be made of this on page 394.

2. *North Plainfield, Union County.*—In Rutgers College is a considerably weathered elephant tooth referred to this species. It was found on Greenbrook road, 2 miles east of North Plainfield. There are about 12 ridge-plates present in the specimen. This locality is on the border of the Wisconsin drift moraine, and the elephant tooth was probably buried in outwash from the moraine.

PENNSYLVANIA.

(Map 11.)

1. *Brookfield, Tioga County.*—In the U. S. National Museum (No. 193) is a part of an upper molar of *Elephas primigenius* sent in 1889 by Mr. Ira Sayles, of Brookfield. It was found along the north fork of Cowanesqua Creek. The hinder 13 plates are present. Mr. Sayles, in a letter to the present writer, stated that originally the tooth had 8 more enamel plates. This would seem to indicate that the tooth is the hindermost molar. Ten of the plates on the side of the tooth are crossed by a line 100 mm. long. The animal probably belonged to the Late Wisconsin stage.

2. *Chadd's Ford, Chester or Delaware County.*—In the collection of the Academy of Natural Sciences, Philadelphia, is a fragment of an elephant tooth labeled as found in kaolin deposits owned by W. W. Jeffries and G. B. Dillingham. The specimen was described by Leidy (Proc. Phila. Acad., 1875, p. 121). In this fragment are six ridge-plates, and a line crossing them measures 60 mm. The tooth appears to have belonged to *Elephas primigenius.* Leidy stated that it had been found lying on the kaolin bed, 8 feet below the surface.

In the same collection is a fragment of a tooth to be referred to *E. primigenius,* consisting of three plates, apparently presented by I. McClure. It is said to have been found in Chester County, but no more exact locality was named.

3. *Harvey's, Greene County.*—From Mr. Andrew J. Waychoff, of Waynesburg, the writer has received for examination a lower jaw of a young individual of *Elephas primigenius* found near the place named. Professor Edwin Linton sent the information that it was discovered in the bed of Gray's Fork of Ten-mile Creek, about 0.25 mile west of Graysville. In the jaw are the second true molars, right and left, slightly worn. The length of each is 165 mm., the width 62 mm.

4. *Lone Pine, Washington County.*—From Professor Edwin Linton, of Washington and Jefferson College, the writer received a photograph of an elephant tooth found at Lone Pine. This place is located on Little Ten-mile Creek, 7.25 miles southeast of Washington. Professor Linton writes that a 100-mm. line crosses ten of the ridge-plates on the side of the tooth. The photograph shows that there are 20 plates present, of which 12 are worn more or less.

5. *Beaverdam, Erie County.*—In 1828 (Amer. Jour. Sci., vol. xiv, p. 31), Mr. Jeremiah Van Rensselaer described a tooth which must have been that

of *Elephas primigenius*. It had been found near Lake Erie, at a place called Beaverdam, near a small rivulet, and at a height of 600 feet above the lake. He stated that there were 13 layers of enamel in a line 4.5 inches long. The tooth was sent to the Lyceum of Natural History, New York, but was probably destroyed in a fire at the old American Museum of Natural History.

OHIO.

(Maps 11, 36.)

1. *Waverly, Pike County.*—In the U. S. National Museum is an upper molar of an elephant said to have been found in a gravel-pit of the Norfolk and Western Railroad, at Waverly. It was sent to the Smithsonian Institution in 1900 by Mr. E. Sehon, who stated that the tooth had been picked up along the railroad mentioned, about 30 miles south of Kenova, West Virginia, but that the gravel had been loaded on the cars at Waverly. The tooth is believed to be the hindermost milk molar. There are 10 plates in a line 100 mm. long. The Pleistocene geological conditions at Waverly may to some extent be learned by consulting Leverett's paper forming Monograph XLI of the U. S. Geological Survey, pages 101–104. There is a possibility that this tooth was buried in gravels older than the last glacial stage.

2. *Zanesville, Muskingum County.*—In 1853 (Amer. Jour. Sci., ser. 2, vol. XV, pp. 146–147) is found a brief account of the discovery of elephant remains at Zanesville. One tusk and four molars were found. Two of the latter weighed (probably while wet) 20 pounds each and two others 14 pounds each. They had been found on the line of what was then called the Ohio Central Railroad and in the eastern part of the city. At about the same time (Proc. Boston Soc. Nat. Hist., vol. IV, p. 377) Warren exhibited a tooth of an elephant, one of three received by him from Zanesville (misprinted Lanesville). In the second edition of his monograph on "Mastodon giganteus" Warren figured one of these teeth (his plate XXVIII). It was stated that he had four of the teeth, all belonging to *Elephas primigenius*. These are now in the American Museum of Natural History, New York. The right upper hindermost molar is a fine large tooth. The large front root is missing, as are quite certainly about 3 plates. There are now 28 present. The length along the nearly straight base is 335 mm. The rear is high and arched. There are 9 plates in a 100-mm. line and the enamel is little festooned. Foster, in 1857 (Proc. Amer. Assoc. Adv. Sci., 10th meeting, p. 156), described the discovery and exhumation of these remains, publishing a geological section illustrated by a figure. The elephant bed is 37 feet above the river and over 20 feet from the surface. In the collection of the State University at Columbus (No. 5296) is a fine upper hindermost molar of *Elephas primigenius* credited to T. W. Lewis and said to have been found at Zanesville. There are nine or ten plates in a 100-mm. line. Zanesville is situated in the unglaciated part of the State; but outwash from both the Illinoian and the Wisconsin glaciers has been deposited along the river. For a knowledge of the Pleistocene epoch in that region, Leverett's work may be consulted (Monogr. U. S. Geol. Surv., vol. XLI, p. 158, plate II).

3. *Duncan Falls, Muskingum County.*—In the U. S. National Museum (No. 308) is a tooth, apparently the first true molar, of *Elephas primigenius* labeled as having been found on Salt Creek, in the county named. Salt Creek is situated in the eastern part of the county, flows southward, and empties into Muskingum River at Duncan Falls. This tooth is probably the one mentioned by J. W. Foster in 1857 (Proc. Amer. Assoc. Adv. Sci., 10th meeting, 1856, p. 158) as having been found near the mouth of Salt Creek and then owned by Mr. A. C. Ross.

4. *Millport, Columbiana County.*—From Professor Edwin Linton, of Washington and Jefferson College, Washington, Pennsylvania, the writer received a letter stating that there is in that institution a tooth of an elephant found in section 7 of Franklin Township (17 north, range 3 west), apparently about 2 miles northeast of Millport and on or near the stream Nancy Run. The locality is outside of the glaciated area. Probably the animal had lived during the Wisconsin stage, but there is a chance that it belonged to an earlier time.

5. *Mount Healthy, Hamilton County.*—In 1914, the writer received the photograph of a skull of *Elephas primigenius* which was found some years before at Mount Healthy. Professor N. M. Fenneman informed the writer that it was discovered on the farm of Barney Miller, in the bank of Whisky Run. Professor C. A. Hunt, of Mount Healthy, has sent the information that it was found in the bed of Taylor Creek, a branch of West Fork of Mill Creek, in the northeast quarter of section 28, township 3, range 1, of the Miami purchase. Taylor Creek is probably another name for Whisky Run. The skull was met with in deep alluvial sediment. At the time of Professor Hunt's writing it was in the possession of Mr. Jacob Kismer, North Side, Cincinnati. In 1920 it was purchased for the U. S. National Museum (No. 10261).

The front of the skull is preserved from the vertex to the front of the premaxilla. A part of one tusk, about 4 inches in diameter, is present. An upper molar was detached and later lost or otherwise disposed of. The one present has 10 ridge-plates in a 100-mm. line. Leverett (Monogr. XLI, p. 283), in speaking of drift deposits in Mill Creek Valley, stated that the greater part of the drift is Illinoian. Professor Fenneman (Bull. 19, Geol. Surv. Ohio, p. 158) refers the deposit to the Wisconsin stage.

15. *Butler County.*—In the collection of the Academy of Natural Sciences at Philadelphia is an elephant tooth which is accredited to W. S. Vaux and labeled as having been found in Butler County. The tooth has now a length of 230 mm., but is worn down to the base in front and the large anterior root is missing. The width is 105 mm. It appears to be a large hindermost upper molar of *E. primigenius*. Nothing more definite is known about the locality. The whole country is covered with Wisconsin drift.

6. *Dayton, Montgomery County.*—In the collection of the Society of Archæology and History at the University of Ohio is a tooth of *Elephas primigenius* which, as reported by Professor W. C. Mills, was found near the middle of the eastern boundary of Montgomery County. This would not be far from Dayton. The locality is within the area covered by Wisconsin drift and the animal lived probably not far away from the foot of the retiring glacier.

7. *Selma, Clark County.*—In Earlham College, Richmond, Indiana, are two upper last molars, right and left, said to have been collected at Selma. There are nine ridge-plates in a line 100 mm. long. Nothing is known regarding the geological conditions connected with the discovery, except that the locality is within the Wisconsin area.

8. *Versailles, Darke County.*—In the U. S. National Museum is an upper hindermost molar of *Elephas primigenius* (No. 4761), recorded as found in Wayne Township, on the farm of Foster Compton, in the northeast corner of the township. This would be probably about 4 miles north of east of Versailles. The country is level and was doubtless originally swampy. This tooth is apparently the one mentioned by A. C. Lindemuth in 1878 (Geol. Surv. Ohio, vol. III, pt. 1, p. 509). He stated that it had been picked up in the creek bottom just north of Versailles.

Under this number may be recorded a tooth of *E. primigenius* found many years ago by George H. Teaford, about 2 miles southeast of Palestine, in Darke County, and now in the collection in the public library at Greenville. It is a lower left hindermost molar. There are 20 plates present and evidently a few are missing from the front.

9. *Jersey, Licking County.*—In the collection of the Ohio State University, Columbus, are two large teeth of *Elephas primigenius* labeled as sent from this place and credited to D. D. Condit. The length along the base of one of the teeth is 286 mm. There are nine plates in a 100-mm. line and the enamel is unusually thin. This locality is on the western border of the Wisconsin terminal moraine and the animal belongs therefore to the Late Wisconsin stage.

10. *Chicago, Huron County.*—In the collection of the Society of Archæology and History, at the University of Ohio, the writer has seen a tooth of *Elephas primigenius,* labeled as having been found at this place, which is located on or close to the Defiance moraine.

11. *Kamms, Cuyahoga County.*—About May 1, 1911, Mr. F. W. Glenn, of Kamms, sent to the U. S. National Museum a photograph of a tooth which the present writer identified as belonging to *Elephas primigenius.* This town is about 4 miles from the shore of Lake Erie.

12. *Cleveland, Cuyahoga County.*—In the collection of Adelbert College, Cleveland, is a lower jaw of *Elephas primigenius* which was obtained here. Professor H. P. Cushing has furnished the writer photographs of this jaw, which belonged to a young animal, inasmuch as the hindermost milk molar had not wholly appeared above the bone. Of this tooth, six ridge-plates were crossed by a line 50 mm. in length.

This jaw was found in 1909, in making a sewer, in hitherto undisturbed materials, 22 feet from the surface. In the section at that point is found 22 feet of sand resting on till, the latter being the upper part of the glacial filling of the preglacial Cuyahoga Valley, 300 feet down to the rock. The jaw was at the base of the sands. Professor Cushing regarded the jaw as older than old Lake Warren and presumably as belonging to the time of Lake Whittlesey.

13. *New Berlin, Stark County.*—At Heidelberg University, Tiffin, Ohio, the writer has seen a well-preserved specimen of an upper second true molar

of *Elephas primigenius* found near New Berlin. There were counted 16 ridge-plates, of which 11 are in a 100-mm. line.

From Rev. J. P. Stahl, Alliance, Ohio, the writer has learned that this tooth was found about a mile south of New Berlin, in a small gravel hill along the Canton and New Berlin highway. The gravel was being removed to make a road-bed. New Berlin is on the Grand River moraine and the elephant belongs therefore to the Late Wisconsin stage.

14. *Amboy, Ashtabula County.*—In the Buffalo, New York, Natural History Society, the writer examined a tooth of *Elephas primigenius,* discovered at this place. It is the front half of the right upper hindermost molar. There are nine ridge-plates in a 100-mm. line. At the same place, and probably under the same geological conditions, were found teeth of *Elephas columbi.* These conditions will be described on page 329.

15. See page 135.

MICHIGAN.

(Map 11.)

1. *Three Oaks, Berrien County.*—Mr. C. K. Warren, of Three Oaks, has in his possession the upper and lower last molars, right and left, of an elephant which appears to have been found somewhere in the neighborhood of Three Oaks. These are large teeth and seem to the writer to belong to *E. primigenius.* The left upper tooth is 300 mm. long and 100 mm. wide. There are 22 plates. The tooth is worn back to the fourteenth plate, 170 mm. high. There are only seven plates in a 100-mm. line, but it must be taken into account that the tooth is a large one for the species. The plates are parallel with one another and the base of the tooth is straight. The enamel is thin.

One of the lower teeth has a length of 342 mm. The height at the first unworn plate, about the fourteenth, is 135 mm. On the outer face there are six plates in a 100-mm. line.

Not knowing exactly where these teeth were found or at what depth, not much can be said regarding them. However, the region about Three Oaks is occupied by Wisconsin drift and the animal quite certainly lived during the Late Wisconsin stage.

As shown by the map of mastodons in Michigan (map 8), at least three specimens of the American mastodon have been found in this county. It is extremely probable that the two species lived together.

2. *Eaton Rapids, Eaton County.*—In the Michigan Agricultural School, at East Lansing, is a lower jaw (No. 8260) of *Elephas primigenius,* found at Eaton Rapids, on the Grand River. Dr. A. C. Lane (Ann. Rep. Geol. Surv. Michigan for 1905, p. 553) says that it was found 2 miles below the town. It was found in 1904 by Charles H. Fry. The jaw contains a tooth on each side, and in front of each is a socket for a missing tooth. Behind the tooth is a cavity in the jaw for a succeeding tooth. The one present is taken to be the first true molar. There are present 13, possibly 14, plates. The length of the tooth is 123 mm., its width 51 mm. The enamel is thin and little crinkled. The jaw is 100 mm. high at the rear of the tooth present.

Eaton Rapids is situated on the Grand River, where the latter breaks through the Charlotte morainic system. In this county there have been found two mastodons, one about Belleview, the other in the vicinity of Olivet.

INDIANA.

(Map 11.)

In Area Covered by Illinoian Drift.

1. *Otter Creek Township, Vigo County.*—In Ward's Natural History Establishment, Rochester, New York, the writer saw a pair of upper second molars which, in 1885, were found in Otter Creek Township. They were dug up on the farm of W. H. Stewart, while making a ditch in low ground. From information received from Mr. S. D. Humphrey, North Terre Haute, it appears that the locality is not far from the common meeting-point of sections 8, 9, 16, 17 of township 13 north, range 8 west. The complete tooth, the one of the left side, had 22 plates and a front and a rear talon. The length was 248 mm., the width 96 mm. There were 10 plates in a line 100 mm. long. This thinness of the plates is evidence as to the specific identity of the animal.

2. *Madison, Jefferson County.*—The collection of the Academy of Natural Sciences, at Philadelphia, contains a large lower last molar of the right side, presented by Dr. Hallowell in 1840, and labeled as coming from Madison. The length is 245 mm., and there are 9 plates in 100 mm. This tooth was mentioned by Dr. Leidy in 1869. From the information furnished one can conclude only that *Elephas primigenius* once lived in southern Indiana.

3. *Vevay, Switzerland County.*—Professor E. Danglade, of the U. S. Fish Commission, presented the U. S. National Museum a tooth (No. 7913), apparently a second true molar, possibly the first, of *E. primigenius*. There are 10 plates present. The tooth was found on the shore of Ohio River about 1.5 miles below Vevay, having been washed out of a gravel bank, and is much weathered. No exact conclusions about the age of the tooth can be drawn from the known facts.

In Area Between the Shelbyville and the Bloomington Moraines.

10. *Webster, Wayne County.*—In the collection of Earlham College are 2 elephant teeth, credited to Jehiel Bond and found on Nolands Fork, near Webster, Wayne County. One is the second molar of the right side of the upper jaw and is much worn; the other is the third upper molar of apparently the same side and is but little worn. These teeth were mentioned by the author in his report on the "Pleistocene Vertebrata of Indiana" (33d Ann. Rep. Geol. Surv. Indiana, p. 750), but he had not then determined to what species they belonged. A renewed study shows that they certainly belong to *Elephas primigenius*. With these teeth is a tusk which measures 1,800 mm. along the convex curve.

Webster is situated south of the Bloomington moraine, in a tract of country indicated by Leverett as covered by undulating drift, in part morainic.

The greater part of this political township, made up apparently of parts of townships numbered 13 north and ranges 8 and 9 west, is occupied by outwash deposits laid down by the Wabash River and brought from further north during the Wisconsin stage; but at present, at least, it is impossible to assign the animal to any particular division of that stage.

In Area North of Bloomington Moraine and South of the Mississinawa Moraine and the Wabash River.

4. *Windsor, Randolph County.*—In the collection at Earlham College, Richmond, Indiana, is a part of a tooth referred to this species. It is either the last milk molar or the first true molar of the right side of the lower jaw. There are present eleven plates and one or more is missing from the rear. The length along the base is 100 mm., the width is 55 mm. There are six plates in a line 50 mm. long. This tooth was found August 20, 1893, in the bed of Stony Creek, near Windsor. According to Leverett's glacial map of Indiana, this is just south of the Union City moraine near its junction with the Bloomington moraine. By what is known of the habits of this species it may have lived even when the glacial sheet was forming the Union City moraine.

5. *Winchester, Randolph County.*—In the collection of Earlham College is a lower molar of the right side, apparently the first, labeled as found at Winchester. No details are furnished. Winchester lies on the border of the Union City moraine and all the country about is occupied by Wisconsin drift. It is quite certain, therefore, that this mammoth lived at some time between the formation of the moraine mentioned and the end of the Pleistocene epoch.

6. *Fairmount, Grant County.*—Here was found, in 1904, the nearly complete skeleton of the mammoth mounted in the American Museum of Natural History in New York City. It has been described and figured by the writer (36th Ann. Rep. Geol. Surv. Indiana, p. 718, figs. 63, 64; Iowa Geol. Surv., vol. xxiii, p. 396, fig. 133). It was found on the farm of Mrs. Dora C. Gift, about 4 miles east of Fairmount. The location is in the southeast quarter of section 23, township 23 north, range 8 east. This information has been furnished by Mr. George Swisher, surveyor of Grant County.

This whole region is mapped by Leverett as being occupied by ground moraine of till plains, and the animal must have lived after the Wisconsin ice cleared away. A tract more or less morainic, an extension of the Union City moraine, is indicated by Leverett on his latest map as passing further south than Fairmount. At the earliest it must have been after the withdrawal of the ice from the Union City moraine that the animal lived. Considering the character of the surrounding country, the nature of the deposit inclosing the skeleton, and the depth at which it was buried, it might be supposed that it was not long after the formation of the Union City moraine that this elephant existed.

9. *North Liberty, St. Joseph County.*—From Professor A. M. Kirsch, of Notre Dame University, the writer received a photograph of an upper molar of *Elephas primigenius* found at New Liberty about 1905. This tooth is

worn to the base in front and to the fourth plate from the rear. Evidently several plates are gone from the front. Apparently 18 remain. The extreme length is 215 mm. The edges of the plates, as seen on the side of the tooth present a sigmoid curve. The enamel was evidently thin.

In Area North of Kankakee River.

8. *Crown Point, Lake County.*—Mr. G. W. Stose, of the U. S. Geological Survey, informed the writer that about 1888 he helped in exhuming some bones of an elephant near Crown Point, discovered in the construction of a large ditch in township 34 north, range 8 west. The bones lay in a swamp clay at a depth of 8 to 10 feet. A part of a tusk, one tooth, and one large bone were put in Guenther's Museum, Chicago. Another tooth (M^3) owned by Mr. Stose (No. 8067) was presented to the U. S. National Museum in 1914. It is worn to the base in front; 22 plates remain. The length of the tooth is 285 mm., and the width 100 mm. There are 8 plates in a 100 mm. line. The enamel is thin and little folded.

In Area Between the Wabash and Kankakee Rivers.

7. *Near Francisville, Pulaski County.*—The writer has received from Mr. W. D. Pattison, of Winamac, Indiana, two photographs of a tooth of an elephant which quite certainly belonged to *Elephas primigenius*. The locality is in the southwest quarter of the southeast quarter of section 20, township 30 north, range 4 west. According to Leverett's map, this is in a tract covered by Wisconsin ground moraine and but little above the level of the Kankakee marshes, the 700-foot contour-line being not far away. Just west of the place is a part of the Marseilles moraine. The spot must be very near Metamonong Creek.

11. *Rochester, Fulton County.*—The American Museum of Natural History, New York, has a well-preserved skull of *Elephas primigenius* which had been exhumed in the vicinity of Rochester. The exact locality is not known to the writer.

The specimen is supposed to have been a female. The tusks are slender and only 700 mm. long. The hindermost upper molar is present. It is 245 mm. long and 75 mm. wide. There are 10 plates in a 100-mm. line. There appear to be 25 or 26 plates present. The second molar was still in use and about 130 mm. long. This was a large elephant, the measurements falling only slightly below the specimen in that museum which was obtained near Fairmount, Grant County.

ILLINOIS.

(Maps 11, 38.)

1. *Cairo, Alexander County.*—The collection of the Buffalo Society of Natural History contains a tooth of an elephant, an upper left second true molar, apparently belonging to *Elephas primigenius*. It is reported to have been found at Cairo, at a depth of 95 feet below the bed of Ohio River. It was probably discovered in preparing the foundations of a railroad bridge. It has 15 ridge-plates, besides the front and rear talons. The length of the base, in a straight line, is 156 mm. There are 10 plates in a line 100 mm.

long, a number too great for *E. columbi*. The tooth is unworn. It has suffered no injury, as from being rolled along the river bed; hence the animal probably died near where the tooth was found. It is impossible to assign the tooth with certainty to any particular stage of Pleistocene times. It seems most probable that the animal lived at the time the Illinoian ice-sheet was only a few miles away; the depth at which it was buried in the filling of the river channel appears to lend confirmation to this view.

2. *Ashland, Cass County.*—In the U. S. National Museum (No. 2195) are some remains of an elephant, referred to *Elephas primigenius*, found at Ashland in the spring of 1901. The remains consist of pieces of one tusk, the symphysis of the lower jaw, the right and left upper hindermost molars, the right lower last molar, a fragment of the rear of a much-worn upper second molar, and another of a correspondingly worn lower second molar. They were found in tilling a farm near Ashland by Mr. J. W. Arnold, of Jacksonville, Illinois.

The upper teeth resemble greatly those figured by the writer in his report on the Pleistocene Mammalia of Iowa (Iowa Geol. Surv., vol. XXIII, plate LIX); but the teeth from Ashland are more worn than those found in Milwaukee. The last molars from Ashland are worn back to about the eleventh ridge-plate, and the second molar is worn so that only its rear portion remained. The length of the upper molars is about 275 mm. The height of the eleventh plate is 185 mm.; the breadth of the grinding-surface is 90 mm. One or two of the hinder plates are missing, but evidently there were at least 24. There are 9 or 10 ridge-plates in a 100-mm. line on the worn surface; farther towards the base 8 plates in the same space. The ridge-plates are little bent; the enamel is thin and little sinuous in its way across the worn surface of the tooth.

The lower last molar is 315 mm. long, 152 mm. high, and 85 mm. wide. It is thus longer than the upper molars, slightly narrower, and not so high.

A fragment of the hinder end of what appears to be the lower left second molar shows 7 ridge-plates remaining. These form two series, an inner and an outer, entirely separate from each other. This condition is sometimes seen in little-worn teeth.

The geology of this region may be studied on the Tallula-Springfield Folio, No. 188 of the U. S. Geological Survey. The Tallula Quadrangle includes a narrow strip of the eastern border of Cass County. Here the surface forms a nearly level prairie. According to the geologists Shaw and Savage, the surface in the region next to Cass County and much of the rest of the quadrangle is covered by a blanket of loess. Its thickness varies from 4 to 20 feet; under this, sometimes, in wells, is to be found a dark-colored ill-smelling deposit, of no great thickness, which is believed to represent the Sangamon stage. Underlying the loess everywhere is the Illinoian drift.

As regards the geological age of the elephant described above, it is quite certain that it lived after the Illinoian stage. It is quite probable, too, that its teeth and bones were found in the loess which overlies the Sangamon soil in some places in the quadrangle. This loess may have accumulated during the Iowan glacial stage or during the succeeding Peorian interglacial. Considering what we know about the habits of *Elephas primigenius*, it

appears most probable that the animal in question passed its life during some part of the Iowan.

3. *Kewanee, Henry County.*—In the collection of the University of Illinois, at Champaign, is a fragment of an upper molar of *Elephas primigenius*, found at Kewanee. It was discovered in 1910, in making an excavation for the National Tube Company, and was presented to the university by Mr. J. E. Kemp, at that time engineer in charge of the work of excavation. This gentleman has furnished very exact information regarding the discovery of the tooth and the nature of the deposits passed through.

Mr. Kemp himself saw the tooth taken out and states that it was found at a depth of about 12 feet. As to the materials passed through, Mr. Kemp writes:

> "After the first 2 feet of soil carrying organic matter we have 5 feet of yellow clay above the ground-water level, and below this approximately 3 feet of yellow clay which becomes very soft unless carefully drained before working. This yellow clay then merges into bluish clay, hard and better packed, going to a depth of approximately 20 to 21 feet. At this level we meet with that black soil which is known locally as 'the chip yard' and which contains vegetation and pieces of wood, as you describe. This 'chip yard' is a softer stratum than the overlying blue clay and caused difficulty in the excavation of a hole approximately 20 feet by 30 feet and 20 feet deep, as the vibration of the reciprocating engines in the building caused the bottom to rise in little hillocks over night, and the last 2 feet of excavation had to be dug out and 24 inches of concrete placed in the bottom, in order to preserve the excavation."

At Galva, 10 miles southwest of Kewanee, in cuttings along the railroad, is found a section which illustrates the geological situation at Kewanee (Monogr. XXXVIII, U. S. Geol. Surv., p. 126, plate X). There is at the top 4 feet of loess, 1 foot of Sangamon soil, 4 feet of Illinoian drift; in another section nearby there are 12 feet of loess, 2 feet of Sangamon soil, and 40 feet of Illinoian drift.

Another section at Galva is described by Leverett (op. cit., p. 130). The loess is 15 feet thick, beneath which is a mucky soil about 1 foot in depth, which caps the Illinoian till sheet. In this soil a log about a foot in diameter and several feet long was found embedded. Alden and Leighton (Iowa Geol. Surv., vol. XXVI, p. 170) mention this occurrence.

From these examples it becomes evident that the "chip bed" at Kewanee is a Sangamon soil overlain by loess. The elephant tooth at a depth of 12 feet must have been buried in the blue clay. This, however, is probably the unweathered part of the loess. If so, the mammoth tooth found at Kewanee is to be referred to the early Peorian stage.

4. *Penny's Slough, Henry County.*—In the collection of the Davenport Academy of Science is a large upper left hindermost molar tooth, labeled as having been found in Penny's Slough. It is very large, the length along the base being 357 mm. (about 14 inches), and the height of the eighteenth plate is 175 mm. There is an unusual number of the plates, apparently 27. There are 7 plates in a line 100 mm. long. The tooth is moderately worn. There are 2 large roots in front and 2 rows of smaller ones behind these. The base is straight and the plates little warped.

Mr. C. C. Martin, of Geneseo, Illinois, county surveyor of Henry County, has informed the writer that Penny's Slough is located in sections 17, 18, 19, and 20 of township 18 north, range 3 east, in the northern part of the county and on Rock River. On Leverett's glacial map of this region (Monogr. U. S. Geol. Surv., XXXVIII, plate VI) the area is indicated as being occupied by sand and gravel plains and terraces of Wisconsin age. It seems most probable that this elephant lived when the Wisconsin glacier was not far away. However, there is a variety of Pleistocene formations in that region and the elephant in question may belong to the Iowan or to the Illinoian glacial stage.

5. *Kendall County.*—In the collection of the National Museum is a plaster cast made from a tooth of *Elephas primigenius*, found somewhere in Kendall County, but the present location of the original tooth is not known. It had a length of 280 mm. along the base. There appears to have been 20 plates, 8 in a 100-mm. line. The tooth seems to have resembled greatly one of *E. primigenius* which was brought from Alaska.

Kendall County is mostly occupied by moraines formed during the Wisconsin stage of the Pleistocene, especially moraines which were built up just before the retirement of the ice into the basin of Lake Michigan. Probably the elephant which possessed the tooth lived during the latter part of the Wisconsin stage.

WISCONSIN.

(Map 11.)

1. *Milwaukee.*—In the Public Museum of Milwaukee are considerable parts of a mammoth skeleton (No. 5351) found within the limits of the city. These were secured in May 1898, in excavating for a sewer along Cold Spring avenue and between Twenty-ninth and Thirtieth streets. On learning of the discovery, Mr. George B. Turner, then taxidermist of the Milwaukee Public Museum, afterwards chief taxidermist in the U. S. National Museum, took charge of the excavations for the skeleton. He furnished the writer with an account of his work, giving a list of the bones, a plan of the area excavated, and a section of the deposits passed through. A description of the remains is given below:

	Feet.	*Inches.*
Filled-in materials	4	0
Clay and peat, mixed	1	0
Peat	1	3
Peat and clay, mixed	1	0
Peat, clay, and shells	1	0
Clear blue clay with the elephant bones at the bottom	4	6
Gravel and cobblestones	undetermined.	

As indicated in Turner's sketch, the surface of the gravel and stones sloped downward toward the north.

It will be seen that the bones were buried about 9 or 10 feet below the natural surface of the ground. The head of the elephant was directed toward the east, the hinder end toward the west. The parts found were within a distance of 10 feet from east to west. Later the excavations on each side of the sewer were extended eastward, as shown on the plan, in

an effort to find the skull, but without success, and iron rods 10 feet long, in two sections, were driven their full length horizontally everywhere around the excavation in the hope of recovering the skull.

For some time after the finding of these bones the theory prevailed that they had belonged to an elephant of one of the circuses which had made use of the ground near there. The fact that the lower jaw was found, but not the upper jaw and the brain-case, and only a part of the vertebræ and a part of the foot-bones, is sufficient to dispose of this theory. Also, some of the bones lack the epiphyses. Besides this, the elephant was neither the African nor the Asiatic species. It is evident that the animal after dying had lain on the surface for some time, so that the bones were somewhat scattered, perhaps by wolves or waves, and some were injured by exposure to the weather.

The following is a list of the bones found: Lower jaw, 5 cervicals, 9 presacrals, 31 ribs, both scapulæ, both humeri, both ulnæ, both radii, 9 wristbones, 14 metacarpals and phalanges, 1 femur and a fragment of the other, 2 tibiæ, 2 fibulæ, 17 metatarsals and phalanges.

It is evident that this elephant lived and died after the Lake Michigan ice-lobe had withdrawn from that vicinity. It may, however, not have been long after that withdrawal; for it is probable that the muddy waters from the foot of that glacial lobe furnished the blue clay which enveloped the bones. Later peat and muck and mixtures of these with clay accumulated over the blue clay. The place is within the area of what Alden has mapped as ground moraine of Lake Michigan glacier. The occurrence of peat and shells seems to show that there was a pond in which the elephant had been buried and afterwards covered with clay and peat.

Under this number must be included the fine palate and teeth found in excavating for a sewer on the South Side, at Milwaukee. The record as to exact location, depth, and kind of materials overlying it is missing. A description of it, with illustrations, was published by the present writer in 1912 (Iowa Geol. Surv., vol. XXIII, p. 409, plate LIX).

This individual probably had a history not greatly different from that of the Cold Spring Avenue elephant.

MARYLAND.

(Map 11.)

1. *Oxford Neck, Talbot County.*—In 1869, Cope (Proc. Amer. Philos. Soc., vol. XI, p. 178) stated he had seen in the collection of the Baltimore Academy of Natural Sciences two molars, the tusk, maxillary and premaxillary bones, and parts of frontals, with fragments of other bones, which he referred to *Elephas americanus* Leidy. These, it is supposed, were remains of *E. primigenius*. Lucas (Maryland Geol. Surv., Pliocene and Pleistocene, 1906, p. 164) refers to these remains and identifies them as certainly those of *E. primigenius*. He found a smaller tooth of this species which had come from Oxford Neck. Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, 1869, p. 255) speaks of the teeth, tusks, and the other parts mentioned above.

VIRGINIA.

(Map 11.)

1. *Saltville, Smyth County.*—In 1914, Mr. H. D. Mount, of the Mathieson Alkali Works, of Saltville, sent to the U. S. National Museum some remains of an elephant, identified as *Elephas primigenius*. These were found about 1896 in making an excavation for the water reservoir. The most important parts sent are teeth, whole or fragmentary, and appear to represent three or four individuals. Among the teeth is a complete but considerably worn upper left hindermost molar and an unworn upper second true molar. The former indicates the presence of 23 ridge-plates; the latter 16 of them. Remarks on this discovery and a list of all the species secured will be found on page 352.

NORTH CAROLINA.

(Maps 11, 39.)

1. *Inland Waterway Canal, Carteret County.*—In the collection of the State Museum, at Raleigh, the writer has seen an upper hindermost molar (A. N. 1326) which certainly belongs to this species and which is said to have been dredged up in Core Creek. The creek forms a part of the Inland Waterway which joins Neuse River with the harbor at Beaufort. The molar was presented to the State collection by Mr. H. T. Paterson, U. S. assistant engineer, now of Newbern, North Carolina. From the director of the museum, Professor H. H. Brimley, the writer has received photographs of this fine tooth. In the same canal was found a jaw of a mastodon which is mentioned on page 117. From Mr. Paterson the writer has received the important information that the tooth was found in Core Creek about 8.5 miles from Beaufort, in 1909, while dredging a sedimentary deposit varying from 6 to 8 feet in depth, containing numerous cypress stumps and roots and underlain by a deposit of sand mixed with shells and other fossils. Into this the dredge went from 6 to 8 feet.

The tooth is worn to the base in front and a very few plates are probably missing. Nevertheless, there are still 22 or 23 remaining. The base of the tooth is nearly straight and the ridge-plates are but little curved. The length of the base is 232 mm. Measured along the side of the tooth are 11 ridge-plates in a 100-mm. line. The enamel is unusually thin, being about 1.3 mm. in thickness, and but little undulating across the grinding surface.

It is believed that the deposit containing this elephant tooth and the cypress stumps belongs to the first interglacial, while the underlying sands containing marine fossils belong to the Nebraskan glacial stage.

FLORIDA.

(Map 11.)

1. *Palma Sola, Manatee County.*—Mr. Charles T. Earle, an enthusiastic collector living at this place, sent to the U. S. National Museum in 1921 various lots of vertebrate fossils which had been washed up on the beach at Palma Sola. Among the fossils belonging to the Pleistocene is a tooth, a right lower second milk molar, which must apparently be referred to *Elephas primigenius*. It is much worn, the plates present rising above the

base only about 10 mm. The anterior root and the posterior had been considerably absorbed. Only 4 ridge-plates remain; evidently at least 1 had wholly disappeared from the front, and 2, possibly 3, from the rear. The original length of the tooth can not be determined. The width is 30 mm. The 4 enamel plates present, together with the portion of cement belonging to each, occupy a length of 30 mm. The enamel is thin.

It would be more surprising to find this species in Florida had it not already been discovered in North Carolina and at two places in Texas, Temple and near San Antonio. One can not state with certainty the stage of the Pleistocene during which this individual lived, but the writer believes that it was during an early stage, perhaps the first interglacial.

TENNESSEE.

(Map 11. Figure 23.)

1. *Whitesburg, Hamblen County.*—In a collection of fossil vertebrates sent many years ago to the U. S. National Museum and described by the writer in 1920 (Proc. U. S. Nat. Mus., vol. LVIII, p. 85) is a fragment consisting of two plates from the rear of a penultimate milk molar, probably of the lower jaw. This is referred to *Elephas primigenius*. Of page 395 will be found a list of the accompanying species.

KENTUCKY.

(Map 11.)

1. *Bigbone Lick, Boone County.*—In the Academy of Natural Sciences at Philadelphia is a fine upper left hindermost molar, sent from the place named. There are present 23 or 24 plates. It is worn back to the apex of the eighteenth plate. The length along the base in a straight line is 253 mm.; there are therefore about 9 plates in a 100-mm. line. Some other teeth from the same place, now in the collection, were regarded as belonging to the same species.

In William Cooper's account of collections made at Bigbone Lick (Monthly Amer. Jour. Geol., vol. I, pp. 168–171) he showed that great numbers of teeth as well as bones of elephants had been collected at various times at this locality. He refers all to *Elephas primigenius,* but certainly many of them must have belonged to the species now known as *E. columbi.* Cooper mentions the discovery of a fine and nearly entire skull of an elephant, 4 feet long, having all of the teeth and one tusk in it. In the nearly 100 years that have elapsed this specimen has probably suffered destruction.

FINDS OF ELEPHAS COLUMBI IN EASTERN NORTH AMERICA

ONTARIO.

(Map 12.)

1. *St. Catharines, Lincoln County.*—In 1898 (Ottawa Naturalist, vol. XII, p. 137), Mr. L. M. Lambe stated that there was in the collection of the Geological Survey of Canada from this place a molar of a mammoth, purchased in 1887 by Mr. Whiteaves. It had been found while excavating under the opera house for a sewer, on Queen Street. In the collection of the Buffalo Society of Natural History the writer has seen a cast of a lower right hindermost molar, the original of which is said to have been found at St. Catharines. It was probably made from the tooth now in the collection at Ottawa. There are 22 plates; probably one or two may be missing from the front, and the wear extends over only 6 plates. Of these there are 7 in a 100-mm. line. The plates of the hinder half are considerably curved, and the hindermost ones lean strongly forward. The writer regards the tooth as that of *Elephas columbi.*

As shown by Fairchild's plate 17 (Bull. 160, New York Geol. Surv.) and Coleman's plate 22 (Bull. Geol. Soc. Amer., xv, p. 347) this town is situated within the Iroquois beach. The elephant could, therefore, hardly have lived at or before the time of the formation of the beach; in reality it probably lived long after the lake had retired to its present limits.

In his "Catalogue of Casts of Fossils," 1866, page 37, Henry A. Ward gave a figure of a cast of an elephant tooth, No. 143, the original of which was said to have been found at St. Catharines. This tooth may be the one now at Ottawa, but if so the figure is incorrect.

2. *Hamilton, Wentworth County.*—In 1863 (Canad. Nat. and Geol., vol. VII, p. 135), a lower jaw of an elephant was described under the name *Euelephas jacksoni* Briggs and Foster. This had been found near Hamilton, at the extreme western end of Lake Ontario. It was mentioned and figured as *Euelephas jacksoni* in the same year by W. E. Logan (Rep. Geol. Surv. Canada, p. 914, figs. 495, 497). The specific name, however, is not to be credited to Briggs and Foster, for it was proposed by W. W. Mather in 1838 (Amer. Jour. Sci., vol. XXXIV, p. 362, figures) for a lower jaw of an elephant found in Jackson County, Ohio. This jaw is, however, from the description and the figure, wholly indeterminable. Lambe (Ottawa Naturalist, vol. XII, p. 136) presents a short history of the specimen found at Hamilton. It was reported first by T. Cottle in 1852 (Ann. Mag. Nat. Hist., ser. 2, vol. x, p. 395; reprint in Amer. Jour. Sci., vol. XV, 1853, p. 282). Besides the jaw, lacking most of the left ramus, there was found a much-curved tusk nearly 7 feet long.

The writer has had the opportunity to examine this jaw, now in the Victoria Museum at Ottawa. It is believed to belong to *Elephas columbi.* The finely preserved last molar has been worn on about 9 of the ridge-plates, and this worn surface is about 110 mm. long. There are 24 plates present, and 8 of these occupy a 100-mm. line. The hinder plates lean forward and the base of the tooth is very convex.

Cottle reported that the remains were discovered at a depth of 40 feet from the surface and at an elevation of 60 feet above the level of the lake. It is stated on the label that the elevation above the lake was 70 feet, and this is the height given by Logan (Geol. Canada, 1863, p. 914). The author stated also that at an elevation of 7 feet more were found antlers of *Cervus canadensis* and the jaw of a beaver.

VERMONT.

(Map 12.)

1. *Mount Holly, Rutland County.*—In 1849 (Proc. Amer. Assoc. Adv. Sci., vol. II, p. 100), Professor Louis Agassiz exhibited before the members of the American Association for the Advancement of Science a tooth and a tusk of an elephant, discovered in making excavations for the Rutland and Burlington Railroad, somewhere on the slope of Mount Holly, Rutland County. It was said to have been found lying under an erratic boulder. Agassiz was doubtful as to the specific identity of the animal. In 1850 (Amer. Jour. Sci., ser. 2, vol. IX, p. 256), Zadock Thompson gave a brief account of this discovery. The remains were found, he said, in Mount Holly Township, at an elevation of 1,360 feet above sea-level, in a deposit of muck, at a depth of about 9 feet. This muck-bed is located on the divide between the streams which flow into Connecticut River and those which empty into Lake Champlain. In 1853 ("History of Vermont," App., p. 14) Thompson presented a more extended report on the discovery. This is reprinted in Edward Hitchcock's "Report on the Geology of Vermont," 1861, page 176. The elevation is given here as 1,415 feet; the location is said to be east of the summit station. On the Wallingford topographic sheet of the U. S. Geological Survey the station named Summit is shown to have an elevation of 1,500 feet. First, there was found a tooth lying on gravel beneath 11 feet of peat; soon afterward a tusk was discovered at a distance of 80 feet, and later the other tusk and some bones were met with not far away. The grinder was in an excellent state of preservation. The length of one tusk along the convexity of the curve is given as 80 inches, while the distance direct from the base to the tip was 60 inches. A figure of the tusk was given by Hager in the second volume of the 1861 report just referred to, on page 934. According to Agassiz's statement, the tooth and tusk were taken to the Lawrence Scientific School, Cambridge.

Dr. J. C. Warren ("Monogr. on *Mastodon giganteus*," ed. 2, 1855, p. 162, plate XXVIII, fig. B) figured and described the tooth. The length was given as 11 inches at the base, and the number of ridge-plates as 22. This would give an average of 8 plates in a 100-mm. line. This number and the general appearance of the tooth indicate that the animal was *Elephas columbi*, instead of *E. primigenius*. The difference between this tooth and that of *E. primigenius* is well shown by the figure of a tooth of *E. primigenius* from Zanesville, Ohio, figured on the same plate with the Vermont tooth. This tooth is now in the American Museum at New York.

Thompson reported the presence of many billets of wood, about 18 inches long, in the bottom of the muck, the work of beavers.

At the Davenport (Iowa) Academy of Natural Science the writer examined a tooth of an elephant labeled as having been found on Mount Holly in excavating for the Vermont Central Railroad. The length along the base is 300 mm., the height of the ninth plate is 160 mm., the length of the grinding-surface 160 mm. There are in all 24 plates, the 10 anterior ones of which are worn. There are 7 ridge-plates in a 100-mm. line, measured on one side of the tooth. This tooth is regarded as belonging to *Elephas columbi;* it certainly belonged to another individual than the one that Warren figured. It is almost certain that the animals represented by the teeth and skeletal remains found on Mount Holly lived after the retreat of the ice from those mountains; and one may suppose that local glaciers lingered long after the main ice-front had abandoned the region. The animals lived certainly as late as near the close of the Pleistocene, if not at the beginning of the Recent; they may have been living on those mountains while the basin of Lake Champlain was an arm of the sea.

NEW YORK.

(Map 12.)

1. *Homer, Cortland County.*—In 1847 (Amer. Jour. Agric. and Sci., vol. VI, p. 31, fig.), Samuel Woolworth reported that an elephant tooth had been found on the bank of a small stream, about 2 miles northwest of Homer. Emmons, in 1858 (Geol. Surv. North Carolina, East. Cos., p. 200), figured the same tooth. In his Manual of Geology (ed. 2, 1860, p. 242, fig. 207) he stated that this tooth was found in Cortland County. Henry A. Ward, of Rochester, advertised and sold casts of this elephant tooth, as the writer is informed by Mr. Frank H. Ward, of Ward's Natural Science Establishment. It is almost certain that this elephant lived in the neighborhood of Homer after the Wisconsin glacial ice had begun its retreat to the far north.

2. *Elmira, Chemung County.*—In the collection of the American Museum of Natural History in New York is a part of an elephant tooth (Cat. No. 10488) which the writer identifies as belonging to *Elephas columbi,* and which is recorded as having been found at Elmira. There are only 3 ridge-plates in the fragment. As to the time during the Pleistocene when this species lived in New York, all that can be said is that it was during the last half of the Wisconsin stage. No specimens have been found as close to the glacial lakes preceding Lake Ontario as in the cases of *Elephas primigenius,* but this may be due to accidents of preservation or to failures of discovery.

NEW JERSEY.

(Map 12.)

1. *Middletown, Monmouth County.*—In 1818 (Cuvier's "Theory of the Earth," p. 384, plate I, figs. 2, 5), S. L. Mitchill referred to a tooth of an elephant found somewhere about Middletown. In his "Catalogue of Organic Remains," 1826, page 10, Mitchill mentioned a singular boat-shaped tooth of an elephant, found on Bennett's farm, Middletown, New Jersey. Both references are to the same tooth; the shape was due to the wear the tooth had suffered. It was said to come from the region where

the horse remains were obtained. This tooth was a lower right hindermost molar, much worn. It evidently belonged to *Elephas columbi.* We have no other information about the specimen. It appears probable that the deposits which yielded remains of horses and of elephants are to be referred to an interglacial stage, at least as old as the Sangamon. The finding of a bone of *Megatherium* along the New Jersey coast suggests that the Aftonian may be represented there.

PENNSYLVANIA.

(Map 12.)

1. *Rogersville, Greene County.*—The writer has received from Mr. Andrew Waychoff, of Waynesburg, a small photograph of a lower hindermost molar, found 3 miles south of Rogersville, in the bed of Hargus Creek. The tooth was found about 1909 or 1910 and passed into the possession of Mr. Waychoff; but it had been broken by the finder, who wished to see what was in it. The tooth has 8 ridge-plates in a 100-mm. line and the form and arrangement of the plates indicate that it belonged to *Elephas columbi.* It is impossible to determine, with the knowledge at command, the stage of the Pleistocene to which this animal is to be assigned.

2. *Pittsburgh, Allegheny County.*—In 1910 (Science, n. s., vol. xxxi, p. 31), an anonymous note stated that there was in Carnegie Museum of Natural History an enormous tusk, supposed to be of this species, found in the banks of the Allegheny River, in a suburb of Pittsburgh. There is, however, no certainty that the tusk was not that of *E. primigenius* or of *Mammut americanum.* In either case it would be difficult to refer the animal to any definite Pleistocene stage.

3. *Tryonville, Crawford County.*—In 1892, Mr. H. Roberts sent to the Smithsonian Institution considerable parts of a skeleton of *Elephas columbi,* including the hinder part of a lower molar, probably the penultimate. These remains had been found in digging a cellar in Tryonville, at a depth of 7 feet. Tryonville is on Oil Creek and in the eastern part of the county. From Mrs. A. A. O'Dell, Niagara Falls, New York, daughter of Mr. Roberts, the writer learns that the cellar was at a height of 80 feet above the level of Oil Creek. Since that time the creek has abandoned its channel at that point.

OHIO.

(Maps 12, 36.)

1. *Stark County.*—In Princeton University is a large lower left hindermost molar catalogued as having been found in Stark County. The tooth has 24 ridge-plates and is worn back to the fourteenth from the front. The length from the front of the tooth to the base of the last plate is 315 mm. There is no exact record of the locality. The Grand River moraine of the Wisconsin ice covers most of this county, so that the animal probably lived after the ice had disappeared from that vicinity.

2. *Amboy, Ashtabula County.*—In the collection of the Buffalo (New York) Natural History Society is a small elephant tooth, evidently a second milk molar, found at Amboy. It is regarded by the writer as belonging to *Elephas columbi.* There are present 7 ridge-plates and all have suffered wear. The length from front to rear is 114 mm.

In the Case School of Applied Science, Cleveland, is a large lower right hindermost molar of an elephant found at Amboy, in the extreme northeastern corner of the State. There is a description and figure of this tooth in the Scientific American for January 23, 1904, on page 60. It is there called *Elephas primigenius*. It presents 23 plates and front and rear talons; the length from the base in front to the rear of the hinder talon is 295 mm. There are from 6 to 8 plates in a 100-mm. line. The tooth was found between 1890 and 1900 in a gravel-pit near Amboy, worked by the Lake Shore Railroad. In the same pit was discovered a tusk which may have belonged to the same animal. A tooth of *Elephas primigenius* at the Buffalo Society of Natural History was probably found at the same place. The writer is informed by Professor Frank R. Van Horn, of the Case School of Applied Science, that the deposit consists of interstratified sands and gravels and is supposed to be the delta formation of the old Conneaut River. Its thickness was from 50 to 75 feet. In this deposit was driftwood, arranged in such regular order that it suggested the idea that it had formed part of a corduroy road.

MICHIGAN.

(Map 12.)

1. *Jackson County.*—In 1863 (Canad. Naturalist and Geologist, vol. VIII, p. 399), Alexander Winchell described an elephant tooth (No. 3163), found in this county. This is now in the collection at the University of Michigan, labeled *Elephas jacksoni*. The writer regards it as belonging to *E. columbi*. It is the much-worn hindermost tooth of the left side of the lower jaw. There are present 17 plates, and about 7 are missing from the front end. Above the bases of the rear plates are only 5 in a 100-mm. line; on the worn face are 7 plates in this distance. The anterior plates lean backward with respect to the base, while the hinder ones lean forward. The plates are more or less bent between base and apex. The Kalamazoo morainic system crosses the middle of Jackson County, running east and west.

In 1861 (1st Bien. Rep. Geol. Surv. Michigan, p. 132), Professor Winchell mentioned this tooth and stated that it had been found in the northern part of the county while a ditch was being made. The locality is, therefore, north of the moraine referred to above.

INDIANA.

(Map 12.)

1. *Terre Haute, Vigo County.*—In the State Museum at Indianapolis is a fine lower left molar of *E. columbi*, labeled as found, in 1896, near Terre Haute, on the farm of Aaron Conover, and presented by Earl Conover. Mr. Herbert C. Anderson, county surveyor of Vigo County, informed the writer that the farm is located in the southwest quarter of section 9, township 12 north, range 9 west. This is 3.5 miles north of Terre Haute. The place is near Wabash River and the deposit is probably outwash from one of the ice-sheets. The depth at which the tooth was found is given as 18 feet. The length from the top of the anterior plate to the base of the hinder-

most is 380 mm.; width of worn face 100 mm. The hinder plates lean strongly toward the front and there are 6 plates in 100 mm.

2. *Monrovia, Morgan County.*—The collection of the State Museum at Indianapolis contains the hinder half of what appears to be the lower right last molar. This was presented January 10, 1911, by David Hobson, of Monrovia, Indiana, and is labeled as found 1.5 miles southeast of Monrovia, in a gravel bar in Sycamore Creek. There are present 13 plates, considerably flexed as they rise from base to summit.

According to Leverett's glacial map of Indiana, Monrovia is situated on the northern edge of the Shelbyville moraine. The tooth seems to have been found in Sycamore Creek, on the moraine or near its southern border, not far from the northern border of the Illinoian drift area. While the possessor of this tooth probably lived during some period of the Wisconsin stage, it is possible that the tooth had been washed out of some deposit of the Illinoian or of some interglacial deposit laid down between the Illinoian and the Wisconsin stages.

3. *Windfall, Tipton County.*—In the Morrill collection, in the University of Nebraska, Lincoln, there are two teeth, an upper and a lower last molar, secured at Windfall by Professor Erwin H. Barbour. These teeth have been described and illustrated by the writer (36th Ann. Rep. Geol. Surv. Indiana, p. 742, plates xxv, xxvi). Windfall is situated on Wisconsin drift, some miles west of the more or less morainic belt which marks the northwestward continuation of the Union City moraine.

4. *Bringhurst, Carroll County.*—In the State Museum at Indianapolis is a last molar found some years ago near Bringhurst and presented by Mr. John Flora. There are 27 plates present, an unusual number. The length of the tooth is 320 mm. from the summit of the first to the base of the twenty-sixth. No information was furnished as to the exact place where the tooth was found, nor as to the depth and kind of materials. Bringhurst is situated on Wisconsin drift, and the animal must have lived at some time after the ice retired from the Fowler-Lafayette moraine.

ILLINOIS.

(Maps 12, 38.)

1. *Staley, Champaign County.*—In the collection at the University of Illinois the writer has seen a lower last molar recorded as having been found by John Early at a point 5.5 miles west and 1.5 miles south of Champaign, apparently not far from Staley. It is said to have been picked up by a dredge; hence probably in some ditching operations. The writer regarded the tooth as belonging to *Elephas columbi.*

Apparently this tooth was found very near the outer border of the Champaign moraine; hence the animal might have lived at any time after the deposition of this moraine. It is more probable, however, that this species did not affect such a cold environment, and haunted those regions when the climate had greatly ameliorated.

2. *Stronghurst, Henderson County.*—In the summer of 1914, Mr. John Shick discovered near Stronghurst, in a well, at a depth of 20 feet, four elephant teeth. A letter, with photographs of these teeth, sent to the

U. S. Geological Survey, was shown the writer, who identified the teeth as belonging to *Elephas columbi*, apparently the second and third upper deciduous molars, right and left. They were reported to have been found in a dark soil. All the region about Stronghurst is occupied by Illinoian drift. Since at a depth of 20 feet an old soil was reached it becomes quite certain that this represents a pre-Illinoian interglacial deposit, probably the Yarmouth stage; and to that must be assigned the time of the elephant in question.

3. *Chillicothe, Peoria County.*—In the palæontological collection of the University of Iowa is a tooth of *Elephas columbi*, recorded as collected at Chillicothe by Fred Wachs. It was found in gravel, at a depth of 40 feet, but the exact locality is not known. The tooth is the first lower true molar.

It is impossible to determine the geological age of this tooth. Chillicothe is situated on Illinois River and within the area of the Wisconsin drift. The valley is filled with deposits brought down from the Wisconsin ice-sheet and by late alluvium; but at a depth of 40 feet there might possibly be some earlier gravels.

4. *Chicago Heights, Cook County.*—From J. H. Knapp, Chicago Heights, the writer has received photographs of a lower hindermost molar of *Elephas columbi*, found in Second Creek, 2.5 miles east of Chicago Heights. This locality is situated on the Valparaiso moraine and we must refer the time of the existence of the elephant to the Late Wisconsin stage.

5. *Pawpaw, Lee County.*—In the collection of the palæontological department of the University of Nebraska the writer saw a lower molar of *Elephas columbi* (apparently the left second), found at Pawpaw. It was presented by Dr. M. H. Everett, of Lincoln, Nebraska. There are present 19 ridge-plates, and there are 7 plates in a 100-mm. line.

On inquiry by the writer Mr. Frank Wheeler, of Pawpaw, furnished detailed information. In constructing an ice-pond there was found at a depth of 4 feet parts of both hip-bones, a femur 4 feet 4 inches long, some much decayed footbones, some vertebræ and ribs, and the head and lower jaw. The head is said to have been nearly 3 feet long and the lower jaw 26 inches long. In the latter were two huge teeth. It appears that the forelegs were present, but much decayed. No tusks were found, nor any upper teeth. It was concluded that the animal was 22 feet 6 inches long and between 15 and 16 feet high; but the dimensions were undoubtedly exaggerated. Certain "streaks and mossy fibers" led to the conclusion that the animal had been covered with a coat of hair. It is probable that all of these remains except the tooth in Lincoln have been lost. Undoubtedly, had an expert in exhuming such skeletal remains been called in there might have been rescued a large part of the skeleton. Up to this time no good skeleton has been secured of *E. columbi*.

The place where the skeleton was found is in the southwest quarter of the southeast quarter of section 10, township 37 north, range 2 east. This is situated on a member of the Bloomington morainic system, a moraine left by the Wisconsin ice-sheet. It is evident, therefore, that

the skeleton of the elephant had, during some Late Wisconsin time, fallen in a pond and become slowly covered up.

There is an account of this discovery in F. E. Stevens's "History of Lee County, Illinois," 1914, page 527.

6. *Woodhull, Henry County.*—In the Galesburg, Illinois, Register of May 14, 1911, appeared an account of the finding of three large molars and some bones of a supposed mastodon in a clay of a brick and tile factory at Woodhull.

Professor Page L. Baker, superintendent of schools in Woodhull, states that first a part, 6 feet 10 inches long, of a tusk was found, 9 inches in circumference at the base, 6 inches at the other end. Some scattered bony plates supposed to belong to the skull were observed, but no limb-bones were found. Five teeth were secured, varying in weight from 6 to 16 pounds; one had 20 enamel plates, and there were 6 of these plates in a 100-mm. line. It can hardly be doubted that the species represented was *Elephas columbi.*

Professor Baker stated that the pit was about 14 feet deep, the upper 2 feet consisting of prairie soil, possibly loess. Below this is 10 feet of red clay, and then about 2 feet of white clay, resting on a layer of muck. The bones were in the white clay, but resting on the muck. The teeth were wholly in the white clay. The tusk was removed about 15 feet from the teeth. This region is covered by Illinois drift, overlain by loess, sometimes of considerable thickness. It does not appear from the depth and character of the deposits that the Illinoian drift had been penetrated. The muck bed belongs probably to the Sangamon stage, possibly to the Iowan. The reader is referred to the geological sections found at Galva, about 18 miles further east (see p. 142).

MARYLAND.

(Map 12.)

1. *Oxford Neck, Talbot County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 178), Cope wrote that there had been found on the farm of Lambert Kirby, in Oxford Neck, a molar tooth resembling that of a half-grown *Elephas primigenius* or *E. columbi.* Besides this tooth were remains of what Cope called *Elephas americanus* Leidy. These, it is supposed, belonged to *Elephas primigenius.* The collection referred to had been placed in the cabinet of the Baltimore Academy of Sciences; but the writer has not seen it. Lucas (Maryland Geol. Surv., Pliocene and Pleistocene, 1906, p. 167) describes the teeth from this locality. He identified one small tooth as belonging certainly to *E. columbi,* and a large one as probably belonging to the same species.

2. *Queen Anne County.*—In 1820, Horace H. Hayden (Geolog. Essays, p. 121) wrote that he had an enormous grinder of the Asiatic elephant, dug up in the county named, on the plantation of Mr. Carmichael. It was said to have been enveloped in a stiff blue clay.

Dr. Samuel L. Mitchill (Cuvier's "Theory of the Earth," 1818, p. 394, plate I, figs. 3, 5) mentions and figures the tooth, apparently that of *Elephas columbi.* It is said to have been dug out of the ground by the side of a marsh. It was the last upper molar of probably the right side.

WEST VIRGINIA.

(Map 12.)

1. *Wirt County.*—From Professor John L. Tilton, of the University of West Virginia, the writer has received for examination a fragment of a tooth of *Elephas columbi* reported to have been found many years ago, somewhere in Wirt County along Little Kanawha River. No details have been preserved. The thick ridge-plates and the heavy crimped enamel betray the species.

NORTH CAROLINA.

(Maps 12, 39.)

1. *New Hanover County.*—In the State Museum at Raleigh, the writer has seen a part of a molar tooth of this species consisting of 9 ridge-plates. It is said to have been found in the quarry of Ross and Larry. There are 8 ridge-plates in a 100-mm. line and the enamel is rather thick.

Captain E. D. Williams, of Wilmington, has informed the writer that this quarry is situated about 9 miles below Wilmington, near the Fort Fisher road. From a point a little below this Captain Williams secured a tooth of *Mammut americanum.*

SOUTH CAROLINA.

(Map 12.)

1. *Beaufort, Beaufort County.*—In 1877, Dr. Leidy (Jour. Acad. Nat. Sci. Phila., vol. VIII, p. 213) stated that there was in the exhibit of the Smithsonian Institution at the exposition at Philadelphia, in 1876, a last lower molar of this species, found at Beaufort. The present writer has not recognized the tooth in the collection of the U. S. National Museum.

In Rutgers College are six or more teeth or parts of teeth of *E. columbi,* recorded as coming from Coosaw River. In the collection of Amherst College the writer has seen two lower hindermost molars, labeled as collected in Coosaw River.

2. *Edisto River.*—In the collection of the Academy of Natural Sciences of Philadelphia there is a fragment of a molar of *Elephas columbi,* comprising only 2 ridge-plates, recorded as having been found in or on Edisto River. The specimen is credited to Dr. H. C. Chapman. While the locality is indefinite, it probably was somewhere around Edisto Island.

3. *Charleston, Charleston County.*—Numerous teeth of *Elephas columbi* have been found in the region surrounding Charleston. Godman (Amer. Nat. Hist., vol. II, p. 257) referred to a statement made by Catesby to the effect that negroes had found teeth along Stono River which they recognized as those of an elephant. This had previously been mentioned by Barton in his "Archæologia Americana," 1814. In Holmes's "Post-Pliocene Fossils of South Carolina," page 108, Leidy stated that small fragments of teeth and bones, usually much water-worn, of the extinct elephant are not infrequently found in the Post-Pliocene deposits in the vicinity of Ashley River. In a foot-note to this remark, F. S. Holmes stated that later a perfect tooth had been discovered and was figured on plate XVII; but the tooth there figured came from Texas.

In 1870 (Proc. Acad. Nat. Sci. Phila., 1870, p. 98), Leidy reported that he had seen in the collection of C. N. Shepard, at Amherst College,

remains of elephant from Ashley River. It is certain that at least a part of these remains belonged to *Elephas columbi*. In the U. S. National Museum are teeth, recorded as having been secured from the phosphate beds about Charleston. As an example may be mentioned No. 2105, a large upper right molar, with 20 ridge-plates. Another has the number 1614 (Hay, Iowa Geol. Surv., vol. XXIII, p. 413, plate LXI, fig. 4).

In the Charleston Museum the writer has seen a lower second milk molar (No. 13504) of this species. There are 9 ridge-plates and front and rear talons. The length is 123 mm., the width 52 mm., with 8 plates in a 100-mm. line. In the same museum is an upper left second milk molar (No. 1109) with 8 plates present. The length along the base is 95 mm.; from the base in front to the rear of the crown 117 mm.; width 55 mm. This tooth appears to have been found somewhere about Charleston. In the same museum are other teeth of this species, mostly parts of the hindermost molars. Other teeth are found in the private collections of Charleston.

In the American Museum of Natural History, New York, there are some teeth (Nos. 13707, 13708) from the vicinity of Charleston which are referred to *Elephas columbi*. One is an upper hindermost molar, worn to the base in front and having left 18 plates. There are 6 plates in a 100-mm. line. The enamel is thick. The length of the tooth is 292 mm.; the width, 90 mm. Another is a worn lower tooth with 16 plates.

Another tooth, either a last milk molar or a first true molar, is not worn to the base and retains the front root. There are 12 plates and a large talon and a 100-mm. line crosses 8 plates. The enamel is thick and considerably festooned. The greatest length of the tooth is 173 mm. There is another lower right tooth, probably the last milk molar, which presents 11 plates and front and rear talons. There are nearly 8 plates in a 100-mm. line.

Another right lower tooth, apparently the first true molar, 165 mm. long on the grinding face, has likewise 8 plates in 100 mm. A part of an upper hindermost molar preserves 11 plates. There are 6 plates in 100 mm. and the enamel is thick and folded.

For a list of the vertebrate fossils found in the region about Charleston, and their geological age, the reader is referred to page 363.

4. *Head of Cooper River, Berkeley County.*—In 1802, John Drayton ("A View of South Carolina," p. 40, plate, fig. 5) wrote that elephant bones had been discovered in the excavation of a canal joining Santee and Cooper Rivers. Drayton's illustration shows that this tooth must have belonged to *Elephas columbi*. The locality was in Biggin Swamp, apparently not far from Monks Corner. At the same time and place were found remains of *Mammut americanum*. The materials are said to have been deposited in the Charleston Library. Barton (Archæologia Amer., p. 22) stated he had examined teeth of both the mastodon and the elephant from this place. Richard Harlan (Jour. Acad. Nat. Sci. Phila., ser. 1, vol. III, p. 66, plate V, fig. 3; Med. Phys. Res. p. 359, plate, fig. 3) stated that a tooth of an elephant from the Santee Canal had been sent to the Academy at Philadelphia.

GEORGIA.

(Map 12.)

1. *Brunswick, Glynn County.*—This is the type locality of *Elephas columbi.* This species was based by Falconer (Quart. Jour. Geol. Soc. Lond., XIII, 1857, table opposite p. 219) on a part of a tooth received from the geologist Charles Lyell and which had been found in the Brunswick Canal. The specimen consisted of 10 median plates of a lower second or third molar. Falconer figured it in 1868 (Palæont. Mem., vol. II, pp. 214, 221, plate X). Lyell (Second Visit, etc. vol. I, p. 348) noted that an elephant had been found in excavating the canal. Richard Harlan, in 1842 (Proc. Acad. Nat. Sci. Phila., vol. I, p. 189), stated that a large collection of bones of various animals had been presented to the Academy by J. Hamilton Couper, of Darien, Georgia. Among these were teeth of *E. primigenius.* Couper, in 1848 (Hodgson's Memoir, etc., p. 45), stated that two lower jawbones with teeth, several loose teeth, two tusks, and several vertebræ of *Elephas primigenius* had been collected in the canal during 1838 and 1839. These remains quite certainly belonged to *Elephas columbi* unless possibly some belonged to *E. imperator.*

Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, 1869, p. 254) records the presence in the collection of the Academy of a lower molar of *E. columbi.* The present writer has seen in this collection parts of four teeth of this species which had been sent from the Brunswick Canal, doubtless parts of the Couper collection. The species are listed on page 369.

2. *Skidaway Island, near Savannah, Chatham County.*—Lyell (Second Visit, etc., vol. I, p. 314) reported that *Elephas primigenius* had been found at this place, with *Megatherium, Mylodon, Mastodon,* and what was doubtless a species of *Bison.* Habersham, in 1846 (Hodgson's Memoir, etc., p. 29), mentioned two teeth which he identified likewise as *E. primigenius.* These elephant teeth are all to be referred with much certainty to *E. columbi.*

For the examination of the geology about Savannah the reader is referred to page 371, map 40.

FLORIDA.

(Maps 12, 13.)

1. *St. Marks River, Wakulla County.*—In 1870 (Proc. Acad. Nat. Sci. Phila., 1870, p. 98), Leidy stated that from this place there was in the collection of the Natural History Society of Boston a molar of the thick-plated variety of elephant. The grinding-surface, irregular and worn so as to present a terraced appearance, has a length of 8.5 inches and included 11 ridge-plates. The species is quite certainly *Elephas columbi.*

It may be mentioned that Sellards (8th Ann. Rep. Florida Geol. Surv., p. 103) reported that part of a skeleton of a mastodon or of an elephant had been obtained from Wakulla Spring by Mr. John L. Thomas. This is near Crawfordville.

2. *Station 120, Duval County.*—Sellards (8th Ann. Rep. Geol. Surv. Florida, p. 106) reported that *Elephas columbi* had been discovered at Station 120, on the Inland Waterway Canal. At the same place had been

found *Mammut americanum,* an undetermined species of *Bison,* and an undetermined species of *Odocoileus.* The locality is probably 5 miles south of Pablo Beach.

3. *Citra, Marion County.*—In January 1914, the writer saw at Ward's Establishment, at Rochester, New York, the hinder half of a lower left hindermost molar of *Elephas columbi,* labeled as found at Citra. No details were preserved respecting the history of the tooth. There were 6 ridge-plates in a 100-mm. line.

4. *Near Mantanzas, St. John County.*—At the residence of Fred R. Allen, St. Augustine, Florida, the writer has seen parts of four hindermost molars, three upper and one lower, of *Elephas columbi,* found in the Inland Waterway Canal, near his farm, 28 miles south of St. Augustine, apparently not far from Mantanzas. At the same place have been found *Mammut americanum, Equus* sp., *Mylodon harlani,* and *Terrapene antipex.* Sellards (8th Rep. p. 106) adds to this list an undetermined species of *Bison* and one of *Odocoileus.*

5. *Ocala, Marion County.*—From this place Leidy (Trans. Wagner Inst., vol. II, p. 17, plate III, figs. 6–9) has described and figured a first and a second milk molar. The figures have been reproduced by the writer (Iowa Geol. Surv., vol. XXIII, plate LXI, figs. 2, 3, 5, 6). These teeth certainly belong to *Elephas columbi.* They were found in a fissure in a limestone rock, near Ocala, in the property of Mr. F. M. Phillips. With them were a part of a skull of *Smilodon floridanus,* teeth of a horse which Leidy referred to his *Equus fraternus* (=*E. leidyi*), and teeth supposed to belong to the little camel *Procamelus* (*Auchenia*) *minimus.* These fossils were referred to the Pliocene, but apparently there is not sufficient reason for doing so. The geology of the locality is treated on page 378.

6. *Dunnellon, Marion County.*—In the collection of the Florida Geological Survey, No. 2232, is a part of the rear of what is regarded as a hindermost upper molar, found in a phosphate mine near Dunnellon. There are 7 ridge-plates, but some are missing from the front and some from the rear. The height of the front plate present is 210 mm.; the width is 82 mm. There are 6 plates in a 100-mm. line. This tooth is remarkable because of its thinness. It is possibly a more anterior tooth, but is rather high to be such.

The geology of the neighborhood of Dunnellon and a list of the species collected there are to be found on page 376.

7. *Holder, Citrus County.*—In the collection of Dr. H. G. Bystra, chemist of the Buttgenbach river mine, is a fragment of a tooth of *Elephas columbi,* found in the mine, on Withlacoochee River, a few miles north of Holder, in section 29, township 17 south, range 19 east. In the same collection are a fragment of an upper and one of a lower molar, found in the same place in dredging for phosphate rock.

21. *Sumterville, Sumter County.*—In the collection of the Florida Geological Survey (No. 240) is a single plate of a tooth of *Elephas columbi,* found by Dr. Sellards 3 miles east of Holder.

16. *Daytona, Volusia County.*—In 1916 (8th Ann. Rep. Florida Geol. Surv., p. 105), Sellards stated that Mr. Morris, of Daytona, had found in a marl-pit a tooth of *Elephas columbi.* As stated on page 122, remains of

Mammut americanum have been found in similar pits. In these pits were collected a piece of a tusk of a proboscidean and a rib of a whale, thought to belong to the genus *Balænoptera.*

In the Fifth Annual Report of the Florida Geological Survey, on pages 222 to 225, are presented the logs of artesian wells put down at Daytona. In one well was found a bed of white marl at a depth of 6 feet, having a thickness of 9 feet. It is possible that this corresponds to the marl-bed which furnished the elephant and whale, and it may belong to the first glacial stage.

8. *Tampa, Hillsboro County.*—In the collection of Heidelberg University, Tiffin, Ohio, the writer has seen a fragment consisting of two plates of an upper molar of *Elephas columbi,* labeled as having been found at Tampa.

9. *St. Petersburg, Pinellas County.*—In the museum of the State University at Gainesville, Florida, is an upper left second molar of *Elephas columbi* recorded as having been found at Indian Rock, a village near St. Petersburg, in the peninsula west of Tampa Bay. The tooth is covered with barnacles and had evidently been in salt-water. No other information was secured respecting the tooth.

10. *Kingsford, Polk County.*—In the collection of Yale University is a fragment of a lower molar of *Elephas columbi,* recorded as having been found at Kingsford. It was obtained under 19 feet of phosphate rock and sand. The collector was Juan C. Edmundoz. There are present 5 coarse plates. The tooth belongs possibly to *E. imperator.* As recorded on another page, teeth of horses have been found in the same situation. If correctly reported, they belong, with the phosphate, to the Nebraskan stage of the Pleistocene.

20. *Palma Sola, Manatee County.*—There has been sent to the U. S. National Museum, with other fossils, a fragment of a tooth of *Elephas columbi,* washed up on the beach at Palma Sola, and found by Mr. Chas. T. Earle. Besides the elephant tooth were fragments of deer antlers, several teeth of *Equus complicatus,* a few of *E. leidyi,* one of *E. littoralis,* and an astragalus and a metapodial of *Bison latifrons?.* These all belong apparently to early Pleistocene. With them came teeth of sharks, a beak of a porpoise, and the distal end of a metapodial of a camel, all probably washed out of Miocene or Pliocene deposits in the neighborhood.

11. *Sarasota, Sarasota County.*—In the American Museum of Natural History are two fragments of teeth of *Elephas columbi* collected about 8 miles southeast of Sarasota by Mr. Barnum Brown, in 1911; one consists of three, the other of two plates. With them were found fragments of extinct turtles and a dermal plate of an edentate, possibly of *Chlamytherium;* also several teeth of horses.

18. *Eau Gallie, Brevard County.*—Sellards (8th Ann. Rep. Florida Geol. Surv., p. 105) announced that teeth of *Elephas columbi* and of *Equus complicatus* had been found in the Hopkins Drainage Canal.

17. *Fellsmere, St. Lucie County.*—Sellards (op. cit., p. 105) reported a tooth or teeth of *Elephas columbi* found in a drainage canal at this place.

12. *Vero, St. Lucie County.*—Numerous fragments of teeth of *Elephas columbi* have been found at Vero. The geology will be discussed on pages

381 to 383, and a list of the fossil vertebrates that have been found at Vero will be presented.

13. *Zolfo, Hardee County.*—In the American Museum of Natural History (No. 15546) is the right ramus with the symphysis and one tooth of *Elephas columbi.* The tooth is quite certainly the hindermost one. Thirteen plates are present and a number must have worn out and disappeared from the front. Zolfo is on Peace Creek.

14. *Arcadia, De Soto County.*—Numerous remains of *Elephas columbi* have been found at Arcadia and vicinity, mostly in the course of dredging for phosphate. The geology of the region is discussed on pages 380–381 and a list presented of fossil vertebrates found there.

Leidy (Trans. Wagner Inst., vol. II, p. 22, plate VII) figured a very large tooth found at Arcadia. It has 27 plates and is 400 mm. long. There are 6 plates in a 100-mm. line. This tooth is in the collection of the Wagner Institute in Philadelphia. Leidy recorded also a part of a last molar, now in the Academy of Natural Sciences at Philadelphia.

In the collection of the Public Museum at Milwaukee, Wisconsin, is an upper, left, hindermost molar labeled as found in the phosphate beds of Peace Creek, probably at Arcadia. It was presented by Mr. Ad. Meinecke. There are 6 plates and a little more in a 100-mm. line. Teeth, Nos. 319 and 1991, from Arcadia, are in the U. S. National Museum. No. 1571 of the Florida Geological Survey was found 6 miles north of Arcadia.

15. *Tourner's, Glades County*—In the U. S. National Museum (No. 8088) is a part of a tooth of *Elephas columbi* sent by J. M. Purvis, Tourner's, Florida. It was reported as having been collected on the Calloosahatchie River at the place named. This place (spelled also Turner's) appears to be near Thompson's and probably in township 43 south, range 29 east. This tooth appears to be the penultimate milk molar; there are 9 ridge-plates in a 100-mm. line. The enamel is thin and much folded.

Leidy (Trans. Wagner Inst., vol. II, p. 23) recorded the discovery of a last molar tooth of *E. columbi* at some point on the river mentioned. The tooth is in the Academy of Natural Sciences of Philadelphia. Dall (Bull. 84, U. S. Geol. Surv., p. 129) on the authority of Leidy stated that *Bison latifrons* and *Equus fraternus* had been found in the Pliocene beds along this river. It is probable that he used *B. latifrons* in a wide sense. Sellards (8th Rep., p. 102) shows that at least the elephant and the horse were from the Pleistocene.

19. *Palm Beach, Palm Beach County.*—Sellards, in his Eighth Annual Report, page 105, stated that there had been secured from the Palm Beach Canal for the drainage of the Everglades, teeth of *Elephas columbi,* as well as those of *Equus complicatus* and *Mammut americanum,* and a femur of a species of *Bison.*

KENTUCKY.

(Map 12.)

1. *Bigbone Lick, Boone County.*—In the Academy of Natural Sciences at Philadelphia the writer has seen a number of teeth which belong to *Elephas columbi,* found at Bigbone Lick. Whether or not these are part

of the collection given by President Thomas Jefferson the writer has not learned. One of these teeth has been described and figured by the writer (Geol. Surv. Indiana, vol. xxxvi, p. 737, plate xxii, fig. 1). It is identified as the upper hindermost milk molar, is wholly unworn, and shows well the form of the crown before it came into action. In that stage the roots are almost wholly undeveloped. The length taken at right angles with the plates is 145 mm. For remarks on the geology of this locality and a list of the species of vertebrates the reader is referred to pages 401 to 404.

2. *Mouth of Big Twin Creek, Owen County.*—In the American Museum of Natural History are two fine teeth and a lower jaw, with the ascending rami missing, found where the creek opens into Kentucky River. From the finders, Mr. H. B. Ogden and his son, the writer learned that the jaw was about on a level with the water. They had fastened their boat to it, thinking it was a stump. The top of the bluff was about 35 feet above the water. Some other bones were secured, among them a humerus. The bones were in a mixture of what Mr. Ogden called hardpan and sand. No certain statements can be made about the geological age of this specimen. It might well be pre-Wisconsin.

FINDS OF ELEPHAS IMPERATOR IN SOUTHEASTERN NORTH AMERICA.

SOUTH CAROLINA.

(Map 14.)

1. *Charleston, Charleston County.*—A number of teeth of *Elephas imperator* have been seen by the writer in the collections made in the vicinity of Charleston.

No. 13557 of the Charleston Museum is a right ramus of the lower jaw containing the hindermost molar. Sixteen plates are counted, but it is probable that about two are missing from the front. There is no indication that there was another tooth behind it. The exact locality of discovery is not known. In the Frost collection is a part (8 plates) of a lower right last molar, which must be referred to this species. Seen on the inner face are only four ridge-plates in a 100-mm. line. In the collection of Rev. Robert Wilson is a fragment of a molar of *E. imperator*. The four plates present occupy 100 mm. of the length of the tooth.

2. *Head of Cooper River, Berkeley County.*—Richard Harlan (Jour. Acad. Nat. Sci. Phila., vol. III, 1823, p. 66, plate v, fig. 2; Med. Phys. Res., p. 359, plate, fig. 2) described briefly and figured an elephant tooth found in constructing the Santee Canal, probably in Biggin Swamp, where the remains of *Mammut americanum* and *Elephas columbi* were discovered. The tooth was a large one, the greatest diagonal length being 14.5 inches (368 mm.). It had been worn back quite to the rear, the trituration having affected 15 ridge-plates. This worn face measured 9 inches (228 mm.). Harlan stated that on this grinding-face 5 inches was occupied by 6 enamel plates and 7 plates of cement. An estimate shows that a 100-mm. line would cross 5 of the ridge-plates. Had this tooth possessed the number (24) of ridge-plates usually found in *E. columbi*, its length would have been 20 inches or more.

FLORIDA.

(Maps 14, 15.)

1. *Dunnellon, Marion County.*—In the collection of the Florida Geological Survey (Nos. 2233, 2234) are two fragments of teeth of an elephant dredged from Withlacoochee River at Dunnellon, presented by Mr. F. J. Titcomb. The teeth are regarded by the writer as being lower last molars, although the plates run nearly directly across the grinding-surfaces. They may belong to one individual. No. 2233 presents six plates; five of these occupy a line 100 mm. in length. They are much bent as they ascend, so that their hinder faces are very concave. The enamel is moderately thick.

The tooth (No. 2234) has been figured by Dr. Sellards of the natural size (8th Ann. Rep. Florida Geol. Surv., p. 85, fig. 12). As shown by that figure, the ridge-plates of the rear portion have a thickness of 25 mm. or even more. Taken all together there are hardly 5 in 100 mm. If that tooth had belonged to *Elephas columbi* and had had 24 plates, the length would have been about 25 inches, which is hardly to be supposed.

2. *Vero, St. Lucie County.*—In the eighth Annual Report of the Geological Survey of Florida, Dr. E. H. Sellards described and figured (p. 150, plate xxv, fig. 1) a lower jaw of an elephant which had been found near Vero. He referred it to *Elephas columbi,* but noted the coarseness of the plates and its resemblance to *E. imperator.* The specimen was found 3 miles west of Vero, along the bank of the drainage canal. It was embedded in a matrix of brown sand, a stratum of which rests on the marine shell-marl which underlies that region. It is evident that a number of plates are missing from the front and that the tooth is the hindermost one. If the jaw had belonged to *E. columbi* with 24 plates, the length of the teeth would have been about 440 mm. In case the tooth is that of *E. imperator,* there were probably about six more plates in front originally and the tooth had a length of about 330 mm. The width appears to be about 90 mm. In the collection at Amherst College is a fragment of a lower right molar, probably the hindermost, of this species. Six plates are represented. It is well worn down, with a very concave grinding-surface. The plates are close to 25 mm. thick. The exact place where the tooth was found is not mentioned on the label, but it was somewhere about Vero.

3. *Labelle, Lee County.*—In the report just cited (p. 112, fig. 46), Sellards described briefly and illustrated a tooth he secured in Caloosahatchee River in 1914. Notes taken by the writer are to the effect that it was found on the north bank of the river, at the first bend above Labelle, probably in Lee County and in township 43 south, range 29 east.

The length of this tooth, as preserved, is 310 mm. from the base in front to the rear of the talon. There are 12 ridge-plates present, but evidently some are gone from the front. There are 5 of these plates in a 100-mm. line, taken at the middle of their height. Sellards's statement that his figure is one-fifth the natural size is evidently an error for one-third.

If this tooth belonged to *E. columbi* and had the usual number of plates, 24, the length would have been near 600 mm., a size not probable. If it belonged to *E. imperator,* as the writer thinks it did, the original length was somewhere near 450 mm., a more reasonable, but at the same time, an unusual dimension.

4. *Everglades.*—In the American Museum of Natural History, New York (No. 8068), is a part of a tooth once supposed to belong to the Indian elephant and said to have been mentioned somewhere by the geologist J. D. Dana as having been found in the Everglades. It appears to be well fossilized. It is apparently the second true molar of the right side. There are 12 plates, of which 5 occupy a line 100 mm. long. Some plates are evidently missing from the front. The writer believes that this tooth belongs to *Elephas imperator.*

5. *Arcadia, De Soto County.*—In the U. S. National Museum (No. 189) is a part of the left ramus of the lower jaw of an elephant recorded as having been found on Peace Creek. This jaw was collected by J. Fras Le Baron, and in a report made to Professor S. F. Baird in 1881, he indicated that this fossil, with many others which he had sent to the Smithsonian Institution, had been found somewhere along Peace Creek between the mouth of Little Charlie Apopka Creek and tide-water, but the place

is no more exactly designated; in any case not many miles away from Arcadia. It, with other Pleistocene fossils, was found in gravel overlying a soft yellow limestone about 4.5 feet thick.

The jaw has been described and figured by Leidy (Trans. Wagner Inst., vol. II, p. 23, plate VIII, fig. 2) as *Elephas columbi.* He stated that eight of the ridges occupy a space of 6.4 inches. His estimate was, however, made near the grinding-surface of the tooth, where the plates converge. The writer has removed the bone and some of the cement from the inner face of the tooth, so as better to expose the edges of the plates. It is found that four of the enamel plates, with the corresponding cement plates, occupy 100 mm. The plates are too coarse for the tooth to be that of *Elephas columbi.* The length of the tooth, in a straight line along the base, is 260 mm. Had the tooth originally had 22 plates, a moderate number for *E. columbi,* the total length would have been 500 mm. or more. Meanwhile, the width is only 85 mm. There are now 12 plates left, and there were at first probably 18. The original length was probably about 400 mm. or less. Leidy thought that the 12 plates present represented the complete number entering into the constitution of the tooth, but the exposure of the base of the tooth in front shows that a number of plates had been worn out and lost.

The species of vertebrates found along Peace River in the vicinity of Arcadia and their geological age are discussed on pages 380–381.

6. *Palmetto, Manatee County.*—From Mr. J. C. Hennessy, of Palmetto, the U. S. National Museum has received a part of a lower left hindermost molar of *Elephas imperator,* found by him on January 10, 1917, on the north shore of Manatee River, within the corporate limits of Palmetto. The specimen presents seven ridge-plates and part of an eighth. Portions of the tooth are missing from both ends. The distance across five plates is 106 mm. The width across the worn face is 100 mm., the height of the hindermost plate present 150 mm. The enamel is strongly plicated. The tooth certainly belongs to *Elephas imperator.* The whole length of the tooth in its complete state was about 360 mm. Had it belonged to *E. columbi,* with 24 plates, the length would have been about 480 mm. (19 inches).

ALABAMA.

(Map 14.)

1. *Bogue Chitto, Dallas County.*—In the U. S. National Museum is a lower left molar which belongs to this species. It was collected by Lawrence Johnson, of the U. S. Geological Survey. It is worn down to the base in front and some plates have thus disappeared. Parts of seven plates and the hinder talon remain. The width of the grinding-face is 90 mm. At the third plate from the rear the height of the crown is 97 mm. The hinder border of the tooth is obtusely keeled and there are no indications that there was another tooth behind it. It seems necessary, therefore, to regard it as the hindermost molar. The large hinder root was developed, but hollow to contain the pulp. The anterior root is entirely missing. The plates of the crown turn backward strongly. Of these plates there are on

the inner face of the tooth hardly four in a 100-mm. line: on the outer face, only four. The enamel is rather strongly folded and of moderate thickness.

With this tooth there came from the same place a molar of *Equus leidyi* and some fragments of teeth of *Mammut americanum*. The writer believes that these species show the presence, along Bogue Chitto, of Pleistocene deposits of about Aftonian age.

2. *"Near Gulf of Mexico."*—J. C. Warren, in the second edition of his work, "The *Mastodon giganteus* of North America," 1855, page 162, plate XXVIII, figure A, described and figured a part of a large upper molar, probably the hindermost, of an elephant which, as the writer believes, belongs to *Elephas imperator*. Warren stated merely that this tooth had been found in Alabama, near the Gulf of Mexico. He regarded the tooth as belonging to *Elephas primigenius* and representing a form with extremely thick plates. Falconer (Palæont. Mem., vol. I, p. 227) described the tooth with somewhat more accuracy than did Warren, although he had only a cast of the tooth. He stated that the specimen presented the middle portion of an enormous last upper molar of the right side. This tooth had lost part of the front by wear and the rear by fracture. There were preserved eight complete ridges and a half of another in front. Falconer said that it bore a close resemblance to the Bollaert tooth found at San Filipe, in Texas, a tooth described in The Geologist, of London, in 1861, 1862, volumes IV and V. He gave the length of the fragment, measured at the base, as 7 inches; the length of the eight hinder ridges, at the base, 6.6 inches; the width of the crown at the third ridge, 4.6 inches; the greatest width behind, 4.9 inches; the height of the last ridge, 8 inches. The average thickness of the plates, including the cement, was 0.8 inch. Warren's figure shows that the enamel is well crimped. Falconer referred the tooth, with some doubt, to *Elephas columbi*, but he was not well acquainted with *E. imperator*. The present writer believes that the tooth belongs to the last species named. It is now in the American Museum of Natural History, New York. The width of the grinding surface is 110 mm. There are 5 plates in a 100-mm. line. The plates are not curved. The enamel is thick and festooned.

FINDS OF ELEPHANTS OF UNDETERMINED SPECIES IN EASTERN NORTH AMERICA.

The rather numerous specimens of elephants here described are those whose specific identity can not at present be determined. Often the discovery of elephant remains, especially of teeth, has been reported without any attempt at description or identification; or they may have been referred to *Elephas primigenius* at a time when no specific distinctions were recognized among our elephants. In probably most cases the specimens reported have been lost. The great majority of them belonged either to *Elephas primigenius* or to *E. columbi.* It has seemed worth while to keep record of these unidentified specimens; for equally with the others they show the presence of Pleistocene deposits.

UNGAVA.

1. *Long Island, James Bay.*—In 1898 (Bull. Geol. Soc. Amer., vol. IX, p. 371, fig. 1), Robert Bell reported the discovery of an elephant tooth on Long Island, identified by Boyd Dawkins as that of *Elephas columbi;* by Cope as probably a variety intermediate between *E. columbi* and *E. primigenius.* No measurements were given by Bell, and the tooth was figured obliquely, so its proportions can hardly be determined. Cope regarded it as a hindermost molar, but it appears to be a last milk molar or a first true molar. It is remarkable for the great thickness of the cement between the enamel plates.

The tooth was reported found on the naked rock of an island nearly bare of soil. It might be supposed that a tooth thus exposed would soon have been destroyed by weathering. Lucas (Geol. Surv. Maryland, Pleistocene vol., p. 151) expressed the opinion that it had been carried there by water or ice. One might suppose it had been brought to the island by human agency. Of its geological age nothing can be said, except that it is Pleistocene. This locality is not marked on the map of elephants of undetermined species, as it lies somewhat too far north.

ONTARIO.

(Map 16.)

1. *St. Catharines, Lincoln County.*—In 1866 (Cat. Casts Foss., p. 37, fig.), Henry A. Ward represented a cast of an elephant tooth which appears to be the lower right hindermost molar. The original is stated to have been found at St. Catharines and to be in a museum at Niagara. It is possible that this is the tooth described on another page as *Elephas columbi* and now in the Victoria Museum at Toronto; but, while Ward's figure represents the greater length of the tooth as worn, in the other tooth only 6 plates are worn. It is possible that the figure is incorrectly drawn.

2. *Hamilton, Wentworth County.*—In 1904 (Bull. Geol. Soc. Amer., vol. XV, p. 352), Coleman mentioned the finding of mammoth remains in a tunnel excavated through Burlington Heights, near Hamilton, and in a gravel-pit about a mile farther westward. A tusk and some bones were

secured, but nothing by means of which the species may be identified. One page 147 is described the jaw of *E. columbi*, discovered at Burlington Heights. Logan (Geol. Canada, 1863, pp. 966, 967) illustrated the jaw just mentioned by two figures, 496, 498, of the symphysis of an elephant, found at Hamilton. Possibly this bone belonged to *E. primigenius*.

3. *Toronto, York County.*—In 1895 (Jour. Geol., vol. III, p. 641), Coleman reported that in 1894 a tooth of a mammoth had been found on Don River, north of Toronto, at a point where the stream flows over the middle till of the region and cuts away banks showing stratified sand and in some cases the upper till. The tooth may, therefore, belong to the interglacial beds, but possibly to the late glacial. In 1901 (Jour. Geol., vol. IX, p. 291), the same author indicated the possible occurrence of mammoth or mastodon in the Don Valley beds. This was recorded in 1900 (Rep. Brit. Assoc. Adv. Sci., p. 330). On page 300 (Jour. Geol., vol. IX) it is stated that an ulna of a mammoth or mastodon had been found in interglacial beds in Toronto, possibly in deposits representing the cold-climate Scarboro beds; but as it showed glacial scratches it may have been lying on the surface at the time of the Wisconsin ice advance. Even in the latter case the bone can, it would seem, be referred to an interglacial stage.

In 1899 (Ottawa Naturalist, vol. XII, p. 194), Coleman stated that teeth of mammoths had been discovered in a bar, a part of the Iroquois beach at York, east of Toronto.

VERMONT.

(Map 16.)

1. *Richmond, Chittenden County.*—Edward Hitchcock (Geol. Surv. Vermont, 1861, p. 176) stated that in 1858 remains of an elephant had been found in Richmond, but no details were furnished. One of the teeth is still preserved in the University of Vermont. The writer regards the species as indeterminable.

NEW YORK.

(Map 16.)

1. *Seneca Lake.*—In 1858 (Geol. Surv. North Carolina, East. Counties, p. 200), Emmons stated that a tooth belonging to the elephant had been taken from the beach of Seneca Lake. When this happened, exactly where, and what was done with the tooth, the present writer does not know.

2. *Wellsburg, Chemung County.*—In 1793 (Mem. Amer. Acad. Arts Sci., vol. II, pt. 1, p. 164), Timothy Edwards reported a horn or bone of some animal had been found in Chemung, or Tyoga, River, about 12 miles from Tyoga Point. Mr. F. W. Ashley, of the Library of Congress, informed the writer that Tyoga Point was a former name of the present town of Athens, Pennsylvania. Whether the tusk was really found in Pennsylvania or in New York is uncertain, nor is it any more certain that the tusk was that of an elephant and not of a mastodon. The fragment was 6 feet 9 inches long, with a circumference of 21 inches at the base and 15 inches at the other extremity. It was estimated to have formed an arc 10 or 12 feet long of a semicircle.

Mather, in 1843 (Geol. 4th Distr., pp. 233, 636), stated that bones of both the mastodon and the elephant had been found in Orange County. On page 44 of the same volume he stated that bones supposed to belong to an elephant had been found 2 miles west of Greenville, in Greene County. Hall regarded them as belonging to a mastodon. The case is doubtful.

PENNSYLVANIA.

(Map 16.)

1. *Chambersburg, Franklin County.*—In 1806 (Phila. Med. and Phys. Jour., vol. II, pt. 1, p. 157), Dr. B. S. Barton reported remains of a mammoth found at Chambersburg.

2. *Pittsburgh, Allegheny County.*—In 1875 (Proc. Acad. Natural Sci., Phila., p. 121), Leidy exhibited drawings of an elephant tooth, dredged up at the confluence of the Allegheny and Monongahela Rivers at Pittsburgh. The tooth was nearly entire and weighed slightly less than 16 pounds. Leidy referred the tooth to *Elephas americanus*, but whether it was *E. primigenius* or *E. columbi* can not be determined.

3. *Meadville, Crawford County.*—In the Geologist, of London, volume v, 1862, on page 431, it was stated that Mr. A. B. Ruhmond, of Meadville, had reported to the Scientific American the discovery of mammoth remains in the excavation of the Atlantic and Great Western Railroad at French Creek. No further information was furnished. In this case the remains might have been those of a mastodon.

4. *Girard, Erie County.*—In the Erie Public Museum are three tusks, said to have been found near Girard; one is about 4 feet long; another somewhat longer. They are slender and probably belonged to *Elephas primigenius*, but there is no certainty about this.

OHIO.

(Maps 16, 36.)

1. *Little Salt Creek, Jackson County.*—Somewhere along this creek was discovered the lower jaw and its teeth, to which was first given the name *Elephas jacksoni*. The creek, with its branches, gathers up the waters of the central part of the county and leaves the county at its northwest corner.

The first notice of this jaw appears to have been given in 1838 (First Ann. Rep. Geol. Surv. Ohio, pp. 96, 97) by C. Briggs, assistant geologist of the survey. He stated that with some other bones it had been found, by unnamed persons, about 1835, in the bank of a branch of Salt Creek, in the northwest part of the county. A second search, made by Briggs and Foster, brought to light fragments of the skull, two teeth, and some other parts of the skeleton. Parts of the tusk in a frail condition were secured. It is interesting to learn that the tusk measured on the outer curve 10 feet 9 inches. The writer has been unable to learn what has become of these bones; none is in the collection of the State University at Columbus. The report made by Briggs on this specimen was reprinted in the American Journal of Science, volume XXXIV, 1838, page 358, in a review of Mather's First Annual Report. The author of the review was almost certainly J. W. Foster. An unsigned letter, apparently also by

Foster, follows, in which are poor figures of the jaw and one of the teeth. In this letter the name *Elephas jacksoni* is applied to the remains. In 1839 (Amer. Jour. Sci., vol. xxxvi, p. 190), Foster contributed a figure of one of the teeth, probably a hindermost molar, but it is uncertain whether it represents the whole tooth or the remaining part of a worn one; nor is the amount of reduction indicated. The present writer finds it impossible to decide whether the tooth belongs to *Elephas primigenius* or *E. columbi.*

2. *Beverly, Washington County.*—In 1874 (Geol. Surv. Ohio, vol. II, pt. 1, p. 471), Mr. E. B. Andrews reported that, several years before he wrote, parts of the skeleton of a huge mammoth had been dug up in Beverly. Among other parts were several large teeth in good preservation, one of which was deposited in the cabinet of Marietta College; but the writer has not been able to learn anything about it. A Dr. Bowen, of Waterford Township, was said to have found, somewhere farther up Muskingum River, a shoulder-blade of a mammoth; but this locality must have been in Morgan County. The identification of the species is also questionable.

3. *Nashport, Muskingum County.*—J. W. Foster (Geol. Surv. Ohio, vol. II, 1838, p. 80) reported a molar and a tusk of an elephant had been dug up at Nashport, in excavating a canal. With these had been found remains of a mastodon, of *Castoroides*, and of a supposed sheep. More probably the latter was an intrusion of a domestic sheep. These remains had been preserved in the Zanesville Athenæum, but the writer can get no trace of them.

4. *Ross County.*—In 1866 (Smithson. Contrib. Knowl., vol. xv, art. 3, p. 15), Charles Whittlesey reported he had seen remains of elephant in alluvial muck in Ross County, at an elevation of about 50 feet above the bottom land of the Scioto Valley. The locality was no more exactly defined and one can not determine whether it is within the Wisconsin area, that of the Illinoian, or that not glaciated. According to Leverett (Monogr. U. S. Geol. Surv. XLI, p. 259), what appears to be an Illinoian terrace along Scioto River opposite Chillicothe stands 120 feet above the river, while the Wisconsin terrace is 60 feet lower. The elephant remains were probably on the Wisconsin terrace.

5. *Cincinnati, Hamilton County.*—In 1843 (Ann. Mag. Nat. Hist., vol. XII, p. 127), Lyell wrote that both elephant and mastodon teeth had been found in the gravelly beds of the higher terraces on the right bank of the river at Cincinnati. In his "Travels in North America" (vol. II, 1845, p. 59), Lyell was more definite in his statement. He stated that near the edge of the higher terrace, in digging a gravel-pit, which he saw open at the end of Sixth street, a tooth of *Elephas primigenius* had been discovered not long before. Dr. E. O. Ulrich informs the writer that this was probably at the eastern end of the street. Inasmuch as all the elephant remains of our country were at that time referred to *E. primigenius*, it is doubtful whether the specimen belonged to this species or to *E. columbi.* Professor N. M. Fenneman writes that the "higher terrace" here mentioned can be nothing more than the terrace on which the lower

city stands, namely, the Wisconsin outwash. He knows of no fragments of Illinoian terrace there.

6. *Fort Jefferson, Darke County.*—In 1878 (Geol. Surv. Ohio, vol. III, pt. 1, p. 508), Mr. A. C. Lindemuth wrote that Dr. G. Miesse had in his collection an almost perfect skeleton of a mammoth, as well as portions of a mastodon, both of which were found in the peat deposits of Mud Creek "prairie." This mastodon is doubtless the one described on page 73 and preserved in the Greenville Public Library. Where the elephant remains are the writer does not know. The locality appears to be in Neave Township (township 11 north, range 2 east).

7. *Circleville, Pickaway County.*—In 1834 (Amer. Jour. Sci., vol. XXV, p. 256), in an unsigned article, the geologist S. P. Hildreth told of having a tooth of an elephant which had been found in gravelly diluvium back of Circleville. This meant probably somewhere east of the town.

8. *South Bloomfield, Pickaway County.*—In the article just cited, Hildreth told of securing, near South Bloomfield, teeth of the "American elephant," in association with those of the mastodon. They were found in excavating for a culvert over a small branch near the town. Hildreth described the teeth, so that it is certain that they belonged to an elephant; but the species can not be determined. A tooth is described as being 7 inches broad, 6 inches long, and 3 inches thick.

9. *Cleveland, Cuyahoga County.*—In 1886 (Proc. Davenport Acad. Sci., vol. IV, p. 308), Dr. E. Sterling reported the finding of an elephant in a small swamp 3 miles from Cleveland and 2 miles from the lake. The swamp had originally occupied about 2 acres of surface. A well-preserved tusk, two vertebræ, three ribs, part of the sacrum, and a molar were secured. In 1873 (Geol. Surv. Ohio, vol. I, pt. 1, p. 183), J. S. Newberry stated that the delta sand deposits, the gravel and sand, which form the surface of the Cleveland plateau, had yielded numerous parts of the skeletons of mastodon and elephant.

10. *Montville, Geauga County.*—In 1873 (Geol. Surv. Ohio, vol. I, pt. 1, p. 526), M. C. Read recorded the discovery of remains of an elephant at this place. Two tusks were secured, also all the bones of the pelvis, seven or eight vertebræ, some ribs, fragments of the skull, and a part of one tooth; the latter was not described. The remains were found in a small marsh; at the surface was a deposit which had resulted from the growth of swamp vegetation; at the bottom was clay; and in this clay the bones were buried. They were supposed to have belonged to a young animal.

11. *Canton, Stark County.*—In Mount Union-Scio College the writer has examined a right tibia of a proboscidean reported to have been found 3 miles northeast of Canton. It is believed to have belonged to one of the elephants and not to a mastodon. The following measurements were taken.

	mm.
Total length	675
Side-to-side diameter of lower end across the articular surface	200
Fore-and-aft diameter of lower end across the articular surface	160
Circumference at middle of length	345
Side-to-side diameter at middle of length	110
Fore-and-aft diameter at middle of length	104
Side-to-side diameter at extreme upper end	245

MICHIGAN.

(Map 16.)

1. *East Saginaw, Saginaw County.*—In 1902 (Ann. Rep. Geol. Surv. Michigan for 1901, p. 252), Dr. A. C. Lane reported the tooth of a mammoth found in ditching close to the Père Marquette shaft No. 2, in East Saginaw, and that this had been identified by the taxidermist William Richter. The size given, 11 by 5 inches, indicates that it belonged to one of the elephants. It was found at a depth of 3 feet or less, and at an elevation of about 25 feet above the lake. The writer has been unable to get any additional information about this tooth. The locality is within the beach-line of the glacial Lake Algonquin, which appears, according to Leverett and Taylor (Monogr. LIII, U. S. Geol. Surv., p. 397), to have stood at a lower level than our present Lake Erie.

2. *Macomb County.*—Alexander Winchell (1st Bienn. Rep. Geol. Surv. Michigan, 1861, p. 132), in speaking of an elephant molar found in the northern part of Jackson County, added that other remains had been found in Macomb County. A. C. Lane (Ann. Rep. Geol. Surv. Michigan for 1901, p. 252, foot-note) takes this to refer to the remains of the mammoth. Here again a discovery is made of little value, through the neglect to collect accurate information and to preserve the specimen. Macomb County, situated on Lake St. Clair, is nearly wholly occupied by deposits laid down by the falling glacial lakes from Lake Maumee to Lake Erie.

3. *Grand Ledge, Eaton County.*—Former State Geologist A. C. Lane (Ann. Rep. Geol. Surv. Michigan for 1901, p. 252) made the following statement:

"Mr. E. R. Grinold, of Grand Ledge, noticed in ditching north of that town that they had cut through a tusk; and through Mr. C. V. Fuller my attention was called. I went there and found the remains barely a foot from the surface, in a little low swale which Mr. Frank Tabor, the owner, said was a duck pond 40 years ago; in other words, a good place for a large, heavy animal to get mired. We exposed three teeth which were plainly those of a mammoth, and were lying just exposed. The teeth were, two of them, 8 inches long, the third 6. The tusk had flattened into an ellipse about 9 by 5 inches near the butt, and 6 or 7 feet long."

Grand Ledge is on the south bank of Grand River, in the northern edge of the county; likewise on the Lansing moraine, one of the concentric moraines laid down by the retreating Saginaw lobe of the Wisconsin ice.

4. *Buchanan, Berrien County.*—Mr. W. Hillis Smith, of Niles, Michigan, informed the writer that in 1899 a drainage ditch was being made through the Bakerstown marsh, south and west from Buchanan, and in the course of the work many mastodon bones were thrown out; also that one tooth of a mammoth was found. This came into the possession of Mr. E. H. Crane, of Kalamazoo.

INDIANA.

(Map 16.)

In Driftless Area.

1. *Vanderburg County.*—John Collett (7th Ann. Report Indiana Geol. Surv., pp. 245, 246) stated that mammoth remains had been found in Vanderburg County. Nothing more is known about these.

2. *Shoals, Martin County.*—Mr. M. F. Mathers, of Orleans, Indiana, informed the writer that in 1880, while at Shoals fishing, a part of the upper jaw of an elephant, with two large teeth in it, was found, in White River below the shoals. Mr. Mathers assures the writer that the teeth were of a kind very different from those of a mastodon found on his place. He did not know what became of the specimen.

E. T. Cox (2d Ann. Rep. Indiana Geol. Surv., 1871, p. 103) stated that remains of the mammoth and of the mastodon had been found in Martin County embedded in marsh clay resting on the drift. The only drift in the county is the Illinoian. These animals must have lived after the Illinoian stage; but not necessarily immediately after.

On Area Covered by Illinoian Drift.

3. *Vigo County.*—John Collett, in 1881 (2d Ann. Rep. Bur. Statist. and Geol., 1880, p. 385), stated that elephant remains had been found in Vigo County.

4. *Gosport, Owen County.*—In 1859, Professor T. A. Wylie (Amer. Jour. Sci., vol. XXVIII, p. 283) gave an account of the discovery of parts of the skeleton of an elephant in the bank of White River, about a mile southeast of Gosport. Two tusks, four teeth, and some fragmentary parts of the skeleton were exhumed, from a bed of sand, overlain by 8 feet of stiff bluish clay. The sand appeared to rest on bed-rock. One tusk had a length of about 9 feet and a diameter of 8 inches, and this diameter was maintained to near the tip. The teeth were evidently the second and third molars, probably of the upper jaw. The largest molar measured 11 inches on the longest diagonal and had 20 plates. "The distance between the plates and the interval between the pairs is about one-fourth inch."

This specimen was probably taken to the University of Indiana and destroyed in a fire. It seems most likely that the remains belonged to *E. primigenius*. They were apparently buried in outwash materials from the Wisconsin ice-sheet.

17. *Wailesboro, Bartholomew County.*—In 1902 (Proc. Ind. Acad. Sci., 1901, p. 247), J. J. Edwards, a physician, reported a tooth of *Elephas primigenius* found in a gravel-pit 0.5 mile south of Wailesboro at a depth of 7 feet. The tooth weighed 9 pounds. It was afterwards destroyed in a fire. Although this was quite certainly the tooth of an elephant, the identification of the species may be doubted.

5. *Brookville, Franklin County.*—Dr. R. Haymond (Amer. Jour. Sci., ser. 1, vol. XLVI, p. 294), under the name *Megatherium*, described a tooth, evidently of an elephant. In 1869 (1st Ann. Rep. Indiana Geol. Surv., p. 200) Haymond stated that he had the tooth in his possession; but the family does not now (1910) know what became of it. It measured 13 inches in length, 6 inches in height, and 4 inches in thickness. It probably belonged to *E. columbi*. No statement was made as to the exact place of discovery.

John T. Plummer, in 1843 (Amer. Jour. Sci., ser. 1, vol. XIV, p. 302), described a tusk found in digging a ditch near Brookville, 15 feet from the surface. It was nearly 6 feet long, had a diameter of 4 inches, and was strongly curved. This might have belonged to a mastodon.

ON AREA BETWEEN THE SHELBYVILLE AND THE BLOOMINGTON MORAINES

6. *Parke, Vermillion, and Putnam Counties.*—John Collett, State geologist in 1881 (2d Ann. Rep. Bur. Statist. and Geol., p. 385) made the bare statement that mammoth remains had been found in these counties. The southern portions of Parke and Putnam Counties are occupied by Illinoian drift; the northern portion of each by Wisconsin. Collett's statement is not of great value for us. Some remains might have been buried on the area covered by the Illinoian drift.

IN AREA NORTH OF THE BLOOMINGTON MORAINE AND SOUTH OF THE WABASH RIVER AND THE MISSISSINAWA MORAINE.

7. *Montgomery County.*—W. H. Thompson, in 1886 (15th Ann. Rep. Indiana Geol. Surv., p. 159), reported the lower jaw of a mammoth found in the bed of Black Creek, on the land of Milton N. Waugh, who was not willing to part with it. Thompson thought that a lake had formerly occupied parts of Sugar Creek and Madison Townships. The jaw contained two teeth; besides this jaw, there were two tusks nearly 11 feet long.

The writer was informed by the late Professor Donaldson Bodine that the locality was on section 12, township 20 north, range 3 west. The teeth and bones were unearthed by a Mr. Parish and afterwards sold by him; but it has been found impossible to trace their history. The locality is on or very near a portion of the Bloomington morainic system, so that it is evident that the animal lived during the latter portion of the Wisconsin stage.

16. *Connersville, Fayette County.*—M. G. Mock has shown the writer a sketch of an elephant tooth found some years ago 3 miles southwest of Connersville. The tooth was 9 inches long, 7 inches high, and weighed 8 pounds. Whether it belonged to *E. primigenius* or to *E. columbi* is not known.

8. *Wayne County.*—John Collett, as mentioned under No. 6, stated that mammoth remains had been found in this county, but he did not enter into details.

9. *Noblesville, Hamilton County.*—John Collett, in the report cited in the last paragraph, on page 385, gave a detailed account of the finding of some remains of a mammoth 4 miles southeast of Noblesville, on the farm of John H. Caylor. The locality is given as on the east half of the northeast quarter of section 16, township 18, range 9 west; but evidently the range is 5 east. In the summer of 1880 a large ditch was being made for the drainage of a swamp, situated, according to Collett, in a valley 20 rods wide and extending several miles from southeast to nearly northwest. The higher land on each side is glacial drift and contains gravel and large

boulders. The ditch was 4 feet deep, 3 feet of which was in recent peat or bog, and the bottom extended down 1 foot into fine blue clay. In this clay were found two well-preserved teeth of a mammoth, a hip bone, a thigh bone, and the tips of two vertebræ. These bones and teeth were scattered along the line of the ditch a distance of 80 feet and in a width of less than 2 feet. What became of these bones we are not informed. According to Leverett's map, this region is covered by Wisconsin ground moraine. I am informed by Professor Leverett that the valley mentioned by Collett was probably originally a subglacial drainage channel.

15. *Muncie, Delaware County.*—M. G. Mock, of Houston, Texas, formerly of Muncie, Indiana, showed the writer a sketch of an elephant tooth, a lower hindermost molar, with considerable parts of the skeleton, found on the farm of S. N. Priddy, July 1, 1895. The tooth was 12 inches long and 5 inches across. This belonged probably to *Elephas columbi,* but of this there is no certainty.

10. *Dora, Wabash County.*—Elrod and Benedict, in 1892 (17th Ann. Rep. Indiana Geol. Surv., p. 241), reported two large teeth of a mammoth found on the farm of John H. Peffley, in the east half of the southwest quarter of section 18, township 27, range 8 east. The writers of the report saw one of the teeth and identified it as *Elephas primigenius;* but probably they did not consider the differences between this species and *E. columbi.*

In Area North of Wabash River.

11. *Jasper County.*—John Collett (12th Ann. Rep. Indiana Geol. Surv., p. 73) reported that mammoth remains had been found in Jasper County. Nothing was added.

12. *Pleasant Township, Wabash County.*—Elrod and Benedict, as noted above, state on their page 240 that some years previously mammoth bones had been discovered while throwing up an embankment for a bridge across Silver Creek. The bones were found under 5 feet of muck. We have no assurance that these bones were not those of a mastodon. It was reported to Elrod and Benedict that some were in Wabash College, at Crawfordsville. On this same creek, near Laketon, were found some mastodon remains, for which see page 98. This township, in the northwestern corner of Wabash County, lies on the great moraine which runs along the north side of Eel River.

13. *St. John's, Lake County.*—Professor W. S. Blatchley, in 1898 (22d Ann. Rep. Geol. Surv. Indiana, p. 90), stated that an almost complete skeleton of a mammoth had been found in a marsh at the headwaters of Deep River, in the north half of section 35, township 35 north, range 9 west. This would be very close to St. John's and on the Valparaiso moraine.

It is not probable that Professor Blatchley saw this skeleton, and we can not, therefore, be certain that it was not that of a mastodon. If it did belong to one of the elephants it is to be regretted that such rare materials have not been preserved.

14. *Allen County.*—Professor C. R. Dryer (16th Ann. Rep. Indiana Geol. Surv., p. 129) recorded the finding of a single mammoth tooth in Allen County. Nothing more is known about this.

ILLINOIS.

(Maps 16, 38.)

Within the Area of the Illinoian Drift.

1. *Equality, Gallatin County.*—In 1875, E. T. Cox (Geol. Surv. Illinois, vol. VI, pp. 213–214), in his report on Gallatin County, Illinois, stated he had picked up numerous plates of elephant teeth at what was called "Half-moon," located near Equality, in section 19, township 9, range 8 east. It is an excavation made many years ago to obtain salt-brine, near the Saline River, as the region thereabout furnishes salt springs. It is implied in Cox's account that other remains of elephants had been found there, but usually in a bad condition. It is impossible to determine to which species of elephant the fragments belonged.

According to Leverett's glacial map of the region (Monogr. XXXVIII, U. S. Geol. Surv., plate VI), the locality is occupied by alluvial terraces older than the Wisconsin drift. Not far away is the border of the Illinoian drift. Most probably the elephants there represented lived after the Illinoian stage, but they may have lived at any time thereafter up to the Late Wisconsin.

2. *Chester, Randolph County.*—Professor A. W. Worthen, former State geologist of Illinois, made (Geol. Surv. Illinois, vol. VIII, p. 8) the statement that Hon. William McAdams had found at Chester and Alton remains of mammoth, *Megalonyx, Bos* (= *Bison*), *Castoroides ohioensis,* and other extinct animals. He did not, however, say what species had been found at each place.

A newspaper statement was published in 1911 to the effect that William Rade, of Belleville, had a large tooth, found in the lowlands along Mississippi River south of Chester. It was described as a molar a foot in length, 6 inches in diameter (in height probably), weighing over 5 pounds, and having several parallel ridges across the face. It was doubtless the tooth of a species of elephant. A letter addressed to William Rade brought no response. It is probable that the tooth had been washed down from higher ground at some time. Its geological age is indeterminable.

3. *Calhoun County.*—William McAdams reported in 1883 (Trans. St. Louis Acad. Sci., vol. IV, p. LXXIX) that he had recovered from the clay in a ravine in Calhoun County, Illinois, "the jaw of an elephant beside which Jumbo would seem small." One of the teeth from this fossil jaw, and which McAdams presented before the Academy for inspection, weighed nearly 18 pounds. It is not known what became of this jaw and the teeth; nor can we determine the geological age of the animal. Such discoveries lose most of their value through lack of exact statements regarding the origin of the objects.

15. *Christian County.*—In 1866 (Geol. Surv. Illinois, vol. I, p. 39), Worthen stated that a tooth of a mammoth had been found by David Miller in a sand drift near the South Fork of Sangamon River, in Christian County. It was presented to the State cabinet. The tooth is said to have been of a chalky whiteness. The drift which covers this county belongs

to the Illinoian. It is not probable that the animal in question lived before the Illinoian stage.

4. *Sangamon County.*—In 1873, Worthen (Geol. Surv. Illinois, vol. v, p. 308) stated that the tooth of a mammoth had been found some years before in the bluffs of the Sangamon River and near the surface. He concluded that it had not come from beds older than the loess. While the probability is that the tooth was found in the Sangamon loess, there can be no certainty about it. The animal might have lived there while the Wisconsin ice was nearby.

5. *Fulton County.*—In Netta C. Anderson's list of 1905 (Augustana Library Pubs. No. 5, p. 10), Professor Albert Hurd, of Knox College, reported that there was in the museum of that college a poorly preserved tooth of some species of elephant, found in Fulton County. All that can be said about the geological age of this find is that the county is covered by Illinoian drift and that the tooth is probably not older. Nevertheless, it might have been found in some excavation or along some ravine which had reached the Yarmouth.

6. *Galesburg, Knox County.*—In Netta C. Anderson's list referred to, page 14, Professor Albert Hurd reported there was in the cabinet of Knox College a much decayed elephant tooth, found near Galesburg in the making of a ditch. The presumption is that the ditch had not passed through the Illinoian drift and that the animal had lived after the Illinoian stage; it may be during the Sangamon stage.

14. *Pekin, Tazewell County.*—In 1909 (Bull. 506, U. S. Geol. Surv., p. 61), Dr. J. A. Udden reported remains of a proboscidean found in Adam Saal's gravel-pit, between Illinois River and Dead Lake, a mile south of Pekin, at a depth of 18 feet. There were two tusks, two teeth, a part of a jaw, and a few other bones. One tooth is reported to have weighed 18 pounds, the other 8 pounds. These were doubtless weighed while wet. Only the teeth of an elephant would weigh so much. It is impossible to determine the species. Udden stated that the gravel probably belongs to the latest Wisconsin terrace. The locality is on the border of the Shelbyville moraine.

9. *Peoria, Peoria County.*—In 1873 (Geol. Surv. Illinois, vol. v, p. 237), A. H. Worthen reported two molar teeth, with a portion of the jaw, found in a gravel bed in the bluff in the city of Peoria. A part of one of these teeth was then in the State Cabinet at Springfield. According to Worthen, these remains were found at a depth between 12 and 48 feet. According to Udden's map (Bull. U. S. Geol. Surv., 506, plate I) the locality would probably be on the early Wisconsin terrace. The animal must have lived during the formation of this terrace. It would seem that this must have been after the Wisconsin ice had begun to retire and while the region was yet much depressed. Baker (Univ. Ill. Bull. XVII, p. 299) stated that this animal was a mastodon.

7. *Rock Island, Rock Island County.*—In Netta C. Anderson's list of mastodons and elephants it is stated that in laying the overflow pipe from the basins of the Rock Island waterworks on the bluff south of the city, a cut was made in the loess to a depth of about 22 feet near the edge of the bluff. In the lower part of this cut were found a part of a tooth of an

elephant and a piece of a leg-bone. These were given to the museum of Augustana College. The loess at this point is said to be about 35 feet thick and the lower part is somewhat peaty in cuts in the streets further west. Probably this loess belongs to the Iowan stage and that beneath it was an old soil deposited in peat swamps. The fossil seems to belong to the Iowan glacial stage, possibly to the Peorian interglacial.

Elephants Found Within the Area of the Wisconsin Drift.

8. *Atwood, Piatt County.*—In Netta C. Anderson's list, page 17, it is stated that in the museum of Northwestern University there is a tooth of a mammoth found near Atwood in 1879. It was dug up from about 6 feet from the surface. Atwood is in the extreme southeastern corner of Piatt County; the region round about is occupied by what Leverett (Monogr. xxxviii, plate vi) calls the Shelbyville till sheet, belonging to the early Wisconsin stage. The animal may have lived at any time since that till was deposited up to Late Wisconsin. The tooth was probably buried in some old peat-swamp and unearthed during tiling operations.

13. *Wheaton, Du Page County.*—In Netta C. Anderson's list, page 10, it was reported on the authority of Charles A. Blanchard, president of Wheaton College, that about 1890 the remains of a mammoth were found in ditches on the Jewell farm, near Wheaton. The remains consisted of about a dozen ribs, as many vertebræ, a femur, and other parts of legs. It appears to the writer that the remains may have belonged to a mastodon.

Wheaton is situated on that part of the Valparaiso moraine which runs parallel with the western shore of Lake Michigan. Whatever the animal was it must be regarded as belonging to the Late Wisconsin stage.

13. *Oak Park, Cook County.*—Under this number 13 must be recorded a mammoth tooth found in a gravel-pit at Oak Park, at a depth of several feet. Only parts of it were secured and the species is unknown. The pit was in the Glenville beach, laid down during the waning of the Wisconsin glacial sheet (Baker, F. C., Univ. Ill. Bull. xvii, p. 70).

10. *Evanston, Cook County.*—In Netta C. Anderson's list, page 9, Professor U. S. Grant, of Northwestern University, reported that the museum contains the tooth of a mammoth, taken from a gravel-pit near Evanston. The animal must have lived after the Wisconsin glacier had withdrawn into the basin of Lake Michigan.

11. *Rochelle, Ogle County.*—In Netta C. Anderson's list, pages 15, 16, Professor Frank Leverett reported that in July 1886 he had seen a collection of mammoth fossils at the house of F. G. Rossman, a farmer living near Rochelle, which he had obtained in a bog in the northwestern part of section 33, Lynnville Township. The materials consisted of a tusk, two teeth, a piece of the jawbone, a few ribs, and some fragments of bones. The fragment of tusk was about 5 feet long, 20 inches in circumference at one end, about 18 inches at the other. The tooth was from 12 to 13 inches long and 4 inches wide.

Rochelle is on the border between the Wisconsin drift sheet and the earlier one lying west of it. On Leverett's map this is put down as being Iowan;

but no Iowan is now recognized in Illinois. Mr. F. N. Rice, county surveyor, reported that Lynnville Township is number 41 north, range 2 west.

In the Unglaciated Region in the Northwest Corner of the State.

12. *Galena, Jo Daviess County.*—The geologist J. D. Whitney reported in 1866 (Geol. Surv. Illinois, vol. I, p. 162) that a few teeth of the elephant had been found near Galena, on the surface. These are said to be preserved in a collection in Galena. Whitney stated that these were all that he had met with in the lead region. In his Geology of the Lead Region (Wisconsin Geol. Surv., vol. I, pp. 129–133) the same author said that, so far as he knew, elephant remains never were found in the lead crevices. The teeth mentioned above had been found within the limits of the city of Galena.

Galena is situated in the driftless region and no conclusion is reached about the geological age of those teeth.

WISCONSIN.

(Map 16.)

1. *Stockholm, Pepin County.*—All that is known regarding the occurrence of an elephant at this place was published by Professor N. H. Winchell in 1910 (Bull. Minn. Acad. Sci., vol. IV, p. 417), as follows: "Capt. Jos. Buisson stated that a mammoth tooth was found opposite Lake City, near Stockholm, on the shore of Lake Pepin." The tooth may have been that of a mastodon.

MARYLAND AND DISTRICT OF COLUMBIA.

(Map 16.)

1. *Upper Marlboro, Prince George's County.*—In B. L. Miller's geological report on this county (Maryland Geol. Surv., 1911, pp. 125, 126) it is stated that a right humerus of a mammoth, as determined by J. W. Gidley, had been found at the road crossing of Cabin Branch, near the western branch of Patuxent River. The bone was sent to Georgetown University, Washington, D. C.

2. *Washington.*—In the Prince George's County volume of the Maryland Geological Survey, 1911, page 123, Dr. B. L. Miller stated that a tooth of *Elephas americanus* (*E. primigenius* probably) had been found in Wicomico materials in the pits of a Washington brick company, at a depth of 35 feet. The brickyard was bounded by Florida and Trinidad avenues and the Bladensburg turnpike. What has become of this tooth is not known, nor can one be certain that the tooth was not that of *E. columbi.* It may with safety be referred to an early stage of the Pleistocene.

VIRGINIA.

(Map 16.)

1. *Warrenton, Fauquier County.*—In 1831, Richard Harlan (Monthly Amer. Jour. Geol., vol. I, pp. 58–67), in a letter to the editor, stated that a "Dr. W." of the village presented him with a fossil molar tooth of an elephant found in that vicinity. Nothing more is known of this specimen.

WEST VIRGINIA.

(Map 16.)

1. *Wheeling, Ohio County.*—The geologist J. W. Foster (Proc. Amer. Assoc. Adv. Sci., 10th meeting, p. 160) reported that Alfred Sears had deposited in the Smithsonian Institution some elephant remains obtained 4.5 miles below Wheeling Creek. They were found on the second bottom or terrace and at a depth of 17 feet from the surface. Within a few feet of this place was an Indian mound. When the mound was built, 17 feet of sediment had accumulated over the elephant remains. One can, however, hardly refer the bones to a time farther back than the Wisconsin. A record in the U. S. National Museum shows that Mr. Sears, in 1852, sent a tusk and a tooth of an elephant to Washington. These were doubtless placed in the collection of the Old National Institute. If they were transferred to the Smithsonian Institution the record has apparently been lost.

NORTH CAROLINA.

(Maps 16, 39.)

1. *16 miles below Newbern, on Neuse River, in Pamlico County.*—Harlan, in 1842 (Amer. Jour. Sci., vol. XLIII, p. 143), stated that he had seen, in the collection made by Nuttall on Neuse River, remains of an elephant. Elisha Mitchell, in the same year (Elements of Geol., p. 128), stated that there was in the cabinet of the University of North Carolina a tooth of an elephant from the locality mentioned. Possibly the tooth referred by Croom (Amer. Jour. Sci., vol. XXVII, 1835, p. 170) to the mastodon and which was 7 inches wide and 9.5 inches deep, was really that of an elephant. Were it not for the fact that *Elephas primigenius* has been found in this region of North Carolina, one might, with confidence, refer the tooth found below Newbern to *E. columbi.* For other species found at this place the reader may consult pages 358 to 359.

2. *Harlowe, Carteret County.*—Elisha Mitchell (Amer. Jour. Sci., vol. XIII, 1827, p. 347) stated that in digging the Clubfoot and Harlowe Canal remains of both the mastodon and the elephant had been found. Nothing more definite was communicated. The probability is that the animal was *Elephas columbi.*

3. *Duplin County.*—At the meeting of the American Association for the Advancement of Science in Charleston, South Carolina, in 1850, Dr. R. W. Gibbes reported that he had obtained a part of a molar of an elephant found somewhere in Duplin County. He spoke of its resemblance in narrowness and in thinness of plates to a tooth found in Vermont and exhibited by Agassiz. Possibly it belonged to *Elephas primigenius.*

FLORIDA.

(Map 16.)

1. *Wakulla Springs, Wakulla County.*—In the collection of the Florida Geological Survey is a right tibia of an elephant reported found at the place

named. The measurements shown in the accompanying table were secured. For comparison the dimensions of the tibia of the great *Elephas primigenius* in the American Museum of Natural History at New York are presented.

Measurement of tibias, in millimeters.

	Wakulla Springs elephant.	E. primigenius.
Total length	813	735
Greatest width across upper end	266	245
Fore-and-aft diameter at middle of length	106	100
Side-to-side diameter at middle of length	132	106
Greatest width across lower end	215	205

With the tibia from Wakulla Springs is the distal half of an immense femur of the left side. The distance across the articular surface of the distal end was at least 241 mm., but the bone has suffered some abrasion. The outer articular surface measures 115 mm.; the inner 1,202 mm. When the bone is placed on a table with the hinder face downward the inner ridge which bounds the patellar groove rises 280 mm. above the table. Whether these bones belong to *Elephas imperator* or to *E. columbi* is uncertain.

2. *Stokes Ferry, St. Mary's River, Nassau County.*—In 1909, Sellards (2d Ann. Rep. Florida Geol. Surv., p. 147) stated that Dr. L. W. Stephenson, of the U. S. Geological Survey, had found at this place, in a phosphate deposit, a fragment of an elephant tooth together with 3 teeth of a fossil horse and some ear-bones of a whale. The elephant belonged probably to *E. columbi,* but possibly to *E. imperator.*

3. *Bartow, Polk County.*—Dr. W. H. Dall (Proc. Acad. Nat. Sci. Phila., 1891, p. 120) has recorded the discovery at this place of tusks supposed to be those of *Elephas columbi.* Possibly the tusks were those of *E. imperator* or even those of *Mammut americanum.*

MISSISSIPPI.

(Map 16.)

1. *Natchez, Adams County.*—In his report on the Geology and Agriculture of Mississippi, 1854, page 284, Wailles wrote that fossil remains of the elephant were not then known to have been found in the State. However, on page 286, *Elephas primigenius* is included in the list of fossil Mammalia furnished by Leidy. The latter does not say where in Mississippi elephant remains had been discovered, but it was probably at Natchez.

In his work on the Lafayette formation (12th Ann. Rep. U. S. Geol. Surv., part 1, p. 400), McGee stated that at least one skull of the American elephant had been found at Natchez in gravel, well down toward the Port Hudson clays, and that to this adhered some of the coarse gravel of the matrix. Probably the species was *Elephas columbi.* It is likely that the skulls referred to by McGee were not as complete as he supposed.

TENNESSEE.

(Map 16. Figure 23.)

1. *Gallatin, Sumner County.*—In 1835, Professor G. Troost (Trans. Geol. Soc. Penn., vol. I, 1835, p. 144) reported that a Mrs. Ephraim Foster possessed a tooth of *Elephas primigenius* found in a well at a depth of 40 feet. The identification followed the opinion of that time that only one species of elephant had existed in the country. It more probably belonged to *E. columbi.*

2. *Columbia, Maury County.*—In the publication just referred to the geologist G. Troost stated that he owned a tooth of *Elephas primigenius,* found a few miles below Columbia, probably near Duck River, but no details as to the exact locality and kinds of deposits were furnished. Hayes and Ulrich (Folio 95, U. S. Geol. Surv.) appear not to have recognized any Pleistocene in this quadrangle. On page 6 they stated that narrow strips of bottom lands occur along the larger streams, particularly along Duck River. The tooth was probably that of *E. columbi.*

KENTUCKY.

(Map 16.)

1. *Bigbone Lick, Boone County.*—Remains belonging certainly to both *Elephas primigenius* and *E. columbi* have been found here, and there is no reason for supposing that any other species has ever been collected. Many specimens have, however, been mentioned in the literature of the subject which one may have difficulty in referring to either of these species. The difficulty arises from the insufficiency of the descriptions and of the illustrations when there are any.

Two elephant molars from America were figured by Cuvier (Oss. Foss., ed. 4, plate xv, figs. 9, 11), without any exact locality being given, so far as the present writer can discover. Adams (Palæontograph. Soc., vol. XXXIII, p. 122) says of these that one was from Mississippi, the other from Bigbone Lick, but which is from the latter place is not indicated. Caspar Wistar (Trans. Amer. Philos. Soc., n. s., vol. I, 1818, p. 376) reported that in the Jefferson collection there were teeth which he referred to the Siberian elephant. Among these were some which belonged to a young animal.

William Cooper (Monthly Amer. Jour. Geol., vol. I, 1831, pp. 168–171) recalled the quantity of elephant remains found at Bigbone Lick before his visit. In the Finnell collection was a tusk with part of the base missing, which was still 11 feet 10.5 inches long and 22 inches in circumference. It was much curved, a fact which induced him to refer it to an elephant. In the same collection were numerous other parts of elephants, including 20 or more teeth. A Mr. Bullock secured a skull nearly entire. It is pretty certain that the greater part of all this fine material has been lost. Many of the bones and teeth collected in early times went to the museums of Europe; some are mentioned by Leith Adams (Palæontograph. Soc., vol. XXXIII, pp. 75, 122) and Lydekker (Cat. Foss. Mamm. Brit. Mus., pt. IV, p. 191).

2. *Newport, Campbell County.*—In 1871 Professor Shaler (Amer. Naturalist, vol. IV, p. 160) stated that he had a tooth of *Elephas primigenius,* which had been found in the uppermost terrace of the alluvial plane opposite Cincinnati, at a depth of over 60 feet from the surface.

In 1877 (Geol. Surv. Kentucky, vol. III, p. 79), the same writer stated that a molar tooth of *Elephas primigenius* had been found in the city of Newport, about 25 feet above high-water mark and at a depth of 40 feet. It is not improbable that the two accounts refer to the same specimen.

3. *Bluelick Springs, Nicholas County.*—In the collection of Mr. Thomas W. Hunter, made at this place, were several much water-worn teeth of elephants, the species not determined.

4. *Eminence, Henry County.*—The geologist David D. Owen, in 1857 (3d Geol. Surv. Kentucky, p. 103), reported that bones and teeth of the mammoth had, at times, been found here. They do not appear to have been preserved.

FINDS OF PLEISTOCENE EQUIDÆ IN EASTERN NORTH AMERICA

MASSACHUSETTS.

(Map 17.)

Gay Head, Martha's Vineyard.—In 1900 (Bull. Geol. Soc. Amer., vol. XI, p. 459, plate XLII, fig. 2), J. B. Woodworth reported finding an astragalus of a horse in an osseous conglomerate, regarded as belonging to the Miocene. It was identified by Professor H. F. Osborn, who remarked that it resembled closely the same bone of some Pleistocene horses. From this conglomerate have been obtained bones of whales, supposedly also a skull of a walrus. While the size of the astragalus suggests more that of a Pleistocene horse, it is possible that there was some large Miocene equid that lived there. The present writer is inclined to believe it will be found that the astragalus came from one of the older Pleistocene deposits recognized as present at Gay Head.

NEW YORK.

(Map 17.)

1. *Throg's Neck, New York County.*—In 1866 (Smithson. Contrib. Knowl., vol. XV, art. 3, p. 16), Charles Whittlesey stated he had a tooth of a horse, taken from the compact marine drift at Throg's Neck. It was obtained by J. A. Bailey from excavations at Fort Schuyler, 18 feet below the surface.

According to Folio No. 83 of the U. S. Geological Survey, Harlem Quadrangle, Throg's Neck is occupied by till which usually thinly covers, or leaves exposed, the underlying Hudson schist; Salisbury gives an account of the drift on page 14 of the folio cited. At the depth indicated the tooth

NOTE.—In 1858 (Proc. Boston Soc. Nat. Hist., vol. VI, p. 303), Dr. Skilton, of Troy, wrote that a farmer had dug up, in what had been marshy ground, 17 teeth of a horse. These, Skilton stated, belonged to *Equus major*. The teeth were greatly decayed. The writer of the report said that the enamel of the first upper molar, meaning the anterior of the six grinding teeth, measured 1.9 inches (47.5 mm.); that of the corresponding lower teeth 2.33 inches (58 mm.). If these measurements were taken correctly, they indicate a horse much larger than any yet known, unless it be *Equus giganteus* of Texas. There is no evidence that Dr. Skilton had made any serious study of the dentition of horses and the teeth were probably those of a domestic horse, or even of some other animal.

In 1884 (Trans. Linn. Soc. N. Y., vol. II, p. 47), Dr. C. Hart Merriam, in his paper "The Vertebrates of the Adirondack Region," stated he had examined several fossil molar teeth of *Equus major* exhumed at Keenes Station, near the Oswegatchie Ox Bow, in Jefferson County, New York. He compared them with the corresponding teeth of an immense dray horse and found them much larger.

Professor G. C. Manse, of St. Lawrence University, Canton, New York, sent me for examination 4 upper teeth of a horse which must be those examined by Dr. C. H. Merriam. They are labeled as having been collected at Gouverneur, a town not far from Keenes Station. After a careful study of these teeth and comparison with those of the domestic horse, the writer concludes that they belonged to the latter. Domestic horses are known to have larger teeth. Professor Manse has unfortunately been unable to trace the history of the teeth back to Dr. C. C. Benton, of Ogdensburg, who showed them to Dr. Merriam.

was probably lying in pre-Wisconsin deposits; and taking into consideration the geological age of other horse remains, one may reasonably conclude that the tooth at Throg's Neck was of a horse that lived during the middle or early Pleistocene. That there may be materials of a pre-Wisconsin stage underlying the surface drift at Throg's Neck is indicated by Woodworth's discovery (Bull. 48, N. Y. State Mus., p. 626, plate I) of deposits older than the Wisconsin along Hempstead Bay, Long Island.

NEW JERSEY.

(Map 17.)

1. *Swedesboro, Gloucester County.*—In 1868 (Cook's Geol. New Jersey, p. 741), Cope stated that *Equus complicatus* was represented in New Jersey by a series of teeth obtained while a milldam at Swedesboro was being cleared. No further information has been secured. At the Academy of Natural Sciences of Philadelphia, the writer has seen a horse-tooth labeled as coming from the town named; but whether or not it is one of those referred to by Cope it is impossible to say.

2. *Fish House, Camden, Camden County.*—In 1869 (Trans. Amer. Philos. Soc., vol. XIV, p. 250, fig. 55), Cope wrote that a partial skull of *Equus fraternus* had been found at Fish House in a blackish clay at a depth of 20 feet from the top of the clay. Over the clay was imposed a bed of sand from 8 to 15 feet thick. This important skull appears to have been lost (fig. 7).

In 1897 (Ann. Rep. Geol. Surv. New Jersey for 1896, p. 208, plate X), Lewis Woolman described other remains of horses supposed to belong to *Equus complicatus*, secured in the same Fish House clays. The writer has seen these and regards them as belonging to the species just named. These remains of horses will be mentioned on pages 302–303.

3. *Navesink Hills, Monmouth County.*—Somewhere in the northeastern part of Monmouth County, in the region of the Navesink (or Neversink) Hills, have been found remains of a fossil horse. They were first mentioned by S. L. Mitchill (Cat. Organ. Remains, 1826, pp. 7, 8). He mentioned a cervical vertebra and teeth in sound condition. Leidy (Jour. Acad. Nat. Sci., Phila., vol. VII, p. 261) wrote that a vertebra and teeth were associated with remains of a mastodon. Mitchill mentions only a part of a tibia of a mastodon. These objects were all presented by Mitchill to the Lyceum of Natural History in New York. The writer believes these teeth had been buried in an early Pleistocene deposit.

PENNSYLVANIA.

(Map 17.)

1. *Pittston, Luzerne County.*—In the collection of the Academy of Natural Sciences at Philadelphia are 2 horse-teeth found at or near Pittston. They were described and figured by Leidy in 1873 (Monograph U. S. Geol. Surv., I, pp. 245–246, plate XXXIII, figs. 16, 17) as *E. major* (= *E. complicatus*). He stated they were found on the banks of the Susquehanna River, associated with remains of mastodons and *Bison latifrons*. The last was, however, a species of *Symbos*. In 1869 (Jour. Acad. Nat. Sci., Phila., vol.

VII, p. 262), Leidy stated that it was reported these remains had come from a stratum "full of bones." This stratum belonged probably to an early or middle Pleistocene interglacial stage.

2. *Stroudsburg, Monroe County.*—In 1889 (Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 6), Leidy reported the finding of "a pair of teeth of a horse, which were yet incompletely developed," in Hartman's Cave, near the town mentioned. He thought they belonged to an indigenous species. The position of the cave, its fossils, and their age will be considered in discussing the Pleistocene geology of the State on pages 308 to 311.

3. *Port Kennedy, Montgomery County.*—As long ago as 1871 (Amer. Jour. Sci., ser. 3, vol. I, pp. 235, 384), Wheatley announced the discovery of 2 unidentified species of horses in the great bone-cave at the place named. They were associated with the remains of 40 other species of vertebrates, besides many insects. In 1899 (Jour. Acad. Nat. Sci., Phila., ser. 2, vol. II, pp. 193–267, plates XVIII–XXI), Cope described the materials collected up to that time from the same cave. Of horses he recorded 2 forms, which he named *Equus fraternus fraternus* and *E. fraternus pectinatus.* He was inclined to believe the latter would prove to be a distinct species. It is not certain whether this conclusion was correct; but if not a species, it is probably a subspecies of *Equus complicatus.* The teeth referred to *E. fraternus fraternus* are pretty certainly those of *E. complicatus.* Of this species Cope had a decayed skull of a young animal with teeth, besides a considerable number of other teeth and some bones of the skeleton. The geological relations of these remains and those of the other species will be discussed on pages 311 to 320.

4. *Rutherford, Dauphin County.*—In 1868 (Proc. Acad. Nat. Sci., 1868, p. 195), Leidy described a horse-tooth, loaned him by Mr. W. Lorenz and found somewhere between Rutherford and Highspire. It was met in a depression 6 feet deep and 20 feet across, filled with diluvium. Leidy thought the tooth might have belonged to a contemporary of the mastodon, but this was equally improbable. All the cement was dissolved from the tooth, and the latter was stained by iron, but not petrified. It was an upper second true molar. It has probably suffered the fate of such specimens as are retained in private hands.

5. *Frankstown, Blair County.*—From Mr. O. A. Peterson, of the Carnegie Museum, Pittsburgh, the writer learns that some part of an unidentified species of horse has been found in the collection made some years ago at Frankstown. For a list of the species page 321 may be consulted.

OHIO.

(Maps 17, 36.)

1. *Cincinnati, Hamilton County.*—In 1895 (Jour. Cin. Soc. Nat. Hist., vol. XVII, p. 217), Mr. Seth Hayes recorded the discovery of a molar tooth and a vertebra of a horse, identified as *Equus fraternus.* It was met with in exhuming the remains of the "Shaw mastodon" in Hyde Park, in the northeastern part of Cincinnati. The details of the exhumation are given in the description of the mastodon. The geological age of these animals dates probably from about the Sangamon stage. The writer has not been

able to examine the horse remains referred to. It is probable that the tooth belonged to *Equus complicatus*.

2. *Columbus, Franklin County.*—In 1848 (Amer. Jour. Sci., ser. 1, vol. v, p. 215), Charles Whittlesey stated that bones and teeth of a horse had been found in fissures or "clay seams" of the Cliff limestone at Columbus. In 1866 (Smithson. Contrib. Knowl., vol. xv, art. 3, p. 16), the same geologist reported that Joseph Sullivant, of Columbus, had, many years before, obtained from the crevices of the Cliff lime rock, on the west side of Scioto River, a number of bones embedded in red clay. Among these was the tooth of a horse. The crevice had not been open since the date of the white settlement of the country and it was wholly filled by the red clay which results from the decomposition of the limestone. Probably all the remains mentioned by Whittlesey have been lost.

In 1875 (Cin. Quart. Jour. Nat. Hist., vol. II, p. 154), Klippart wrote that, in excavating the exterior wall at the Ohio penitentiary, the warden, Mr. Burr, found the fossil jaw of a horse with the molars in good condition. He stated the horse must have been one-third larger than the ordinary horse of to-day.

From Professor Clinton R. Stauffer, of Adelbert College, Cleveland, the writer received for examination a horse-tooth, labeled: "Catalogue No. 356. Horse tooth. Given by Robert Cartwright. Found at Columbus, Ohio, in excavating in a peat bed for a gas holder in the penitentiary grounds, October 30, 1873." It is possible that this is the same tooth mentioned by Klippart, but probably it is another. The present writer identifies the tooth as that of *Equus complicatus*. The geological age is probably approximately that of the Sangamon stage.

3. *Salt Creek, Columbiana County.*—In 1866 (Smithson. Contrib. Knowl., art. 3, vol. v, p. 16), Charles Whittlesey reported a tooth of a horse found, about 20 years before, in making the Sandy and Beaver Canal, along Sandy Creek, in Columbiana County, at a depth not exceeding 12 or 15 feet. Probably the locality was in the southwestern corner of the county. The sources of Salt Creek are in Hanover Township, not far from the sources of Little Beaver Creek. From this vicinity Salt Creek flows westward. This county lies within the Illinoian drift region and the horse probably lived during the Sangamon stage or earlier.

INDIANA.

(Map 17.)

1. *Evansville, Vanderburg County.*—So far as the writer knows, remains of extinct horses have been found in Indiana only at the mouth of Pigeon Creek, a short distance below Evansville. Only a single vertebra, a last cervical, was secured. This formed part of a collection made at the place named by Mr. Francis A. Lincke. The collection was described by Dr. Leidy (Proc. Acad. Nat. Sci. Phila., 1854, p. 199). The bone was referred to *Equus americanus*, a name employed at that time for the horse now known as *Equus complicatus*. Although it would usually be impossible to identify a species of horse on such materials, it is probable that Leidy was correct. The geological age of the bone-bed is discussed on page 32. It

is concluded that the age is most probably the Sangamon, but possibly Aftonian. The same species has been found at Bigbone Lick, above Louisville, on the Kentucky side. The deposits there overlie the Illinoian drift and are, in part at least, Sangamon.

Associated with the horse bone at Pigeon Creek were megalonyx, a probably extinct bison, the Virginia deer, a tapir, and the extinct wolf *Ænocyon dirus*.

ILLINOIS.

(Map 17.)

1. *On the line between Bond and Fayette Counties.*—In 1899, Leidy (Trans. Wagner Inst., vol. II, p. 39, figure) described under the name of *Equus major* an equine maxilla, containing 4 premolars, sent him by A. H. Worthen, State geologist of Illinois. This maxilla had been found in a bog between Bond and Fayette counties. It was referred by Gidley (Bull. Amer. Mus. Nat. Hist., vol. XIV, p. 135, fig. 24) to *Equus pectinatus* Cope. The specimen is in the collection of the State museum at Springfield and has been studied by the writer, who regards it as belonging to *Equus complicatus*. A fossil horse-tooth found at Bigbone Lick, Kentucky, greatly resembles one of the premolars of this jaw.

The region where this jaw was found lies within the area of the Illinoian drift; and, inasmuch as the specimen was found on a bog lying on this drift, the animal must have lived after the withdrawal of the Illinoian ice-sheet. The bog deposit belonged probably to the Sangamon stage.

The writer has endeavored earnestly, but in vain, to obtain more exact details regarding the locality where the jaw was found and the depth of interment.

2. *Alton, Madison County.*—At a meeting of the St. Louis Academy of Science, December 4, 1882 (Trans. St. Louis Acad. Sci., vol. IV, p. LXXX), William McAdams reported he had seen the fossil tooth of a horse from near Alton. No details were added, except that all the horses he had seen from the drift were large animals, while those from the bad lands of Dakota were mostly quite small.

In the McAdams collection, an account of which will be given on page 339, is a fragment of an incisor of a horse. It has on it McAdams's No. 25. It is doubtful that this tooth was found in the loess. All the fossils of that collection purporting to have been found in the loess are very white, while this is of a brownish color, and there is a coat of iron oxide adhering to some parts of it. This may or may not be the tooth mentioned by McAdams as above reported.

3. *Greene County.*—At the meeting of the St. Louis Academy of Science just referred to, Mr. McAdams stated that teeth of an extinct horse had been brought up from the bottom of a well being dug in Greene County. More exact situation and the depth of the well were not mentioned.

Both Greene and Madison counties are occupied by the Illinoian drift-sheet. The horse-teeth found in these counties might have come from Sangamon deposits; or possibly the Illinoian drift had been passed through and Yarmouth interglacial had been entered.

The geologists J. A. Udden and E. W. Shaw (Belleville-Breese Folio, No. 195, U. S. Geol. Surv., p. 7) have noted in those quadrangles deposits which may consist of pre-Illinoian till; also old black soils which may belong to the Yarmouth. The quadrangles mentioned lie along the southern border of Madison County. The old soils were found at depths varying from 30 to 75 feet. In this region, too, the Illinoian drift is overlain by a blanket of loess. To arrive at any valuable conclusion, one ought to know just where specimens are found and at what depths and in what kind of deposits. On the other hand, the information is of the most meager kind. The specimens mentioned are not in a collection made by McAdams and now in the National Museum.

MARYLAND AND DISTRICT OF COLUMBIA.

(Map 17.)

1. *Marshall Hall, Charles County.*—In the U. S. National Museum is an upper right molar, first or second, of a horse labeled as found at this place. It is credited to Mr. O. N. Bryan, who, some years ago, contributed many articles to the museum. The conditions of discovery are not known. The length of the grinding-surface is 28 mm., the width 27 mm. It probably belongs to *Equus leidyi*. According to Shattuck's map of the Pliocene and Pleistocene of Maryland (Maryland Geol. Surv., 1906, plate I) this locality is occupied by Talbot deposits. Shattuck regards the Talbot as belonging to late Pleistocene times. The present writer does not accept this view.

2. *Georgetown, District of Columbia.*—In 1835 (Med. and Phys. Researches, p. 267), Dr. Richard Harlan acknowledged the receipt, at the Academy of Natural Sciences of Philadelphia, of remains of a fossil horse found at Georgetown in constructing the canal along the Potomac. These were probably teeth and had been sent by Colonel I. J. Abert, of Washington. They ought now to be in the Academy mentioned. In 1850, R. W. Gibbes (Proc. Amer. Assoc. Adv. Sci., vol. III, p. 67) presented before the American Association of Sciences a specimen (a tooth?) which he said came from the bank of the Potomac and was associated with a tooth of *Bos* (*Bison*). How he came to have this was not related, nor is it certain that it was found near Washington.

3. *Mitchellville, Prince George's County.*—In the U. S. National Museum are 2 upper teeth, molars or premolars (No. 8813), of a horse found on his estate northwest from the town named, by Mr. Edward S. Walker. They were presented to the National Museum by Dr. Edward W. Berry, of John Hopkins University. These teeth, apparently first and second molars, seem to belong to an undescribed species. The table gives the height of the teeth and dimensions of the grinding surface in millimeters.

Tooth.	Height.	Length.	Width.	Protocone.
M^1.....	70	29.5	25	12
M^2.....	73	30	23	14.5

The teeth present the appearance of having been little worn. Measurements of the crown taken about one-third the distance to the base are as follows:

Tooth.	Length.	Width.	Protocone.
M^1.....	25	25	11
M^2.....	26	25.2	13

The teeth are moderately curved, so that the outer face is convex, the inner concave. Some of the cement is retained and is colored blue with vivianite. The enamel presents less complication than is usually found in either *Equus complicatus* or *E. leidyi*. The dimensions of the teeth and the narrowness, especially of the second molar, seem to exclude reference to either of the species mentioned.

4. *Chesapeake Beach, Calvert County.*—Mr. William Palmer, of the U. S. National Museum, had for many years been making collections, mostly of Miocene vertebrates, along the cliffs at Chesapeake Beach. Among other fossils found there are some remains of horses, among them one much worn upper tooth, probably a premolar. The height is only 21 mm., the length of the grinding-surface 22.4 mm., the width 24 mm. It may be referred provisionally to *E. leidyi*. Mr. Palmer had also an ungual phalanx and a cervical vertebra and various other bones and teeth of horses. The geological situation at the place and the other Pleistocene species found there will be discussed on pages 347–348.

5. *Cavetown, Washington County.*—In his work on the exploration of Bushy Cavern, near Cavetown, Mr. Charles Peabody (Bull. IV, Dept. Archæol., Phillips Acad., p. 12) stated that in a limestone quarry, south of the cave, in the red earth, was found a tooth which J. W. Gidley identified as probably *Equus complicatus*. In 1920 (Proc. U. S. Nat. Mus., vol. LVIII, pp. 96–109), the writer described a collection made at Cavetown. In this were other remains referred to *Equus complicatus*. Some fragments of a large tooth were referred with doubt to *Equus giganteus*.

6. *Corriganville, Allegany County.*—In a crevice in a limestone rock, at a point about 3 miles west of north of Cumberland, taken in a straight line, J. W. Gidley, in the fall of 1912, made a large collection of fossil vertebrates. In this collection is a first phalanx of an extinct horse. The species has not been determined. A list of the accompanying species, so far as determined, will be presented on pages 349–350.

VIRGINIA.

(Map 17.)

1. *Abingdon, Washington County.*—In the U. S. National Museum is the outer half of an upper hindermost molar of a horse sent, in 1869, by Mr. Wyndham Robinson. With it were remains of *Mammut americanum*. The length of the grinding-surface is 30 mm. It belongs pretty certainly to *Equus complicatus*.

2. *Saltville, Smyth County.*—Mr. O. A. Peterson (Ann. Carnegie Mus., vol. XI, p. 474) reported the occurrence of an upper left molar of a horse at Saltville. The species has not been determined. The matter will be referred to again on pages 352–353.

3. *Ivanhoe, Wythe County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, pp. 171–182), Cope gave an account of the discovery of remains of numerous fossil vertebrates somewhere along New River, in the county named. Among these animals were upper and lower milk and permanent molars of a horse. Cope identified these as belonging doubtfully to *Equus complicatus*. One page 353, the Pleistocene geology of the region and a list of the accompanying vertebrates will be presented.

4. *Staunton, Augusta County.*—From Dr. W. F. Deekens, surgeon dentist of Staunton, a tooth of a horse found somewhere in that vicinity, was sent to the U. S. National Museum. It had been found in a limestone quarry, 70 feet below the surface, in a narrow stratum of clay. Probably the tooth had been carried down into a crevice in the limestone by a current of water. The length of the grinding-surface is 31 mm. The arrangement of the enamel folds is simple, but the tooth had only just begun to be worn. The narrowness of the tooth is remarkable and it may belong to an unrecognized species.

5. *Denniston, Halifax County.*—From Mr. G. W. Joyner, living near this place, the U. S. National Museum in 1920 received a left lower grinding-tooth of a horse, found by the donor in a little stream on his farm.

WEST VIRGINIA.

(Map 17.)

1. *Point Pleasant, Mason County.*—From Dr. L. V. Guthrie, superintendent of the West Virginia Asylum, at Huntington, the U. S. National Museum received for examination a horse-tooth dredged up with gravel from Ohio River at Point Pleasant. The writer has not been able to distinguish this tooth (either the last or the next to the last premolar) from that of *Equus niobrarensis*. If further discoveries confirm this provisional determination, the known range of the species will be greatly extended. The tooth has been deposited in the U. S. National Museum by the owner, Captain H. S. Wert, of Point Pleasant. The presence of this tooth proves that there are, somewhere not far away, some early Pleistocene deposits, probably in some high terrace along the Ohio, such as are found in abundance along the upper part of the river and its affluents.

NORTH CAROLINA.

(Maps 17, 39.)

1 *Elizabethtown, Bladen County.*—The geologist E. Emmons (North Carolina Geol. Surv., 1858, p. 197, fig. 18) described and figured an upper left second or third molar tooth of a horse which he called *Equus caballus*, the domestic animal. It, with a tooth from the lower jaw, had been found in a bed of Miocene age at Elizabethtown. Whatever may have been the age of the marl-bed, the horse lived during the Pleistocene. Conrad, how-

ever (Amer. Jour. Sci., vol. XLVII, 1869, p. 359), insisted on the Miocene age of the animal. The same tooth was, in 1860 (Holmes's Post-Pl. Foss. South Carolina, plate XV, fig. 16), figured by Leidy and referred to *E. fraternus*. It is now known as *E. leidyi*. Miller (North Carolina Geol. and Econom. Surv., vol. III, p. 248) points out that patches of Miocene marl do occur in the vicinity of Elizabethtown.

2. *Sixteen miles Southeast of Newbern, on the Neuse River, in Pamlico County.*—In a locality on the left bank of Neuse River, about 16 miles below Newbern, bones of *Equus* and various other animals were first found long ago, apparently by Nuttall. T. A. Conrad, in 1838 (Fossils Medial Tert. U. S., p. X), spoke of great numbers of bones of horse, mastodon, etc. Harlan (Med. Phys. Res., p. 267) says that Conrad possessed specimens from the locality. Lydekker (Cat. Foss. Mamm. Brit. Mus. part 3, p. 89) states that there is in that museum an upper cheek-tooth from Newbern. So far as the writer knows, none of the teeth found here has been figured or accurately described.

On pages 358–359 will be found a list of the vertebrate fossils collected at Newbern and a consideration of the geology.

3. *Greenville, Pitt County.*—In 1852, E. Emmons (Geol. Surv. North Carolina, p. 106) said he had procured a grinder of a horse at Greenville, in the sandy stratum just above the Miocene marl. In 1858 (Geol. Surv. North Carolina Agric., Eastern Counties, p. 197, fig. 21), the same writer figured an incisor tooth found in the Miocene of Pitt County. Conrad (Amer. Jour. Sci. 1871, vol. I, p. 468) spoke of the finding of black and mineralized teeth of a horse, which he regarded as *E. fraternus,* in Miocene marl. Leidy (Proc. Acad. Nat. Sci. Phila., 1871, p. 113) reported on the upper molar tooth which Conrad had found. He regarded it as occurring accidentally in the Miocene and as belonging to *E. complicatus;* but as the tooth was injured, Leidy thought it might belong to *Hipparion.* In the collection of the Academy of Natural Sciences at Philadelphia the writer has seen quite certainly the same tooth. It appears to be an upper premolar, the third or the fourth. It has a height of about 50 mm. and a length of 30 mm. The inner half has been split off. It is that of *E. complicatus.*

4. *Plymouth, Washington County.*—E. Emmons, in 1858 (North Carolina Geol. Surv. Agric., Eastern Counties, p. 197, figs. 19, 20), figured 2 teeth, an upper left molar or premolar and a hindermost left molar, which had been washed up on the beach at Plymouth. This place is on the south bank of Roanoke River. Judging from Emmons's figures, one must conclude that these teeth belong to *Equus leidyi.*

SOUTH CAROLINA.

(Map 17.)

1. *Beaufort, Beaufort County.*—In the museum of Rutgers College, at New Brunswick, New Jersey, the writer has seen 6 teeth of *Equus,* presented by Mr. G. U. Shepard jr., and obtained on Coosaw River; but no more detailed information has been furnished. In the Charleston Museum

is a tooth of *Equus complicatus* which was found by Mr. Earle Sloan, in Coosaw River.

2. *Charleston, Charleston County.*—The remains of horses, especially teeth, are among the most abundant Pleistocene fossils in the region around Charleston. Most of the specimens have been discovered in dredging for phosphate rock, and usually nothing is recorded about the exact locality where found or about the conditions of burial. A considerable number of well-preserved teeth have, however, been discovered in known localities and under defined conditions.

The earliest collection of fossils described from about Charleston was made by Professor F. S. Holmes, of Charleston, and Captain A. H. Bowman, U. S. Army. These fossils were sent to Dr. Joseph Leidy and described by him as early as 1858, but more fully in 1860, in Holmes's "Post-Pleiocene Fossils of South Carolina." Most of these fossils were obtained on the shores of Ashley River, about 10 miles above Charleston. From this locality were described 5 upper teeth of *Equus complicatus* (Leidy, op. cit., p. 102, plate xv, figs. 2–5, 7) and 2 lower ones (plate xvi, figs. 19, 21).

Of *Equus leidyi* (=*E. fraternus* Leidy) the author quoted described from Ashley River 2 lower teeth (op. cit., plate xvi, figs. 20, 22). Leidy (Proc. Acad. Nat. Sci. Phila., 1870, p. 98) reported that there were in the collection of C. N. Shepard, at Amherst College, teeth of *Equus major* (=*E. complicatus*) and *E. fraternus* (=*E. leidyi*) secured in the Ashley River deposit. Leidy, in 1873 (Contrib. Ext. Vert. Fauna West. Terrs., p. 245, plate xxxiii, figs. 14, 15) reported an upper molar and a lower one of *E. complicatus*, found in the "phosphate beds" of Ashley River.

From Doctor Swamp, Johns Island, southwest of Charleston, Leidy (op. cit., p. 103, plate xv, fig. 6) described an upper tooth as that of his *Equus fraternus*. This was afterwards made by Cope the type of this species; but Gidley (Proc. U. S. Nat. Mus., vol. xiv, p. 111) determined that this type belongs itself to *E. complicatus*. It was this determination which made it necessary to give a new name, *E. leidyi*, to the teeth of medium size which had gone under the name of *E. fraternus*.

In the National Museum is a finely preserved upper right third or fourth premolar of what appears to be *Equus complicatus* which is recorded having been found in Wando River, northwest from Charleston. The tooth is 75 mm. high, 31 mm. long on the grinding-face, and 27 mm. wide. The enamel is much complicated. In Holmes's "Post-Pleiocene Fossils of South Carolina," on pages 102 and 104, Leidy mentions an upper second premolar of *Equus fraternus* found on Goose Creek, about 12 miles from Charleston. He added a paragraph on the geology. Further reference to this will be found on page 363. In the Charleston Museum and in the private collections about Charleston the writer has seen many teeth of horses found in that region, most of them without statements about exact localities, though some were found in Stono River. The teeth of *E. leidyi* appear to be more numerous in the collections than those of *E. complicatus*. Many teeth of both species are contained in the Scanlan collection, made in the region about Charleston and now owned by Yale University. In

this collection are found also two lower molars which the writer refers to *Equus littoralis*. The reader is referred to pages 362 to 366.

3. *Richland County.*—On the occasion referred to in the next paragraph, Robert W. Gibbes presented a tooth of a horse found in Richland district at a depth of 17 feet, in a slough, supposed to have been a former bed of Congaree River.

4. *Darlington, Darlington County.*—In 1850 (Proc. Amer. Assoc. Adv. Sci., vol. III, p. 67), Gibbes showed before the Association several specimens of horse-teeth, referred to *Equus americanus* (*E. complicatus*), found in supposed Pliocene at Darlington. They were reported as having been discovered associated with bones of a mastodon, presumably of *Mammut americanum*. No additional information was furnished. Darlington is situated on a branch of Black Creek, an affluent of Great Pedee River. The teeth were probably found in a Pleistocene terrace deposit.

GEORGIA.

(Map 17.)

Apparently remains of extinct horses have been found in Georgia in only two places, as follows:

1. *Brunswick, Glynn County.*—During the construction (in 1838–39) of a canal which connected Altamaha and Turtle Rivers, remains of various fossil vertebrates were discovered. A list of these will be given on page 370. Among the remains was a lower left last premolar or first molar of an extinct horse, described by Leidy in 1847 (Proc. Acad. Nat. Sci. Phila., 1847, p. 266) and again in 1860 (Holmes's Post-Pleiocene Foss. South Carolina, p. 104, plate XVI, fig. 23). In the first publication he referred the tooth to his species *Equus americanus* (=*E. complicatus*); but in 1860 he referred it to his *Equus fraternus* (=*E. leidyi*). The size of the tooth appears to justify his later conclusion.

Lyell, in his "Second Visit to the United States," made in 1845 (ed. 2, vol. 1, p. 348), stated that remains of *Equus* had been found in the Brunswick Canal. He referred it to *Equus curvidens*, and stated that this species had the upper teeth more curved than any living horse.

On page 436 of Bulletin No. 26 of the Geological Survey of Georgia, J. W. Gidley furnished a list of vertebrates dredged up somewhere near Brunswick. Among the species are 3 horses, *Equus fraternus* (=*E. leidyi*), *E. complicatus*, and *E. tau* (probably *E. littoralis*). Through the liberality of Professor S. W. MacCallie, State Geologist of Georgia, the writer has been permitted to study these teeth. There is one damaged upper molar which belongs to *E. complicatus;* 4 upper and 1 lower grinders belong to *E. leidyi;* 2 upper left molars are certainly those of *E. littoralis;* one having a height of 72 mm., a crown-length of 23 mm., and a width of 22 mm. The length is slightly greater than that of the type of the species.

In the collection of the Academy of Natural Sciences of Philadelphia the writer has examined an equine tibia presented by J. H. Couper, probably found in the Brunswick Canal with the other remains presented by Mr. Couper. It is compared in size with a tibia of the horse Edwin For-

rest, with that of a draft horse in the U. S. National Museum, and with that of *E. scotti,* No. 10628, in the American Museum of Natural History.

Measurements of tibiæ of horses, in millimeters.

	Brunswick horse.	Edwin Forrest.	Draft horse.	E. scotti.
Total length of tibia	455	365	420	370
Side-to-side diameter at middle of length	65	42	50	49

The Brunswick horse was evidently a very large one, but it may have been an unusually large specimen of *Equus complicatus.*

2. *Skidaway Island, near Savannah, Chatham County.*—On page 27 of William B. Hodgson's "Memoir on the Megatherium," in Joseph Habersham's memorandum, is noted the fact that among the fossils found here was a well-preserved tooth of a horse. The height of the tooth is given as being 2.75 inches, greatest diameter 1.2 inches, the least 1 inch. The tooth was evidently an upper premolar or molar. It belonged probably either to *Equus complicatus* or *E. leidyi,* but to which is uncertain.

In 1850 (Proc. Amer. Assoc. Adv. Sci., vol. III, p. 67), Robert W. Gibbes reported the discovery of horse remains, probably a tooth, in the alluvium of Skidaway Island, a few miles southeast of Savannah. No further information was furnished. The geological conditions at this island and the fossils found there will be considered on pages 370 to 372.

FLORIDA.

(Maps 17, 18.)

1. *Stokes Ferry, St. Mary's River, Nassau County.*—In 1909 (2d Ann. Rep. Florida Geol. Surv., p. 147), Sellards stated, on authority of notes received from Dr. L. W. Stephenson, that 3 teeth of a fossil horse had been found at the place named. At the same place was discovered a fragment of a tooth of an elephant, most probably *Elephas columbi,* and some earbones of a whale. The writer has not seen these and does not know to what species they belonged.

Measurements of tibiæ of horses.

Dimensions taken.	Equus sp. Florida.	E. scotti.	E. caballus.
Total length of bone	396	370	392
Length on outer border	360	...	
Length on inner border	378	...	
Width across upper end	125±	107	108
Fore-and-aft diameter at middle of length	45	40	37
Side-to-side diameter at middle of length	56	49	43
Greatest width at lower end	94	93	86

2. *Almero Farm, St. John County.*—In the collection of Mr. Fred R. Allen, of St. Augustine, Florida, the writer has examined a left tibia of an

extinct horse, found in the Inland Waterway Canal, about 28 miles south of St. Augustine. The species has not been determined, but it may be well to put on record the measurements. It apparently belonged to a rather large horse. For comparison, other corresponding measurements are given, taken from *Equus scotti*, No. 10628 of the American Museum of Natural History, and from *Equus caballus*, No. 74 of Mr. Chubb's collection at the museum mentioned, a trotting stallion.

It will be seen that the tibia found below St. Augustine is a relatively stouter bone than those it is compared with. The large horse, known to have existed in Florida, is *Equus complicatus*.

3. *Neals, Alachua County.*—This place is near Newberry. Here have been collected *Gomphotherium floridanum, Tapirus terrestris?*, and *Hipparion* sp. indet.

4. *Wade, Alachua County.*—The writer has seen at Tallahassee, 4 fossil *Equus* teeth, found at this place. One is No. 1470 of the Florida Geological Survey and labeled as found in the Buttgenbach "cummer" mine. It is a lower left second premolar, 40 mm. high, 31 mm. long, and 14.5 mm. wide, not including the cement present. Another tooth, No. 1462, from Buttgenbach's river mine, near Wade, is the hindermost left molar of the lower jaw, 32 mm. long, and 13 mm. wide in front. It is thought these teeth belonged to *Equus leidyi*.

5. *Newberry, Alachua County.*—This is the locality mentioned by Dall (Bull. 84, U. S. Geol. Survey, p. 128) under the name of Hallowells; but he mentioned no fossils from this place. In the Report of the Florida Geological Survey, volume v, page 58, Sellards stated that a species of *Hipparion* had been discovered in the hard phosphate. In the eighth report of the same survey, on page 42, the present writer described a specifically undetermined species of *Parahippus*, also from the phosphate deposits. On page 94 Dr. Sellards reported *Equus littoralis* and *Odocoileus* from Newberry. The writer has identified as *Equus littoralis*, a horse represented by a lower left hindermost molar, found at Newberry.

6. *Archer, Alachua County.*—Dr. Joseph Leidy, in 1885 (Proc. Acad. Nat. Sci. Phila., pp. 32, 33), described from this place a rhinoceros, *Rhinoceros proterus, and Hippotherium ingenuum*. In 1886 (ibid., pp. 11, 12) he again mentioned these species and described in addition to them *Mastodon floridanus* and 3 species of camels which he referred to the genus *Auchenia*. In a list furnished by Leidy to Dr. W. H. Dall (Bull. U. S. Geol. Surv., No. 84, p. 129), there are listed, besides the species mentioned, *Megatherium* and *Cervus virginianus?*, all found in the Alachua clays and usually referred to the Lower Miocene or Upper Pliocene. In the list presented on page 375, under the geology of Florida, a species of tapir is added. At present the writer assigns the deposits known as the Alachua clays to lowermost Pleistocene.

7. *Williston, Levy County.*—In the American Museum of Natural History, New York, is an upper last molar of *Equus*, found at the place named and presented by E. Mixon. The enamel is not much plicated. The size of the tooth indicated that it belonged to *E. leidyi*. In the list of vertebrates unearthed at Mixon's (near Williston), furnished by Leidy to Dall, were

included two species of *Hippotherium, H. ingenuum* and *H. plicatile.* These species are now referred to the genus *Hipparion. H. plicatile* was described by Leidy in 1887 (Proc. Acad. Nat. Sci. Phila., p. 309). A list of the species at present known to have been obtained here is to be found on page 375 under the geology of Florida. They have all been found in the Alachua clays and are usually regarded as belonging to the late Tertiary.

8. *Ocala, Marion County.*—In 1889 (Trans. Wagner Inst., vol. II, p. 13), Leidy reported the discovery of some fossil vertebrates in a fissure in a limestone rock near Ocala. Some equine teeth he referred to *Equus fraternus* (=*E. leidyi*). The other species were identified as *Smilodon floridanus, Elephas columbi,* and (with some doubt) *Procamelus minimus.* For conclusions regarding the geology of the locality see page 378.

9. *Dunnellon, Marion County.*—The writer has examined 2 fossil horse-teeth found near Dunnellon, now the property of the Florida Geological Survey. No. 1366 is from the Camp Phosphate Company's Blue Run mine. It is a first or second upper molar, worn down to a height of only an inch and having a grinding-surface 26 mm. long and 25 mm. wide and with a protocone 12 mm. long fore and aft. No. 1444, also a first or second upper molar, has a height of 47 mm., a length of 24 mm., a width of 23 mm., and a protocone of 11.5 mm. The enamel of the lakes is much plicated. The teeth are identified as those of *Equus leidyi.* No. 1444 has been figured by Sellards (7th Ann. Rep. Florida Geol. Surv., p. 111, fig. 40) and described as dredged from the Schilmann and Bene river mine, on Withlacoochee River.

On page 376, under the geology of Florida, will be found a list of the species obtained at Dunnellon and the surrounding region. In this list is included *Parahippus* sp. indet. and *Hipparion plicatile.* Dr. Sellards believes that many species of that list belong to the Pleistocene. The horse-like species, the rhinoceros, and the camel are held by him as being older than the Pleistocene.

10. *Hernando, Citrus County.*—At this place have been secured *Gomphotherium floridanum, Hipparion* sp. indet., and *Procamelus* sp. indet., all from the phosphate deposits and referred by Sellards to the Upper Miocene or the Lower Pliocene.

11. *Holder, Citrus County.*—In the collection of Dr. H. G. Bystra, of Holden, is a fossil horse-tooth dredged from Withlacoochee River, in section 29, township 17 south, range 19 east. The species to which the tooth belonged has not been determined.

12. *Orange County.*—The writer has seen, in the collection of the Academy of Natural Sciences of Philadelphia, an upper right last molar of *Equus,* labeled as found in the county named. Nothing more is known by the writer about the tooth.

13. *Eau Gallie, Brevard County.*—In 1916 (8th Ann. Rep. Florida Geol. Surv., p. 105), Sellards stated that at this place, in the Hopkins drainage canal, had been collected teeth of *Elephas columbi* and *Equus complicatus.*

14. *Kingsford, Polk County.*—In the U. S. National Museum are 3 horse-teeth collected in 1903 by Mr. Juan C. Edmundoz, from some of the phosphate mines in the region about Kingsford. Although most of the fossils

from these mines have been supposed to belong to the late Miocene or early Pliocene, these horse-teeth are certainly of Pleistocene age. One tooth, No. 8620, is an upper right true molar, either the first or the second. It is worn down to about half its original length. The length of the grinding-surface is 25 mm.; its width is 26 mm. The enamel surrounding the lakes is extremely complicated. Another tooth, No. 8619, is a right hindermost molar with the protocone missing. A third tooth, No. 8618, is a little-worn lower molar, probably the second. The height is 83 mm., the length 25 mm., width 14 mm. The teeth are to be referred to *Equus leidyi.*

15. *Brewster, Polk County.*—In volume VIII of the Florida Geological Survey, pages 95, 96, Dr. Sellards states that from the phosphate mines at Brewster have been obtained teeth of *Hipparion minor.* A list of the associated species is to be found in the discussion of the Pleistocene geology of Florida on page 380.

16. *Alafia River, Hillsboro County.*—In the American Museum of Natural History, New York, is a collection of 10 teeth of *Equus,* said to have been dredged in Alafia River. Some belong to *E. leidyi.* One, a right third or fourth upper premolar worn down to a height of 40 mm., has still a length of 30 mm. and a width of 27 mm.; apparently it belongs to *E. complicatus.* The writer has described an extinct species of box-tortoise, *Terrapene putnami* (Fossil Turtles, N. A., p. 360) dredged by Professor F. W. Putnam in Alafia River about a mile above its entrance into Tampa Bay. With the bone, which forms the type of the species, were dredged a peripheral bone of a *Testudo,* possibly *T. crassiscutata,* and remains of horses and tapirs. It is pretty certain that the 10 teeth above mentioned were secured by Professor Putnam.

In Heidelberg University, Tiffin, Ohio, is a part of a lower right premolar of *Equus,* apparently *E. leidyi,* said to have been found near Tampa Bay.

17. *Palmetto, Manatee County.*—At several places about the mouth of Manatee River have been found relics of fossil horses. Mr. Ernest Leitzel, of Palmetto, sent to the U. S. National Museum for identification some teeth found in Manatee River, others in Terra Ceia Bay. The teeth are all well fossilized; some are upper teeth, others belong below. The writer regards them as belonging to *Equus leidyi.*

In the same museum are 2 lower right true molars, a second and a third, sent from Manatee by Mr. N. B. Moore. The teeth are moderately worn. The length of the grinding surface of the hindermost molar is only 23 mm., the width 12 mm. They must have belonged to a small horse and are referred to *Equus littoralis.*

From Mr. Charles T. Earle the U. S. National Museum received in February 1921, several teeth of *Equus leidyi,* 2 of *E. complicatus,* and 1 of *E. littoralis,* which had been washed up on the beach at Palma Sola, about 10 miles below Palmetto. With these teeth came parts of antlers of a deer, a part of a metacarpal and an astragalas of *Bison latifrons?,* a part of a beak of a platanistid porpoise, a part of a tooth of *Elephas columbi,* a fragment or two of a terrapin (*Trachemys* sp. indet.) a fragment of the carapace of a soft-shelled turtle, and teeth of sharks. The porpoise and

the sharks, also a part of a metapodial of a camel, may belong to Miocene or Pliocene deposits near the locality.

18. *Sarasota Bay, Sarasota County.*—The region a little further south than Manatee River has furnished remains of extinct horses. Sellards (7th Ann. Rep. Florida Geol. Surv., p. 112, fig. 47) has figured a lower tooth of a large horse, found by Mr. Joseph Willcox, at White Beach, on Sarasota Bay. Inasmuch as the fore-and-aft dimension of the tooth is 30 mm., it very probably belonged to *Equus complicatus*. Mr. Willcox has submitted to the writer 2 large lower teeth, regarded as belonging to the species just mentioned. Another lower tooth, apparently a third or fourth lower premolar, found on the same beach, has the fore-and-aft dimension only 26 mm., the width 15 mm. This is referred to *Equus leidyi*. At Blackburn's place, 12 miles south of White Beach, Mr. Willcox secured a tooth of *Equus* apparently little worn. The height is 83 mm., the length at the summit 28 mm., but a little further down only 26 mm.; the width 12 mm. This tooth is to be referred to *Equus leidyi*.

In the American Museum of Natural History, New York, are 7 teeth of *Equus*, collected in 1911 by Mr. Barnum Brown at a place 8 miles southeast of Sarasota. They appear to belong to the Florida horse of medium size, *Equus leidyi*.

19. *Calvenia, Hardee County.*—In the U. S. National Museum (No. 4838) is an upper right last molar of a horse labeled as found near the mouth of Charlie Apopka Creek and as having been presented by Captain Le Baron through L. C. Johnson. The tooth belongs to *Equus leidyi*. Another tooth found at the same place, at the same time (December 16, 1883), and presented in the same way, is a lower grinder. The height is 75 mm., the length, 27 mm., the thickness 12.3 mm. It is to be referred to *E. leidyi*.

20. *Arcadia, De Soto County.*—Many remains of horses, especially teeth, have been collected at and near this place, by Mr. Joseph Willcox, on a sand-bar at Arcadia being explored for phosphate. The first published description of these remains appears to be that of Leidy in 1889 (Trans. Wagner Inst., II, p. 19). Leidy had at hand 17 upper molars, 2 lower molars, and 2 incisors. He was, at that time, uncertain whether these teeth pertained to an indigenous species of *Equus* or to the domestic horse. The manager of the Arcadia Phosphate Company, Mr. T. S. Moorhead, informed Mr. Willcox that the main source of the materials of the bar extended for miles along the shores of Peace Creek and was about 8 feet thick.

Among the materials examined by Leidy (Proc. Acad. Nat. Sci. Phila., 1890, p. 182) was a tooth which he regarded as belonging to *Equus major* (=*E. complicatus*), but, on the suggestion of Professor Cope, he described and figured as *Hippotherium princeps*. Later, Lucas (Trans. cit., vol. IV, p. 49, plate XIX, figs. 12, 13) concluded that Leidy's first opinion was correct. The tooth is abnormal in having the column of the protocone free from the other cusps of the tooth for a short distance from the grinding-surface. In Bulletin No. 84 (p. 129) of the U. S. Geological Survey, Leidy referred the Peace Creek horses to his *Equus fraternus* (=*E. leidyi*), and

it is found that in size and other respects the type of *Hippotherium princeps* agrees with this species. It is retained, however, as *Equus princeps*.

In the U. S. National Museum are 6 teeth collected on Peace Creek, probably not far from Arcadia, which all apparently belong to *E. leidyi*. J. W. Gidley (Bull. Amer. Mus. Nat. Hist., vol. xiv, 1901, p. 121) stated that there is in the American Museum a tooth from Peace Creek, much too small to be referred to any species at that time reported from the United States, but resembling closely *Equus tau*, from Mexico. This tooth probably belongs to *Equus littoralis*.

Besides the horses of the genus *Equus*, there have been found at or near Arcadia the 3-toed horse *Hipparion ingenuum*. Whether this is to be referred with the great majority of the fossils found in this region to the Aftonian fauna of the first interglacial or to the Nebraskan stage it is impossible to say.

21. *Vero, St. Lucie County.*—Numerous remains of extinct horses have been found here, but they always consist of single bones or teeth, sometimes in fine condition, sometimes somewhat waterworn. The remains occur in both deposits, designated as No. 2 and No. 3, but in the latter the materials are more fragmentary and not specifically identifiable. Sellards has figured some of the teeth in his seventh Annual Report (1915, pp. 110, 111, figs. 40–43). In his eighth report, on page 149, he has recognized the occurrence here of 3 species, *Equus complicatus, E. leidyi,* and *E. littoralis*.

The writer has examined a large canine tooth found in the stratum of sand, No. 2. From its size it is referred to *Equus complicatus*. Its fore-and-aft diameter is 14 mm. Another tooth from the stratum, an upper right third true molar, finely preserved and retaining some of the cement, is regarded as belonging to *E. leidyi*. Two lower teeth from No. 2 are waterworn, but retain their structure. The fore-and-aft diameter of each is 21 mm. They must have belonged to the little horse called *E. littoralis*. A fragment of an upper tooth is referred to this species. It is not waterworn, but has been split from the crown to the root. A hinder first phalangeal bone found in the canal (No. 1802 of the Florida Geological Survey) is 96 mm. long. This indicates a horse as large as our ordinary domestic horses and it probably belonged to *Equus complicatus*.

22. *Labelle, Lee County.*—In 1889 (Trans. Wagner Inst., vol. ii, p. 17), Leidy stated that Mr. Joseph Willcox had obtained, from a Pliocene shell-bed on Caloosahatchee River, some remains of a fossil horse, consisting of two cervical vertebræ and a part of a lower jaw, which contained the first and second molar teeth. These teeth are probably what would be called premolars 2 and 3. Leidy referred the remains to his *Equus fraternus* (=*E. leidyi*).

Dall (Bull. No. 84, U. S. Geol. Surv., p. 129) stated that *Equus fraternus, Bison latifrons,* and *Elephas columbi* were found in Pliocene beds on the Caloosahatchee, but Sellards (8th Rep. Florida Geol. Surv., p. 102) corrects this error as to the age.

The writer has received a letter from Mr. Willcox in which he states that the fragment of lower jaw was found about 2 or 3 miles below Labelle.

23. *Palm Beach, Palm Beach County.*—In 1916 (8th Ann. Rep. Florida Geol. Surv., p. 105), Sellards wrote that Mr. J. L. Hayes had secured for the Florida State Geological Survey, from the Palm Beach Canal, teeth of *Elephas columbi* and *Equus complicatus* and a femur of a species of *Bison.*

ALABAMA.

(Map 17.)

1. *Newbern, Hale County.*—In August 1914, there was received at the U. S. National Museum, from Mr. J. W. White, of Newbern, a lower left first incisor of a horse. This, with a lower molar of a species of *Bison,* had been found in a creek. The incisor is somewhat worn, but still retained a part of the cup. The grinding-face is 14 mm. from side to side. The species can not be determined.

2. *Bogue Chitto, Dallas County.*—In the U. S. National Museum is an upper right true molar, first or second, of a horse, found at this place in 1883, by L. C. Johnson, of the U. S. Geological Survey. The tooth is identified as that of *Equus leidyi.* The enamel is much crenated. At the same place was found a tooth (a lower molar) of *Elephas imperator,* and teeth of *Mammut americanum.* It seems to the writer that the presence of these species indicates that the deposits along Bogue Chitto belong to the early part of the Pleistocene, about equivalent to the Aftonian.

MISSISSIPPI.

(Map 17.)

1. *Orizaba, Tippah County.*—In the U. S. National Museum (No. 1907) is a fossil tooth of a horse, a third or fourth right premolar, found apparently not far from this little town. It is labeled as having been picked up at Lander's mill, 9 miles south of Ripley, on Cane Creek, out of débris of Cretaceous marl, and given to Dr. T. E. Stanton. How it came to be mingled with the marl is not known. The tooth is only moderately worn, the height being 75 mm. The length of the grinding-surface is 28 mm., the width 27 mm. It has the enamel unusually strongly folded. The tooth is referred provisionally to *Equus leidyi.*

2. *Natchez, Adams County.*—Elsewhere will be found an account of the discovery of fossil vertebrates near Natchez by Dr. M. W. Dickerson (p. 390), among which were found horse teeth, referred to two species. One of these horses, represented, as supposed, by 12 teeth, was at first called by Leidy *Equus americanus* (Proc. Acad. Nat. Sci. Phila., 1847, vol. III, p. 265, plate II); but later *Equus complicatus* (Proc. cit., 1858, p. 11). In 1901 (Bull. Amer. Mus. Nat. Hist., vol. XIV, p. 109, fig. 7), Gidley selected one of the teeth, that of Leidy's plate II, figs. 1, 6, referred to above, as the special type of the species *Equus complicatus.* These Natchez teeth are now in the collection of the Philadelphia Academy of Natural Sciences.

Some of the teeth from Natchez were described by Leidy in 1860 (Holmes's Post-Pliocene Fossils of South Carolina, pp. 100-105, plate XV, figs. 11–15, plate XVI, figs. 24–26, 30, 31) as *Equus complicatus.* Others (pp. 100–

105, plate xv, figs. 17, 18, plate xvi, fig. 27) were referred to a hitherto unrecognized species *Equus fraternus*.

TENNESSEE.

(Map 17. Figure 23.)

1. *Rogersville, Hawkins County.*—In the U. S. National Museum (No. 520) is a single horse-tooth found many years ago in a crevice in a marble quarry at this place. It is referred by the writer to *Equus leidyi* (Proc. U. S. Nat. Mus., vol. LVIII, p. 84). With it were sent a canine tooth and a few bones of a peccary, described as *Mylohyus setiger* (p. 394).

2. *Whitesburg, Hamblen County.*—In 1885 Mr. Ira Sayles collected at this place a lot of bones and teeth of vertebrates, described by the present writer (Proc. U. S. Nat. Mus., vol. LVIII, p. 87). Among them is an upper right second premolar of a horse, identified as *Equus leidyi*. A list of the species will be found on page 395. *E. littoralis* also is present.

3. *Lookout Mountain, Hamilton County.*—In the American Museum of Natural History, New York, is an upper second molar tooth brought from Lookout Mountain (Gidley, Bull. Amer. Mus. Nat. Hist., vol. XIV, p. 121). Under what conditions this tooth was found have not been recorded. It belongs probably to the species *Equus littoralis*.

4. *Nashville, Davidson County.*—From William Edward Myer, of Nashville, Tennessee, the writer received, June 26, 1920, some fossils collected near Nashville, about 300 yards upstream from Lock A, in Cumberland River, at a depth of nearly 30 feet beneath a bank of gravel. Below this gravel is a bed of sand apparently 2 or 3 feet thick and this is underlain by another bed of gravel apparently about 2 feet thick. This itself lies on bed rock at about the level of low water in the river. In the lower gravel were found a lower molar of *Equus leidyi*, a part of a left femur of a large horse, and an antler of a small undetermined and probably undescribed deer. In the layer of sand were discovered a heel bone of a camel, a part of a tooth of a young mastodon, and some fragments of turtle bones. The equine tooth belongs to the right side. It has a height of about 80 mm., a length of 28 mm. on the grinding-surface, and a width of 16 mm. It is black, and like the others thoroughly fossilized.

The fragment of femur appears to have belonged to a horse perhaps larger than *Equus leidyi*. It begins at the lower border of the third trochanter and descends to the lower part of the deep fossa for the plantaris muscle. Immediately above the fossa the side-to-side diameter of the bone is 50 mm., the fore-and-aft 60 mm. In a horse of medium size these diameters are respectively 45 mm. and 53 mm.

Later there was discovered at the same locality the upper two-thirds of the right metatarsal. The fragment is 230 mm. long. The upper articular end is somewhat injured; 75 mm. below the upper end the fore-and-aft diameter is 45 mm., the side-to-side diameter 38 mm. The latter diameter was somewhat greater, as the bone appears to be slightly crushed. The specimen is referred to *Equus complicatus*. Probably the femur mentioned above belonged to this species.

KENTUCKY.

(Map 17.)

1. *Bigbone Lick, Boone County.*—In their report published in 1831 (Amer. Jour. Sci., vol. xx, p. 371), Cooper, Smith, and Dekay reported they found in the collection from this place large teeth and bones of a horse. They regarded these as being of equal antiquity with the extinct animals associated with them. In 1847 (Proc. Acad. Nat. Sci. Phila., vol. III, p. 263, 264) Leidy stated that there were in the Academy 10 permanent molars of a horse from Bigbone Lick. These he referred to *Equus curvidens*. In 1853 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 263) he wrote that several teeth supposed to have come from this locality had possibly been obtained elsewhere.

In 1851 (Proc. Acad. Nat. Sci., Phila., p. 140), he spoke of foot-bones of the horse, a calcanum and first phalanx, from the same place. In 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 104), Leidy mentioned several horse-bones from Bigbone Lick presented to the American Philosophical Society by President Jefferson. In Rochester University are 2 hoof phalanges labeled from Bigbone Lick. Osborn ("Age of Mammals," p. 478) puts down *Equus* from Bigbone Lick as being doubtful. There appears to be no good reason for this.

The remains of horses from this locality appear all to belong to *Equus complicatus*.

2. *Monday's Landing, Mercer County.*—From Professor Arthur M. Miller, of the University of Kentucky, the writer has received for examination a much-worn upper left molar or premolar of a horse found at the place named. It was met with in a fissure filled with crystallized calcite, near the bank of Kentucky River. The vein of calcite was about 6 feet wide. Similar veins at this locality have been worked down to a depth of 200 or 300 feet. A part of a lower jaw of a deer-like animal was found in one of these veins. The horse-tooth is badly worn, but it appears to have belonged to a small species, the fore-and-aft length of the crown being only 19 mm. The enamel of the anterior lake is considerably complicated. It is impossible, from the lack of other fossil remains, to determine the geological age of this horse.

FINDS OF PLEISTOCENE TAPIRIDÆ IN EASTERN NORTH AMERICA.

PENNSYLVANIA.

(Map 19.)

1. *Port Kennedy, Montgomery County.*—In 1871, Wheatley announced (Amer. Jour. Sci., ser. 3, vol. I, p. 384) that he had discovered in the Port Kennedy bone cave 2 species of tapirs (*Tapirus americanus* and *T. haysii*). In 1899 (Jour. Acad. Nat. Sci., Phila., vol. II, p. 253), Cope stated that remains of 35 or more tapirs had been discovered in this cave. He referred all to *T. haysii*. These tapirs will be mentioned again on page 312, where the geological relations of the cave and its contents are considered.

2. *Frankstown, Blair County.*—In 1908, Dr. W. J. Holland reported (Ann. Carnegie Mus., vol. IV, p. 231) found in a bone cave at Frankstown the third and fourth lower premolars of a tapir about the size of *Tapir americanus*, which name is a synonym of *T. terrestris*. This will be mentioned in the discussion of the geology of the region on page 321.

OHIO.

(Maps 19, 36.)

1. *New Salisbury?, Columbiana County.*—Somewhere in the region probably of the town named was found, about 1850, a jaw of a tapir, apparently mentioned first by Louis Agassiz (Proc. Amer. Assoc. Adv. Sci., vol. V, 1851, p. 179), who referred to it as a jaw of a pachyderm. Leidy, in 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 107), reported that he had studied a much-mutilated fragment of the lower jaw of the smaller variety of the extinct tapir, which had belonged to Professor J. Brainerd, of Cleveland. It had been found in the valley of Yellow Creek, in Columbiana County, in an erosion of the coal series. It was covered with 30 feet of clay, at a height of 186 feet above low-water in Ohio River. Charles Whittlesey, in 1866 (Smithson. Contrib. Knowl., vol. XV, art. 3, p. 16), stated that this specimen was taken from "valley drift," of Yellow Creek, in Columbiana County, by Mr. E. White, C. E., in a cut of the Pennsylvania Railroad. Inasmuch as Yellow Creek itself does not enter the county named, reference must be to what is called, on the topographical sheet of the U. S. Geological Survey, North Fork of Yellow Creek. The railroad follows this creek for many miles in the county. The town of New Salisbury is taken as being probably not far from the locality. It is not known what became of this specimen, nor is it possible to say to which species it belonged. It is to be referred probably to the Sangamon stage.

INDIANA.

(Map 19.)

1. *Evansville, Vanderburg County.*—Tapir remains have been found at only one place in Indiana, viz, in the banks of the Ohio River at the mouth of Pigeon Creek, a short distance below Evansville. A single lower hinder

molar formed part of a collection made by Mr. Francis A. Lincke and described by Leidy (Proc. Acad. Nat. Sci. Phila., 1854, p. 199). This tooth was figured by Leidy in 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 107, plate XVII, figs. 9, 10) under the name *Tapirus haysii.* Associated with the tooth were remains of *Megalonyx jeffersonii,* a bison of probably an extinct species, the Virginia deer, the horse known as *Equus complicatus,* and the large extinct wolf *Ænocyon dirus.*

On page 32 is discussed the probable age of the bone-bed which contained the animals named above. It is concluded that the age is possibly the Aftonian, but more probably the Sangamon. This species of tapir has been found at Bigbone Lick, Kentucky, between Louisville and Cincinnati, in deposits containing *Equus complicatus,* 2 extinct species of *Bison,* deer, etc. The deposits lie on Illinoian drift and are in part, at least, of Sangamon age.

MARYLAND.

(Map 19.)

1. *Corriganville, Allegany County.*—In a crevice in limestone rock, at a point about 3 miles west of north of Cumberland, Mr. J. W. Gidley found a tooth of a tapir. The tooth has never been specifically identified. A list of the associated species, as far as determined, will be given on page 350.

VIRGINIA.

(Map 19.)

1. *Ivanhoe, Wythe County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 176), Cope announced the discovery of several lower molars of a tapir in what he regarded as cave breccia, along New River. These teeth he found to be somewhat larger than those of *T. terrestris,* the Central and South American species, and he referred them to *Tapirus haysii.* A list of the species found here is given on page 353.

SOUTH CAROLINA.

(Map 19.)

1. *Charleston, Charleston County.*—In 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 106, plate XVII, figs. 2, 3), Leidy described briefly and figured 2 injured upper cheek-teeth of a tapir found in the Pleistocene of Ashley River, and referred by him to *Tapirus americanus fossilis,* on the supposition that they were not different from those of the existing South American tapir, but larger. The larger of the two teeth (fig. 2) appears to have had a fore-and-aft diameter of about 29 mm. It seems, therefore, to belong to Leidy's species *Tapirus haysii.* Under the same name, *T. americanus fossilis,* Leidy illustrated (figs. 11, 12) a lower molar found on Ashley River. This appears to be too small to have belonged to *T. haysii.* Instead, however, of referring it to *T. americanus* (=*T. terrestris*) it may possibly be found to belong to *T. veroensis* Sellards, the lower molars of which are not certainly known. The length of the tooth figured by Leidy is that of a second molar of *T. terrestris,* but the width is greater than in the latter.

In the Charleston Museum is a part of a left ramus of the lower jaw of a tapir likewise referred to *T. veroensis* Sellards. This fragment contains all 3 of the true molars. The following measurements were secured:

Measurements, in millimeters, of lower molars of tapirs in the Charleston Museum.

	Tapirus veroensis?		Tapirus haysii.	
	Length.	Width.	Length.	Width.
Length of all 3 molars combined	66	....	79	....
First molar	20	17	25	28
Second molar	23	18.5	26	31.5
Third molar	24	18	28	32

In the collection of Charles C. Pinckney, at Lambs, South Carolina, are 2 tapir teeth, one of which is an upper molar, not yet come into use, apparently the last tooth of the right side. The length of the crown is 25.5 mm., the width in front 27.5 mm., behind about 23 mm. In front is a pretty strong cingulum, but there is none behind. This tooth is referred to *Tapirus haysii.*

In the Scanlan collection from Charleston, now the property of Yale University, are various specimens of tapirs. An upper left second molar is slightly worn. The length is 24 mm., the width 30 mm. The outer border of the crown makes a right angle with the anterior border; in *T. terrestris* the outer anterior corner is considerably less than a right angle. In the latter the hinder faces of the protocone and of the hypocone are concave; in the tooth here described both hinder faces are swollen, and the crests appear more depressed than in *T. terrestris.* It is regarded as belonging to *T. haysii.*

In the Scanlan collection are 3 lower molars which the writer refers to *T. haysii.* The following are the measurements:

Measurements, in millimeters, of lower molars of tapirs in the Scanlan collection.

	Length.	Width.
Left third? molar, with the rear cingulum broken off	28±	22.5
Left second molar	25.5	21
Right second molar	27	21

In the Scanlan collection is a fragment of the left maxilla with 4 teeth, the last premolar and the 3 molars. The specimen resembles figure 1 of Leidy's plate XVII of Holmes's "Post-Pliocene Fossils of South Carolina." The teeth of the Scanlan specimens are, however, less worn. The hinder

molar had not yet come through the gum. The specimen is referred to *T. terrestris*. The following are the measurements:

Measurements, in millimeters, of upper teeth of Tapirus terrestris.

Tooth.	Tapir from Charleston.		T. terrestris, U. S. Nat. Mus. No. 238110	
	Length.	Width.	Length.	Width.
Pm^1	19	24.5	19	25
M^1	20	25.5	21	23
M^2	22.5	28	23.5	27
M^3	24.5	27.5	25.5	26

The molar teeth have an acute angle between the anterior and the outer borders, and the front and the hinder faces of the protocone and the hypocone are not so swollen as in the tooth referred to *T. haysii*. In apparently every respect the teeth of the fossil agree with the teeth of *Tapirus terrestris* from Brazil. It is to be hoped that before long a good skull of the Pleistocene tapir whose teeth so closely resemble those of *T. terrestris* will be discovered. If the two prove to be the same species it will seem that only the descendants of those which migrated to North America perished during the Glacial period.

There is another tooth, an upper left second molar, of *T. terrestris* in the Scanlan collection; also the rear half of an upper molar labeled as coming from Bull River. Other fragments of teeth are recorded as coming from Ashley River.

In the Charleston Museum (No. 13495) is a part of the left ramus of the lower jaw with the 3 molars. On measurement it is found that the teeth and jaw agree closely with those of *T. terrestris*.

GEORGIA.

(Map 19.)

1. *Brunswick, Glynn County.*—In Bulletin No. 26 of the Geological Survey of Georgia, Mr. J. W. Gidley published a list of species of vertebrate fossils which belong to the State collection at Atlanta, secured during some dredging operations at Brunswick. This list, with modifications, is incorporated in that presented on page 370. Among the fossils examined by Gidley, a tooth was recognized as that of *Tapirus haysii*.

FLORIDA.

(Map 19.)

1. *Neals, Alachua County.*—Through the kindness of Dr. E. H. Sellards, State geologist of Florida, the writer has been permitted to examine various teeth (No. 1186, Florida Geological Survey) taken from the T. A. Thompson phosphate mines at Neals. Among these is a lower left milk molar of a

tapir. The length of the crown is 21 mm., the width at the front lobe 14 mm., at the hinder lobe 12.5 mm. The buttresses are well developed. The tooth may be provisionally referred to *Tapirus terrestris*, yet living in Brazil. Although this tooth was found in phosphate materials, it seemed to Dr. Sellards more probable that it was an intrusion from Pleistocene deposits. The present writer refers the Alachua clays to the Nebraskan stage of the Pleistocene. Sellards has referred to this tooth in his Eighth Annual Report, 1916, p. 94.

2. *Archer, Alachua County.*—In 1884 (Proc. Acad. Nat. Sci. Phila., 1884, p. 119), Leidy briefly described a tooth of a tapir found by Dr. J. C. Neal, of Archer, Florida. This is now in the U. S. National Museum, No. 3329. The tooth is the third premolar of the left side, implanted in a fragment of maxilla. The crown is 23 mm. long and 27 mm. wide. Leidy stated that it differed neither in form nor size from the corresponding tooth of the living *Tapirus americanus* (*T. terrestris*); but in a specimen of this the corresponding tooth is only 18.5 mm. long and 25 mm. wide. The fossil agrees in size with the same tooth of *T. haysii* from the Port Kennedy Cave in Pennsylvania (Hay, Geol. Surv. Indiana, vol. XXIII, p. 593). With this tooth had been found teeth of a young mastodon, remains of several individuals of a species of rhinoceros, some foot-bones of a llama, a calcaneum which Leidy thought possibly belonged to the extinct *Cervus americanus* (*Cervalces scotti*), and vertebral centra of a small crocodile. The cervalces was afterwards dropped from the lists. These remains had been found in a bed of clay, occupying a ridge in a pine forest. The deposits are now known as the Alachua clays, and they, as well as the contained fossils, will be discussed on page 375. The tapir remains are not included in Leidy's list given in Bulletin 84 of the U. S. Geological Survey.

3. *Dunnellon, Marion County.*—The writer has examined a number of tapir teeth found in phosphate beds in Withlacoochee River, at Dunnellon. From the Florida geological survey an upper left second premolar (No. 1440) has been received which is considerably larger than the corresponding tooth of *Tapirus terrestris* and presents other peculiarities. It may have belonged to *T. haysii*. An upper second true molar (No. 1440) has the crown 23 mm. long, 27 mm. wide across the front lobe, and 23 mm. across the hinder lobe. The corresponding dimensions of a specimen of *T. terrestris* from Surinam are 24 mm., 25.5 mm., and 21.5 mm. A tooth (No. 1378) which appears to be the lower left second molar is 22.5 mm. long, 19 mm. wide in front, and 20 mm. wide behind. The corresponding measurements of *T. terrestris* are 22.5 mm., 18.5 mm., and 17.5 mm. The buttresses which descend from the outer ends of the crests of the fossil tooth are not so strongly developed as in *T. terrestris*. Probably these teeth belong to an undescribed species. An upper molar having a length of 23 mm. has been shown the writer by Dr. L. W. Stephenson; it was found in phosphate deposits at Dunnellon and sent to him by Sister M. Catherine, of St. Joseph's Academy, at St. Augustine.

4. *Near Ocala, Marion County.*—Mr. J. D. Robertson, of Ocala, presented to the National Museum a tooth of a tapir, found in phosphate deposits a few miles from Ocala, section 5, township 15 south, range 23 east.

5. *Tampa, Hillsboro County.*—In the collection of fossils, at Vanderbilt University, made from the phosphate-producing beds in Hillsboro County, is part of the left ramus of a lower jaw of a tapir containing the first and second true molars. The first molar has a length of 24 mm. and a width of 20 mm. in front. This is smaller than the corresponding tooth of *T. terrestris* and near that supposed to belong to *T. veroensis*. The second molar has lost its hinder crest. Under the first molar the jaw is 54 mm. deep and 37 mm. thick.

The writer (Fossil Turtles of North America, p. 361) reported the finding of tapir teeth in Alafia River, in this county.

6. *Vero, St. Lucie County.*—At this important locality remains of tapirs have been found in the bed of sands known as No. 2, and likewise in the bed of muck mentioned in discussions of the locality as No. 3. From the latter have been secured parts of 2 lower jaws and a number of detached teeth (Sellards, 8th Ann. Rep., p. 149). One at least of these (No. 6943) appears to belong to *Tapirus haysii*. From No. 2 Dr. Sellards has obtained a nearly complete skull of a tapir, described (10th and 11th Ann. Rep. Fla. Geol. Surv., p. 57, plates I–IV) as *Tapirus veroensis*. From the same stratum he (8th Ann. Rep., p. 139) secured a part of a tooth which he referred with some doubt to *T. haysii*.

7. *Arcadia, De Soto County.*—Dr. Joseph Leidy (Trans. Wagner Free Inst., vol. II, p. 19) stated he had examined 3 crowns of upper molars and fragments of others. In no way did he find them differing from those of the South American tapir, *T. americanus* (*T. terrestris*). On page 380 will be found a list of the vertebrate fossils found in this vicinity.

MISSISSIPPI.

(Map 19.)

1. *Natchez, Adams County.*—In 1849 (Proc. Acad. Nat. Sci. Phila., vol. IV, p. 182), Dr. Leidy wrote that there was in the collection of the Academy a tooth of a tapir discovered by Dr. M. W. Dickeson near Natchez. It had been found in association with remains of the mastodon and the horse *Equus americanus* (= *E. complicatus*). The tooth was pronounced a lower molar of the left side, apparently the third milk molar, and was referred to *Tapirus americanus fossilis;* that is, it was looked upon as a fossil tooth of the existing South American tapir. The molar was mentioned by Leidy in 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 106). The writer has seen this tooth in the Academy of Natural Sciences at Philadelphia.

In 1852 (Proc. Acad. Nat. Sci. Phila., vol. VI, p. 148), Leidy called the attention of the Academy to a fragment of a left lower jaw with 2 teeth of a tapir found in the Pleistocene near Natchez and sent to Leidy by the geologist B. L. C. Wailles. It was referred to *Tapirus haysii*. This specimen was figured and described by Leidy in 1860 (Holmes's "Post-Pliocene Fossils of South Carolina," p. 107, plate XVII, figs. 4, 5). Wailles mentioned this jaw in his work (Agric. Geol. Mississippi, 1854, p. 285), and stated that it was found in a ravine on Pine Ridge, which runs through townships 7 and 8, range 3 west, about 6 miles north of Natchez.

In a list (furnished by Dr. Joseph Leidy) of fossil mammals found in the Pleistocene of Mississippi, 2 species of tapirs are included, viz, *Tapirus americanus* (= *T. terrestris*) and *T. haysii* (Wailles, op. cit., p. 286; Hilgard, Agric. Geol. Mississippi, 1860, p. 196). The associated species will be listed on page 391.

TENNESSEE.

(Map 19. Figure 23.)

1. *Whitesburg, Hamblen County.*—In the U. S. National Museum is a collection of bones and teeth of several species of vertebrates, made in what may once have been the floor of a cave, near the village mentioned. On page 395 will be found a list of the species. Among the remains are 10 teeth, in fine preservation, of a young tapir, described by the writer (Proc. U. S. Nat. Mus., vol. LVIII, p. 88, plate III, figs. 4 to 11), and made the type of a new species, *Tapirus tennesseæ.*

2. *Dandridge, Jefferson County.*—On the left bank of Dumplin (or Dumpling) Creek, about 5 miles above its entrance into French Broad River, and apparently about as many miles northwest from Dandridge, is a cavern known as Zirkel's Cave. Dr. H. C. Mercer briefly described (Dept. Amer. and Prehis. Archæology, Univ. Penn., 1896) his investigation of the cave. He reported the finding of remains of tapir, peccary, bear, and small rodents; but these were not specifically determined.

3. *Lookout Mountain, Hamilton County.*—In 1894 (Amer. Naturalist, vol. XXVIII, p. 356), Mercer reported that he had found teeth of a tapir in a cave on Lookout Mountain. Cope, on page 597 of the same volume, identified these teeth as those of *T. haysii.* With them was found a bone, thought to belong to a mylodon.

According to a letter received by the writer from Dr. Mercer, the tapir specimen consisted of a lower right ramus, 1 left incisor, and 5 molars. The teeth appear all to have been loose and the jawbone was broken into about 8 fragments. The cave and its contents will be discussed on page 396.

4. *Bristol, Sullivan County.*—In the U. S. National Museum are 2 tapir teeth in a fragment of the left maxilla. These are the fourth premolar and the first molar, both considerably worn. The size of these teeth indicates that they belong to *Tapirus haysii.*

KENTUCKY.

(Map 19.)

1. *Bigbone Lick, Boone County.*—The evidences for the occurrence of a species of tapir at this place are not as convincing as might be desired. In 1852, Dr. I. Hays (Proc. Acad. Nat. Sci. Phila., vol. VI, p. 53) presented to the Academy a tooth of a tapir which he had had in his possession two years and which was said by him to have come from the bed of a canal in North Carolina. This tooth was named by Leidy *Tapirus haysii* on page 106 of the volume cited and again on page 148, but without description. It was again mentioned by him in 1853 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 201) and again without description. In 1860, Leidy (Holmes's "Post-Pliocene Fossils of South Carolina," p. 106, plate XVI, figs. 7, 8) described

and figured the tooth and stated that it was supposed to have come from Bigbone Lick. Which of the statements was correct the writer does not know.

2. *Stamping Ground, Scott County.*—In 1910 the writer received for examination from Professor Arthur M. Miller, professor of geology in the State University at Lexington, Kentucky, a part of a lower jaw of *Tapirus haysii,* found between the town named and Georgetown, in the bottom of a filled-up sink-hole encountered in lead-mining operations, on McConnell's Run. In this specimen all the molars are complete and the roots of the 3 hinder premolars are present.

3. *Yarnallton, Fayette County.*—From Professor Miller there was received with the specimen above described pieces of the jaws of *Tapirus haysii,* discovered in an old stream-deposit at the place named. A fragment of a lower jaw was sent; also a piece of a right maxilla, with the anterior true molar complete and parts of the second molar and of the hindermost premolar. Some other parts of the skeleton were found, but they seem not to have been cared for.

FINDS OF RHINOCEROSES IN EASTERN NORTH AMERICA.

FLORIDA.

1. *Archer, Alachua County.*—Two species of rhinoceros have been described from this locality. In 1884 (Proc. Acad. Nat. Sci. Phila., p. 118), Dr. Joseph Leidy reported the discovery, with other fossils, of remains of a species of the genus *Rhinoceros* in Alachua clays, but he gave it no name. This was, however, done in 1885 (same Proceedings, 1885, p. 32). In 1896, after the death of Leidy, his unfinished paper, completed and edited by Professor F. A. Lucas, was published (Trans. Wagner Free Inst. Sci., vol. IV, p. 41 seq., with numerous figures). This species is now referred to *Teleoceras,* as *Teleoceras proterus.*

In 1890 (Proc. Acad. Nat. Sci. Phila., 1890, p. 94), Leidy described another species which he called *Rhinoceros longipes,* from the same place and deposit. This species is now called *Aphelops longipes.*

These species are usually credited to the Upper Miocene or Lower Pliocene. The reader is referred to page 376, where the geological position of these beds is discussed.

2. *Williston, Levy County.*—In his list of 1892 (Bull. U. S. Geol. Surv., No. 84, p. 129), furnished by Leidy, W. H. Dall included *Rhinoceros proterus* among the fossils found at Mixon's, near the village of Williston.

3. *Dunnellon, Marion County.*—In 1913 (5th Ann. Rep. Florida Geol. Surv., p. 58), Dr. E. H. Sellards stated that some remains of a rhinoceros had been found in the mines worked along Withlacoochee River, in the region about Dunnellon. In volume VIII of the Florida Survey, page 94, *Aphelops malacorhinus* (= *A. longipes*) is included among the fossils found in the Dunnellon formation. It is not included in his list of Pleistocene species found in the Withlacoochee River (Florida Geol. Surv., vol. VIII, p. 104). This was doubtless because he regarded it as belonging to an earlier formation.

4. *Mulberry, Polk County.*—In 1915 (7th Ann. Rep. Florida Geol. Surv., p. 72), Sellards stated that a tooth of *Teleoceras fossiger* (in the present work recognized as *T. proterus*) had been discovered in the Bone Valley phosphate formation, at the place named. As in other cases, the Bone Valley formation was referred to the Late Tertiary.

5. *Brewster, Polk County.*—In the volume last referred to, on page 72, Sellards mentions parts of jaws and teeth found in a phosphate mine at Brewster which are different from those of *Teleoceras proterus.* Some of these are figured by Sellards on his pages 107 and 108. They have not been specifically or generically determined.

FINDS OF PLEISTOCENE PECCARIES IN EASTERN NORTH AMERICA.

NEW YORK.

(Map 20.)

1. *Rochester, Monroe County.*—In 1889 (Trans. Wagner Inst. Sci., vol. II, pp. 33–40), Leidy described and figured a skull of *Platygonus compressus*, purchased of Ward's Natural Science Establishment, at Rochester, and said to have been found in a gravel bank in a railroad excavation, a few miles from Rochester. This skull was a part of 2 incomplete skeletons found lying together.

The writer received word from Professor Henry L. Ward, director of the Milwaukee Public Museum, that he recollects that, when a small boy, about 1873 or 1874, he went with his father, Henry A. Ward, to some point on the New York Central Railroad, where peccary remains had been found. He thinks the place was at or near Pittsford. Dr. F. A. Lucas, director of the American Museum of Natural History, New York, then in the employ of the elder Ward, writes that the place was at Pittsford, and in a gravel bank being worked by the railroad company to obtain materials for a fill. The exact depth at which the bones were found is not recalled, but it was not great.

The locality, according to Fairchild's plate 42 (Bull. 127, State Mus., New York), is on the predecessor of Irondequoit Bay, extending out from Lake Iroquois. The peccaries possibly lived rather early in the late Wisconsin stage; but more probably their time of existence was considerably later, when the climate had become milder.

2. *Gainesville, Wyoming County.*—From Mr. C. A. Hartnagel, assistant State geologist of New York, the writer received notice of the discovery, in 1914, of the remains of 2 peccaries at a point about one-third of a mile northwest of Gainesville. The remains consist of 2 nearly complete skulls, parts of 5 ribs, 2 scapulæ, 2 metacarpals, 1 innominate bone, 1 ilium, 1 radius, 1 ulna, and 2 tibiæ. These have been identified by Dr. John M. Clarke as belonging to *Platygonus compressus*.

The manner of burial of these peccaries is puzzling and interesting. They were found in a hill, or drumlin, which stands out on a plain of considerable extent and whose long axis runs north and south. The elevation is 1,625 feet above sea-level. The drumlin is about 600 feet long, about 300 feet wide, and 40 feet high. It is composed of sand, gravel, and stones up to a foot in diameter. The bones are said to have been discovered by a contractor who was removing sand and gravel. The bones were at the south end of the drumlin and buried in a considerable pocket of sand. Those reporting the position of the bones place them at least 10 feet from the surface, and perhaps as much as 30 feet. Mr. Hartnagel thinks it is almost necessary to suppose that the skeletons were there when the drumlin was built. To the writer it would appear still more difficult to explain how they happened to be there at that time.

NEW JERSEY.

(Map 20.)

1. *Shark River, Monmouth County.*—In 1869 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 387), Leidy described a tooth of a peccary shown to him by Timothy Conrad, but found by Dr. P. Knieskern, supposedly in a Miocene formation of Shark River. Leidy expressed the conclusion that the tooth resembled very closely a premolar of *Dicotyles nasutus*, now called *Mylohyus nasutus*. It is very probable that the tooth had gotten into Miocene materials by accident or that there was some error in the history, and that it really belonged to a Pleistocene peccary.

PENNSYLVANIA.

(Map 20.)

1. *Stroudsburg, Monroe County.*—Leidy (Proc. Acad. Nat. Sci. Phila., 1880, p. 347) reported *Dicotyles nasutus* from the Crystal Hill (Hartman's) cave near Stroudsburg; but later (Ann. Rep. for 1887, Pennsylvania Geol. Surv., p. 8, plate II, figs. 3–6) he described the teeth and parts of the jaws as *Dicotyles pennsylvanicus*. This species will be found on page 310 under the name *Mylohyus pennsylvanicus*, in the list of fossils found in this cave. There too will be found a discussion of the location of the cave and the probable age of the remains.

2. *Port Kennedy, Montgomery County.*—In the bone cave at this place have been found 3 species of peccaries. Cope, in 1899 (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. II, pp. 259–263) described these under the names *Mylohyus tetragonus, M. pennsylvanicus,* and *M. nasutus*. The first was a new species, based on a damaged lower jaw with some of the teeth (op. cit., plate XXI, figs. 3–3*b*). For the present the writer refers it to the genus *Tagassu,* inasmuch as the interval between the canine and the first premolar (pm^2) is only half the length of the whole tooth row, and the molars have the structure found in *Tagassu*. Some teeth belonging to an upper jaw were referred with doubt to this species. They may have belonged to *Mylohyus pennsylvanicus*. Of the species last named, Cope had fragments of 2 lower jaws with some teeth in them and some teeth free from the jaws. Of *Mylohyus nasutus,* Cope had from the cave only an upper canine and its reference to this species is uncertain.

On page 312 will be found a list of the species of vertebrates found in the Port Kennedy Cave; also remarks on their geological age.

3. *Milroy, Mifflin County.*—In 1882, Leidy described (Proc. Acad. Nat. Sci. Phila., 1882, p. 302) a species of peccary found in a limestone cave in the county named, but he gave no more exact information; nor did he do so in his two subsequent references to it in 1889 (Trans. Wagner Inst., vol. II, p. 49; Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 12, plate II, figs. 1, 2). The specimen is in the Academy of Natural Sciences at Philadelphia. In the Pennsylvania survey, as quoted, the giver is called John Schwarzer. The name of the species is *Platygonus vetus*. The writer has been informed by J. C. Swigart, county surveyor of Mifflin County, that the proper name

of the donor of the specimen was John Swartzell, a former surveyor who lived near Milroy and who was much interested in geology.

From Professor Mosheim Swartzell, of Washington, D. C., son of John Swartzell, the writer has received a letter in which are given this son's recollections regarding the finding of the specimen in question. He states that it was discovered in Naginey's limestone quarry, 1.5 miles south of Milroy. It came from a considerable, but now unknown, distance from the surface and was first noticed in the débris of the quarry. While Mr. John Swartzell was observing it, an ignorant workman struck it with a tool and damaged it, exclaiming that it was only the jaw of a hog. It was later sent to Philadelphia. Professor Swartzell writes that there was a cave not far away, but that the jaw was not found in it; it probably had fallen down into a crevice of the limestone.

4. *Frankstown, Blair County.*—In 1908 (Ann. Carnegie Mus., vol. IV, p. 231), Dr. W. J. Holland reported remains of a number of peccaries found in a bone cave at the place named. He mentioned especially *Dicotyles pennsylvanicus,* but thought it belonged properly in *Platygonus.* It is probably to be referred to *Mylohyus* as *M. pennsylvanicus.*

OHIO.

(Maps 20, 36.)

1. *Wilmington, Clinton County.*—In the collection of the Archæological and Historical Museum of the University of Ohio, at Columbus, are considerable parts of the jaws, teeth, and other parts of the skeleton of a specimen of *Platygonus compressus* exhumed at a point about 4.5 miles north of west of Wilmington. The locality is given as being in the northeast corner of Adams Township, south of the road running northeast and southwest between Todd and Dutch Creeks; also about 0.6 mile south of the north line of Adams Township and about 0.75 mile from the east line. It would therefore be near the second northwesterly directed loop of Todd Creek in that neighborhood.

2. *Columbus, Franklin County.*—In 1875 (Proc. Amer. Assoc. Adv. Sci., vol. XXIII, Hartford, pp. 1–6; also in Cin. Quart. Jour. Sci., vol. II, pp. 1–6), J. H. Klippart gave an account of the finding of about a dozen skeletons of *Platygonus compressus.* These were buried in 2 "nests" not far from each other. The bones were rather brittle and were damaged somewhat in exhuming them. The place of burial was in the bank (apparently the right) of Olentangy River, at the crossing of Olentangy and Montgomery streets. The remains were here buried in a sand bank. One lot of 6 of the smallest animals was found in penetrating the sand bank about 20 feet from the entrance and at a depth of 8 feet from the surface. They were embedded in calcareous clay and sand. The other 6 and largest animals were found about 6 feet farther in and about 4 feet deeper. It appears that all the animals were lying with their snouts directed toward the southeast. Klippart thought that they had been destroyed suddenly and violently. It is, however, probable that they had been frozen in their beds during a winter storm. Of these skeletons it appears that half went to Professor O. C. Marsh, of Yale University, and the present writer has had

the privilege of studying them. The geological age of the animals will be considered on page 330.

3. *Chalfants, Perry County.*—In the collection of the Archæological and Historical Museum at the University of Ohio are considerable parts of a specimen of *Platygonus compressus* found not far from Jonathan Creek, about a mile northeast of Chalfants. The locality, as given the writer by Professor W. C. Mills, is as follows: center of southwest quarter of section 14, township 17 north, range 16 west. The name of the political township is Hopewell. The locality appears to be on the area covered by Illinoian drift. This fact makes it possible that the animals lived during the Sangamon stage.

4. *Lisbon, Columbiana County.*—In the collection just mentioned is the left ramus of a lower jaw of a peccary which the writer referred with doubt to *Mylohyus nasutus* Leidy. It lacks so much of the front end that only 18 mm. of the symphysis is present; also, the ascending ramus is broken off. There are present the 3 milk molars and the first molar, but this is yet in its cavity in the bone. A comparison with Leidy's *M. pennsylvanicus* seems to show that the jaw did not belong to that species. Of *M. nasutus* no lower jaw is known.

Table of measurements, in millimeters.

Specimen.	Lisbon jaw.		M. penn.	
	Length.	Width.	Length.	Width.
Dm_2.....	9	5	7	4.5
Dm_3.....	12	8	11	7
Dm_4.....	19.5	11	18	10.5
M_1.....	16.5	12	16	13

This specimen was found near the southern edge of Lisbon, on Middle Fork of Little Beaver Creek, in the northwest quarter of the northeast quarter of section 24, township 18 north, range 3 west. The locality is apparently outside of the glaciated area; and it is at present impossible to determine the geological age of the animal beyond that it undoubtedly belongs to the Pleistocene. The writer believes that *Mylohyus nasutus* did not survive the Wisconsin ice-stage. The specimen was described and figured by the writer in 1914 (Iowa Geol. Surv., vol. XXIII, p. 226, plate XXV, figs. 4–6).

MICHIGAN.

(Map 36.)

1. *Belding, Ionia County.*—So far as the writer knows, no species of peccary has been found in the State of Michigan, except at Belding. The remains are in the palæontological collection of the University of Michigan, at Ann Arbor, and belong to the species *Platygonus compressus* Le Conte. The remains are said to consist of bones of 5 individuals; and Mr. N. A. Wood, preparator at the university, informed the writer there are 294 bones.

The skull of one of the 5 individuals was missing when the collection was made. The skeletons were found in a peat swamp, in 1877, and were sent to Professor Alexander Winchell by Mr. A. Tuttle. A skull belonging to this collection was described in 1903 (Jour. Geology, vol. xi, p. 777, figs. 1–4) by Mr. George Wagner.

It seems probable that there, as in two or three other known cases, a herd of these animals, asleep together, had succumbed to rigorous weather, probably to a winter blizzard.

Belding is situated on Flat River, a tributary of Grand River. It lies close to a part of the Charlotte moraine system, thought to be correlated with the Valparaiso system. These peccaries could not have lived in that region until after the Wisconsin ice had retired into Lake Michigan, or nearly so. It is more probable that they lived there long after this retirement, at a time when the climate had become much warmer.

INDIANA.

(Map 36.)

1. *Gibson County.*—The type specimen of *Mylohyus nasutus* was found somewhere in this county. The specimen was first mentioned by Leidy in 1860 (Proc. Acad. Nat. Sci. Phila., p. 416), but without other designation than peccary. Leidy wrote that it had been sent to him by Dr. David D. Owen, who informed him that it had been discovered in Gibson County, in digging a well, at a depth of between 30 and 40 feet. No more exact locality has ever been determined. The specimen consisted of the front of the skull only. It was later described by Leidy (Proc. same Academy, 1868, p. 230), under the name *Dicotyles nasutus;* and in 1869 (Jour. Acad. Nat. Sci. Phila., vol. vii, p. 385, plate xxviii, figs. 1, 2) was further described and illustrated. The figures referred to have been reproduced by the present writer in 1912 (Geol. Surv. Indiana, vol. xxxiii, p. 607, text-figs. 42, 43), and again in 1914 (Iowa Geol. Surv., vol. xxiii, plate xxvi, figs. 1, 2).

It is unfortunate that Owen and Leidy did not more accurately establish the locality where this jaw was found. In Gibson County there is a considerable variety of geological deposits, even considering only those belonging to the Pleistocene and Recent. The eastern and the southeastern portion lies outside the drift-covered region. A strip along the Wabash is occupied by alluvial deposits belonging to the Recent epoch. Outside of this is another strip covered mostly by Illinoian drift.

The Patoka Quadrangle, described in Folio No. 105 of the U. S. Geological Survey, published in 1904, covers nearly the whole of Gibson County. An examination of this folio shows how complicated are the later geological features of the region. It is fair to suppose that a well from 30 to 40 feet in depth was dug, especially at that time, in the higher parts of the county, where the elevation is somewhere near 500 feet above sea-level. Here such a well would probably go through the rather scattering Wisconsin deposits of various kinds or through the loess referred to the Iowan stage, reaching perhaps the Sangamon; or through later Illinoian or early Sangamon lake deposits and Illinoian glacial accumulations into pre-Illinoian deposits. The folio cited notes (p. 3) the presence of deposits supposed to belong to the

beginning of the Illinoian stage. These contained zones of black muck and other organic materials; and in places were found logs and what were thought by the well-diggers to be "black-oak" leaves. All these might have been of Aftonian age; and in deposits of that time might have been found the jaw of *Mylohyus nasutus*.

This species has been reported from a number of other localities; but the remains have been of so imperfect character that the identifications may have been erroneous. Professor Cope reported in 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 176) that he had found several molars and canine teeth of this animal in cave breccia in Wythe County, Virginia. The breccia appeared to be very old, and in them were found a species of *Megalonyx*, *Equus complicatus?*, *Tapirus haysii*, *Ursus amplidens*, and many other extinct species.

Cope in 1899 (Jour. Acad. Nat. Sci. Phila., vol. XI, p. 263) announced this species from the Port Kennedy cave in southeastern Pennsylvania. In this case there were found only a canine and 4 molars; hence not too much reliance must be placed on the identification. A large majority of the numerous species found in the Port Kennedy cave are extinct. Among these are species of *Megalonyx*, a mylodon, a bear, 2 species of saber-tooth tigers, a tapir, 1 or 2 species of horse, and 3 species of peccaries. One can hardly doubt that the animals belonged to the early part of the Pleistocene. The indications are that the known examples of *Mylohyus nasutus* belonged to the first half of the Pleistocene; that is, to the Sangamon stage or to the Aftonian.

2. *Near Williams, Lawrence County.*—In the collection of the University of Indiana are some peccary remains found in Rock Cliff quarry, not far northwest from Williams. These were described by the writer in 1912 (Geol. Surv. Indiana, vol. XXXIII, pp. 596, 605). The remains were secured by Professor J. W. Beede. A part of a lower jaw which contained a first true molar and impressions of the second and third molars was referred to Leidy's species *Tagassu lenis*. A large last upper molar (op. cit., p. 605, plate IV, fig. 2) was referred with some doubt to *Platygonus vetus*.

These remains, together with some bones of one or the other of these species and a carapace of the box-tortoise still living in that region, were inclosed in masses of stalagmite which appear to have pretty completely filled an old cave in the limestone, encountered in quarrying operations. According to Professor Beede, the cave had, when he saw it, been all quarried away except one corner. This was from 20 to 30 feet below the general surface at that place. It was about 100 feet above the present level of White River, about on a level with the highest terrace along that stream. The probabilities are that the peccaries and the box-tortoise belong to one of the earlier Pleistocene interglacial stages. Professor Beede is inclined to believe that the cave was filled during the Illinoian glacial stage by streams carrying in mud and sand and gravel. If this view is correct the inclosed remains would be at least as old as the Yarmouth.

The species *Tagassu lenis* is closely related to the peccary which now lives in southwestern Texas and Mexico, and it has been regarded as identical with it; but there appear to be reasons why it should be retained under

its own name. It was first described from teeth found among materials coming from the phosphate deposits about Charleston, South Carolina. Certainly many of the species found there lived during the early part of the Pleistocene.

It is possible that certain teeth referred by Cope (Proc. Acad. Nat. Sci., Phila., 1867, p. 155) to the existing peccary belonged to *T. lenis;* but there is nothing known regarding their exact geological age. Other teeth found in the lead region of Illinois were identified by Wyman as those of the existing peccary. They too may have been those of *T. lenis.* The writer regards the animals found in the lead crevices as belonging to rather late Pleistocene, possibly to Peorian or Sangamon times. As to the remains found in the cave in Lawrence County it is probable that they date back to the Sangamon stage.

3. *Laketon, Wabash County.*—In the Fourteenth Annual Report of the Geological Survey of Indiana, page 20, Cope and Wortman stated there was in the Survey's collection the symphyseal portion of the lower jaw and a large part of the left ramus with all the premolar teeth, except the last. This had been found at Laketon, in Wabash County. There were given no further details, and the writer failed to find the specimen in the collection. In the collection of Earlham College, Richmond, are photographs of probably this specimen and of a part of the upper jaw. The latter bone shows 3 premolars and the first molar; the lower jaw presents the symphysis, the right canine, and the 2 anterior premolars. The photographs are labeled as those of *Platygonus compressus*, determined by Cope, and as made from the Wabash County specimen.

All the region about Laketon is covered with Wisconsin drift or materials derived from it. The peccary found must have lived after the retirement of the border of the glacier beyond the Wabash River. It was probably long after this and when the climate was perhaps warmer than it is now.

ILLINOIS.

(Maps 20, 38.)

1. *Galena, Jo Daviess County.*—In 1848, Dr. John L. Le Conte (Amer. Jour. Sci., vol. v, pp. 102–106) described what he regarded as 5 new species of fossil mammals from the lead region of Illinois. These had been secured by Mr. Wm. Snyder, of Galena, in a lead crevice 50 feet below the surface, filled with a mixture of clay and sand cemented by oxide of iron into a hard mass from which the specimens could not be removed without great injury. The species described were called *Platigonus compressus, Hyops depressifrons, Protochœrus prismaticus, Procyon priscus,* and *Anomodon snyderi.* The last was regarded as related to the moles. *Procyon priscus* resembled closely the existing *P. lotor.* The 3 species first mentioned are now regarded as belonging to a single species, which takes the name *Platygonus compressus.* It may be remarked that the original spelling of the generic name was due perhaps to a lapsus calami or to a printer's error. In the complete paper published shortly afterward the name was spelled *Platygonus.* It is to be added that the teeth which served as the type of

the so-called species *Protochœrus prismaticus* were found at a locality 15 miles from the place where the other remains were obtained; but as to where this place was nothing is said.

In 1848 (Mem. Amer. Acad. Arts, Sci., vol. III, pp. 257–274, plates I to IV) *Platygonus compressus* was more completely described. Various teeth and parts of the skull and some limb-bones were figured. In this article it is stated that the remains described had been found in a lead crevice a few miles from Galena. A portion of the bones had been preserved by the miners and had at length found their way into the hands of Mr. Snyder, a merchant in Galena.

In 1852 (Proc. Acad. Nat. Sci. Phila., vol. VI, pp. 3–5) *Hyops depressifrons* and *Protochœrus prismaticus* were further described, the first being placed in the genus *Dicotyles*. Both of these are now regarded as belonging to *Platygonus compressus*.

The writer has considered it as probable that the peccary remains, as well as *Procyon priscus* and *Anomodon snyderi*, are of Late Wisconsin age; but it is possible that they are somewhat older. The leader is referred to page 343, where the Pleistocene of the lead region is discussed.

2. *Alton, Madison County.*—In the McAdams collection, of which a general account has been given on page 339, is a part of a lower canine tooth which apparently differs in no way from the corresponding canine of *Platygonus cumberlandensis*, found by Mr. J. W. Gidley in a limestone fissure near Cumberland, Maryland. On page 350 will be found a list of the species found in this fissure and their geological age.

WISCONSIN.

(Map 20.)

1. *Bluemounds, Dane County.*—In 1862, Professor J. D. Whitney reported (Geol. Surv. Wisconsin, vol. I, pp. 135, 136) that he had discovered in a crevice at Bluemounds, accompanied by bones and some teeth of the mastodon, a buffalo, and a wolf, several fragments of jaws and some teeth and other bones of a peccary, in an excellent state of preservation. At the top of his page 134 Whitney indicates that these remains belonged to the species now called *Platygonus compressus*. On page 422 of the same volume Jeffries Wyman, in reporting on the vertebrate remains collected in the lead region, mentions only 3 teeth; and these, he said, differed much from either of the fossil species and agreed with the existing peccary. From Whitney's note at the bottom of his page 135 we may suppose that these 3 teeth were found in Iowa, near Dubuque. It is probable that the teeth found at Bluemounds belonged to *Tagassu lenis*.

In 1866 (Geol. Surv. Illinois, vol. I, p. 162), Whitney stated that from a crevice near Bluemounds he got peccary bones and teeth which were supposed to be identical with the animals now living. Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 384) stated that he believed that teeth found in Wisconsin belonged to *Dicotyles lenis*. One can not be certain regarding the age of these animals found in this lead region. They are probably pre-Wisconsin. The age will be discussed on page 343.

MARYLAND.

(Map 20.)

1. *Benedict, Charles County.*—More than 50 years ago Cope (Proc. Nat. Sci. Phila., 1867, p. 155) reported the finding of peccary jaws mingled with remains of Miocene vertebrates collected by James T. Thomas, near his residence in Charles County, not far from Patuxent River, near Benedict. Cope recognized that the peccary and a part of a jaw of *Grison macrodon* (referred by Cope to *Galera*) belonged to the Pleistocene. The peccary was referred to the existing species *Dicotyles* (*Tagassu*) *torquatus;* likewise their similarity to the remains described by Leidy from Charleston, South Carolina, was noted. They are assigned here to *Tagassu lenis.* The jaws from the Patuxent locality are now in the Academy of Natural Sciences at Philadelphia.

2. *Chesapeake Beach, Calvert County.*—Mr. William Palmer, of the U. S. National Museum, has shown the writer 3 teeth of a peccary secured at the place named. These will be mentioned in the discussion of the geology of the locality. A left third premolar is 10.3 mm. long and 6.2 mm. wide. A left second molar is 12 mm. long and 10 mm. wide. These apparently belonged to *Tagassu lenis.*

In March 1921, Dr. Adolph H. Schultz, of the Johns Hopkins Medical School, presented to the U. S. National Museum a part of the left ramus of the lower jaw of a peccary found at Chesapeake Beach. This fragment contains the first and second molars and the sockets of the fourth premolar and the third molar. This jaw and the teeth have been compared with the corresponding parts of a specimen of *Tagassu angulatus* (No. 35815, U. S. Nat. Mus.), secured along the boundary between the United States and Mexico. In size the fossil teeth differ little from those of *T. angulatus;* the first molar is, however, somewhat wider; the conule between the two hindermost cones, the hypoconulid, is much smaller than in the existing peccary used for comparison. The inner face of each tooth is not so flat in the fossil as in the other species. In the fossil the height of the jaw at the second molar is 28 mm.; in *T. angulatus* 35 mm. The specimen is referred to *Tagassu lenis.*

3. *Corriganville, Allegany County.*—In a rock crevice 3 miles west of north of Cumberland, J. W. Gidley found abundant remains of peccaries. These were described by him in 1920 (Proc. U. S. Nat. Mus., vol. LVII, pp. 651–678, plates LIV, LV, 13 text-figs.). He recognized 4 species, 2 belonging to *Platygonus* and 2 to *Mylohyus.* The new species, *Platygonus cumberlandensis* and *P. intermedius* and *Mylohyus exortivus,* are based on materials found in the fissure. With the other materials he recognized a part of a lower jaw, which he referred to *M. pennsylvanicus.*

4. *Cavetown, Washington County.*—In 1920 (Proc. U. S. Nat. Mus., vol. LVII, pp. 96–109), the writer described a collection of fossil vertebrates made at Cavetown by the officers of Phillips Academy, Andover, Massachusetts. Among the species are 6 which belong to the group of peccaries, as follows: *Mylohyus nasutus* (Leidy), *M. exortivus* Gidley, *M. obtusidens* Hay, *Tagassu? tetragonus?* (Cope), *Platygonus vetus* Leidy, *P. cumberlandensis* Gidley.

These and the associated species apparently lived here during approximately the Middle Pleistocene, probably the Sangamon stage. A list of the species found in the fissure and their geological relations are presented on page 348. The specimen above referred provisionally to *Tagassu tetragonus* was called, in the paper cited above, *Platygonus tetragonus*. It appears, however, to be nearer *Tagassu*. It may even belong to an unnamed genus.

VIRGINIA.

(Map 20.)

1. *Ivanhoe, Wythe County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 176), Cope reported he had found several molar and canine teeth of *Dicotyles nasutus*, in cave breccia on New River, with remains of many other species of vertebrates. This now bears the name *Mylohyus nasutus*. A list of the species is given on page 353, where the Pleistocene geology of Virginia is discussed.

2. *Augusta County.*—In 1857 (Trans. Amer. Philos. Soc., vol. XI, p. 104), Leidy stated he had examined a fragment of a lower jaw of a young individual of *Platygonus compressus*, found in the county named. The jaw contained the last milk molar, unworn. The first true molar had not yet begun to protrude. The writer has seen this specimen in the collection of the Academy of Natural Sciences at Philadelphia. No other information regarding its place of origin has been secured.

WEST VIRGINIA.

(Map 20.)

1. *Renicks, Greenbrier County.*—In 1920 (Rep. Smithson. Inst. for 1918, p. 288, plates I–VI), J. W. Gidley reported on a visit he had made to a cave situated on Greenbrier River, near Renicks. The cave was discovered during quarrying operations in limestone. The greater part of the bones had been destroyed before the workers appreciated their value. Only a part of a skull of a peccary was secured, probably of the species *Platygonus intermedius* (Gidley, Proc. U. S. Nat. Mus., vol. LVII, p. 669). It has the catalogue No. 8003 of the U. S. National Museum. This animal is to be referred to the Middle Pleistocene.

SOUTH CAROLINA.

(Map 20.)

1. *Charleston, Charleston County.*—In 1860 ("Holmes's Post-Pliocene Fossils of South Carolina," p. 108, plate XVII, figs. 13, 14), Leidy reported the finding of teeth of a peccary in the Ashley River deposits. These teeth, a lower third molar and probably a lower second molar, were described under the name *Dicotyles fossilis* and were said to have the size and form of the corresponding teeth of the collared peccary, *Dicotyles torquatus* (=*Tagassu tajacu*). Fragments of some upper teeth were said to have the size of those of *D. labiatus*. In 1869 (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. VII, p. 384), the fossil teeth just mentioned were referred, with some

others, to the new species *Dicotyles lenis*. The principal character distinguishing the teeth of this species from those of the existing peccaries mentioned is the absence of accessory tubercles. This is shown also in an upper hindermost molar of the same species, described by the writer (9th Ann. Rep. Florida Geol. Sur., 1917, p. 48, plate III, fig. 2) under the name *Tayassu lenis*. The name should have been *Tagassu lenis*.

In the Pinckney collection, at the Pinckney residence, Lambs, South Carolina, near Charleston, the writer examined a tooth of a peccary, which apparently belongs to another species. It is taken to be a lower hindermost molar. A part of the anterior crest and a part of one side are broken off. The heel is relatively large, consisting of a hinder and 2 anterior tubercles; between the anterior tubercles is another minute one. In the middle of each cross-valley is a tubercle. The length of the fragment is 20.2 mm., the width 9.5 mm. This was evidently a larger animal than *Tagassu lenis*.

FLORIDA.

(Map 20.)

1. *Vero, St. Lucie County.*—Apparently 2 species of peccaries have been found in the deposits along the drainage canal, near Vero, in the uppermost stratum (No. 3). One, represented by a canine tooth, has not been determined (Hay, Rep. Florida Geol. Surv., vol. IX, p. 50). It appeared to be too large to belong to *Tagassu lenis*.

The other remains belonged to a small peccary and have been referred to *Tagassu lenis*. In 1916 (Rep. Florida Geol. Surv., vol. VIII, p. 149), Sellards reported the finding of 2 cheek-teeth and a tibia. One of the teeth was taken from the stratum called No. 2; the other teeth and the tibia had washed out of the bank and it was uncertain from which stratum they had come. In 1917 (Rep. Florida Geol. Surv., vol. IX, pp. 45, 48, plate III, fig. 2), the writer reported the finding of a hindermost molar of a small peccary, believed to be *T. lenis*, in stratum No. 2; also the discovery by Isaac M. Weills of a small canine of *T. lenis* in stratum No. 3 (op. cit., plate III, fig. 3). On page 50 of the same paper the writer referred provisionally to *T. lenis* the tibia above mentioned.

2. *Palma Sola, Manatee County.*—From this place have been sent to the U. S. National Museum many specimens of fossil vertebrates, a list of which will be found in the discussion of the Pleistocene geology of Florida (p. 379). Some of these belong to the Pleistocene, others apparently to the Miocene. Among the specimens is a right astragalus of a peccary. While it is possible that the original possessor of this astragalus lived during the Miocene, it does not seem probable. It may have belonged to *Tagassu lenis*. The length of the bone is 32 mm., the width across the lower end 19 mm.

TENNESSEE.

(Map 20. Figure 23.)

1. *Rogersville, Hawkins County.*—In the U. S. National Museum is a part of a lower left canine tooth of a peccary found near the place mentioned. With it came an upper molar of *Equus leidyi*. The tooth lacks

most of the crown. It has been described by the writer under the name *Mylohyus setiger* (Proc. U. S. Nat. Mus., vol. LVIII, p. 84, plate III, figs. 21–23). The root of the tooth is 93 mm. long, measured along the convexity of the curve. A little of the tip of the root is missing. The size of the tooth indicates a very large animal.

2. *Whitesburg, Hamblen County.*—In the U. S. National Museum is a considerable collection of bones and teeth made in 1885 near Whitesburg. This locality and the accompanying species will be discussed on another page. Among the remains are 3 upper canine teeth, referred by the writer (Proc. U. S. Nat. Mus., vol. LVIII, p. 90, plate III, figs. 12–13) to *Mylohyus nasutus* Leidy. A list of the associated species will be found on page 395.

3. *Dandridge, Jefferson County.*—In 1896 (Dept. Amer. and Prehist. Archæol. Univ. Penn.), Dr. H. C. Mercer reported he had found remains of the tapir, peccary, bear, and small rodents in Zirkel's Cave. The cave is situated on the left bank of Dumplin Creek, about 5 miles above its entrance into French Broad River. The species to which the peccary remains belonged was not determined.

KENTUCKY.

(Map 20.)

1. *Rockcastle County.*—In 1853, Dr. Leidy (Trans. Amer. Philos. Soc., vol. x, p. 331, plates XXXV, XXXVI, XXXVII, figs. 5–8, 17, 19) described under the name *Euchœrus macrops*, a fine skull of a peccary which had been lying for 47 years in the collection of the society. It had been sent there by Dr. Samuel Brown, of Lexington, Kentucky, and was said to have been found in one of the nitrous caves of that State. The writer is informed by Dr. Arthur M. Miller, Professor of Geology in the University of Kentucky, that it is unlikely that the skull came from any of the caves in the region about Lexington, as he had never heard any of them had been worked for saltpeter. In the Transactions of the American Philosophical Society for 1804 (vol. VI, pp. 235–247) is a paper by Samuel Brown, in which he describes a cave in what is now Rockcastle County. In this and some other neighboring caves were found immense quantities of saltpeter. Probably the skull which Leidy afterward described from this region was brought to light. It appears to have been mentioned by Dr. B. S. Barton as early as 1806 (Phila. Med. and Phys. Jour., vol. II, plate I, p. 158). It is now in the collection of the Academy of Natural Sciences at Philadelphia. It was recognized by Leidy as belonging to *Platygonus compressus*.

FINDS OF PLEISTOCENE CAMELIDÆ IN EASTERN NORTH AMERICA.

PENNSYLVANIA.

(Map 21.)

1. It is not certain that any fossil camel remains have ever been found in Pennsylvania. In 1899 (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. XI, p. 264, plate XXI, figs. 4, 4*a*) Cope described *Teleopternus orientalis* and referred it to the Camelidæ. This was found in the Port Kennedy cave, and whatever its relationships it belongs to the early Pleistocene. Matthew (Osborn, Age of Mamm., p. 469) suggested that its affinities might be with the musk-oxen.

FLORIDA.

(Map 21.)

1. *Archer, Alachua County.*—In 1886 (Proc. Acad. Nat. Sci. Phila., 1886, p. 12), Dr. Joseph Leidy briefly described three species of the genus *Procamelus* from materials collected near Archer by Dr. W. H. Dall. The teeth and bones had been found in what has been called the Alachua clays, and were associated with a considerable number of species of vertebrates. The list will be found on page 375, where the Pleistocene geology is considered. The three species of camels were called *Auchenia major, A. minor,* and *A. minimus.* They are now referred to the genus *Procamelus.* In 1896 they were (Trans. Wagner Free Inst. Sci., vol. IV, pp. VII–XIV, 15–61, with plates) described in more detail and illustrated by Leidy and Lucas. The error of calling *P. minor* by the name *P. medius,* first introduced by Cope, was followed in the paper just mentioned; and some authors have continued this practice. Dr. W. H. Dall included these camels in his list (Bull. U. S. Geol. Surv. No. 84, p. 129). Authors have in general referred to the Tertiary the deposit which furnished these camels; the present writer believes that the Alachua beds belong to the first glacial stage. The matter is further discussed on pages 376 to 378.

2. *Williston, Levy County.*—In 1892 (Bull. U. S. Geol. Surv., No. 84, p. 129), Dr. W. H. Dall published a list, furnished by Joseph Leidy, of the vertebrate fossils found at what was then known as Mixon's bone-bed. The species, with some additions, are listed on page 375. Among others is *Procamelus major.* The species were found in the Alachua clays, and these clays are referred by Sellards to the Upper Miocene or Lower Pliocene.

3. *Ocala, Marion County.*—In 1889 (Proc. Acad. Nat. Sci. Phila., 1889, p. 31; Trans. Wagner Free Inst. Sci., vol. II, pp. 13–17), Leidy mentioned the discovery of a tooth of a camel, regarded by him as belonging to *Procamelus,* in a limestone quarry at Ocala. With it were described the saber-tooth tiger *Machairodus floridanus.* Teeth were found also of a horse which is referred to *Equus leidyi.* A list of the species found at this locality is on page 378. In the Philadelphia Academy paper Leidy called the camel *Auchenia minor.* In the next paper cited he regarded it as *A. minimus.*

4. *Dunnellon, Marion County.*—In 1916 (8th Ann. Rep. Florida Geol. Surv., pp. 94, 104), Dr. Sellards presented a list of the species of vertebrates discovered in the Dunnellon formation at Dunnellon and vicinity. Among

the species is the camel *Procamelus minor*. This, however, he did not include among the Pleistocene animals.

Undetermined teeth of a camel are mentioned by Sellards as found in the phosphate mines at Dunnellon (5th Ann. Rep. Fla. Geol. Surv., p. 58).

5. *Hernando, Citrus County.*—Sellards (5th Ann. Rep. Florida Geol. Surv., p. 58) reported a discovery of teeth of an undetermined species of camel in a phosphate mine at Hernando. These probably are of the genus *Procamelus*.

6. *Vero, St. Lucie County.*—Some remains of a camel have been found in the stratum at Vero known as No. 2, the one immediately overlying the bed of marine marl. Sellards (8th Rep., p. 149) states there had been secured up to that time two upper cheek-teeth, a distal end of a cannon-bone, and a phalanx. The latter, a hinder first phalanx, is figured (plate xxx, fig. 5). It resembles considerably the bone figured by Leidy and Lucas (Trans. Wagner Free Inst., vol. iv, plate xviii, fig. 8), but it presents important differences.

The anterior phalange figured by Leidy and Lucas is 85 mm. long; a hinder phalange of the same animal would have been shorter. The hinder phalange found at Vero is 104 mm. long. The probability is that its owner was an animal considerably larger than Leidy's *Procamelus minimus*. The phalanx referred by Leidy and Lucas to *Procamelus medius* (=*P. minor*) has exactly the length of that of *P. minimus*, but is a much stouter bone, the side-to-side diameter at the middle of the length being one-half greater. The Vero camel appears, therefore, to be distinct from any of the Pliocene camels of Florida. It probably belongs to the genus *Camelops*.

TENNESSEE.

(Map 21. Figure 23.)

1. *Nashville, Davidson County.*—From Mr. W. E. Myer, of Nashville, the writer has received for examination a right calcaneum of an undetermined species of camel, belonging probably to the genus *Camelops*. This was found near Nashville, in the bank of Cumberland River. At the same locality were found part of a tooth of a young mastodon, a tooth of *Equus leidyi*, a fragment of a femur of a probably larger horse, an antler of a young deer, a tooth of *Mylodon*, and some fragments of turtle bones. However, the horse remains and the antler are said to have been lying in a layer of gravel, while the camel and mastodon were in a bed of sand just above the gravel. Over these beds are nearly 30 feet of gravel.

The total length of the calcaneum is 138 mm., the greatest height 67 mm., and the thickness at the rear of the articular surface for the astragalus, 45 mm. From the rear end to the surface for the astragalus is 85 mm. The surface for union with the cuboid is 19 mm. wide, considerably narrower than in the dromedary and in an astragalus from Denver, Colorado, which apparently belongs to *Camelops huerfanensis*. The outer face of the bone is considerably less concave than in either of the two species referred to. The tuberosity is relatively thicker at the middle of its length than is either of the species mentioned; its height at its middle is relatively less than in the Denver specimen. It is believed that the age of the beds containing these fossils is about that of the Aftonian interglacial.

FINDS OF PLEISTOCENE DEER OF THE GENUS ODOCOILEUS IN EASTERN NORTH AMERICA.

ONTARIO.

(Map 22.)

1. *Toronto.*—In the Guide-book No. 6, issued by the Ontario Bureau of Mines in 1913, and prepared by Professor A. P. Coleman, it is recorded on page 18 that in the Don beds at Toronto, supposed to belong to the Sangamon stage, had been found bones of a deer resembling those of the Virginia deer. On page 29 deer bones are reported as found in other beds situated in the western part of Toronto. The age of these is uncertain; they may be older than the Don beds or younger than the Scarboro beds. In these same beds have been found also a lower jaw of a bear, possibly *Ursus americanus;* an atlas of a bison, a part of an antler of *Cervalces borealis,* and some parts of either a mastodon or a mammoth.

The geology of the Pleistocene in the region about Toronto is treated on pages 281 to 283, figure 3.

NEW YORK.

(Map 22.)

1. *Orange County.*—Emmons, in 1858 (Geol. Surv. North Carolina, East. Counties, p. 201), stated he had found, in a fresh-water marl-bed in Orange County, a horn of an extinct deer, associated with remains of mastodon. The exact locality is unknown.

2. *Greenville, Greene County.*—In 1846 (Boston Jour. Nat. Hist., vol. v, p. 390), James Hall mentioned the finding of a jawbone, with teeth, of a deer in Greene County. It was associated with remains of a mastodon.

3. *Cuba, Allegany County.*—In 1843 (Geol. 4th Dist., p. 367), Hall reported that an engineer of the Genesee Valley Canal informed him that near New Hudson, 4 miles from Cuba, several antlers of deer and one of an elk had been found 12 feet below the surface, in a muck deposit. New Hudson appears to be about 10 miles north of Cuba, and not on the canal. The locality is said to be at the summit of the canal.

4. *Hinsdale, Cattaraugus County.*—James Hall (op. cit., pp. 364, 366) stated that a tusk, supposed to belong to a mastodon, with some horns of deer, had been found at Hinsdale in sand and gravel, 16 feet below the surface. Clarke (Bull. 69, N. Y. State Mus., p. 933) suggested that these may have been antlers of the elk.

There appear to be no good reasons for suspecting that any of the deer remains found in New York are older than Late Wisconsin.

NEW JERSEY.

(Map 22.)

1. *Woodstown, Salem County.*—In the palæontological collection at Yale University is a fragment of an antler of a deer, most probably of *Odocoileus virginianus,* discovered in Salem County. It is not accompanied by any information as to the exact locality where found or as to the conditions of

burial. The fragment of the shaft is 135 mm. long, and from it springs a tine, the partial length of which is about 45 mm.

2. *Vincentown, Burlington County.*—In the collection of the Academy of Natural Science at Philadelphia are some fragments of antlers labeled as having been found at Vincentown.

In 1869 (Jour. Acad. Nat. Sci., Phila., vol. VII, p. 376), Dr. Joseph Leidy stated that remains of the deer had been found in Burlington and Monmouth Counties, but no exact localities were mentioned. Many of the specimens seem to have been found, as accidental occupants, in marl-beds of Cretaceous age. In the Academy of Natural Sciences at Philadelphia there are specimens from Pemberton.

3. *Deal, Monmouth County.*—In the Academy's collection, at Philadelphia, there is a specimen labeled as having been found at this place. No details are recorded.

PENNSYLVANIA.

(Map 22.)

1. *Stroudsburg, Monroe County.*—In 1889 (Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 6), Dr. Joseph Leidy reported on a collection which many years before had been found in Hartman's Cave, near Stroudsburg. Nearly all the species still exist, but in the collection was included *Castoroides* and *Rangifer*. Among the fossils were jaw-bones, with teeth, and broken bones of the Virginia deer. It seems possible that the remains had collected there at the close of the Pleistocene; but some may belong to the Recent.

2. *Frankstown, Blair County.*—In 1908 (Ann. Carnegie Mus., vol. IV, p. 231), Dr. W. J. Holland reported the discovery of remains of a deer, possibly *Odocoileus virginianus,* in a cave at Frankstown. With this deer were many other species of mammals. A list is presented on page 321.

OHIO.

(Map 22.)

1. *New Knoxville, Auglaize County.*—In his "History of Ohio and of Auglaize County," 1905, on page 338, C. W. Williamson, in describing the finding of a skull of *Castoroides* near New Knoxville, stated that some bones of the deer had been found in what was believed to have been the house of the giant beaver. They were supposed to have been brought there by carnivorous animals; but the deer may have died there before the house was covered up.

MICHIGAN.

(Map 22.)

1. *Adrian, Lenawee County.*—In 1880 the U. S. National Museum received from Professor Kost, then of Adrian College, a skull of *Castoroides ohioensis* discovered at the place named above. In his communication he wrote that at the same place there had been found previously a mastodon and bones of an elk and of a deer. The place was in a marsh, in Adrian, and the fossils were at a depth of 4 feet.

2. *Ann Arbor, Washtenaw County.*—In 1908, Russell and Leverett (Folio 155, U. S. Geol. Surv., p. 9) reported the discovery of bones of deer and elk in a peat-swamp, 3 miles south of Ann Arbor. In the same swamp had been found, at a depth of 5 feet, a skull of *Castoroides ohioensis.* The bones of the deer and elk were at a somewhat higher level, so that it is not wholly certain they belong to the Pleistocene.

The specimens found both at Adrian and Ann Arbor lived there after the retreat of the Wisconsin ice.

INDIANA.

(Map 22.)

1. *Evansville, Vanderburg County.*—In a collection of bones and teeth made at the mouth of Pigeon Creek, a short distance below Evansville, and described by Leidy (Proc. Acad. Nat. Sci., Phila., 1854, pp. 199–200) were included remains of the Virginia deer. With these bones were parts of the skeleton of *Megalonyx jeffersonii,* a bison of probably an extinct species, a cervical vertebra of the horse known as *Equus complicatus,* a tooth of a tapir, and the type upper jaw of the extinct wolf *Ænocyon dirus.*

On page 32 is discussed the age of the bone-bed. It is concluded that it belonged possibly to the Aftonian stage, but more probably to the Sangamon. Although this species of deer yet exists, abundant remains of a species not yet distinguishable from it are found in early Pleistocene deposits in Florida and elsewhere. According to D. D. Owen (Smithson. Contrib. Knowl., vol. VII, art. v, p. 7), this deer was found associated with megalonyx bones a few miles below Henderson, Kentucky. Also, these two species, together with *Equus complicatus* and an extinct species of *Bison* and other extinct species of mammals, have been exhumed at Bigbone Lick, halfway between Louisville and Cincinnati, on the Kentucky side.

Under this number may be considered the deer *Odocoileus dolichopsis,* which Cope described in 1878 (Amer. Naturalist, vol. XII, p. 189). This was represented by a left ramus of the mandible, found, as reported by the State geologist, John Collett, in a late lacustrine deposit in Vanderburg County. In the same deposits was found an ulno-radius of a species of *Bison.* The deer jaw was further described and figured by Cope and Wortman in 1884 (Geol. Surv. Indiana, vol. XIV, p. 22, plate II). Here, in quoting Cope's description found in volume IV of Bulletins U. S. Geological Survey, page 379, the authors substituted Harrison County for Vanderburg County. In 1912 (Geol. Surv. Indiana, vol. XXXVI, p. 615), the present writer accepted Cope and Wortman's statement as to the county; but it appears that the locality was really in Vanderburg County. Cope and Wortman's plate was reproduced by the writer in 1912 (Geol. Surv. Indiana, vol. XXXVI, p. 615, plate VI, figs. 2, 2*b*). Figure 1 of the plate represents a part of an upper jaw which may or may not belong to the same species. It was supposed to have been found in the same deposits.

2. *Harrisville, Randolph County.*—In the collection at Earlham College, Richmond, Indiana, the writer has examined some bones which apparently belonged to the Virginia deer, *Odocoileus virginianus.* The distal end of the radius, a right calcaneum, and a sacrum have been identified. These

were found in a swamp known as "The Dismal," situated about 6 miles nearly east of Winchester. This would not be far from the village of Harrisville. In this swamp were collected the fine specimen of the giant beaver, preserved at Earlham College, and the bones of an elk. The swamp is located near the Union City moraine, and the animals buried there must have lived at some time after the retirement of the Wisconsin ice-sheet; probably the time was long enough after that retirement for the climate to become relatively mild.

3. *Roann, Wabash County.*—In 1892 (Geol. Surv. Indiana, vol. XVII, p. 241), Elrod and Benedict reported that in 1882 a Mr. Rantz, while digging a ditch on the farm of William Runkle, 3 miles north of Roann, unearthed, at a depth of 9 feet, the antlers and part of the skeleton of the deer *Odocoileus virginianus*. The locality is evidently north of Eel River and near the southern border of the great moraine which runs parallel with this stream and north of it. Undoubtedly this deer lived after the Wisconsin ice had withdrawn from the vicinity. In similar situations in that region have been found several mastodons. It is probable, therefore, that the deer belonged to the late Pleistocene.

From Mr. B. E. Galtry, of Roann, the writer learns that Mr. Runkle informed him that none of the bones found has been preserved. There were many found, shin-bones, ribs, and antlers, from 3 to 4 feet below the surface. Large numbers of poles were found, and the ditch diggers got the notion that these poles had formed a bridge.

ILLINOIS.

(Maps 22, 38.)

1. *Niantic, Macon County.*—In 1873, Worthen, State geologist of Illinois, reported (Geol. Surv. Illinois, vol. v, p. 308) that he had found some deer bones in a bog near Niantic; with them were remains of the mastodon, buffalo, and elk. What is known regarding the locality and the geology is here recorded on page 102. All these remains were probably buried near the close of the Wisconsin glacial stage.

2. *Whitewillow, Kendall County.*—In Netta C. Anderson's list, page 11. E. S. Riggs, assistant curator of palæontology in Field Museum of Natural History, reported that in 1902 Mr. John Bamford, in enlarging a spring in a bog, encountered a layer of about 2 feet of bison, deer, and elk bones at a depth of about 5 feet. With these were found skulls of at least 6 mastodons. From Mr. George Langford, of Joliet, the writer has received a base of a large antler and a nearly complete small antler of the right side. These are not to be distinguished from those of *O. virginianus*. Mr. Langford wrote that the mastodon bones were mingled with the other bones to the bottom of the pit dug. In the same excavation were found remains of mastodon, *Cervalces*, the existing moose, the elk, the buffalo, and the cannon-bone of a large sheep-like animal. The exact levels in which these bones occurred is not known. The reader may consult page 109.

3. *Ottawa, La Salle County.*—J. D. Caton ("Antelopes and Deer of North America," p. 227) tells of having found a nearly complete skeleton and three antlers of the Virginia deer in the valley of Fox River, near

Ottawa. These remains were in a stratum of gravel at a depth of more than 16 feet. Over this was the surface loam, then sand, sand and clay, then more sand. It seems probable that these deposits belonged to the Late Wisconsin.

4. *Evanston, Cook County.*—Dr. Frank C. Baker (Univ. Ills. Bull. XVII, pp. 4, 86) presented a geological section taken in the Toleston beach at Evanston. This beach was laid down after the withdrawal of the Wisconsin ice. At the depth of about 9 feet was found a bone of a deer. In 1891, W. K. Higley (Bull. Chicago Acad. Sci., vol. II, No. 1, p. XIV) reported that a pelvis, referred to a deer, had been found in Late Wisconsin deposits at Evanston. He had in mind the bone found in Toleston beach. At the same place was found a femur of a deer at a depth of 9 feet (Leverett, Bull. Chicago Acad. Sci. Geol. Nat. Hist. Surv., II, 1897, pp. 76, 77). Apparently the femur and the pelvis had been discovered by Dr. Oliver Marcy in 1864, from whom both Leverett and Baker quote the geological section.

5. *Lemont, Cook County.*—Dr. F. C. Baker (op. cit., pp. 56, 89) reported the finding of a portion of a skull of *Odocoileus virginianus* and a skull of the muskrat in the Des Plaines Valley, at Lemont, in a bed of peat.

WISCONSIN.

(Map 22.)

1. *Lead region.*—In 1862 (Geol. Surv. Wisconsin, p. 421), Jeffries Wyman, in his report on the vertebrate animals found by J. D. Whitney, stated that there was a series of several molar teeth which, in form and size, corresponds exactly with those of the red deer (*Cervus virginianus*). He mentioned also various bones which seemed to belong to the same species, but some were larger than those of the Virginia deer.

In 1876 (Amer. Jour. Sci., vol. XI, p. 49), Allen described as a new species *Cervus whitneyi,* basing the name on a left humerus, a left radius, and a right metatarsal found in the Whitney collection. It appears probable that these bones are those mentioned by Wyman as being larger than the existing Virginia deer and the mule deer. Allen does not, however, mention what Wyman wrote. Allen's species is now referred to the genus *Odocoileus.* It is not stated by either Wyman or Allen even from what State the remains were secured. It is most probable that it was Wisconsin.

From the Pleistocene of that region two species of *Odocoileus* are therefore known, *O. virginianus* and *O. whitneyi.*

2. *Menomonie, Dunn County.*—In a letter to the author dated January 21, 1917, Dr. S. Weidman, State geologist of Wisconsin, noted that a vertebra of a deer had been found in brick clay at Menomonie. It was sent to the American Museum of New York and identified by Dr. W. D. Matthew. This clay is at present regarded by Dr. Weidman as probably belonging to the Sangamon interglacial.

MARYLAND.

(Map 22.)

1. *Oxford Neck, Talbot County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 178), Cope reported that fragments of antlers not distinguishable

from those of the Virginia deer, *Odocoileus virginianus*, had been found on the farm of Lambert Kirby, in Oxford Neck. These, with remains of other vertebrates, were placed in the Baltimore Academy of Sciences.

2. *Cavetown, Washington County.*—In 1920 (Proc. U. S. Nat. Mus., vol. LVIII, p. 104), the writer described the distal end of two radii found at Cavetown in a fissure in a limestone quarry. These were associated with remains of 24 other species of vertebrates, mostly mammals. The radii appeared to be those of *Odocoileus virginianus*. Another deer, *Sangamona fugitiva*, was found in the same fissure.

A list of the accompanying species is given on page 348.

VIRGINIA.

(Map 22.)

1. *Saltville, Smyth County.*—Mr. O. A. Peterson (Ann. Carnegie Mus., vol. XI, p. 474, fig. 7) reported the finding of an astragalus of some deer-like animal at Saltville. He states that the bone agrees with that of *Odocoileus virginianus*, but is larger. To the present writer the bone is not only too large to be that of the Virginia deer, but is relatively too narrow, it being assumed that Peterson's figure is correct. In both the Virginia deer and the elk the width of the bone is about 70 per cent of the greatest length, while the figure given is only 60 per cent as wide as long. It is not improbable that the animal belonged to another genus.

2. *Ivanhoe, Wythe County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 176) Cope stated that molars and other fragments of *Cariacus* (*Odocoileus*) *virginianus* were abundant in the cave breccia which he examined. A list of the accompanying species will be found on page 353.

WEST VIRGINIA.

(Map 22.)

1. *Wood County.*—In 1835 (Amer. Jour. Sci., vol. XXIX, p. 147), Hildreth stated that bones of a deer had been found in this county, then a part of Virginia, involved in the travertine on the floor of the cave. No facts are known that give any clue to the geological age of these bones. They probably belong to some early or middle stage of the Pleistocene.

NORTH CAROLINA.

(Maps 22, 39.)

1. *On Neuse River, Pamlico County, 16 Miles below Newbern.*—According to both Croom (Amer. Jour. Sci., vol. XXVII, 1835, p. 168) and Harlan (op. cit., vol. XLIII, 1842, p. 143), remains of deer had been found at this locality. For want of more exact information we may refer them to *Odocoileus virginianus*. On page 359 will be found a list of the species collected here.

SOUTH CAROLINA.

(Map 22.)

1. *Charleston, Charleston County.*—Numerous fragmentary remains of *Odocoileus* have been found in the region about Charleston. F. S. Holmes, as early as 1859 (Proc. Acad. Nat. Sci., Phila., 1859, p. 177), announced

the discovery of remains of deer in the vicinity of Charleston. Leidy (Holmes's Post-Pliocene Foss. South Carolina, p. 109, plate xx, figs. 1–4) stated that the collections of Professor Holmes and Captain Bowman contained fragments of antlers, portions of jaws, and teeth which had been found in the Post-Pliocene beds of Ashley River. Leidy concluded these remains did not differ from the corresponding parts of the existing white-tailed deer (*O. virginianus*). Many fragments of antlers belong in the Scanlan collection at Yale University. They are thoroughly fossilized and are hard and heavy.

In the Charleston Museum (No. 1047) is an anterior cannon-bone of a deer, but no definite locality is recorded. It is black and apparently phosphatized, as are the numerous fragments of antlers found in the private collections at Charleston. The cannon-bone mentioned is 188 mm. long.

While the materials so far discovered do not enable us to distinguish the deer remains found about Charleston from *Odocoileus virginianus,* it is not improbable that they belonged in reality to another species, some perhaps to the Floridan Pleistocene species *O. sellardsiæ.*

Antlers of the white-tailed or Virginia deer are common in the collections about Charleston. In the Scanlan collection are bases of antlers of adult bucks and two simple spikes of young deer. One base is different from the others in being much flattened in one border, probably the one on which the first tine arose. It is possible that it represents a distinct species.

2. *Darlington, Darlington County.*—In 1848, Tuomey (Rep. Geol. South Carolina, pp. 177–180) stated that on the land of a Rev. Mr. Campbell, somewhere in the vicinity of Darlington, he had found fragments of the horns of a deer. He regarded the beds as belonging to the Pliocene.. In the neighborhood, in a similar deposit, had been found molars of *Mastodon maximus* (=*Mammut americanum*). Both species may belong to the early Pleistocene.

FLORIDA.

(Map 22.)

1. *Pablo Beach, Duval County.*—Dr. Sellards (8th Ann. Rep. Florida Geol. Surv., p. 106) reported remains of *Odocoileus* found at station 120 of the Inland Waterway Canal, about 5 miles south of Pablo Beach. Further mention is made of this on page 374.

2. *Neals, Alachua County.*—In his eighth report (page 94) Sellards stated that at Neals, near Newberry, teeth had been collected which probably belonged to a species of *Odocoileus.* These were found while phosphate rock was being mined; but they, with a tooth of a tapir and one of *Equus littoralis,* doubtless belong to the early Pleistocene.

3. *Archer, Alachua County.*—In 1896 Leidy (Trans. Wagner Free Instit., vol. IV, p. X), in a note on the species of vertebrates found in the Alachua clays, included among these a tapir, a mastodon, and a megatherium. In his list furnished for Dr. W. H. Dall's report (Bull. U. S. Geol. Surv. No. 84, p. 129), is included *Cervus virginianus?.* The tapir, the deer, and the megatherium have been regarded as Pleistocene fossils which became mixed with those of the Pliocene. For that reason *Odocoileus* is here credited

to Archer. See also Sellard's conclusion (6th Ann. Rep. Florida Geol. Surv., p. 162). It is not certain exactly where the species above named were found. One locality mentioned by Leidy is 10 miles south of Archer, now Williston; another is 10 miles north of the same town, now Newberry. For the geological age of the species found at Archer, consult page 375.

4. *Ocala, Marion County.*—From a fissure in a limestone rock at Ocala, Sellards (8th Ann. Rep., p. 103) secured some remains of *Odocoileus*, but it was not determined to what species they belonged.

5. *Dunnellon, Marion County.*—The writer (8th Ann. Rep. Florida Geol. Surv., p. 43, plate VIII, figs. 3–5) described some teeth of a deer found near Dunnellon, in the "Cullens river mine." These were referred provisionally to the species or subspecies now living in that region, *Odocoileus osceola*.

6. *Palmetto, Manatee County.*—In a small collection of fossil vertebrates sent from this place by Mr. Ernest Leitzel to the U. S. National Museum for identification were some fragments of antlers of *Odocoileus*..

7. *Palma Sola, Manatee County.*—From Mr. Charles T. Earle the U. S. National Museum received, in 1921, many fragments of antlers found on the beach at Palma Sola, about 10 miles below Palmetto and on the south side of Manatee River. With these came teeth of *Equus leidyi, E. complicatus, E. littoralis,* teeth and bone of *Bison latifrons?,* a tooth of *Elephas columbi,* and a fragment of the beak of a ziphoid porpoise. The last and various sharks' teeth probably originated in Miocene deposits not far away. A list of the species found at this place and believed to belong to the Pleistocene is presented on page 379.

8. *Arcadia, De Soto County.*—In 1889 (Proc. Acad. Nat. Sci., Phila., 1889, p. 96; U. S. Geol. Surv. Bull. No. 84, p. 129), Leidy reported the discovery of antlers of deer, *Odocoileus* (*Cervus*) *virginianus,* at Arcadia. These may have belonged to *O. osceola* or *O. sellardsiæ.* In 1884 (Proc. U. S. Nat. Mus., vol. VI, p. 428), Mr. S. T. Walker reported the finding of fossils, among them fragments of deer antlers, on sand-bars in Peace River, from a point about where the town of Hull now is to a point 8 miles by land above Fort Ogden, apparently not far from the present town of Owens. On this matter see Sellards (8th Ann. Rep. Florida Geol. Surv., p. 109). This locality and its fossils are further described on page 381.

9. *Vero, St. Lucie County.*—Numerous remains belonging to one or two species of *Odocoileus* have been found at Vero. Fragments of various parts of the skeleton and some teeth have been found in the two upper strata, No. 2 and No. 3, which lie above the marine marl. The writer (9th Ann. Rep. Florida Geol. Surv., 1917, pp. 50–57, plate III, fig. 3) referred some of these bones to the new species, *O. sellardsiæ.* Possibly only this species is represented at that locality, but probably some of the bones belong to *O. osceola.* Lists of the species found in the two deposits bearing fossil vertebrates will be found on pages 381 to 383.

MISSISSIPPI.

(Map 22.)

1. *Natchez, Adams County.*—Dr. Leidy wrote (Proc. Acad. Nat. Sci., Phila., 1854, p. 199) as follows:

"Fossil bones of a deer not larger than the *Cervus virginianus* have been found in association with bones of the *Megalonyx, Mastodon,* etc., in the vicinity of Natchez, Mississippi. In the cabinet of the Academy mentioned there are several specimens from the locality, consisting of a portion of a lower jaw, a fragment of an antler, and the posterior and inferior portions of two crania."

The geology of this important locality is discussed on pages 389 to 393.

2. *Aberdeen, Monroe County.*—In 1869 (Jour. Acad. Nat. Sci., ser. 2, vol. VII, p. 376), Leidy stated that remains of a deer had been found at this place in a railroad cutting. No details were given.

TENNESSEE.

(Map 22. Figure 23.)

Whitesburg, Hamblen County.—In 1920 (Proc. U. S. Nat. Museum, vol. LVIII, pp. 85–95), the writer described bones and teeth of Pleistocene animals which had been found at Whitesburg. A list of the species is given on page 395. In the collection are 21 teeth which were referred to *Odocoileus virginianus,* but their small size suggests that they may belong to another species of deer.

Nashville, Davidson County.—On page 201 is presented an account of a collection made at Nashville. Among the fossils was an antler of a deer which is referred by the writer to an undetermined species of *Odocoileus* (p. 399).

KENTUCKY.

(Map 22.)

1. *Bigbone Lick, Boone County.*—The bones and teeth of the Virginian deer have been reported with some doubt from Bigbone Lick; even if found it is not certain that they belonged to Pleistocene deposits.

2. *Bluelick Springs, Nicholas County.*—In the collection made in cleaning out Bluelick Springs, in Nicholas County, remains of a deer were secured. The geological age of these can not be determined with certainty, but they were probably of Late Wisconsin time. For a list of the associated species see page 405.

3. *Henderson, Henderson County.*—In a letter to Dr. Joseph Leidy, published by the latter (Smithson. Contrib. Knowl., vol. VII, art. 5, p. 7), Dr. D. D. Owen stated that many antlers and bones of deer had been found about 6 miles below Henderson, associated with bones of *Megalonyx jeffersonii.*

FINDS OF CERVUS CANADENSIS IN THE PLEISTOCENE OF EASTERN NORTH AMERICA.

ONTARIO.

(Map 23.)

1. *Hamilton, Wentworth County.*—On Burlington Heights, near Hamilton, many years ago antlers of the elk were found associated with a jaw of a beaver. They were discovered 30 feet from the surface and at a level 7 feet higher than the jaw of *Elephas columbi* described on page 147. The age of all these bones is late Pleistocene. The elk had, therefore, spread over the northern part of our country before the close of the Wisconsin stage.

The geology of this locality and the species found there are considered on pages 284–285.

2. *Near Strathroy, Middlesex County.*—In 1901 (Ottawa Naturalist, vol. xv, pp. 95–97, fig.) L. H. Smith wrote on the occurrence of the elk in Ontario. None had been known to exist there since the settlement by white men. The writer of the article had a number of specimens of antlers collected in the neighborhood of Strathroy and the neighboring county, Lambton. A fine pair of antlers and a part of a skeleton of an elk had been discovered in a boggy spring in lot 15, 12th concession, township of Lobo. It was evidently not deeply buried. This and the others, notwithstanding shallowness of burial, may have been buried in Late Pleistocene times; but there is no assurance that they did not live during the early Recent.

3. *Kingston, Frontenac County.*—In 1898 (Bull. Geol. Soc. Amer., vol. ix, p. 377), Robert Bell stated that remains of the elk had been found in shell marl in at least two places near Kingston.

VERMONT.

(Map 23.)

1. *Grand Isle, Champlain Lake.*—In 1840 (Rep. on Quadrupeds, Massachusetts, p. 82), Emmons reported the finding of an antler on this island, which he concluded belonged possibly to a young elk. It had been thrown out by the plow from an elevated piece of ground, near a spring of water. He concluded that it was the antler of the second year, and stated that it had no branches. It was somewhat curved and had a total length of 849 mm. The diameter just above the burr was given as 183 mm.; but this is much greater than that in any specimens of young elks at hand. Possibly some other species is represented and it may not have belonged to Pleistocene.

NEW YORK.

(Map 23.)

1. *Racket River, St. Lawrence County.*—J. E. De Kay, in 1842 (Zool. N. Y., Mamm., p. 120, plate xxix, fig. 1), described a part of a skull, to which were attached the damaged antlers of an elk, which had been dug up near the mouth of Raquette River. This must have been not far from the town of Racket River. Nothing appears to be known regarding the conditions under which the skull was found. Leidy (Jour. Acad. Nat. Sci.,

Phila., vol. VII, 1869, p. 377) refers to the specimen. It was at one time in the Lyceum of Natural History, New York, but is probably no longer in existence.

2. *Seneca Castle, Ontario County.*—Mr. E. Hitchcock (Science, vol. VI, 1885, p. 450) reported the finding of an antler of an elk at this place. It was associated with supposed remains of a mastodon, in a peat morass, near Flint Creek. It is to be credited to the Late Wisconsin.

3. *Farmington, Ontario County.*—James Hall, in 1887 (6th Ann. Rep. State Geologist, New York, p. 391), reported the discovery of about two-thirds of the skeleton of an elk at the place named, in a cedar swamp, buried in peat at depths of from 6 to 18 inches. The antlers had projected above the surface and had been gnawed by rodents. Hall remarked that the elk had not been known to live in that region since the coming of the white race. The skeleton may or may not have been deposited there during the late Pleistocene.

4. *Livingston County.*—In the collection at Princeton University is a calvarium of an elk labeled as found in Livingston County. The finder had, with a tool, chopped off the antlers and otherwise hacked the skull. One can not be certain as to the geological age of the specimen.

5. *Cuba, Allegany County.*—In 1843, James Hall (Geol. 4th Dist., p. 367) reported that several horns of deer and one of an elk had been found at the summit of the Genesee Valley Canal. The place given was New Hudson, 4 miles from Cuba; but this town is about 10 miles from Cuba and apparently not on the canal. The antlers were found at a depth of 12 feet, in muck.

6. *Jamestown, Chautauqua County.*—Hall (op. cit., p. 365) stated that Dr. Emmons had in his possession a tooth which he regarded as belonging to this species. De Kay (Zool. N. Y., Mamm., p. 120, plate XXIX, fig. 4) describes and figures this tooth. Emmons, in 1840 (Rep. Quadrupeds of Massachusetts, p. 82), first mentioned the tooth and said it had been found in a clay bed with several others. The tooth may belong to the Pleistocene, but this can not be proved. It is of value, as are the other cases, as showing the former distribution of the species.

7. *Boonville, Oneida County.*—In 1884 (Trans. Linn. Soc. N. Y., vol. II, p. 46), Dr. C. Hart Merriam reported that Mr. Calvin V. Graves, of Boonville, had parts of elk horns, plowed up in an old beaver meadow. These may have belonged to very late Pleistocene time or to any part of the Recent.

8. *Third Lake of Fulton Chain, Herkimer County.*—In the publication just referred to and on page 45, Merriam stated he had seen a number of elk antlers, found in a bog near the place mentioned. Their geological age can not be determined any more closely than in the preceding case.

9. *Steele's Corners, St. Lawrence County.*—On page 46 of the paper just cited, Merriam reported that Dr. C. C. Benton, of Ogdensburg, had parts of antlers discovered at the place named. No details as to mode of occurrence were given. The antlers were discarded by their owners some time after the clearing away of the Wisconsin drift.

NEW JERSEY.

(Map 23.)

1. *Deal, Monmouth County.*—In 1869 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 377), Leidy stated that there were in the museum of the Philadelphia Academy portions of two antlers of the elk obtained in the earth just above the Cretaceous greensand near Deal. No further information was furnished. Deal is about 5 miles south of Long Branch. The antlers may have belonged to the Pleistocene or to the Recent.

2. *Trenton, Mercer County.*—In 1911 (Papers Peabody Mus., vol. v, p. 123), Mr. Ernest Volk detailed the finding of a fragment of an antler of an elk in the glacial gravels at Trenton, at a depth of 5.5 feet. For the geology of this locality see page 304.

Cope (Cook's Geol. N. J., 1868, p. 742) wrote that this species has left antlers and bones in various parts of the State in the gravel drift, but he mentions no localities.

PENNSYLVANIA.

(Map 23.)

1. *Stroudsburg, Monroe County.*—In 1899 (Ann. Rep. Geol. Surv., Pennsylvania, for 1887, p. 6), Leidy reported the discovery of various fragmentary remains of this species in the Crystal Hill (Hartman's) Cave, near Stroudsburg. This cave and its contents will be considered on page 310.

2. *Riegelsville, Bucks County.*—From Durham Cave, situated near Riegelsville, there was sent to the Academy of Natural Sciences of Philadelphia, about 70 years ago, a collection of bones. They were examined by Leidy, who reported on them (Proc. Acad. Nat. Sci. Phila., 1880, p. 349). In this list the elk was not mentioned. In 1889 (Ann. Rep. Geol. Surv. Pennsylvania, 1887, pp. 18, 19), further attention was given to the collection, and the elk was included. The bison, which was mentioned in the first list, was omitted in the second.

MICHIGAN.

(Map 23.)

1. *Adrian, Lenawee County.*—In 1880, Professor J. Kost, of Adrian College, sent to the U. S. National Museum a skull of *Castoroides ohioensis* and a jaw of a mastodon found in a marsh in the town of Adrian, at a depth of 4 feet. At the same place another mastodon, together with bones of a deer and of an elk, had previously been secured. These belong to a late period in the Wisconsin.

2. *Ann Arbor, Washtenaw County.*—In 1908 (Folio 155, U. S. Geol. Surv., p. 9), Russell and Leverett told of the finding of bones of elk and deer in a peat-swamp, 3 miles south of Ann Arbor. In the same swamp, at a depth of 5 feet, a skull of *Castoroides ohioensis* had been discovered. The bones of the elk and deer were at a somewhat higher level. While they are probably of late Pleistocene age, one can not be wholly sure of it.

INDIANA.

(Map 23.)

1. *Cambridge City, Wayne County.*—In the collection of Earlham College, at Richmond, Indiana, is a part of the skull of an elk (No. 5070) labeled as found a mile northwest of Cambridge City, and as presented by Lee Ault, superintendent [of schools?]. It is recorded on the specimen that it was found in Little Simond's Creek and lay partly exposed in a bed of gravel 4 rods below the mill-dam, and 0.25 mile from where the creek empties into the West Fork of Whitewater River. The specimen is pretty thoroughly mineralized and stained with iron oxide. The geological age of the skull is uncertain, but it has the appearance of being old. Found in that region, it must, however, be younger than the Shelbyville and Bloomington moraines, which are nearby.

2. *Fountain City, Wayne County.*—In Earlham College is the rear of the skull of an elk recorded as found on Nolan's Fork, near the border of the Bloomington moraine. It has the No. 5069 and is credited to Mr. Isaac Thomas. The remark made in the preceding paragraph about the age of the specimen from Cambridge City may be repeated here.

3. *Harrisville, Randolph County.*—In the collection at Earlham College, Richmond, are some bones which belong to *Cervus canadensis* and reported found in May 1893, by Messrs. Shoemaker, Graves, and Moore, in a ditch or canal being put through the swamp known then by the name of "The Dismal," apparently about 6 miles east of Winchester, near the town of Harrisville. It was here that was found the fine specimen of *Castoroides ohioensis* which is at Earlham. Just at what depth the elk bones were found is not known. With them came some bones of the white-tailed deer, *Odocoileus virginianus*. Of the elk there are a dorsal and two lumbar vertebræ, most of the sacrum, some pieces of ribs, the articular end of the scapula, a complete humerus, most of the right side of the pelvis, most of the left pubis, the left cubo-navicular bone, the distal end of the left cannon-bone, and three phalanges.

We can not be certain that the animal lived at that place during Pleistocene times. At most, it lived after the Wisconsin ice had withdrawn from that vicinity. Dr. A. J. Phinney (Geol. Surv. Indiana, vol. xxi, p. 181) stated that in draining swamps in this county elks' antlers had been found, but no details were given. At any rate, in that region all such remains would belong to a time following the middle of the Wisconsin stage.

4. *Pennville, Jay County.*—McCaslin, in his report on the geology of Jay County (Geol. Surv. Indiana, vol. xii, p. 169), stated that the bones of the mastodon and post-glacial deer, or elk, had been frequently met with. "The gigantic antlers of the latter have been found in size indicating an animal 8 or 9 feet high and 10 or 11 in length. These have been picked up in a bog north of Camden." Making proper allowances for miscalculations, we must conclude that these antlers belonged to the elk (*Cervus canadensis*). The antlers had probably been laid out so as to give their maximum extent. This township (24 north, range 12 east) is in the northwest corner of the county. The name Camden no longer appears on the maps, being apparently a former name for Pennville. The bog referred to

was evidently north of the Salamonie River and close to or on the moraine bearing the same name. The elk must have lived there after, probably a long time after, this moraine was laid down.

5. *Wabash County.*—Elrod and Benedict reported in 1892 (Geol. Surv. Indiana, vol. XVII, p. 240) that a Mr. Longnecer had unearthed the head and antlers of an elk in a swamp on his farm "near the west county line." The antlers measured 8 feet from tip to tip. In this case they probably were given their greatest possible span. It is to be regretted that no more definite locality was given. For those in that region who might be interested, it would be possible to learn the location more accurately by searching the office of the county surveyor or of the county clerk. At any rate, the animal lived there in Late Wisconsin time.

6. *Foresman, Newton County.*—In the State Museum at Indianapolis is the left antler of an elk said to have been found in 1884, at Foresman. It is credited to D. E. Howe, and the writer has not been able to get any additional information. Foresman is on Iroquois River; and, according to Leverett's map (Monogr. LIII, plate VI), the region about there is occupied by clay of a glacial lake bottom. The antler may be of the Recent period, but more probably of Late Wisconsin times.

7. *Rensselaer, Jasper County.*—In the State collection at Indianapolis just mentioned is a part, about 16 inches long, of the antler of an elk, presented by Dr. Loughridge, of Rensselaer, but no additional information is furnished. The animal may have lived at any time during or since the Late Wisconsin stage.

8. *Lake County.*—In the Twenty-second Annual Report of the State Geologist of Indiana, page 90, Blatchley stated that antlers of the elk had been found in this county, but no details were given.

9. *Kouts, Porter County.*—In the report just cited, on page 90, Blatchley, State geologist, reported antlers of a large elk found close to teeth of a mastodon. This was somewhere near Kouts.

The reports of fossil remains of *Cervus canadensis* in Indiana are not very satisfactory. In few cases has any effort been made to record anything like exact information as to the locality and the depth of burial and the nature of the deposit and to preserve the specimens. Nevertheless, in most instances at least, it is quite certain that the remains referred to this species were really such. While, again, some of the remains have possibly belonged to the Recent period, probably most of them date back to late Pleistocene; that is, Late Wisconsin times. In many cases the remains have been found at a depth of several feet in swamps that were being drained. It is certain that these swamp deposits accumulated with exceeding slowness. Not infrequently fossil mastodon bones and teeth have been found within a few inches of the surface. In the case of none of the finds of elk materials is there any indication of an age beyond that of the Late Wisconsin.

ILLINOIS.

(Maps 23, 38.)

1. *Niantic, Macon County.*—In 1873 (Geol. Surv. Illinois, vol. V, p. 308), A. H. Worthen reported the discovery of remains of mastodon, elk, buffalo,

and deer in a bog near Niantic. The exact locality and the conditions are described on page 102. In that account it is concluded that the mastodon remains went to the museum of C. F. Günther, of Chicago, and from there to the collection of the Chicago Academy of Sciences. What became of the bones of the elk, the buffalo, and the deer is not known. As no record appears to have been kept of the depths at which each of the species was found, we do not know whether or not the others were as old as the mastodon. However, it is certain that these old ponds and marshes left on the surface of the Wisconsin drift filled up very slowly.

2. *Near Whitewillow, Kendall County, 5 miles west by north of Minooka.*—Dr. E. S. Riggs, of the Field Museum of Natural History, informed the writer that he had found here bones of the elk. These were also reported by him in Netta C. Anderson's list (Augustana Coll. Publ., No. 5, page 11). Mr. George Langford, of Joliet, has likewise found elk antlers here and remains of *Cervalces* and *Alces americanus*.

For the location of this place and its geological situation page 337 may be consulted. All the species found are without doubt of Late Wisconsin age. Riggs's statement referred to appears to indicate that the elk, buffalo, and deer bones found are of more recent age than those of the mastodons, but Mr. Langford writes that the antlers were mixed up with the mastodon bones.

3. *Palos Park, Cook County.*—This place is on the Wabash Railway, about 20 miles southwest of Chicago. Dr. E. S. Riggs wrote the author that in October 1915, the Field Museum of Natural History had received a fine head and antlers of the elk from the Sag Drainage Canal near Palos Park. It was found in peat at a depth of 13 feet. One can hardly doubt that the animal lived there during the latter part of the Wisconsin stage.

4. *Batavia, Kane County.*—Dr. E. S. Riggs, writing April 3, 1916, informed the author that he had picked up the jaw of an elk along a ditch, somewhere about Batavia, in which mastodon bones had been found. At what depth the bones had been buried could not be determined. In this case all that can be said is that the animal lived there after the Wisconsin ice had retired from that place.

5. *Union Grove, Whiteside County.*—In the U. S. National Museum, No. 7335, is a right astragalus of an elk found near Union Grove, 3 feet below the surface of a bed of peat, in an old channel of the Mississippi River. This astragalus was presented by Mr. Leo B. Lincoln, of Chicago, through the peat expert of the U. S. Geological Survey, Professor Charles A. Davis.

The locality is said to be in the southeast quarter of the southeast quarter of section 7, Union Grove Township, apparently township 21 north, range 4 west. This section appears to be about 5 miles away from the present bed of the river. Although the area is outside of the Wisconsin drift-sheet, it is not probable that the elk antedates the Wisconsin stage. Its age is more probably Late Wisconsin.

6. *Lead Region of Illinois.*—In 1876, J. A. Allen (Amer. Jour. Sci., vol. XI, p. 48) stated he found in a collection made in this region by J. D. Whitney an imperfect radius that seemed not to differ at all from that of a young male *Cervus canadensis*. This collection is that reported on by

Jeffries Wyman in 1862 (Geol. Surv. Wisconsin, vol. I, pp. 421–423). It is impossible to say whether the specimen was found in Wisconsin, Iowa, or Illinois.

As elsewhere stated, the writer formerly regarded the vertebrate fossils found in that region as belonging mostly to the Late Wisconsin; but it now appears possible they lived during a pre-Wisconsin time.

7. *Beecher, Will County.*—Mr. George Langford, of Joliet, Illinois, an intelligent collector of the fossils of that region, informed the author that he obtained an antler of the *Cervus canadensis* at a place along Trim Creek, about 3 miles north of east of Beecher. The fragment included the base and two tines. The exact locality and the geological conditions are discussed on page 107. Mr. Langford reported that the antlers were above the mastodon bones. At the same place was found a fragment of an antler of *Cervalces*. All these species belonged probably to very late Pleistocene time.

WISCONSIN.

(Map 23.)

1. *Wauwatosa, Milwaukee County.*—In the Public Museum of Milwaukee are parts of both antlers of an elk found at Miller's brewery, in Wauwatosa, at a depth of 4 feet.

Wauwatosa is a suburb west of Milwaukee, on the Menomonie River, situated principally on one of the moraines laid down just before the Wisconsin ice-sheet retired into Lake Michigan. The elk must have lived there since that withdrawal of the ice. It is possible that the antlers were found in marsh deposits of Recent age along the Menomonie River.

2. *Pewaukee, Waukesha County.*—This town is situated about 20 miles north of west of Milwaukee. In the Public Museum at Milwaukee is an antler which was plowed up somewhere about Pewaukee by Stanley G. Haskins and presented by him to the museum. Probably the antler belongs to the Recent epoch.

3. *Whitehall, Trempealeau County.*—From Dr. S. Weidman, State geologist of Wisconsin, the writer received a tibia found near Whitehall and which he identifies as belonging to *Cervus canadensis*. The following account of the discovery has been furnished by Dr. Weidman:

"The gully (fig. 2) in which the tibia was found is eroded out of stratified sand, containing fragments of local sandstone and cherts. The stratified sand, with local small fragments of sandstone, is, of course, pre-loessial in origin, but the erosion of the lower terrace is post-loessial, and the gully is very recent. The tibia was taken 2 feet below the lower terrace, along the side of the gully about 5 or 6 feet deep at the lower end and 3 or 4 feet deep at the upper end; length of gully 300 or 400 feet. The bone may possibly have been inserted after the development of the lower terrace, but I could see no indication of disturbance or change in the upper 2 feet of the lower terrace further exposed by the gully at this point, the upper 2 feet being essentially the same at this point as elsewhere along the side of the gully. If the bone was deposited along with the small fragments of sandstone in the stratified formation, the fragments being usually flat, about 0.5 inch thick by 1 to 2 inches wide, then the bone is evidently pre-loessial in age. I am inclined to think the bone was deposited with the sandstone fragments during the process of the filling up of the valley with the

stratified surface, long before the loess was deposited in the region, rather than after the loess and the lower terrace was formed."

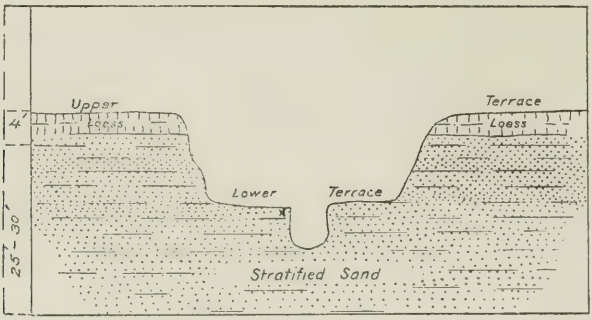


FIG. 2.—Diagrammatic section of gully near Whitehall, Wisconsin, showing place of burial of elk bone.

According to this account the specimen belonged to the Peorian stage or an earlier one.

MARYLAND.

(Map 23.)

1. *Oxford Neck, Talbot County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 178), Cope stated that a collection of vertebrate fossils had been found on the farm of Lambert Kirby, in Oxford Neck, including parts of antlers. These were not distinguishable from those of the elk and the Virginia deer. They were placed in the Baltimore Academy of Natural Sciences.

NORTH CAROLINA.

(Maps 23, 39.)

1. *On Neuse River, Pamlico County, 16 miles below Newbern.*—On page 117, in discussing the occurrence of mastodons at this place, it is stated that H. B. Croom had reported also the presence of elk remains. A more competent witness was Richard Harlan, who included the elk in his list of species (Amer. Jour. Sci., vol. XLIII, 1842, p. 143). The reader is referred to page 358, where the locality and the species are further considered.

SOUTH CAROLINA.

(Map 23.)

1. *Charleston, Charleston County.*—Dr. Joseph Leidy does not seem to mention the occurrence of the wapiti at Charleston. F. S. Holmes, in the introduction to his work on Post-Pliocene fossils of South Carolina, page 7, mentions the elk among the animals found in the Pleistocene beds which still have living representatives.

In the collection of the Academy of Natural Sciences, at Philadelphia, are two teeth, labeled as from Ashley River and credited to Captain A. H. Bowman. It is possible that Leidy did not mention them because he regarded them as teeth of elk that lived within Recent times.

GEORGIA.

(Map 23.)

1. *Brunswick, Glynn County.*—In a list of fossil vertebrates dredged, probably, from the harbor at Brunswick, Gidley (Bull. No. 26, Geol. Surv. Georgia, p. 436) announced the finding of some part, supposedly a tooth, of a cervuline, "probably belonging to the genus *Cervus*." That *C. canadensis* might have lived in that region during some part of the Pleistocene is not at all improbable; that it lived there during the time that *Megatherium* existed we have not at present sufficient evidence.

FLORIDA.

(Map 23.)

1. *Alafia River, Hillsboro County.*—From the late Professor F. W. Putnam the writer learned that he had obtained from Alafia River some part of the elk. The present writer has not seen the specimen.

TENNESSEE.

(Figure 23.)

Whitesburg, Hamblen County.—In a collection of fossil vertebrates secured at Whitesburg and described by the writer in 1920 are some fragments of teeth which were referred to *Cervus canadensis* (Proc. U. S. Nat. Mus., vol. LVIII, p. 92). A list of the species is presented on page 395.

KENTUCKY.

(Map 23.)

1. *Bigbone Lick, Boone County.*—In his report of 1831 on Bigbone Lick, William Cooper (Monthly Amer. Jour. Geol., vol. I, p. 207) stated that he had found remains of *Cervus canadensis;* but he did not appear to be wholly certain of this. Shaler was likewise in doubt regarding the presence of the elk (Geol. Surv. Kentucky, vol. III, n. s., p. 197). Other authors have mentioned the elk as occurring here, but not in a convincing way. Nevertheless, it is not at all improbable that this species was represented here. The geology of this locality is considered on pages 401 to 404 and a list of the species is presented.

2. *Bluelick Springs, Nicholas County.*—In the collection of fossil vertebrates secured by Mr. Thomas W. Hunter, living near Bluelick Springs, were teeth, some bones, and fragments of antlers. This collection had been secured in an attempt to clean out and restore the failing springs. Whether or not these remains date back to the Pleistocene is uncertain. They are reported to have been found above the bones of the mastodon.

FINDS OF RANGIFER IN THE PLEISTOCENE OF EASTERN NORTH AMERICA.

GRINNELL LAND.

Dumbbell Harbor.—In 1877 (Ann. Mag. Nat. Hist., ser. 4, vol. xx, p. 488), Fielden published a paper on the post-Tertiary beds of Grinnell Land and north Greenland. In 1878 (Quart. Jour. Geol. Soc. Lond., vol. xxxiv, p. 566), Fielden and De Rance presented a report on the same subject.

At a station in latitude 82° 30′ N., in beds at an elevation of 400 feet, there were secured meager remains of *Ovibos moschatus* and *Phoca hispida*. At another station, in latitude 82° 25′, there were obtained remains of *Rangifer tarandus, Ovibos moschatus,* and *Phoca barbata.* The invertebrate fauna was found to be identical with that now existing there. In case the beds are Pleistocene they are probably those of a late stage.

ONTARIO.

(Map 24.)

1. *Toronto, York County.*—In 1899 (Ottawa Naturalist, vol. xii, p. 195), Coleman stated that horns of the caribou were common in the Carleton Bar, just west of Toronto. This bar belonged to the Iroquois beach. In the same bar near York, east of Toronto, mammoth teeth had been found. In 1904 (Jour. Geol., vol. xv, p. 366), the same writer states that antlers are very common at Toronto Junction. This is probably the same locality as that spoken of as Carleton Bar.

In 1901 (Jour. Geol., vol. ix, pp. 290, 298), Coleman wrote that a shed horn of a caribou had been found at Taylor's brick-yard. This is nearly a mile north of the Gerard street bridge in Toronto (Amer. Geologist, vol. xiii, p. 87). It was in a blue peaty clay, in which were found also unios and wood. This clay is about 4 feet 6 inches thick and near the top of the warm-climate beds. Notwithstanding the presence of the antler of a caribou, the stratum is assigned by Coleman to the warm-climate beds, because of the character of the vegetation. At present the caribou is not known to come nearer than 150 or 200 miles to Toronto.

VERMONT.

(Map 24.)

1. *Woodbury, Washington County.*—In 1910 (Rep. Geol. Surv. Vermont, p. 7), Professor G. H. Perkins stated that there are in the State Cabinet at Burlington a fully developed antler and a part of the upper jaw, with five molars, of *Rangifer caribou* found at Woodbury in a peat-bog at a depth of 7 feet. Probably the animal lived at about the close of the Pleistocene epoch. The species has not been known in the State since historical times.

CONNECTICUT.

(Map 24.)

1. *New Haven, New Haven County.*—In 1875 (Amer. Jour. Sci., ser. 3, vol. x), Professor J. D. Dana gave an account of the finding of a humerus

and a tibia of a reindeer in the Quinnipiac Valley, near New Haven. The humerus was discovered in a bed of clay at a depth of 11 feet; the tibia at a depth of 7 feet. The two bones belonged to different individuals. Marsh, as quoted by Dana, thought that the tibia resembled more closely that of *Rangifier tarandus* of Europe than it did that of *R. caribou*, but that the humerus was more similar to that of the caribou. Dana concluded that the clays had been laid down after the glacier had retreated from the valley, but while it was yet near enough to send down ice-floes. Woodworth (17th Ann. Rep. U. S. Geol. Surv., pt. 1, p. 978) was inclined to refer the clays to some pre-Wisconsin time.

NEW YORK.

(Map 24.)

1. *Ossining, Westchester County.*—In 1859, Dr. Joseph Leidy (Proc. Acad. Nat. Sci. Phila., vol. XI, p. 194) read a letter from Dr. G. J. Fisher, of Ossining (then Sing Sing), in which was reported the finding of an antler of a reindeer in that vicinity, in excavating a peat-bed, 6 feet from the surface. The peat-bed had an area of about an acre, was surrounded by high ground, and looked as if it had been the site of an ancient lake. It is to be regretted that the situation of the place was not more accurately given.

Woodworth (Bull. 84, New York State Mus., 1905, p. 187) remarked that he did not know the circumstances under which the reindeer remains had been found; but its occurrence there was consonant with his views of the nonsubmergence of the lower Hudson valley. On the other hand, there appears to be no good reason why the caribou might not have occupied that region step by step as the glacier retired, and have remained there long enough for its bones to become buried in mucks overlying the deposits laid down in the Hudson while it was at sea-level.

2. *Racket River, St. Lawrence County.*—In 1869 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 377), Leidy mentioned the occurrence of caribou (*"Cervus tarandus"*) remains at Racket River, basing his statement on a remark of S. L. Mitchill (Cat. Organ. Remains, 1826, p. 26). On the same page Leidy referred to Mitchill's skull of the elk found at Racket River, and to De Kay's figure of it. In De Kay's description (Zool. N. Y. Mamm., p. 120) of the skull he stated that it bore a label in Mitchill's handwriting purporting that the skull belonged to the reindeer. It looks, therefore, very much as if the crediting of the caribou to this locality is due to an error of identification on the part of Mitchill; on the other hand, it is barely possible that Mitchill had remains of both animals from the locality.

NEW JERSEY.

(Map 24.)

1. *Vincentown, Burlington County.*—In 1869 (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 377, plate XXVIII, fig. 9), Leidy described and figured a part of an antler of a reindeer found at Vincentown. It was discovered 4 feet from the surface in soil overlying greensand. According to Lewis and Kümmel's geological map, the region about Vincentown is occupied by Cape

May deposits resting on Manasquan marl, of Cretaceous age. It may be supposed, therefore, that this reindeer was in that region during the prevalence of the Wisconsin glacial stage (Geol. Surv. New Jersey, vol. VIII, p. 183). This antler is peculiar in having no brow-tine, in having the bez-tine placed at an unusual height, 6 inches above the base, and in having no tine arise from the rear of the shaft up to a height of about 2 feet from the base. Where the last-mentioned tine might be expected is simply a sharp ridge. Leidy thought that the antler resembled more closely that of the barren-ground reindeer than that of the woodland reindeer. It may, however, belong to a distinct but as yet unnamed species.

2. *Trenton, Mercer County.*—In 1884 (17th Ann. Rep. Peabody Mus., Harvard Univ., for 1883, p. 372), Professor F. W. Putnam reported as follows on a fragment of antler of *Rangifer* found at Trenton by Dr. C. C. Abbott: "A piece of worked antler, probably a handle to a stone knife, from the gravel in the railroad cut where the human tooth (No. 27798) was found. Collected and presented by Dr. C. C. Abbott."

This specimen is mentioned by Mr. S. N. Rhoads (Mamm. of Pennsylvania and New Jersey, 1903, p. 241) as belonging to *Rangifer grœnlandicus*. From Dr. C. C. Willoughby, director of Peabody Museum, the writer learns that this part of an antler is yet in that museum. He writes that it has been a handle for apparently a steel knife and that he sees nothing whatever about the specimen to indicate a prehistoric origin. It may, he thinks, have been washed out of some recent Indian grave. In a personal letter to Mr. S. N. Rhoads, Professor Putnam wrote that the fragment had been identified by Dr. J. A. Allen as belonging to *Rangifer*. In 1883 (Jour. Franklin Inst., vol. CXV, pp. 366, 374), H. C. Lewis stated on the authority of Dr. C. C. Abbott that remains of *Rangifer* had been discovered in the Trenton gravels.

PENNSYLVANIA.

(Map 24.)

1. *Stroudsburg, Monroe County.*—In Crystal Hill (Hartman's) Cave, near Stroudsburg, there was found, many years ago, bones and teeth of what Leidy (Proc. Acad. Nat. Sci. Phila., 1880, p. 347) called *Rangifer caribou*. In 1889 (Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 5) the remains are spoken of as fragments of jaws and teeth.

2. *Riegelsville, Bucks County.*—In his earliest mention of remains found in Durham Cave, near Riegelsville, Leidy included the woodland caribou (*Rangifer caribou*). In his list published in 1889 (Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 18) this species is not included, but the writer does not know why it was not.

ILLINOIS.

(Map 24.)

1. *Alton, Madison County.*—In the collection of fossils made in the region about Alton by William McAdams, a list of which will be given on page 339, is a single upper right molar, the first or second, which belongs to this genus. The tooth has McAdams's No. 11. To the base of the tooth a mass

of very hard matrix adheres and a part of the grinding-surface is covered by the same material. The tooth is likewise somewhat shattered. The length of the tooth is 19 mm., the width across the anterior lobe 13.5 mm.

From the materials at hand it is not possible to determine to what species the tooth belonged. It is referred provisionally to *Rangifer muscatinensis*. This tooth differs from other *Rangifer* teeth observed in having the front of the protocone, at its base, less fully rounded out, and in that the mesostyle, on the inner face of the tooth, widens more extensively as it approaches the base than in any other species observed. Nevertheless, the width of the mesostyle varies in species and individuals.

WISCONSIN.

(Map 24.)

1. *Menomonie, Dunn County.*—From Professor S. Weidman, of the Wisconsin Geological and Natural History Survey, the writer received a part of an antler of a female or a young individual of some species of *Rangifer*. Professor Weidman sends the information that this was obtained in a sand formation just below the clays worked at Menomonie for brick. He regards the brick-clays as being of Sangamon interglacial age. He states, too, that a part of a leg-bone believed to belong to a mastodon had been found in the clays; also bones of a fish, which have been identified by Dr. Hussakof as the Mackinaw trout, *Cristivomer namaycush* (Jour. Geology, vol xxiv, pp. 685–689, figs. 1, 2).

Probably the caribou represented by this specimen lived in that region at the beginning or at the close of some one of the glacial stages, when the climate was yet severe. The supposed mastodon bone may have belonged to *Elephas primigenius*. It is described on page 111.

At a later time Dr. Weidman sent the writer a large part of the beam of an antler of a caribou which likewise had been found in the lacustrine clay at Menomonie. It was met with in the red clay, near the top of the lacustrine clay bed.

KENTUCKY.

(Map 24.)

1. *Bigbone Lick, Boone County.*—The presence of reindeer bones at this place appears first to have been mentioned by William Cooper (Monthly Amer. Jour. Geol., vol. i, p. 207). He wrote that "antlers, jaws, and other remains of *Cervus canadensis, C. virginianus, C. alces,* and perhaps *C. tarandus* are not very rare." Shaler (Proc. Bost. Soc. Nat. Hist., vol. xiii, 1871, p. 167; Geol. Surv. Kentucky, n. s., vol. iii, p. 197) reported that antlers of the caribou had been found by him here. A list of the species found at Bigbone Lick will be given on page 403.

FINDS OF MUSK-OXEN IN THE PLEISTOCENE OF EASTERN NORTH AMERICA.

GRINNELL LAND.

Dumbbell Harbor.—In 1877 (Ann. Mag. Nat. Hist., ser. 4, vol. xx, p. 488), H. W. Fielden presented a paper on the post-Tertiary beds of Grinnell Land and north Greenland. He reported the discovery of a bone and a tooth of *Ovibos moschatus* and a bone of *Phoca hispida* in deposits at an elevation of 400 feet. This was in latitude 82° 30′ N. At another station, in latitude 82° 25′, Fielden procured fossil remains of *Rangifer tarandus, Ovibos moschatus,* and *Phoca barbata.* A report to the same effect was presented by Fielden and De Rance in 1878 (Quart. Jour. Geol. Soc. Lond., vol. xxxiv, p. 566).

NEW JERSEY.

(Map 25.)

1. *Trenton, Mercer County.*—In 1900 (Ann. Rep. Amer. Mus. Nat. Hist. for 1899, p. 16), Professor F. W. Putnam stated that Mr. Ernest Volk, of Trenton, had found in the Trenton gravels a part of the scapula of a musk-ox, now at the American Museum of Natural History, New York. The part present is that bearing the glenoid cavity. This report is reprinted on pages 248 to 249 of Volk's "Archæology of the Delaware Valley" (Papers Peabody Mus., vol. v). On page 111 of this work, Mr. Volk gives an account of the discovery of the bone, and illustrates it by plates lxxxvi and lxxxvii. The bone was identified by Putnam, Matthew, Allen, Boas, Lambe, True, and Lucas. Inasmuch as the comparison must have been made with the scapulas of *Ovibos moschatus,* the fossil probably belonged to this species.

PENNSYLVANIA.

(Map 25.)

1. *Pittston, Luzerne County.*—In 1872 (Contrib. Ext. Fauna West. Terrs., p. 255, plate xxviii, fig. 8), Leidy briefly described and figured a molar tooth which he referred to *Bison latifrons.* It had been found along the bank of Susquehanna River at Pittston, associated with the mastodon and a horse. Dr. J. A. Allen (Amer. Bisons, 1876, p. 12) expressed the opinion that the tooth belonged to some species of *Ovibos.* The present writer agrees that the tooth is not that of *Bison.* It seems to agree more nearly with teeth of *Symbos cavifrons;* but it differs from the teeth of that species in some respects. The writer has examined this tooth at the Academy of Natural Sciences at Philadelphia. It is worn almost to the roots and is 34 mm. long and 32 mm. thick at the base of the hinder lobe. It agrees in form more closely with the first molar of both *Ovibos* and *Symbos;* but it is much larger than the same tooth in *Ovibos moschatus* and somewhat larger than that of *Symbos cavifrons.* The inner face of the anterior lobe is much more rounded than in *Symbos,* and the inner face of the hinder lobe forms an angle with the hinder face, instead of rounding into it, as it does in *Symbos cavifrons.* The teeth appear to have been packed together more closely,

on the lingual side, than in *Bison, Symbos,* and *Ovibos.* The tooth is probably worthy of being given a new name.

Mr. S. W. Rhoads has examined this tooth and concluded that it belonged to *Bison bison.* To this view it seems sufficient to say that in *Bison* teeth the outer face of each of the lobes is very convex and column-like, while the parastyle and especially the mesostyle are relatively small. In the Pittston tooth the mesostyle stands out beyond the outer face of the hinder lobe, and the latter is nearly flat; this is also the condition in *Symbos.* The writer will say further that the accessory column is not always present in teeth of *Symbos.*

2. *Riegelsville, Bucks County.*—Mr. Rhoads, as cited above, on pages 246 to 248, described a part of a horn-core of a bovine animal to which he applied the name *Bison appalachicolus.* Later (Proc. Acad. Nat. Sci., Phila., 1897, p. 492) he concluded that the horn-core had belonged to an animal of the genus *Ovibos;* and accordingly it bears the name *O. appalachicolus.* Leidy had in 1889 called attention to a collection of bones made in Durham Cave, near Riegelsville (Ann. Rep. Geol. Surv., Pennsylvania, for 1887, pp. 18–19). He recorded 20 species, all of which lived there or at most, not far away, when the country was discovered. These may have all entered the cave at a later period, but the musk-ox may have antedated the others. A list of these fossils is presented on page 311.

OHIO.

(Map 25.)

1. *Urbana, Champaign County.*—At Urbana, Ohio, in the possession of Mr. Charles McDarg, the writer has seen a skull of *Symbos cavifrons* which had been found on the farm of Ed. Jennings, while a ditch was being dug. It was buried in mud at a depth of 10 feet. This region is covered by the Wisconsin drift, and the animal must have lived not long after the ice had withdrawn from the neighborhood.

2. *Youngstown, Mahoning County.*—In the geological collection of the Ohio State University is a part of a skull of *Ovibos moschatus* secured at Youngstown. The specimen shows the base of the skull and the forehead. Between the bases of the horns is a narrow channel, characteristic of *Ovibos.* The specimen shows the effects of abrasion, the horn-cores being worn down to their bases. The specimen is said to have been found in gravel at a depth of 60 feet. It appears to have been presented in 1890 by H. McGinnis. It is probable that this skull was found along Mahoning River, but the elevation was, unfortunately, not given. The probability is that the deposits inclosing the fossil were laid down during the Wisconsin stage.

According to Leverett (Monogr. U. S. Geol. Surv., XLI, p. 149), the old trough of Beaver River was filled with gravel during the Wisconsin glacial stage, and this filling is now in process of excavation. The same is probably true of its tributary, the Mahoning. If the skull was buried in this gravel its age is thereby determined.

3. *Trumbull County.*—In 1853 (Smith. Contrib. Knowl., vol. v, art. 3, p. 16), Leidy stated that he had received, for inspection, from Professor Samuel St. John, of Hudson, Ohio, a fragment of a skull, with one horn-core

attached, which had been found in Trumbull County. No further details were given as to the locality or of the geological conditions. The skull appeared to be much waterworn. It belongs to *Symbos cavifrons*. Trumbull County is wholly occupied by Wisconsin drift. The animal is, then, probably to be credited to the Late Wisconsin. It is possible, however, that this skull was found in an older deposit exposed in the valley of some stream.

MICHIGAN.

(Map 25.)

Up to the present time it appears that remains of musk-oxen have been found in Michigan in only two localities, Manchester, Washtenaw County, and near Moorland, in Muskegon County. These remains belonged to two different genera, *Symbos* and *Boötherium*.

1. *Manchester, Washtenaw County.*—In No. 13 of the Occasional Papers of the Museum of Zoology, pages 1–3, plates I, II, issued by the University of Michigan, November 12, 1915, Dr. E. C. Case reported the finding of a fine skull of *Symbos cavifrons* at a place near Manchester. This was given by Case as being about 3 miles northeast of Manchester, but Mr. Schlicht, owner of the farm, has sent the writer a description and plat of the section which show that the spot is situated about 0.5 mile northwest of the town. It is near the center of the northwest quarter of the northwest quarter of section 1, township 4 south, range 3 east. A drain was being made in a swampy tract and the skull was found at a depth of 4 feet, lying on a bed of clay. This was covered by a black muck filled with plant remains and interrupted by a few thin layers of fine gravel.

The skull was in fine condition, but lacked the lower jaw. The spade of a workman struck the nose and injured the bones so that some parts were lost. The teeth were almost perfectly preserved.

The locality which furnished this skull is in the valley of the Raisin River. According to Leverett's glacial map of Michigan (Monogr. U. S. Geol. Surv., LIII, plate VII), this valley crosses, at this point, the northern end of the Fort Wayne moraine. It is not improbable that this musk-ox lived when the foot of the ice-sheet was not far removed. Even in case the skull had gotten into a drainage channel it could not, because of its fine state of preservation, have been moved far from where the animal died. The circumstances appear to indicate that the skull had been left on the clayey bottom of a shallow pond of a tundra and become covered by the muck of a milder epoch.

2. *Moorland, Muskegon County.*—In 1908 (Proc. U. S. Nat. Mus., vol. XXXIV, p. 683, plate LXXIX), J. W. Gidley described, as belonging to a new species, *Boötherium sargenti*, a skull of a musk-ox found on the farm of Mr. Charles McKay, reported to be near Grand Rapids. Further inquiry showed that the farm is located near Moorland, in the northeast quarter of section 16, township 10 north, range 14 west. The skull was found in a marsh at a depth of 2 or 3 feet and lying beneath the pelvis of a mastodon. It and the mastodon are now preserved in the Kent Scientific Museum, at Grand Rapids, Michigan.

In 1915 (Proc. U. S. Nat. Mus., vol. XLVIII, p. 525, plate XXXI), the writer redescribed the specimen. Dr. J. A. Allen, in 1913 (Mem. Amer. Mus. Nat. Hist., vol. I, pp. 214, 215), referred to this skull and concluded that it had belonged to the female of *Symbos cavifrons*. The writer does not accept this opinion. He has examined more than 25 skulls of *S. cavifrons*, some of which must have been females. In none did the rough surfaces for the horns fail to meet at the midline as it does fail in the Moorland specimen.

The Moorland marsh is surrounded by what Leverett has called the Lake Border moraines. It is probable that this musk-ox existed there after, but not long after, the ice had withdrawn into Lake Michigan. From what is known about the habits of musk-oxen in general, we must conclude that the climate was yet cold.

The fact that the mastodon remains were so closely associated with the musk-ox skull does not prove that the animals lived there together. Near Alma, in Gratiot County, the late Charles A. Davis found mastodon bones in a peat-bog within a few inches of the surface. If by chance the pelvis of a modern horse or cow had fallen on that spot, it might easily have been pressed down into contact with those bones.

INDIANA.

(Map 25.)

1. *Wailesboro, Bartholomew County.*—In the American Museum of Natural History, New York, is a portion of a skull of a musk-ox which the writer identifies as *Symbos cavifrons*. It is labeled as found along the East Fork of White River, in 1904, near Wailesboro, Bartholomew County, Indiana. This locality is about 45 miles east of south of Indianapolis. The skull is reported to have been washed out of a bank composed of alluvium which overlies from 10 to 20 feet of glacial gravel. It is also said that out of the same gravel a tooth of *Elephas primigenius* had been secured. It seems to be implied that the musk-ox skull came from the gravel; but the record is not clear. It was presented to the museum in New York by Dr. J. J. Edwards, of Columbus, Indiana. He is said to have been interested to some extent in collecting palæontological materials. It is likely that he depended on others for his knowledge of the origin of the skull.

The specimen presents the brain-case to the rear of the orbits, including the basioccipital bone and the bases of the horn-cores. It has been rolled somewhat and many ridges and processes have been eroded off. Measurements were given by the writer in his paper on the "Pleistocene Period in Indiana and its Vertebrata" (Geol. Surv. Indiana, vol. XXXVI, pp. 638–639). Dr. J. A. Allen (Mem. Amer. Mus. Nat. Hist., vol. I, p. 201) has examined this skull and concluded that it is not specifically determinable, but the writer, after re-examining the specimen, sees no reason for changing his original conclusion.

This skull was found within the area of Illinoian drift; but the border of the Wisconsin forms the high ground just east of the river. According to Leverett's glacial map of Indiana (Monogr. LII, U. S. Geol. Surv., plate VI), the valley of the river is filled with sands and gravels resulting from glacial

drainage, and this came mostly, if not all, from the Wisconsin ice. Most probably the animal which possessed this skull lived there at some time when the Wisconsin glacial ice was not far away.

2. *Richmond, Wayne County.*—In the collection at Earlham College, Richmond, Indiana, is the brain-case of a skull identified as that of *Ovibos moschatus*. This fragment was described and figured by the writer in 1912 (Geol. Surv. Indiana, vol. XXXVI, p. 641, plate IX, fig. 2). The skull was unearthed by some workmen in the vicinity of Richmond and put into the hands of Professor D. W. Dennis, who loaned it to the writer. It is referred to *Ovibos moschatus*, the species now existing in the Arctic region of North America. Possibly if we had more complete remains specific differences might be found.

This animal probably lived in the region about Richmond at a time when the Wisconsin moraine was yet lingering in Indiana and when the climate was yet severe.

3. *Randolph County.*—In the collection belonging to Earlham College is the rear portion of the skull of a musk-ox, identified as belonging to *Symbos cavifrons*. At what place in Randolph County it was found is not known. It had been somewhat eroded and injured. Measurements approximately correct were given by the writer in 1912 (Geol. Surv. Indiana, vol. XXXVI, p. 638). We may suppose that the animal lived in that region at some time during the last half of the Wisconsin stage.

4. *Beaver Lake, Newton County.*—In 1870, F. H. Bradley (Geol. Surv. Illinois, vol. IV, p. 229), reported that upon the bottom of Beaver Lake, just east of the State line, since the lake had been partially drained, skeletons of *Mastodon* and *Boötherium* had been found by Dr. H. M. Keyzer, of Momence, Illinois, and others. Unfortunately, we do not know what became of these valuable materials. Probably the *"Boötherium"* was the animal now known as *Symbos cavifrons*, inasmuch as it is far more abundant than any other species of musk-ox. If any parts of the skeleton of this musk-ox were really found the loss is great, inasmuch as very few bones have ever been discovered.

The time when the mastodon and the musk-ox lived about Beaver Lake must have been after the withdrawal of the Wisconsin glacial sheet beyond that region. For remarks on this locality see page 96. The name Beaver Lake has disappeared from the maps, but it was in township 30 north, range 9 west.

5. *Hebron, Porter County.*—In the American Museum of Natural History is a nearly complete skull of the musk-ox known as *Symbos cavifrons*, collected about 6 miles east of Hebron. It was found by workmen while making excavations for a railroad bridge. The exact location is given as section 16, township 33 north, range 6 west, in the marshy lands just north of Kankakee River. The depth was about 7 feet and the deposit was described as a mixture of sand and clay. Doubtless the animal died near the spot where its skull was found, inasmuch as this had undergone little injury.

This skull was described and figured by the writer in 1912 (Geol. Surv. Indiana, vol. XXXVI, pp. 635–638, figs. 49, 50) and in 1914 (Iowa Geol.

Surv., vol. XXIII, pp. 299–302. figs. 98, 99); also by Dr. J. A. Allen (Mem. Amer. Mus. Nat. Hist., vol. I, p. 214. plates XVII, XVIII).

On Leverett's glacial map of Indiana this region is represented as being occupied by sand and gravel deposits resulting from glacial drainage. The musk-ox must have lived after the foot of the glacier had withdrawn nearly to the end of Lake Michigan.

ILLINOIS.

(Map 25.)

1. *Bondville, Champaign County.*—In the collection of the University of Illinois, at Champaign, is the rear portion of the skull with the horn-cores of a specimen of *Symbos cavifrons*. It is reported as found on the farm of John Busey, southwest of Champaign and 4 miles from Bondville. Professor S. A. Forbes informed the writer that the locality is in section 31, township 19 north, range 8 east. No details are known regarding the conditions under which the skull was found. The region is occupied by the Champaign moraine and it was after the retirement of the ice from this moraine that the animal lived. It may, however, have been not long after that time.

2. *Manito, Mason County.*—Mr. John Wiedmer, of St. Louis, presented to the U. S. National Museum (No. 7800) the rear half of the skull of a specimen of *Symbos cavifrons* found near Manito, at a depth of 5 feet, by workmen who were cutting out peat. A tooth of a mastodon, *Mammut americanum*, sent with the skull, is said to have been embedded in the upper part of the sand which underlies the peat. The skull was reported as found at about the same depth, but it was quite certainly not in the sand.

The exact location of the skull was in section 22, township 23 north, range 6 east, within the area of the Illinoian drift sheet, but the Wisconsin drift is not far away. The valley of the Illinois River in this county is mapped by Leverett as occupied by sands and gravels of Wisconsin age. Probably the animal lived when the Wisconsin ice-sheet was not far distant.

The skull described apparently belonged to a rather small, perhaps not fully grown individual. For purposes of comparison with other skulls, as the one found at St. Louis, Missouri, and the one found at Hebron, Indiana (p. 252), the following measurements have been taken of this skull:

	mm.
From tip to tip of horn-cores	437
Height of rear of skull from bottom of condyles	168
Width across the mastoid region	183
Width between hinder ends of temporal fossæ	117
Width at space between bases of horn-cores and orbits	127
Width at the rear border of orbits	231
Length of rough surface of forehead, at midline	200
Fore-and-aft width of base of horn-core	98
Vertical thickness of base of horn-core	78
From front of foramen magnum to rear of nasal bones	260

The exostosis between the bases of the horn-cores is longitudinally deeply excavated, the excavation being 50 mm. wide and 27 mm. deep. The tips of the horn-cores come forward only even with the rear border of the orbits.

In some other cases the horn-cores come forward to the front, or even in advance of the front border of the orbits. It is possible that this Manito skull was that of a cow.

3. *Alton, Madison County.*—In a collection of fossil mammals made at Alton by William McAdams and now in the U. S. National Museum is a single tooth, a lower left second molar, referred with some doubt to *Symbos promptus*. The crown is 34 mm. long and 25 mm. wide at the base. The tooth has been described briefly by the writer (Proc. U. S. Nat. Mus., vol. LVIII, p. 115). A list of the species accompanying it will be found on page 339.

WEST VIRGINIA.

(Map 25.)

1. *Mahan, Brooke County.*—In 1902 (Science, n. s., vol. XVI, pp. 707-709, fig.), J. B. Hatcher reported the finding of a part of a skull of *Symbos cavifrons* at a point in Brooke County, somewhat over a mile below Steubenville, Ohio. The locality is further defined as being the sand-pit of the Steubenville Sand Company, on the Thomas Mahan farm, on the east side of the Wheeling branch of the "Panhandle" Railroad. The details regarding the locality were furnished by Mr. Sam Huston. The sand-pit was located in the glacial terrace which rises about 70 feet above low-water mark and from about 35 to 40 feet above high water. The river has never been known to rise as high as to the spot where the skull was found. It had doubtless been brought down by the waters which built up the terrace. These waters probably came from the Wisconsin ice-sheet. The skull is now in the Carnegie Museum at Pittsburgh.

The interesting geology of this region is described on page 355.

MISSISSIPPI.

(Map 25.)

1. *Natchez.*—The first notice of the occurrence of any species of the Ovibovinæ at Natchez seems to be the inclusion of *Symbos* (*Boötherium*) *cavifrons* in Leidy's list of fossil Mammalia found in the State of Mississippi (Wailles's Rep. Agric. Geol. Mississippi, 1854, p. 269), but the locality is not mentioned. The occurrence of the species in the State was not mentioned by Leidy in 1853 in his "Memoir on Extinct Species of Fossil Ox" (Smithson. Contrib. Knowl., vol. v, art. 3). Leidy's list mentioned above was quoted by Hilgard in 1860 (Agric. Geol. Mississippi, p. 196). In neither place was any statement made regarding the part preserved. In his "Memoir on the Extinct Sloth Tribe of North America," published in 1855 (Smithson. Contrib. Knowl., vol. VII, art. 5, p. 6), Leidy stated that *Boötherium* had been found at Natchez. Five years later (Proc. Acad. Nat. Sci. Phila., 1870, p. 73) Leidy reported that an isolated tooth, a last lower molar not yet protruded from the jaw, had been received from Natchez and was preserved in the museum of the Philadelphia Academy. On comparison with a last molar in a jaw of a supposed *Ovibos cavifrons* received at the Smithsonian Institution and found near Woodbine, Iowa, Leidy concluded that the Natchez tooth belonged to the same species.

Probably he had already based on this tooth the announcement of the presence of this species at Natchez. At least, the writer knows of no other parts of *Symbos cavifrons* found at Natchez, and he has seen neither the tooth from Natchez nor the jaw from Woodbine, Iowa.

Leidy stated that the tooth in question had a height of 2.25 inches, a length antero-posteriorly of 2 inches.

KENTUCKY.

(Map 25.)

1. *Bigbone Lick, Boone County.*—In his account of Bigbone Lick and the collections made there (Monthly Amer. Jour. Geol., vol. I, pp. 158–174, 205–217), William Cooper included in his list of species both *Bos bombifrons* (*Boötherium bombifrons*) and *Bos pallasii* (*Symbos cavifrons*). Already in 1818 Wistar (Trans. Amer. Philos. Soc., ser. 2, vol. I, p. 379, plate XI, figs. 10, 11) had described, without systematic name, the skull which later was made the type of *Bos bombifrons* by Harlan (Fauna Amer., p. 271). This skull was a part of the collection made at Bigbone Lick by Governor William Clark for President Thomas Jefferson. In the account presented by Cooper (p. 173) he stated that in the Finnell (sometimes spelled Phinnell) collection, made in 1830, he had found a second head of the species, but what became of it is not known. Harlan, as cited (p. 272), stated that in the collection of fossils made at Bigbone Lick by Major Long were teeth which probably belonged to the musk-ox. They differed little from those of the bison, but were thicker at the crown, more deeply grooved at the sides, and altogether more robust. In 1870 (Proc. Acad. Nat. Sci. Phila., p. 97), Dr. Leidy mentioned that in the Museum of Comparative Zoology, in Cambridge, he had seen a skull of *Symbos cavifrons* which Professor Shaler had collected at Bigbone Lick. The present writer has seen this skull. A list of the species found at this locality is recorded on page 403.

2. *Bluelick Springs?, Nicholas County.*—In the collection at Yale University is the hinder part of a skull of *Symbos cavifrons,* bought in 1876 from Henry Ward, Rochester, and labeled as found in the Bluelick region. The locality is not more definitely known.

3. *Winchester, Clark County.*—In the U. S. National Museum is a part of the rear of the skull of *Symbos cavifrons* labeled as found at Winchester. It is credited to J. W. Fitch. It shows well the condyles, some of the base of the skull, and the base of the right horn-core.

Besides the remains above described a part of a cranium of *Symbos cavifrons* from Kentucky is preserved in the Boston Society of Natural History. Leidy (Smithson. Contrib. Knowl., vol. v, art. 3, p. 16) stated that it had been found in the alluvium of Kentucky River.

FINDS OF EXTINCT BISONS IN THE PLEISTOCENE OF EASTERN NORTH AMERICA.

ONTARIO.

(Map 26.)

1. *Toronto, York County.*—Through the kindness of Professor B. A. Bensley, of the University of Toronto, the writer has had the opportunity to examine a malar bone of a bison found in the Don interglacial beds at Toronto. It is slightly waterworn and the edges are somewhat injured. The bone has been compared with the corresponding one of a large specimen of *Bison bison,* No. 22374 of the U. S. National Museum, and with a complete skull of *Bison alleni* from Alaska. The Toronto bone is about one-third larger than that of the *Bison bison* and about one-tenth larger than that of *B. alleni.* The projecting outer plate, immediately below the orbit, narrows little if any from behind forward, while in both the other species referred to it becomes much narrower toward the front. The bone quite certainly belonged to an extinct species, but without the horn-cores it is impossible to determine to which one.

In 1901 (Jour. Geol., vol. IX, p. 301), Coleman stated that a large atlas vertebra of a bison which he thought might belong to *B. americanus* had been found in interglacial beds in Toronto. It is more probable, however, that it belonged to one of the extinct species. It is uncertain whether the deposits belonged to the Don series or the Scarboro.

The geology of this region is treated on pages 281 to 283.

PENNSYLVANIA.

(Map 26.)

1. *Pittston, Luzerne County.*—In 1873 (Contrib. Ext. Fauna West. Terrs., p. 255, plate XXVIII, fig. 8), Leidy described and figured a tooth as that of *Bison latifrons.* This has been referred here to an undetermined species of *Symbos.* In a paper on the distribution of the American bison in Pennsylvania, Mr. S. N. Rhoads (Proc. Acad. Nat. Sci. Phila., 1895, p. 245) concluded that this tooth belonged to the existing bison. He stated also that the Academy had two other teeth, lower molars, from the same place, which Leidy had labeled as "*Bison americanus*" and regarded as more recent than the figured tooth. Rhoads thought the identification correct, but that they belonged to the same individual as did the tooth figured by Leidy. The writer has not seen these lower teeth and admits them here only provisionally. They were found along Susquehanna River, in association with remains of *Mammut americanum* and *Equus complicatus?* (*"E. major"*). If any of the bovine teeth belong to *Bison* the species belonged to early or middle Pleistocene and is now extinct.

2. *Port Kennedy, Montgomery County.*—The presence of *Bison* in the famous cave at this place was announced by Wheatley in 1871 (Amer. Jour. Sci., ser. 3, vol. I, p. 384). Cope, in his account of 1899 (Jour. Acad. Nat. Sci. Phila., vol. XI), does not mention the genus; but Mercer, on page 280 of the same volume, credits Wheatley with having found remains of three individuals of one undetermined species. He used the generic name *Bos.*

A description of the Port Kennedy Cave and its contents and remarks on the geological age of the fossils will be given on pages 311 to 320.

OHIO.

(Map 26.)

1. *Fincastle, Brown County.*—In 1887 (Jour. Cin. Soc. Nat. Hist., vol. x, p. 20), Horace P. Smith, curator of the society, described a fine pair of horn-cores of *Bison latifrons* found in Brown County and which had come into the possession of the society. They were discovered at a depth of 18 feet, in making excavations for the piers of a bridge across Brush Creek. Inasmuch as nearly the whole of the course of this stream is in Adams County, the locality must have been in the northeastern corner of Brown County, near Fincastle, where the creek has its source, and within the area of the Illinoian drift. Smith thought that the horn-cores were in the drift; but, if so, the overlying materials must have been washed down over them after their burial. It is improbable that they were ever beneath or in the glacier. The animal probably lived during the Sangamon interglacial stage; quite certainly before the Wisconsin.

2. *North Fairfield, Huron County.*—In the Norwalk Museum, at Norwalk, are some skull-bones of a bison found at some point not known to the writer, about 7 miles from North Fairfield, while search was being made for bones of the megalonyx which belongs partly to the museum at Norwalk, partly to the Niver family at North Fairfield. These bison bones served as the type of *Bison sylvestris*, described by the writer in 1915 (Proc. U. S. Nat. Museum, vol. XLVIII, p. 515, plate XXX). This is the only species of extinct bison known that lived after the close of the Wisconsin stage.

INDIANA.

(Map 26.)

1. *Evansville, Vanderburg County.*—Many years ago Dr. Leidy (Proc. Acad. Nat. Sci. Phila., 1854, pp. 199–200) described a collection of mammalian remains made on the banks of Ohio River at the mouth of Pigeon Creek, a short distance below Evansville. Among these materials was a fragment of a cervical vertebra of a species of *Bison*, which Leidy identified with doubt as *Bison americanus*, the existing bison, now known as *Bison bison*. It would be impossible to determine to which of our several species of the genus *Bison* this bone belonged; but it probably did not belong to *B. bison*. This species is not known from times preceding the Wisconsin drift and the bone-bed at Pigeon Creek is undoubtedly older. On page 32 is a discussion of the probable age of the bone-bed. It may be as old as the Aftonian stage, but more probably it belonged to the Sangamon.

The other species found at the locality named are *Megalonyx jeffersonii*, the Virginia deer, the extinct horse known as *Equus complicatus*, *Tapirus haysii*, and the extinct wolf *Ænocyon dirus*. At Bigbone Lick, midway between Louisville and Cincinnati, on the Kentucky side, have been found two extinct species of *Bison*, *B. antiquus* and *B. latifrons*. At the same place has been found *Equus complicatus*. The beds there overlie the Illinoian drift and belong, in part at least, to the Sangamon.

Under this number may be included mention of a bone of a species of *Bison* which Cope reported in 1878 (Amer. Naturalist, vol. XII, p. 189) from Vanderburg County. Cope stated that John Collett, then State geologist of Indiana, had discovered in a late Pleistocene deposit a number of fossils. One of these was the ulno-radius of a *Bos* (now to be referred to *Bison*); another was a part of the mandible of the deer *Odocoileus dolichopsis*. In 1884 (Geol. Surv. Indiana, vol XIV, p. 22), Cope and Workman, inaccurately quoting Cope's original description of the deer *Odocoileus dolichopsis*, state that this deer and the bison bones were found in Harrison County.

By consulting the Patoka Folio, No. 105, of the U. S. Geological Survey, it will be seen that the northern part of Vanderburg County, four townships, Nos. 4 and 5 south, ranges 10 and 11 west, are included. The two northern townships are largely occupied by lacustrine deposits which the geologists Fuller and Clapp regarded as having been laid down in lakes produced by the damming of the drainage by the Illinoian ice-sheet. Farther south, along the streams emptying into Pigeon Creek, are wide areas which are covered by "fine silts, mainly of pre-Wisconsin age, but including some of more recent age." Whether or not the bison bone and the jaw of *Odocoileus dolichopsis* were found in any of these deposits we are unfortunately left in the dark. It is most probable that the bison and the deer lived there after the Illinoian stage and before the Wisconsin.

2. *Vincennes, Knox County.*—In the geological collection of Earlham College, Richmond, Indiana, is preserved the greater part of the skull of a bison which belonged to the species known as *Bison antiquus*. This skull was first described and figured by Mr. W. G. Middleton and Professor Joseph Moore (Proc. Ind. Acad. Sci. for 1899, pp. 178–181, with a plate); afterwards by the writer (Geol. Surv. Indiana, vol. XXXVI, p. 651, figs. 50, 51).

This fine skull is said to have been found in 1896 by a Mr. Brower, a few miles from Vincennes, in a ditch, at a depth of 6 feet. Beyond this the writer has not been able to learn. It would be of value to know exactly where this place was, for then some conclusion might be reached as to the geological age of the animal. The greater part of the county is occupied by drift of Illinoian age, which appears in some places to have on it some loess, and doubtless its surface has been much modified since the materials were laid down. Even in this area there may be some deposits of later times, interglacial and glacial.

According to Leverett's glacial map of the region, there are along Wabash River sand and gravel terraces of Wisconsin age; while along White River there are said to be alluvial terraces older than Wisconsin.

At present one can arrive at a conclusion only from general knowledge. The writer knows of no extinct bison (except one rather peculiar species) which lived after the Wisconsin glacial stage. It appears most probable that the skull at Earlham College came from some interglacial deposits laid down about the middle of the Pleistocene, most likely during the Sangamon stage.

The writer has been informed that another skull of a buffalo was for years on exhibition in a business house conducted by Mr. T. L. Cheney, but it seems to have disappeared. Mr. J. Gimble, of Vincennes, informs the

writer that it was found in the bed of Wabash River, near St. Francisville, Illinois, about 10 miles below Vincennes.

ILLINOIS.

(Map 26.)

1. *Alton, Madison County.*—In the U. S. National Museum are four teeth of an undetermined species of *Bison* found somewhere in the vicinity of Alton. They are part of a collection made many years ago by Mr. William McAdams, and afterwards passed into the hands of Professor O. C. Marsh, then vertebrate palæontologist of the U. S. Geological Survey. It now belongs to the U. S. National Museum. Nearly all of these fossils were originally inclosed, wholly or partially, in nodules of fine sand, cemented together with carbonate of calcium. Where the teeth are exposed to view they are shown in a beautifully white condition; but the remaining matrix is so hard and adheres so strongly that it is practically impossible to remove it without greatly damaging the teeth. A list of the species found at Alton will be given on page 339; also a discussion of their geologic age.

The bison teeth consist of four upper molars and the hinder half or more of the left hindermost molar. They were described by the writer (Proc. U. S. Nat. Mus., vol. LVIII, p. 115). They are somewhat larger than any belonging to the existing buffalo measured. They are larger, too, than those of the commonest extinct species, *B. occidentalis*. It is impossible to say at present to which extinct species they belonged. One naturally thinks of *Bison latifrons*, the bearer of the immense horns, but teeth have not yet been found associated with the horn-cores of that species.

WISCONSIN.

(Map 26.)

1. *Coon Valley, Vernon County.*—In the U. S. National Museum is a well-fossilized tooth of a species of bison which was sent, in 1899, by Rev. P. Moe, of Coon Valley. This tooth has been regarded as belonging to *Bison bison*, but its fossilization seems to indicate that it antedates the time of this species. It was found in section 26, township 14 north, range 6 west. This would be between the towns of Coon Valley and Chaseburg. This locality lies within the "driftless area," and it would probably be difficult for the geologist, even on the ground, to determine the age of the deposit, especially as no details were furnished regarding the depth at which the tooth was found or the nature of the inclosing materials.

MARYLAND.

(Map 26.)

1. *Chesapeake Beach, Calvert County.*—Mr. William Palmer, of the U. S. National Museum, collected at this place, in 1912, a fragment of a lower last molar which apparently belonged to some species of *Bison*. A few other remains have later been secured.

VIRGINIA.

(Map 26.)

1. *Saltville, Smyth County.*—In the U. S. National Museum is an upper second molar of a species of *Bison*, found at Saltville. It was sent in 1904 by Mr. H. D. Mount, of Saltville, with remains of *Elephas primigenius* and

Mammut americanum. It is understood that all were found in excavating for the water reservoir of the town. The bison tooth is little worn, the height being still 46 mm. At the summit the crown is 34 mm. long, at the base 23 mm. long and 29 mm. wide. It resembles closely that of *Bison bison,* but is slightly larger than the same tooth in a large specimen of the existing species. The base of the skull is present, with the occipital condyles. The latter are slightly larger than in the specimen of *B. bison* just mentioned. The species can not be determined, but it probably was not *B. bison.* A list of the associated species found at this locality is presented on page 352.

2. *Ivanhoe, Wythe County.*—In 1869 (Proc. Amer. Philos. Soc., vol. XI, p. 176), Professor Cope stated that he had found molar teeth of a bison which he identified with doubt as *Bison antiquus.* The animal may quite as well have belonged to any one of four or five other extinct species.

SOUTH CAROLINA.

(Map 26.)

1. *Charleston, Charleston County.*—In 1860, Leidy (Holmes's Post-Pl. Foss. South Carolina, p. 110, plate XVII, figs. 15, 16) described briefly and figured a tooth of a bovine animal found in the Pleistocene of Ashley River. This he suspected belonged to *Bison latifrons,* but he added that it presented nothing to distinguish it from that of the existing bison. Numerous teeth resembling those of the domestic ox and the bison have been found on Ashley River and have been regarded as those of the domestic animal. (See letter of Agassiz to Professor F. S. Holmes in the Introduction to Holmes's work cited above.) While the teeth of our cattle may have been picked up along the shores of Ashley River, it is highly probable that the great majority of similar teeth belonged to some extinct species of *Bison.* Probably only the discovery of horn-cores will lead to the determination of the species. Leidy probably used the name *Bison latifrons* in a very wide sense. In the collection at Amherst College the writer has seen an upper molar of a bison, apparently the second molar, which is 38 mm. long on the outer face. This length is too great for *B. bison* and the tooth probably belongs to *B. latifrons.* It was probably found in the region about Charleston.

In the Charleston Museum the writer has seen an anterior cannon-bone of *Bison* which had quite certainly been found somewhere about Charleston. The following measurements were secured, and corresponding measurements of *B. bison* are added for comparison:

Measurements of anterior cannon-bones of bisons, in millimeters.

	Fossil bison.	B. bison.
Length along the outer border	242	206
Width of upper articular surface	90	...
Side-to-side diameter at middle of length	64	52
Fore-and-aft diameter at middle of length	39	33
Width of lower articular surface	96	91

Other measurements may be found in J. A. Allen's work, "The American Bisons," page 45. Apparently the bison which possessed the bone described above had a height about one-eighth greater than the large individual of the existing bison compared with it. Fossil remains found elsewhere show that at least one large species of *Bison* formerly inhabited this country. *B. latifrons* was a species with very large horns, and its body may also have been larger than that of the existing bison. To this species may have belonged the large cannon-bone described above.

GEORGIA.

(Map 26.)

1. *Brunswick, Glynn County.*—Remains of an undetermined species of *Bison* were found at the time of excavating the Brunswick Canal, south of Darien, in 1838–39. In a communication to the Academy of Natural Sciences (Proc. Acad. Nat. Sci. Phila., vol. I, pp. 216–217), Mr. J. Hamilton Couper gave an account of the geology of the locality and mentioned the fact that remains of *Megatherium, Elephas primigenius, Mastodon giganteus, Hippopotamus,* horse, *Bos,* and *Sus americana* had been secured. As was later determined by Owen (Proc. Acad. Nat. Sci. Phila., 1848, p. 93), the supposed hippopotamus incisor was a lower tusk of a mastodon. *Sus americana* was referred by Owen to his genus *Harlanus;* but was afterwards found to belong to *Bison.* Owen (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. I, p. 20, plate VI) described and furnished an excellent figure of the jaw. The jaw is now in the collection of the Academy of Sciences at Philadelphia. Measurements show that it is larger than the jaw of *Bison bison,* corresponding well with the other bones of *Bison* found at the same place. Leidy regarded it as belonging to *B. latifrons;* but he used this name in a very wide sense. In the Academy of Natural Sciences at Philadelphia is a part of the right ramus of the lower jaw labeled "*Bison latifrons,* Darien canal, Ga." The teeth are badly worn. The jaw itself is larger than that of *Bison bison.* The following measurements were taken:

Measurements of bison jaws, in millimeters.

	B. latifrons.	B. bison.
Height of jaw just behind third molar	91	83
Thickness of jaw just behind third molar	36	32.5
Height of jaw in front of third molar	63	52
Thickness of jaw in front of third molar	31	29

The jaw has the appearance of being much more massive than that of *B. bison.*

In his work on the "Extinct Species of American Ox" (Smiths. Contrib. Knowl., vol. v, p. 11), Leidy stated that Couper had presented to the Academy in Philadelphia a tibia and a part of a humerus of *Bison,* which bones he reported were larger than those of the existing American bison, and he referred them to the species *Bison latifrons.* The tibia was 456 mm.

long and 87 mm. wide at the lower end; in a large *Bison bison* in the U. S. National Museum the tibia is 412 mm. long and 78 mm. wide below.

Couper presented to the Boston Society of Natural History an atlas and a metatarsus from the same locality. The atlas had a width of 247 mm.; that of the existing bison just referred to is 220 mm. wide. The metatarsal is said to have been 272 mm. long; that of the living bison mentioned is 255 mm. A front cannon-bone at Harvard is 256 mm. long. In a collection determined by J. W. Gidley (Bull. No. 26, Geol. Surv. Georgia, p. 436) some bison remains, probably a tooth or teeth, were referred with doubt to *Bison bison.* It is far more probable that they belonged to an extinct species, and that *B. latifrons.*

2. *Skidaway Island, near Savannah, Chatham County.*—On page 29 of Joseph Habersham's Memorandum, forming a part of William B. Hodgson's "Memoir on the Megatherium," published in 1846, a portion of the humerus of a *Bos* is listed among the fossils found at Skidaway Island. This bone is to be assigned to an undetermined species of *Bison.* The width across the condyles is given as 4.5 inches, which is not greater than in *B. bison;* but it is not probable that it was this species. Lyell (Second Visit, etc., ed. 3, vol. I, p. 348) includes "a species of the ox-tribe" among the fossils found at this locality.

For further remarks on the species of vertebrates found at Brunswick, the reader may consult page 371, where also the geology of the locality is discussed.

FLORIDA.

(Map 26.)

1. *Wade, Alachua County.*—In the collection of the Florida Geological Survey is an upper left last molar of *Bison,* found in the Buttgenbach river mine, in Santa Fe River, 6 miles north from Wade. Although this tooth was found in a phosphate mine, it certainly belongs to Pleistocene time. The tooth is but little worn and is well fossilized. Its height is 45 mm., the length on the outer face 30 mm., the length at the middle of the width 27 mm., the width at the base of the first lobe 24 mm.

There is another tooth in the collection, apparently the second upper molar of the left side, from the same place and fossilized in the same way. For a list of the species found at this locality and the writer's view regarding their geological age, the reader is referred to page 376.

2. *Pablo Beach, Duval County.*—In the collection just mentioned there are, from near Pablo Beach, three bones which apparently belonged to some extinct species of *Bison.* No. 4444 is the left fibular bone; No. 4443 the left third cuneiform of the hinder foot; and No. 4442, a first phalange of a hinder foot. These were found along the Inland Waterway Canal, about 20 miles north of St. Augustine. The locality appears to be about 5 miles south of Pablo Beach. At the same place have been found *Mammut americanum, Elephas columbi,* and remains of a species of *Odocoileus.*

3. *Ocala, Marion County.*—Sellards (op. cit., p. 103) reported remains of an undetermined species of *Bison* found in a fissure in limestone rock near Ocala.

4. *Dunnellon?, Marion County.*—Sellards (op. cit., p. 104) presented a list of Pleistocene vertebrates, found in or along Withlacoochee River, but the exact localities are not given. Among these is an undetermined species of *Bison*. Lucas (Proc. U. S. Nat. Mus., vol. xxi, 1898, p. 767) stated that there is in the U. S. National Museum an imperfect skull of *Bison latifrons*, obtained from Withlacoochee River. The writer has not seen this skull. On page 376 the other species found here are listed and their geological age discussed.

5. *Tampa, Manatee County.*—In the Jarman collection, now in Vanderbilt University, and made in the region about Tampa, is a right lower third molar of *Bison*. It is well fossilized, but structurally does not appear to differ from a tooth of the existing American bison. It belonged, however, quite certainly to an extinct species. In the American Museum of Natural History, New York, is a well-worn lower left last molar of a bison, dredged up in Alafia River. With it were a mastodon tooth, teeth of two or three extinct horses, and various extinct tortoises. The reader is referred to page 379.

6. *Palmetto, Manatee County.*—Mr. Ernest Leitzel, of Palmetto, sent from that place to the U. S. National Museum some teeth for determination. Teeth of the horses are described on page 379. With these was a part of a lower right molar, possibly the last molar, of *Bison*.

From Palma Sola, on the south side of Manatee River and about 10 miles below Palmetto, there has been sent to the U. S. National Museum, by Mr. Charles T. Earle, the distal end of a metacarpal bone. This has a width of 93 mm. It may have belonged to *Bison latifrons*. With it came teeth of *Equus complicatus, E. littoralis,* and *E. leidyi,* a part of an antler of a deer (*Odocoileus*), a part of a beak of a platanistid porpoise, and a tooth of *Elephas columbi*. Probably the porpoise and teeth of sharks came from Miocene deposits somewhere in the neighborhood.

7. *Grove City, Charlotte County.*—Leidy, in 1889 (Trans. Wagner Free Inst., vol. II, p. 12), stated that Mr. Joseph Willcox had found, on Rocky Creek, 30 miles north of Sarasota Bay, some remains of the great extinct *Bison latifrons*. Sellards (8th Rep., pp. 103, 112) learned that the locality was really Stump Pass, near Grove City. The horn-core was lost by accident, but Leidy speaks of it as being huge. With it was the proximal part of a radius whose upper end measured transversely 1.4 times that of an existing bison.

In a letter to the author, Mr. Willcox writes that, as nearly as he can recollect, the diameter of the horn-core was about 5 or 6 inches.

8. *Vero, St. Lucie County.*—Sellards (8th Rep., Florida Geol. Surv., p. 150) stated that an extinct bison is represented in the collection of the Florida Geological Survey by a number of teeth, the distal end of a humerus, and some foot-bones. They were supposed to have been derived from stratum No. 2.

When in Vero in 1916, the writer secured a much-worn upper left premolar 3 of *Bison* from the base of the muck layer No. 3. It is in some respects different from the corresponding tooth of the existing bison. For lists of the species found at Vero and for a discussion of the geological age the reader may consult pages 381 to 383.

9. *Arcadia, De Soto County.*—In the U. S. National Museum are some teeth of *Bison,* obtained at or near Arcadia, on Peace Creek. In general, these resemble closely the corresponding teeth of *B. bison.* Leidy (Trans. Wagner Free Inst., vol. II, p. 22) mentioned a tooth and a first phalanx of *Bison* from Peace Creek. These are probably in the collection of the Wagner Free Institute.

In the U. S. National Museum (No. 1989) is a hinder cannon-bone from Arcadia. It resembles the corresponding bone in *B. bison,* but doubtless belonged to a species now extinct. Lucas (Proc. U. S. Nat. Mus., vol. XXI, p. 767) referred the teeth and the metacarpal to *B. latifrons.*

In the same museum is a calcaneum labeled as collected on Peace Creek by J. F. Le Barron. The reader may consult page 381 for further information.

10. *Labelle, Lee County.*—Remains of *Bison* apparently have been found at Labelle, or near there. Leidy, in Dall's report (Bull. No. 84, U. S. Geol. Surv., p. 129, referred this to *B. latifrons.* The bison, *Elephas columbi, Equus fraternus,* and a mylodon were supposed to have been buried in Pliocene deposits, but this opinion appears to be erroneous. Sellards (8th Rep., p. 102) has shown that the elephant and probably the horse were in Pleistocene marls. As shown on page 384, the elephant is *Elephas imperator.*

11. *Palm Beach, Palm Beach County.*—In his eighth report, Sellards (p. 105) stated that a femur of an undetermined species of *Bison* was found near this place, in the Palm Beach Drainage Canal. In the collection of the Museum of Comparative Zoology, at Harvard University, are a front cannon-bone, lacking the epiphyses, and the proximal end of a humerus. The size of these indicate that they belong to *B. latifrons.* The glenoid cavity measures 80 mm. by 60 mm. The neck of the humerus is 100 mm. wide.

ALABAMA.

(Map 26.)

1. *Newbern, Hale County.*—In August 1914, there was received at the U. S. National Museum, from Mr. J. W. White, of Newbern, a lower right last molar of a species of bison reported found in a creek, and an incisor tooth of a horse, which appear to be fossilized. The bison tooth had just begun to wear. The fore-and-aft length of the crown is 37 mm. The locality is somewhat outside of the range of *Bison bison* as given by Allen on his map ("American Bisons, Living and Extinct"). The fossil may well belong to some extinct species and have lived in that region in middle Pleistocene times.

MISSISSIPPI.

(Map 26.)

1. *Natchez, Adams County.*—In Dr. M. W. Dickeson's account of a collection of bones and teeth made near Natchez (Proc. Acad. Nat. Sci. Phila., 1846, p. 106) he included remains of the genus *Bos.* To-day these would be referred to the genus *Bison.*

In 1854 (Smithson. Contrib. Knowl., vol. v, art. III, p. 9, plate II, figs. 2–7), Leidy described and figured bovine teeth from Natchez, which he referred to *Bison latifrons*. Two of these teeth had been found, as Leidy stated, by M. W. Dickeson, in association with remains of *Mastodon (Mammut)*, *Equus, Ursus, Cervus (Odocoileus)*, *Megalonyx,* and *Mylodon.* Three others had been presented by W. H. Huntington, who discovered them in association with remains of *Mammut americanum, Equus complicatus,* and *Felix atrox.* Three of the teeth were upper molars, the others, lower molars. Leidy gave the measurements of most of these. The following measurements are those of an upper second and an upper third molar:

Measurements of bovine teeth, in millimeters.

Tooth.	Height.	Length.	Width.
Second molar.....	67	37.5	27
Third molar.....	75	42.5	29

These teeth are considerably larger than those of *Bison bison* and *B. occidentalis* (Geol. Surv. Iowa, vol. XXIII, p. 320).

KENTUCKY.

(Map 26.)

1. *Woolper Creek?, Boone County.*—The type of *Bison latifrons* is usually regarded as having been found at Bigbone Lick, but Leidy (Jour. Acad. Nat. Sci. Phila., vol. VII, p. 372) stated it had been found a dozen miles or more north of Bigbone Lick, in the bed of a creek that enters into the Ohio River. It seems probable that this creek is the one named above.

2. *Bigbone Lick, Boone County.*—It was at this place that was found the horn-core and attached part of skull which forms the type of *Bison antiquus.* It was a part of the Jefferson collection and was described by Leidy (Proc. Acad. Nat. Sci., Phila., vol. VI, 1852, p. 117). Richard Lydekker (Cat. Foss. Mamm. Brit. Mus., pt. 2, p. 27) wrote that there is in that museum a fragment of a right mandible, probably belonging to *Bison latifrons.* However, the identification is hardly to be relied on. Shaler (Geol. Surv. Kentucky, n. s., vol. III, p. 197) reported the finding of bones of *Bison latifrons,* but it is doubtful in what sense he used this name; and he did not indicate how these bones differed from those of other bisons. He probably had in mind *B. antiquus.* Hence the presence of the species with the widely spread horns at Bigbone Lick is doubtful.

A list of the species of mammals collected at this place will be found on page 403.

FINDS OF BISON BISON IN THE PLEISTOCENE OF EASTERN NORTH AMERICA.

ONTARIO.

(Map 27.)

1. *North Bay, Nipissing County.*—In the U. S. National Museum is a horn-sheath, found at this place. It was sent by Dr. Charles E. Cook, of Lockport, New York, who himself saw it thrown out of a ditch, about 5 feet deep, which was being made from the shore of the lake. The horn was found at a distance of 600 feet from the lake and in front of the Hotel Queen's. It certainly belongs to the existing species, *Bison bison.* Whether the presence of the horn at that spot is due to the former existence of the American buffalo there or to its introduction by man it is impossible to say at present.

MASSACHUSETTS.

(Map 27.)

1. *Orleans, Cape Cod.*—In 1920 (Jour. Mamm., vol. I, pp. 161–164, figs. 1–3), Dr. G. M. Allen presented an account of the discovery of a maxilla containing the penultimate and the hindermost milk teeth of a calf of *Bison bison,* at Orleans, Cape Cod. This specimen had been collected about 20 years previously by Dr. A. W. Grabau and presented by him to the Boston Society of Natural History. The bone and teeth were found "wholly embedded in till about halfway up on a section of a glacial moraine, situated on Town Cove and about 70 or 80 feet high." With the specimen were associated many fragments of the shells of the mollusk *Venus.* Dr. Allen suggested that this bison calf had either come to its end while wandering on the moraine or had more likely lived and died during the preceding Peoria interglacial stage. It might be questioned whether bones which had been buried and thereby become softened would have endured the rough treatment of a glacial mill.

NEW YORK.

(Map 27.)

1. *Albany, Albany County.*—Dr. John M. Clarke, State geologist of New York, sent the writer some teeth of a species of *Bison,* probably *B. bison,* for which he gives the assurance that they were found somewhere in the vicinity of Albany, and in the "Albany clays." These clays are supposed to belong to the Champlain stage. While this is somewhat further east than the bison has extended within historical times, it is entirely reasonable to suppose that at some time in the not distant past its range went to the Hudson. Indeed, Dr. G. M. Allen has recently shown (Jour. Mamm., vol. I, pp. 161–164) that at some time during the late Pleistocene a bison lived in the region of Cape Cod. The specimens sent by Dr. Clarke must have occupied eastern New York late in the Wisconsin stage.

2. *Syracuse, Onondaga County.*—In 1890 (Amer. Naturalist, vol. XXIV, p. 953), Professor Lucien Underwood reported the discovery of a skull of a bison in Syracuse, while a sewer was being excavated. Underwood stated

that it was found at a depth of 10 feet, in a black muck. Professor E. D. Cope identified the skull as that of *Bison bison*. The present writer, in 1914, examined the skull at Syracuse University. He also talked with Mr. John Cunningham, who bought the skull from the finder, a laborer, paying him one dollar. Mr. Cunningham stated that he went to the spot and measured the depth from the surface, and found it to be 17 feet. Above the muck that inclosed the skull was what he regarded as clay. Dr. Burnett Smith has examined the deposits in a cellar dug within a few rods of the spot where the skull was found. The upper 7 or 8 feet was a mixture of shells and clay, and had been used to make a kind of cement. This discovery appears to make it certain that the bison lived in New York shortly after the Wisconsin ice had retired from the Finger Lake region.

3. *Jamestown, Chautauqua County.*—In the American Journal of Science, volume XXVII, 1835, page 166, is an account, by Knight, of the discovery, at Jamestown, of what were probably two teeth of a bison in a fragment of the jaw. These were encountered by John Hazeltine, in digging for a foundation of a building at the outlet of Chautauqua Lake, and at a depth of 10 feet. The soil was mostly gravel, but the jaw was said to have been lying in black muck. It was sent to Yale College, but was not recognized as belonging to *Bison*. Reasons were suggested why it did not belong to a young mastodon. The measurements given of the teeth agree well with the upper molars of an American buffalo. Joseph Leidy (Jour. Acad. Nat. Sci., Phila., vol. VII, 1869, p. 371) quoted Knight's account as indicating a buffalo. The discovery is interesting, taken in connection with the finding of the specimen at Syracuse.

NEW JERSEY.

(Map 27.)

1. *Trenton, Mercer County.*—Mr. Ernest Volk (Papers Peabody Mus., vol. v, 1911, p. 209, plate CXX) reported the discovery of a part of a femur of *Bison* (probably *B. bison*) in the "yellow drift," at Trenton, 2.5 feet from the surface. A first right upper molar, identified as that of *Bison*, was found in another sand-pit at a depth of 9 feet (op. cit., p. 136). This appears to have belonged in the Trenton gravel, but at that point the materials were apparently a mixture of sand and loam. The reader is referred to page 304, where the geology of this locality is described and a list of the species is given.

PENNSYLVANIA.

(Map 27.)

1. *Stroudsburg, Monroe County.*—In Crystal Hill (Hartman's) Cave, near Stroudsburg, was found a lower jaw containing the last molar, as noted by Leidy (Proc. Acad. Nat. Sci., Phila., 1880, p. 347; Ann. Rep. Geol. Surv. Pennsylvania for 1887, p. 5). Mercer (Proc. Acad. Nat. Sci. Phila., 1894, p. 98), mentions a tooth of the existing bison found in Hartman's Cave.

2. *Riegelsville, Bucks County.*—From a cave near Riegelsville, was sent to the Academy of Natural Sciences of Philadelphia, more than 70 years ago, a collection of bones, reported on by Leidy in 1880 (Proc. Acad. Nat. Sci., Phila., 1880, p. 349) and in 1889 (Ann. Rep. Geol. Surv., Pennsylvania,

1887, pp. 18–19). In the contribution of 1880, Leidy included *Bison* among the animals represented, but this is not included in the list of 1887. Why this was omitted is not known. If *Bison* occurred there, the probability is that it was represented by the existing buffalo.

INDIANA.

(Map 27.)

1. *Jasper County.*—The only record known to the writer of the finding of buffalo bones worthy to be regarded as fossil is that of the former State geologist, John Collett (Geol. Surv. Indiana, vol. XII, p. 73), who makes the statement that in Jasper County bones of the buffalo, the beaver, and the bear are common.

ILLINOIS.

(Map 27.)

1. *Sullivan, Moultrie County.*—In 1875 (Geol. Surv. Illinois, vol. VI, p. 186), the geologist George C. Broadhead reported that he had found the skull of a bison on the west bank of Kaskaskia River, about 3 miles southeast of Sullivan, on the land of John Purvis. The locality appears, therefore, to have been somewhere near the south half of the eastern line of township 13 north, range 5 east. The summit of the bluff here is described as rising about 25 feet above the stream. At the height of about 8 feet was a bench approximately 10 feet wide, and the skull was found on this bench, "a few feet from the top." The surrounding clay was described as being a rich black loam.

Broadhead stated that the skull measured 12 inches across the forehead above the eyes and the same between the roots of the horns. The latter were short, thick, and slightly curved. In the Transactions of the St. Louis Academy of Science, volume III, page XXIII, practically the same account is given of the discovery. Here Broadhead expressed the idea that the skull belonged to *Bison latifrons,* and said that the horns were short, thick, and curved upwards and forwards. It is not known where the skull now is. To the writer it appears most probable that the skull was that of *Bison bison.* There is nothing in the description to indicate any of the other known species. As to the age of the deposits, the presumption is reasonable that they belong to the Late Wisconsin or Recent, for the locality is north of the Shelbyville moraine. It is possible that the bench belongs to the Illinoian; but the nature of the material, "a rich black loam," seems to show that the bench is an alluvial deposit laid down since Wisconsin times.

2. *Homer, Champaign County.*—In the collection at the State University of Illinois, at Champaign, are the horn-cores and the rear of the skull of *Bison bison,* reported to have been thrown out of a ditch near Homer. The writer is informed by Professor R. M. Bagg, of Appleton, Wisconsin, that the specimen was found in excavating a ditch, at a depth of 4 feet, according to the report made to him. Homer is situated on a part of the Champaign moraine and the bison in question must be not older than Late Wisconsin. If it was really found at a depth of 4 feet it would seem to date well back in the Recent, if not into the Pleistocene.

3. *Niantic, Macon County.*—Professor A. H. Worthen reported (Geol. Surv. Illinois, vol. v, p. 308) the presence of bones of the buffalo in an old filled-up marsh near Niantic. The situation is more particularly described on page 102. With the bison bones were found those of the mastodon, the elk, and the Virginia deer. The bones of these animals are said to have been found under 4 feet of black muck, partly embedded in a light-gray quick-sand filled with shells of *Planorbis, Cyclas,* and *Physa.*

Inasmuch as Niantic is situated near the border of the Shelbyville moraine, all these remains probably belong to Late Wisconsin times. It would be useful to know whether the bones of the buffalo, the elk, and the deer were found above those of the mastodons or mingled with them.

4. *East of Whitewillow, Kendall County.*—In township 35 north, range 8 east, probably in section 27, on land owned by John Bamford, in clearing out a well in a bog, have been found the bones of mastodons and other species of vertebrates. For a description of the locality and the species found there see page 337. Mr. George Langford, of Joliet, has reported the occurrence of bones of the existing bison there and has sent to the writer a maxilla which contained finely preserved teeth.

Unfortunately, no thorough and systematic examination of the place has yet been made. All of the species and the deposit belong to the Late Wisconsin, that part of it following the withdrawal of the ice. Mr. George Langford informed the author that he found the bison and deer bones mixed up more or less with the mastodon bones. At a depth of about 4 to 5 feet the owner of the place began to strike bones of the bison, which appeared very fresh, retaining considerable animal matter. From about 6 feet down to gravel, about 13 feet, mastodon and other bones were literally packed together.

5. *Batavia, Kane County.*—Dr. E. S. Riggs, of the Department of Palæontology, Field Museum of Natural History, wrote to the author that he had picked up some bison bones along a ditch in which mastodon bones had been found; but the depth at which they had been met with could not be determined. At the same time bones of the elk were found. Undoubtedly the mastodon remains belong to Late Wisconsin times; and it is probable that the bison and elk remains are to be referred to the same.

6. *Galena, Jo Daviess County.*—In the collection of the Academy of Natural Science of Philadelphia is a lower hindermost molar collected in a lead crevice somewhere near Galena. It was presented to the Academy by Mr. Henry Green, of Elizabeth, a town near Galena. This, with a metacarpal bone of *Megalonyx jeffersonii,* had been found at a depth of 130 feet from the surface. It was described and figured by Leidy (Contributions to Extinct Vert. Fauna, etc., 1873, p. 255, plate xxxvii, fig. 4). Leidy thought that it might have belonged to *Bison bison,* but not improbably to *B. latifrons.* J. A. Allen (The American Bisons, etc., p. 13) concluded that it belonged undoubtedly to the existing American species. The structure of the tooth will apparently not decide this matter. It is probable that most of the animals found in those lead crevices belong to pre-Wisconsin times; and the tooth in question may belong to an extinct species. A list of the species found in the lead region of Illinois, Iowa, and Wisconsin is to be found on page 343.

7. *Mitchell, Madison County.*—In "Records of Ancient Races in the Mississippi Valley" (1887), William McAdams, of Alton, Illinois, stated that in a large mound, square in shape, 300 feet on each side and 30 feet high, through which the railroads pass in the American bottom, at Mitchell, had been found, in contact with a number of copper implements and ornaments, a number of teeth of the buffalo. These McAdams had in his possession. While these teeth can not be regarded at all as belonging to Pleistocene times, the fact is of interest in connection with McAdams's statement that in all his explorations during a period of more than 30 years, in no other case had he been able to find any evidences of the buffalo associated with the remains of the ancient people of this country. In this connection may be considered Shaler's views on the modern coming of the buffalo east of the Mississippi River. On the other hand, account must be taken of the finding of a skull of a buffalo deep in lake deposits at Syracuse, New York.

WISCONSIN.

(Map 27.)

1. *Bluemounds, Dane County.*—In his report, made in 1862, on the geology of the lead region of Wisconsin (Geol. Surv. Wisconsin, vol. I, p. 136), J. D. Whitney recorded the finding of bison bones in a crevice at Bluemounds. From the same crevice were obtained bones and teeth of the mastodon and of a peccary, and bones of a wolf. It was supposed that these remains were found at a depth of about 40 feet and embedded in the red clay commonly found in such crevices. These bones were put into the hands of Jeffries Wyman for identification, who, on page 421, stated that the bison bones were all of the size of the same parts of the existing buffalo and closely resembled them. J. A. Allen (Amer. Jour. Sci., vol. XI, 1876, p. 47), in referring probably to the same bones, speaks of "an extinct bison," without, however, giving any reasons for his conclusion. It is nevertheless possible that he was correct.

The writer formerly believed that the fossil vertebrates, collected in the fissures in the lead region, had lived after the close of the Wisconsin glacial stage. It seems now more probable that they belong to a pre-Wisconsin time.

2. *Oshkosh, Winnebago County.*—The writer has received from Dr. S. Weidman, State geologist of Wisconsin, a humerus, found in a marsh near Oshkosh, quite evidently that of *Bison bison.* Although stained by iron on the outside, the remainder of the bone is white and full of animal matter. The animal may have lived during the Recent period.

KENTUCKY.

(Map 27.)

1. *Bigbone Lick, Boone County.*—Great numbers of individuals of *Bison bison* have been found at Bigbone Lick. Cooper (Monthly Amer. Jour. Geol., vol. I, pp. 207, 211) reported numerous bones of buffaloes and even an entire skeleton, but they appear to have been near the surface or even on it. Lyell ("Travels in North America," Murray's ed., vol. II, p. 65) stated that

he had seen great quantities of remains of the bison in a superficial stratum in the river bank; but he was left in doubt whether or not the animals had been contemporaneous with the mastodon. Shaler (Geol. Surv. Kentucky, n. s., vol. III, p. 197) found abundant remains of the buffalo at this place; but the bones were not found at any great depth, except in the bog about the spring. He regarded it as proven that the musk-ox and the caribou did not come into contact with the recent buffalo, but were extinct before it came. Some of the bison materials collected by Shaler were described by Dr. J. A. Allen, in 1876 (Mem. Mus. Comp. Zool., vol. IV; Mem. Geol. Surv. Kentucky, vol. I, pt. 2). It may be difficult to prove that any of the bison bones and teeth found here are of Pleistocene age; but there appears to be no good reason why this species might not have reached that region at the close of the Wisconsin ice stage. A list of the species of mammals found here is given on page 403.

2. *Bluelick Springs, Nicholas County.*—In the mass of materials collected in the spring at Bluelick Springs by Mr. Thomas W. Hunter, were skulls and parts thereof, teeth, limb-bones, and vertebræ. The actual geological age of these remains can not be established; but they were of probably late Wisconsin age.

FINDS OF CASTOROIDES IN PLEISTOCENE OF EASTERN NORTH AMERICA.

NEW YORK.

(Map 28.)

1. *Clyde, Wayne County.*—A skull of the giant beaver was found, about the year 1846, near Clyde, on the farm of Gen. W. H. Adams. The locality and the geological conditions were described by James Hall (Proc. Boston Soc. Nat. Hist., vol. II, 1846, p. 167; Boston Jour. Nat. Hist., vol. v, p. 385). The region is on the divide between the streams flowing north into Lake Erie and those flowing southward into Clyde River. The actual spot was at the head of a shallow stream which flows into Lake Ontario. At this point the Sodus Canal was cut and ran in a north-and-south direction. The farm was only partly swampy. Hall's section is as follows from above downward:

1. Vegetable soil, 2 feet or more.
2. Fine sand, with some alternating layers of clay, containing twigs, leaves, etc., 2 to 3 feet.
3. Muck, or peaty soil, with decayed wood, bark, leaves, and even trunks of large trees, about 4 feet.
4. Fine sand, with fresh-water shells, 2 to 3 feet.
5. Drift, with boulders; depth unknown.

The skull was found at the bottom of No. 3, at a depth of 8 feet. It is evident that this animal lived here near, or after, the close of the Wisconsin stage, and after the old Lake Iroquois had withdrawn from the region.

2. *Canastota, Madison County.*—In 1914, Dr. Burnett Smith, of Syracuse University, reported (Amer. Jour. Sci., vol. XXXVIII, p. 463) the discovery, at this place, of an incisor tooth of the giant beaver. The exact locality is given as about 225 paces northwest from the southeast line of lot 10, town of Lenox, on Cowaselon Creek, otherwise known as the "State ditch." The tooth was found at a depth of 9 feet, in a sticky blue clay, containing a few fresh-water shells. Just above this, at a depth of 7 feet, is a layer made up principally of shells, with some vegetable matter. This animal could not have lived here until after the withdrawal of Lake Iroquois, and therefore not till near the close of the Wisconsin stage.

PENNSYLVANIA.

(Map 28.)

1. *Stroudsburg, Monroe County.*—In 1889, Dr. Joseph Leidy reported (Ann. Rep. Geol. Surv. Pennsylvania, 1887, p. 14, plate II, figs. 7–20) the discovery of teeth of *Castoroides ohioensis* in Hartman's (or Crystal Hill) Cave, about 3 miles southwest of Stroudsburg and 5 miles from Delaware Water Gap. Its elevation is about 800 feet above the level of Delaware River. The species associated with this giant beaver will be listed on page 309. The parts figured by Leidy are a portion of a palate, with the molars and some of the premolars, and both rami of the lower jaw, showing the

three temporary molars and the first true molars, with some incisors and the permanent canines.

OHIO.

(Maps 28, 29, 36.)

1. *Nashport, Muskingum County.*—In 1836 (Amer. Jour. Sci., ser. 3, vol. XXXI, pp. 79–83), S. P. Hildreth, in an unsigned article, gave an account of the finding of remains of the type specimen of the giant beaver, in association with remains of mastodon and of a supposed fossil sheep, at a point 2 miles north of Nashport. A canal, now abandoned, was being constructed, which followed two small streams, one of which flowed into Licking River, the other into Wakitomika Creek. The land traversed was flat and swampy. The distance from Nashport to Wakitomika Creek is nearly 4 miles, so that in saying that the spot was on this creek Hildreth spoke in general terms. The bones of the mastodon and the right halves of the lower jaws of two giant beavers were found resting on a bed of gravel at a depth of 14 feet. Foster (2d Ann. Rep. Geol. Surv. Ohio, 1838, p. 80) stated that a molar and a tusk of an elephant had also been found here. Hildreth concluded that the jaws and teeth were perhaps those of an animal of the beaver family; "or, from the grooved outer surfaces of the incisors, a marine animal of the walrus or seal race, and a borderer of the ancient ocean." It was afterwards described by J. W. Foster (2d Ann. Rep. Geol. Surv. Ohio, 1837, p. 80, figs.) under the name of *Castoroides ohioensis*. The remains described consisted of the front end of one side of a lower jaw with its incisor, an upper incisor, and a radius. They showed signs of some attrition; but in a region like that they could not have been transported any considerable distance.

In the mud in which the canal at this point was cut, there were found three skulls of a species of sheep, which Hildreth thought were different from those of the domestic sheep and to which he gave the name of *Ovis mamillaris*. They are said to have been discovered at a depth of 8 feet. It seems quite possible that they had been lying on or near the surface and had made their way to the side of the canal by the flow of the mud, which gave much trouble by filling up the canal during the night. Most, if not all, of the differences thought to separate these skulls from the domestic sheep disappear on comparison. The specimens of both *Castoroides* and of the sheep have probably been lost. They appear not to be at Zanesville. On page 82 of the article above cited, Hildreth stated that he had received, from some point on Wills Creek, a portion of a tooth similar to the one found at Nashport; the place was said to be about 40 miles east, apparently, of Zanesville. This would seem to be in Noble County. The tooth was described as being embedded in dark-colored carbonate of lime and as having fallen from a calcareous rock which lies near the tops of the hills, 150 feet above the bed of the creek. It is very probable that this was not a tooth of *Castoroides*. It may have been the spine of a palæozoic shark.

2. *Wilmington, Clinton County.*—From Professor W. C. Mills, of the Ohio State University, the writer in 1913 obtained information that a fine skull of *Castoroides*, without the lower jaw, had been found on the farm

of Mr. J. M. Richardson, on the western border of Wilmington. Nothing more has been learned about the discovery. The locality is north of the Hartwell moraine, and the animal must have lived there after the withdrawal of the ice-sheet from that region.

3. *Germantown, Montgomery County.*—One mile east of Germantown, Edward Orton, State geologist of Ohio, found along Twin Creek a large tooth which (Amer. Jour. Sci., ser. 2, vol. L, 1870, p. 54) he compared with the tusk of a hog. It was later identified by J. S. Newberry (Proc. Lyc. Nat. Hist. New York, vol. I, 1870, p. 83) as belonging to *Castoroides*. It was found in a bed of peat which is overlain by from 50 to 100 feet of glacial drift. One might conclude that the animal had lived there at some time between the Illinoian and Wisconsin stages. However, opinions have differed.

The geology along Twin Creek has been studied by Orton, Wright, and Leverett. The last named published his views in 1902 (Monogr. U. S. Geol. Surv., XLI, pp. 363–365, plate XIV, fig. 1). He states (p. 365) that there seem to be good reasons for believing that the peat-bed indicates the lapse of a considerable interval of deglaciation. Whether the interval preceded or followed the formation of the early Wisconsin moraine is yet to be determined. That seems to mean that the interval may be mid-Wisconsin or pre-Wisconsin. Wright thought that but a few hundred years had elapsed between the deposit of the till below the peat and that above. Orton's description of the locality was published in 1870 (Amer. Jour. Sci., ser. 2, vol. L, p. 54).

4. *West Sonora, Preble County.*—In 1893 (Amer. Geologist, vol. XII, p. 73), Professor Joseph Moore reported that a fragment of an upper incisor of *Castoroides* had been found at West Sonora. It was associated with remains of a mastodon. West Sonora is on the Englewood moraine.

5. *Greenville, Darke County.*—In 1883 (Jour. Cin. Soc. Nat. Hist., vol. VI, p. 238), F. W. Langdon described a tooth of *Castoroides*, found at a depth of 4 feet, in a swampy locality near Greenville. In 1893 (Amer. Geol., vol. XII, p. 73), Joseph Moore stated that this tooth belonged to Dr. J. W. Jay, of Richmond. It may now possibly be in the collection of Earlham College. Moore said that it had been found associated with mastodon.

In the public library at Greenville is a fragment of an upper incisor of *Castoroides*, found in making a ditch along Bridge Creek, in 1889, by Mr. Leo Katzenberger, who writes that the place is in the northwest corner of section 1, township 11, range 2 west, 1.5 miles southwest of Greenville. These animals likewise lived on or near the Sidney moraine.

6 *New Knoxville, Auglaize County.*—In C. W. Williamson's "History of Ohio and Auglaize County," 1905, on page 338, with a figure, is an account of the finding of a skull of *Castoroides ohioensis* in section 29 of Washington Township, which is in township 6 south, range 5 east, and near New Knoxville. The discovery had been made that beneath a bed of humus there was a stratum of gravel of a quality for road making. In removing the upper peaty layer, the head of the giant beaver was discovered, near the south margin of the pond. Williamson stated that the house of the animal was uncovered. It was between 3 and 4 feet high and about 8 feet square;

the poles of which it was constructed were about 3 inches in diameter and were laid after the manner of the houses of modern beavers. Apparently the beaver died in the house, and it was thought that after the death of the beaver wolves or other carnivorous animals had inhabited the house, since bones of deer and other animals were strewn over the floor. It is to be regretted that the house, if such it was, was not taken up in a way that it might have been accurately reconstructed. Williamson's account is reproduced in Bulletin 16, Geological Survey of Ohio, 4th series, 1912, page 39.

In Heidelberg University, Tiffin, Ohio, the writer has seen a very large skull of *Castoroides*, labeled as found at Wapakoneta, but it is quite certainly the one found at New Knoxville. Both incisors are broken off close to their insertion in the skull. Williamson's figure represents at least the left one present.

MICHIGAN.

(Map 28.)

1. *Berrien County.*—In the American Museum of Natural History, New York, is a nearly complete skull with the left ramus of the lower jaw, purchased from Mr. George A. Baker. The exact place in the county where it was found is unknown, and the writer has been unable to get into communication with Mr. Baker.

As to the time in the Pleistocene when this individual lived, we may be sure that it was after the Wisconsin glacial ice-sheet had abandoned this county. How long after this retirement it is impossible to say. It is to be noted that both mastodons and mammoths have been found in this county, in what appear to be deposits of the same age.

2. *Adrian, Lenawee County.*—In the U. S. National Museum is a skull of *Castoroides* (Cat. No. 197), of which the lower jaw is missing. This was received June 10, 1880, from Professor J. Kost, then of Adrian College, Michigan. In his letter Professor Kost wrote as follows:

"Found in freshwater marsh, 4 feet under, in Adrian, Lenawee Co., Michigan. In same place as the Decker mastodon, now in Adrian College; also of lower jaw of smaller mastodon (sent in this consignment), with various bones of elk, deer, etc."

The mastodon jaw referred to is in the U. S. National Museum (No. 188). The present writer has not been able to learn exactly where all these bones were obtained. It would be interesting to know whether all—mastodons, giant beaver, elk, and deer—were found in the same excavation. It is probable that they were at least in nearly the same spot. For remark on the age of the deposits at Adrian see page 81.

3. *Ann Arbor, Washtenaw County.*—In the collection of the Department of Geology in the University of Michigan is a skull which lacks the lower jaw and is otherwise slightly injured. A report of this specimen was made in 1914 by Mr. N. A. Wood (Science, n. s., vol. xxxix, p. 759). This was found several years ago in a peat-bog on the farm of Professor J. B. Steere, 3 miles south of Ann Arbor, at a depth said to have been about 3 feet. Beneath the peat and muck is a gravelly marl. According to the Ann

Arbor Folio (No. 155, U. S. Geol. Surv.), there is, running south from the city, a strip of low ground designated as occupied by peat and muck. This borders on the east a part of the Fort Wayne moraine, and must have provided an ideal spot for colonies of these great beavers. Naturally these specimens must be credited to the Late Wisconsin stage.

4. *Attica, Lapeer County.*—In the collection of Alma College, Alma, Michigan, is a fragment of an upper incisor, found at a depth of 7 feet, in digging the tail-race of a mill in Attica. The statement was made that at the same place there were often found what appeared to have been beaver dams made of wood. This wood crumbled on coming to the air. In cases like this there is a fine opportunity to determine whether or not the wood had been gnawed by the broad incisors of *Castoroides* or by the narrower ones of the existing beaver. The wood might easily be prevented from crumbling by replacing the water with a solution of gum arabic or even of glue.

Attica is situated some distance outside of the beaches of old Lake Maumee, and on low ground between morainic tracts left by the Saginaw lobe in its retreat. These gigantic beavers must, therefore, have lived near the close of the Pleistocene.

5. *Owosso, Shiawassee County.*—In the collection of the University of Michigan (No. 3109) is the greater part of a lower jaw of a giant beaver, found somewhere near Owosso, in a swamp deposit. An account of this specimen was given in 1914 by Mr. N. A. Wood (Science, n. s., vol. XXXIX, p. 758). It was received from Mr. A. G. Williams in 1892. According to Leverett and Taylor's glacial map of Michigan, Owosso lies a few miles outside of the beach of old Lake Saginaw. This is supposed to have come into existence about the close of the period of Lake Maumee. The earliest time when this beaver might have existed, leaving out the question of the climate, would coincide closely with the time when the one found at Attica might have lived. It is most probable that both lived at a time when the glacier front was farther away.

INDIANA.

(Maps 28, 30.)

1. *Vanderburg County.*—In 1884 (14th Ann. Rep. Geol. Surv. Indiana, pt. 2, p. 37), in a foot-note written probably by John Collett, State geologist, it is stated that remains of *Castoroides ohioensis* had been found in this county. Inasmuch as this county lies outside of the drift region, and as no details as to place and depth were given, we can arrive at no conclusion as to the stage of the Pleistocene in which the possessor of this tooth lived. The reader may consult page 258.

2. *Richmond, Wayne County.*—About 2 miles east of Richmond, where a farmer was scooping out wet earth for a fish-pond, there was found by Joseph Moore (Amer. Geologist, vol. XII, p. 73) a fragment of an upper incisor of this species. With it were sound and decayed teeth of the mastodon. Most probably this fish-pond was being excavated in low ground where a marsh had existed. Richmond is situated just south of the Bloomington moraine, on an area which is undulating and more or less

morainic. The animal must have lived at some time after the culmination of the Wisconsin stage.

3. *Greenfield, Hancock County.*—In 1893 (Amer. Geologist, vol. XII, p. 73), Joseph Moore mentioned the fact that some remains of *Castoroides* had been found near Greenfield and that these were in the possession of Dr. M. M. Adams. In 1900 (Proc. Ind. Acad. Sci. for 1899, p. 171, plates I, II), Moore presented figures of the skull and made some brief statements regarding it. At that time the skull had come into the possession of Earlham College. If restored this skull would have had a length of 13 inches. Nothing is known as to the exact place where it was found, but it can not be doubted that the animal lived after the Wisconsin ice had retreated further north.

4. *Jamestown, Boone County.*—In the State Museum at Indianapolis is a lower jaw of a giant beaver which has all of the molars, but whose incisors are broken off at the border of the bone. This specimen was presented by Mr. A. E. Deatley, of Lizton, Hendricks County, who found it in earth thrown out by a dredging machine, but the exact locality was not stated. Jamestown is situated on Eel River where it crosses the Champaign moraine. The geological age of the animal is therefore Late Wisconsin.

5. *Summitville, Madison County.*—In the State Museum at Indianapolis is an upper right incisor of the giant beaver in its premaxilla, labeled as presented by Mr. J. F. Cartwright. Nothing more is known of the history of the specimen.

Summitville is surrounded by plains of Wisconsin drift. It is about 12 miles from the place where was found the fine mounted specimen of *Elephas primigenius* now in the American Museum of Natural History, New York.

6. *Union City, Randolph County.*—Here was found the nearly complete skeleton of *Castoroides ohioensis* at Earlham College, Richmond, Indiana. This was secured by Professor Joseph Moore, who described and figured it. It was discovered on the farm of John M. Turner, about 8 miles nearly east of Winchester. Mr. Turner has informed the writer that the farm is a part of section 15, township 17, range 1.

The bones occurred in a layer of fine-grained marly silt from 2 to 3 feet thick, overlain by from 3 to 4 feet of dark loose mold abounding in fragments of shrubby stems and vines in various stages of decay. Under the silt containing the bones were coarser and finer drift gravels which formed the bottom of the ditch. In the silts were found fresh-water gasteropods and bivalve shells. Along the same ditch, within a distance of 30 rods, other fragments were found which were supposed to indicate 9 individuals of *Castoroides*. As this region is covered by Wisconsin drift, the animal evidently lived after the Wisconsin ice-sheet had retired from the Union City moraine, possibly a long time thereafter.

7. *Fairmount, Grant County.*—Near Fairmount were found some limb-bones and other parts (but no skull) of the giant beaver. These were obtained not far from where the large specimen of *Elephas primigenius* was discovered which is mounted in the American Museum of Natural History in New York. The remains of this castoroides are in the Field Museum of Natural History. No details regarding the find have been published. It

was stated that near the bones were parts of trees, as though a dam had been built there; but this interesting matter appears not to have been investigated.

The elephant mentioned above was found on the farm of Dora C. Hitt, in the southeast quarter of section 23, township 23 north, range 8 east.

8. *Carroll County.*—In 1884 14th Ann. Rep. Geol. Surv. Indiana, pt. 2, p. 37) the State geologist, John Collett, wrote that *Castoroides* had been found in this county; but nothing was added to this statement. On the map the number is placed arbitrarily.

9. *Logansport, Cass County.*—In the U. S. National Museum is a fine skull of *Castoroides,* without lower jaw, which, according to the newspaper report accompanying it (dated January 30, 1894), was found 2 or 3 miles north of Logansport, by Mr. S. L. McFadin, who sold it to the National Museum. It lay at a depth of 7 feet on a fine sand, above which was a foot of solid gravel, then 3 feet of solid clay, and at the top 3 feet of alluvium. According to Leverett and Taylor's map of the region (Monogr. U. S. Geol. Surv., vol. LIII, plate VI), this place would be on the moraine which lies north of the Wabash River, the meeting-place of the ice-lobes coming from Lake Michigan, Lake Erie, and Saginaw Bay.

10. *Macy, Miami County.*—From Mr. C. F. Fite, Denver, Indiana, the writer received a photograph of a tooth of *Castoroides,* apparently the lower right incisor. This was found in Allen Township. Mr. Fite gives as the exact locality section 23, township 29, range 3 east. This would be not far from Macy. It lies, therefore, on or near the northern border of the great moraine which extends from Delphi, Indiana, to the northeastern corner of the State.

11. *Kosciusko County.*—As in the case of Cass County, we depend for our knowledge of the discovery of *Castoroides* in Kosciusko County on the statement made by John Collett, in the place there cited.

12. *Grovertown, Starke County.*—From Dr. E. S. Riggs, of Field Museum of Natural History, the information has been received that there is at that museum a fine skull, with the right half of the mandible, of a giant beaver which was found 1.5 miles west of Grovertown, in making an excavation for the abutment of a bridge, 6 feet below the surface in township 34 north, range 1 west. This is within the region of the Pleistocene Lake Kankakee.

ILLINOIS.

(Maps 28, 38.)

1. *Shawneetown, Gallatin County.*—In the collection of the Academy of Natural Science of Philadelphia are a part of one incisor, two molars, and two petrous bones which were many years ago obtained by a Dr. Feuchtwanger, from a well at a depth of 40 feet. These were mentioned by Le Conte in 1852 (Proc. Acad. Phila., vol. VI, p. 53). Leidy has figured the incisor (Holmes's "Post-Pliocene Fossils of South Carolina," 1860, plate XXII, fig. 5; Ann. Rep. Geol. Surv. Pennsylvania, 1887, plate II, fig. 10). Leverett (Monogr. U. S. Geol. Surv., vol. XXXVIII, p. 65) states that at Shawneetown a boring for gas and oil penetrated 112 feet of alluvial and other deposits before reaching rock. His map (plate VI) indicates that

here the valley of the Ohio is composed of sand and gravel plains of Wisconsin age. Under the conditions it seems impossible to form any certain conclusions regarding the geological age of this specimen. It belongs possibly to the later half of the Pleistocene.

2. *Alton, Madison County.*—In the McAdams collection, described on page 338, is a part of a large upper incisor, in two pieces, of a specimen of *Castoroides,* with McAdams's Nos. 209, 210, and a small fragment of another incisor. All three specimens are more or less enveloped in nodules of hard materials. In 1883 (Trans. St. Louis Acad. Sci., vol. IV, p. LXXX) McAdams stated that he had seen, both in true and modified drift, remains of rodents large and small, but one, an extinct beaver, was of monstrous size.

For conclusions as to the age of the fauna secured by McAdams see page 339.

3. *Charleston, Coles County.*—In 1867 (Proc. Acad. Nat. Sci. Phila., p. 97), Leidy briefly described a skull of *Castoroides,* sent to him for examination by Professor A. H. Worthen. It lacked both zygomatic arches and the incisor teeth. The length of the skull was 10.5 inches. This skull had been found by someone while he was plowing in a field near Charleston. The region about Charleston is covered by the Shelbyville lobe of the early Wisconsin drift. The animal must have lived at some time after the deposition of that drift.

4. *Naperville, Dupage County.*—H. M. Bannister (Geol. Surv. Illinois, vol. IV, p. 113) reported a skull and other parts of the skeleton of *Castoroides,* found by a farmer in a slough not far from Naperville. The skull went to Colonel Wood's Museum in Chicago, and it was probably destroyed in the great fire of 1871. This animal quite certainly lived after the retirement of the Wisconsin ice-sheet.

SOUTH CAROLINA.

(Map 28.)

1. *Charleston, Charleston County.*—In 1860, Dr. Joseph Leidy (Holmes's Post-Pl. Foss. South Carolina, p. 114, plate XX, figs. 6–8) recorded the fact that fragments of the teeth of the giant beaver had been found in the Pleistocene deposit of Ashley River.

In the Pinckney collection is an upper cheek-tooth, the fourth premolar. The height of the tooth is 37 mm., the length is 16 mm., the width 11.5 mm. It was found in the vicinity of Charleston.

In the Scanlan collection, the property of Yale University, and made in the vicinity of Charleston, are five more or less injured teeth. One is a left upper molar, either the second or the third. The length of the grinding-surface is 12 mm., the width 13 mm. Two fragments of upper right incisors are interesting. One of these, 140 mm. long, bears the oblique excavated surface worn by the lower incisors. Each diameter of the tooth is 25 mm. The other fragment is 123 mm. long and comes from the middle of the tooth. The two diameters of this tooth are, as in the other one, 25 mm. Both of these teeth appear to be more strongly curved than the teeth of more northern specimens. Also, the striation on the outer face of the tooth is finer, finally becoming hair-like lines as the rear face is approached. More of

the larger ridges in the front of the tooth are directed obliquely and terminate along a front groove than in specimens hitherto observed. It is possible that an undescribed species is indicated. The two teeth present some differences between themselves. Another fragment, 103 mm. long, has a diamter of 20 mm. At the base is seen a part of the pulp-cavity.

GEORGIA.

(Map 28.)

1. *Brunswick, Glynn County.*—In a small collection of vertebrate fossils made during dredging operations at Brunswick not many years ago, and which now belongs to the Geological Survey of Georgia, Gidley found a fragment of an incisor tooth of *Castoroides ohioensis*. The accompanying species will be recorded on page 370. Gidley's list is found on page 436 of Bulletin No. 26 of the Geological Survey of Georgia.

MISSISSIPPI.

(Map 28.)

1. *Natchez, Adams County.*—James Hall, in 1846 (Proc. Bost. Soc. Nat. Hist., vol. II, p. 168; Jour. Bost. Soc. Nat. Hist., vol. v, p. 380), announced that remains of this animal had been found in the neighborhood of Natchez. The exact locality is unknown and likewise the conditions under which the specimens were discovered. This species is not included by Leidy in his list of fossil mammals found in Pleistocene deposits in Mississippi up to 1854 (Wailles, Agri. Geol. Mississippi, p. 196).

A list of the species found in the vicinity of Natchez is presented on page 392.

TENNESSEE.

(Map 28. Figure 23.)

1. *Memphis, Shelby County.*—In 1850, Dr. Jeffries Wyman reported (Proc. Bost. Soc. Nat. Hist., vol. III, p. 281) that a part of a lower jaw of *Castoroides* had been found at Memphis. With it were a toe-bone of *Megalonyx*, a tooth of a young mastodon, and a part of the lower jaw of a beaver. It was thought that these remains had been buried in the deposits laid down by Mississippi River. It is to be regretted that the locality and the height above the river were not more exactly specified. The specimen of *Castoroides*, a right ramus of the lower jaw, is now in the Academy of Natural Sciences of Philadelphia.

ON THE PLEISTOCENE GEOLOGY OF NORTH AMERICA AND ITS RELATION TO ITS FOSSIL VERTEBRATES.

ONTARIO.

For a knowledge of the Pleistocene of Canada, the student ought first to read Dr. J. W. Dawson's "Canadian Ice Age," published in 1894. In this will be found references to the earlier literature of the subject. For the results of more recent studies the reports of the Canadian Geological Survey are to be consulted, as well as papers published in the scientific journals. For the more important of these papers the reader may consult the list published by Dr. H. L. Fairchild in 1918 (Bull. Geol. Soc. Amer., vol. xxix, pp. 229).

To state the matter briefly, one may say that almost everywhere in Ontario are deposits of glacial drift of Wisconsin age. In a few localities have been discovered beds which belong to earlier glacial and interglacial epochs. On the other hand, around Hudson Bay, around the Gulf of St. Lawrence, along St. Lawrence and Ottawa Rivers, and the Bay of Fundy are marine deposits, laid down after the Wisconsin ice had retired from those localities and while the region which had been occupied by this ice-sheet was depressed so much that the sea could enter the basins named.

The most interesting locality in Canada for the student of vertebrate palæontology is doubtless Toronto, because of the presence there of Pleistocene deposits belonging to more than one stage, and because of the discovery of several species of extinct vertebrates and of many mollusks, insects, and plants. For an understanding of the geology of the region Coleman's papers must be studied, as well as those of authors cited by him. On the interglacial deposits three of Coleman's papers may be especially cited (Jour. Geol., vol. ix, 1901, pp. 285–310; 10th Internat. Cong. Geol., 1906, Mexico, pp. 1237–1258; Bull. Geol. Soc. Amer., vol. xxvi, 1915, pp. 243–254).

According to Coleman's figure 1 of the first paper cited, the known interglacial deposits in that region extend from the mouth of Humber River eastward beyond the mouth of Rouge River, a distance of about 22 miles, and away from the lake a distance of about 8 miles. Deposits have been found even 14 miles north of Toronto (Coleman, 1915, p. 246). Coleman's sketch map of the region, taken from his paper of 1901, is here reproduced (fig. 3).

According to Coleman (paper of 1915, p. 243) there are known at Toronto five well-defined sheets of boulder clay, with four sheets of interglacial sand and clay separating them. So far as the writer knows, only the lowest of these beds have been described with any particularity. These lowest beds constitute the Toronto formation, and it is these which have furnished nearly all the fossil animals and plants discovered in that region. This Toronto formation is divisible into two portions, and these have been designated as the Don beds and the Scarboro beds. They are regarded as having been deposited in the valley of an ancient river running from Georgian Bay

to Scarboro. Of these the Don beds are the older. Sections of these are found in Toronto and outside, especially along Don River. They have been laid down usually on a boulder clay, 1 to 9 feet thick, which itself reposes on Hudson River shales. At one point along the Don an interglacial river had cut through both the boulder clay and the shale to a depth of 16 feet. The Don deposits consist of varying layers of sands, gravels, and clays.

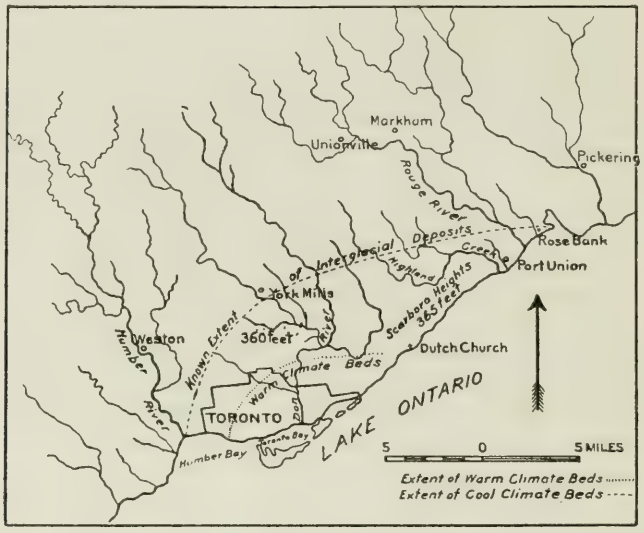


FIG. 3.—Region about Toronto, Ontario, showing location of Toronto and Scarboro Heights Pleistocene beds. From Coleman.

At one point the section obtained amounted to about 27 feet; but this, combined with another, made up about 44 feet. At one place trunks, 12 or 15 feet long, of trees have been found, which were flattened into the surface of the boulder till; also shells of unios, which are embedded in clay close to the boulder till.

In 1913 (Ontario Bur. Mines. Guide Book No. 6, pp. 15–18), Professor Coleman presented a list of the species found in the Don beds. Of the plants 32 species of trees had been secured, among them the papaw, the red cedar, and the osage orange; 41 species of fresh-water mollusks were listed, of which 12 were Unionidæ.

As bearing on the climate, it may be said that there are 12 species of the genus *Unio* listed, of which 4 species are now known only from localities south of the St. Lawrence drainage; while 3 other species live in Lake Erie, but not in Lake Ontario. The plants are mostly trees; and several species, as the osage orange and the papaw, are now found only considerably farther south. One species of maple no longer exists. Penhallow gave it as his opinion that the flora points conclusively to the existence of climatic conditions of a character more nearly like that of the middle United States to-day. The unios now missing from that region give evidence to the same fact. For these reasons the Don deposits are spoken of as the warm-climate beds.

The Scarboro beds are finely displayed at Scarboro heights, a few miles east of Toronto. The thickness of the clay here amounts to about 94 feet. In these deposits have been found possibly mammoth or mastodon and caribou, but there is some uncertainty about these. Only 14 species of plants have been secured and these are trees; but apparently no mollusks have been reported. As an offset there are great numbers of beetles. Of these there have been described 72 species, and all are extinct except 2.

The trees, according to Penhallow, indicate a climate somewhat cooler than that now prevailing in that region. The same conclusion was reached by Scudder from his study of the insects. In his paper of 1901, Coleman took the view that the Toronto formation had been laid down in the interval between the Iowan and the Wisconsin glacial stages, that is, during what is now known as the Peorian. In the address of 1906, page 44, he appears to have been inclined to accept Leverett's view that at least the Don beds belonged to the Sangamon stage. By 1915 (paper cited, p. 252) he had about concluded that the Toronto beds were as old as the Aftonian stage.

Dr. G. F. Wright, in 1912 (Bull. Geol. Soc. Amer., vol. xxv, pp. 205–218), accounted for the deposits and fossil animals and plants found at Toronto in a different way. At a certain time in the Pleistocene the region about Toronto was occupied by some species of animals and plants now found only considerably further south. An ice-sheet from the Keewatin center extended thither and laid down the Don beds. Later the Labrador glacier pushed into that region and deposited the Scarboro beds. According to this view the whole succession of events would be much shortened.

The writer is disposed to accept Leverett's estimate of the geological position of the interglacial beds at Toronto. The presence there of *Elephas primigenius, Mammut americanum,* and the probable *Ursus americanus* hardly counts in the determination of the geological age, for all these animals appear to have continued on from at least the Aftonian interglacial to the close of the Wisconsin. There are no specimens that show that either *Rangifer* or *Cervalces* existed during the Aftonian, although one can hardly doubt that they did then exist. In order to show that the Toronto formation belongs to the Aftonian, it would be necessary to produce satisfactory stratigraphical evidence or to find there genera and species of mammals which characterize the Aftonian, such as camels, *Elephas imperator,* and those horses which belong to the early Pleistocene. If the deposits belong to the Sangamon stage, such horses as *Equus complicatus* and *E. leidyi* ought in time to be discovered there.

Coleman has discussed the interglacial beds that occur elsewhere in Canada (10th Internat. Geol. Congr. 1906, Mexico, pp. 1237–1258; Bull. Geol. Soc. Amer., vol. xxvi, 1915, pp. 243-254). He refers to Chalmers's account of interglacial deposits along Lake Erie; but so far as the writer has been able to determine, most of the deposits referred to are of Late Wisconsin age. However, as he says, Spencer found interglacial materials near Niagara Falls. Other beds have been discovered along Moose River, south of James Bay; but their geological position has not been definitely determined, and the fossils discovered there, mostly proboscideans, are not referred with certainty to the interglacial deposits.

Most of the vertebrate fossils found in Ontario, excepting many of those found at Toronto, belong to the Late Wisconsin stage; and in studying their geological relations one must, as in the States of New York, Ohio, Indiana, and Michigan, take into consideration the history of the Great Lakes after the Wisconsin ice-sheet began to retire. According to Leverett and Taylor's maps (Monogr. LIII, U. S. Geol. Surv., plate XIV), as early as the time when the glacial ice had just begun to withdraw from Lakes Michigan and Erie, a considerable area of land had become cleared of ice in the peninsula bounded by Georgian Bay, Lakes Huron, Erie, and Ontario. We can hardly suppose, however, that any mastodons or any elephants, except possibly *Elephas primigenius,* could have made their way to that area. Even the last-mentioned species would have had to travel over many miles of glacial ice. Conditions were hardly more favorable when Lake Whittlesey had come into existence (op. cit., plate XVI). At a later stage (op. cit., plate XVII) the ice-free parts of the peninsula could have been reached only by crossing the lakes or over wide stretches of glacier. It is possible that some of the mastodons and elephants that have been found had crossed over into Ontario at about the stage represented by plate XIX of the work cited, but it is more probable that they lived there at a later time.

Brief mention is here made of the fossil vertebrates found in Ontario and their localities. More detailed statements will be found on the pages cited.

Beginning in the west, a mastodon has been found at Blythewood, Essex County (p. 45). In Elgin County a mastodon has been met with at St. Thomas (p. 45), and a mastodon (p. 45) and an undetermined species of elephant at Highgate (p. 45). A little farther back from the lake, at London, Middlesex County, has been found a mastodon (p. 45). At Marburg, not far from the shore of Lake Erie, Dr. H. M. Ami exhumed a mastodon (p. 45). The writer has not learned how this locality is related to the ancient beaches. At Dunnville, Haldimand County, a mastodon has been secured (p. 46). It could hardly have lived there before the lake had assumed nearly its present level. The same remark will apply to the time when the mastodon (p. 46), *Elephas columbi* (p. 147), and possibly *E. primigenius* (p. 166) lived at St. Catharines. From Hamilton, at the extreme western end of Lake Ontario, have been described remains of *Elephas columbi* (p. 147), *E.* sp. indet. (p. 166), elk, *Cervus canadensis* (p. 235), and the beaver. *Elephas primigenius* has been found at Toronto, (p. 130); also *Cervalces,* a bison (p. 256), and a reindeer (p. 244). The same elephant has been discovered at Amaranth, in Dufferin County (p. 130). The elk, *Cervus canadensis,* has been reported from Strathroy, Middlesex County, and Kingston, Frontenac County (p. 235). At Smith's Falls, Lanark County, the humpback whale, *Megaptera boöps,* has been discovered (p. 17). White whales, *Delphinapterus leucas* and *D. vermontanus,* have been found at Pakenham, Lanark County (p. 17), at Cornwall, Stormont County (p. 18), Nepean Township (p. 17), Ottawa East, Carleton County, and Williamston, Glengarry County (p. 18). At Ottawa has been discovered an assemblage of species, as listed on page 287.

The geology of the Hamilton locality has been described by Logan (Geol. Canada, 1863, p. 914), by Spencer (Canad. Naturalist, vol. x, 1883, pp.

222–230, 306–308), and by Coleman (Bull. Geol. Soc. Amer., vol. xv, 1904, p. 351). The remains mentioned were found in deposits forming what is called Burlington Heights. Here Dundas Valley opens into the extreme western end of Lake Ontario. The valley is about a half mile wide. Across this had been formed a bar, interrupted only at its northern end, with a height of 108 feet above the level of the lake and a width varying from a few hundred yards to less than a half mile. Its height is almost that of the Iroquois beach found on the south shore of the lake and continuing on the northern shore. Many years ago a canal was cut through the narrowest part of the bar, and it was in the construction of this that the elephant (p. 166), elk (p. 235), and beaver bones were found. It is evident that the bones were deposited there while the bar was being built and at a time when it lacked 38 feet of being as high as it now is. The elephant jaw is in good condition, and this indicates that the animal died near the spot.

Coleman (op. cit., p. 352) stated that afterwards a railroad cut had been made across the southern end of the bar, exposing 30 feet of coarse stratified gravel, followed below by 2 feet of brown clay (evidently an old soil) and 8 feet of blue till. In the old soil were found quantities of decayed wood, as well as bones of mammoth and other animals. About a mile farther west, pits were opened for clay, sand, and gravel. Coleman gives the following geological section at this place. The column at the right gives the heights above the lake level.

	feet.	*feet.*
Clay making red brick	6	78
Gravel	30	72
White sand	5	42
Hard pan	4	37
White sand with mammoth tusks and bones	..	33
Covered to level of the bay	..	0

The mammoth tusks and bones were not waterworn. It will be observed that they were found 83 feet below the top of the Iroquois beach (116 feet above the present lake), while the jaw was only about 45 feet below the beach. Both Coleman, as cited, and Fairchild (Bull. Geol. Soc. Amer., vol. xxvii, p. 247) regard the formation of the bar at Hamilton as showing that during Iroquois times the lake became flooded to a height of about 82 feet.

Besides the interglacial species found at Toronto, which have already been mentioned, there may be noted a tooth of *Elephas primigenius* (p. 130), a cast of which was reported by Winchell. Whether this was derived from interglacial or late Wisconsin beds is not known. Coleman, as elsewhere cited, reported the finding of remains of one of the elephants on the Iroquois beach. On the same beach have been collected antlers of reindeer (p. 244). These animals must have lived there not earlier than the time when that beach was forming, perhaps later.

In a buried gorge extending in a northwestern direction from the whirlpool at Niagara to the Niagara escarpment, Dr. J. W. Spencer (Bull. Geol. Amer., vol. xxi, p. 433) has discovered what he regards as deposits equivalent to the Toronto formation, while older glacial and interglacial beds are found below and more recent ones above. No fossils were met with except wood. At Amaranth have been secured considerable parts of a skeleton of

Elephas primigenius (p. 130). This elephant must have existed rather late in the Wisconsin stage. About Kingston in Frontenac County, at two places, have been secured remains of the elk (p. 235), but lack of details as to places and conditions precludes certainty as to their geological age. The fact that they were found in shell marl is favorable to the idea that they belonged to the Pleistocene. Here may be mentioned again the bison horn of uncertain geological age which was found on the north shore of Nipissing Lake (p. 266). In Algoma County, on the banks of Moose River, was found a part of a skull of a mastodon, but there is uncertainty whether it had been buried in interglacial deposits or in marine Champlain beds. The region in the extreme eastern end of Ontario is interesting because it furnishes a considerable fauna belonging to the Champlain stage. During

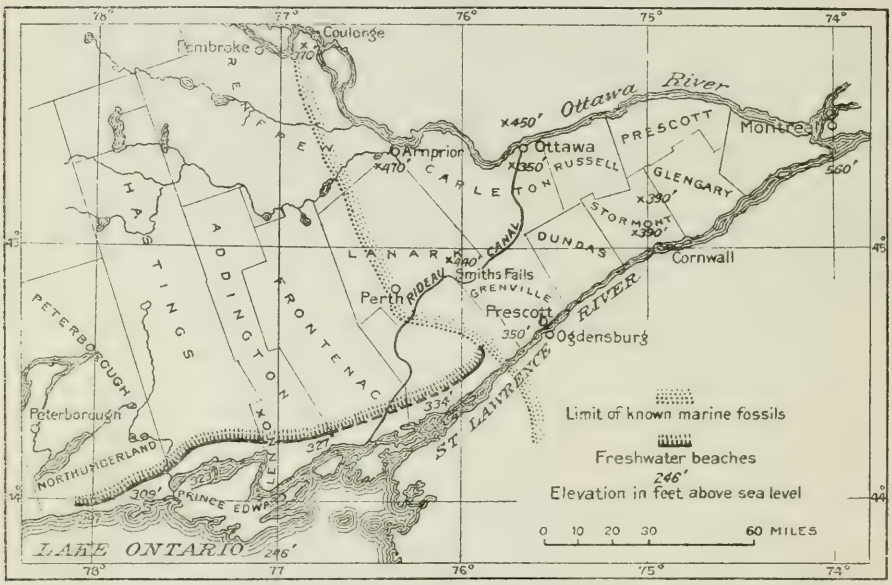


FIG. 4.—Eastern Ontario, showing limit of freshwater beaches and marine fossils. Redrawn from Coleman.

the last glacial stage the region on which the Wisconsin ice-sheet was resting became depressed to such an extent that when this ice retreated beyond the St. Lawrence River, marine waters occupied the basin nearly to the eastern end of Lake Ontario and Ottawa River as far as Lake Coulonge. Coleman's figure of the region (Bull. Geol. Soc. Amer., vol. XII, pp. 129–146, fig. 1) is here reproduced (fig. 4) to show the western limits of the marine waters, so far as known, and the corresponding fresh-water beach along the north shore of Lake Ontario. Figure 5 from Coleman shows how the Champlain Sea was limited on the south. Marine fossils, especially mollusks, have been found along the upper St. Lawrence as far as Brockville, Quebec, and on the opposite side of the river, in New York. On Coleman's map the present elevations of the old beaches at important localities are marked, that at Ottawa having an elevation of 450 feet and at Coulonge

370 feet. According to Johnston, who has described the Pleistocene geology in the vicinity of Ottawa (Mem. 101, Canad. Dept. Mines, 1917), there is a point about 8 miles northwest of the city where a marine terrace is found at a height of 690 feet above sea-level. The marine beds at Ottawa are divided into the Leda clays at the base and Saxicava sands above. The former have a maximum thickness of about 200 feet, the Saxicava sands, a thickness of about 40 feet. The fossils occur mostly in the Leda clays. In 1897, Dr. H. M. Ami (Ottawa Naturalist, vol. XI, pp. 20–26), and again in 1901 (Geol. Surv. Ann. Rep., XII, G, pp. 51–56), published lists of the fossils found in the Ottawa Valley, nearly all of them in the vicinity of

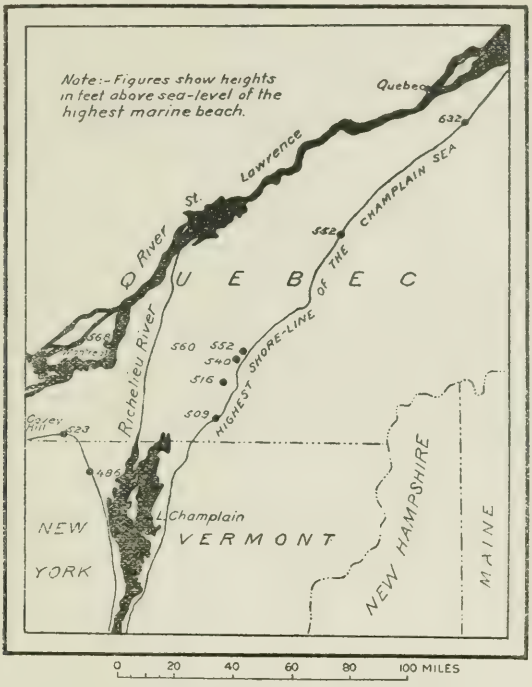


FIG. 5.—South shore-line of ancient Champlain sea. Redrawn from Coleman.

Ottawa. There were listed 26 species of plants, about 13 species of marine mollusks, and the following vertebrates:

Mallotus villosus, capelin.
Cyclopterus lumpus, lump-sucker.
Osmerus mordax, smelt.
Artediellus atlanticus (Cottus uncinatus), sculpin.
Gasterosteus aculeatus, stickleback.
Phoca vitulina, common seal (p. 22).
Phoca grœnlandica, Greenland seal (p. 23).
Tamias striatus, chipmunk.

The aquatic forms are all species existing in the Gulf of St. Lawrence and along the northern Atlantic coast. The chipmunk lives at Ottawa. Specimens of feathers of birds also have been found in nodules, but the species have not been determined. The remains of the chipmunk were probably washed in by some fresh-water stream.

According to Johnston's paper just cited, there are deposits of glacial drift underlying the marine Champlain beds, but they have furnished no fossils. The marine deposits extend up the Ottawa Valley at least as far as Coulonge Lake, and here has been found *Mallotus villosus*. At Welshe's, 3 miles north of Smith's Falls, Lenark County, have been found some remains of the humpback whale, *Megaptera boöps* (Dawson, Amer. Jour. Sci., vol. xxv, 1883, p. 200). It was met with (p. 17) at an elevation of 440 feet above present sea-level. It appears to have been left there during the time when the Saxacava sands and gravels were being laid down (Coleman, Bull. Geol. Soc. Amer., vol. xii, p. 133).

QUEBEC.

The Pleistocene of Quebec was described by Logan in 1863 (Geol. Canada, pp. 917–926) and by J. W. Dawson, 1894, in his "Canadian Ice Age." Dawson divided the epoch, as represented in Canada, into the early Pleistocene, the mid-Pleistocene, and the later Pleistocene. He did not accept the glacial theory as it is now understood, admitting only great local glaciers. His early Pleistocene deposits embraced the great bulk of the boulder clays. His mid-Pleistocene represents an interglacial period, during which were deposited the marine Leda clays, Saxicava sands, and their fresh-water equivalents. The climate was supposed to be milder than at present. During the later Pleistocene there was to some extent a recurrence of local glaciation and of deposition of boulder clay. This stage was followed, according to Dawson, by the Early Modern, which he regarded as the age of the mammoth and mastodon.

Mr. J. Stansfield has described with some detail the Pleistocene and Recent deposits of the island of Montreal (Mem. 73, Geol. Surv. Canada, 1915). The boulder clay is of variable thickness and does not appear to be divisible into beds of different epochs. The Leda and Saxicava deposits are present. When the latter were laid down the region about Montreal was depressed about 600 feet below its present elevation. This has been confirmed by Goldthwaite (Summary Rep. for 1913, p. 211). Later it began to rise; and Stansfield thinks that when the elevation had reached about 100 feet less than that of the present the water of the St. Lawrence at that point had become fresh. He found some apparent evidences of a recurrence of glaciation after the Champlain stage, but, on the whole, left the question undecided. He published a list of about 85 species of marine invertebrate fossils, collected from the Leda clay about Montreal, and 22 species obtained from the Saxicava sands. Besides the invertebrates secured from the Leda clays at that place, there are two vertebrates, *Phoca grœnlandica* (p. 22) and *Delphinapterus leucas*, or *D. vermontana* (p. 18). At Rivière du Loup, in Temiscouta County, whale remains were reported in 1894 (p. 18), which were thought to belong to *Delphinapterus leucas*. At Metis, Rimouski County, a jawbone of a whale has been discovered in the shelly marl of the lower terrace (p. 19); whether or not it belonged to *Megaptera boöps* is not certain. The specimen of the former species was described by Leidy in 1856.

According to Logan's report of 1863 (Geol. Canada, p. 920), the single bone was found in a brickyard. At the same place was found some vertebræ of the whale. At Bic, Rimouski County, has been found a nearly complete skeleton of a walrus, at an elevation of more than 100 feet (p. 21). Dawson (Canadian Record Sci., 1895, vol. VI, p. 352) described a nearly complete skeleton of the whale which had been found at Montreal in the Leda clay, 22 feet below the surface. This Leda clay was supposed by Dawson to have been deposited at a depth of from 50 to 80 fathoms, which depth, he said, corresponded approximately to the marine shore-lines at Montreal at an elevation of about 470 feet above sea-level, and to the sea-beach at Smith's Falls, above referred to. Hence at the time that the whale was buried the mountain at Montreal was only a rocky islet in the sea which prevailed then over the region from the Laurentian hills on the north to the highlands of Quebec, south of the St. Lawrence.

At Tétreauville, in Ottawa County, on Ottawa River, have been found some bones, supposed to belong to the harbor seal, *Phoca vitulina*.

NEW BRUNSWICK, NOVA SCOTIA, AND CAPE BRETON ISLAND.

All three of these regions were involved in the glaciation of the Wisconsin stage. According to Goldthwait (Summary Rep. for 1913, pp. 244–250), New Brunswick was the center from which the ice flowed out over the other two lands. From this center it moved southward over the western end of Nova Scotia, more and more southeastward over the rest of the peninsula, while over Cape Breton Island the direction was eastward and northeastward. Some indications were observed of an earlier glaciation. As regards post-glacial submergence, Goldthwait found that at St. John, New Brunswick, this had amounted to about 190 feet, while on Cape Breton Island no signs of any submergence were found. Robert Chalmers had arrived at similar conclusions; and these agree well with the theoretical isobases drawn by Taylor for that region (Monogr. U. S. Geol. Surv. LIII, 1915, p. 503). G. F. Matthew in 1879 (Geol. Surv. Canada, Rep. for 1877–78, EE, pp. 1–36) described the geology of southern New Brunswick. Few fossil vertebrates of Pleistocene age have been discovered in these countries. On Cape Breton Island mastodon remains have been found in two places, Middle River and Baddeck (p. 46). As long ago as 1874 remains supposed to belong to *Delphinapterus* were found near the mouth of the Jaquet River, in the northernmost part of New Brunswick; but Professor G. H. Perkins has shown that the animal was probably the narwhal, *Monodon monoceros*. The discovery is discussed here on page 19. At the southern extremity of New Brunswick, along Mace's Bay, Charlotte County, a jaw supposed to belong to a species of *Delphinapterus* was found, which had been buried in the Leda clay (p. 19). Near Fairville, at the mouth of St. John River, there has been discovered some bones of the seal *Phoca grœnlandica* (p. 21). In the Academy of Sciences at Philadephia is a skull of a walrus (p. 21) found apparently in the water near Sable Island about 50 years ago. It is not certain that it is a Pleistocene fossil.

NEW ENGLAND.

Inasmuch as relatively few vertebrates belonging to the Pleistocene have been discovered in the New England States, it will not be necessary to enter into details regarding the geology of the glacial period in this region. Nevertheless, the subject is one of great interest and one which has engaged the attention of many geologists. For those who wish to enter on the study, the writer recommends first a paper written in 1906 (Bull. Geol. Soc. Amer., vol. XVIII, pp. 505–556) by Frederick G. Clapp, entitled "Complexity of the Glacial Period in Northeastern New England," which gives a brief history of the development of the idea that in the region mentioned there are evidences of more than one glacial and of more than one interglacial stage. There are also citations of the principal papers written on the subject. Among the writers cited are Shaler, Woodworth, Fuller, Upham, Stone, and Tarr. Clapp concluded that New England had been invaded by at least three ice-sheets and that these invasions had been separated by two interglacial intervals of long duration. On account of the greater thickness of the drift and because of fewer favorable exposures, due to the rocky nature of the coast and other causes, many difficulties are encountered in studying the deposits. He regarded absolute correlations as not yet possible. The last glaciation he accepted as corresponding closely with the Wisconsin, as displayed in States further west. What is known as Montauk drift, forming a part of the Gay Head interval of Woodworth, appeared to Clapp to correspond possibly to the Illinoian. Still older drifts would seem to have their place nearer the pre-Kansan (Nebraskan) than to the Kansan. What have been called "Leda clays" are found from Boston north into the St. Lawrence Valley. Clapp divides them into the "high-level" and the "low-level" clays. The former are the older and regarded as being about the equivalent to the Iowan stage. The "low-level clays" are referred to the Wisconsin stage. Another body of clays named by Fuller (Bull. Geol. Soc. Amer., vol. XVI, p. 375) the Gardiner clays, from their type locality, Gardiner Island, near the east end of Long Island, lies beneath the Montauk till and has been referred by Fuller to the Yarmouth interglacial.

In his paper cited Clapp presents (pp. 520–523) a list of the fossils, mostly mollusks, which have been collected in the Pleistocene deposits from New Brunswick to New York.

Along the New England coast are evidences of uplift which followed the retirement of the Wisconsin ice. Katz (Jour. Washington Acad. Sci., vol. VIII, 1918, p. 410) reported elevations of 155 feet at Stratham, New Hampshire, and 300 feet at Pawnal, Maine. Fairchild (Bull. Geol. Soc. Amer., vol. XXIX, p. 214) records the elevations at various localities in Maine.

A brief interesting account of the Pleistocene epoch as recorded in Massachusetts and Rhode Island may be found in an article by B. K. Emerson (Bull. U. S. Geol. Surv., No. 597, pp. 134–149). It deals in part with the geology of the valley of the Connecticut River.

Goldthwait (Appalachia, vol. XIII, pp. 1–23) and Foshay (Amer. Jour. Sci., ser. 4, vol. XXXVIII, pp. 345–348) have found evidences of an early Pleistocene glaciation in the White Mountains of New Hampshire.

Vermont is interesting especially on account of the Pleistocene history of Lake Champlain. This history has been recently discussed by Professor H. L. Fairchild (Rep. State Geologist Vermont, vol. x, 1916, pp. 1–41, with maps and views), who presents (pp. 40–41) a list, 37 in number, of the more important papers relating to the subject.

While the Wisconsin ice-sheet was resting upon Canada and the northern part of the United States, the land thus occupied, and probably a considerable area beyond the ice, became depressed. The valleys of the St. Lawrence, the Ottawa, the Hudson, and the Connecticut had been pressed down to such an extent that, as the ice-sheet retired these valleys became filled with water standing at sea-level. When at length the glacial front had retreated beyond the St. Lawrence, sea-water entered Lake Ontario and passed up Ottawa River far above the city of Ottawa (Leverett, Monogr. U. S. Geol. Surv., LIII, plate XXI). South of the St. Lawrence, marine waters occupied what is now Lake Champlain and as much of the surrounding land as was then at or below sea-level. In his account Fairchild makes use of the plate which is here reproduced (map 31) from his article of 1917 (Bull. Geol. Soc. Amer., vol. XXVIII, p. 279, plate XI). This geologist believes that the Hudson formed for a while a connection with Lake Champlain, although the Hudson waters may not have been actually saline. But in Lake Champlain the presence of fossil marine mollusks and at least one whale skeleton shows that its waters were salt. The lines crossing the plate obliquely are the isobases which show the amount of elevation which has taken place along those lines since the end of the Pleistocene. South of New York City this is zero. At the northern end of Lake Champlain the elevation is 800 feet. This means that the north end of the lake for a while stood 800 feet lower than now. Marine fossils have, however, been found at an elevation of only about 300 feet. The waters which first occupied the lake and stood at the highest level were of glacial origin and fresh. When the ice-front had receded so as to open the St. Lawrence and admit sea-water, the northern end of the lake had been uplifted about 500 feet. It was then that the marine animals entered.

Other important papers to be consulted in this connection are as follows: One by J. B. Woodworth (Bull. 84 New York State Mus.); one by Charles E. Peet (Jour. Geol., vol. XII, 1904, pp. 415–469; 617–660), and two by Professor Fairchild (Bulls. 105, 127, New York State Mus.).

It is proper to say that certain glacial geologists maintain that the depression in the New England States has been less than supposed by Fairchild, and that the isobases curved around toward the north as the New England coast was approached, somewhat as represented by Taylor (Monogr. LIII, U. S. Geol. Surv., p. 503). Fairchild, in a later paper (Bull. Geol. Soc. Amer., vol. XXIX, 1918, pp. 187–244), has reached the same conclusion and presented a map on which are drawn the isobases, or lines passing through points affected by the same amount of postglacial uplift; from this map 32 has been prepared. On his map the location of the heavy or solid lines is regarded by Fairchild as being based on clear evidence. Where the lines become thin the evidence is less trustworthy; where the lines are broken their positions are hypothetical. The numerals

on the lines show the amount of uplift along those lines. Two points of importance are brought out on the map. The first is that Newfoundland formed an independent center of glaciation and of subsequent uplift, a conclusion based on good geological evidence. The second point is that the center of the Wisconsin glaciation was located southeast of James Bay, considerably farther south and west than is usually supposed. The confirmation of this is left to the future.

It does not seem to have been demonstrated that there are in Connecticut any Pleistocene deposits older than those laid down by the Wisconsin ice-sheet. In case Fuller (U. S. Geol. Surv. Prof. Paper 82) is correct in his determination of beds of the early, middle, and late Pleistocene on Long Island, it is to be expected that beds of corresponding ages will yet be recognized in Connecticut. Woodworth (17th Ann. Rep. U. S. Geol. Surv., pt. 1, p. 978) mentions deposits of clay at Berlin and at New Haven that may be older than the Wisconsin.

While the correlations recorded above of the Pleistocene of the New England States with the glacial and interglacial stages of the Mississippi Valley may be subject to modifications, it is interesting to learn that the presence of Middle and Early Pleistocene deposits in the Eastern States has received the recognition of so many students of glacial geology. The hope is awakened that in New England there may yet be found interglacial deposits which will furnish remains of Pleistocene vertebrates, as these have come to light from Throg's Neck, New York, to southern Florida. It is possible that the astragalus of an equine animal (p. 183), found at Gay Head, Martha's Vineyard, belongs to a species of *Equus* of early Pleistocene age.

In order to illustrate still further the events connected with the history of the Pleistocene in the region of the Great Lakes, three additional figures are introduced. One of these (map 33) shows J. W. Spencer's conception of the drainage of the region in preglacial times. The areas now occupied by the lakes were then traversed by rivers. It will be observed that the rivers above Pittsburgh now discharging into the Ohio then emptied northward into the Erigan. This is shown also by a map (fig. 6) taken from Leverett (U. S. Geol. Surv. Monogr. XLI, p. 89). Figure 5, on page 287, shows the position of the shore of this Champlain Sea.

The number of Pleistocene vertebrates found in the New England States is limited, and most of them have been mentioned.

Somewhere on the coast of Maine have been found specimens of the fish *Mallotus villosus* (Gould, Proc. Bost. Soc. Nat. Hist., vol. III, 1848, p. 67). At Charlotte, Vermont, a white whale, *Delphinapterus vermontanus*, was found many years ago (p. 19). Some bovid teeth were found many years ago at Gardiner, Maine, and referred to *Bison bison*, but it is now believed that they are teeth of the domestic ox. However, Dr. G. M. Allen has reported from Cape Cod, Massachusetts, teeth of a young bison (p. 266). At Woodbury, Washington County, Vermont, at a depth of 7 feet, an antler and a piece of the upper jaw with five molars of *Rangifer caribou* (p. 244) have been discovered (Rep. Geol. Surv. Vermont, vol VI, p. 7). Mastodons have been discovered in Massachusetts at Coleraine and Shrews-

bury (p. 47). Many years ago a tooth and a tusk and some bones of an elephant were found at Mount Holly, Vermont (p. 148); the writer refers the animal to *Elephas columbi*. An undetermined elephant has been found in Vermont at Richmond (p. 167). Walrus remains have been recovered

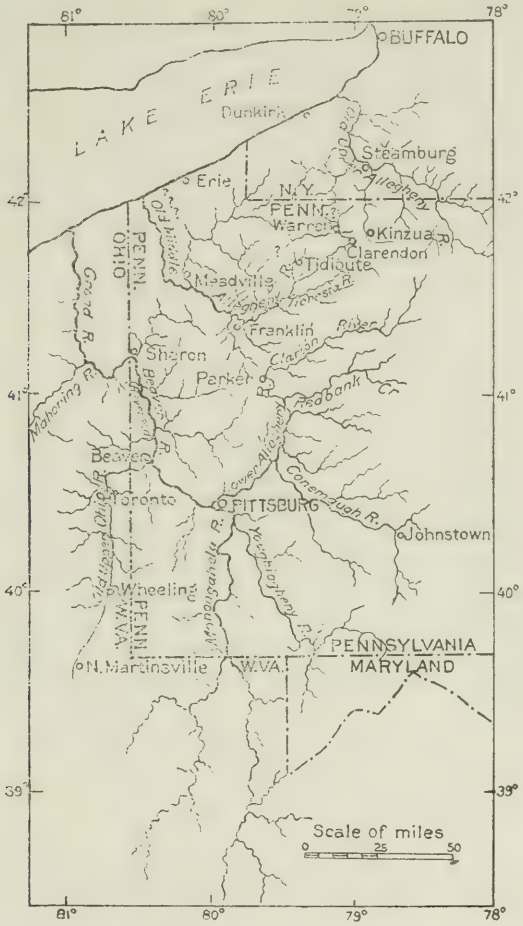


Fig. 6.—Probable preglacial drainage of the Upper Ohio. From Leverett.

at Addison Point (p. 23), Andrews Island (p. 23), Gardiner (p. 23), and Portland (p. 24), all in Maine; off Portsmouth, New Hampshire (p. 25); and on Martha's Vineyard, Massachusetts (p. 25). At the latter place a tooth supposed to belong to the hooded seal (p. 26) was found long ago. With respect to the specimens found at this place there is some doubt as to their geological age. With the exception that the reindeer bones (p. 244) found near New Haven may be of pre-Wisconsin age, no Pleistocene vertebrate fossils older than Late Wisconsin appear to have been discovered anywhere in Connecticut. As shown elsewhere (p. 48), there were found

long ago at Sharon, Litchfield County, remains which were identified as those of mammoth, but these have since been regarded as those of the common mastodon. Only a single vertebra was preserved.

Mastodons have been found in four other places, Cheshire, New Britain, Bristol, and Farmington (pp. 47, 48). The animals which left their bones at those places certainly lived after the last glacial sheet had withdrawn from the State. As mentioned on page 291, Fairchild has found reasons for believing that, while the Wisconsin ice-sheet was withdrawing from the Hudson and Connecticut Valleys, the whole region was so depressed that these valleys became occupied by water at sea-level. In these waters there were laid down thick deposits which now stand at levels much above tide, varying, in Connecticut, from nearly 200 to about 300 feet. Map 31, reproduced from Professor Fairchild (Bull. Geol. Soc. Amer., vol xxviii, 1917, plate xi) is intended to show how wide an extent of territory along the Connecticut Valley was then submerged. It is probable that the emergence of these deposits was not accomplished until after the glacier had retired beyond the State.

It will be observed (map 6) that the localities just mentioned, where the mastodons have been found, lie very close to or on the areas covered by the deposits mentioned. The pond in which the Farmington mastodon (fig. 6, No. 3) was buried is in a range of hills which must have stood as an island in the Connecticut inlet. While it is possible that mastodons lived on this island while the land was depressed, it is more likely that they lived there after it had been more or less elevated. Judging from the topographical maps, one may conclude that the mastodons that have been found at Cheshire (fig. 6, No. 1) and New Britain (fig. 6, No. 2) were buried in deposits that overlie those laid down at sea-level. Their time of existence must have been near the end of the Pleistocene. Too little is known about the mastodons reported from Bristol and Sharon to form any definite opinion about the stage of the Pleistocene when they lived; but it was probably after the withdrawal of the last ice-sheet.

NEW YORK.

From the geologist's point of view there is hardly, if at all, another State which presents for solution more numerous or more interesting problems connected with the Pleistocene than does New York. Among these are the geography and topography of the State at the beginning of the Pleistocene; the number and identity of the glacial stages which affected its surface; the origin and development of the bordering Great Lakes, of the numerous interior lakes, and of the river courses, actual and abandoned. For a knowledge of these one must consult the various reports issued by the Geological Survey of the State; above all, the numerous and instructive papers that have been published by Professor H. L. Fairchild, of the University of Rochester.

For the student of Pleistocene vertebrate palæontology, the State of New York is not so attractive as some others; but it is far from being devoid of interest. Few species of vertebrates of Pleistocene age have been found in its deposits, and these, with one exception, belong to the latest episodes

of the last glacial stage. So far as the writer is aware, the following list comprises all of the Pleistocene vertebrates known to have been found within the borders of the State; those marked with an asterisk (*) are now extinct:

*Equus sp. indet (p. 183).
*Platygonus compressus (p. 212).
Bison bison (pp. 266, 267).
Odocoileus virginianus (p. 226).
Cervus canadensis (pp. 235, 236).
Rangifer caribou? (p. 245).
*Mammut americanum (pp. 48–63).
*Elephas columbi (p. 149).
*Elephas primigenius (pp. 131, 132).
Castor canadensis.
*Castoroides ohioensis (p. 272).

Deposits of materials belonging to Pleistocene stages older than the Wisconsin are apparently of rare occurrence in the State. If existing they are usually concealed beneath the widely spread Wisconsin drift. On Long Island, Fuller (U. S. Geol. Surv. Prof. Paper 82) has described beds of gravels, sands, and clays, which he regards as belonging to the Nebraskan, Aftonian, Yarmouth, and Illinoian. None of these has furnished any vertebrate fossils. However, in 1866 (Smithson. Contrib. Knowl., vol. xv, art. 3, p. 16), Whittlesey reported that he had a tooth of a horse (p. 183) found at Fort Schuyler, Throg's Neck, 18 feet below the surface. This must have been lying beneath the Wisconsin drift. Inasmuch as Fuller has found the Manhassett formation, regarded as equivalent to the Illinoian, around Manhassett Bay, within 4 or 5 miles of Throg's Neck, it seems entirely reasonable to suppose that deposits of similar or earlier age exist at Throg's Neck.

With the exception of small areas, the whole of the State was at one time covered by the ice-sheet of the Wisconsin stage. The glacial ice filled the basins of the Great Lakes, and overrode even the peaks of the Adirondack and Catskill Mountains. Only along the southern side of Long Island and in the loop formed in Cattaraugus County by Allegheny River does the ice-sheet appear to have been absent.

Nearly everywhere, even on the southern coast of Long Island as outwash, it left its burden of clay, sand, gravel and boulders, usually many feet in thickness; in the mountainous regions this drift material is present, at least in the valleys. At the extreme southern edge of the glacial sheet there was laid down the terminal moraine, which, more or less distinctly determinable, has been traced from the eastern end of Long Island to the southwestern corner of Cattaraugus County, and onward into Pennsylvania. This moraine is shown here on maps 3 and 6-A.

As the ice-sheet withdrew toward the north, the surface which it had occupied was, for many reasons, very uneven, and in the depressions there were formed numerous lakelets and lakes. Into the smaller lakes and ponds especially, were swept, by running water and blown by winds, coarse materials and dust, so that they began at once to fill. Water-loving plants in due time took possession of their borders, and in time marshes were formed. In some of these bodies of waters are now found deposits of shell marl, which show that for a long period the lakes and ponds were inhabited by fresh-water mollusks. Sometimes below this marl, but usually above it, is found a layer of peat, the product of the partial decay of the vegetation. It is in such peat-bogs, sometimes buried in the peat, sometimes in the marl,

that have been found most of the bones and teeth of the fossil animals recovered. Inasmuch as such deposits lie upon the Wisconsin drift, it is certain that these animals lived, at the localities where found, after the retirement of the glacier from that locality; how long afterward one usually can not be certain.

It is in such Late Wisconsin deposits that have been found the numerous remains of mastodons on Long Island, on Staten Island, around New York City, and especially in Orange County (pp. 48–54). This county has furnished some of the most complete skeletons of mastodons ever discovered. Whether or not the conditions for their existence were more favorable in this region than in that between this county and the Finger Lake region may be regarded as doubtful; but it is certain that the conditions for the preservation of skeletons were extremely favorable.

A remarkable case is presented at Cohoes, where a part of a skeleton of a mastodon was found in one of the great pot-holes existing there, and another part of the same skeleton in a neighboring pot-hole. The case is discussed below.

In the western half of the State, after the foot of the glacier had retired beyond the divide between the present northward and southward flowing streams, bodies of water began to collect between the divide and the foot of the glacier. To these bodies, regarded as lakes, changing from time to time their dimensions and their outlets, have been given various names. At first, the waters that collected in the Finger Lake region found their outlet southward through the Susquehanna River; later through the Mohawk and Hudson; then westward into the Mississippi drainage; afterward through a channel leading around west and north of the Adirondacks and into Lake Champlain and down the Hudson; and finally, as now, into the St. Lawrence River (map 34).

The waters of the Erie basin, for most of the time, found their outlet toward the west into the Mississippi; but at a later time they escaped for a while eastward through central New York into the Mohawk. For information regarding these lakes one must consult Leverett and Taylor (Monogr. LIII, U. S. Geol. Surv.) and Fairchild (Bulls. 127, 160, N. Y. State Mus.).

From a study of the geological history we may arrive at some approximately correct ideas as to the time when the mastodons, elephants, horses, giant beavers, etc., lived within the limits of the State. Of these animals, apparently none of the specimens discovered up to this time belongs to any pre-Wisconsin stage, except the horse whose tooth was found at Throg's Neck (p. 183). The history of our extinct horses and the depth at which the specimen was found indicate that the animal had lived either during the first or the second third of the Pleistocene.

We may be certain that none of the mastodons (p. 49) which have been reported from Long Island lived there while the northern border was occupied by the glacier, and the remainder by the ocean. Not until the land had risen to about its present level could mastodons have become buried in the muck-filled ponds where they have been met with. Where the glacier front was when mastodons got foothold on the island we can not tell cer-

tainly; but it required perhaps hundreds or probably thousands of years for the elevation of the island to the extent of about 100 feet. We can hardly doubt that the mastodon lived on up to near, possibly into, the Recent period (see map 34).

It is interesting to speculate on the time and manner of entombment of the skeleton, described on page 56, which was found at Cohoes, part in one pot-hole, part in another not far away. Hall adopted the theory that the carcass of the mastodon had been frozen in the glacial ice and, on the thawing of this ice, had been dropped into the pot-holes. In fact, he thus explained the frequent presence of mastodon skeletons in swamps. We have, however, no evidence that mastodons were ever thus frozen up in the ice of the glacier; but there is a possibility that this happened sometimes. If a skeleton should thus have been engaged in the moving stream of ice it is not probable that it would ever have emerged in a recognizable condition. In the production of cracks and crevices in the glacial ice, of which Hall spoke, the bones would have been broken up and scattered, if not ground to powder. If a cadaver had been frozen in the ice for any considerable time it would certainly have come out in such a waterlogged condition that it would hardly have floated. Weighted down by its heavy tusks, it would have drifted against rocks and at least the tusks would probably have been broken off. If we exclude the idea that the mastodon had first been frozen in the glacier, the writer sees no reason for denying that it might thus have been transported for some distance; but little is gained by granting it. The animal could as well have lived near Cohoes as farther up the Mohawk.

As stated on another page, James Hall concluded that the pot-holes belonged to some pre-glacial time. Professor H. L. Fairchild has expressed in a letter to the present writer the following opinion:

"When the ice-sheet melted from Cohoes the locality was 355 feet lower than it is to-day. Deep estuary deposits partially filled the Hudson Valley and buried the Cohoes district. The Mohawk channel at Cohoes is excavated through marine sediments. There is no suggestion of any river channel there previous to the present river work. The pot-holes are post-glacial, but they probably represent a more copious and vigorous flow than that of the present river. That was supplied by the diminishing Iromohawk, the latest outflow through the Mohawk Valley of the Iroquois water. In this view the pot-holes were drilled by the latest glacial waters."

It appears that, when the mastodon skeleton fell into the pot-holes, these had been drilled long before; for the principal one had become filled with gravel to a depth of at least 10 feet. They were, therefore, probably well above the stream-level, except in times of high-water. However the carcass reached the locality, it must have arrived in a complete state. Had it already attained an advanced stage of decay, some limbs or the feet or the lower jaw, probably the whole head, weighted down as it was by the heavy tusks, would have dropped off. It may be assumed that the skeleton was lying on land or in some pond not far above the pot-holes. The flesh was not wholly decayed, and the bones were held together by the ligaments. While the skeleton was in this condition the river rose and swept it over the first pot-hole, where the right leg dropped off; and then onward over

the second, where more of it was deposited. Some unimportant parts may have been carried farther, and some of the missing bones may have decayed in the pot-holes. After the bones were deposited there the pot-holes became slowly filled up, probably mostly during times of high-water, with muck and branches and trunks of trees of several species (Hay, Science, n. s., vol. XLIX, 1919, p. 378).

The retreat of the Wisconsin ice-sheet far beyond the St. Lawrence and the rise of the land to its present elevation, 350 feet above the sea at Cohoes, belong to the closing chapter of Pleistocene history. When the Cohoes mastodon was buried the ice-sheet was probably already north of the St. Lawrence and, as Professor Fairchild writes, 150 feet of the rise of the land had already occurred. The time could, therefore, not have been long before the beginning of the Recent epoch. If these animals lived at such a late time at Cohoes they doubtless existed at the same time in all parts of the eastern region where their remains have been discovered. They may have been able to occupy Long Island a little earlier than places further north, but the interval would be geologically inconsiderable.

The writer has learned of no discoveries of mastodon bones in materials laid down by the marine waters that occupied Lake Champlain, the St. Lawrence Valley, and that of Ottawa River, or in deposits overlying these marine beds.

On the basis of one of Professor H. L. Fairchild's plates (Bull. 127, N. Y. State Mus., plate XXXV) the writer has prepared map 34, which is intended to show the position of the Wisconsin ice-sheet in New York after it had retired somewhat north of the divide. This divide is marked by a line of dots. The area then occupied by the ice is stippled. Lake Erie was already nearly free from ice and was discharging its water by way of the Mississippi. Impounded waters from the melting glacial ice were collecting in the region of the Finger Lakes, forming Newberry Lake, and escaping down the Susquehanna. The Mohawk afforded outlet for the water from the southeastern lobe of ice. Fairchild's plates 36 to 42 show the successive positions occupied by the ice-front as it retired northward and the various lakes that were formed.

Although not many species of vertebrate animals have been found in the Pleistocene deposits of New York, a large number of localities have furnished remains of the mastodon, *Mammut americanum*. These localities are recorded and brief descriptions of the remains and their geological environment have been presented on pages 48–63. The localities are indicated on map 34. It will be seen that several specimens have been found on Long Island and many in Orange County, in the southeastern corner of the State. In the western half of the State most of the finds occur within the area once occupied by the successive lakes. The animals could have lived there only after the ice-sheet and the lake waters had disappeared. It will be seen that a few finds have been made close to the shores of the present lakes. The animals must have lived there at the very end of the Pleistocene, if not within the Recent epoch.

The finds of other vertebrates are recorded on the following pages: *Equus* sp. indet. on page 183; *Platygonus compressus* on page 212; *Bison*

bison on page 266; *Odocoileus virginianus* on page 226; *Cervus canadensis* on page 235; *Rangifer caribou* on page 245; *Elephas columbi* on page 149; *Elephas primigenius* on page 131; *Castor canadensis* on page 272; *Castoroides ohioensis* on page 272.

In 1850 (Proc. Amer. Assoc. Adv. Sci., vol. II, pp. 255–256), W. C. Redfield reported that he had received remains of a fox of the genus *Vulpes* from Gulf Summit, Broome County. The lower jaw and other bones had been discovered in a cutting of the New York and Erie Railroad, 40 feet below the natural surface. The deposit above these bones was evidently the Wisconsin drift. The fine clay inclosing the bones may have belonged to the Sangamon, or even some older interglacial deposit. It is impossible to say whether this fox was *Vulpes fulvus* or *Urocyon cinereoargenteus*.

NEW JERSEY.

(Map 6-A.)

In the consideration of the problems of Pleistocene geology and palæontology, New Jersey is one of the most important States. Its northern part is occupied by glacial drift deposits, while the southern two-thirds is covered more or less completely by materials laid down beyond the limits of the glaciers. The glacial materials appear to belong to two widely separate epochs. The geologists who have been connected with the geological survey of New Jersey recognize in the materials composing the Pleistocene deposits south of the glacial region three formations, the Bridgeton, oldest; succeeded by the Pensauken; and the Cape May, the youngest. The geologists of Maryland recognize in New Jersey three formations which correspond to the three of Maryland, the Sunderland, the Wicomico, and the Talbot. However, the author of the Maryland Pliocene and Pleistocene volume, Professor Shattuck, insists that parts of Salisbury's Bridgeton, Pensauken, and Cape May all enter into the Sunderland; parts of the Cape May, Pensauken, and possibly of the Bridgeton, into the Wicomico; and parts of the Pensauken and Cape May into the Talbot.

There are wide divergences in the views of the two groups of geologists regarding the manner in which the materials have been laid down. The Maryland geologists hold that their three terraces represent three epochs of submergence, and that the gravels, sands, and clays were deposited in the salt waters of the ocean or of estuaries. Salisbury and Knapp (Geol. Surv. New Jersey, vol. VIII, 1917, p. 3) adopt the view that the formations are partly of subaerial and partly of marine and estuarine origin, with emphasis on the subaerial mode. Of the Bridgeton, the authors referred to say (their p. 18) that the accessible parts are primarily of terrestrial origin. A part of what remains may be marine or estuarine, and part of what has been removed may have been so. No palæontological evidences of marine deposits of this epoch are found in the State. The writer records his dissent from the theory that the terraces and the deposits called the Sunderland, Wicomico, and Talbot have been the product of marine submergence. A part only of the Talbot can be referred to deposition in the sea.

Of the Pensauken, Salisbury and Knapp say (p. 87): "There is nothing in its constitution to negative the hypothesis of the whole formation being

river work; nor is there anything, as now understood, to prove it." As to the deposits which they refer to the Cape May, the authors quoted say (p. 162) that the southern part of the State seems to have stood a few feet (30 to 50) lower than at present; but that it could not have stood long at this height, for sea-cliffs are essentially wanting. At one point, near Millville, Cumberland County, marine fossils are met with at an elevation of about 10 feet above tide.

The Cape May was, according to Salisbury and Knapp, laid down during the last glacial epoch, the Wisconsin (p. 162). This determination of age would doubtless gain the acceptance of the Maryland geologists and their adherents, although the latter would include under this name many local deposits which Salisbury puts in the Pensauken.

It is remarkable that, so far as the writer knows, no remains of Pleistocene vertebrates have ever been discovered in that portion of New Jersey which is mapped as occupied by the Cohansey sands, an area including nearly half the State. It lies southeast of a straight line which would run from Navesink River to Salem. The reason for this lack of fossil vertebrates does not occur to the writer. A large portion of this region is mapped as being covered with deposits of all three of the Pleistocene formations, Bridgeton, Pensauken, and Cape May. On or near to the line of outcrop of the Cretaceous deposits from Salem to Raritan Bay, not fewer than ten localities are known where mastodon remains have been discovered, besides two localities which have furnished horses and two which have furnished elephants. Since the southeastern part of the State has yielded no vertebrate fossils and little else to throw light on the age of its deposits, we shall dismiss it from consideration.

The glacial geology of the State has been studied by Professor Rollin D. Salisbury, of the University of Chicago, and his assistants, Henry B. Kümmel, Charles E. Peet, and George N. Knapp. The results of their studies on the glacial-drift deposits have been published in volume v of the final report of the State geologist, 1902.

The Quaternary formations of the southern part of the State are described in volume VIII of the final report. A more succinct description of the events of the Quaternary period is found in Bulletin 14 (1915) of the New Jersey Survey. The authors are J. Volney Lewis and Henry B. Kümmel.

In the vicinity of Perth Amboy is a heavy glacial moraine which may be traced eastward through Staten and Long Islands. West of Perth Amboy it turns northward, and swinging around it reaches Springfield. Thence it runs northwestward to Rockaway, and continues west by south to Delaware River, at Belvidere. This moraine marks, in New Jersey, the southward limit of the last ice-sheet, the Wisconsin. All the drift deposits of the State north of this moraine are regarded as belonging to the Wisconsin stage. It is to be supposed that this is, at least to some extent, underlain by older drift deposits.

South of the moraine just described are scattered deposits of glacial drift and other evidence of glacial action which are referred to a much older ice-sheet, one supposed to correspond to the Kansan drift of the Mississippi Valley (Salisbury, Geol. Surv. New Jersey, vol. v, p. 781). On the other

hand, it is sometimes referred (Chamberlin and Salisbury, Geology, vol. III, pp. 383, 384) to the first glacial (sub-Aftonian).

As has been said, three formations are recognized which were laid down otherwise than by glacial ice-sheets, the Bridgeton, the Pensauken, and the Cape May. The deposition of the Cape May is regarded as being contemporaneous with the Wisconsin ice-sheet (Salisbury and Knapp, New Jersey Geol. Surv., vol. VIII, p. 162; Lewis and Kümmel, Bull. 14, p. 120). The Pensauken formation is believed to be much older than the Cape May; it may (Salisbury and Knapp, op. cit., p. 78) be older than the extra-morainic drift, mentioned above as being of about Kansan times; but it may have coincided in part only with the Kansan. According to Lewis and Kümmel (op. cit., p. 111) the old, extra-morainic, Jerseyan drift was coincident with at least the later stages of the Pensauken. Hence, we may believe that the Pensauken corresponds somewhat to the Aftonian stage of Iowa. The Bridgeton formation is still older than the Pensauken and, being Quaternary, must be referred either to the early part of the first interglacial or to the first glacial; but the New Jersey geologists are not specific on this point.

It is unfortunate that nowhere in New Jersey has any considerable number of species of Pleistocene vertebrates been found buried together. We are thus deprived of one means of estimating the age of the species and of the beds. Most of the specimens found, as the mastodon and the two elephants, belong to species which lived during the whole or a large part of the Pleistocene and hence do not testify definitely to the age of the deposits in which they occur. Too often the information we have regarding the place and conditions of burial is extremely meager.

In Salem County a mastodon has been found in Mannington Township, at Chestnut Hill (p. 63); and a deer, probably *Odocoileus virginianus*, at Woodstown (p. 226). Although the geological map shows that in Mannington Township Cape May Pleistocene prevails, while about Woodstown there is Pensauken, one can not well conclude that the animals are of corresponding age.

In Gloucester County *Mammut americanum* has been found at Harrisonville (p. 63), Mullica Hill (p. 64), and Woodbury (p. 64); *Equus* at Swedesboro (p. 184). As to the former species, we can not be certain of the age, either from our knowledge of the age of the deposits inclosing the remains or from the history of the species. As to the horse found at Swedesboro, one may, from the history of the genus in this country, arrive at some conclusion; but this will be deferred to page 303.

In Camden County, so far as the writer has knowledge, no vertebrate remains have been found except in the Fish House beds, along Delaware River, just above Camden; but the horse remains (p. 184) are of great importance. These beds were originally supposed to be of Cretaceous age, but in 1869 (Trans. Amer. Philos. Soc., vol. XIV, p. 250), Cope expressed the conviction that they belonged to the Pliocene period. He presented a geological section (fig. 7) of the beds which shows a thin stratum of soil above, then from 8 to 15 feet of light-brown sand, followed below by a blackish clay about 25 feet in thickness. Near the bottom of the latter was

found a layer containing shells of several species of *Unio* and *Anodonta*. Just above this bed of unios there was discovered a large part of a skull of an extinct horse which Cope referred to *Equus fraternus*. This was deposited in the collection of the Academy at Philadelphia, but later disappeared.

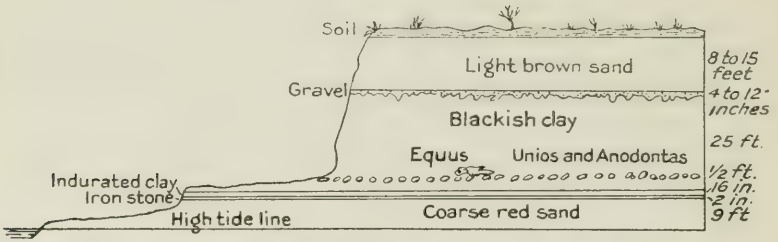


FIG. 7.—Geologic section of Fish House beds, Camden, New Jersey. Redrawn from Cope.

In 1897 (Rep. State Geologist, New Jersey, for 1896, pp. 201–247, plates X–XIV) Woolman published a paper on the stratigraphy of the Fish House beds and described and illustrated other horse-teeth which he referred to *Equus complicatus*. These teeth were found at a depth of 12 feet below the top of the black clay; 6 feet of surface gravels had been removed from the clay. The teeth are now in the collection of the Academy, at Philadelphia. Woolman stated that in the same collection are a patella and a fragment of a long bone of a horse found in the black clay, in 1892.

Woolman regarded the clay in question as belonging to Pensauken times. Salisbury and Knapp (op. cit., p. 104, fig. 49) state that there is here 20 feet of black clay overlying Pensauken sand and that the clay is overlain by Pensauken gravel. If this judgment of the geological age of the clay is correct, the horses probably lived during the first interglacial (Aftonian) or the beginning of the second glacial stage (Kansan). There are, however, those who insist that these Fish House clays belong really to the Cape May formation. This would make the geological age of the horse about that of the Wisconsin drift.

Besides the horse remains, only some bones of a wolf have been found in the clays mentioned, and these too have disappeared. They probably would have thrown little light on the age of the beds. We must reach conclusions from other data.

This fact seems to be pretty certain: Had horses lived at Fish House during the deposition of the Cape May they would (as did the mastodon, *Elephas primigenius*, and *E. columbi*) quite certainly have spread out over northern New Jersey and over the grassy plains of New York and Ohio; and their remains would somewhere have been found, as are those of the other species just mentioned, in old swamp and lake deposits overlying the Wisconsin drift; but no horse remains have ever been reported from such deposits. Furthermore, in all the digging that has been done at Trenton, in deposits acknowledged by all to belong to Wisconsin times, no trace has been found of horse remains.

Near the bottom of the Fish House clay bed, just below the level of the horse remains, there is found a layer which contains river clams represented by the genera *Unio* and *Anodonta*. Ten species of *Unio* have been recognized and two of *Anodonta*. When these were first studied the beds were believed to belong to the Cretaceous. Nevertheless, the close resemblance of the shells to still living species was recognized; and to them were given names differing from those of the related existing forms by the ending *oides*. The species were described by Lea and Whitfield and have been restudied by Dr. H. A. Pilsbry, of the Academy of Natural Sciences, Philadelphia. The species are probably identical with forms yet living; but half of them no longer exist in the region of Delaware River. Pilsbry (Proc. Acad. Nat. Sci. Phila., 1896, pp. 567–570) stated that five of them have no longer any representatives in the Atlantic drainage south of the St. Lawrence River system. It is probable that these species had, when they lived at Fish House, spread into other rivers south of the Delaware and thus were not trapped in this river by the Wisconsin ice. It seems certain, therefore, that a longer period of time and a longer series of vicissitudes must have intervened to produce such changes in geographical distribution. According to C. T. Simpson's work, "Descriptive Catalogue of the Naiades," 1914, *Unio* (*Quadrula*) *subrotundus* now inhabits the Ohio, Cumberland, and Tennessee Rivers; *U.* (*Lampsilis*) *anodontoides* occupies the Mississippi River and Gulf drainage regions; while *Anodonta corpulenta* is found in the Upper Missouri region. The Wisconsin ice-sheet and the short period of time since its disappearance are hardly sufficient to explain this wide dispersion of species, while others have been able to retain their place in the Delaware.

Opposed to this view regarding the identity of the unios of the Fish House beds, see Ortmann (Proc. Amer. Philos. Soc., vol LII, p. 280, 1913) and Baker (Univ. Ills. Bull., XVII, p. 205, 1920). These writers contend that the species have no especial relationship to western forms. According to Baker the deposits are older than the earliest glacial stage. On the other hand, according to Dr. E. W. Berry (quoted by Baker), who has studied the plants, the beds belong to the late Pleistocene.

We have, then, these reasons for holding that the Fish House clays are of early Pleistocene age: (1) Competent geologists have determined them as belonging to the Pensauken formation, laid down at or before the time of the Kansan stage; (2) the presence of remains of horses, evidences of whose existence during or after the Wisconsin have not been produced; (3) the presence of many species of naiades, some of which yet live in that region, but the majority of which now live only in far-distant regions.

We may confidently conclude that the horse remains which were found at Swedesboro belonged likewise to the Pensauken.

In Burlington County mastodons have been found at Pemberton (p. 64), but one can not be certain of their geological age. A reindeer has been unearthed at Vincentown (p. 64). It seems highly probable that it lived there while the Wisconsin ice-sheet occupied the northern part of the State; but there is a possibility that it is older. In the Academy of Natural

Sciences at Philadelphia are some remains of *Odocoileus* found at Vincentown (p. 227).

In the vicinity of Trenton, Mercer County, scant remains of six species of Pleistocene mammals have been reported. These are *Mammut americanum* (p. 64), *Elephas primigenius* (p. 132), *Bison bison* (p. 287), *Ovibos moschatus* (p. 248), *Cervus canadensis* (p. 237), and *Rangifer caribou?* (p. 248). All are known to have existed elsewhere during late Pleistocene times, and three indicate a cold climate. The presence of fossil vertebrates here is of special interest because many evidences have been found of man's occupation of the region in apparently late Pleistocene times.

At and in the vicinity of Trenton are found both Pensauken and Cape May deposits, the latter overlying the former (Salisbury and Knapp, op. cit., pp. 120, 165). The Cape May rises about 60 feet above sea-level. At various places the Pensauken protrudes through the mantle of Cape May and rises to a height of as much as 130 feet above sea-level. Its base is about 20 feet above sea-level. The materials consist of sand, gravel, and cobblestones. So far as the writer knows, no fossils have been found in the Pensauken about Trenton.

The Cape May at Trenton is held to have been laid down principally during the presence of the Wisconsin ice-sheet in the northern part of the State; and naturally it consists mostly of sands, gravels, coarse and fine, and some boulders. In the localities where excavations have been made for sand and gravel for building purposes, for sewers, and for railroads, and in search for relics of man, two principal divisions are recognized. Below are strata of clays, sands, gravels, and boulders which are believed to have been deposited by the floods of varying intensity which issued from the glacial moraine then about 60 miles above Trenton (figs. 8, 9). Over this lies a bed of what is called yellow drift, which reaches a thickness of about 3 feet. It consists mostly of fine sand, but there are many pebbles and occasionally some large boulders. It is everywhere characterized by wavy red bands. While some geologists have held the opinion that this deposit had been produced by winds, it appears to be definitely determined that it was waterlain (Wissler, Scient. Monthly, vol. II, p. 237). This "yellow drift" is overlain by about a foot of black soil which belongs to the Recent epoch and is the result of cultivation by whites. For details regarding the Trenton gravels and the yellow sands above it the reader should consult Ernest Volk's work, "Archæology of the Delaware Valley" (Papers Peabody Mus., vol. v, 1911).

All the species mentioned above have been reported from the beds known as the Trenton gravels. A femur of a bison was found also in the yellow drift (see p. 287).

Monmouth County has furnished more fossil vertebrates of the Pleistocene than any other county. Mastodons have been discovered at Englishtown, Freehold, Marlboro, Long Branch, Manasquan, and in the Navesink Hills (pp. 65, 66). Many specimens, as those about Freehold and Long Branch and Manasquan, are in such superficial positions in peat that they do not seem to be very old, probably of Cape May age; and yet of this one can not be wholly certain. The discovery of a heel-bone of a megatherium (p. 31) at Long Branch appears to indicate the presence there of early Pleistocene

deposits. At Englishtown the remains had apparently become mixed with marl, and they may belong to an older stage of the Pleistocene. In the Navesink Hills, according to Leidy, the mastodon remains were associated

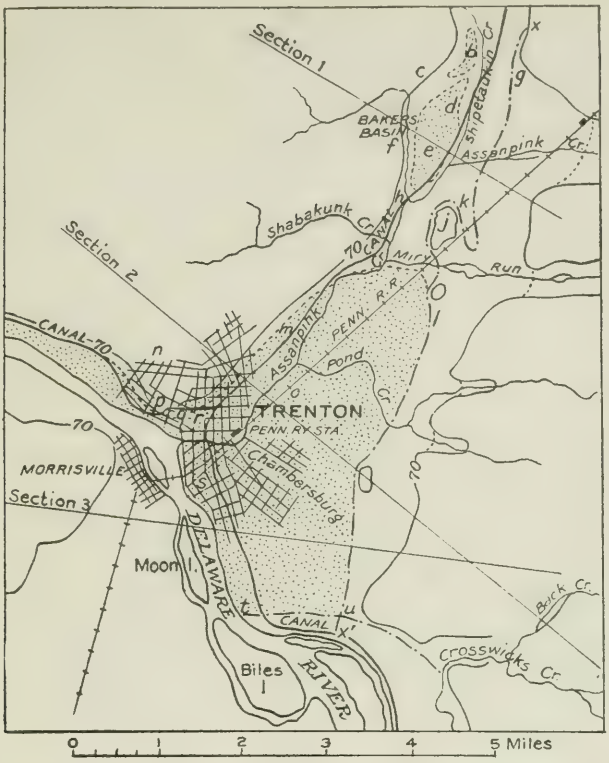


Fig. 8.—Sketch of vicinity of Trenton, showing distribution of Trenton gravels. Redrawn from Salisbury and Knapp.

with those of an extinct horse (p. 184). If so, both species probably were buried in Pensauken deposits. In this same region there was found long ago a tooth of *Elephas columbi* (p. 149); but it is useless to speculate on its

Fig. 9.—Sections taken at Trenton, New Jersey.
Upper figure taken along the line 3 of Fig. 8.
Lower figure taken along the line 2 of Fig. 8.
The black represents the glacial gravel. A, the crystaline rock of the region; T, Trias; K, Cretaceous; Pp, Pensauken; O, sea-level.

geological age. At Long Branch (p. 26), damaged skulls of walruses, probably of the existing species, have been met with. It seems natural to associate this southward migration, which extends to South Carolina, with the Wisconsin epoch; but it is possible that it was earlier. At Deal (p. 227) have been found remains of a deer, probably *Odocoileus virginianus*.

Somewhere about Shark River, a tooth of a peccary (p. 213) was found, as was supposed, in Miocene marl. Leidy could not distinguish this tooth from that of *Mylohyus nasutus*. So far as our evidence goes, this species belongs to the early and middle Pleistocene.

Near North Plainfield a tooth was found which is referred to *Elephas primigenius* (p. 133). The locality is very close to the moraine of the Wisconsin ice-sheet, and the animal probably lived there when the Plainfield outwash plain (Salisbury, Geol. Surv. New Jersey, vol. v, 1902, p. 738) was being laid down.

Near Schooley's Mountain, but west of Musconetcong River and in Warren County, remains of a mastodon (p. 67) were encountered in excavating the Morris Canal. It is probable that these were buried in a swamp left over from the Wisconsin times; but Lewis and Kümmel's map of 1910–1912 indicate in this region only drift older than the Wisconsin.

The mastodons found at Hackettstown and Hope, in Warren County, are probably of Late Wisconsin origin (pp. 67, 68).

Near Mount Hermon, about 5 miles northeast from Delaware, in Warren County, and about 2 miles northwest of Hope, was found the splendid skeleton of the moose *Cervalces scotti*, which forms one of the treasures of Princeton University (Scott, Proc. Acad. Nat. Sci. Phila., 1885, p. 174). It was discovered in a bog. All this region is (Salisbury, Geol. Surv. New Jersey, vol. VIII, plate XXVIII) occupied by Wisconsin drift and the bog doubtless rested on this drift. It seems certain, therefore, that this stately relative of our existing moose lived after the disappearance of the Wisconsin ice-sheet.

A mastodon (p. 68) which was found at Greendell in Sussex County quite certainly lived there after the last glacial stage.

Berry (Torreya, vol. x, p. 261) has studied a collection of nine species of plants which had been obtained in peat from near Long Branch. Only three of these now range north of Long Branch. He concluded that the last glacial stage had been followed by a period of climate warmer than the present climate. This is in accord with views which the present writer has held. It ought not, however, to be assumed with too much confidence that the peat-bed is of Late Wisconsin origin.

PENNSYLVANIA.

About half of the area of Pennsylvania lies outside of the region which was glaciated. Figure 10 is a map taken from Folio 172 of the U. S. Geological Survey, published in 1910 and compiled by Dr. W. C. Alden in 1901. A broad strip along the southern part of the State, being non-glaciated, is not represented. The areas shaded by parallel ruling and stippling are those which present evidences of glacial action.

The glaciated area consists of two principal portions. One of these, that subjected to the action of the Wisconsin ice-sheet, is represented on the map by means of oblique parallel lines coming down to an interrupted heavy line. This line, representing the Wisconsin terminal moraine, starts on Delaware River north of Easton, runs northwestward to Potter County, thence into New York, thence back into Pennsylvania, in Warren County, and then enters Ohio north of the Ohio River. The course of this moraine was worked out especially by H. C. Lewis and G. F. Wright and was described in report L of the Pennsylvania Geological Survey, in 1881. The moraine crosses the Delaware at Belvidere, New Jersey, and passes through the following counties: Northampton, Monroe, Carbon, Luzerne, Columbia, Sullivan, Lycoming, Tioga, Potter, Warren, Crawford, Venango, Butler, Lawrence, and Beaver.

South of this moraine are two areas which, on this map, are represented by stippling. These are occupied by drift materials, usually forming a considerably thinner covering, which are believed by most glaciologists to belong to an older Pleistocene stage, probably about as old as the Kansan. Especially in the valleys these older drift-deposits may reach thicknesses of 200 or 300 feet. These old glacial deposits are represented also by terraces along the margins of the valleys. Some of these in the vicinity of Warren stand at a height of about 1,400 feet above the sea. Figure 17 is taken from Shaw and Munn (Folio 178, U. S. Geol. Surv., p. 12). The uppermost gravels are supposed to represent the Kansan stage. A few small patches lying in the angle of the unglaciated area are of doubtful age, as indicated on the map. It must be stated, however, that there is some dissent from this conclusion as to the age of this outer drift. Professor E. H. Williams has published a number of papers in which he takes the position that this drift is a deposit laid down by the same ice-sheet that later on built up the Wisconsin moraine (Amer. Jour. Sci., vol. XLVII, 1894, pp. 32–36; Science (n. s.), vol. XXXVII, pp. 447–450; Pennsylvanian Glaciation, first phase, 1917, pp. 1–101). Professor G. F. Wright appears to take the same view. The writer sees no sufficient reason for distrusting the opinions of Dr. Alden and his colleagues.

It must not be assumed that an animal whose remains have been found within the area occupied by the Wisconsin drift lived during or after that stage. Even within this area there may occur fossil-bearing deposits of an older Pleistocene time. These older deposits may underlie the Wisconsin drift or they may occur as old terraces high up on the sides of the valleys of rivers. Cases of the latter kind are found along Allegheny River (Leverett, Monogr. XLI, U. S. Geol. Surv., pp. 229–252; Shaw Jour. Geol., vol. XIX, 1911, pp. 140–156; folio 178, U. S. Geol. Surv., p. 8). On the other hand, an animal of very late Pleistocene age, or even of the Recent, may be buried in deposits which overlie an old Pleistocene deposit. It is necessary, if it can be done, to determine the actual age of the deposit containing the remains; otherwise one must depend on the geological age of the species involved, or be content to wait for further information. Unfortunately, but few of the quadrangles in the glaciated area have had their geological

structure studied and reported on. At present the U. S. Geological Survey has published only Folios 92 (Gaines) and 93 (Elkland and Tioga), lying mostly in Tioga County, partly in Potter; also Folio 172 (Warren), occupying a part of Warren County. Information may sometimes be secured from the numerous volumes which have been published by the Geological Survey of Pennsylvania and from articles in the scientific journals.

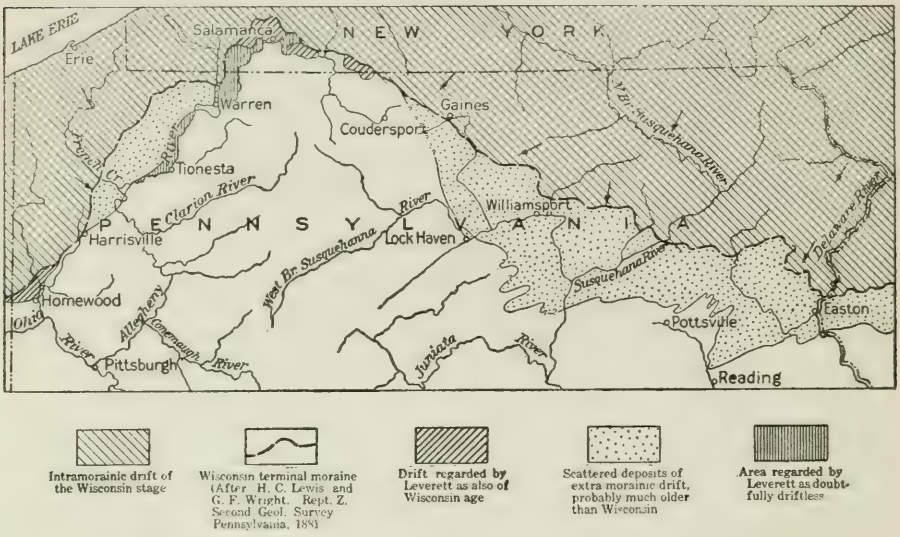


FIG. 10.—Glaciated areas of northern Pennsylvania. From W. C. Alden.

The Pleistocene deposits which lie outside of the glaciated areas have been mostly laid down along rivers. Some of the materials were transported by the streams which carried away the drainage from the glaciers; in other cases the materials were brought down from the higher lands and laid down along the lower and less sloping parts of the streams. In the unglaciated area many of the quadrangles have been surveyed by the U. S. Geological Survey and the folios aid in determining the age of deposits which contain fossil vertebrates.

Important collections have been made in a few localities, and these will now be considered:

At Pittston, in Luzerne County, on Susquehanna River, have been found teeth of the horse *Equus complicatus* (p. 184), remains of mastodon (p. 68), and of a musk-ox (p. 248). The presence of the horse makes it evident that the deposit containing the fossils belongs to a stage older than the Wisconsin, although the locality is within the area of the Wisconsin.

We consider now the contents of a cave found near Stroudsburg, Monroe County. The Hartman (or Crystal Hill) Cave was discovered in 1880 and explored first by Mr. T. Dunkin Paret, of Stroudsburg. It was soon afterward examined by Dr. Joseph Leidy, of Philadelphia, and Dr. Thomas

C. Porter, of Easton. Leidy published the first description of it in 1880 (Proc. Acad. Nat. Sci. Phila., pp. 346–348) and presented a list of the species of animals which had been secured by Mr. Paret. In 1889 (Ann. Rep. Geol. Surv. Pennsylvania, for 1887, pp. 1–18, plates I, II), a more detailed report was made by Leidy, including descriptions and illustrations of some of the vertebrates and of certain artifacts which had been discovered.

In 1894, Dr. H. C. Mercer made a re-exploration of the cave and gave a more extended description of it (Proc. Acad. Nat. Sci. Phila., pp. 96–104).

Combining the statements of Leidy and Mercer with data obtained from the Delaware Water Gap topographical sheet issued by the U. S. Geological Survey, one finds that the cave is situated on Crystal Hill, about 3.5 miles in a straight line southwest of Stroudsburg and close to the village of Stormville. Crystal Hill is a part of an anticlinal fold, Godfrey Ridge, of the Helderberg limestone. South of the fold runs Cherry Creek; north of it, Mt. Michaels Creek. On the northeast the hill is cut off from the rest of the ridge by a valley about 300 feet deep. Mercer's account states that the cave is on the top of the hill, about 0.25 mile from Cherry Creek, but the topographical map locates the top of the hill about 0.75 mile away from this stream. Mercer also wrote that the cave was 800 feet above Delaware River, 5 miles away. However, the hill has an elevation of somewhat less than 840 feet above sea-level, while the river at the nearest point is somewhat more than 280 feet above sea-level. Inasmuch as the cave is probably somewhere on the southern slope of the hill, it is about 500 feet above the Delaware and about 300 feet above the bed of Cherry Creek.

The opening of the cave in the rock was wide (Mercer, p. 96, fig. 1), but had become almost wholly choked by débris. Nevertheless, a hole large enough for adventurous boys to enter remained (Leidy, op. cit., 1880, p. 346). After a few feet descent the cave extended nearly horizontally more than 100 feet. It had become filled nearly to the roof by various deposits. Excavations showed that on top was a layer, about a foot, of "black friable earth mingled with animal and vegetal remains" (Leidy). Mercer describes it as a "top layer of limestone roof-splinters and downslidden outer talus thinning inward into less stony cave earth." Beneath this layer was a thin stratum of stalagmite. Further digging showed that below this stalagmite flooring the cave was filled to a thickness of as much as 14 feet in one place. This deposit is described by Mercer as being a continuous homogeneous bed of exquisitely fine clay deposited in thin laminæ rarely sprinkled with sand pockets and underlain with a thin film of sand. Neither in this deposit nor in the stalagmite was there found a trace of any formerly living thing. All the remains of animals and all the artifacts were discovered in the uppermost layer.

It should be noted at this point that this cave is situated about 5 or 6 miles north of the Wisconsin moraine.

The following is a list of the species of vertebrates identified by Leidy. When his names differ from those now in use they are inclosed in parenthesis.

List of species of vertebrates.

Chelydra serpentina.
Terrapene carolina (Cistudo clausa).
Meleagris gallopavo sylvestris (M. gallopavo).
Equus sp. indet (p. 185).
Mylohyus pennsylvanicus (Dicotyles (p. 213).
Rangifer caribou (p. 246).
Odocoileus virginianus (Cervus) (p. 237).
Cervus canadensis (p. 237).
Bison bison? (B. americanus) (p. 267).
Marmota monax (Arctomys).
Tamias striatus.
Sciurus carolinensis.
Castor canadensis (C. fiber).
Peromyscus leucopus (Hesperomys).
Neotoma magister (N. floridana).
Microtus pennsylvanicus (Arvicola riparius).
Erethizon dorsatum.
Castoroides ohioensis (p. 272).
Sylvilagus floridanus (Lepus sylvaticus).
Myotis subulatus (Vespertilio).
Eptesicus fuscus (Vespertilio).
Scalopus aquaticus (Scalops).
Procyon lotor.
Mustela noveboracensis (Putorius erminеus).
Mephitis putida (M. mephitica).
Urocyon cinereoargenteus (Canis virginianus).
Canis lycaon? (C. lupus).
Lynx canadensis (Felis).

Besides these vertebrates, there were reported by Leidy the land snails *Helix albolabris, H. alternata,* and *H. tridentata;* also a pair of valves of the river mussel *Margaratina margaritifera* and a fragment of another valve. Leidy regarded these as showing that this mussel formerly lived in Delaware River; whereas in his view it no longer existed there; but specimens of it from Philadelphia are in the U. S. National Museum.

An examination of the list shows that nearly all of the species of vertebrates are yet in existence and most of these still living in that general region. *Rangifer caribou* lives now far to the north and *Lynx canadensis* has its range somewhat further north. The two indicate a colder climate, especially the reindeer. Both got into the cave probably after the glacial front had withdrawn from that vicinity. The remains of *Castoroides* may have been carried in there at about the same time. The type specimen of *Mylohyus pennsylvanicus* was found in this cave. Cope referred specimens of a peccary found in Port Kennedy Cave to the same species with doubt. Undetermined species of the genus were recognized by Barnum Brown in his collection made in the Conard fissure in northwestern Arkansas. Dr. W. J. Holland reported *Mylohyus pennsylvanicus* from the cave at Frankstown, Pennsylvania. The type of the genus, *M. nasutus,* was found in Indiana. Beyond the testimony furnished by the Crystal Hill Cave, we have no evidence that the genus *Mylohyus* existed after the Wisconsin stage; the possibility exists that this species got into the cave before this stage.

The specimen of *Equus* is still more doubtful. It consisted of two isolated first and second milk molars of a very young colt. Leidy was in doubt whether the colt belonged to the domestic horse or to an indigenous species. The specimen had been collected with no record as to the part of the cave or of the depth in the upper layer of soil where it was buried. A fragment of a jaw of a colt might easily have been carried into the cave by some carnivorous animal since the coming of the whites. A fragment of the lower jaw of a bison also was found which had in it the last molar; and this was referred by Leidy to the existing buffalo.

It can hardly be doubted that this cave was hollowed out before the Wisconsin ice period. It may have been formed during the early Pleistocene. The fact that it was filled to a depth of 14 feet, in some places, with a fine laminated clay devoid of all traces of organic beings seems to indicate that for ages it had been shut off from the outer world, and that streams charged with fine sediment were permitted to pass through it. During possibly some glacial stage preceding the Wisconsin, erosion may have opened the cave so that the horse remains, those of a bison, and of *Castoroides* were dragged into it. The evidence for these suppositions is slender, but so too is that for a late Wisconsin indigenous species of horse in Pennsylvania. It is probable that most of the species found in the cave belong to the late Pleistocene or even to the Recent.

Fossil vertebrates found in a cave in Bucks County require our attention.

In 1880 (Proc. Acad. Nat. Sci. Phila., 1880, p. 349), Leidy presented a list of vertebrate remains which had been lying unstudied for 40 years in the collection of the Academy. These had been found in Durham Cave, somewhere near Riegelsville, in Bucks County. It is not improbable that the cave took its name from the village of Durham, about 2 miles southwest of Riegelsville. Leidy stated that the cave appeared to have been obliterated in the quarrying of limestone. In 1889 (Ann. Rep. Geol. Surv. Pennsylvania, for 1887, pp. 18–19) Leidy published a list of the species which he had identified.

List of fossil vertebrates from Durham Cave.

Acipenser sturio.
Ameiurus nebulosus (Amiurus atrarius).
Thamnophis sirtalis (Eutænia).
Chelydra serpentina.
Terrapene carolina (Cistudo clausa).
Melcagris gallopavo sylvestris (M. gallopavo).
Rangifer caribou (p. 246).
Cervus canadensis (p. 237).
Alces americanus (Alce).
Odocoileus virginianus (Cervus) (p. 227).
Erethizon dorsatum.
Marmota monax (Arctomys).
Sciurus carolinensis.
Castor canadensis (C. fiber).
Neotoma pennsylvanica (N. floridana).
Ondatra zibethica (Fiber).
Sylvilagus floridanus (Lepus sylvaticus).
Ursus americanus.
Procyon lotor.
Mephitis putida (M. mephitica).
Urocyon cinereoargenteus (Vulpes virginianus).

This list differs in its species from Leidy's list of 1880 only in the exclusion of the bison and the inclusion of the elk, *Cervus canadensis*. All the species are still in existence, most of them in that region. The presence of the reindeer, the moose, and the porcupine suggests a cooler climate than now prevails there. These animals may all have become buried in that cave during the latest times of the Wisconsin stage or even during the Recent.

We are now to study a case which furnishes us with a store of knowledge regarding the life of the Pleistocene. In 1871 there was found at Port Kennedy, Montgomery County, a cave which was worked for its fossils by Charles Wheatley and later by Dixon, Mercer, and Cope, the latter having devoted himself to the description of the vertebrates. First of all will be given a list of the species of vertebrates, mostly mammals which have been recognized in the materials found in the cave. When Cope's names differ from those employed here they are put in parenthesis.

List of species of vertebrates found in Port Kennedy Cave.

Ranidæ:
- Rana sp. indet.

Emydidæ:
- Clemmys insculpta.
- C. percrassa.
- Terrapene eurypygia (Toxaspis anguillulatus).

Colubridæ:
- Coluber acuminatus (Zamenis).

Meleagridæ:
- Meleagris superbus (M. altus).

Megatheriidæ:
- Megalonyx (p. 31).
- M. scalper (p. 31).
- M. tortulus (p. 31).
- M. wheatleyi (p. 31).
- Mylodon harlani? (p. 31).

Equidæ:
- Equus complicatus (E. fraternus) (p. 185).
- E. pectinatus (E. f. pectinatus) (p. 185).

Tapiridæ:

Tapirus haysii (p. 203).

Tagassuidæ:
- Mylohyus nasutus (p. 213).
- M. pennsylvanicus? (p. 213).
- Tagassu tetragonus (Mylohyus) (p. 213).

Camelidæ?:
- Teleopternus orientalis (p. 224).

Cervidæ:
- Odocoileus lævicornis.
- O. virginianus?

Bovidæ:
- Bison sp. indet. (Bos) (p. 256).

Elephantidæ:
- Mammut americanum (Mastodon) (p. 69).

Sciuridæ:
- Sciurus calycinus.

Castoridæ:
- Castor canadensis (C. fiber).

Cricetidæ:
- Peromyscus leucopus? (Hesperomys).
- Anaptogonia hiatidens.

Cricetidæ—continued,
- Sycium cloacinum.
- Microtus dideltus.
- M. diluvianus.
- M. involutus.
- M. speothen.

Zapodidæ:
- Zapus hudsonius?

Erethizontidæ:
- Erethizon dorsatum?

Ochotonidæ:
- Ochotona palatina (Lagomys).

Leporidæ:
- Sylvilagus floridanus (Lepus sylvaticus).

Talpidæ:
- Scalopus sp. indet. (Scalops).

Soricidæ:
- Blarina simplicidens.

Vespertilionidæ:
- Myotis? sp. indet. (Vespertilio).

Ursidæ:
- Ursus americanus.
- Arctotherium haplodon.

Mustelidæ:
- Taxidea taxus (T. americana).
- Mephitis fossidens.
- M. leptops.
- M. obtusata.
- M. orthostica.
- M. putida.
- Osmotherium spelæum.
- Pelycictis lobulatus.
- Mustela diluviana.
- Gulo luscus.
- Lutra rhoadsii.

Canidæ:
- Canis priscolatrans.
- C. dirus? (C. indianiensis).
- Urocyon cinereoargenteus.
- U. latidentatus.

Felidæ:
- Machairodus gracilis.
- Smilodontopsis mercerii (Smilodon).
- Felis eyra.
- F. inexpectata (Uncia).
- Lynx calcaratus.

Into this list there are admitted 60 species, of which 54 are mammals. Of these, 41 are extinct, not counting the doubtful species unless there is good reason for it. There are, therefore, 68 per cent of the species extinct.

No remains of *Rana* were mentioned by Cope in his list of 1899. One species unnamed was recorded by Wheatley in his lists of 1871 and by Mercer in his paper of 1899. The turkey (*Meleagris superbus*) was not included by Cope in 1899, but it was included by Wheatley and Mercer and Cope in their papers of 1871 and in that of Cope in 1896 (p. 378). Mercer

(1899, p. 280) mentions a leg-bone of a turkey, with spur, found by Wheatley. Remains of *Megalonyx* were abundant, but of *M. loxodon* only a single tooth was met with. *Mylodon,* believed to be *M. harlani,* was found only by Wheatley and was represented, as stated by Cope, by only a claw phalanx. The horse remains were originally (Cope, 1895, p. 447) referred to *Equus major* (=*E. complicatus*). Mercer, in 1899, in his figure 9, following Cope's nomenclature, uses the name *E. complicatus.* In 1899, Cope concluded that the equine remains represented two races of *Equus fraternus, E. f. fraternus* and *E. f. pectinatus.* The present writer believes that the teeth referred to the subspecies *fraternus* are too large to belong to the species which was called *E. fraternus,* but which is now called *E. leidyi.* Only a single species of tapir, *Tapirus haysii,* was recognized. Cope (1895, p. 447) stated that it was the most abundant of the larger mammals. Cope (1899, p. 257) reported that 18 individual peccaries were represented by teeth, while bones were numerous. He recognized the presence of three species. The identifications of *Mylohyus nasutus* and *M. pennsylvanicus* were uncertain. A new species, *M. tetragonus,* was based on a ramus of a lower jaw. Milk molars were yet present and the third molar had not appeared. Cope spoke of the long diastema; but, to judge from his figure, the diastema equals only about the length of the milk molars and the first molar.

Cope, in 1899, described *Telcopternus orientalis,* basing it on a few teeth which belonged to three individuals. He was doubtful about the family position of the animal, but put it provisionally in the Camelidæ. In many respects the teeth resembled those of the Cervidæ. Matthew (Osborn, Age of Mammals, p. 469) has suggested its affinity to *Ovibos.*

Two species of deer were found in the cave, of which one was not distinguishable from *Odocoileus virginianus.* In Wheatley's second list of 1871 and that of Cope of the same year there was recorded an undetermined species of *Bos* (*Bison*). Mercer (1899, p. 280) recorded from the Wheatley collection remains of three individuals of one species of the same genus. In Cope's paper on the remains of this cave nothing is said about the genus; but in 1872 (Proc. Amer. Philos. Soc., XII, p. 96) he stated that *Bos* was represented by a part of a femur and some other bones. Hence in the list given above an undetermined species of *Bison* is included.

Abundant remains of the mastodon occurred in the cave, but none of any of the elephants. One need not, however, on that account conclude that elephants were not living in that region at that time.

It will be observed that a considerable number of rodents is included in the list. One species of porcupine is recognized. This was at first regarded by Cope as an extinct form and called *Erethizon cloacinum;* but in 1899 he referred all the remains, with some doubt, to the existing species, *E. dorsatum.* Cope found remains of about 50 individuals of a species of rabbit which he determined as *Lepus sylvaticus,* but this is now called *Sylvilagus floridanus.* In the Wheatley collection a species of bat was recognized and put in *Vespertilio.* Probably it belonged to *Myotis.*

Bears were abundantly present in the cave. One species, *Arctotherium haplodon,* was larger than the grizzly bear and represented by parts of

about 25 individuals. A smaller bear, indicated by 8 individuals, appeared to be in no way different from the existing black bear, *Ursus americanus.* Of skunks there are listed 7 species, belonging to 3 genera, all the species being extinct except a supposed *Mephitis putida.* Besides these mustelids, there have been identified remains of the existing badger, the existing glutton, an extinct weasel, *Mustela diluviana,* and an extinct otter, *Lutra rhoadsii.* Remains of true dogs were not abundant in the collection. Cope recognized, however, 2 species of the genus *Canis,* one of about the size of the more common form of the existing wolf; the other exceeding in size the largest wolf known to him. This he thought might belong to Leidy's *Canis indianensis* (=*C. dirus* Leidy). There were present 2 foxes, the existing gray fox (*Urocyon cinereoargenteus*) and an extinct species, *U. latidentatus.* Of the cat family a species, thought at first to be a hyæna (*Crocuta*), received the name *Felis inexpectata.* It had the size of the jaguar, and was represented by teeth and various bones. An extinct lynx, much like *Lynx ruffus,* was present. Another cat was identified as *Felis eyra.* Of this species G. S. Miller (Bull. 79, U. S. Nat. Mus., p. 116) remarks that its type locality is Paraguay and that it is supposed to range north to Central America. It appears somewhat doubtful, therefore, that the fossil remains belong to this species. Nevertheless, the progenitors of the species, in their wandering from Asia or Alaska to Central America and Paraguay, might have sent a colony into Pennsylvania, later to become extinct. Cope stated (1899, p. 250) that there was an isolated calcaneum in the collection which was of the proper size for *Felis eyra,* but which differed from that of this species. Two species of saber-tooth cats were found, *Smilodontopsis gracilis* and *S. mercerii.* The former is represented by various bones and teeth, especially by a damaged skull which presents the dentition. The crown of the great canine is 113 mm. long.

Besides the species included in the list given above, there are a few whose presence for one reason or another is doubtful. In both of his lists of 1871 Wheatley reported the presence of *Crotalus, Coluber,* and *Tropidonotus* (*Natrix*). Cope (1871, p. 98) said that the reptiles included three or four serpents, but in 1895 (p. 447) he wrote that two species of *Ophidia* were recognized. In his final paper he mentioned only his *Zamenis acuminatus,* here referred to *Coluber.* Wheatley (1871, p. 255) recorded an unidentified snipe as belonging to *Scolopax.* Cope (1871, p. 98) wrote that a snipe was one of two species of birds present. Mercer (1889, p. 280) recognized the same remains as belonging to a species of *Gallinago.* Wheatley in his last list (1871, p. 384) and Cope (1871, p. 98) reported *Scalopus* (*Scalops*) as being represented by an undetermined species. It is catalogued by Mercer in the same way. Cope (1895, p. 447) stated that the raccoon was very rare; but it was not mentioned in any of his later papers. On the same page he wrote that there were fragments of teeth closely similar to those of *Bassariscus astutus;* but the species was not mentioned afterward.

As already said, there are admitted into the list given above, as identified in a reasonably good manner, 60 species, of which 54 belong to the Mammalia. It is a matter of interest to compare these with the species of mammals which were living in that general region before the fauna was

disturbed by the arrival of the whites. The number of species of the existing mammals, as shown in the second column, is obtained from Rhoads's "Mammals of Pennsylvania and New Jersey." The subspecies are not included.

Families of land mammals represented in Port Kennedy Cave and those that have lived in that region within Recent times, together with the number of known species in each family at each of the two epochs.

Families.	No. of species, Port Kennedy.	No. of recent species.	Families.	No. of species, Port Kennedy.	No. of recent species.
Megatheriidæ...	5		Zapodidæ.....	1	2
Didelphidæ.....		1	Erethizontidæ...	1	1
Equidæ.....	2		Ochotonidæ.....	1	
Tapiridæ.....	1		Leporidæ.....	1	2
Tagassuidæ.....	3		Soricidæ.....	1	5
Camelidæ?.....	1		Talpidæ.....	1	3
Cervidæ.....	2	2	Vespertilionidæ..	1	8
Bovidæ.....	1	1	Procyonidæ.....	?	1
Elephantidæ....	1		Ursidæ.....	2	1
Sciuridæ.....	1	6	Mustelidæ.....	11	9
Castoridæ.....	1	1	Canidæ.....	4	3
Cricetidæ.....	7	9	Felidæ.....	5	3

In the column of fossils there are 54 species; in that of the Recent there are 58 species. Of two families represented at present in the region, but not included in the Pleistocene column, Didelphidæ and Procyonidæ, the latter named has had remains referred to it with doubt. Without doubt members of both families existed there at that time.

Of the families of the Pleistocene column two no longer live anywhere near the region; four nowhere on the continent; one nowhere on the earth. Even of such families as the Ursidæ and the Felidæ important elements, as *Arctotherium* and the saber-tooths, are extinct. Of the 54 species admitted in the Pleistocene column 40 are extinct; that is, 74 per cent.

If we consider the sizes of the animals in question we gain this result: Only 15 of the existing species are of any considerable size, ranging from that of a raccoon to that of a bison, about 26 per cent. Of the 54 fossil species of mammals, about 30 vary in size as indicated, about 57 per cent. It is hardly to be doubted that this preponderance is due to the poorer chances which the smaller skeletons had of preservation and of rescue from the matrix. Had the smaller fossil species been preserved and collected in the same proportion that the smaller existing ones have to the larger, the cave ought to have furnished twice as many species of mammals as it did. It is, of course, possible that the larger species are more liable than the smaller ones to become extinct as time passes on. We can hardly doubt, in any case, that when the Port Kennedy animals were being buried in that cave there lived in that region a considerably larger number of species than within Recent times. There must have existed in that region more moles, more rabbits, more cricetids, more squirrels, and many more

bats. Certainly there is no adequate record of the number of birds, snakes, turtles, and amphibians that must have existed about Port Kennedy and have perished in that cave.

From the collection that has been made in the cave at Port Kennedy some definite conclusions ought to be reached regarding their time of existence. In his account of the cave and of the exhumation of the animal and vegetable remains, Mercer (1899, pp. 269–286) has shown what extreme care was taken in recording the position which each specimen occupied in the deposits. In his figure 9 he has noted the levels which the various species occupied. While the existence of four beds of materials makes it evident that the deposition went on for some time, it is noted that few or no differences exist in the character of the species included. Possibly Mercer's subdivision 1 is to be excepted in this statement. Certainly no great changes went on in the fauna while the cave was being filled; no such changes as occurred in the glaciated region from the Aftonian interglacial stage up to the Late Wisconsin. It appears more probable that the deposits in the cave and the animals entombed there appertain to about a single Pleistocene stage. Is, then, the stage the Late Wisconsin?

This cave is situated only about 55 miles south of the Wisconsin moraine. At the time the species found in the cave existed they must each have occupied a wide extent of territory. It is not to be doubted that the range of nearly every species extended northward far beyond the moraine mentioned. Why, then, in deposits overlying the Wisconsin drift have there never been found any remains of the four Port Kennedy species of *Megalonyx,* of *Mylodon,* of the two species of horses, of the tapir, of the three species of peccaries, of the deer *Odocoileus lævicornis,* of the five extinct species of cricetids, of *Ochotona,* of the extinct species of *Blarina,* of the great bear *Arctotherium,* of the six extinct species of skunks, of the extinct otter, of the extinct dog, of the extinct fox, of any species of saber-tooth tiger, or of the extinct cats *Felis inexpectata* and *Lynx calcaratus?* The absence of so many species of animals, most of them of large size, from deposits so well adapted to preserve bones and teeth, render it very certain that the animals no longer existed there.

Did the extinct species which are referred to above exist in eastern Pennsylvania at some time during the Wisconsin glacial stage and perish before the close?

A few of the species found in the cave and still existing are at present inhabitants of regions somewhat more northerly than Port Kennedy. Such are *Erethizon dorsatum* and *Gulo luscus;* but the great majority, living and extinct, indicate a climate at least as warm as that of the present; many of them suggesting a still milder condition. Within historical times both of the species just named have inhabited the Alleghany Mountains at least as far south as Port Kennedy. Cope, in 1871 (Proc. Amer. Philos. Soc., vol. XII, p. 99), concluded that he had then identified in the cave remains of 11 neotropical species. It appears, therefore, wholly improbable that this assemblage of animals lived in that region, so close to the foot of the glacier, during the Wisconsin stage. These animals must have had their time of existence previous to this inhospitable epoch. It seems to the

writer that the proportion of extinct species, three-fourths, and the history of many of the genera and species, indicate a time about equivalent to the Aftonian.

Professor A. Heilprin (Proc. Phila. Acad. Nat. Sci., 1895, p. 451) expressed himself as being inclined to refer this cave fauna to the Pliocene. An examination of this opinion would show that it is no more tenable than the opinion that the fauna is of the Wisconsin stage. It will not be discussed here beyond saying that deposits containing a similar fauna are found along the Atlantic coast from New Jersey to the Gulf, and that at one place at least, Vero, Florida, these are underlain by abundant Pleistocene sea-shells.

Besides the vertebrates which have been listed, a number of beetles were found and about 10 specifically determined plants. Wheatley (1871, p. 385) presents a list of the beetles as determined by Dr. G. H. Horn, but the names were not accompanied by descriptions. When later (Trans. Amer. Entom. Soc., vol. v, 1876, pp. 241–245) Horn came to describe them he reduced the number of species and, in some cases, gave them other names. The following is a list as given in Horn's paper just cited: *Cychrus wheatleyi, C. (minor), Pterostichus* (spp. indet.) *Cymindis aurora, Chlœnius punctulatus, Dicœlus alutaceus, Choeridium? ebeninum, Phanœus antiquus, Aphodeus precursor.* All of these, as the writer is informed by Dr. E. A. Schwarz, of the U. S. Department of Agriculture, are regarded as extinct, but as closely allied to species now living in that general region. The plants, as reported by Mercer, are *Quercus palustris, Q. alba, Q. macrocarpa, Fagus ferruginea, Corylus americana, Pinus rigida, Carya porcina, C. alba, Ampelopsis quinquefolia, Cratœgus crus-galli?,* and all still flourish in eastern Pennsylvania.

Mercer (1899, p. 269) has given a description of the cave found in quarrying operations. It was located on the right bank of the Schuylkill River, at the village of Port Kennedy and about 2 miles below Valley Forge. Wheatley (1871, p. 236) gave a map which showed the position of the quarries. A comparison of this with the topographical map of Folio 162 of the U. S. Geological Survey shows that they were situated about 800 feet away from the river and facing the valley of an unnamed streamlet. None of the descriptions give the elevation of the cave above the river or above the sea. The river at that place is apparently about 70 feet above sea-level. The 100-foot contour-line runs along near the location of the quarries, but these may have extended back to a higher level. Putting all of the statements together, it appears probable that the mouth of the cave was, in Wheatley's time, about 50 feet above the level of the river. Originally the surface elevation may have been still greater, but may have been reduced by erosion of the hill. The surface rock here is red shale of the Stockton formation, belonging to the Triassic, and is underlain by the Shenandoah limestone, a member of the Cambro-Ordovician series. This limestone was being quarried in 1871, when a cave was broken into, filled with incoherent materials and exposing fossil bones in abundance. It was visited by Charles Wheatley, who proceeded to make excavations and collect the fossils. In studying the fossils he worked with Professor E. D. Cope and Dr. G. H. Horn. The results were published in Wheatley's two papers of 1871 and in

two papers by Cope in the same year (Proc. Amer. Philos. Soc., vol. XII, pp. 15, 73–102). According to Wheatley's description and his figures, the part of the cave seen was about 20 feet wide at the top, expanded below to about 30 feet, and then narrowed at the bottom, as then recognized, to about 10 feet. The depth was given as 40 feet, but Mercer thinks that this was improbable and that Wheatley's measurements were to some extent guesses. Mercer (1899, p. 271) stated that this cave might be compared to a bottle of unknown size. It had opened to the surface; and on his page 283 Mercer spoke of it as forming a well-like hole that might have been as much as 70 feet deep. Evidently Mercer here included that part of it which he himself excavated. The materials filling it were, according to Cope (1871, p. 73), the débris of the neighboring Triassic strata. Figure 11 is taken from Mercer's paper and is a reproduction of a sketch made by Wheatley in 1871. After Wheatley had made his collection the cave was covered over by débris from the quarry and forgotten.

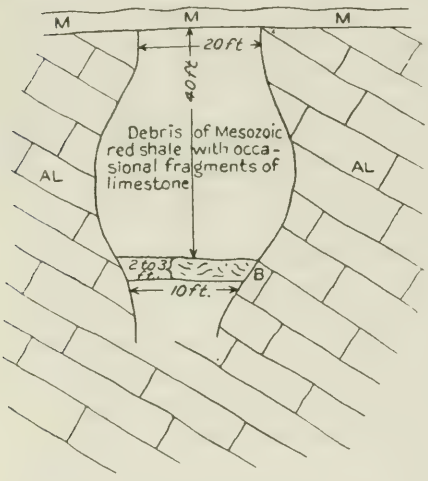


FIG. 11.—Section of Port Kennedy bone cave at time of first exploration, 1871. Redrawn from Mercer.
M, M, Triassic shale; AL, Triassic shale; B, black clay, with leaves, etc.

In the course of further quarrying operations the same cave was broken into again in 1893. Excavations in the materials that filled the cave were

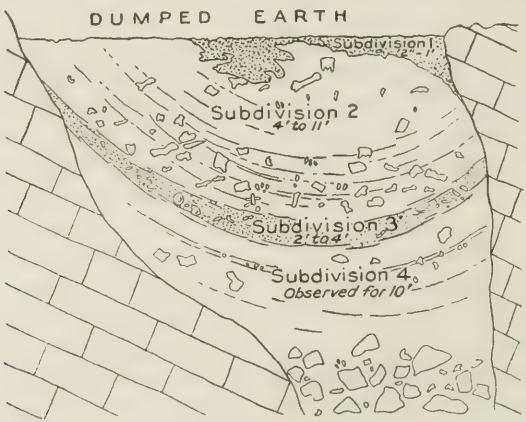


FIG. 12.—Section of Port Kennedy bone cave at time of last exploration, 1894. Redrawn from Mercer.

made in 1894 by Dr. Samuel Dixon, H. C. Mercer, and others, resulting in the securing of the collection which formed the subject of Cope's paper of 1894 and his final report of 1899. At this time, according to Mercer, the

quarrying operations carried on from 1855 had transformed a gently sloping hillside into an amphitheater several acres in extent, walled with perpendicular escarpments of rock, sometimes a hundred feet high. At this time the floor of the quarry had been lowered and the cave was broken into at a level below that reached by Wheatley. Figure 12, reproduced from Mercer's figure 5, shows the relation of the later excavations to those of 1871. As already stated, Mercer concluded that Wheatley's dimensions were probably results of guesses, inasmuch as the top of Mercer's exposure was not more than 30 or 33 feet below the original level of the hilltop. According to Mercer's figure 5, his own excavation probably extended down about 16 feet below the level reached by Wheatley; but other statements appear to make this somewhat greater.

Mercer wrote that the materials filling the cave had been stratified by the action of water. He recognized four subdivisions, most of which stood higher around the walls than at the center of the cave. Of these subdivisions, the first and uppermost was supposed to mark the lowest level attained by Wheatley. It consisted of fine clay and loam of black color, intermingled with fine and coarse muck, in which were found some remains of small mammals, just what species was not stated. On his chart, his figure 9, a tapir is indicated as occurring in it. Subdivision 2 was composed of from 4 to 11 feet of sandy clay, with fragments of sandstone and limestone, from small ones up to about 2 feet in diameter. In this matrix there were numerous bones and teeth of large animals, but it lacked small ones and vegetal matter. Subdivision 3 was a sandy clay, blackened by vegetable matter and containing numerous bones of vertebrates, large and small. The lowest subdivision, 4, was a zone which was followed down about 10 feet and which consisted of sand, clay, and stones, all of a yellow color. In this were found remains of the larger mammals, better preserved than in the upper subdivisions. At the lowest depth reached the excavation appears to have extended below the level of the Schuylkill River and the water came in so rapidly that further descent was not practicable.

Mercer's theory of the filling of the cave is expressed in these words, on his page 277:

> "Enough had been seen to convince us that a fresh-water flood, rising to a level of from 15 to 20 feet above the present level of the hill-top, hence a general inundation of the whole surrounding country, bearing in its current the clay, stones, and earth of neighboring levels, had tumbled into the fissure, carrying with it the bones of creatures previously denuded of flesh and softened by decomposition."

And further, on page 284:

> "Not unreasonably, therefore, we may suppose, not only that the creatures had perished together, but also that they had perished on the spot or at the chasm—not meeting this fate during a long interval of time, and through a long series of chance tumbles, but suddenly and by force of a common event."

Are we to suppose that during some summer freshet animals in such numbers were swept away that those that were found in the cave, and doubtless many more which decayed utterly, were only the relatively few that happened to pass over that 20-foot hole? Where, then, were picked up all the other animals that must have burdened the swollen Schuylkill?

Or did it possibly happen that all the animals that were swept away were in some unaccountable manner directed into that hole? If the current was strong enough to sweep along stones up to 2 feet in diameter, how did it happen to deposit there fine sand and clay, leaves, cones, seeds, and sticks? It is difficult to accept the theory that the filling of the cave was due to a catacylsm such as has been invoked. It seems far more probable that the mouth of the cave was open for many hundreds of years, possibly thousands of them, so that animals, plants, stones, and fine and coarse earth could in various ways get into it. Animals wandering about might inadvertently fall in or be pushed in by the herd. Doubtless at some former time the Schuylkill flowed at a higher level than now, and during times of unusually high water might have risen to the level of the mouth of the cave and carried into it at each rise some mud, some vegetation, and some animals. The filling was quite certainly a slow process.

To the writer the part of the cavern which was worked and pictured by Wheatley has all the marks of an enormous pot-hole, such as those which have been discovered at Cohoes, New York. While the latter appear to have been drilled out in late Pleistocene times, the Port Kennedy hole must have been fashioned during the early Pleistocene or even in the Pliocene. One may suppose that, after the pot-hole had reached the depth where the constriction was found, the water began to find its way out at the bottom through fissures or passages in the limestone. When this happened, the passages may have been enlarged mechanically or by means of solution, resulting in the formation of the various lower caverns. When the river had been lowered enough to reach only occasionally the mouth of the pot-hole, the latter became choked first by the coarse materials now found in subdivision 4, and afterwards by finer sand and mud.

Some vertebrates of the late Pleistocene or early Recent observed at Carlisle deserve consideration.

In 1850 (Proc. Amer. Assoc. Adv. Sci., vol. II, 1849, pp. 352–355) Professor S. F. Baird gave an account of his explorations in the caves in the region about Carlisle, Cumberland County. One of these caves was near Carlisle, and in it Baird found a large number of animal remains. A second cave, the situation of which was not given, was on the top of a hill and was a vertical shaft 30 feet deep, which opened into a large gallery. It furnished a skeleton of a bear, but this appeared to have only recently fallen into the cave. Another cave was on the bank of the Susquehanna, 0.5 mile below a railroad bridge. It was, therefore, probably near Harrisburg. The entrance was in limestone rock, nearly vertical, and 20 feet deep. Here Baird found many bones, embedded in mud, but of these he obtained only a few. Another cave, apparently nearby, which Baird spoke of as "the main cave," furnished some of his specimens. Still another cave, probably in the same neighborhood, was the source of his most perfect specimens. This presented a series of galleries near the roof and these were reached by ladders. These galleries were filled with mud, and in this mud the bones were buried. The number of species which he obtained, he reported, was nearly twice the number living there at the present time. Of these fossil species he estimated that about 5 per cent were extinct.

Baird appears never to have completed his study of his collection. His list designates the animals only by their vernacular names. The mammals consisted of panthers, lynxes, wolves, foxes, otters, bears, muskrats, deer, beavers, and rabbits. There were bird remains in great quantities, and these included wild turkeys, some of great size, swans, wild ducks, and pelicans?. There appeared to be 8 or 10 species of tortoises. Bones of snakes were quite common; also scales and vertebræ of fishes, and a lower jaw of a salamander. In the uppermost 2 or 3 inches of mud were many relics of Indians.

Baird supposed that these bones had in most cases been washed in from above through sink holes. This collection, or some of it, was brought by Baird to the Smithsonian Institution; and they, or some of them, are in the collection of mammals; but the bulk of the collection has apparently been lost. All of these animals belong evidently to either the very late Pleistocene or to the Recent period.

A cave at Frankstown has furnished fossils of about Middle Pleistocene time. In 1908 (Ann. Carnegie Mus., vol. IV, pp. 228–233) and again in 1912 (Proc. Internat. Zool. Congr., Boston, 1907, pp. 748–752), Dr. W. J. Holland gave an account of the discovery of vertebrate fossils in a fissure in limestone rock at Frankstown, Blair County. This village is situated on the Frankstown Branch of Juniata River, a little more than 2 miles north of east of Hollidaysburg. The fissure was excavated in a Devonian rock known as the Lewistown limestone. The quarries are reported to be in the village and on the top of a hill that rises about 400 feet above the banks of the Juniata. According to the Hollidaysburg topographical sheet, the 920-foot line crosses the river just above the village. The highest hill, 1,260 feet above sea-level, is 0.3 mile away toward the northwest. In this hill, as Dr. Holland stated, there are several small caves. The one which furnished the fossils appeared to be about 40 feet in length, averaging from 6 to 8 feet in width, and at the most was not more than 10 or 12 feet high. The floor was about 30 feet below the top of the hill. The fissure appeared to have once continued up to the surface, but the opening had been filled with fallen blocks of limestone. The floor of the cave is described as being occupied by about 2 feet of red soil, everywhere traversed by bands and layers of dark materials charged with organic matter. With the finer deposits were mingled fragments of rock, some being large blocks. The fossil remains appear to have been carefully collected, but were mostly fragmentary. They were only cursorily studied at the time of Holland's writing and nothing has since been published on them. The number of species obtained was estimated to be from 30 to 40. The following genera and species are mentioned:

Meleagris sp. indet.
Megalonyx sp. indet. (p. 31).
Tapirus sp. indet. (p. 203).
Mylohyus pennsylvanicus (p. 214).
Odocoileus virginianus (p. 227).
Cervalces? sp. indet.
Bison sp. indet.
Mammut americanum (p. 69).
Sciurus sp. indet.
Ondatra sp. indet.
Erethizon sp. indet.
Lepus sp. indet.
Ursus americanus.
Arctotherium haplodon.
Mephitis sp. indet.
Canis sp. indet.
Felis? sp. indet.

After the foregoing had been put in type Mr. O. A. Peterson, of the Carnegie Museum, sent the writer a revised list in which additions are made. The following are the most important:

Cryptobranchus sp. indet.
Rana catesbiana?
Clemmys insculpta.
Blarina sp. indet.
Ænocyon dirus.
Canis priscolatrans?
Spilogale putorius.
Brachyprotoma putorius.
Boötherium bombifrons.
Equus sp. indet.

Besides these forms, remains belonging to bats, various birds, snakes, and batrachians have been recognized. Of the fossils identified generically or specifically those belonging to *Megalonyx, Tapirus, Mylohyus, Cervalces, Mammut,* and *Arctotherium* are certainly extinct. Probably, too, the bison and the species of *Felis* are extinct. There are, therefore, pretty certainly close to 50 per cent of the species which are no longer living. This percentage and the history of some of the genera make it improbable that the assemblage belongs to the Late Wisconsin stage. Some of them could hardly have been living during the Wisconsin, when the foot of the glacier was within 100 miles toward the northeast and northwest. On the other hand, there are no species or genera present which make it necessary to refer the collection to the first interglacial. The assemblage probably belongs to the middle Pleistocene.

Coming now to the very southwestern corner of the State, we find that *Elephas columbi* has been met with in the bed of Hargues Creek, 3 miles above Rogersville, in Greene County (p. 150), and *E. primigenius* on Gray's Fork of Ten Mile Creek, near Graysville (p. 133). In the Rogersville Folio (No. 146, U. S. Geol. Surv.), Dr. F. G. Clapp described the geology of this quadrangle. On his page 10 he briefly discussed the meager Quaternary deposits of the area. These he referred to the Carmichaels formation, and indicated his opinion that it belonged to very early Pleistocene. On the geological map it is represented as occurring along Ten Mile Creek at and just below Rogersville. The occurrence of a tooth of *Elephas columbi* just above this town and of *E. primigenius* just above Harveys (p. 133) renders it probable that other patches of the formation exist further up the stream and along some of its branches, and that the fossils were derived from that formation. It is, of course, possible that small patches of a later deposit exist there.

Reference has been made to the Carmichaels formation. The type locality is found at Carmichaels, on Muddy Creek in Washington County. The geological description of the locality has been presented by Marius R. Campbell in the Masontown-Uniontown Folio (No. 82, U. S. Geological Survey). The formation occurs extensively along Monongahela River and other streams of western Pennsylvania. For information the reader should consult the Geological Survey Folios Nos. 144, 146, 121, 82, and 177. The deposits occur at levels considerably above the present streams and are regarded as having been laid down in old and now abandoned river channels and in tributaries of these. The time when this occurred is believed by many, if not most geologists to belong to the early Pleistocene, the Kansas

stage, or possibly the Nebraskan. In the opinion of some geologists the glacial ice dammed the streams and caused their valleys to be filled with detritus. More recent Pleistocene deposits, possibly of Wisconsin age, occur at lower levels in some places south of the Wisconsin moraine; and perhaps the age of some of them has not yet been recognized. When remains of vertebrate animals are discovered, it is of great importance to determine, if possible, the exact levels of their origin.

On another page mention is made of the finding of a tooth of *Elephas primigenius* at Lone Pine (p. 133), 7.25 miles south of southeast of Washington. This village is on Little Ten Mile Creek. No details of the discovery have been received. From Folio 144 of the U. S. Geological Survey it is learned that patches of the Carmichaels formation are found for several miles along Ten Mile Creek, near the southern boundary of the quadrangle. It seems probable that there may be patches of the same deposit along Little Ten Mile Creek, in the neighborhood of Lone Pine.

As detailed on page 70, a mastodon tooth was found many years ago about 1.5 miles south of the village of Hickory, Washington County, about twenty miles southwest of Pittsburgh. Westland Run empties into Chartiers Creek, and this into the Ohio at Pittsburgh. The geology of Burgettstown and Carnegie Quadrangles has been described by E. W. Shaw and M. J. Munn (Folio 177, U. S. Geol. Surv. 1911). No Pleistocene deposits are mapped on the stream mentioned; but just a little lower down, on Chartiers Creek, is a patch of the Carmichaels formation. Below Hickory somewhere there must be a Pleistocene deposit of some kind, and it is more probably early than late Pleistocene.

From the vicinity of Pittsburgh there have been reported remains of the mastodon (p. 69), of *Elephas columbi* (p. 150), and of an undertermined species of elephant (p. 168). Neither of the elephants is certainly determinable. The mastodon, represented by fragments of bones and teeth, is said to have been found in the river-bank, at the junction of Monongahela and Allegheny Rivers. It is impossible to determine the Pleistocene stage to which any of these proboscidean remains belong. As shown on the geological map of the Carnegie Quadrangle (Folio 177, U. S. Geol. Surv.) there are indicated here Pleistocene deposits of early, intermediate, and late stages.

Little information is furnished by a mastodon reported found on Dicks Creek in Butler County. The statements regarding the finding of elephant remains on French Creek near Meadville are vague and valueless (p. 168). Some remains of *Elephas columbi* have been found at Tryonville, at a depth of 7 feet (p. 150). The town is on the Wisconsin moraine and the elephant probably belongs to the Late Wisconsin.

Nearly a hundred years ago a tooth of *Elephas primigenius* was reported from a place in Erie County, called Beaverdam (p. 133). From Mr. Clyde C. Hill, civil engineer, Northeast, Erie County, the information is received that Beaverdam is a cross-roads hamlet about 23 miles south of the lake, near the prolongation of the western New York boundary line. This is within the area covered by Wisconsin drift, and it is pretty certain that the animal lived there after or near the close of the Wisconsin stage.

Just west of Erie a mastodon tooth has been found along Chase Creek (p. 70). Unless there are some unrecognized pre-Wisconsin deposits along this creek, the animal must have lived there at a time after the lake had retired to about its present limits. This would be near the very close of the Pleistocene epoch. The same conclusion must be arrived at from a study of the proboscidean remains (supposed to be those of an elephant) found at Girard.

Brief mention is made here of finds of fossil vertebrates in Pennsylvania which have not yet been mentioned; also, the localities are given where they are found, and citations of the pages where fuller descriptions are furnished:

A horse has been reported from Rutherford, Dauphin County (p. 185), and a peccary, *Platygonus vetus* (p. 213), from Milroy, Mifflin County. Mastodons have been reported from Tunkhannock, Wyoming County; Berwick, Columbia County; Reading, Berks County; Jackson Township, York County; near Reedsville, Mifflin County; Chambersburg, Franklin County, and Bedford, Bedford County (see pp. 68, 69). *Elephas primigenius* has been met with at Brookfield, Tioga County (p. 133); and somewhere about Chadd's Ford, in Chester or Delaware County (p. 133).

OHIO.

(Maps 35, 36.)

The State of Ohio is partly glaciated, partly not. The unglaciated portion forms the southeastern border and constitutes close to 28 per cent of the whole surface. The glaciated area is mostly covered by the Wisconsin drift, which makes up 60 per cent of the whole surface. The remainder is covered by that part of the Illinoian drift-sheet which projects beyond the edge of the Wisconsin. This occupies about 12 per cent of the surface of the State. The unglaciated area contains Pleistocene deposits along the streams, especially along Ohio, Muskingum, Hocking, and Scioto Rivers. Probably the greater part of the materials forming these deposits were brought down the rivers which headed at the foot of the Illinoian and Wisconsin glacial ice-sheets. However, all that part of the country which was not covered by glacial ice was acted on by atmospheric agencies and suffered erosion. Hence abundant materials of non-glacial origin were swept down those tributaries of the Ohio which had their sources in the Alleghany region and down those which flowed through the unglaciated part of the State. Much of these materials was deposited along the banks of these streams and mingled with the débris from the glacial ice-sheet. Doubtless such deposits were being made during the whole Pleistocene epoch and were mostly swept away; or they may have been covered up by subsequent deposits; or the deposits of one stage may in many cases not be distinguishable from those of other stages. A perusal of chapter v of Leverett's monograph of 1902 (Monogr. U. S. Geol. Surv., vol. XLI, 1902, pp. 228–252) and of the papers there cited, also of others published since that time, will impress the reader with the fact that an old drift, probably of Kansan or pre-Kansan age, has left traces of itself in Ohio just outside of

the terminal moraine of the Wisconsin drift. This is found especially in Columbiana County; but, according to Wright (2d Geol. Surv. Pennsylvania, Z, p. 207) it extends as far westward as Canton, Stark County.

It is shown in Leverett's paper that the streams, especially the larger ones, of southwestern New York, western Pennsylvania, and eastern Ohio had, at some time preceding that of this old drift, been deeply excavated into the underlying rocks, and that these ancient channels had become filled by the outwash from the older drift. Furthermore, terraces composed of this drift are now found along rivers of the region mentioned, at heights varying from 150 to as much as 500 feet above the present streams. Those old, deeply excavated valleys may therefore have once been filled to the highest terraces and since that time have been re-excavated to the level of the present streams. The ancient rocky floors in many cases lie now from a few to some hundreds of feet below the beds of the existing rivers. It is easily possible that the bones and teeth of early Pleistocene animals may have been buried in such valley fillings and such terrace deposits. Again, remains of such vertebrates may have been buried beneath the glacial "fringe" that has been mentioned. In such cases it may be impossible for one who is not a glaciologist, perhaps not even for him, to determine the real age of the fossils. It is, therefore, of the utmost importance that a record be kept of the exact spot where the fossil was found, so that at some future time the geology of the locality may be studied by a competent person. Naturally, other information, as that relating to the kind of deposit, depth of burial, elevation of place of burial, and the like, is valuable.

A discussion of the Illinoian drift-sheet, including that part found in Ohio, forms chapter VI of Leverett's work of 1902 (Monogr. cit., pp. 253–291). As shown by his plate II, Illinoian drift covers a small area in the southwestern corner of the State, along Ohio River; then leaving the river and running first in a northeasterly direction, then directly north, it forms a narrow strip outside the border of the Wisconsin as far north as Richland and Holmes Counties. If it extends further east than this, it is concealed beneath the Wisconsin. It is to be expected that Illinoian drift will be discovered here and there in the greater part of the State beneath the Wisconsin where the latter shall have been penetrated in digging wells, in borings, and where streams have cut down through the later drift-sheet. In such places it will be possible to find remains of animals and plants buried in interglacial deposits laid down before the Wisconsin stage; that is, in either Sangamon or Peorian or even more remote times. On page 269 of the work just quoted, Leverett mentions a case near Lancaster, Fairfield County, where a black mucky soil was found between the Wisconsin and the Illinoian drifts. On page 273 of the same work is mentioned the occurrence of logs and pieces of wood at Bethel, Clermont County, in a gravel-bed beneath the Illinoian drift. This might be interpreted as indicating a deposit belonging to the earliest part of the Illinoian or to the Yarmouth.

The general aspects of the Illinoian drift are described by Leverett on his pages 270 to 285.

Deposits of Illinoian age may occur beyond the border of the ice-laid Illinioan drift and even beyond the Wisconsin as the result of outwash. Leverett (op. cit., p. 285) mentions the occurrence of what appears to be an Illinoian terrace along Sandy Creek, near Waynesburg, Stark County, at 70 feet above the stream, while the Wisconsin terrace is hardly 40 feet above the creek. High-level terraces are found along Licking and Muskingum Rivers from Hanover, Licking County, to McConnellsville in Morgan County, and are thought to be possibly of Illinoian age, while lower ones belong to the Wisconsin. Illinoian gravels and cobble are likewise met with along Hocking River (Leverett, op. cit., p. 288); also along the Scioto from Chillicothe nearly to its mouth. On lower-level terraces other deposits of Wisconsin age are to be looked for. Again it is seen how important it is that accurate information should be sought regarding the exact spot of interment of any vertebrate remains, as well as the elevation, the depth, and kind of materials passed through.

Map 35 has been prepared to show the distribution of the Wisconsin and Illinoian drift-sheets in Ohio. The driftless area, shown without shading of any kind, occupies the southeastern side of the State and forms a broad tract somewhat parallel with Ohio River. The Illinoian belt lies between this driftless area and the Wisconsin. Naturally it passes beneath the Wisconsin drift and probably underlies most of it. A part of the map is shaded by horizontal lines in order to show the position and extent of former Lake Maumee. This lake was an early predecessor of Lake Erie and emptied into Wabash River. The moraines laid down by the Wisconsin ice on its gradual withdrawal from the State are indicated by the stippled areas and by the letters at the sides of the map. Most of the names applied to these moraines in Ohio differ from the parts of the same moraines in Indiana. The Germantown, Eaton, and Englewood correspond to the Bloomington of Indiana; the Sidney to the Union City; the Loramie to the Salamanie; the Celina to the Wabash; and the Lima to the Fort Wayne.

Map 36 shows the localities where Pleistocene mammals have been discovered in the State and the relation of these localities to the drift-sheets and the moraines.

It is to be supposed that any animal whose remains are found in deposits overlying the Wisconsin drift lived there after the retreat of the ice-sheet from that locality. Any mastodon (maps 5, 7) that has been discovered within the area covered by the old Lake Maumee probably lived there after that lake had subsided. However, it might be possible to find along rivers, or deep cuts along railroads, animals that had lived there during Sangamon times; but this may be supposed to occur rarely. Mastodons, Nos. 34, 37, and 39 of map 7, probably lived and died after later Lake Warren had shrunken into Lake Erie.

Most of the fossil vertebrates that have been found in Ohio belong to the Late Wisconsin; that is, they lived in their respective localities after the glacial ice had retired from those localities. A few fossils may be credited to an interglacial stage, Sangamon or Peorian, which intervened between the Illinoian and the Wisconsin. Inasmuch as in the area occupied by the

Illinoian drift this deposit may be cut through by rivers or railroads, it is possible that pre-Illinoian fossils might be discovered.

A tooth of *Elephas primigenius* has been found at Waverly, Pike County, on Scioto River, as recorded on page 134. Along that river there are deposits of gravel and sand which were derived apparently from Illinoian drift, while below these Illinoian deposits is a Wisconsin terrace. The tooth above mentioned appears to have been found in a gravel-pit of the Norfolk and Western Railroad about the year 1900. The writer has not been able to secure any information as to the elevation of the pit. The elephant remains observed by Whittlesey along Scioto River, as mentioned on page 169, were probably buried in the Wisconsin terrace. A mastodon has been found in Pike County (p. 70), but the more exact locality is not recorded.

An important but apparently now lost and therefore indeterminable specimen of elephant is that to which was given the name *Elephas jacksoni*, described on page 168. It was found in the northwestern corner of Jackson County, on Little Salt Creek, probably a short time before 1838. The probability is that it was found in Wisconsin deposits, but its age is possibly greater. According to Leverett (op. cit., pp. 120, 121, 289), there are in this valley deposits which were probably laid down during the Illinoian stage. An elephant skeleton is reported to have been dug up many years ago in the village of Beverly, Washington County (p. 169), on Muskingum River. Leverett (Monogr. XLI, p. 157) states that glacial deposits belonging probably to the Wisconsin stage are found here at a height of 119 feet above the river. Inasmuch as the greater part of the village is below this level, the elephant probably belongs to Wisconsin time.

Further up the Muskingum, at or near Duncan Falls, there was found about 1857 a tooth of *Elephas primigenius* (p. 135). The animal probably lived and died there at a time when the Wisconsin glacier was not far away. Other remains of the same species have been described from Zanesville. The bed which contained these is said to be at a height of 37 feet above the river and 20 feet from the natural surface of the ground. Inasmuch as drift outwash, believed to be of Wisconsin age, is built up here to a height of 100 feet above the river (Leverett, op. cit., p. 157), it is wholly probable that the elephant, like the one just described, lived in the vicinity of the Wisconsin ice-front. At Nashport have been discovered in swampy ground remains of *Castoroides* (p. 273) and of *Mammut* (p. 70). Although there is at Hanover, Licking County, across Licking River, a great dam of supposed Illinoian age and probably more or less hidden deposits of the same age along the river, the giant beaver and the mastodon just mentioned may not be older than the Wisconsin. Nevertheless, as they were found lying on gravel at a depth of 14 feet, they may have been buried there during the Sangamon stage. Along the eastern border of the State, in Columbiana County, on Salt Creek, in the southwestern part of the county, there was found, about 1845, a tooth of a horse (p. 186). It was discovered while a canal was being excavated and at a depth not to exceed 12 or 15 feet. The locality is apparently some miles south of the Wisconsin moraine. The animal lived there evidently at some time preceding the Wisconsin drift

stage, possibly after the Illinoian, but quite as likely before the Illinoian. Not far away from where the horse was discovered, apparently on Little Yellow Creek, and probably not far from New Salisbury, there was found, about 1850, a fragment of the lower jaw of a tapir (p. 203). It probably lived at about the same time that the horse did. Near Millport a tooth, referred to *Elephas primigenius*, has been found (p. 135). The locality is beyond the Wisconsin moraine, but it is impossible to determine whether the beast lived there early or late in the Pleistocene.

At this point may be mentioned the discovery of remains of a peccary, supposed to be *Mylohyus nasutus* (p. 215), and of *Mammut americanum* (p. 70) in the southern edge of Lisbon, Columbiana County, apparently along Middle Fork of Little Beaver River. This locality is on the border of the Wisconsin drift-sheet, and the peccary and the mastodon might well have lived there with the horse and the tapir mentioned above.

Not many localities within the area of the Illinoian drift in Ohio have furnished vertebrate fossils.

Lyell in 1843, as stated on page 71, reported that teeth of mastodons and of elephants had been found on the Cincinnati side of the river, on the high terraces.

From Professor N. M. Fenneman the writer learns that Lyell's reference could hardly apply to any other locality than Terrace Park or Milford. Here are found some fragments of an Illinoian terrace that would hardly be spoken of casually as such, while the Wisconsin deposit is present as an upper and a lower terrace.

In Hyde Park, as detailed on page 71, considerable parts of a mastodon and some remains of a horse (p. 185), probably *Equus complicatus*, have been discovered. The age of these remains certainly antedates that of the Wisconsin; and it is not improbable that the excavation was carried through the Illinoian drift into an older and probably interglacial deposit. Professor Fenneman writes that this area is only thinly covered by Illinoian drift and is also far beyond the limits of the Wisconsin outwash.

The occurrence of *Bison latifrons* near Fincastle, in Brown County (p. 257), must be noted. The fine pair of horn-cores now in the Cincinnati Society of Natural History may have been buried in deposits of Sangamon age. It is not, however, impossible that they were in an interglacial bed below the Illinoian drift.

On page 135 there has been given an account of the finding of a skull of *Elephas primigenius*, somewhat more than a mile east of New Burlington. The locality is treated in proper detail in N. M. Fenneman's paper entitled "Geology of Cincinnati and Vicinity" (Bull. 19, Geol. Surv. Ohio, p. 158). According to this account the skull was buried in a lacustrine silt laid down probably when the Wisconsin glacier was not far away from that region. The surrounding country is covered with Illinoian drift. This skull is now the property of the U. S. National Museum.

In the collection of the Ohio State Archæological and Historical Society at Columbus there are remains of *Platygonus compressus*, jaws and good teeth, which were found about a mile north of Chalfants, in Perry County, and along Jonathan Creek. This place is within the area covered by Illi-

noian drift. It is possible that the remains are as old as the Sangamon, but it is also possible that they belong to the close of the Wisconsin stage (p. 215).

The writer knows of no other fossil vertebrates that have certainly been found within the area occupied by the Illinoian till as a surface deposit.

As shown by map 36, by far the larger number of Pleistocene vertebrates which have been discovered in Ohio have been met with within the region occupied by the Wisconsin drift-sheet. One reason for this preponderance is the greater area included. Another reason may be found in the fact that the conditions were more favorable for the preservation of teeth and bones. Much of the country was flat and swampy and the bones buried in clay and muck have always been soaked with water. Also there has been less erosion going on. Erosion leads to exposure and therefore to destruction of skeletons.

On the map referred to are shown the various moraines that were left by the Wisconsin ice-sheet in its retreat toward the north. Inasmuch as most of the burials were in swamps resting on the drift, the animals must have lived and died there after the ice had left that vicinity; how long after one may not be able to determine. The mastodons and elephants which have been found close to the shore of Lake Erie, especially if buried near the surface, must have lived there at or after the time when the waters had shrunken into Lake Warren. Such cases are furnished by the mastodons and elephants found at Amboy (east of Ashtabula) (pp. 137, 150), at Cleveland (p. 79), and in Brownhelm Township, in Lorain County (p. 79). The town of Amboy is about 130 feet above lake-level and the gravel-pit which there furnished *Elephas primigenius* and *E. columbi* was probably at about the same level. The writer has not been able to confirm any case in which remains of proboscideans have been met with on the south shore of the lake at a level lower than the Warren beach. Mastodons may be traced to a lower level at the western end of the lake. The one found in Springfield Township, Lucas County (p. 77), was buried in deposits only about 45 feet above Lake Erie. As shown by the topographical maps, the descent from this place and from Bowling Green, Wood County, to the lake is a gradual one. It may become possible to follow the presence of the mastodons, the elephants, and the giant beaver in Ohio up to the time when the lake assumed its present level.

For information regarding the several interesting discoveries of the giant beaver (*Castoroides ohioensis*) pages 273 to 275 may be consulted.

It is hardly necessary to take up one by one all the cases of vertebrates that have been met with within the area covered by Wisconsin drift. With the few exceptions noted below, their geological age is usually to be regarded as Late Wisconsin. Along the southern border of this drift, where the remains are deeply buried, it is not unlikely that they lie in a pre-Wisconsin interglacial deposit. Along Great Miami and Muskingum Rivers there is always a possibility that the fossils may occur in a terrace or in a deep valley deposit of Illinoian age.

About a mile east of Overpeck, Butler County, there has been found the skull of an extinct bear, *Ursus procerus* Miller (Hay, Geol. Surv. Indiana, vol. xxxvi, 1912, pp. 772–776, figs. 71–73). It was found at a depth of 28

feet and about 3 or 4 feet above the limestone rock of that region. To the writer it seems quite certain that the Wisconsin drift had been penetrated and that the skull was in either a Sangamon interglacial deposit or something still older.

Columbus furnishes one of the rare cases in which horse remains have been found within the Wisconsin glaciated area (p. 186). We are then required to determine whether or not the horse, *Equus complicatus,* did not live there after the close of the Wisconsin stage. As said on the page cited, the first remains of horses discovered at Columbus were reported as having been found in crevices of the limestone and in the red clay filling such fissures. An examination of the Columbus Folio (197, U. S. Geol. Surv., p. 8) will show that in such crevices, south of Scioto River, a red clay is found which antedates the Illinoian drift, so that one might fairly refer the horse remains reported by Whittlesey to a pre-Illinoian interglacial stage, possibly the Aftonian. The horse-teeth found in the excavations at the penitentiary close to Scioto River may be as old as those found in the rock fissures, or they may have been buried in a post-Illinoian interglacial deposit. Such deposits have been found at various places in the quadrangle (fol. cit., p. 9).

As to the peccaries discovered at Columbus (p. 214), the writer sees no reason why they should not be regarded as belonging to the Late Wisconsin.

MICHIGAN.

To understand the Pleistocene geology of the southern peninsula of Michigan, it is indispensable to study Monograph LIII of the U. S. Geological Survey, by Frank Leverett and F. B. Taylor. The whole peninsula is overlain by glacial deposits laid down by the Wisconsin ice-sheet. A glance at their glacial map (plate VII) will indicate to the student the complexity of glacial problems in this region. The ice invaded the State from three sides: on the west from Lake Michigan, on the east from Lake Huron, and on the southeast from Lake Erie.

On the west, close to Lake Michigan, is a system of Lake-border moraines. This system has been traced more or less satisfactorily around to Saginaw Bay, Lake Huron. A little farther out, in the southwestern corner of the State, is Valparaiso moraine. This extends nearly to the northern end of the peninsula, where it connects with Charlotte moraine system. Farther in than the Valparaiso system is the Kalamazoo. This extends northeastwardly from the Indiana line to Barry County, where it turns east and at Jackson joins the Mississinawa system reaching northeast from the northeastern corner of Indiana. The Valparaiso and Kalamazoo moraines are in places closely associated. The attack on the eastern side of the State came principally from a lobe which flowed through Saginaw Bay. Nearest Lake Huron, following it around from Port Huron to the northern end of the peninsula and then turning west, the Port Huron moraine connected with the moraine along Lake Michigan.

Farther inland is the Charlotte system. On the north, just above latitude 44°, this joins the Valparaiso moraine, runs southward west of Lansing, then turns eastward, then northeastward, and connects with the

Defiance moraine, which passes around the western end of Lake Erie. Reaching far out from the head of Saginaw Bay, and concentric with it, to Hastings, 100 miles away, are many minor moraines.

Besides the Wisconsin drift which forms the surface deposit in Michigan, there are, according to present indications, one or more pre-Wisconsin drifts. Leverett (Monogr. LIII, p. 72) mentions several localities where what appears to be more indurated till is encountered, sometimes at a depth of 100 feet. Taylor (op. cit., pp. 289–290) states that "a till older than that deposited by the Wisconsin ice-sheet seems to underlie more or less continuously all of the later, or Wisconsin, drift in Indiana and the southern peninsula of Michigan." Along the western shore of Lake Huron, north of Port Huron and along the streams, as reported by Taylor (p. 290), there are several exposures of Illinoian till, in some cases as much as 30 to 50 feet thick. In one case there is an old soil at the top of this till. In such old soils it may be possible to find fossil vertebrates of Sangamon or Peorian times, horses for example.

The fossil vertebrates found up to the present time in Michigan are not numerous in species or individuals; all appear to belong to the middle or late Wisconsin times. A peccary, *Platygonus compressus,* has been found at Belding, Iona County (p. 215). Two musk-oxen have been discovered in the State. At Manchester, Washtenaw County, has been found a fine skull of *Symbos cavifrons* (p. 250). At Moorland, Muskegon County, was obtained a skull which has been called *Boötherium sargenti.*

Details regarding the mastodons which have been found in Michigan are given on pages 80 to 88. Only two localities in the State have furnished remains of *Elephas primigenius.* These are Three Oaks, Berrien County (p. 137), and Eaton Rapids, Eaton County (p. 137). *Elephas columbi* has been encountered only once in the State, as far as is known; this was in the northern part of Jackson County (p. 151).

Elephants belonging quite certainly to either *E. primigenius* or *E. columbi,* but for one reason or another not determined, have been found in four localities. These are East Saginaw, Saginaw County; Macomb County; Grand Ledge, Eaton County; and Buchanan, Berrien County. (See page 171.)

The giant beaver, *Castoroides ohioensis,* found a congenial home in the swamps of southern Michigan in the late Pleistocene. It has been met with somewhere in Berrien County; at Adrian, Lenawee County; at Ann Arbor, Washtenaw County; at Attica, Lapeer County; and at Owosso, Lapeer County (pp. 275–276).

INDIANA.

(Map 37.)

Whoever wishes to gain a knowledge of the Pleistocene geology of Indiana, as it is understood to-day, must study Leverett's two great treatises, forming Monographs XXXVII and LIII of the U. S. Geological Survey. The first is entitled "The Illinois Glacial Lobe," and was published in 1899; the second has the title "The Pleistocene of Indiana and Michigan and the History of the Great Lakes." The portion of the latter monograph which

deals with Michigan was written by F. B. Taylor. On pages 33 to 54 is a very full bibliography of the subject, consisting of about 400 titles.

From the glacial map of Monograph XXXVIII, plates V and VI, the writer has prepared map 37. This shows which part of the State has escaped glaciation, which has been subjected to the action of the Illinoian ice-sheet, and which has been covered by the last, or Wisconsin, glacial ice. It will be seen that about one-sixth of the State, that forming an irregular triangle whose apex is in Brown County and whose base is formed by the Ohio River, has never been covered by glacial ice. North of this is a bilobed area which is covered by till of Illinoian age. The rest of the State (somewhat less than two-thirds of it) is overlain by the débris left by the Wisconsin ice-sheet and subsequent deposits.

This northern area is to a great extent occupied by belts called moraines, along which the materials are usually coarse, often full of boulders, and frequently standing at a higher level than the surface on each side of them. These moraines show where for long periods during its retreat, or perhaps sometimes its advances, the ice-sheet paused and piled up a part of its load of rocks, gravel, and sand. It will be noticed that these moraines are somewhat concentric. On the right of the map are seen those moraines which were left by the ice-lobe which came down Lake Erie and later retired in that direction. Around the southern end of Lake Michigan are the moraines laid down by the ice of the Michigan lobe. The latter will be better seen on a glacial map of Illinois (Monogr. U. S. Geol. Surv. XXXVIII, plate VI). In their advance the two lobes met and coalesced and produced more or less irregular and anastomosing moraines.

On the right hand the moraines of the Erie lobe pass on into Ohio, where, however, they have often been given other names. On the left the moraines of the Lake Michigan lobe continue into Illinois and retain the same names. Both groups of moraines are prolonged into the southern peninsula of Michigan.

On account of the comparatively recent recession of the Wisconsin ice-sheet, the surface has not become eroded sufficiently to drain away the water which was left in depressions of the surface. A large part of Indiana is, or has been until recently, covered by swamps, lakes, and ponds, and in such localities the bones and teeth of vertebrate animals are best preserved during the early stages of fossilization. For this reason great numbers of teeth and bones, sometimes nearly whole skeletons, are met with in draining these swamps.

The southern border of the Illinoian drift, beginning at Cincinnati, follows Ohio River on the Kentucky side to Jeffersonville, then passes west of north into Brown County, whence, turning southwest, it strikes the East Fork of White River in Du Bois County; thence, following White River a short distance, it crosses the Wabash in Posey County. Northward, along this terminal moraine (map 37, figs. 1, 2) of the Wisconsin drift, the Illinoian, passing beneath this, disappears from the surface.

The surface of the Illinoian area is better drained than the Wisconsin area. Fewer fossils are found, and on various accounts they are of less value. Usually the exact locality and kind of deposit is not recorded.

They may be found washed out of river and creek banks and may have in reality been buried in sediments that were laid down in Wisconsin times by the streams that carried away the mud, sand, and gravel from the glacier. The driftless area has been exposed for many geological ages to the influence of physical and chemical agencies. Its surface is, therefore, more diversified by hills and valleys and streams. In the limestones of this region caves are likely to be found, and these now and then furnish fossil bones and teeth.

During more than one of the glacial stages, perhaps during the earliest, the Ohio has served as the drainage-way for the waters that escaped from the glacial front. This subject is discussed by Leverett in Monograph XLI of the U. S. Geological Survey. As a result of this conveyance of glacial waters, the great trough of this stream may contain here and there deposits of the Illinoian stage or even of older deposits. Remains of *Megalonyx* (p. 32) and of a horse (p. 186) have been found in the right bank of the Ohio, at Evansville, Indiana. At Bigbone Lick, Kentucky, close to the Ohio, horses have been discovered, *Mylodon* and *Megalonyx*. These seem to occur in Sangamon interglacial beds overlying the Illinoian.

The Illinoian drift, probably everywhere in central and northern Indiana, underlies the Wisconsin. For some miles back from its terminal moraine the Wisconsin drift is thin; and possibly the Illinoian may be found exposed in creek or river banks, or in railroad cuts. Furthermore, Leverett (Monogr. LIII, p. 72) writes:

"Probably a considerable number of the heavy deposits of drift in central and northern Indiana are of pre-Wisconsin age, but as they are largely sand and gravel, or loose-textured material, they can not easily be discriminated from the Wisconsin."

Such deposits are likely to be covered by only a thin layer of Wisconsin till. In many places in Indiana there have been found, deep down in the drift, old soils, muck-beds, and vegetation in various forms. These beds appear to indicate interglacial deposits, most probably the Sangamon. Now, various genera of vertebrates, among them horses, tapirs, and mylodons, are not known to have existed after the Wisconsin glacial stage. If, however, remains of such animals should be collected in central or northern Indiana, or Ohio, or in southern Michigan, they might be reported as having been found in late Wisconsin beds, when really they had been derived from pre-Wisconsin interglacial soils.

It is interesting to observe that when the Wisconsin ice-sheet began to withdraw lakes began to form along its borders. One of these, Lake Chicago, appeared at the south end of the present Lake Michigan and for a long time discharged its waters down Illinois River. Another, Lake Maumee, occupied the basin of Maumee River as far west as Fort Wayne, and emptied down the Wabash. For details connected with the close of the Pleistocene in the region of Lake Michigan the reader should consult Frank C. Baker's "The Life of the Pleistocene, or Glacial Period" (Univ. Ill. Bull. XVII, 1920).

A brief mention will be made here of the principal Pleistocene vertebrates that have been found in Indiana; also the localities where found, together with citations of the pages where fuller information is furnished.

The ground-sloth *Megalonyx* has been collected near Evansville (p. 32). With it were secured remains of an undetermined bison (p. 257), a Virginia deer (p. 228), a horse (p. 186), a tapir (p. 203), and the dog *Ænocyon dirus* (p. 32). Peccaries have been found in Gibson County (p. 216), in Wabash County (p. 218), and two species at Williams, Lawrence County (p. 217). At the same place was discovered the shell of a box-tortoise. Remains of deer have been discovered somewhere in Vanderburg County, including the existing deer and an extinct species, *Odocoileus dolichopsis;* at Harrisville, Randolph County; and at Roann, Wabash County. Bisons of an extinct species have been secured at Vincennes (p. 258).

The existing bison appears to have been found in Jasper County (p. 268). Of musk-oxen, *Symbos cavifrons* has been collected at Hebron, Porter County (p. 252); at Wailesboro, Bartholomew County (p. 251); somewhere in Randolph County (p. 252); and probably in Beaver Lake, Newton County (p. 252). The existing musk-ox, *Ovibos moschatus,* has been discovered near Richmond (p. 252).

Mastodon remains are not uncommon, especially in the northern half of the State. It is hardly to be supposed that these animals were more abundant there during the late Pleistocene than in many other places in the region east of the Mississippi. The conditions for their preservation were evidently more favorable there than anywhere else, unless in Orange County, New York. Burial in swamp mud kept the bones from decay; and the imperfect drainage protected them from destruction by erosion. The various finds are described on pages 88 to 100.

Elephants are less well represented in Indiana than are the mastodons, but are not rare (pp. 138, 151, 171). Two species were present in the State, *Elephas primigenius* and *E. columbi.* Beavers were doubtless abundant, but there appears to be no definite record of any find. However, the giant beaver has been recorded from several localities (pp. 276 to 278).

The great extinct dog *Ænocyon dirus* was first found near Evansville (p. 32), and the coyote, *Canis latrans,* has been reported from Boone County. The latter is said to have been found in association with the mammoth (Cope and Wortman, 14th Ann. Rep. Geol. Surv. Indiana, p. 7).

ILLINOIS.

(Map 38.)

As a foundation for a knowledge of the Pleistocene geology of Illinois, the student must take Leverett's work entitled "The Illinois Glacial Lobe." This is Monograph XLVIII of the U. S. Geological Survey, a volume of 817 pages, with maps and figures. For a knowledge of the changes which occurred around the south end of Lake Michigan on the retirement of the Wisconsin glacier, see Dr. Frank C. Baker's work, "The Life of the Pleistocene, or Glacial, Period" (Univ. Ills. Bull. XVII, 1920).

Illinois is eminently a glaciated State, as is to be recognized on Leverett's plate VI. A little triangle in the northwestern corner, comprising about 600 square miles, and an irregular tract of perhaps 3,000 square miles at the southern end of the State constitute the whole of the unglaciated area out

of 56,650 square miles. Two glacial stages are prominent, the Wisconsin and the Illinoian. The first was laid down by the Lake Michigan lobe, which sent its icy mass southwestward as far as Shelbyville. Westward the border moraine extends to Peoria, then north to west of Princeton, then northeast to enter Wisconsin 55 miles west of Lake Michigan. Eastward, of course, the deposits of till and the moraines extend into Indiana. North of the Shelbyville moraine is the Champaign. A more powerful moraine is the Bloomington, which forms a loop through the State, extending from Danville, Illinois, through Bloomington to Peoria, where it appears to have overridden the Shelbyville and thence northward, forming the outer border of the Wisconsin drift area. North of this moraine is located that called the Marseilles, while sweeping around the south end of Lake Michigan into Indiana and Michigan is the Valparaiso system.

South and west of the area of the Wisconsin drift is the Illinoian. At Mount Vernon the border crosses the Wabash and traverses Illinois, striking the Mississippi River at Carbondale. It then follows the Mississippi north to a point above Keokuk, where it enters Iowa. It reenters Illinois between Rock Island and Clinton and extends into Wisconsin.

On Leverett's map (Monogr. XXXVIII, plate VI) there is indicated in northern Illinois, between the Illinoian and the Wisconsin, a tract supposed to belong to the Iowan; but Alden (U. S. Geol. Surv., Prof. Pap. 106, 1918, p. 173) holds that there is no good evidence that the Iowan extends into southern Wisconsin and Illinois. The supposed Iowan (op. cit., plate III) is mapped as Illinoian.

The glacial stage which preceded the Illinoian is the Kansan. This in Iowa extends eastward to the Mississippi, and one might naturally expect that it would be found underlying the Illinoian east of the river. Leverett (Monogr. XXXVIII, p. 105) presents evidences of its presence in western Illinois. Among these evidences is the presence in Hancock and Adams Counties of another till sheet below the Illinoian and separated from it by a black soil. This Kansan or some other pre-Illinoian till sheet has been found in many places in Illinois (op. cit., pp. 107–118).

Animal remains are not likely to be inclosed in the materials of the moraines or of the intermorainal till; but this is possible. A musk-ox or a hairy mammoth might have died not far away from the foot of a stationary or advancing glacier and its bones might have become incorporated in the moraine. Furthermore, inasmuch as any glacial stage began while the glacier was yet in the far north and ended only when it got back there, many non-glacial deposits belonging to that glacial stage were probably laid down south of it; and it would be difficult or impossible to distinguish these from interglacial deposits. However, it was these deposits which were laid down after the glacial ice had withdrawn, whether glacial or interglacial, which are of more interest to the palæontologist, because in them are to be found the fossil remains of animals and plants.

The last of the interglacial stages, that which immediately preceded the Wisconsin and followed the Iowan, is known as the Peorian. This takes its name from a locality a few miles east of Peoria (Leverett,

Monogr. XXXVIII, p. 187). Here the Shelbyville till-sheet is underlain by a bed of fossiliferous loess from 8 to 12 feet in thickness. Beneath the loess is fully 100 feet of Illinoian drift. This loess seemed to the geologists who examined it to be a deposit of more recent date than the Sangamon.

The Peorian interglacial stage and the preceding Iowan glacial stage have received much attention within recent years. In 1917 (Geol. Surv. Iowa, vol. XXVI, pp. 49-212), Alden and Leighton presented the results of their studies on the Iowan drift and the loess associated with it. In 1918 (U. S. Geol. Surv., Prof. Pap. 106, pp. 1–356), Alden dealt with the Quaternary geology of southeastern Wisconsin. The results of these investigations have been to establish the fact that a sheet of till intermediate between the Illinoian and the Wisconsin had been laid down, that which had already been designated as the Iowan; furthermore, that immediately following this there was deposited a covering of loess. It was further concluded that this is the main loess deposit, much of what has been regarded as Sangamon loess being really loess of a later stage, the Peorian.

As no Iowan drift is known to be present in Illinois to separate the loess of the Sangamon from the Peorian, it must be difficult, often impossible in our present state of knowledge, to distinguish the one from the other. The Sangamon loess was laid down probably long after the Illinoian ice disappeared, so that there was time for the Illinoian drift to become leached and otherwise modified and for the accumulation of old soils and peat-beds.

On the other hand, the old soils of the Peorian stage are likely to overlie the loess. Unfortunately, the desired indications of geological age are not always present where bones and teeth are found; or, if present, are not always observed. We must, therefore, make our assignments of fossils to one stage or the other with great circumspection or leave the decision in abeyance.

Reference has already been made to the presence of Kansan drift in western Illinois and of black soils intervening between it and the Illinoian. Such soils must be referred to the Yarmouth interglacial stage. Whether or not still older glacial or interglacial deposits occur in Illinois is problematic.

In Illinois any considerable number of species of fossil vertebrates are rarely found together. The localities are widely scattered and a single species or two in each is the rule (map 38). In later glacial deposits around the south end of Lake Michigan have been discovered the dogfish *Amiatus calvus* and a sun-fish belonging to the genus *Lepomis*. Baker (Univ. Ill. Bull. XVIII, p. 85) reported the humerus of the merganser, *Mergus serrator*, from the same region. The ground-sloth *Megalonyx jeffersonii* (pp. 33–34) has been found at Urbana, Galena, and Alton.

The few horses are described on page 187. Peccaries have been found at three localities (p. 218). For the specimens of deer that have come to light, see page 229. A species of *Cervalces* and the moose *Alces*

americanus have been met with in Will County (p. 107). The reindeer has been recognized from poor materials found at Alton. The prong-horn *Antilocapra* appears to have lived in the region of Galena, as shown by Wisconsin specimens. The remarkable antelope *Taurotragus americanus* has been found at Alton (p. 339). As to the musk-oxen and the bisons, the reader may refer to pages 251, 259, 268; for the mastodons and elephants, to pages 100, 140, 152, and 176.

Of the rodents, the musk-rat has been found about Chicago; the pocket gopher at Alton and Galena; the ground hog at the same places (p. 343). The beaver (p. 339) likewise occurs at Alton. The giant beaver, *Castoroides ohioensis,* has been collected at four widely removed places (p. 279). The rabbit, *Sylvilagus floridanus,* was included among the animals found in the lead crevices of the region about Galena, where also have been found an extinct species of raccoon, *Procyon priscus,* what appears to be a large dog *Canis* (or *Ænocyon*) *mississippienis,* the coyote, *Canis latrans,* and the fox *Urocyon cinereoargenteus.* The bear, *Ursus americanus,* and the common gray wolf, *Canis nubilus,* appear to have existed in the middle Pleistocene at Alton.

A skull of *Felis couguar,* the yet existing panther or mountain lion, has been found in Randolph County, in the bed of Kaskaskia River. It probably belongs to the late Pleistocene.

A considerable fauna has been secured in the lead region about Galena, in Illinois, Iowa, and Wisconsin. The collectors and describers of this were not careful to designate the localities, and in some cases these can not at present be determined. These collections are discussed on page 343, in the account of the geology of Wisconsin.

An interesting list of Late Wisconsin mammals has been secured near Whitewillow, Kendall County. From Dr. E. S. Riggs, of Field Museum of Natural History, and from Netta C. Anderson's list, the writer learns that at least six skulls of the common mastodon, together with many other parts of the skeleton, has been taken from a well 10 feet in diameter (p. 109). Above, there were bones of bison (p. 269), deer (p. 229), and elk (p. 240). It is stated that a layer of these about 2 feet thick was encountered at a depth of about 5 feet.

Mr. George Langford, of Joliet, states that he made a collection of bones 15 miles west of Joliet and 5 miles west by north of Minooka. The more exact locality he gave as township 35 north, range 8 east, and probably section 27, on the farm of John Bamford. Apparently both Riggs and Langford obtained their materials at the same spot. The latter has sent the writer some bones from this place, including those of *Cervalces, Alces americanus,* and a leg-bone of some undescribed species of sheep or goat. He also reported the finding of the elk. For other remarks see page 269. This locality is in the region mapped by Leverett as having been occupied, after the retirement of the Wisconsin glacial ice, by temporary lakes. The presence of the moose here seems to indicate a climate somewhat severer than that now prevailing in that region. Since the occupancy of the country by the European race the moose has not been known to come further south

than northern Wisconsin. The list of species obtained is as follows: *Mammut americanum, Ovis* sp. indet., *Odocoileus virginianus, Cervus canadensis, Alces americanus, Cervalces roosevelti?*.

A brief description of the bone referred to *Ovis* is presented. The lower epiphysis is missing, but an allowance is made for this (fig. 13).

Comparisons of the metatarsals of a sheep, of a goat, of Naemorhedus, and of Ovis sp. from Whitewillow, in millimeters, together with indices in one-hundredths of the length.

Measurements taken.	Næmorhedus.	Indices.	Capra hircus 155623.	Indices.	Sheep.	Indices.	White-willow animal.	Indices.
Length on outer border of bone..	170	100	120	100	152	100	185±	100
Side-to-side width of upper articular surface.....	36	21.2	23.	19.2	23.	15.1	37.5	20.3
Fore-and-aft width of upper articular surface.....	30.5	17.4	20	16.7	21	13.8	37.5	20.3
Side-to-side width, at middle of length.....	23	13.5	15	12.5	14	9.2	19.0	10.3
Fore-and-aft width at middle of length.....	17.5	10.3	11.5	9.1	13	8.6	20.0	10.8
Side-to-side width at lower end just above epiphysis.....	38	22.4	27	22.5	27	17.8	35.0	19.5
Side-to-side width across lower articular surface.....	41	24.1	27.2	22.5	25	16.4	.....	.....

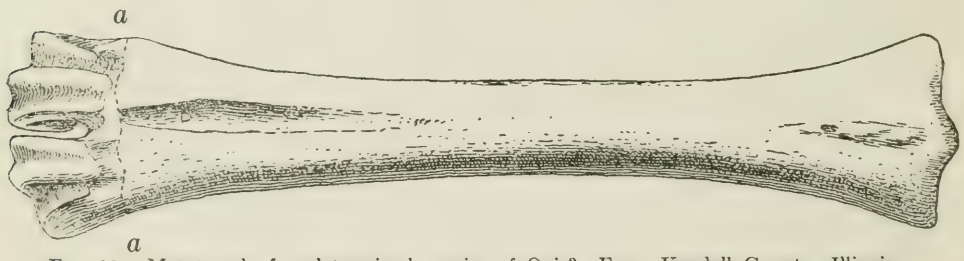


FIG. 13.—Metatarsal of undetermined species of Ovis? From Kendall County, Illinois.

From Alton, the U. S. National Museum has come into possession of a collection which furnishes 15 species of fossil mammals. This was made some time before 1883 by Hon. William McAdams, of Alton. It was briefly mentioned by him at the Minneapolis meeting of the American Association for the Advancement of Science in 1883 (Proceedings, vol. XXII, p. 268). Apparently the collection was secured for the U. S. Geological Survey by Professor O. C. Marsh and remained at Yale University until after his death. The species were described by the writer in 1920 (Proc. U. S. Nat. Mus., vol. LVIII, pp. 109–117). This collection seemed especially valuable because the species were found inclosed in supposed nodules of loess. In our country

the loess has furnished few such remains. The following is the list of the species as determined. Those marked by a dagger are extinct.

†Megalonyx jeffersonii (p. 33).
†Equus sp. indet. (p. 187).
†Platygonus cumberlandensis? (p. 219).
†Sangamona fugitiva.
†Cervalces roosevelti?.
†Rangifer muscantinensis? (p. 246).
†Taurotragus americanus.
†Symbos cavifrons (p. 254).
†Bison sp. indet. (p. 259).
†Mammut americanum (p. 102).
Castor canadensis.
Marmota monax.
†Castoroides ohioensis (p. 279).
Geomys bursarius.
Ursus americanus.

Of these 15 species at least two-thirds are now extinct. This large number might appear to indicate that the time of their existence was rather early in the Pleistocene. However, it is quite certain that the loess belongs somewhere about the middle of the Pleistocene; and there are no species that require an earlier date.

After the writer's descriptions of the fossils had been published, an important paper on the geology of the locality was issued (Jour. Geol., vol. XXIX, 1921, pp. 505–514) by Professor Morris M. Leighton, who had been commissioned by the Illinois Geological Survey to visit and study the deposits involved. With the aid of Mr. John D. Adams, son of the collector of the mammalian fossils, Professor Leighton succeeded in finding the quarry in which most of the fossils had been collected.

At one quarry in Alton Professor Leighton obtained the following geological section, the description of which is here somewhat abridged:

	Feet.
Soil loessial, dark brown, leached	1
Loess, brown above, grading below into buff, leached 4 to 5 feet, maximum thickness	20
Loess distinctly more reddish than that above; many fossil snails, thickness about	30
Glacial till, reddish, with pebbles of Canadian rocks; more oxidized than overlying loess; thickness	1-3
Mississippian limestone, about	100

The concretions which hold the mammalian fossils were found to lie between the upper surface of the till and the overlying loess; occasionally a concretion bears a drift pebble. The concretions have resulted from the lime which in solution was brought down from the loess and again precipitated so as to cement the loess materials around the fossils.

Professor Leighton was not able to determine definitely the ages of the till and of the two deposits of loess. As to the till, its geographic location suggested that it belonged to the Illinoian, but it had many of the characteristics of the Kansan. The latter is believed to be present at St. Louis and other localities not far away. Before the overlying reddish loess had been deposited the till had suffered weathering and erosion, indicating a considerable lapse of time had intervened. The lower reddish loess presented many evidences that it is a deposit distinct from the upper buff loess; and there seemed to be some indications of at least a short interval between them. Leighton's conclusion was as follows:

If the drift is Kansan in age, the reddish loess may be Sangamon; if, on the other hand, the drift be Illinoian, the reddish loess probably is

Peorian. It is unlike any Peorian loess of which the writer knows, but the color does not necessarily preclude that possibility.

As to the upper loess, Leighton thought it might be of early Peorian age, but possibly of early Wisconsin. However, his final conclusion was thus expressed:

> "If the till proves to be Kansan in age, the weathering of the drift may be credited to the Yarmouth interglacial epoch, the mammalian fauna to late Illinoian or early Sangamon times, the reddish loess probably to the Sangamon, and the buff loess to the Iowan. . . . However this may be, the Illinoian and Sangamon epochs are post-mid-Pleistocene from the standpoint of duration of the Pleistocene and the fauna represented by the McAdams collection may be regarded as post-mid-Pleistocene."

WISCONSIN.

The greater part of this State is covered by the drift-sheet which has derived its name from the State, but in the southwestern corner is a considerable tract which has never been subjected to glacial action. A small part of this area extends southward into Illinois and another part into northeastern Iowa. In Wisconsin it reaches eastward to Baraboo. East of this driftless area is a tract lying along the southern border of the State and reaching eastward about to 88° 40′ longitude, which is covered by the Illinoian drift.

The most detailed geological survey of any part of Wisconsin, so far as regards the Pleistocene, is that made by Dr. W. C. Alden, of the U. S. Geological Survey, of the area comprised between the boundary of the State on the south and 44 degrees of latitude on the north and between Lake Michigan on the east and 90 degrees of longitude on the west. On the western side it joins the Mineral Point Quadrangle, to be mentioned further along. There is, therefore, a wide strip surveyed across the whole State. The area treated by Alden is, of course, nearly entirely covered by Wisconsin drift. In the southwestern corner a considerable part of the driftless region is included. East of this, as already stated, is a tract which the Wisconsin ice-sheet did not reach and which shows Illinoian ground moraine and some terminal moraines of Illinoian drift. This narrows as it approaches its eastward limit.

Alden (p. 166) informs us that at no place in the area subjected to vigorous glaciation by the Wisconsin ice-sheet had soils or vegetal deposits been found between the Wisconsin drift and the earlier drifts. At several places, however, deposits have been discovered which probably belong to earlier glacial stages. Just outside the area mapped by Alden, in Calumet and Outagamie Counties, Lawson (Bull. Wis. Nat. Hist. Soc., vol. II, pp. 170–173) has recorded the discovery of much wood and other vegetable matter. Baker ("Life of the Pleistocene," p. 317) has referred the deposits to the Sangamon. These interglacial deposits of uncertain age need not be here noted further. In this Wisconsin area some remains of mastodons and elephants have been met with, but all are relics of a time after the partial or complete recession of the Wisconsin glacier. Remains of two individuals of *Elephas primigenius* have been found in Milwaukee (p. 143). It is evident that they lived there after the withdrawal of the Wisconsin ice-

sheet. One of these was buried beneath peat and clay at a depth of 10 feet or more and at a level of about 100 feet above the present level of Lake Michigan.

At Dover, in Racine County, in 1878, a proboscidean tusk and some bones were found in a peat-bog. They have been identified as those of a mastodon, but of this one can not be certain. The age of the deposits is that of the Late Wisconsin stage, after the withdrawal from that vicinity of the ice, but how long after one can not say. The Milwaukee Public Museum has a tooth of a mastodon (p. 111), labeled as found at Waukesha. Its geological age is that of the other remains here referred to. In the collection of the University of Wisconsin is a large vertebra of a proboscidean which was found in Lake Monona. Its time of burial must have been late Wisconsin. Inasmuch as no remains of vertebrate animals have yet been found in Wisconsin, in the area covered by the Illinoian drift, it is not necessary to dwell on this region. It is not certain that there is beneath it a still older drift; but there are, according to Alden, some indications of such deposits.

For a knowledge of the driftless area, first of all, may be consulted the report made by Chamberlin and Salisbury in 1885 (6th Ann. Rep. U. S. Geol. Surv., pp. 199–322, with plates). Alden's work above referred to maps a part of the region. Grant and Burchard have studied the geology of the Lancaster and Mineral Point Quadrangles (Folio U. S. Geol. Surv. 145). Their text-figure 1 is here reproduced, inasmuch as it shows the relation of the region to the surrounding glaciated areas (fig. 14). The topographical map of Folio 145 and that of Chamberlin and Salisbury will show the uneven character of the surface. This has resulted from the erosion undergone during the whole of the Pleistocene. Much of the area is covered with a coating of loess. Along Mississippi River this may be as much as 10 feet thick, but at a distance of from 30 to 40 miles it becomes reduced to a few inches. Considering this erosion, one might conclude that few vertebrate remains would be preserved; nevertheless they are not wholly missing.

In 1862 (Geol. Surv. Wisconsin, vol. I, p. 136), J. D. Whitney stated that he had found in a crevice at Blue Mounds, Wisconsin, remains of the mastodon (p. 111), a peccary (p. 219), bones and teeth of a buffalo (p. 270), and a wolf which he referred with doubt to *Canis latrans*. The depth was uncertain, but it may have been as much as 40 feet. The fossils were embedded in reddish clayey loam, the usual crevice earth. On page 422 of the same volume, Jeffries Wyman referred the wolf remains to two distinct species, *Canis occidentalis* and *C. latrans*. In 1876, Dr. J. A. Allen (Amer. Jour. Sci., ser. 3, vol. XI, pp. 47–49) described from the same lot of bones the species *C. mississippiensis*. This apparently did not include jaws and teeth that Wyman had referred to *C. occidentalis*. In Wyman's paper, on page 422, he assigned three teeth to *Dicotyles torquatus*, an existing peccary, without stating that it had been found at Blue Mounds. In 1869 (Jour. Acad. Nat. Sci. Phila., ser. 2, vol. VII, p. 384), Leidy referred this peccary to his *Dicotyles lenis*, an extinct species. Inasmuch as the peccaries found at Galena were identified by Leidy (Whitney, vol. cit., p. 424)

as *Platygonus compressus* (p. 218), it appears pretty certain the *Dicotyles lenis* (*Tagassu lenis*) was among the fossils collected at Blue Mounds (p. 219). It must, however, be kept in mind that Whitney, on page 35,

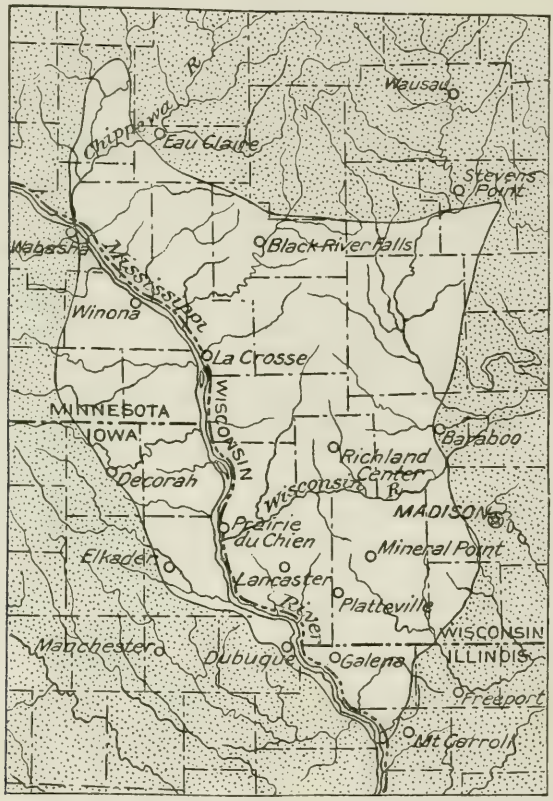


FIG. 14.—Relation of driftless region of Wisconsin, Iowa, and Illinois to glaciated areas. From Grant and Burchard. Unshaded area represents driftless region.

stated that he had collected bones and teeth of the same animal near Dubuque, Iowa. Allen regarded the buffalo as belonging to an extinct species; but it is really undeterminable. Accordingly there may be credited to this locality the following species: *Tagassu lenis, Bison* sp. indet., *Mammut americanum, Canis nubilus* (*C. occidentalis*), *C. mississippiensis, C. latrans.*

In Whitney's report, on page 133, he announced the finding of a large quantity of bones of mastodons at Sinsinawa Mound (p. 111), but he did not know at what depth they occurred. It seems probable that they had been met with in one or more crevices.

It seems probable that the animals found in crevices in the lead region of Wisconsin, Illinois, and Iowa belong approximately to one geological

stage of the Pleistocene. The following appears to include all known to have occurred in such situations:

Megalonyx jeffersonii?.
Platygonus compressus.
Tagassu lenis.
Odocoileus virginianus?.
Cervus canadensis.
C. whitneyi.
Antilocapra americana.
Bison sp. indet.
Mammut americanum.
Marmota monax.
Microtus sp. indet.
Geomys bursarius.
Sylvilagus floridanus? (Lepus sylvaticus).
Anomodon snyderi.
Procyon priscus.
Canis nubilus (C. occidentalis).
C. mississippiensis.
C. latrans.

The writer was at one time inclined to believe that these animals belonged to the time succeeding the withdrawal of the Wisconsin ice-sheet. Baker ("Life of the Pleistocene," p. 353) thinks that they belong probably to the Peorian, inasmuch as the region is covered by Iowan loess, beneath which many of the bones have been found. It is quite probable that those crevices were open during at least some part of the Pleistocene and that animal remains collected in them. The fossils are reported as being sometimes inclosed in a matrix of cave or fissure materials which are cemented together by iron. The considerable number of extinct species, certainly 7 out of about 18, makes it probable that the fauna is not so recent as the Late Wisconsin.

It appears to be determined that the Iowan loess was formed immediately after the retirement of the Iowan ice-sheet. It might, therefore, be a question whether all of these animals might have got into those crevices in time to be covered in by the loess. On the other hand, the Illinoian drift was, for a long time, exposed to weathering and erosion before the Iowan drift and loess were laid down. Also, the Sangamon interval was probably much longer than the Peorian, so that the chances for the accumulation of the fossils were greater. It seems, however, that we can only say that the fossils are post-Illinoian and probably pre-Wisconsin.

Besides the vertebrate fossils referred to above, a few others, especially mastodons (pp. 110, 111), have been found at other places, but so little is known of the conditions of their interment that they furnish little geological information.

A very interesting region is found in the western part of the State, in Dunn and Pepin Counties. This has been examined with great care by Dr. Samuel Weidman, State geologist of Wisconsin. About Menomonie there are several brickyards, whose excavations furnish opportunities for studying the formations at that point. Sections of one of these brickyards are described and illustrated by Dr. E. R. Buckley, in Bulletin VII, part 1 (1901), page 194, plate XXXVII. A section and brief description is found also in a paper by Dr. Hussakof (Jour. Geol., vol. XXIV, p. 688). In that region are found outwash gravels which have been definitely correlated by Weidman with Iowan drift. In some places this is overlain by loess. These gravels vary from 10 to 20 feet in thickness at Menomonie. Beneath the gravels are found lacustrine clays varying in thickness from 20 to 40 and even 60 feet. These are stratified and consist

of layers from 1 to 12 inches in thickness, with intervening thin layers of sand. Toward the bottom the sand increases in amount. Beneath the clay-bearing formation is a bed of sand attaining a maximum thickness of about 150 feet. This is underlain by coarse sand and gravel. The lacustrine clays and the underlying sands and gravels are included by Weidman in his Menomonie formation, and this is believed by him to be of Sangamon interglacial age. In northwestern Wisconsin are found other glacial deposits believed to belong to the Illinoian drift epoch.

In the lacustrine clay at Menomonie have been found remains of the great lake trout, *Cristivomer namaycush* (Hussakof, as cited above), of a deer (p. 230), a caribou (p. 247), and probably a mastodon. The deer is represented by a single vertebra, identified by Dr. W. D. Matthew. The supposed mastodon is indicated by the distal end of the right femur, the caribou by an antler of a young and probably female individual and by the shaft of a large individual.

At Woodville, in St. Croix County, about 20 miles west of Menomonie, has been found a forest bed regarded as belonging to the Aftonian. This was described by Arthur Koehler (Amer. Forestry, vol. xxvi, Feb. 1916, p. 92, 3 figs.). Wood was found that was identified as that of spruce.

In 1913 (Science, n. s., vol. xxxvii, p. 457), in a brief abstract, Weidman reported that in Wisconsin he recognized drift deposits of Wisconsin, Iowan, and Kansan ages and another still older. No localities were mentioned, but his statements were doubtless based mostly on his work in the western part of the State. The loess was found to be laid down after the Iowan and before the Wisconsin. Interglacial deposits were found between the Kansan and the Iowan.

In 1905 (Jour. Geol., vol. viii, pp. 238–256) and in 1910 (Jour. Geol. vol. xviii, pp. 542–548), Dr. R. L. Chamberlain presented the results of his investigations on the "Pleistocene Geology of the St. Croix Region in Western Wisconsin." His conclusion (p. 548) was that in that part of the State there were present (1) a surface mantle of gray Wisconsin drift deposited by a glacier from the Keewatin center; (2) red Wisconsin drift deposited by a glacier coming from the Labrador center; (3) a red drift left by an ice invasion from the Labrador center, its age consistent with Illinoian; (4) a grayish-black till that had come from the Keewatin center and whose age was probably Kansan.

MARYLAND AND DISTRICT OF COLUMBIA.

For obvious reasons the Pleistocene geology of the District of Columbia is considered in connection with that of Maryland. This region is of especial interest, because of the long time and the care which has been bestowed on it by geologists and because the conclusions reached have been applied to the geological study of States both toward the north and toward the south.

The most complete exposition of the Pleistocene geology of the region is to be found in the volume of the Maryland Geological Survey entitled "Pliocene and Pleistocene," published in 1906. The geological treatise itself was written by George Burbank Shattuck and is illustrated by many

maps and text-figures. Included in this is a bibliography of the subject which occupies 17 pages. There is a chapter by W. B. Clark, Arthur Hollick, and F. A. Lucas, on the interpretation of the palæontological criteria; another by F. A. Lucas on the mastodons and the elephants. The Pleistocene mollusks found in the State, 40 species, were described and figured by W. B. Clark; while the plants, also nearly 40 in number, were described and figured by Arthur Hollick.

The history of the development of our present knowledge of the geology of Maryland and the classification of its formations up to 1906 is given by Shattuck in the volume just cited (pp. 25–40). This geologist recognized in the superficial deposits of the State five formations (fig. 15). These are, beginning with the oldest, Lafayette, Sunderland, Wicomico, Talbot, and Recent.

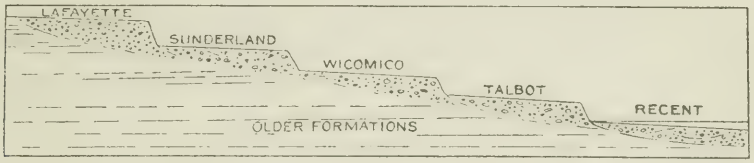


Fig. 15.—Diagram showing the ideal arrangement of the supposed terraces in the Maryland Coastal Plain. From Shattuck.

The Lafayette is regarded as having been laid down during the Pliocene. The Sunderland, Wicomico, and Talbot form three terraces, of which the Sunderland is the oldest, most elevated, and farthest away from the larger bodies of water. It is composed of clay, peat, gravel, and boulders supposed to have been brought in by the ice. The coarser materials appear to occupy usually the lower parts of the formation. The elevation near Washington is about 200 feet, but southward it descends gently, until in St. Mary's County it is only about 60 feet. The thickness varies from about 80 feet to nothing. According to Shattuck, at the time of deposition of the Sunderland the coast was depressed to an extent of about 200 feet, so that its materials were laid down either in salt water or in that of wide estuaries. No deposits belonging to it have been found in the eastern peninsula. In the western peninsula considerable areas are recognized along the Potomac up to Washington and along the Patuxent and Chesapeake Bay to Baltimore and Elkton. Except in the southern part of this peninsula, the Sunderland is found only in widely separated patches. No marine organisms are known to have left their remains in the Sunderland, but forest trees of a number of existing genera and several extinct species have been described by Hollick in the volume cited.

The Wicomico formation is described as occupying a large portion of the central and higher parts of the eastern peninsula; in the western it forms a narrow and often interrupted fringe around the Sunderland. North of Washington and Annapolis it occurs only in patches. Its materials are very similar to those of the Sunderland. Its greatest elevation is about 100 feet above sea-level, and this, according to Shattuck's view, marks the amount of depression of the land at that time. The thickness may be as much as

70 feet, but is usually much less. No marine fossils proper to the period have been discovered in the deposits, but at a point in Prince George's County plant remains have been found in a deposit about 20 feet thick.

The Talbot formation forms a fringe, sometimes of great width, sometimes narrow or interrupted, along all the large bodies of water in this State and in Delaware. It is the lowest of the terraces. The greatest elevation is about 45 feet; the thickness does not exceed 40 feet. The materials noted are those of the other two formations—clay, peat, sand, gravel, and ice-borne boulders. At several points along Chesapeake Bay and on the lower part of Patuxent and Potomac rivers, deposits containing plant remains have been discovered, including pines, cypress, hickory, beech, elm, and black locust. In contrast with the other formations, the Talbot has furnished many marine fossils, mostly mollusks; but in all cases the localities are close to the present coast.

The writer does not accept the theory that the materials forming what have been called the Sunderland, Wicomico, and Talbot terraces have been to any great extent laid down in the sea. Some part of the Talbot, that lying near the present coast, has undoubtedly had such an origin. Nor has the Coastal Plain suffered, so far as is determinable, any such amount of depression as the theory mentioned requires. The materials of the Sunderland and Wicomico have, in the writer's opinion, been brought down by rivers whose beds lay at levels nearly as high as those of the real or supposed terraces. When the Talbot materials were laid down, the rivers and estuaries of the coast had been cut down nearly to their present levels, and this was not long after the beginning of the Pleistocene.

The authors of the submergence theory admit that no satisfactory evidence of the presence of marine organisms, vertebrate or invertebrate, are to be found in the body of the assumed terraces, except again in parts of the Talbot which immediately border the ocean or the great estuaries. It is almost inconceivable that the ocean could occupy the Coastal Plain from New Jersey to Mexico for thousands of years and lay down great thicknesses of clay, sand, and gravel without having left somewhere beds of molluscan shells in such situations that they would have been discovered. While these marine fossils are lacking, there are found on all these terraces from Maryland to Florida and to the Rio Grande an abundance of land vertebrates such as elephants, mastodons, horses, camels, peccaries, and many other forms. Nor do our palæobotanists have difficulty in finding oaks, walnuts, hickories, poplars, etc. On the theory of submergence there are missing all the things that ought to be found and there are met with just the things that would not be expected.

A figure is here reproduced (fig. 15) from the Maryland Pliocene and Pleistocene volume, page 66, with the explanation there accompanying it. The reader may judge for himself whether the sea could occupy the Atlantic coast since Pliocene times without leaving any traces of marine fossils, while at the same time there were preserved in those terraces remains of land animals and land vegetation.

Another section (fig. 16) is reproduced from Folio 179 of the U. S. Geological Survey, the authors of which are G. W. Stose and C. K. Swartz.

The uppermost terraces are by these authors supposed to belong to the late Pliocene, the formation formerly known as the Lafayette. These figures suggest that the one set of terraces have some connections with the other set.

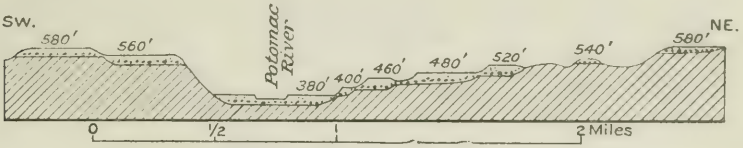


FIG. 16.—Section across Potomac River near Big Pool, Maryland. Shows gravel-covered terraces. Folio 179, U. S. Geol. Survey.

Beginning at the southern extremity of Maryland, we notice the occurrence of remains of *Mammut americanum* at or near St. Mary's City. Other remains of the same animal have been secured near St. Clements in St. Mary's County (p. 112). Both of the localities are situated on territory mapped by Shattuck as Wicomico; but as remarked on page 112, our knowledge of the conditions under which the fossils were found is not sufficient to allow us to say more than that they belong to the Pleistocene. The species existed from early to late Pleistocene and can not be used to determine the age of the deposits.

Along Patuxent River, in Charles County, not far from Benedict, Cope (Proc. Acad. Nat. Sci. Phila., 1867, p. 155) recognized jaws and teeth of *Grison macrodon* and of *Tagassu lenis* (p. 220). Both are extinct species.

According to Shattuck's map of 1906, this region is covered by the Talbot formation; but inasmuch as the species named were obtained from pits furnishing Miocene marl, one can not be sure that they are not older than the supposed Talbot. It would probably require a search in the land records in order to determine exactly where the objects were found. The presence of *Elephas primigenius* suggests that this animal had been pushed down here during one of the glacial stages.

Nearly a hundred years ago an elephant tooth (p. 154) was found somewhere in Queen Anne County, but it would probably be now impossible to determine the locality. In case the elephant tooth was found near Chesapeake Bay, as is very probable, there is no record of any Pleistocene vertebrate having been found in the central and eastern parts of the eastern peninsula.

In the eastern peninsula remains of Pleistocene vertebrates have been recorded from only two localities, Oxford Neck, Talbot County, and an undetermined locality in Queen Anne County. From Oxford Neck, Cope (Proc. Amer. Philos. Soc., vol. XI, 1869, p. 178) reported *Elephas primigenius, E. columbi, Cervus canadensis, Odocoileus virginianus, Chelydra serpentina,* and *Terrapene eurypygia.*

At Chesapeake Beach, William Palmer, of the U. S. National Museum, discovered a few remains of Pleistocene vertebrates. One of these is a tooth of an undetermined species of *Bison,* probably not the existing one. Another

species is probably *Equus leidyi* (p. 189). Three teeth appear to represent the peccary *Tagassu lenis* (p. 220). In 1921, Dr. Adolph H. Schultz, of the Johns Hopkins Medical School, presented to the U. S. National Museum another specimen of *T. lenis* which he had found at Chesapeake Beach. Inasmuch as the fossils were picked up after having fallen from their resting-place, it is impossible to say to which formation they belonged. In the opinion of the writer, none of the three species indicates a late Pleistocene time.

On the opposite side of the western peninsula, at Marshall Hall, Charles County, there was found long ago a tooth which the writer refers to *Equus leidyi*.

Coming north into the District of Columbia, we find recorded the discovery of remains of horses and possibly at two different times. According to Darton's work (Folio 70, U. S. Geol. Surv.), there is some later Columbia laid down along the route of the Chesapeake and Potomac Canal above Georgetown. This would now doubtless be regarded as belonging to the Talbot. It seems to follow that either the Talbot is much older than has been supposed or that some of the extinct horses continued on until a comparatively late time in the Pleistocene.

Within the limits of the city of Washington there has been found a tooth of probably *Elephas primigenius* at a depth of 35 feet, in the Wicomico formation (see p. 178). On any theory of the origin of the terraces, the presence of the tooth at that depth in the ground and at that elevation appears to indicate a considerable geological age for the animal. To what extent materials may have been washed down from the surrounding higher land may be difficult to determine.

In Prince George County, near Mitchellville, have been found two teeth of an extinct horse (p. 188). These are as yet unidentified. They are in the U. S. National Museum, No. 8813.

Near Towson, in Baltimore County, a mastodon tooth has been found (p. 112); but beyond proving that there is at that locality some Pleistocene deposit, it gives us little information.

In 1920 (Proc. U. S. Nat. Mus., vol. LVIII, pp. 96–109), the writer described a collection of vertebrate fossils, collected in a cave or fissure in limestone at Cavetown, Washington County, by anthropologists from Phillips Academy, Andover, Massachusetts. The following is the list of species that were found in the collection:

Crotalus horridus.
*Equus complicatus (p. 189).
*Equus giganteus? (p. 189).
*Mylohyus nasutus (p. 220).
*M. exortivus (p. 220).
*M. obtusidens, n. sp. (p. 220).
*Platygonus tetragonus? (p. 220).
*P. vetus? (p. 220).
*P. cumberlandensis (p. 220).
*Sangamona fugitiva.
Odocoileus virginianus (p. 231).
*Elephas columbi?
*Sciurus tenuidens, n. sp.
S. hudsonicus.
S. carolinensis.
Marmota monax.
Castor canadensis.
Ondatra zibethica.
Neotoma magister.
Microtus pennsylvanicus.
Erethizon dorsatum.
Sylvilagus floridanus.
Ursus americanus.
*Smilodontopsis mooreheadi.
Felis couguar.

Of the 22 species here recognized 12 are extinct. This large number of itself indicates that their time of existence was not recent. Similarly, the presence of 2 species of horses, several species of peccaries, and of a saber-tooth tiger points to a rather ancient period. The writer believes that the assemblage belongs to the Sangamon stage of the Pleistocene.

In Washington County, probably along Lane's Creek, was found, in digging a mill race, the skull of a mastodon (p. 112). Further east, near Clear Spring, and about a mile above the entrance of Conococheague Creek into the Potomac, was discovered a tooth of a mastodon (p. 113). This had been washed out of some deposit along this creek, probably not far away from where it was found. As Stose has shown (Hancock Folio, No. 179, U. S. Geol. Surv.), along the Potomac and its tributary streams there are extensive Pleistocene deposits of sand and gravel, laid down when the river was as much as 200 feet above its present level. It is probable that such deposits date from the early Pleistocene (fig. 17). A more important

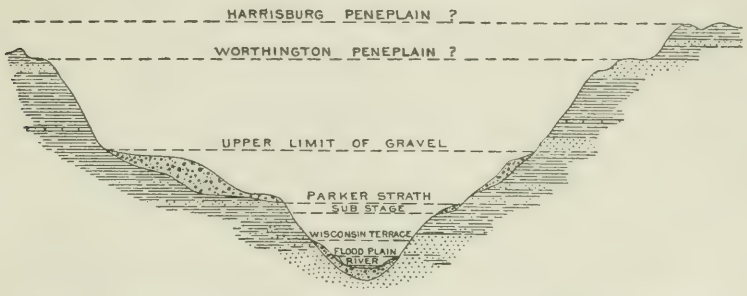


FIG. 17.—Generalized section across the Allegheny Valley at Parkers Landing, West Virginia, showing various stages of erosion and valley fill. U. S. Geol. Surv. Folio 178.

locality for Pleistocene vertebrates is that near Corriganville, about 3 miles west of north of Cumberland, Maryland. The cave is in Allegany County, west of Wills Creek and south of Jennings Run, about 0.5 mile south of the village of Corriganville. An account of this locality, with a list of the species determined up to that time, has been published by Gidley (Proc. U. S. Nat. Mus., vol. XLVI, 1913, pp. 93–102). In cutting through a spur of limestone in making a railroad, at a depth of about 100 feet there was exposed a cave or fissure which contained many bones and teeth. Gidley secured some hundreds of specimens belonging to about 35 species. Unfortunately nothing has been published which shows the relation of this cave to the terraces which are found along Potomac River and its tributaries. Through the kind offices of Mr. F. S. Rowe, welfare agent of the Western Maryland Railway, the writer has received from the division engineer, Mr. P. Cain, of Cumberland, a topographic map of Allegany County and a profile of the road extending through the rock cut. From these it appears that the level of the track, at the fissure, is 837 feet above sea-level. This seems, therefore, to be considerably above the highest terrace along the Potomac in that region. It is to be supposed that the fissure was formed long before the animal remains accumulated in it.

In a paper published in 1920 (Proc. U. S. Nat. Mus., vol. LVII, pp. 651–678, plates LIV, LV, text-figs. 1–10) Gidley added to his former list four species of peccaries, as follows: *Platygonus cumberlandensis, P. intermedius, Mylohyus exortivus* (all new), and *M. pennsylvanicus*. In another communication he reported also a deer, a wolverine, a beaver, a lynx, a badger, a marten, an eland, and a crocodile or an alligator (Rep. Smithson. Inst. for 1918, pp. 281–287). Many of the identifications are merely provisional.

Provisional list of fossils found near Corriganville.

1. Alligator or Crocodylus sp. indet.
2. Blarina brevicauda?.
3. Vespertilio grandis.
4. Vespertilio sp. indet.
5. Myotis sp. indet.
6. Ursus vitabilis.
7. Ursus americanus?.
8. Canis armbrusteri.
9. Canis sp. indet.
10. Vulpes? sp. indet.
11. Mustela vison?.
12. Gulo luscus?.
13. Taxidea sp. indet.
14. Lynx sp. indet.
15. Mammut americanum.
16. Equus sp. indet. (p. 189).
17. Tapirus haysii? (p. 204).
18. Platygonus cumberlandensis (p. 220).
19. P. intermedius (p. 220).
20. P. vetus? (p. 220).
21. Mylohyus exortivus (p. 220).
22. M. pennsylvanicus (p. 220).
23. Odocoileus sp. indet.
24. Taurotragus americanus.
25. Ochotona princeps?.
26. Lepus americanus?.
27. Lepus sp. indet.
28. Sciurus hudsonicus.
29. Sciuropterus alpinus?.
30. Marmota monax?.
31. Castor sp. indet.
32. Neotoma sp. indet.
33. Microtus chrotorrhinus?.
34. Synaptomys borealis?.
35. Synaptomys sp. indet.
36. Peromyscus leucopus?.
37. Napæozapus sp. indet.
38. Erethizon sp. nov.

On account of the present unstudied condition of the collection, it is difficult to reach conclusions that are satisfactory. It appears, however, that there are at least 6 hitherto undescribed species, one-fifth of the whole number. Another 6, if at all correctly determined, indicate a wide removal from their ranges of the present day. *Lepus americanus* now lives well toward the north, coming down to Saginaw, Michigan. *Ochotona princeps* lives in the Rocky Mountains of British America. *Synaptomys borealis* is known only from the region about Great Bear Lake, Mackenzie, Canada. *Microtus chrotorrhinus* has its habitat in Quebec and the northeastern United States. The species of *Napæozapus* are Canadian in their range, but descend to southeastern Maryland and to North Carolina in the mountains. *Sciuropterus alpinus* is found from Alaska to Hudson Bay, but descends on the Pacific coast to southern California. This northern habitat of so many supposed species suggests that the fissure received its contents during one of the glacial stages, and this may be the case. However, it is not unlikely that these species and some others are really undescribed ones. One may reasonably expect to find in a fauna containing *Equus* and *Tapirus* a much higher percentage of extinct species than Gidley has recorded.

The most remarkable member of the fauna is *Taurotragus americanus*, a species closely related to the eland of southern Africa (Gidley, Smiths. Misc. Coll., vol. LX, No. 27). Its presence in western Maryland gives a vivid impression of the widely extended journey that some animals have made from one continent to others. The same species has since been found

in collections made at Alton, Illinois (p. 339), and at Kimmswick, Missouri (Proc. U. S. Nat. Mus., vol. LVIII, p. 113).

According to the author's views, the fauna found at Cumberland, like that of localities in western Virginia, belongs to a time somewhere about the middle of the Pleistocene. Most of the species may be supposed to have lived there during the warm Sangamon stage; others, as the wolverine, at a somewhat earlier or later time when the climate was cooler.

VIRGINIA.

For the student of Pleistocene vertebrate palæontology, as for the geologist, Virginia may be divided into three physiographic regions, the Coastal Plain, the Piedmont Plateau, and the Appalachian Mountains. The line which divides the Coastal Plain from the Piedmont Plateau begins at the southern boundary of the State, at about 77° 31′ longitude. The towns on or not far from this nearly north-and-south line are Emporia, Petersburg, Richmond, Hanover, and Fredericksburg. Near the latter the line inclines slightly eastward and passes a few miles west of Alexandria and Washington, D. C. The Coastal Plain is much less elevated than the region west of it and consists of deposits of Mesozoic or Cenozoic age, and much of it is covered by Pleistocene materials. The Plateau region is elevated and consists mostly of Palæozoic rocks, mostly metamorphosed into a crystalline condition. The Appalachian region presents nearly parallel ranges of mountains and intervening valleys.

For a knowledge of the Pleistocene geology of the Coastal Plain the reader should consult Bulletin IV, 1912, of the Virginia Geological Survey. The authors who discuss the physiography and geology of this region are William B. Clark and Benjamin L. Miller. On pages 19 to 45 they present a very full bibliography of the geological literature pertaining to this region. Additional valuable assistance may be obtained from the various folios issued by the United States Geological Survey, but unfortunately not many species of vertebrate animals have been found on this Coastal Plain of Virginia.

In Bulletin IV, already mentioned, Clark and Miller recognize the presence of three terraces belonging to the Pleistocene. To these are given the names applied in Maryland and North Carolina to what are regarded as equivalent terraces. The oldest of these, most elevated and farthest from the coast, is the Sunderland; eastward of this lies the Wicomico; the Talbot is the youngest and lowest and borders the coast. Unfortunately, the geologists referred to did not map the areas occupied individually or collectively by these terraces. They accept the theory that these terraces were laid down in the sea. It is admitted, nevertheless, that no marine fossils are found in deposits of the Sunderland and Wicomico. In the Talbot, 26 species of marine mollusks have been reported from Talbot deposits of the Dismal Swamp Canal, all regarded as belonging to living species. It will be recollected that Woolman (Proc. Acad. Nat. Sci. Phila., 1898, p. 414), in a study of mollusks collected in the Dismal Swamp Canal, found 7 extinct species in a collection of 49 species, equal to about 16 per cent. It is, however, not unlikely that the collections had been dredged up from deeper deposits.

In Bulletin v of the Virginia Geological Survey, on page 25, Sanford stated that the Talbot had a width of 30 miles at the south. On consulting Stephenson's map of the superficial formations of the Coastal Plain in North Carolina (North Carolina Geol. Surv., vol. III, plate XIII) it will be seen that this corresponds quite exactly with the width of the Pamlico formation at that line. For the writer's views on the terraces named the reader may consult page 346 on the geology of Maryland.

On page 113 is recorded the discovery of a tooth of a mastodon in a marsh near Disputanta, in Prince George's County. Not enough is known about the geology of the region to say more than that the deposit belongs to the Pleistocene.

About 6 miles east of Williamsburg, a little more than 100 years ago, remains which pretty certainly belonged to the genus *Mammut* and probably to the species *M. americanum* (p. 113) were discovered, said to have been found on the banks of York River; but by this was probably meant the banks of the flood-plain. The bones were found in marsh mud and were surrounded by roots of cypress trees. The adjacent bank was 20 feet higher than this level. The topographical map of the Williamsburg Quadrangle shows that an abrupt rise of this amount is to be found only about 10 miles away from the river. Whether the cypress roots were those of trees that had grown within recent years or whether they were remains of a Pleistocene forest, such as was exposed at Tappahannock, Essex County (Bull. IV, p. 186), the writer does not know. The information at hand about this case does not make it possible to pronounce on the geological age of the mastodon.

On page 28 an account is given of the discovery of a skull of a walrus on the Atlantic coast of Virginia, at Accomac. It had doubtless been washed up by the sea from a Pleistocene deposit. It is easiest to suppose that the walrus had been driven southward along the coast during the Wisconsin glacial stage; but possibly this happened during an earlier glacial time.

No vertebrate fossils of Pleistocene age appear to have come to light anywhere on the Piedmont Plateau, and little or nothing is known about its Pleistocene geology.

From the geological surveys we get little information about the Pleistocene formations of the Appalachian region. At most, mention is made of soils of undetermined age along the streams; and yet from this region have been obtained a very considerable number of Pleistocene vertebrates.

From Mr. Wyndham Robinson, of Abingdon, Washington County, the U. S. National Museum received in 1869 a tooth of *Mammut americanum* (p. 113) and one of *Equus complicatus* (p. 189). Nothing has been learned regarding the conditions under which they were unearthed. The horse-tooth points to an age preceding the Wisconsin drift.

From Saltville, in Smyth County, the following forms have been obtained:

Crocodylus sp. indet.
Megalonyx dissimilis (p. 34).
Equus sp. indet. (p. 190).
Odocoileus? sp. indet. (p. 231).
Cervalces sp. indet.
Bison sp. indet. (p. 259).
Mammut americanum (p. 113).
Elephas primigenius (p. 145).

That a crocodile should have lived in this region during the Pleistocene is remarkable. *Megalonyx dissimilis* is otherwise known only from Natchez, Mississippi, from deposits which appear to be of about Illinoian or Sangamon age. The horse-tooth points to about this time or earlier, while the other species do not contradict this conclusion. The astragalus referred to *Odocoileus* probably belongs to some other genus.

Mr. M. D. Mount sent to the U. S. National Museum remains of *Bison* (p. 259), *Mammut americanum* (p. 113), and *Elephas primigenius* (p. 145). These, he reported, had been found at a depth not greater than 8 feet in excavating for the city reservoir. He has written that the valley of Holston River at Saltville, within about 80 years, had been a lake, at least at certain times of the year, and that the reservoir was excavated at the margin of this low area.

Mr. O. A. Peterson (Ann. Carnegie Mus., vol. xi, 1917, pp. 469–474) reported from this place the crocodile, the megalonyx, cervalces, the supposed deer, the horse-tooth, and remains of mastodons. The bones were found in a sink-hole, in a layer of coarse gravel, pebbles and cobblestones, a fact indicating that a stream of some size had occupied the place. Overlying this layer was one in which there were fragments of large river shells. The bone layer appears to have been only about 4 feet from the surface. Peterson concluded that at the close of the Pleistocene or later the remains had been moved and redeposited from some place not far away, but this would not affect the geological age of the fossils and it is evident that remains of vertebrates are widely dispersed in that valley. All the species reported are extinct, but only large forms were secured.

Professor Cope, probably in 1868, found the following 24 species. He did not state the localities exactly, except that they were along New River, in Wythe County. Two were on the land of Abraham Painter. The writer applied to the surveyor of the county named and has been informed that the farm which belonged to Abraham Painter is on New River, near the town of Ivanhoe. The nomenclature of the species has been revised. The species preceded by a dagger are extinct.

†Megalonyx jeffersonii (p. 34).
Castor fiber.
Neotoma floridana?
Marmota monax.
Peromyscus leucopus.
†Tamias laevidens.
†Sciurus panolius.
Sylvilagus floridanus.
Blarina sp. indet.
Vespertilio sp. indet.
†Tapirus haysii (p. 204).
†Equus complicatus? (p. 190).
†Mylohyus nasutus (p. 221).
Odocoileus virginianus (p. 231).
†Bison sp. indet. (p. 260).
†Ursus amplidens.
Procyon lotor.
Spilogale putorius.
†Myxophagus spelaeus.
Crotalus sp. indet.
Amyda sp. indet.
Terrapene sp. indet.
Cryptobranchus sp. indet.

At least 9 of the 24 species are extinct. None of the recorded species requires us to refer the deposit to early Pleistocene times. *Ursus amplidens* was described from the deposits at Natchez. This and *Tapirus haysii*, *Equus complicatus*, and *Mylohyus nasutus* point to middle Pleistocene, apparently about to Illinoian or Sangamon times.

Cope reported that the teeth and bones were found in a cave breccia. This consisted of a number of irregular masses which occupied "depressions and short galleries" in the southeast side of a line of hills. When those masses were excavated from their beds the floor and roof of a portion of a cave were exposed, with the stalactites, stalagmites, and usual incrustations. It would appear, therefore, that at some time in the early Pleistocene or in the late Pliocene the caves had been formed through the effect of streams of carbonated waters on the limestone; that in some way the bones and teeth of the animals listed above had got into the cave; that by a change in the amount or character of the water the caves had gradually filled up; and that afterwards the limestone which contained these caves had undergone great erosion.

Further north, in the valley of Jackson River at Covington, there is evidently a deposit of Pleistocene clay, for in it at a depth of 12 feet was found a tooth of a mastodon (p. 114). Another mastodon tooth was found near Hot Springs, at the head of Wilson Creek, in Bath County, possibly in similar deposits (p. 114). In Augusta County an unidentified species of horse (p. 190) and the peccary *Platygonus* (p. 221) have been discovered.

WEST VIRGINIA.

So far as the writer has learned, vertebrate remains belonging to the Pleistocene have been found in West Virginia in only eight places and only seven species are represented: *Mammut americanum* (p. 115), *Elephas* sp. indet. (p. 179), *Equus niobrarensis?* (p. 190), *Symbos cavifrons* (p. 254), *Meyalonyx jeffersonii* (p. 34), *Odocoileus virginianus?* (p. 231), and a peccary (p. 221). The horse appears to indicate an early Pleistocene time, possibly pre-Kansan, but all the other species continued from at least the Aftonian stage through to the Late Wisconsin. The specimens, therefore, do not help us to determine the age of the deposits in which they are found.

No part of the State lies within the glaciated area; hence, during the whole of the Pleistocene epoch its surface was subjected to weathering and to the erosion of running water. At times the streams built up deposits on their beds. Later they deepened their channels and left a part of their former deposits as terraces. At a still later time the deposition and deepening may have been repeated, and as a result there is sometimes a series of terraces one above another. The age of these terraces and their origin have been the subjects of a good deal of controversy.

In the Masontown-Uniontown Folio (U. S. Geol. Surv. No. 82), M. R. Campbell has discussed the terraces along the Monongahela River, which occur at an altitude of about 1,000 feet above sea-level and perhaps 150 feet above the present river. Also more than 100 feet above the present river are old abandoned river channels which are now partially filled up.

In 1911 (U. S. Geol. Surv. Folio 178, pp. 11–13), E. W. Shaw and M. J. Munn described the Quaternary of the Foxburg and Clarion quadrangles in Pennsylvania, where the same Pleistocene problems are involved. They present an account of the different views regarding the high-level terraces and the abandoned channels. They concluded, as did Campbell, that these

terraces and channels dated back to the early Pleistocene and probably to the Kansan stage. Figure 17 is a reproduction of Shaw and Munn's figure 10, on their page 12. It represents a section across Allegheny River at Parker's Landing, Armstrong County, Pennsylvania. The uppermost gravels in the figure would be those of supposed Kansan age; while the lowermost are those laid down during the last glacial stage, the Wisconsin. In the materials of the high terraces one may expect to find fossil vertebrates of the early Pleistocene, as in the case of the mastodon reported from Stewartstown, West Virginia (p. 116). The conditions of burial should, however, be carefully studied and recorded; for it would be possible for remains to be left at a later time on such a terrace and to be covered up by earth washed down from above.

On page 254 an account is given of finding a musk-ox skull near Steubenville, Ohio, on a terrace about 75 feet above the low-water mark. The region of the western part of West Virginia, western Pennsylvania, and northeastern Ohio is interesting because of its history during the late Pleistocene. The reader is referred to Leverett's monograph, "The Glacial Formations and Drainage Features of the Erie and Ohio Basins" (Monogr. U. S. Geol. Surv., vol. XLI, 1902, pp. 88–158, with figs.). Leverett essays to show that the upper part of the Ohio River, the Allegheny, and the Monongahela with its branches at one time emptied into Lake Erie. The connection was made through Beaver River, which now flows into the Ohio, and Grand River, in eastern Ohio, now emptying into Lake Erie. When the Wisconsin ice filled Lake Erie and occupied its southern shore the mouth of Grand River was dammed and the water could escape only to the south. The flow was reversed, and after it had reached the top of the divide it entered the stream that then represented the head of the Ohio. When at length the mouth of Grand River was reopened, the new channel had been cut so deep that most of the streams of western Pennsylvania and West Virginia continued to flow down the Ohio. Leverett's figure representing the preglacial drainage of the upper Ohio region is here reproduced (fig. 10).

NORTH CAROLINA.

(Map 39.)

Our knowledge of the Pleistocene geology of North Carolina is at present confined almost wholly to the Coastal Plain of the State. The most recent general discussions of the geology of this region are found in volume III of the North Carolina Geological and Economic Survey, 1912. The authors who contributed to this volume are William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker. L. W. Stephenson has furnished an article on the Cretaceous deposits, and in his numerous geological sections he has referred to the Pleistocene materials there found. Benjamin L. Miller wrote on the Tertiary formations and likewise noted the Pleistocene materials found in his sections. The most important part of the volume for the student of the Pleistocene is Stephenson's article on "The Quaternary Formations," which occupies pages 266 to 290. Clark, Miller, and Stephenson united in a chapter on the "Geological History of the Coastal Plain of North Carolina." Clark, besides, deals with

the "Correlation of the Coastal Plain Formations." In addition to numerous plates and text-figures, a colored map shows the area covered by the surficial formations of the Coastal Plain and another the distribution of the formations exclusive of the surficial. Finally, Miller and Stephenson presented a bibliography which includes 150 titles, occupying pages 44 to 73.

According to Clark and Stephenson, the Pleistocene of North Carolina comprises five formations; the oldest is the Coharie, farthest removed from the coast and lying back against the so-called Lafayette, itself supposed, with some doubt, to belong to the Pliocene. Toward the coast there come in, in succession of position and time, the Sunderland, the Wicomico, the Chowan, and the Pamlico. These formations are described as forming more or less well-defined terraces having higher and higher elevations as they are followed back from the coast. The Pamlico nowhere exceeds 25 feet above sea-level. The Chowan varies in elevation from about 25 feet to about 50 feet. The Wicomico formation slopes from about 50 feet up to about 90 or 100 feet. The Wicomico may attain elevations of from 140 to 150 feet at the western border. The Coharie varies from about 160 feet along its eastern border to as much as 235 feet along its western border. From its western border each formation sends up the rivers prolongations into or across the next formation toward the west.

Each terrace may present along its coastward border an escarpment of varying elevation and obviousness. The Coharie and Sunderland formations are regarded by the authors named as being correlated with the Sunderland of Virginia and Maryland, although the Coharie may be really Pliocene. The Wicomico is equivalent to that called by the same name in the States farther north, while the Chowan and the Pamlico together are correlated with the Talbot of Virginia and Maryland.

The area occupied by the Pamlico is extremely narrow or absent along the southernmost third of the coast of the State. At longitude 77° the boundary between it and the Chowan turns and runs north, very slightly to the east, striking the northern boundary of the State at about 76° 15′. Just south of Albemarle Sound its width east and west is nearly equal to that of all the other Pleistocene formations at that latitude, taken together.

Clark, Miller, and Stephenson (op. cit., p. 300) accept the theory of McGee that during Lafayette times, probably in the late Pliocene, the Coastal Plain was depressed some 500 feet below its present level and covered by the sea. Into this sea were poured, by the rivers coming down from the higher lands to the west, the clay, sand, and gravel, sometimes boulders, which make up the so-called Lafayette. Somewhat later the region was uplifted enough to expose the Lafayette deposits and they suffered erosion. When the Coharie formation began to be laid down the sea-level must have been about 160 feet higher than at present; it continued to rise until it reached an elevation of about 200 feet. A subsidence and a succeeding elevation occurred, during which the Sunderland terrace was produced. In like manner the succeeding deposits and terraces are supposed, by the geologists named, to have been formed—the Wicomico, the Chowan, and the Pamlico.

One objection already offered (p. 346) to this theory to account for the deposits belonging to the Lafayette and the formations of the Pleistocene

is that, instead of beds of seashells, remains of marine fishes, porpoises, and whales, there are found scattered here and there over this region the bones and teeth of elephants, mastodons, horses, and other land animals. In maintaining this objection it is not necessary to assume that the lower parts of the Pleistocene area have never been submerged.

The writer has caused to be prepared a map showing the geographical distribution of the five formations referred (in the work cited) to the Pleistocene. It is based on the maps found in that volume. It shows also the localities where fossil vertebrates have been discovered, and where marine fossils and land plants have been secured (map 39).

One difficulty met with in our study of the distribution of the finds of extinct vertebrates in North Carolina, as elsewhere, arises from carelessness in recording and preserving proper data. In several cases here to be considered, no more is known than that a fossil has been found in a certain county. Happily, more is known in many other cases.

Examination shows that no fossil vertebrates are known to have been found in North Carolina within the area of the Coharie formation, but that mastodons have been met with in the areas of all four of the other formations as laid down in Stephenson's map, plate XIII of the work cited above. Horse remains, too, seem to have occurred within all the areas last noted. This does not mean necessarily that these remains were buried in the corresponding formations. A mastodon may have lived long after the Sunderland was laid down and his remains have become buried in some isolated deposit, say of Pamlico times; or, the remains may be found within the area of Pamlico, but really buried in underlying Chowan. Each case must be decided on the evidence bearing on it.

Mention is made on page 155 of the finding of a tooth of *Elephas columbi* about 9 miles below Wilmington. Whether this was buried in Pamlico deposits close along Cape Fear River, in Chowan deposits which prevail there, or beneath these, in Wicomico, it is impossible to say. A short distance below this place was found a tooth of *Mammut americanum*.

On page 190 is given an account of the discovery of a tooth of *Equus leidyi* in what was supposed to be Miocene marl in the vicinity of Elizabethtown, on Cape Fear River, in Bladen County. Miller (op. cit., p. 248) states that the Pleistocene about Elizabethtown rests usually directly on the Cretaceous, but that south of the town are found some patches of Miocene marls. The region about this town is mostly occupied by the Sunderland formation, but the Wicomico extends up the river far above the place. It is, however, mapped as lying mostly on the north side of the river. It seems pretty certain that the horse-tooth occurred in the Sunderland, probably at its base.

Mastodon remains, as stated on page 115, have been found in Pender County, but where is not known. Along the coast is a narrow strip of Pamlico. The southeastern half of the county is occupied by the Chowan, the northwestern by the Wicomico.

Mastodon teeth have been found in Duplin County, but there is no record as to exact locality, depth, or matrix. The southeastern two-thirds of the county is covered by deposits of the Wicomico, the northwestern third by Sunderland. The mastodon probably belongs to one or the other

of these. The Pleistocene deposits are, however, underlain by Tertiary rocks, and possibly the mastodon came from these and belongs to a different genus.

On page 116 will be found an account of remains of a mastodon, probably *Mammut americanum,* which was found near Jacksonville, in Onslow County. Three of the supposed Pleistocene formations are found near Jacksonville. The Pamlico comes up the New River quite to the town. Immediately at the town is (following Stephenson's map) the Chowan. The southeastern border of the Wicomico comes down nearly to the town. In which of the three areas the teeth were discovered we do not know. A case is here furnished which illustrates the need of most accurate observation and record of locality, depth, and character of materials.

As stated on page 116, teeth and tusks of *Mammut americanum* have been obtained at Maysville, Jones County. The writer does not know exactly the place where the remains were discovered. The region about Maysville is occupied by the Chowan formation, but the Pamlico sends an extension up White Oak River as far as Maysville.

Remains of both *Mammut* and *Elephas* have been reported from Carteret County. In 1828 (see p. 117) Elisha Mitchell stated that remains of the elephant and mastodon had been met with in digging the Clubfoot and Harlow Canal. This canal passed from Neuse River to Newport River. In 1876 (Senate Ex. Doc. No. 35, 44th Congr., p. 17) S. T. Abert transcribed, from an earlier report made by Professor Olmstead, a geological section taken in this canal. The excavation went to a depth of 16 feet. The uppermost of the four layers consisted of the peaty mold usually found in the swamp. The next layer was made up of a yellowish-brown potter's clay. The third layer consisted of sand and was full of sea-shells and fossil remains of "mammoths" (mastodons) and elephants. The shells belonged to species now found near Cape Lookout, principally conch, scallop, and clam. The layer below this was blue clay. In the case here presented there can hardly be a doubt that the stratum containing the shells and the bones belonged to a Pleistocene formation older than that assigned to the Pamlico.

On page 145 is described a tooth of *Elephas primigenius,* dredged up in Core Creek, forming part of the Inland Waterway in Carteret County. The conclusion seems unavoidable that this boreal animal had been driven to this southern latitude during one of the glacial stages, and one naturally thinks of the latest one, the Wisconsin; but it may have been at a much earlier time. A mastodon jaw has been secured in the same canal.

Doubtless the locality in North Carolina, the most important to the student of Pleistocene vertebrate palæontology, is that reported long ago on the northern shore of Neuse River, 16 miles below Newbern. As stated on page 117, in a mention of the mastodon bones discovered, H. B. Croom seems first to publish a statement concerning the animal remains found there. Some of his identifications were certainly wrong. According to Harlan (Amer. Jour. Sci., vol. XLIII, 1842, p. 143), there were secured remains of elephant, mastodon, hog, elk, deer, horse, seal, cetaceans, a tortoise, snake, fish, shark, and skate. As in another case, Harlan may have

mistaken worn teeth of *Bison* for teeth of the hog (*Sus*). For our purpose the most important animals of the list are the elephant, the mastodon, and the horse. According to Croom, the animal remains were found in a marl-pit. He was informed by the owner that in an upper layer there were found teeth of sharks and fragments of bones of marine fishes, mingled with sea-shells. In a deeper layer, 20 to 25 feet below the surface, there occurred the remains of land animals, together with sea-shells of great variety. Croom thought that some teeth belong to the hyena, and Foster reported the hippopotamus; but in both cases the identifications were wrong.

Conrad (Amer. Jour. Sci., vol. XXVIII, 1835, pp. 107–110; Proc. Nat. Inst. Prom. Sci., vol I, pp. 191–192) reported that the bones of animals found here were water-worn, black, and silicified. He concluded that they had been brought down the Neuse River and mingled with sea-shells. The fossiliferous stratum did not rise anywhere more than 10 feet above the river. In the first publication quoted, Conrad published a list of 66 mollusks in this stratum, of which 7 were not yet known as living species and 2 others are noted as new. According to this list, less than 90 per cent are recent. He referred the deposits to his newer Pliocene. In the second publication cited he concluded that the stratum belonged to the post-Pliocene. Stephenson (op. cit., p. 289) refers to the investigations made at this locality. It is not improbable that the deposit which furnished these fossils belongs to the earliest Pleistocene stage, the Nebraskan. The same may be said about the coquina rock mentioned by Stephenson which occurs at Old Fort Fisher, in New Hanover County (op. cit., p. 289, plate XXVIII).

On page 115 the writer refers to a lower jaw of a mastodon found by the geologist W. C. Kerr, near Goldsboro, and described by Joseph Leidy. The jaw was reported to have been found in gravel overlying Miocene marl. The writer believes that the mastodon belonged to the species *Mammut progenium*. Goldsboro, on Neuse River, is near the western border of the Sunderland formation, but the Wicomico is prolonged up the river far above Goldsboro. According to Stephenson and Johnson (op. cit., p. 475), Miocene sands and clays are found over a portion of the northern part of the county (Wayne). The geological age of this mastodon depends more on the age of the gravels in which it was found than on the age of the terrace, although the writer is willing to concede an early Pleistocene stage for the terrace.

A mastodon tooth has been found (see p. 117) somewhere in Wilson County. The county is covered mostly by Pleistocene of Sunderland age, but a small part of the western end is occupied by the Coharie; while, according to Stephenson's map, both the Chowan and the Wicomico follow up Contentnea Creek into Wilson County. The geological age of the mastodon is doubtful.

At Greenville, Pitt County, have been found remains of *Equus complicatus*, perhaps also of another species of horse (see p. 191). While supposed to have been found in Miocene marls, the tooth belonged without doubt to the Pleistocene. Pitt County is occupied by four Pleistocene

formations, Pamlico, Chowan, Wicomico, and Sunderland. The probability is that the horse-teeth were found in an early Pleistocene deposit.

As indicated on page 117, remains of *Mammut americanum* have been found in Pitt County, possibly at Greenville.

As noted on page 117, a tooth of *Mammut americanum* has been found at or near Tarboro. Nothing more is known about its origin. At this place are found deposits belonging to the Chowan, Wicomico, and Sunderland formations; it is impossible to say from which the tooth was derived.

Emmons (Geol. Surv. North Carolina, 1852, p. 56) reported finding mastodon bones in marl-pits on the farm of Mr. Knight, on the banks of Tar River, in Nash County, 3 miles west of Rocky Mount. The same Pleistocene deposits occur here as at Tarboro. The bones were supposed to have been buried in Miocene marl, and this may have been true. If so, they belonged to some other species of mastodon than *Mammut americanum*.

On page 191 is given an account of the discovery of teeth of *Equus leidyi* which were washed up on the beach at Plymouth. This town is on Roanoke River, several miles from Albemarle Sound, and on the border between the Pamlico and the Chowan formations. Our determination of the geological age of the teeth must be based on other evidence than that furnished by the discoverers.

Elsewhere in this work is given an account of finding a part of a skull of a walrus at Kitty Hawk. It was probably during the Wisconsin glacial stage that this animal lived along the coast as far south as Charleston.

As to the geological age of the Pamlico formation, the geologists who have contributed to the report of 1912, the volume cited, hold that it belongs to late Pleistocene. The writer believes that the formation was laid down at a much earlier time. The mastodon jaw and the tooth of *Elephas primigenius* found in the Inland Waterway Canal may have been buried there during the prevalence of the Wisconsin ice epoch; but, on the other hand, this may have happened during an older Pleistocene stage.

It will be observed that the Pamlico becomes very narrow along the southern third of the coast of North Carolina. In South Carolina it may be represented by one of the older Pleistocene deposits recorded by Sloan; in part possibly by the Wando clays or the Sea-island sands. In the author's view, it is pretty certain that the Pleistocene molluscan fauna which had been found in the Clubfoot and Harlow Canal and at the locality below Newbern corresponds to the Wadmalaw in the vicinity of Charleston. It seems to appear at the southeastern corner of the State, at Southport, and again in the northeastern corner in Dismal Swamp. According to Shaler (10th Ann. Rep. U. S. Geol. Surv., pt. 1, 1890, p. 315), a collection of mollusks made near the northern border of the swamp was submitted to Dr. W. H. Dall. There were 29 forms, of which 24 are yet existing, 5 extinct. There were, therefore, 17 per cent of extinct forms. Dall regarded the deposits as belonging to the Pliocene; the writer believes that they may be referred to the Nebraskan stage of the Pleistocene.

From a study of mollusks collected later in the Dismal Swamp Canal, Woolman (Proc. Acad. Nat. Sci. Phila., 1898, pp. 414–428) concluded that they belonged to a time not earlier than late Pliocene and possibly as late as the Pleistocene. Darton (U. S. Geol. Surv., Folio 80) referred the

deposits to the Pliocene. Stephenson (op. cit., p. 290) states that recent investigations have led to the conclusion that the beds should be referred to the Pleistocene. The parties in such a dispute may compromise by referring the beds to the Nebraskan stage. It seems probable that the Chowan formation belongs to a stage a little later than these mollusk-bearing beds and represents a strip of old coast marsh, inhabited by elephants, mastodons, horses, and various other animals.

In discussing the causes which led to the production of Cape Hatteras, Professor Shaler (Proc. Bost. Soc. Nat. Hist., vol xiv, 1872, p. 117) remarked that the hard shelly limestone which comes to the surface just above high-tide level along the shore of the mainland from Newbern to the mouth of the Roanoke River looks much like the shell-bed found near Charleston, South Carolina.

SOUTH CAROLINA.

To the reader who wishes to know what work has been done on the Pleistocene geology of South Carolina, two papers may be recommended. The first of these, historical in nature, was published in 1890 by Professor Joseph A. Holmes (Jour. Elisha Mitchell Sci. Soc., vol. vii, pp. 89–117), the second in 1905 by Dr. Griffith T. Pugh (Thesis, Vanderbilt Univ., pp. 1–74). Those who have contributed most to a knowledge of the palæontology of this formation are Tuomey, F. S. Holmes, Leidy, Dall, Dall and Harris, Earle Sloan, and G. T. Pugh. J. A. Holmes, Tuomey, F. S. Holmes, and Dall have made important contributions to the knowledge of the invertebrate animals. For our knowledge of the vertebrates we are indebted principally to F. S. Holmes and Joseph Leidy. The author who has dealt most recently and in considerable detail with the stratigraphy of the Pleistocene deposits is Earle Sloan, State geologist (Bull. No. 2, ser. iv, South Carolina Geol. Surv., 1908, 479 pages). From these authorities we learn that, while the larger part of the Coastal Plain may be to a greater or less extent overlain by deposits referable to McGee's Columbian, the deposits which bear fossils are confined almost wholly to a narrow strip along the coast. In this strip have been found the numerous mollusks listed and described by Tuomey, F. S. Holmes, and W. H. Dall, as well as most of the species of vertebrate fossils. The fossiliferous deposits do not usually extend back from the coast more than about 10 miles.

Undoubtedly fossil-bearing Pleistocene deposits are to be found here and there along all the rivers, perhaps to the western border of the Coastal Plain. This is indicated by the discovery of remains of horses and mastodons in Darlington and Richland counties. The thickness of the Pleistocene deposits along the coast is said to amount to as much as 60 feet, but it is usually much less. Only a part of this is fossiliferous, a bed that appears to vary in thickness from about 3 to 8 feet. This is found as much as 8 feet above mean-tide level, sometimes below it. The materials of this fossiliferous bed vary greatly. Sometimes they consist almost entirely of shells of mollusks, in other cases of a blue mud or sand, and with these may be mingled peaty materials, gravel, and again rolled masses derived from the underlying deposits. The fossils contained in the

bed mentioned consist of mollusks, and in some places bones and teeth of vertebrates occur in more or less abundance. The bed is underlain often by deposits of Tertiary age. Bones and teeth of the vertebrates, as fishes and cetaceans, that lived when those Tertiary rocks were being deposited may occasionally have been washed into the Pleistocene bed. Again, where the older and the newer beds are exposed along the shores, fossils may be washed out of both and commingled on the beach; then again, a great part of the fossils collected along this coast of South Carolina have been rescued from the phosphate rock gathered for commercial purposes. This has been to a great extent dredged from the rivers; and thus remains of Pleistocene and of Tertiary animals have been mixed indiscriminately together. It is often impossible to determine to what formation a fossil may belong. To add to the difficulty of the palæontologist, the vertebrate remains are sometimes found washed out and mingled with bones or teeth of what appear to have been domestic animals.

Beginning at the northern end of the South Carolina coast-line, the first locality furnishing Pleistocene fossils is, or rather was (Pugh, op. cit. p. 33), White (or Price's) Creek, in Horry County. Here at a height of about 5 feet above tide was found a bed approximately 6 feet thick apparently thrown up on the shore by storms (Tuomey, Geol. Rep., 1848, p. 187). No vertebrates have been reported from the locality. At Laurel Hill, in the extreme northeastern corner of Georgetown County, Tuomey (op. cit., pp. 187, 188) found a perpendicular bluff 30 feet high, at the base of which was a bed 8 feet thick made up of sand and broken shells. The top of the bed was 8 feet above tide, the highest elevation reached by the bed along the South Carolina coast. Tuomey mentions other localities around Georgetown where the fossiliferous bed was discovered. One was on Santee River. No vertebrates appear to have been met with in this region. In Christ Church parish, in Charleston County, Tuomey discovered several exposures of the bed in question, and this was sometimes so superficial as to be within reach of the plow.

Pugh (Pleistocene Deposits, etc., p. 34) quotes from F. S. Holmes a section which was found at Goose Creek, north of Charleston, as follows:

Yellow sand	12 feet
Blue mud	2 feet
Ferruginous sand, containing bones, etc	3 inches
Yellow sand	3 feet
Pliocene marl resting on Eocene white marl	12 feet

The bones occurred likewise in the blue mud, and such were especially well preserved. Leidy (Holmes's Post-Pl. Foss. S. C., p. 102) recounts his observations at this locality; nevertheless, the only vertebrate fossil that the writer finds credited by Leidy to this locality is a tooth of *Equus fraternus* (=*E. leidyi*), which he figured (plate xv, fig. 8).

Dredging for phosphate rock has been carried on extensively in Cooper River; but of Pleistocene vertebrate fossils secured here the writer has record of only *Megatherium mirabile*. This is represented in the Charleston Museum by a portion of a lower jaw.

Wando River is situated northeast of Charleston, runs parallel with the coast, and empties into Cooper River. From this have (according to the

writer's knowledge) been secured only *Equus complicatus* and a part of a tusk of *Odobenus*. The latter is in the Charleston Museum. In most cases no record has been kept of the origin of the specimens in collections.

The Pleistocene bed along Ashley River is famous for the number of fossil vertebrates which it has furnished. It has been described by F. S. Holmes in various publications, especially in the Introduction to his Post-Pleiocene Fossils of South Carolina, 1860, pages I–XII. In the same work, on pages 99–100, Dr. Leidy briefly described the geological character of the beds; and on subsequent pages he described the vertebrate species found there. The principal beds were located on Ashley River, about 10 miles above Charleston. According to Pugh ("Pleistocene Deposits of South Carolina," p. 34), the fossiliferous deposits rest on Miocene marls. At the top are 4 feet of yellow sands with bands of clay; below, is a foot or more of blue mud lying on the Miocene. The bones are more numerous and best preserved in the blue mud. The Pleistocene bed is elevated only a few feet above tide-level. Inasmuch as nearly all the species of Pleistocene vertebrates which have been found along the South Carolina coast have been secured along the Ashley River, the few found elsewhere will be included in the following list. Some of those marked found somewhere about Charleston may have been collected in or along Ashley River. In this list the contractions following the names signify as follows: A, Ashley River; B, the region about Beaufort; C, somewhere around Charleston; C. r., Cooper River; E, Edisto River; G. c., Goose Creek; J. i., John's Island; S. r., Stone River; W. r., Wando River; Y., Yonge's or Young Island. The species preceded by the dagger are extinct.

Odobenus rosmarus A., W. r. (p. 29).
Lynx ruffus C.
†Canis sp. indet. C.
Procyon lotor A.
†Arctodus pristinus A.
Ursus americanus C.
Sylvilagus floridanus? A.
†Hydrochœrus æsopi A.
†Hydrochœrus pinckneyi C. (p. 365).
†Castoroides ohioensis A. (p. 279).
Castor canadensis A.
Ondatra zibethica A.
†Elephas imperator C. (p. 162).
†Elephas columbi A., B. (p. 155).
†Mammut americanum A., B. (p. 118).
Mammut progenium (p. 118).
†Bison latifrons? A. (p. 260).
†Bison sp. indet. A. (p. 260).
†Alces runnymedensis C. (p. 364).
Cervus canadensis A. (p. 242).
Odocoileus virginianus? A. (p. 231).
Camelops sp. indet.
†Tagassu lenis A. (p. 222).
†Tagassu sp. indet.? A. (p. 222).
†Tapirus haysii A. (p. 204).
†Tapirus sp. indet. A. (p. 205).
†Equus complicatus A., W.r., B. (p. 192).
†Equus leidyi A., J. i., G. c., S. r., B. (p. 192).
†Equus littoralis C. (p. 193).
†Hipparion venustum A.
†Physeter vetus A.
†Trichechus antiquus A.
†Megatherium mirabile A., C. r., S. r. (p. 35).
†Mylodon harlani A. (p. 35).
†Megalonyx jeffersonii B. (p. 35).
†Didelphis virginiana J. i.
†Alligator mississippiensis A.
†Pseudemys sp. indet. A.
†Testudo crassiscutata? A.
Trichiurus lepturus Y.
†Istiophorus robustus Y.
†Ischyrhiza mira? A.
Lepisosteus osseus A.
Dasyatis hastata? Y.

Besides the species enumerated, the early collectors found remains which were identified as belonging to such domestic animals as the dog, ox, sheep, and hog. Leidy rejected these as Pleistocene species, while Holmes and Agassiz accepted them as such. Possibly the supposed dog was in reality a

wolf and the supposed ox a bison. Small teeth like those of cows are fossilized as are the teeth of extinct animals. At Bee's Ferry on Ashley River the fossiliferous bed has a thickness of 3.5 feet and is at about high-water mark. It is overlain by from 15 to 20 feet of loose sands.

By far the most of the species have been entered in the list on the authority of Joseph Leidy. Only F. S. Holmes reported the elk (*Cervus canadensis*), and the writer has seen two teeth of the species at the Academy of Natural Sciences in Philadelphia credited to Charleston. Holmes also reported *Glyptodon*, but that is not included in the list. *Lynx ruffus, Ursus americanus, Hydrochœrus pinckneyi, Elephas imperator, Bison latifrons, Alces runnymedensis, Camelops* sp., and *Equus littoralis* are included on the evidence of specimens seen by the writer in the Charleston Museum or in some of the other collections made on the coast of South Carolina. Loomis has recently (Amer. Jour. Sci., vol. XLV, 1918, p. 438) described a specimen of *Mammut progenium* (as *Mastodon americanus*) from near Charleston and another from near Beaufort.

Alces runnymedensis was first briefly referred to in Year Book No. 14 of the Carnegie Institution of Washington, 1915 (1916), page 387. The name is based on an upper right hindermost milk molar in the Charleston Museum (No. 13534). It is the property of Mr. Charles C. Pinckney. Where the tooth was found is not known, but it was somewhere near Charleston, in the phosphate-bearing area. The specific name is that of the estate of the owner. The tooth closely resembles the corresponding one of *Alces americanus*, but is larger and has a flatter crown. Only the crown of the tooth is preserved, and of this a part of the enamel of the inner anterior cone is broken off; otherwise it is in fine condition. The color is very black. The following measurements are given of this tooth and of the corresponding one of *Alces americanus*, No. 117055 of the U. S. Biological Survey. The two teeth are only slightly worn.

Measurements of milk molars of Alces, in millimeters.

Dimensions taken.	A. americanum.	A. runnymedensis.
Length of tooth near outer border	24.0	25.5
Length of tooth at middle width	21.5	23.0
Width of tooth along front border	23.0	23.0
Width of tooth from median style to base of inner hinder cone	21.0	24.0

The angle between the outer and inner faces of the hinder half of the tooth is 54° in the tooth of the existing species, 64° in the fossil tooth. On the grinding-surface the fossettes are wider than in the tooth of the existing moose.

It is interesting to find this moose in the region about Charleston. We must suppose that it lived there during one of the glacial stages, probably when the walrus occupied that part of the coast.

In the Pinckney collection is a tooth of a capybara that deserves attention. A figure of it is here presented (fig. 18), a side view. Exactly where the tooth was found is not known, but it was somewhere in the vicinity of

Charleston. The tooth is the upper left hindermost molar. In the figure the front end is directed toward the left hand. There are present 17 plates. None of the plates either in front or behind are missing. The free edges of the plates are not turned backward. The length of the tooth is 62 mm., the width is 17.5, the height of the plates on the inner face 37 mm., but probably the less calcified bases of the plates have been destroyed.

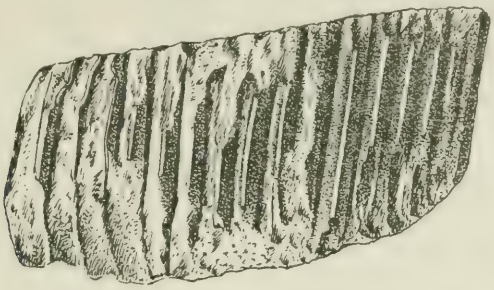


FIG. 18.—Side view of upper last molar of *Hydrochœrus pinckneyi* from Charleston, S. C. ×1. Type.

On the grinding-surface the plates run obliquely from the inside outward and backward. As seen on the inner face, the plates, as they pass to the grinding-surface, lean backward. The corresponding tooth of a capybara from Surinam has a length of 37 mm. The length of its skull from foramen magnum to the front of the snout is 215 mm. In case the skull of the fossil was long in proportion to the length of the tooth, the length as given above would be 360 mm., about 15 inches.

To this fine large species I give the name *Hydrochœrus pinckneyi,* in honor of Mr. Charles C. Pinckney, the owner of a collection of fossils from the region about Charleston and the proprietor of the estate of Runnymede, near Lambs, South Carolina.

In the same collection is a part of the lower jaw, right side, of a rather large wolf. In this jaw there remain the complete fourth premolar, the roots of the third premolar, and one root of the second (fig. 19).

The following measurements are taken from the fragment mentioned; from the corresponding part of a jaw of *Ænocyon dirus,* No. 8307, from La Brea, California; from the gray wolf, *Canis occidentalis,* from Fort Simpson, British America, No. 9001, U. S. National Museum; and from the type of *C. floridanus,* in the U. S. National Museum.

Measurements of jaws and teeth of wolves, in millimeters.

Parts measured.	Charleston jaw.	La Brea jaw.	C. occidentalis jaw.	C. floridanus type.
Height of jaw in front of pm_4	28	32	33	21.5
Thickness at front of pm_4	14	16	14.2	10.2
Length of pm_4	18.5	20.2	18.5	14.5
Thickness of hinder lobe of pm_4	9.5	11	9.5	7
Thickness of front lobe	8.5	9.8	8.5	6.4

The measurements show that the fossil is much too large to belong to the wolf now inhabiting Florida. It appears also to be too small to belong to the wolf *Ænocyon dirus*, and *A. ayersi* was but little if any smaller. The lower teeth of the latter species are not known. The accordance in measurements with those of *C. occidentalis* makes it probable that the fossil jaw found at Charleston belonged to a wolf not greatly different. With the materials at hand it is impossible to refer the jaw specifically.

FIG. 19.—Part of the right side of the lower jaw of an undetermined species of wolf, showing premolar. Charleston, S. C. ×1.

Within the city of Charleston the bed bearing vertebrate fossils is said to be several feet below tide-level. At Young Island, Wadmalaw Sound, nearly 20 miles southwest of Charleston, the top of the fossil-bearing stratum is at tide-level. This locality is otherwise known in the literature as Simmons's. The only Pleistocene vertebrate fossils that the writer finds reported from the place are the fishes *Lepisosteus osseus* and *Trichiurus lepturus*.

In the region about Beaufort, the same fossil-bearing stratum, having about the same composition and the same elevation, is met with in many places. A few species of fossil vertebrates and many invertebrates have been secured. Here have been found *Mammut americanum* (p. 118), *Elephas columbi* (p. 155), *Equus complicatus* (p. 191), and *Megalonyx jeffersonii* (p. 35).

A brief notice will be taken of the few known localities where, away from the immediate coast, vertebrate fossils have come to light.

Tuomey, in 1848 (Rep. Geol. South Carolina, p. 177), in describing marls found near Darlington, on the farm of G. W. Dargan, and which he regarded as belonging to the Pliocene, reported the discovery of two perfect molars of a mastodon (p. 118). The locality was in a swamp, and the bed of marl was covered with 3 or 4 feet of black mud. The teeth were immediately below the mud and enveloped in the marl. These teeth belonged to *Mammut americanum* and had been deposited at some time during the Pleistocene. At another place fragments of the antlers of a deer were found in the marl. In such cases the marls formed at one time the surface of the ground, or more probably the bottom of a swamp; and the Pleistocene bones and teeth

might have been trampled down into the marl by living animals. On page 119 is given an account of another mastodon tooth discovered in the same county; and the teeth of a horse have been reported as having been found, associated with those of the mastodon (see p. 193).

In Lee County, adjoining Darlington County on the southwest, at a locality "near Concord church," between Lynch's Creek and Black River, Tuomey (op. cit., p. 178) found a bed of Pliocene marl about 4 feet thick. From an excavation in this marl had been taken a tusk which Tuomey regarded as that of a mastodon, but this may have belonged to an elephant. In Berkeley County, at the head of Cooper River, there is, or was, a morass known as Biggin Swamp. This was passed through in constructing the Santee Canal. On page 156 is an account of the discovery of remains of *Elephas columbi* and of *Mammut americanum;* on page 162, the finding of a tooth of *Elephas imperator.* The discovery of the latter marks the age of the deposits as being about that of the Aftonian interglacial.

It has been seen that at many points along the coast there is a fossiliferous stratum varying from 2 to 8 feet. At most localities the fossils consist principally of marine animals, especially mollusks, and the deposits have evidently been laid down in salt water. Along Ashley River and at some localities in the region about Beaufort it seems evident that the surface was above, but not far above, sea-level, and that it formed a swamp on which a great variety of land animals could move about and feed. After death their bones would suffer the fate which befalls them in such cases. Most of them would undergo decay. Parts would be trampled into the muck, broken into fragments, and undergo still further decay. Only the most durable parts, as the teeth, antlers, and the more solid bones would usually stand a chance for preservation. Apparently, on this coast, no considerable parts of one skeleton have ever been found, or at least reported. In Charleston Museum are many bones of a skeleton of *Megatherium,* but it is uncertain where it was found.

The list of vertebrates referred to the Pleistocene of the South Carolina coast contains 33 species of mammals, of which 24 appear to be extinct. This high proportion of extinct species seems to confirm our reference of the fauna to the early Pleistocene. Besides the extinct forms, it is to be noted that within historical times the muskrat, beaver, and elk have not lived in the region about Charleston.

Pugh (Pleist. Deposits S. C., p. 66), from a study of the Pleistocene marine mollusca of South Carolina, has concluded that, if the Pleistocene sea-temperature differed at all from that of the present, it was slightly higher rather than slightly lower. It must be remembered, however, that the Pleistocene represented a very long period of time and that, farther north, the climate underwent great fluctuations. That these fluctuations would not have affected the temperature of the sea along the coast of the Carolinas is not probable. It is hardly supposable that capybaras and manatees lived about Charleston at the same time that the moose and the walrus were there. The latter had been forced down there during some glacial stage, possibly the Wisconsin; while the horses, tapirs, elephants, manatees, the mylodon, and the megatherium had their existence, we may suppose, about the time of the Aftonian. During this stage, too, lived the

species of mollusks which Pugh has elaborated. It would seem that after that time some change took place in conditions, probably a slight elevation, so that little more than beds of unfossiliferous sand and marls were deposited.

Professor Earle Sloan, in his "Mineral Localities of South Carolina" (Bull. No. 2, ser. IV., South Carolina Geol. Surv.), has recognized the following divisions in the marine Pleistocene of the State:

6. Sea Island loams.
5. Wando clays and sands.
4. Accabee gravels.
3. Bohicket marl-sands.
2. Wadmalaw marl.
1. Ten-Mile sands.

Of these, the fossiliferous deposits referred to above appear to belong to the Wadmalaw marl. It may be confidently expected that somewhere along the South Carolina coast, beneath the beds bearing the vertebrate fossils, there will yet be discovered other Pleistocene deposits, probably shell marls, which belong to the Nebraska stage.

GEORGIA.

The only part of Georgia at present of interest to the student of vertebrate palæontology is that which lies immediately along the Atlantic coast and along a few of the larger rivers. The northwestern corner of the State is mountainous and probably contains little or no Pleistocene. The Coastal Plain extends landward to a line which starts at Augusta, on Savannah River, passes through Milledgeville and Macon, and ends at Columbus, on the Chattahoochee. A large part of this region is mantled by a deposit resulting from the decay of the underlying rocks. These deposits are of uncertain age, a part belonging probably to the Pleistocene, but the large part to the Pliocene or to still older Tertiary. The Pleistocene has not yet been differentiated from the remainder, and, in any case, has furnished no vertebrate fossils. For information on the subject the reader may consult McGee (12th Ann. Rep. U. S. Geol., Surv., pt. I, pp. 478–484), Spencer (Geol. Surv. Georgia, 1890–91, pp. 61–81), and Veatch and Stephenson (Bull 26, Geol. Surv., Georgia, pp. 400–456).

The deposits in Georgia which can with certainty be referred to the Pleistocene form a broad belt lying along the coast and extending landward a distance of about 30 miles along Savannah River and about 60 miles at the Florida boundary line. For a description of these deposits the reader is referred to Veatch and Stephenson's article in Bulletin 26 just mentioned, pages 424–456. These deposits are disposed in two terraces, a higher and older and a lower and younger. The older is named the Okefenokee formation, the younger the Satilla formation. The positions of these may be observed in the figure here presented, taken from Bulletin 26 above referred to (fig. 20).

The Okefenokee terrace has a breadth of 20 to 40 miles and an elevation of 60 to about 125 feet above sea-level. It forms a plain which Veatch and Stephenson describe as in general flat and almost featureless. It is dotted with cypress ponds and swamps, with here and there low ridges and hills of sand. Along the larger streams which cross the plain are found terraces supposed to have been laid down while the Okefenokee terrace was forming;

they extend far back into the State. In neither the main terrace nor the fluviatile terraces have any fossils been found, except a little silicified wood.

The Satilla Plain extends backward from the coast 20 to 30 miles and varies in elevation from 15 to 40 feet. On the landward side it ends in an escarpment which is taken, by the authors quoted, to be an old sea-beach. Along the large rivers it is continued as a series of terraces occupying a lower position than those of Okefenokee time. According to Veatch and

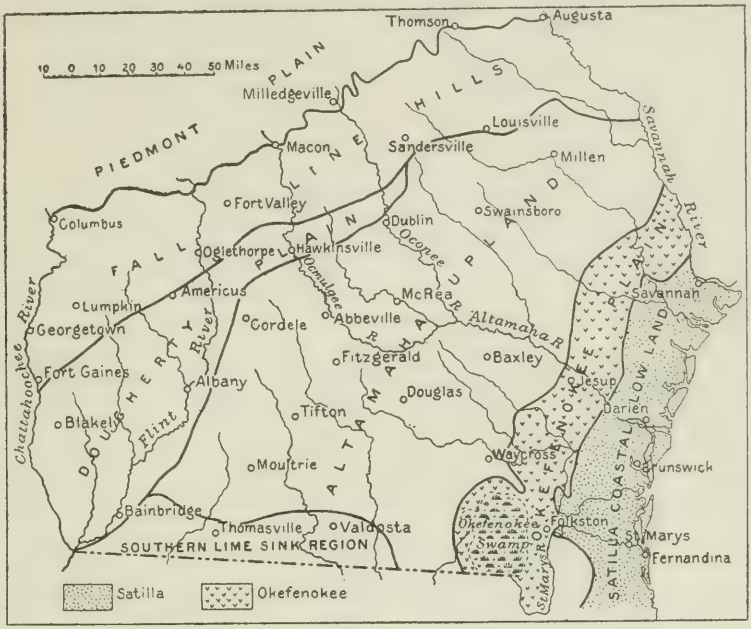


FIG. 20.—The Coastal Plain of Georgia. Adapted from Veatch.

Stephenson, this formation consists of unconsolidated clays, sands, and thin layers of gravel. The thickness averages about 15 feet, but may become as much as 45 or 50 feet.

The Satilla deposits are fossiliferous. At various places, at some distance from the coast, sea-shells occur, especially shells of oysters. This shows that at times the plain, or at least some parts of it, has been under sea-water. Bones and teeth of vertebrate animals have been discovered at several localities, but at only two places have identifiable materials been secured. The region about Brunswick and that just south of Savannah have furnished important collections of vertebrate animals.

During the years 1838 and 1839 an attempt was made to construct a canal to connect Altamaha River with Turtle River at Brunswick. Some bones of large mammals were met with and came to the notice of Hamilton Couper, and through him became known to the scientific world. The most striking was the great ground-sloth, of the genus *Megatherium*, and which Leidy afterwards called *Megatherium mirabile*. At a more recent time, during dredging operations, probably in the harbor, other remains were found and turned over to the Geological Survey of Georgia. The frag-

mentary bones and teeth were identified by Mr. J. W. Gidley (Bull. No. 26, Geol. Surv. Georgia, p. 436).

The fragments of teeth regarded by Gidley as belonging to *Mammut floridanum* appear to the writer to represent *Gomphotherium rugosidens,* a species rather common in that region and belonging to the upper Miocene or Lower Pliocene. Four teeth identified as those of *Physeter vetus* or *Physeterula neolassicus* appear to be identical with Leidy's *Orycterocetus quadratidens;* but this may be possibly the same as *Physeterula neolassicus* (= *P. dubusi*). It, too, is older than the Pleistocene. From the two collections have been determined the following list:

Castoroides ohioensis (p. 280).
Elephas columbi (p. 157).
Mammut americanum (p. 120).
Bison sp. indet. (p. 261).
Cervus? sp. indet. (p. 243).
Tapirus haysii (p. 206).
Equus complicatus (p. 193).
E. leidyi (p. 193).
E. littoralis (p. 193).
Megatherium mirabile (p. 36).
Mylodon harlani (p. 36).
Chelonia(??) couperi.
Crocodylus(?) sp. indet.
Lamna sp. indet.
Galeocerdo sp. indet.
Carcharodon sp. indet.
Dasyatis sp. indet.

With the bones found in the canal was a femur 13 inches long, which Harlan described as *Chelonia couperi,* but which resembles more closely that of some edentate mammal. Gidley stated that the shark-teeth probably represent Eocene and Miocene species. This may be true, but the supposition is not necessary, inasmuch as species of all three genera are yet living on our Atlantic coast.

J. Hamilton Couper (Hodgson's Memoir, pp. 37–40) has given an account of the topography and geology of the region through which the Brunswick Canal was being constructed (map 40). On one of the plates of the work is a section from the ocean westward 21 miles. About 10 miles west of St. Simon's Island the canal passed through Six-mile Swamp. This is connected at its northern end with Altamaha River, at the southern with Turtle River. The swamp has thus the appearance of a lake which has become filled with alluvial deposits. These consist of a compact clay, usually yellow and impregnated with iron. There are thin strata of soft, chalky marl and many fragments of petrified wood. At the bottom of this deposit were found the bones of *Megatherium, Elephas, Mammut, Equus,* and *Bison.* Beneath the clay stratum was sand with marine shells. Overlying the clay was a thin stratum of vegetable and sandy loam. The bones occurred at a depth of from 4 to 6 feet. In no instance, except when they had been washed out into the salt-water creek, was there any abrasion of the surface or incrustation of marine shells.

The geologist Charles Lyell (Second Visit, etc., vol. I, p. 347) stated that part of a skeleton of a megatherium, dug out in cutting the canal, was so near the surface that it was penetrated by the roots of a pine tree. As a considerable number of the bones of one skeleton were found together, Lyell supposed that a whole carcass had been floated down the river to the spot.

Even before remains of fossil vertebrates had been found at Brunswick, bones had been discovered at Skidaway Island, near Savannah. As early

as 1823, S. L. Mitchill (Ann. N. Y. Lyc. Nat. Hist., vol. I, p. 58) announced the finding of teeth of *Megatherium* at this place. More than 20 bones of the same animal were reported from the same locality in 1824 by William Couper. In 1846 (Hodgson's "Memoir on Megatherium," pp. 25–30), Dr. Joseph Habersham published a list of the species discovered up to that time. Lyell (Second Visit, etc., vol. I, p. 313) gave an account of his visit to the locality and noted the species obtained. The following list appears to contain all found there:

Elephas columbi (p. 157).
Mammut americanum (p. 120).
Bison sp. indet. (p. 262).
Equus leidyi? (p. 194).
Megatherium mirabile (p. 36).
Mylodon harlani (p. 37).
Terrapene canaliculata.

The box-tortoise *Terrapene canaliculata* was described by the writer in 1907 (Bull. Amer. Mus. Nat. Hist., vol. XXIII, p. 850, figs. 5–7) on fragmentary materials found in the U. S. National Museum. These had been sent there by Dr. J. P. Scriven, who had been active in collecting the fossil vertebrates about Savannah. Whether the remains of this box-tortoise were found on Skidaway Island or in Whitemarsh Island is uncertain.

Besides these species, found on Skidaway island, two species, *Mammut americanum* and *Mylodon harlani,* have been found at Heyner's (or Hainer's) Bridge. This is about 7 miles south of Savannah, where the road crosses Vernon Creek (Lyell, "Travels in North America," vol I, pp. 163–164). Here the stream is called White Bluff Creek. In order that the reader may get a clear understanding of the conditions at this important locality, a map found in Hodgson's Memoir is reproduced (map 40).

The whole region south of Savannah, between the mouths of Savannah and Ogeechee Rivers, is low and much divided into islands by streams connected with the rivers mentioned. A considerable part of these islands consists of marshes, which are usually overflowed by the tides. Most of the fossil bones were found along the southern bank of Skidaway River, in two places, apparently about 0.5 mile apart and near the western end of the island. On the map Hodgson has named the locality Fossilossa. Here Skidaway River made a bend which caused the bank to be eroded away, thus exposing the bones. According to Couper (Hodgson's Memoir, p. 40), the bones were embedded in the marsh formation at about the level of very low-water. Lyell (Second Visit, etc., vol. I, p. 314) stated that the bones occurred in a dark peaty soil, or marsh mud, above which was a stratum of sand 3 or 4 feet thick; while below the peaty soil and below sea-level was sand containing many marine fossil shells, all belonging to species yet living on the neighboring coast.

The authors quoted state that at various places along the Georgia coast are found stumps of trees, cypress, cedar, and pine, in the deposits of the salt marshes and at a depth of from 2 to 4 feet below high-water. This is taken as evidence of subsidence in that region.

It is a matter of importance to know how those animal remains reached their place of burial. It has been suggested that whole carcasses had been floated down the streams and sunken where the bones are found. This is possible, but not probable. The peaty nature of the deposit inclosing

the bones appears to be opposed to this view; nor could disarticulated bones have been washed down far from above, for they show no signs of attrition. The most probable explanation is that these animals lived and died about where their bones were discovered. At some past time the surface stood at a higher level than at present, although low enough to be more or less marshy. It probably supported a dense forest growth, and hither the species listed above resorted, with many others not yet discovered.

The animals inhabiting the region represent the same fauna found at so many places in Florida and Texas. The writer believes that they existed during the early part of the Pleistocene, approximately during the Aftonian interglacial; and that some of the species, as *Megatherium, Mylodon, Equus,* and *Tapirus haysii* became extinct before the advent of the Wisconsin glacial stage, probably a long time before this.

FLORIDA.

(Maps 7, 8, 15.)

For the most recent descriptions of the geology of Florida one must consult the Annual Reports of the Florida Geological Survey, issued by the State geologist, Dr. E. H. Sellards, and Water-supply Paper 319 of the U. S. Geological Survey, prepared by George C. Matson and Samuel Sanford and published in 1913. In the latter work are two large maps, one representing the topography of the State and the distribution of the various geologic formations; the other presents a generalized view of the distribution of Pleistocene terraces, as recognized by Matson and Sanford. The Second Annual Report of the Florida Geological Survey contains a map similar to the first mentioned.

From these maps it will be seen that the surface of Florida is largely occupied by Pleistocene deposits. According to Matson and Sanford, these deposits present themselves as disposed mostly in three principal terraces; and these are believed to indicate that the State was at one time largely submerged beneath the sea and that its present condition was attained after three principal upward movements. As shown on plate v of the geologists just named, the northern half of the peninsula at the time of greatest depression was represented by a number of islands, two of considerable size. One of these was situated at the northern end of the peninsula, the other near its center. The materials laid down around these islands and bordering the dry land along the northern border of the western half of the State form what is called the Newberry terrace. Its surface stands now at a height varying from 70 to somewhat more than 100 feet above sea-level. A second elevation exposed the deposits which, at least in part, constitute the next terrace, the Tsala Apopka. Its surface is a plain having an elevation of 40 to 60 feet above sea-level. At this stage the islands of the peninsula had coalesced, and the dry land extended southward nearly to the present Lake Okeechobee. A broad belt along the Atlantic and Gulf coasts, now dry land, was still occupied by salt water. A third elevation of the land left exposed the lowest terrace, the Pensacola, that bordering the Atlantic and Gulf coasts and including the southern end

of the peninsula somewhat farther north than Lake Okeechobee. The elevation of this terrace varies from that of sea-level up to about 40 feet.

The materials composing the terraces in Florida are principally sand with local deposits of clays. In the southern part of the State important beds of limestone are found in the Pensacola terrace. These beds are shown on Matson and Stanford's geological map. At St. Augustine and along the coast southward are beds of sea-shells cemented into coquina. Where cementation has not occurred there are beds of loose shells and of marl and sand.

The writer has already (p. 346) expressed his opinion regarding the Coastal Plain terraces found in the States farther north. He finds in Florida nothing to contradict, but much to confirm, that opinion. Whatever may be the origin of Newberry and Tsala Apopka terraces, they were not laid down in salt water. From the descriptions of the deposits there the stratification and the alternation of the materials do not exist that one might expect; but, above all, there seem to be no marine fossils to attest to the presence of the sea. In Florida, too, here and there over these higher lands there are found, in place of marine fossils, the remains of many extinct land animals, as mastodons, elephants, horses, ground-sloths, and the like.

As regards the Pensacola terrace, there are found at its base, within a few feet above or below sea-level, deposits containing remains of such animals as have just been mentioned, besides many others. Often the state of preservation of these remains and the condition of their burial are such that we must conclude that the animals lived and died on the spot. Furthermore, these animals constitute an assemblage corresponding to that found in western Iowa, in Nebraska, and in Oregon, which are believed to have existed during the first interglacial stage. It corresponds also to that met with under similar conditions and at the same level at Savannah, at Charleston, at Brunswick, and at Long Branch. In most cases, too, this fossiliferous stratum is overlain with very scant deposits. By some geologists and palæontologists the animals are regarded as belonging to the Pliocene.

If the reference of the fossil vertebrates mentioned is not wholly wrong, it follows that the lowest terrace or plain along the coast was not laid down late in the Pleistocene, but at an early stage, and the higher plains must have been formed at still earlier times.

At Vero, as will be shown on page 382, a large assemblage of fossil vertebrates has been secured. The bed furnishing the oldest fossils, those of the bed known as No. 2 and believed to be of about first interglacial age, is underlain by a bed of marine shells, also of Pleistocene age. This bed is regarded by Dr. E. H. Sellards as being equivalent to the coquina which is so well known at St. Augustine; and the same formation is found here and there along both coasts of the peninsula (Matson and Sanford, op. cit., p. 192). Probably not all deposits that are called coquina are of the same age, but the deposits in question pass, on the landward side, beneath the deposits which bear vertebrate fossils. The bed at Vero, No. 2, must have been laid down after an uplift had brought above sea-level the bed of shells No. 1, on which No. 2 reposes; that is, between the

time of deposition of No. 1 and No. 2 there must have elapsed a considerable interval of time. The shell deposit, therefore, probably belongs to the first glacial epoch, the Nebraskan. Inasmuch as a similar vertebrate fauna is found on both the eastern and the western coasts of the peninsula, it follows that any Pleistocene deposits underlying these vertebrate-bearing beds belongs to the Nebraskan stage; in places these have great thickness. Matson and Sanford (op. cit., pp. 194–195) concluded that the maximum thickness of the Pleistocene in southern Florida, disregarding the sandhills, is probably about 125 feet. Even if it were a matter of importance to determine in or on which terraces the vertebrate fossils are found, it would not always be easy to do so. The majority of specimens have been discovered around the coasts of the State, and therefore in deposits referred to the youngest terrace. In other cases it is difficult to determine the terrace in which fossils are buried, partly because of imperfect records as regards locality, kind of deposits, and depth of burial, partly because each terrace extends up the river valleys beyond its general border. The various fossil-bearing localities will therefore be taken up by counties, beginning at the western end of the State and ending at the southern end.

Jackson County.—As already recorded on page 121, a tooth of *Mammut americanum* has been found at Marianna. No details have been recorded. The Newberry terrace extends nearly or quite to this town. If it could be shown that this tooth had been buried in that terrace when it was formed, it would probably have to be referred to the time of the first glacial stage.

Gadsden County.—It appears that no vertebrate remains belonging to the Pleistocene have been found in this county, except a tooth of *Mammut americanum* (p. 157) which was discovered somewhere in Little River.

Wakulla County.—On page 157 the finding of a tooth of *Elephas columbi* somewhere along St. Marks River has been mentioned; also the discovery of a part of a skeleton of either a mastodon or an elephant somewhere about Wakulla Springs.

Columbia County.—A mastodon tooth has been found in this county 3 miles northwest of Fort White (p. 121). To which terrace it belonged or what is its place in Pleistocene time it is impossible to say.

Nassau County.—At Stokes Ferry have been found some teeth of an extinct horse (p. 194), a fragment of a tooth of an elephant (p. 180) and some ear-bones of a whale. Veatch and Stephenson (Bull. 26, Geol. Surv. Georgia, p. 394) report that these appeared to come from either the Charlton formation or the Satilla. If the Charlton really belongs to the Pliocene it is not probable that the fossils were derived from it; if they were derived from the Satilla, they do not belong to late Pleistocene.

Duval County.—On page 106 of the Eighth Annual Report of the Florida Geological Survey, Sellards reported the finding of remains of *Mammut americanum* (p. 122), *Elephas columbi* (p. 157), an undetermined species of *Bison* (p. 262), and an undetermined species of *Odocoileus* (p. 232), near Pablo Beach, at station 120 on the Inland Waterway Canal. Here, too, has been discovered a bone of *Trachemys? nuchocarinata.* Sellards stated that the position of the beds here is the same as that of the other localities along the Atlantic coast, the fossils being found in sand and muck which rest upon Pleistocene shell-marl. The locality is, of course,

on the youngest terrace; but that, in the opinion of the writer, belongs to the early Pleistocene.

St. John's County.—At a place 28 miles south of St. Augustine, along the Inland Waterway Canal, Mr. Fred P. Allen, of St. Augustine, collected on the Almero farm remains of *Mammut americanum* (p. 122), *Elephas columbi* (p. 158), *Mylodon harlani?* (p. 37), *Equus* sp. indet. (p. 194), the box-tortoise *Terrapene antipex,* and a dermal plate of perhaps *Alligator mississippiensis.* These were found in the banks of the canal. Here, at least, the horse and the mylodon, taking into consideration the geological circumstances, indicate early Pleistocene, equivalent to the first interglacial stage.

Levy and Alachua Counties.—Geologically these counties furnish important localities because of the presence of the Alachua clays (usually referred to the lower Pliocene or even the Upper Miocene) and deposits belonging to all three of the Pleistocene terraces, Newberry, Tsala Apopka, and Pensacola. The Alachua clays first require consideration, for in them have been found a considerable number of species of vertebrates which usually indicate Pleistocene deposits. The localities where Alachua clays have furnished vertebrate fossils, as indicated on Matson and Sanford's map (Water Supply Paper 319, U. S. Geol. Surv., plate I), are situated, one around Archer, Alachua County (the type locality), second, about 5 miles west of Williston, in Levy County, and a third about 5 miles east of Newberry, in Alachua County.

The clays referred to form accumulations in depressions on the surface of the Ocala limestone, itself belonging to the Eocene. The deposits are said to average in depth about 10 feet, but are often thinner and occasionally much thicker. They have furnished a considerable number of species of vertebrates. A list, prepared by Dr. Leidy, of those found at Archer was published in 1892, in Bulletin 84 of the U. S. Geological Survey, on page 129. Besides these, Leidy had previously reported a tapir, a small crocodile or alligator, and a bone thought to belong to the extinct *Cervus americanus* (*Cervalces scotti?*), but which was not afterward mentioned. The rhinoceroses and the camels were described by Leidy and Lucas in 1896 (Trans. Wagner Free Inst., vol. IV, pp. 1–61 with plates).

Herewith is presented a list of such vertebrates as have been found at Archer. It appears necessary to retain for the rhinoceroses the specific names given them by Leidy.

Gomphotherium floridanum (p. 121).
Odocoileus osceola? (p. 232).
Procamelus major (p. 224).
P. minor (p. 224).
P. minimus (p. 224).
Teleoceras proterus (p. 211).
Aphelops longipes (p. 211).
Tapirus haysii? (p. 207).
Hipparion ingenuum (p. 195).
Megatherium mirabile (p. 37).
Alligator (or Crocodylus) sp. indet.

The following vertebrates have been collected east of Williston, in the place mentioned in Dall's report of 1892, on page 129, as Mixon's:

Gomphotherium floridanum (p. 121).
Procamelus major (p. 224).
Teleoceras proterus (p. 211).
Hipparion ingenuum (p. 196).
Hipparion plicatile (p. 196).
Thinobadistes segnis (p. 37).
Manatus antiquus?.
Pseudemys caelata.
Atractosteus lapidosus.

The list from the locality east of Newberry (Hallowell's place of Dall's report) is rather short. *Equus littoralis, Odocoileus osceola?, Hipparion* sp. indet., and *Parahippus* sp. indet. have been reported (Rep. Florida Geol. Surv., vol. v, p. 58; vol. viii, pp. 42, 94). At Neals, Alachua County. *Tapirus terrestris?, Gomphotherium floridanum,* and *Hipparion* sp. indet. have been collected (Sellards as cited). At Juliette, same county, *Gomphotherium floridanum* has been secured, and at Hernando the same species; also *Hipparion* sp. indet. and *Procamelus* sp. indet. (Sellards Florida Geol. Surv., vol. v, p. 58). Along Santa Fe River, in the Buttgenbach mines, 6 miles north of Wade, have been found teeth of *Equus* and a tooth of *Bison.*

At Dunnellon, about 25 miles south of Williston, from the phosphate mines along the Withlacoochee River, have been obtained fossil vertebrates so similar to those found in the Alachua clays that Sellards concluded to unite his Dunnellon formation and the Alachua clays into one to be called the Alachua formation (6th Ann. Rep. Florida Geol. Surv., p. 161). The list of vertebrates found at and about Dunnellon is as follows, including the species dredged in Withlacoochee River:

Megalonyx sp. indet (p. 38).
Chlamytherium septentrionale (p. 138).
Ursus sp. indet.
Felis sp. indet.
*Gomphotherium floridanum (p. 122).
Mammut americanum (p. 122).
Elephas imperator (p. 162).
Trichechus manatus.
*Parahippus sp. indet. (p. 196).
*Hipparion plicatile (p. 196).
Equus leidyi (p. 196).
Tapirus sp. indet. (p. 207).
*Aphelops longipes (p. 211).
*Procamelus minor (p. 225).
Odocoileus osceola (p. 233).
Bison sp. indet. (p. 263).

The species marked by an asterisk are regarded by Doctor Sellards and others as belonging to the Miocene or Pliocene (8th Ann. Rep. Florida Geol. Surv., p. 94). See also Sellards, 1913 (5th Ann. Rep. Florida Geol. Surv., p. 58; 8th Rep., p. 104).

On the basis of the fossil vertebrates it can hardly be denied that the Alachua clays and the phosphate mines at Dunnellon are of the same geological age. According to Sellards, the formation belongs to the upper Miocene or to the lower Pliocene. Merriam (Bull. Dept. Geol. Univ. Cal., vol. x, p. 439) refers it to the Pliocene. Although there is present a strong palæontological element which represents the Pleistocene, the reference of the formation to the late Miocene or early Pliocene has seemed to be required by the presence of *Gomphotherium, Procamelus, Teleoceras,* and *Hipparion.* The Pleistocene species are usually accounted for on the supposition that they are intrusions from more recent deposits.

A figure from Sellards (Geol. Surv. Florida, vol. vii, p. 53), only slightly modified is intended to show the relation of the phosphate-bearing formations to those underlying them (fig. 21).

It is worth our while to consider whether or not the reference of the Alachua formation to the Miocene or early Pliocene is required by palæontological evidence. *Gomphotherium* is characterized by having molar teeth which on abrasion at one or both ends of each crest, present a trefoil pattern of the enamel; also by having a band of enamel on each of the upper tusks. Now, teeth having the same structure are not uncom-

mon in deposits of undoubted Pleistocene age in Kansas and Texas. That the animals possessing these teeth had tusks with enamel bands is not known, but it is quite possible that such enamel bands were present.

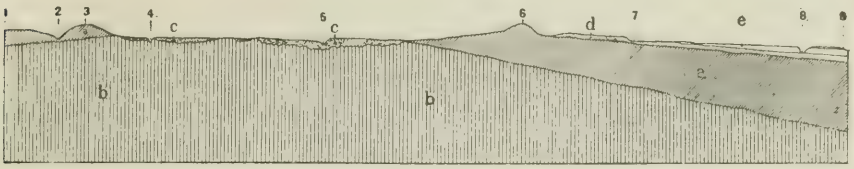


FIG. 21.—Diagrammatic sketch of geologic structure of Florida from north to south passing through the hard rock and pebble phosphate fields, showing relation of the phosphate deposits to the underlying formations. After Sellards.

1. Georgia–Florida State line.
2. Suwannee River.
3. Lake City.
4. Santa Fé River.
5. Withlacoochee River.
6. Lakeland.
7. Arcadia.
8. Caloosahatchee River.
9. Gulf Coast.

a Upper Oligocene phosphatic marls.
b Ocala limestone.
c Hard rock phosphate.
d Bone Valley formation.
e Pleistocene deposits (Pliocene and Pleistocene of Sellards).

The genus *Hipparion* is not confined to the Tertiary. Teeth have been discovered in the Aftonian of Iowa (Hay, Geol. Surv. Iowa, vol. XXIII, p. 150) and in Missouri (op. cit., p. 149). The writer has described a species of the genus, *Hipparion cragini*, collected by Professor Cragin in the Sheridan beds in Kansas (Kansas Univ. Sci. Bull., vol. x, p. 42).

One may be justified in suspecting that *Procamelus* lived on into the Pleistocene. Not only has it been found associated with Pleistocene fossils in five places in Florida—Archer, Williston, Dunnellon, Hernando, and Ocala—but it has been met with in possible Pleistocene deposits (the Idaho formation) in Idaho, which furnishes *Equus, Cervus, Castor,* and *Stegomastodon mirificus* (the type of which belongs in the Sheridan beds). Furthermore, the writer has had occasion to describe a collection of fossils, believed to belong to the early Pleistocene, which was obtained at Anita, Coconino County, Arizona. Among these fossils are two species of *Procamelus* much like those described by Leidy from the Alachua formation (Proc. U. S. Nat. Mus., vol. LIX, pp. 622–626). The writer believes that the genus *Procamelus* persisted into the early Pleistocene.

Two species of rhinoceros have been collected in the Alachuan formation, *Teleoceras proterus* Leidy and *Aphelops longipes* Leidy. Both occurred at Archer, while *T. proterus* was found near Williston and *A. longipes* at Dunnellon. A rhinoceros has been discovered in the Idaho formation, with the Pleistocene species named above in connection with *Procamelus* of these beds. In Oregon Cope made a collection which has been examined by Dr. W. D. Matthew (Bull. Amer. Mus. Nat. Hist., vol. XVI, p. 321). Here again *Teleoceras* was supposed to have been found with *Hipparion,* camels belonging to *Camelops* (or *Procamelus*), *Elephas,* and *Equus.* Matthew thought that there had happened, either before the fossils were collected or afterwards, a mingling of elements of two distinct faunas.

To the writer it seems improbable that the commingling of *Procamelus* and the rhinoceroses with Pleistocene forms should occur thus accidentally so often and at such widely removed localities. It appears more probable that these Tertiary genera did not become extinct so early as has been supposed and that the association was not a secondary one. The association is what might be expected in collections made in deposits of the earliest Pleistocene.

It must not be forgotten in these discussions that the Pleistocene genera and species with which the collections in question are being compared are those of the so-called *Equus* beds, which appear to represent the fauna of the first interglacial stage. This, however, was preceded by the Nebraskan, the first glacial, which probably occupied a long period of time; possibly it was half as long as all the rest of the Pleistocene (Chamberlin and Salisbury, Geology, vol. III, p. 383). About the vertebrate life of this long stage we know as yet very little. The writer is quite convinced that the Idaho formation and the Alachua, or Bone Valley, belong to the earliest Pleistocene.

Marion County.—In a fissure in the limestone-rock quarry at Ocala there has been found an important collection of vertebrates. The following list is thought to include all that have been reported:

Trucifelis floridana.
Sylvilagus sp. indet.
Elephas columbi (p. 158).
Bison sp. indet.
Odocoileus sp. indet. (p. 233).
Procamelus minimus (p. 224).
Tapirus sp. indet. (p. 207).
Equus leidyi (p. 196).
Dasypus sp. indet. (p. 38).
Terrapene formosa.
Testudo distans.
T. incisa.
T ocalana.

A part of this list was published by Sellards in 1916 (8th Ann. Rep. Florida Geol. Surv., p. 103). The tortoises were described in the same volume.

Inasmuch as *Trucifelis floridana* has been found in the Pleistocene at Vero, Florida, one may safely regard the specimen found at Ocala as also of Pleistocene age. All of the other mammals are admitted to be of Pleistocene age except *Procamelus minimus*. The fissure may have been open during some part of the Nebraskan stage.

Volusia County.—At Daytona, situated on the east coast, therefore on the youngest terrace, remains of *Mammut americanum* (p. 122) have been found. At DeLand there has been recovered the skull of a dolphin which Sellards (8th Ann. Rep. Florida Geol. Surv., p. 107, plate XIV) has described as *Globicephalus bœreckii* (p. 20). It was found at a depth of 10 feet, in sands which overlie Pliocene shell-marls. The sands are regarded as belonging probably to the Pleistocene. DeLand is on the Tsala Apopka terrace. At a depth of 10 feet there was reached the supposed marine base of this terrace.

Orange County.—As stated on page 196, a tooth of an extinct horse was found somewhere in the county.

Pinellas County.—On the western shore of Tampa Bay (p. 159), near St. Petersburg, at Indian Rock, a tooth of *Elephas columbi* was found.

Hillsboro and Manatee Counties.—The region around Tampa Bay is important because of the wealth of vertebrate fossils dredged up by the collectors of phosphate rock from the beds of Hillsboro, Alafia, and Manatee Rivers. Unfortunately, few accurate records have been kept of localities and conditions of occurrence of the fossils, and we usually know only that a collection was made in a certain river, perhaps not so much as that. For that reason it is concluded to group together all the fossils regarded as Pleistocene and known to have been found in Hillsboro, Manatee, and Sarasota Counties. In order to indicate as far as possible the localities, the names of the species are followed by contractions which apply as follows.

A, Alafia River.
E, Ellenton, on Manatee River.
Hc, Hillsboro County.
Hr, Hillsboro River.
Ls, Little Sarasota Bay.
Ps, Palma Sola.
M, town of Manatee.
P, Palmetto.
S, 8 miles southeast of Sarasota.
T, around Tampa Bay.
Wb, White Beach, on Sarasota Bay.

List of Pleistocene vertebrates found in Hillsboro, Manatee, and Sarasota Counties.

Homo sapiens, Ps.
Elephas imperator, P (p. 164).
E. columbi, T, S, Ps (p. 159).
E. primigenius, Ps (p. 145).
Mammut americanum, T, Hc, A (p. 123).
Bison latifrons, Ps (p. 263).
B. sp. indet., T, A, P, Ps (p. 263).
Odocoileus sp. indet., P, Ps (p. 233).
Tapirus sp. indet., T, A (p. 208).
Tagassu lenis?, Ps (p. 222).
Equus complicatus, A, Wb, Ps (pp. 196, 197).
E. leidyi, A, P, Wb, Ps, S (pp. 196, 197).
E. littoralis, M, Ps (p. 197).
Chlamytherium septentrionale, Hr, Wb, S (p. 38).
Testudo crassiscutata?, A.
T. ocalana, Hc.
Terrapene putnami, A.
Deirochelys floridana, Hc.
Trachemys euglypha, E.
T. jarmani, Hc.
T. sculpta, Hc.
Pseudemys extincta, Hc.
P. cælata, Ps.
Platypeltis ferox, Hc.

The bones of man belonged to the skull and are as completely fossilized as the bones of a horse and are wholly free from organic matter.

Among the mammals of this list there are no genera and few species that have not been found in the Pleistocene at many places in the United States. The presence of *Elephas imperator* and three species of *Equus* and *Chlamytherium* apparently indicate Pleistocene of about Aftonian times.

From Palma Sola, Manatee County, there have been sent to the U. S. National Museum by Mr. Charles T. Earle many specimens of fossil vertebrates, found at various times washed up on the beach. Some belonged evidently to deposits older than the Pleistocene, probably to Miocene, and included teeth of sharks, a beak of a platanistid porpoise, and a lower tooth of a sirenian, *Metaxytherium floridanum.* Other specimens, as bones of a camel, parts of the shells of tortoises, alligator or crocodile teeth and bones are of uncertain age. Ten species of the list are referred to the Pleistocene. All of the teeth are isolated, but many are well preserved and little water-worn. The bones are mostly fragmentary, some worn, some not.

Polk County.—On page 159 is an account of a tooth of an elephant, *Elephas columbi,* reported as being found at Kingsford, Polk County, under

19 feet of phosphate rock and sand. It may belong to *E. imperator*. On page 196 is detailed the finding of several teeth of *Equus* in the phosphate mines of Kingsford. The species *E. leidyi* and *E. littoralis* are recognized. Unless these elephant and horse teeth had been incorrectly reported or had been secondarily introduced into the phosphate beds, they are, in the writer's opinion, to be referred to the first glacial stage, the Nebraskan. Dr. W. H. Dall has somewhere reported the finding of tusks at Bartow; these were supposed to have belonged to *Elephas columbi* (p. 180). At Nichols the large land-tortoise *Testudo hayi* Sellards has been recovered from a phosphate mine. From phosphate mines at Brewster has been secured the following list of vertebrates, obtained from Dr. Sellard's reports (Florida Geol. Surv., vol. VII, pp. 100, 106, 108; vol. VIII, pp. 95, 96, 98, 100).

Gomphotherium floridanum? (p. 123).
Mammut progenium (p. 123).
Hipparion minor (p. 197).
Procamelus minor?
Teleoceras or Alphelops sp. indet. (p. 211).
Agriotherium schneideri.
Tomistoma americanum.

All of this list are referred by Sellards to the upper Miocene or lower Pliocene. The writer regards them as belonging to the first stage of the Pleistocene.

From a phosphate pit at Christina, Sellards (Florida Geol. Surv., vol. VII, p. 106, fig. 35) has reported a tooth of an undetermined species of *Gomphotherium*.

Sellards (Florida Geol. Surv., vol. VII, pp. 72, 110) has reported the collection of remains of *Hipparion* sp. indet. and of *Teleoceras proterus* (p. 211) from phosphate mines at Mulberry. In the U. S. National Museum are undetermined remains of *Gomphotherium* from the same place, sent in by Matson.

Brevard County.—In the Hopkins drainage canal at Eau Gallie have been found remains of *Equus complicatus* (p. 196) and *Elephas columbi* (p. 159).

Zolfo, Hardee County.—At Zolfo, near the border of the Bone Valley area, have been found *Megatherium* (p. 38) and *Elephas columbi* (p. 160).

De Soto County.—With one exception, apparently, fossil vertebrates have been discovered in De Soto County only in deposits along Peace Creek. The exception is a place called Tourner's or Turner's, on Caloosahatchee River. The elephant found there will be considered among the fossils found in Lee County. At Calvenia, at the entrance of Charlie Apopkee Creek into Peace Creek, *Equus leidyi* (p. 198) has been secured.

Most of the fossils found below Calvenia are accredited to Arcadia. According to Leidy (Trans. Wagner Inst., vol. II, p. 19), those of his list were found on a sand-bar at Arcadia; but certainly others have been taken from phosphate rock dredged both above and below the town. As complete and as accurate a list as the writer has been able to prepare is here presented.

Peace Creek, or Peace River, has been the source of many fossil vertebrates, the greater part of them obtained at or near Arcadia. Most of the species were described by Joseph Leidy in 1889 (Trans. Wagner Free Inst., vol. II, pp. 19–31). The region was examined by Dr. W. H. Dall,

whose report was published in 1892 (Bull. 84, U. S. Geol. Surv., pp. 128–133). He referred the bed bearing vertebrate fossils to the Pliocene. Cope (in Dall's report, p. 130) regarded them as equivalent to the *Equus* beds of the Great Plains, or between these and the Loup Fork. Sellards (Florida Geol. Surv., vol. VII, pp. 78–83) places the formation in the Pleistocene.

List of fossil vertebrates found in Peace Creek at or near Arcadia.

Elephas imperator (p. 164).
E. columbi (p. 160).
Mammut americanum (p. 124).
Bison sp. indet (p. 264).
Odocoileus osceola? (p. 233).
Tapirus terrestris (p. 208).
Equus leidyi (p. 199).
E. littoralis (p. 199).
Hipparion ingenuum (p. 199).
Delphinid sp. indet.
Trichechus antiquus.
Glyptodon petaliferus (p. 39).
Glyptodon rivipacis (p. 40).
Chalamytherium septentrionale (p. 40).
Megalonyx jeffersonii (p. 39).
Alligator mississippiensis?.
Testudo crassiscutata.
T. obtusa.
Trachemys euglypha.
Macrochelys floridana.
Chætodipterus faber.
Diodon sp. indet.
Myliobatis sp. indet.
Galeocerdo sp. indet.
Isurus sp. indet.

Of all the genera and species of mammals and reptiles appearing in the list, there is none that it is necessary to suppose was derived from Pliocene deposits, or even from those of a Pleistocene stage earlier than the first interglacial. The marine fishes and sharks have been derived possibly from the Arcadia marls. On the other hand, the presence of *Elephas imperator,* the species of *Equus, Hipparion, Glyptodon, Chlamytherium,* and the gigantic tortoise *Testudo crassiscutata* furnishes evidence that the age was about that of the *Equus,* or Aftonian, beds of the Great Plains.

St. Lucie County.—At Fellsmere, a place near the northern border of the county and about 10 miles west of Indian River, teeth of both *Elephas columbi* (p. 159) and *Mammut americanum* (p. 122) have been found, in the construction of drainage canals.

The most important locality for Pleistocene fossils in St. Lucie County, one may say in the whole State, is Vero. The topographical, geological, and palæontological conditions found here are described in the Eighth and Ninth Annual Reports of the Florida Geological Survey. Papers on the subject may be found also in the Journal of Geology for January 1917 and for October 1917; also in the American Anthropologist for the first and second quarters of 1918. Besides the large number of species of vertebrates found here, the interest is heightened by the fact that, associated with these, are human bones and objects of human manufacture. Through the valley of an insignificant stream was dug a large drainage canal, the construction of which brought to light vertebrate bones and teeth. Three beds of Pleistocene materials were exposed. At the bottom is found a bed of marl filled with marine mollusks and which is the geological equivalent of the coquina rock at St. Augustine. The same deposit is found in various places along the coast and has received from Dr. Sellards the name Anastasia formation. Above this lies a stratum composed mostly of sand, but containing also some muck. In the discussion of the locality this bed is designated as No. 2, the marl being No. 1. No. 2 has a thickness of

about 2 feet. It in turn is overlain by No. 3, which consists mostly of vegetable matter and sand. It is called also the muck-bed. In places the muck is replaced by a bed of marl, which here and there may become pretty firmly consolidated. The thickness of No. 3 is about 2 or 3 feet. Vertebrate fossils are found in both No. 2 and No. 3. It is the purpose of the author first to present lists of the fossils which have been found in each of the upper beds, beginning with the stratum of sand, No. 2.

List of fossil vertebrates found at Vero in stratum No. 2.

Trucifelis floridanus.
Felis veronis.
Ænocyon ayersi.
Vulpes palmaria.
Lutra canadensis.
Procyon lotor.
Cryptotis floridana.
Blarina brevicauda peninsulæ.
Sylvilagus sp. indet.
Neofiber alleni.
Hydrochœrus robustus.
Sigmodon sp. indet.
Elephas columbi (p. 159).
Mammut americanum (p. 122).
Bison sp. indet. (p. 263).
Odocoileus osceola? (p. 233).
Camelops? sp. indet. (p. 235).
Tagassu lenis (p. 222).
Tapirus haysii? (p. 208).
T. veroensis (p. 208).
Equus complicatus (p. 199).
E. leidyi (p. 199).
E. littoralis (p. 199).
Dasypus sp. indet. (p. 38).
Chlamytherium septentrionale (p. 38).
Megalonyx jeffersonii (p. 38).
Mylodon harlani (p. 39).
Didelphis virginiana.
Jabiru weillsi.
Cathartes aura.
Querquedula floridana.
Herodias egretta.
Alligator mississippiensis.
Testudo sellardsi.
Terrapene innoxia.
Chelydra laticarinata.

List of fossil vertebrates found at Vero, in stratum No. 3.

Lynx ruffus floridanus.
Canis riviveronis.
Canis sp. indet.
Vulpes palmaria.
Lutra canadensis.
Ursus floridanus.
Procyon lotor.
Scalopus aquaticus australis.
Sylvilagus palustris.
Neofiber alleni.
Neotoma floridana.
Sigmodon hispidus.
Oryzomys palustris.
Elephas columbi (p. 159).
Mammut americanum (p. 122).
Odocoileus osceola? (p. 233).
O. sellardsiæ (p. 233).
Bison sp. indet. (p. 263).
Tagassu lenis (p. 222).
Tapirus haysii? (p. 208).
Equus littoralis? (p. 199).
E. leidyi? (p. 199).
Chlamytherium septentrionale (p. 38).
Dasypus sp. indet. (p. 38).
Didelphis virginiana.
Ardea sellardsi.
A. herodias.
Ardea? sp. indet.
Herodias egretta?
Aluco pratincola.
Cathartes aura septentrionalis.
Larus vero.
Larus? sp. indet.
Mycteria americana?
Alligator mississippiensis.
Crotalus adamanteus.
Farancia abacura.
Drymarchon corais couperi.
Gopherus polyphemus.
Terrapene antipex.
T. innoxia.
Pseudemys floridanus persimilis.
Trachemys? nuchocarinatus.
Chelydra sculpta.
Chelonia mydas.
Caretta caretta.
Siren lacertina.
Amphiuma means.
Caranx hippos.
Caranx sp. indet.
Amiatus calvus.
Lepisosteus platystomus.
Aëtobatis narinari.

Besides those remains which are to be assigned with certainty to one or the other or both of the strata, there are a few others about whose place in the deposit there is uncertainty:

Testudo luciæ.
Gopherus præcedens.
Trachemys bisornata.
T. sculpta.

At a point about 3 miles west of Vero, a lower jaw of *Elephas imperator* (p. 163) was found in the bank of the drainage canal. It was embedded in a matrix of brown sand which rests upon the stratum of marine shell marl.

The list of mammals found in stratum No. 2 shows that there are 29 species and that 21 of these are extinct. This high proportion of species no longer existing is of itself enough to show that the deposit is an old one. Again, such species as *Elephas imperator* and camels occur in the glaciated region only in Aftonian beds, and outside of the glaciated region only in those which are quite certainly of approximately the same age.

In the list of species found in stratum No. 3 there are 25 mammals, of which 12 species are extinct. These form, therefore, 48 per cent of the whole, indicating apparently a more recent geological time, perhaps about the Sangamon stage. It is true that the geologists hold that there has been continuous deposition and that no interval elapsed between the laying down of No. 2 and No. 3. In a region so near to the level of the sea, where the streams are small and short and have little fall, deposition must have gone on with extreme slowness; hence there may have been no period when deposition ceased. Apparently, too, there was a time when the region was somewhat lower than at present and salt water came up the stream as far as the locality where the fossils are found. The presence of *Chelonia mydas*, *Caretta caretta*, the two species of *Caranx* and *Aëtobatis narinari* may thus be explained.

The fresh-water and terrestrial mollusks of stratum No. 2 were submitted to Dr. Paul Bartsch, of the U. S. National Museum, who has reported on them (Rep. Florida Geol. Surv., vol. VIII, p. 144). He lists 29 species, all living.

The marine mollusks found in the stratum called No. 1, and which the writer refers to the first glacial stage, have been studied by Mr. W. C. Mansfield, of the U. S. Geological Survey (Rep. Florida Geol. Surv., vol. IX, pp. 78–80). Seventy-four species are specifically determined, and of these 61 are identical with living forms. Three or four species are possibly extinct. There is no question that the deposit belongs to the Pleistocene.

Nearly all of the plants were found in the bed designated as No. 3, the upper or muck-bed. These were studied by Dr. Edward W. Berry, of the Maryland Geological Survey. His report, published in 1917 (Rep. Florida Geol. Surv., vol. IX, pp. 19–33), states his conclusion that the plants belong to the late Pleistocene, either the Peorian or the Late Wisconsin. It may be stated that Dr. Berry adopts the theory that the terraces supposed to be found along the Atlantic Coast were formed during stages of submergence beneath the sea, the lowest one late in Pleistocene time.

Lee County.—The whole of Lee County is occupied by Pleistocene deposits which form a part of the Pensacola terrace. Naturally the Pleistocene is overlain, generally, at least, by accumulations of Recent materials,

and it may not always be easy to distinguish the one from the other. So far as the writer knows, all the vertebrate fossils discovered in this county have been collected along Caloosahatchee River above Fort Myers. The geology of this river has been described by Heilprin (Trans. Wagner Inst., vol. 1), Dall (Bull. 84, U. S. Geol. Surv., pp. 142–145), Matson and Sanford (Water Supply Paper 319, pp. 134–138), Sellards (2d Ann. Rep. Florida Geol. Surv., p. 123, 6th Ann. Rep. Florida Geol. Surv., pp. 41–46). The Pleistocene is underlain by Pliocene marls and hard and soft limestones and consists of beds of muck, marl, and sand of little thickness. At Labelle it is said (Sellards, 2d Ann. Rep., p. 126) that there is a fossiliferous Pleistocene marl covered by 3 feet of sandy loam. The following seem to be the species which have been found in the Pleistocene in this region:

Elephas imperator (p. 163).
Equus leidyi (p. 199).
E. sp. indet. (p. 199).
Bison latifrons (p. 264).
Mylodon harlani (p. 40).
Testudo obtusa?.
Trachemys bisornata.
T. sculpta.

The presence of *Elephas imperator* is an indication that the deposits belong to the early part of the Pleistocene. None of the species appear to indicate an older stage than the Aftonian.

Dade County.—Sellards (8th Ann. Rep., p. 106) records that some fragmentary remains of a proboscidean had been found in Miami River, Dade County.

Palm Beach County.—On page 105 of the report just cited, Sellards stated that *Elephas columbi* (p. 160), *Mammut americanum* (p. 123), *Equus complicatus* (p. 200), and *Bison* sp. indet. (p 264) had been found in the Palm Beach Canal, constructed to drain the Everglades.

At some unknown point in the Everglades, possibly in Lee County, there was found many years ago a tooth of an elephant which the writer believes belonged to *Elephas imperator,* already mentioned on page 163. It was formerly reported as *E. columbi.*

ALABAMA.

An account of the Quaternary formations of Alabama may be found in Eugene A. Smith's "Report on the Geology of the Coastal Plain of Alabama." This was published in 1894, and the part pertaining to the Pleistocene is found on pages 28 to 65. Along the coast Smith recognized the presence of a formation which he called the Biloxi. The upper part of this was regarded as belonging to the Recent, while the lower portion was thought to be the equivalent of Hilgard's Port Hudson, those deposits numbered 1 to 4 in the section shown on page 387, under Geology of Mississippi. The thickness of the Port Hudson is given as about 100 feet. Borings revealed the presence of shells and lignitized wood.

Along the rivers which traverse the Coastal Plain are found three terraces. The first or lowest is that which is subject to annual overflow. The second terrace, "the second bottom," occurs along most of even the smaller streams of the Coastal Plain. It may be as much as a mile wide. The height above low water may vary from 10 to 15 feet in the lower courses of the rivers to 60 feet farther up stream. Near water-level a

blue clay is frequently found which contains stumps, roots, and other remains of vegetation, often well preserved. Smith concluded that this second terrace was the substantial equivalence in time to the Port Hudson.

Smith presents a geological section taken along Black Warrior River, in Hale County, 150 miles above Mobile. The section included about 50 feet. As caving went on, stumps and logs were frequently brought into view. Similar sections were found on Coosa River, above Montgomery, and on Alabama River, 50 miles above Mobile.

The third terrace is found at elevations of from 50 to 100 feet above the second. It is sometimes 3 miles or more in width.

In his paper on the Citronelle formation (Prof. Paper U. S. Geol. Surv., 98, pp. 167–208), Matson discusses briefly (pp. 189–190) the Pleistocene of the area studied by him. This extends from the western end of Florida to Mississippi River. Here he recognized four terraces, from the youngest to the oldest, the Pensacola, the Hammond, the Port Hickey, and the St. Elmo. The St. Elmo merges into the Natchez formation, which Matson, quoting Chamberlin and Salisbury, regarded as sub-Aftonian. The Port Hickey terrace is stated to take its name from a locality on the Mississippi River where the typical materials of the Port Hudson formation are exposed. The Port Hickey terrace may, as suggested by Matson, be of post-Iowan age. Naturally, these correlations require confirmation.

Berry has described fossil plants (Amer. Naturalist, vol. XLI, pp. 689–697; Amer. Jour. Sci., ser. 4, vol. XXIX, pp. 387–398) which were found along Chattahoochee River, not far below Columbus, Georgia; on Warrior River, up to 356 miles above Mobile. Pleistocene deposits must occur along all the larger streams still farther north, and these deposits will yield in time bones and teeth of vertebrated animals.

Nothwithstanding the considerable area of Pleistocene deposits discovered in Alabama, the number of species of vertebrates met with is remarkably small. On page 40 is recorded the finding of *Megalonyx jeffersonii* somewhere about Tuscumbia. At Newbern, Hale County, have been found an incisor tooth of a horse (p. 200) and a molar of a bison (p. 264). At Bogue Chitto, Dallas County, have been collected *Equus leidyi* (p. 200), *Mammut americanum*, and *Elephas imperator*. The last species indicates that the deposits probably belong in the Aftonian. The writer knows of no other localities in the State where vertebrate fossils of the Pleistocene have been obtained.

MISSISSIPPI.

(Text-figure 22.)

The geological history of the lower part of the Mississippi Valley during Quaternary times appears to be particularly difficult to understand and at present is far from being unraveled. It is easy to see that such a region will offer great difficulties. Here debouches into the ocean a majestic river which drains not only the glaciated portions of the United States from western New York to northwestern Montana, but the larger part of the region south of this from the Blue Ridge to the Rocky Mountains, and brings down every year enormous quantities of sand and silt,

which are dropped partly on its flood-plain, but mostly near its mouth. Through the ages during which this has been proceeding, this river has been ever changing its bed, sometimes eroding away one bank, sometimes the opposite one; so that its flood-plain is, in most places below the mouth of the Ohio, many miles wide, varying, according to Russell ("Rivers of North America," 1898, p. 267) from 5 miles to 80 miles in width. During the Quaternary there have been also elevations and subsidences of the bed at least from Cairo northward, as a result of which at one epoch the current was hastened and the valley cut out deeper; at another the current was checked, the channel clogged up, and the river forced to seek a new channel or even new temporary or permament outlets to the Gulf (E. A. Smith, Geol. Surv. Alabama, 1894, pp. 30–34).

To get a correct idea of the Pleistocene geology of the lower Mississippi region, one must understand the situation at the beginning of this epoch. I. C. Russell, on page 267 of his work just quoted, calls attention to the differences displayed by the valley of the river within the glaciated region and that south of it. South of the mouth of Ohio River the wide flood-plain of the Mississippi lies from 300 to 500 feet below the general level of the bordering uplands. He states further that the hard-rock bottom of the valley is only imperfectly known, but that the records of wells and borings show that an ancient valley has been filled with alluvium to a depth of at least 100 or 200 feet in its northern part and to an increasing depth southward. If to this thickness, given by Russell, we add the depth, 300 to 500 feet, which the flood-plain occupies below the bordering uplands, we get a measure of the depth of the great trench which once existed where now lies the flood-plain of Mississippi River. In his paper on the underground waters of southern Louisiana (Bull. 1, Louisiana Geol. Surv., 1905, p. 42, plate II) Harris presents the record of the Fabacher well, which was bored at New Orleans. At a depth of about 1,200 feet fossil remains were brought up which appeared to be of Pleistocene age. It is evident from these facts, as in the case of those obtained from the rivers of Texas, that at about the beginning of the Pleistocene, or more probably during the time of the so-called Lafayette, at the close of the Pliocene, the country east of the Rocky Mountains, at least, stood for a long time at a much higher level than at present and that, as a result of this elevation, there was an enormous general erosion of the face of the country and a great widening and deepening of the river valleys. This time of elevation was quite certainly followed by a prolonged period of depression, during which these canyon-like trenches and their tributaries, up to their last ramifications, were nearly completely refilled. This refilling must have occurred during the early stages of the Pleistocene, for in the materials are buried the bones of early Pleistocene animals. As quoted below, in considering the geology at Natchez, Chamberlin and Salisbury state that since the Natchez formation, 200 feet thick, was laid down, the trench of the Mississippi, 60 miles wide, has been excavated. One might change this expression and say that it had been re-excavated, but not to its original depth.

When we reflect that the greater part of the sediments which, during the Pleistocene epoch, were deposited at the mouth of Mississippi River and

on its flood-plain from Kentucky southward, were certainly derived from the glaciated portions of its great valley, and that those regions were alternately affected by the events of five glacial and four interglacial epochs, we must conclude that corresponding deposits or phenomena of some kind exist throughout the valley. The matter is, however, so complicated that many years must elapse before a satisfactory solution will have been reached.

In his Report on the Geology and Agriculture of the State of Mississippi, 1860 (1863–65), the geologist E. W. Hilgard, on pages 5 to 46, described under the name of Orange sand a deposit which characterizes the greater part of the surface of that State. He referred this to the Quaternary and regarded it as being the southern equivalent of the northern drift. This formation is now believed to belong mostly at least to the Pliocene. Besides the Orange sand, Hilgard (op. cit., pp. 194–201) referred other formations to the Quaternary. These in order would be as follows, the latest above:

5. Modern alluvium.
4. Second bottom, or Hommock deposits.
3. Yellow loam deposits.
2. The Bluff formation.
1. Orange sand.

The Bluff formations were described as occupying a narrow belt along the borders of the Mississippi bottom in northern Mississippi and along the river itself in the southern part of the State. He stated that the fossils belonged to terrestrial species, and quoted Leidy's list of vertebrates, already mentioned, remarking that the blue clay which furnished them was said to belong to the Bluff formation. He reported that the snails found in the Bluff formation seemed all to belong to living species. The yellow loams occupied a large part of the surface of the State, overlying the Orange sand and forming a great part of the soils of the State. The succeeding formations were found along many of the rivers.

In 1869 (Amer. Jour. Sci., vol. XLVII, pp. 331–346), Hilgard reported the results of a geological reconnaissance of Louisiana. In this he proposed the name Port Hudson group for extensive deposits of clays which were especially well displayed at Port Hudson. This formation was further described by Hilgard in 1872 (Smithson. Contrib. Knowl., vol. XXIII, No. 248, p. 5). Two geological sections taken near Port Hudson were presented, one of which is here reproduced.

Section midway between Port Hudson and Fontana.

6.	Yellow loam, sandy below	8–10
5.	White and yellow hardpan	18
	Orange and yellow sand, sometimes ferruginous sandstone, irregularly stratified	8–15
4.	Heavy greenish or bluish clay	7
3.	White indurate silt, or hardpan	18
2.	Heavy green clay with porous calcareous concretions above, ferruginous below; some sticks and impressions of leaves	30
1.	Brown muck / White or blue clay with cypress stumps	3–4

The cypress stumps of No. 1 were numerous and well preserved.

The writer reproduces Hilgard's geological map of the lower Mississippi region, in which is represented the distribution of the Port Hudson according to that writer's views (fig. 22). It will be seen that it was supposed to

pass eastward into the coast region of Mississippi, Alabama, and Florida. Westward from Atchafalaya River it was believed to occupy a large part of southern Louisiana and to pass into Texas and around the Gulf coast to near the Rio Grande. It will be observed that in the latter State it corresponds in a general way to what has been called by Deussen the Lissie formation.

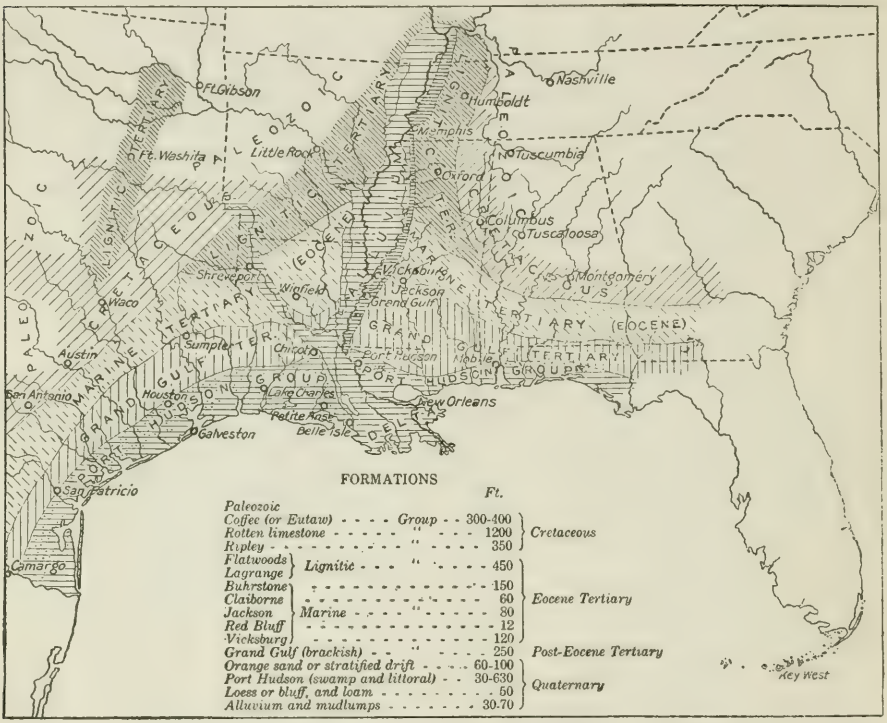


FIG. 22.—The Mississippi embayment. Redrawn from Hilgard. Used to show the distribution of the Port Hudson group.

Although Hilgard represents on his map an alluvial deposit as covering the region of the delta, a belt along the western side of the great river as far up as Cairo, and the wide tract between Mississippi and Yazoo Rivers, a study of his paper shows that he believed that much of these regions was underlain by his Port Hudson. He recognized it at Greenwood on the Yazoo, 60 miles east of the Mississippi; at Vicksburg, and at various places in the delta. Usually its upper surface occurs at about low-water level along rivers, and elsewhere is met with in digging wells. At Vicksburg it was encountered by Grant's Army in digging his famous canal. It was believed by Hilgard that the same deposit was present at Petite Anse, overlying the Orange sand and overlain by more recent deposits.

Inasmuch as Hilgard believed that the Orange sand was laid down at the time when the northern drift was being deposited, he had to refer his Port Hudson to a later time, and this time he seemed to regard as being the epoch called by Dana the Champlain.

McGee referred the deposits of the lower Mississippi Valley (sometimes called the Mississippi embayment) to his Columbia formation (12th Ann. Rep. U. S. Geol. Surv., plate I, p. 392). This formation, in his view, had been laid down during a great subsidence of the borders of the continent and when the waters of the Gulf reached as far north as the mouth of Ohio River or beyond. He relegated Hilgard's Orange sand to the Pliocene and recognized four phases as belonging to the Pleistocene. These were, beginning below: (1) Port Hudson; (2) Orange sand (of Safford, not that of Hilgard); (3) loess; (4) brown (or yellow) loam. Of these divisions there were really only three, for he regarded the loess as only a phase of the loam and as lying sometimes above, sometimes below the latter. He recognized the Port Hudson clays as flooring the entire flood-plain of the Mississippi from the mouth of the Ohio well toward the gulf shore. The formation was believed to be usually a low-lying one; but at Natchez (as seen by his section given on page 391) it is elevated high above the present flood-plain.

Gilbert D. Harris, geologist in charge of the geological survey of Louisiana, and Arthur C. Veatch, assistant geologist, have contributed much to our knowledge of the Pleistocene geology of the State. Reference to their works will be found in the descriptions of several fossil-bearing localities, especially in the description of Petite Anse.

Harris, in 1905 (Bull. 1, Geol. Surv. Louisiana, p. 13), expressed the conclusion that the longer the geology of southern Louisiana is studied the more futile appears the attempt to make satisfactory subdivisions in the Quaternary deposits—subdivisions that have any definite time or structural limits. He regarded it as a mistake to assign to the Port Hudson a special place in geologic time.

Chamberlin and Salisbury in 1906, as quoted below, made no mention of the Port Hudson formation; but that part of it supposed to be found at Natchez was evidently included in their Natchez formation.

Inasmuch as Petite Anse and Natchez have furnished more species of fossil vertebrates than any other localities in their States, and likewise human relics supposed to be of equal age with the extinct mammals, these places will receive especial attention.

Natchez is the most important locality in Mississippi as regards Pleistocene vertebrate palæontology. So far as the writer knows the first mention of the occurence of vertebrate fossils here was a note by Dr. G. Troost in 1835 (Trans. Geol. Soc. Penn., vol. I, p. 143), who stated that he had in his possession a tooth of a mastodon found at Natchez.

In 1845 (Proc. 6th Meet. Assoc. Amer. Geologists and Naturalists, pp 77–79), Dr. M. W. Dickeson, of Natchez, read a paper entitled "On the Geology of the Natchez Bluffs," in which he distinguished 22 several beds. These were said to be of varying thickness and distinctly marked, but all composed of various colored clays and sands, and containing numerous organic remains, embedded wood, and detrital matter. Probably by far the greater part of these beds were of subordinate importance and do not appear to have been noted since that time. Beneath the surface soil Dickeson recognized a mass of yellow loam 20 to 30 feet in thickness, exceedingly fine and free from gravel. In this had been found shells

of *Helix* and scattered bones of mastodons. Below this came a bed of ferruginous sands and gravels 4 feet thick. This was succeeded below by what he called the mastodon bed, in which Dickeson had detected remains of more than 30 individual mastodons. The thickness of this was not given. The next stratum, his No. 6, was a fine clay of blue color, from 12 to 15 feet thick. In this and his No. 22, an ash-colored clay, at low-water mark, he discovered remains of what has since proved to be *Megalonyx jeffersonii*. The localities where his fossils were found were not given with exactness.

At a meeting of the Academy of Natural Sciences, October 6, 1846 (Proc., etc., vol. III, p. 107), Dickeson exhibited a large collection of fossil bones obtained by him in the vicinity of Natchez. Among these were the head and lower jaw of the *Megalonyx* already mentioned. He stated that the stratum that contains these organic remains is a tenacious blue clay that underlies the diluvial drift east of Natchez and which diluvial deposit abounds in bones and teeth of the *Mastodon giganteus*. Associated with the megalonyx were remains of bear, bison, deer, and horse. The collection was more notable because of the presence of a part of a human innominate bone. Dickeson affirmed that this had been taken out of the blue clay about 2 feet below three associated skeletons of the megalonyx; and it is further stated to have accorded in respect of color, density, etc., with those of the megalonyx and other associated bones. This bone is now in the collection of the Academy of Natural Sciences, Philadelphia.

In 1846 the English geologist, Sir Charles Lyell, studied the geology of the region at Natchez (Second Visit to U. S. N. A., ed. 2, vol. II, pp. 194–201). With him were Dr. Dickeson and B. L. C. Wailles, afterwards State geologist of Mississippi (Wailles, Agric., Geol. Miss., 1854, p. 213). In the yellow loam of the bluffs Lyell recognized loess deposits, from their resemblance to those of the Rhine. These he estimated to occupy the upper 60 feet of the bluff, and in them were found 20 species of land-snails, all yet living. He reported that this loess sometimes passed into a lacustrine deposit which contained shells of *Lymnæa, Planorbis, Paludina, Physa,* and *Cyclas,* and that with the land-snails had been found, at different depths, remains of the mastodon, while in clay under the loam (meaning evidently the loess) and above the sand and gravel, entire skeletons of the megalonyx had been met with, associated with bones of the horse, bear, stag, ox (*Bison*). Lyell noted especially the recent development of deep ravines. One of these, called the Mammoth Ravine, had been formed, he was assured, within the preceding 35 years. Its length was 7 miles and its depth 60 feet. In this ravine was found the human innominate bone referred to above. He was shown this bone, and states that Dr. Dickeson was persuaded that the bone had been taken out of the clay underlying the loam (loess). This indicates that Dickeson himself did not take out the human bone. Lyell thought that, like most of the other fossils, it had been picked up in the bed of the stream, which would simply imply that it had been washed out of the cliffs, and that it may have been dislodged from some Indian grave near the top. He (p. 197) stated that the place where the

bone was found was 6 miles from Natchez. The reader may consult further Lyell's account of his observations at Natchez in volume III of the American Journal of Science, 1847, page 266.

In 1854 Wailles (op. cit., p. 286) published a list of the vertebrate fossils which had been found in the State. This list had been prepared by Dr. Leidy. While no localities are mentioned in either publication, it is quite certain that most, if not all, of the species had been found at Natchez. Wailles (p. 285) stated that the most prolific locality was on Pine Ridge, in townships 7 and 8 north, range 3 west, 6 miles north of Natchez. While the name is not used, it is supposed that reference is here had to the Mammoth Ravine mentioned by Lyell. Leidy's list was as follows:

Felis atrox Leidy.
Ursus americanus fossilis.
U. amplidens Leidy.
Equus americanus Leidy.
Cervus virginianus fossilis.
Bison latifrons Leidy.
Boötherium cavifrons Leidy.
Elephas primigenius.
Tapirus americanus fossilis.
T. haysii Leidy.
Megalonyx jeffersonii Harlan.
M. dissimilis Leidy.
Mylodon harlani Owen.
Ereptodon priscus Leidy.
Mastodon giganteus.

Hilgard (Agric. Geol., Mississippi, 1860, p. 196, a work not issued until the early part of 1863), republished Leidy's catalogue of species just mentioned and stated that these had been found in a solid blue clay.

In J. W. Foster's "Prehistoric Races of the United States," published in 1873, p. 61, is a statement made by Professor C. G. Forsley, in which he says that he visited the locality where the human innominate bone was found and that it was in Bernard's Bayou, 2.5 miles north from Natchez. This does not accord with the statement of Wailles, who lived near Natchez and who visited the locality in company with Lyell and Dickeson. Forshey presented reasons for concluding that the bone was not derived from the Bluff formation. He stated that the mastodon bones and all others, of which there were many, were rotten, and that it was only with difficulty that any of them could be preserved. On the other hand, Leidy, in speaking of the bones of the megalonyx found in the Mammoth Ravine (Smithson. Contrib. Knowl., vol. VII, art. 5, p. 6), and of those of the *Mylodon* (op. cit., p. 48), says that they were in a good state of preservation.

In his work on the Lafayette formation published in 1891 (12th Ann. Rep. U. S. Geol. Surv., pp. 347–521), McGee discussed the geology about Natchez. On page 397 he presented a composite section obtained along about 3 miles of the bluff. This in a modified form is here given.

Section at Natchez.

	feet.
7. Loess	10 to 50
6. Brown loam	10 to 40
5. Stratified loamy sand	5 to 15
4. Tenacious blue clay (Port Hudson)	10 to 15
3. Cross-stratified sand, with pebbles	30 to 50
2. Stratified gravel	5 to 15
1. Greenish and blue clay, to above low water (Grand Gulf, Tertiary)	5 to 10

McGee noted that these divisions (except the Port Hudson and Grand Gulf) are purely arbitrary, inasmuch as the character and thickness of the beds change more or less within no great distances.

He noted the fact that the loess abounded in mollusks mostly of land and swamp species; also that some of the gravelly beds well down towards the Port Hudson clays had yielded bones and teeth of elephants and mastodons.

In 1898, Dr. B. Shimek visited Natchez and studied especially the loess (Amer. Geologist, vol. xxx, pp. 279–298, with plates x–xvi). He estimated the thickness of the loess as not exceeding 30 feet. He collected from this loess more than 4,600 shells of mollusks; and these proved to belong to 39 species or well-recognized subspecies. These species are all terrestrial in habit and all are now found living either on the hills in the immediate vicinity or in similar situations in other parts of the South. Shimek came to the conclusion that the loess of that region had been deposited by the action of the winds. He was unable to find any "brown loam" above the loess, the presence of which other authors had affirmed.

Shimek found no traces of mammalian bones in the loess and was inclined to doubt that they occur there. He does not appear to have visited the locality from which most of the bones were reported.

Chamberlin and Salisbury, in 1906 (Geology, vol. iii, p. 386, fig. 513), discussed briefly the geological situation at Natchez. The Natchez formation (evidently including the Port Hudson) has a thickness of about 200 feet and is made up of materials derived mostly from the so-called Lafayette, on which it there rests unconformably. In this Natchez formation are also crystalline pebbles and calcareous clays assignable to wash from the glacial regions. Between this Natchez formation and the overlying loess a marked interval is indicated. The authors are inclined to assign the Natchez deposits to the earliest part of the Pleistocene, viz, to the Aftonian and the drift epoch preceding the Aftonian. Since the time when the Natchez formation was deposited the great trench of the Mississippi Valley, about 60 miles wide, has been excavated.

Already on page 391 has been given the list of fossil mammals which Leidy made out for the State geologist of Mississippi, B. L. C. Wailles. A revision of this is here presented, with the addition of *Castoroides ohioensis*.

Megalonyx jeffersonii (p. 40).
M. dissimilis (p. 41).
Mylodon harlani (p. 41).
Ereptodon priscus (p. 41).
Equus complicatus (p. 200).
E. leidyi (p. 200).
Tapirus haysii (p. 208).
T. terrestris (p. 208).
Odocoileus virginianus (p. 233).
Symbos cavifrons (p. 254).
Bison latifrons? (p. 265).
Mammut americanum (p. 125).
Elephas columbi? (p. 180).
Castoroides ohioensis (p. 280).
Ursus americanus.
U. amplidens.
Felis atrox.

According to Lyell (Amer. Jour. Sci., vol. iii, 1847, p. 268), *Megatherium* and *Castoroides* had been found in the bluffs at Natchez.

From this list of mammals it is possible perhaps to reach some conclusion regarding the geological age of the deposits containing them. In case we accept without reserve the species, 16 in number, as determined, only 3, *Tapirus terrestris*, *Odocoileus virginianus*, and *Ursus americanus*, are yet living, leaving about 81 per cent of the whole as being extinct, and what was called *Tapirus terrestris* was probably an extinct form. This alone makes it probable that the time of their existence was early in the Pleisto-

cene. All three of the supposed existing species may, however, prove to belong to extinct species closely related to those whose names they yet bear.

Certain species may be left out of consideration because of paucity of specimens and our consequent lack of knowledge of them. These are *Megalonyx dissimilis, Ereptodon priscus,* and *Ursus amplidens.*

In case the high percentage of extinct species is not recognized as being decisive, we may consider the assemblage from another point of view. Certain species of the list appear to have existed throughout the Pleistocene, at least from the time of the first interglacial stage. These are *Megalonyx jeffersonii, Mammut americanum, Elephas columbi,* and *Castorides ohioensis,* and their presence indicates only a Pleistocene time. Others of the list are not known to have existed after the time of the last Wisconsin drift-sheet, and may be supposed to have become extinct before that time. These are *Mylodon harlani, Equus complicatus, Equus leidyi, Tapirus haysii,* and *Bison latifrons.* All of these quite certainly existed until after the Illinoian drift period, probably into the Sangamon interglacial, except apparently *Equus leidyi.*

The list contains no species of primitive mastodons belonging to the genus *Gomphotherium,* no species of *Hipparion,* no camels; and *Elephas imperator* appears to be missing. There is, therefore, no necessity for believing that the mammal-bearing deposits at Natchez are as old as the Sheridan, or Aftonian stage, but the ancient forms mentioned may at any time turn up there or elsewhere in the immediate region.

The presence of *Symbos cavifrons* might be supposed to point to a rather late date in the Pleistocene; but evidence has accumulated which indicates that it reaches back farther in time than we have supposed. Taking all into consideration, the writer concludes that the fossil vertebrates found at Natchez date back at least as far as the time of the Illinoian drift stage. There is nothing to prove that they are not as old as the Aftonian stage, except the apparent absence of camels, *Elephas imperator,* mastodons belonging to *Gomphotherium,* and a multiplicity of species of *Equus.*

Unfortunately, vertebrate fossils, especially those known to belong to definite horizons in the Pleistocene, are, aside from Natchez, rarely found; but near Orizaba, in Tippah County, a tooth of a horse has been discovered which appears to have been *Equus leidyi* (p. 200). Remains of a deer (p. 234) have been found in a railroad cutting at Aberdeen, Monroe County. Mastodons are not uncommon, as may be seen on consulting the pages where these animals in Mississippi are discussed (pp. 124 to 126).

TENNESSEE.

(Figure 23.)

There are not many States which furnish fewer Pleistocene deposits of any considerable area than does Tennessee. Lying, as it does, away from the sea, there are no marine Pleistocene beds; situated beyond the glacial area, there are no glacial-drift deposits; and almost half of the State, the eastern, being mountainous, with rivers running in narrow valleys, there has been little opportunity for accumulation of loose Pleistocene materials.

The U. S. Geological Survey has published about 25 folios describing the geology of this mountainous part of Tennessee. One will search these folios, perhaps in vain, for any mention of Pleistocene deposits and for traces of these on the maps. Now and then mention is made of narrow strips of alluvium along some of the larger rivers; nevertheless there are evidences that in some of these strips there are Pleistocene deposits. From the mountainous region westward to near Mississippi River there have doubtless been, during the Pleistocene, better opportunities for deposition of alluvium along the river courses, but such deposits have been little studied. Along the great river forming the western boundary there is a band, 10 to perhaps 25 miles in width, overlain by loess. This may attain a depth along the river varying from 20 to 70 feet, but away from the river it thins out to a feather-edge (Glenn, Water Supply Paper 114, U. S. Geol. Surv.). Up to this time, however, it has furnished few, if any, Pleistocene fossils.

Notwithstanding the paucity of Pleistocene areas in the mountainous portion of Tennessee, this region has furnished a considerable number of species of Pleistocene vertebrates, and bids fair to furnish its due proportion (fig. 23). These species occur, not in water-laid or wind-laid deposits, but in caves which abound in the limestones of that region. In 1918 (Resources of Tenn., vol. VIII, pp. 85–142), Mr. Thomas L. Bailey located and described more than 100 caves of considerable size. Many had been worked to obtain saltpeter. Bones have been reported from a few of them; probably bones had been met with in others, but were not regarded as important. In these caves (and in others yet to be discovered) may hereafter be found numerous remains of animals. Other sources for such fossils are the crevices that are sometimes opened up in quarrying operations. Caves and crevices of this kind are found in the Alleghany Mountain region from northern Pennsylvania to Lookout Mountain in Tennessee, and from them there is already known an extensive Pleistocene fauna.

Beginning in the northeastern corner of the State, a brief survey will be made of the localities and fossils which concern us. At Kingsport, in Sullivan County (fig. 23, *1*) the writer has learned of the finding of a mastodon tooth (p. 127), but beyond the fact that it was owned by Mr. D. M. Lafitte, the writer has been able to learn nothing.

From Bristol, Sullivan County (fig. 23, *2*), in the northeastern corner of the State, there has been sent to the U. S. National Museum a fragment of a maxilla containing two teeth of a tapir. This is referred to *Tapirus haysii*. No details regarding the place of discovery or of the geological conditions are known (p. 209).

From Hawkins County, at a locality not specified (fig. 23, *3*) another mastodon tooth has been reported by Dr. S. W. McCallie (Science, ser. 2, vol. xx, p. 333) (p. 127). These announcements show at least that these animals could exist in those rough and elevated regions. From crevices in a marble quarry near Rogersville (fig. 23, *4*), Hawkins County, there were sent many years ago to the U. S. National Museum a tooth of the horse *Equus leidyi* (p. 201); and a canine tooth of a very large peccary, *Mylohyus setiger* (p. 222). The same peccary has been secured from Cavetown, Maryland.

In the U. S. National Museum is a collection of remains of vertebrate animals made about 1885 by Mr. Ira Sayles, a collector for the U. S. Geological Survey, from a point about a mile north of Whitesburg, Hamblen County (fig. 23, *5*). Some masses of the matrix which contained the bones

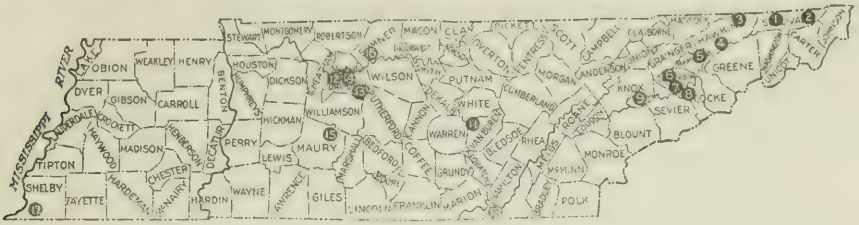


FIG. 23.—Localities where fossil vertebrates have been found in Tennessee.

1. Kingsport, Sullivan County. Mammut americanum (p. 127).
2. Bristol, Sullivan County. Tapirus haysii (p. 209).
3. ———— Hawkins County. Mammut americanum (p. 127).
4. Rogersville, Hawkins County. Equus leidyi, Mylohyus setiger (p. 394).
5. Whitesburg, Hamblen County. 19 species (p. 395).
6. Mossy Creek, Jefferson County. Mammut americanum (p. 127).
7. Zirkel's Cave, Jefferson County. Tapir, peccary, bear, etc., (p. 396).
8. Dandridge, Jefferson County. Mammut americanum (p. 127).
9. Near Knoxville, Knox County. Mammut americanum (p. 127).
10. Lookout Mountain, Hamilton County. Equus littoralis, Mylodon? sp. indet., Tapirus sp. indet, etc., (p. 396).
11. Elroy, VanBuren County. Megalonyx jeffersonii, etc. (p. 397).
12. 11 miles west of Nashville. Mammut americanum (p. 127).
13. 11 miles southeast of Nashville. Mammut americanum (p. 127).
14. Nashville, Davidson County. Equus leidyi, E. complicatus?, Camelops? sp. indet., Mylodon harlani, Odocoileus sp. indet. (p. 399).
15. Columbia, Maury County. Elephas sp. indet. (p. 181.)
17. Memphis, Shelby County. Megalonyx sp. indet., Castoroides ohioensis, Mammut americanum (p. 400.)

accompany the collection. This matrix is a red earth such as is often found in the floor of caves and in fissures in limestone, the result of the decomposition of the calcareous rock. Some fragments are to a great extent made up of broken bones. It is evident, however, that there is now no cave at that place. Sayles suggested that the bones were "kitchenmiddens" and that there had been an old fortification there. Possibly a cave or a fissure once existed there and the rock inclosing it may have dissolved away, leaving the floor.

In this collection the writer has found the following species; these were described in 1920 (Proc. U. S. Nat. Mus., vol. LVIII, pp. 85–95, plates III, IV; text-figs. 1–3). Those preceded by an asterisk are extinct.

List of species.

*Testudo munda.
*Equus leidyi (p. 201).
*E. littoralis (p. 201).
*Tapirus tennesseæ (p. 209).
*Mylohyus nasutus (p. 223).
Odocoileus virginianus (p. 234).
*Sangamona fugitiva.
Cervus canadensis (p. 243).
*Elephas primigenius.
Sciurus carolinensis.
Tamias striatus.
Marmota monax.
Castor canadensis.
Neotoma pennsylvanica?.
Microtus pennsylvanicus.
Lepus americanus.
Ursus floridanus.
Procyon lotor.
*Ænocyon ayersi?.

In this list there are 19 species, of which 8 are extinct. The latter form, therefore, 42 per cent of the whole list. This ratio appears to indicate a time about the middle of the Pleistocene. There are no forms that require an earlier date and there is good reason for believing that the horses and the tapir did not exist after the last glacial stage, perhaps not after the Sangamon interglacial.

It is interesting to find in eastern Tennessee the remains of *Elephas primigenius*. The discovery of teeth of this animal at Beaufort, North Carolina, in eastern Tennessee, and especially in Texas, proves that the range of that species extended even farther south in the New World than it did in the old. It is not improbable that the animal withdrew to the south during one or more of the glacial stages. However, none of the other species found at Whitesburg suggests a cooler climate than now prevails there.

It is possible that some of the forms referred to existing species are really extinct. The teeth identified as those of *Odocoileus virginianus* are smaller than those usually found in Recent individuals. The deer *Sangamona fugitiva* appears in a collection made at Cavetown, Maryland, and in another made at Alton, Illinois, in or beneath deposits of loess that are believed to have been laid down about the time of the Sangamon stage.

In Jefferson County mastodon remains have been found at two places, Dandridge (fig. 23, *8*) and Mossy Creek. No details are known about the first case; in the case of the tooth found 3 miles south of Mossy Creek (fig. 23, *6*) it is stated that it was discovered at a depth of 6 feet and beneath a white-oak stump. Between the two villages, on the left bank of Dumplin Creek, 5 miles above its mouth, is Zirkel's Cave. From this cave (fig. 23, *7*) Mercer (Dept. Amer. Archæol. Univ. Penn., 1896) reported the discovery of remains of tapir (p. 395), peccary (p. 223), bear, and small rodents; but to what species they belonged is not known. The tapir and the peccary indicate Pleistocene times. The bear probably belonged to the same epoch.

At a point 7 miles southeast of Knoxville (fig. 23, *9*) Professor S. W. McCallie reported the finding of a mastodon tooth beneath 30 inches of clay. At Lookout Mountain (p. 395, fig. 23, *10*) have been secured a tooth of a horse, probably *Equus littoralis* (p. 201), remains of tapir and probably of *Mylodon* (p. 43). Just where the horse-tooth was found is not known. The tapir was found in a cave on the left bank of Tennessee River, 0.25 mile below the mouth of Chattanooga Creek (Mercer, as cited above; also in Amer. Naturalist, vol. XXVIII, p. 355). Mercer's accounts are brief and were intended only as preliminary reports. From him, through Miss Harriet Newell Wardle, of Philadelphia, the writer has received a letter in which are given some details about the investigation of this cave in 1893 and 1896.

Dr. Mercer extended his trench inward from the entrance a distance of about 50 feet and downward to the rocky bottom of the cave. He recognized the presence of three layers, as follows: (1) top layer, from 6 to 8 inches deep, containing relics of both white man and Indian; (2) middle layer, about 2 feet thick, containing evidence of Indian only; (3) red cave

earth, varying from one to several feet in thickness, according to the uneven conditions of the cave floor. This latter layer was subdivided into an upper zone (*a*) about a foot deep, which showed evidences of intrusion of bones and refuse from the overlying layer, and (*b*) the undisturbed red earth which contained bones of bats and perhaps of some other animals. In the upper zone (*a*) of the red-earth layer Mercer found a jawbone and loose teeth of *Tapirus haysii* (p. 209) and a jawbone of *Mylodon* (p. 43) without teeth, both as identified by Professor Cope. Later, Cope became doubtful as to the *Mylodon* bone. In this upper zone of red earth, "within a few varying inches of the depth of the tapir specimen above or below it," Mercer found bones of cave rats (*Neotoma*), marmot (*Marmota*), squirrel, deer, opossum, teeth and fragments of the skull of a large unidentified mammal, a small and a large bird, wild turkey, two species of turtles, frogs, and drum-fish. The skull and other bones of the large unidentified mammal had plainly been cracked to secure the marrow, and were otherwise crushed and splintered. Also, as many as 493 hornstone chips were found, besides bones rubbed to a point, and 10 potsherds. It becomes a question how the tapir bone and teeth and perhaps the bone of the mylodon and the evidences of the Indian's presence got into this upper layer of red earth. Mercer "thought it reasonable to conclude that the tapir had been intruded into the red earth from the upper layer and had been in contact with the Indians." This appears to indicate the idea that the tapir had existed there at a late period, probably after the Pleistocene; but the evidences appear to show that this animal lived in the United States not later than about the Sangamon stage of the Pleistocene. It is more probable that the tapir remains had not been disturbed and that the relics of man had, by some means, made their way down into the red earth. There remains also the possibility that Indians and tapirs and mylodons had lived together in that region during the middle of the Pleistocene and while the upper foot of red clay was being deposited. The presence of the other animals mentioned by Mercer does not disprove this possibility, for all of them pretty certainly existed there during the middle Pleistocene.

Not far from Elroy, Van Buren County (fig. 23, *11*) there is an interesting cavern known as Bigbone Cave. This and the bones which it has furnished are now to be described.

Mercer (Proc. Amer. Philos. Soc., vol. XXXVI, pp. 36–70) found that in the greater part of this cave the nitrous earth that had formed the floor had been removed to such an extent that on the walls its stains remained at a height of one's waist. Wherever any of this deposit remained it was exceedingly dry and any disturbance of it produced a cloud of dust. It appears to have consisted mostly of the dung and excretions of animals, such as bats and cave rats. The preservation of the cartilage and horny sheaths of the claw was due to this dryness of the atmosphere. Where Mercer found the bones he recognized four layers, to represent which he published a figure (op. cit., p. 47, fig. 4). This is here reproduced with unimportant changes (fig. 24). On top there was a layer from 2 to 3 inches thick which had resulted from the disturbance produced by the passing of white men and possibly to some extent of Indians. With the

dust were mingled remains of charred vegetable substances that had been used as torches.

The second layer was 2 to 5 feet deep and consisted almost entirely of well-preserved dried excrements of cave rats (*Neotoma*) and of porcupines (*Erethizon*). In it were observed nuts, sticks, fur, and moss. The only animal remains found in this layer were the bones of *Megalonyx* (p. 42),

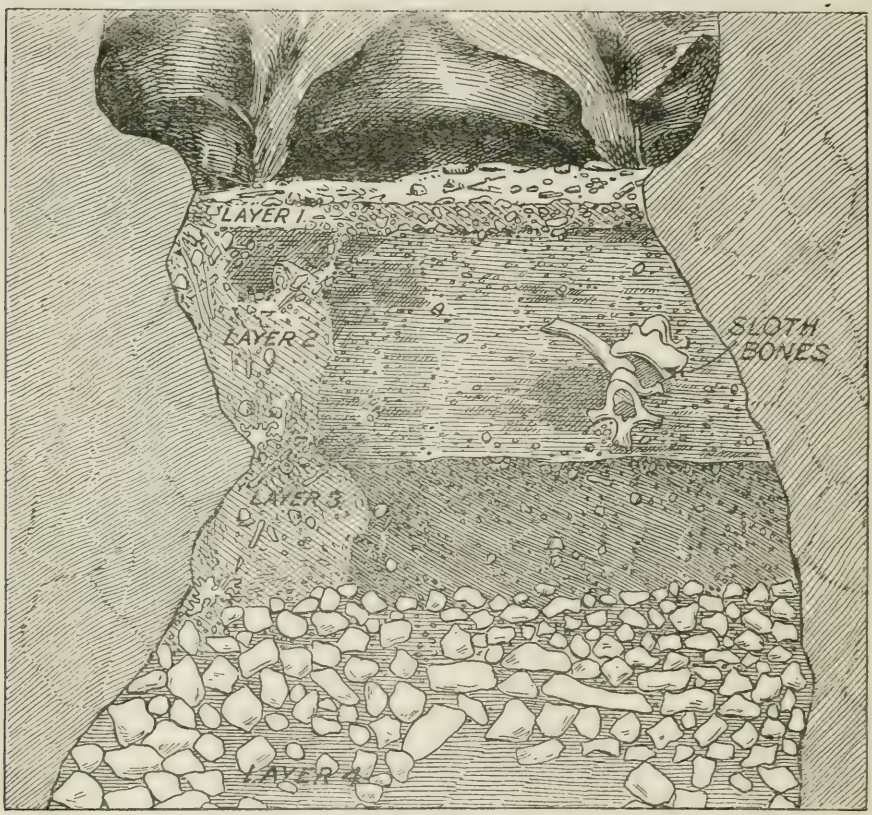


FIG. 24.—Diagram showing a vertical section of the gallery in Bigbone Cave near Elroy, Van Buren County, Tenn. Adapted from Mercer.

quills and coprolites of *Erethizon dorsatum*, coprolites and a jaw of a cave rat referred to *Neotoma magister*, and jaws of two bats, *Adelonycteris fuscus* and *Myotis subulatus* (*Vespertilio gryphus* of Mercer). Some traces were found of an undetermined herbivorous mammal about as large as a bear. With the lot of *Megalonyx* bones from this cave which were described by Harlan there were remains referred to *Bos* (*Bison*), *Ursus*, *Cervus* (*Odocoileus?*), and a human metatarsal; but these were reported as having been picked up on the surface and may therefore have belonged to quite recent skeletons.

Besides the animal remains found by Mercer in his second layer, there were present quantities of vegetable matter belonging to several species. All, however, were forms yet living in that region.

Mercer's third layer appears to have consisted of dry excrements which had become somewhat hardened. Its thickness was a foot. In it were found vegetable matter, some bat jaws and fur, and the carcass of a "window fly." The fourth layer consisted of a fine water-laid clay which on drying had contracted and broken up into small angular masses. The interstices appear to have been filled by materials soaking down from the upper layers of excrement. No organisms were found in it.

Mercer concluded that the sloth remains were geologically recent, and this may be true. *Megalonyx jeffersonii* has been found in the northern States in deposits overlying the Wisconsin drift, and it is quite reasonable to suppose that the animal existed in Tennessee up to as late a time as it did in Ohio and Illinois. The persistence of the cartilages of the sloth, and the framework of the window fly which lay below the sloth bones, naturally suggests a comparatively short time; but if, through the dryness of the cave, they could endure a thousand years, they might possibly endure several thousand. One must consider also the length of time required for 1.5 or 2 feet of cave floor to be built up from the excrements of bats, porcupines, and cave rats, but there is no reason to refer the time back further than about the close of the Wisconsin stage.

On another page (p. 127) is presented the little that is known about the remains of two mastodons which have been reported from the region about Nashville. One tooth was found 11 miles west of the city (fig. 23, *12*); a part of a skeleton at a point 11 miles southeast of it (fig. 23, *13*). A tooth of an undetermined species of elephant was found long ago near Columbia, Maury County (p. 395, fig. 23, *15*). According to Folio 95 of the U. S. Geological Survey, there are some narrow strips of alluvium along Duck River, at Columbia. The tooth may or may not have been found in this alluvium. Apparently in the neighborhood of Gallatin, Sumner County (fig. 23, *16*), was found before 1835, at a depth of 40 feet, a tooth of an elephant (p. 181). The information furnished by the tooth, as reported, is not worth much.

In June 1920, the writer received from Mr. William Edward Myer, of Nashville, a small box of fossils, collected near Nashville (fig. 23, *14*). The exact locality is given as being about 300 yards upstream from Lock A, in Cumberland River. According to a sketch sent by Mr. Myer and here reproduced (fig. 25), there are loose deposits about 30 feet in thickness lying upon bed-rock. This bed-rock is found at about the level of low-water in the river. On this rock there is found first a bed of gravel, which, to judge from Myer's sketch, is 2 or 3 feet in thickness. Above this comes a bed of sand of about the same thickness. The rest of the 30 feet is composed of gravel; and this rises to the level of the flood-plain. In the lowermost stratum, the bed of gravel, were found a tooth of *Equus leidyi* (p. 201), a part of a femur of a horse of large size (p. 201), and an antler of a small and probably unnamed deer (p. 234). This antler resembles those of some of the Central American species of *Odocoileus*. In the next stratum above were found some indeterminable fragments of turtle bones, a tooth of a young mastodon (p. 127), and a calcaneum of a large camel (p. 225), belonging probably to the genus *Camelops*. In October 1920, Mr. Myer

sent from the same locality a part of a molar of *Mylodon harlani* (p. 43). These remains appear to the writer to indicate that the deposits are of early Pleistocene age, about that of the first interglacial.

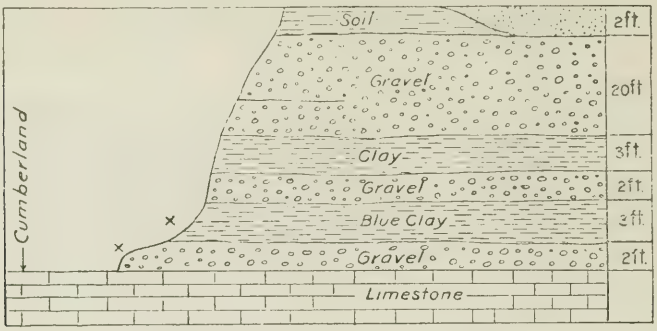


Fig. 25.—Section on Bank of Tennessee River at Nashville.

Somewhere about Memphis (fig. 23, *17*), were found, about the middle of the last century, some scanty remains of a young mastodon, a bone of *Megalonyx* (p. 43), and a part of a lower jaw of *Castoroides* (p. 280). Jeffries Wyman thought that these remains had been found in diluvium of the Mississippi River. It appears probable that they were found in the loess, which is well developed at that locality. Some exactness in reporting the locality would have led to the solution of this question.

KENTUCKY.

The State of Kentucky lies almost wholly south of the area of glaciation. Only along Ohio River, from about 50 miles above Cincinnati to about as many miles below, do any ice-laid drift materials appear, and these belong to the Illinoian glacial stage. For information on this drift the reader may consult Leverett's account (Monogr. U. S. Geol. Surv., vol. XLI, pp. 256–258, plate II). Near Carrolton, between Ohio and Kentucky Rivers, is a ridge of Illinoian drift which rises as much as 200 feet above low water. Later-formed terraces of these rivers are found up to 90 feet. Not far away from this locality drift materials are found on the highlands to a height of 300 feet above the Ohio. Below Rising Sun, Indiana, on the Kentucky side, are knolls of drift deposits rising about 150 feet above the river. This Illinoian drift occupies nearly the whole of Boone County; elsewhere it forms a narrow strip along the Ohio.

Naturally there were laid down, at various times during the Pleistocene, deposits beyond the glacial front. Rivers coming down from the glaciers brought into the Ohio valley enormous quantities of gravel, sands, and clay, much of which must have been deposited along the banks or at the bottom. Such materials may have been laid down there during all or some of the earlier glacial stages, some perhaps during interglacial times. Probably at later times the most of these early deposits were swept away, but some may have persisted. The rock floor of the Ohio (Leverett, op. cit., p. 83) is below the level of the present stream, generally between 30 and

60 feet, and, at some points in its lower course, 75 feet. There might, therefore, now exist Illinoian drift materials anywhere above this rocky floor, as well as high up on the bluffs. It may be difficult, sometimes impossible, to determine the actual age of such deposits. During the whole Pleistocene, the rivers which enter the Ohio from the south were bearers of fine and coarse materials from the higher lands where they took origin. Sometimes, and in some parts of their courses, they may have occupied channels other than those now holding the waters. During times of depression of the country the sediments were dropped along the channels until the latter may have been nearly filled. Then the country may later have become elevated, so that the streams again cut down and left some of the old deposits as terraces. In some parts of the State, as in the region of Mammoth Cave, water circulating in the limestone rocks has dissolved these so as to produce caverns and fissures of various sizes. In such caves, when they became opened to the surface, animals would seek hiding-places and would perhaps bring in others as their prey. Dying there, their bones might be preserved. From such a cave has been secured a fine specimen of the skull of a peccary (p. 223). Such caves should be examined with great care.

One of the most famous localities for fossil vertebrates in this country is that known as Bigbone Lick, in Boone County, about 22 miles in a straight line southwest of Cincinnati. Fossil bones were collected there as long ago as 1739. A condensed history of the explorations made there for fossils was given by William Cooper in 1831 (Monthly Amer. Jour. Geol., vol. I, pp. 158–174, 205–216). An account of the locality, its geology, and something about the fossil vertebrates and fresh-water mollusks found there was given by the geologist Charles Lyell in 1845 ("Travels in North America," Murray ed., vol. II, pp. 62–66).

Enormous quantities of bones and teeth, especially those of *Mammut americanum,* have been collected at this place. When it was first discovered, bones of this animal, of the elephants, and some others, must have been lying exposed on the surface, the result probably of erosion by the creek passing there through what was then a marsh. General William Henry Harrison, in 1795, shipped from there 13 hogsheads of bones, but these were lost on their way to Pittsburgh. Dr. Goforth is reported to have got as many mastodon teeth as a wagon and four horses could draw. These teeth are said to have weighed from 12 to 20 pounds each. If this statement of weights is true, some or all of the teeth were those of elephants. In 1807, General William Clark made a collection at Bigbone Lick, at the instances of President Thomas Jefferson. Brief notices of these were published by Dr. Samuel L. Mitchill and by Dr. Caspar Wistar. Some of these bones were sent to the American Philosophical Society at Philadelphia and were afterwards put into the collection of the Academy of Natural Sciences. Another part was sent to Paris. Remains of various species, mostly the mastodon, have gone into many museums of this country and of Europe; but it is evident that the greater part of the things collected there, and especially of the finest things, has been lost to science.

Notwithstanding the amount of work done at Bigbone Lick, the geology of the locality, and especially of the bone-bearing levels, is not well known.

Most persons who have labored there were interested almost wholly in getting as many bones as possible and then in getting away. Cooper, as cited, published a map of the region and indicated where the excavations had been made up to that time. This map is here presented, redrawn (map 41). From Cooper's account it appears that all of the bones had been found within a very circumscribed area, near a number of salt springs. The bones occurred on the surface and as deep as 25 feet. Cooper attributed this variation of depth to the unevenness of the surface, his idea being that the bone-bearing stratum occupied a certain level. He concluded that the valley had been filled up to a depth of not less than 30 feet by unconsolidated beds of various kinds, of which the uppermost was a light-yellow clay. This appeared to have been brought down from the higher grounds by flowing water. In it were found bones of buffaloes and other modern animals. Below this came a thinner layer of darker color, softer and more gravelly, which contained remains of reedy plants and fresh-water mollusks. It is described as being sometimes very thin or even wanting. It was in this layer that the bones, or most of them, were buried. It was itself underlain by a bed of blue clay of a very compact and tenacious kind. Cooper added that this bone-bearing layer appeared sometimes to be embedded in the blue clay.

The next important investigations made at this place, so far as the writer knows, are those instituted by Professor N. S. Shaler in 1868 (Geol. Surv. Kentucky, 2d ser., vol. III, 1877, pp. 196–198; Allen's "The American Bison," 1876, pp. 232–236). He reported that he had sent to the Museum of Comparative Zoology at Harvard at least a ton of bones. Immediately at the salt springs Shaler appears not to have been able to discover any order in the disposition of the bones. "It is only at points remote from the springs, where the beds seem to have been formed by a mixture of the creek mud and the waste from the springs, that we find the remains in the order which will enable us to form some opinion as to the succession of occurrence of these animals at this point." At one place he thought he had succeeded in finding a distinct order of succession. Just where this place was he did not indicate, nor what kinds of deposits were passed through. The depth reached appears to have been only 8 feet. Unfortunately, the great collection made by Shaler has remained unstudied, except the remains of the buffalo (J. A. Allen, "The American Bison," 1876, with plates).

Shaler thought that the beds of glacial drift did not extend south of Ohio River. The discovery that the Illinoian drift-sheet covers most of Boone County (Leverett, Monogr. U. S. Geol. Surv., vol. XLI, pp. 257–258) throws much light on the history of the locality. It appears rather strange that Shaler did not find rocks of far northern origin at Bigbone Lick. The geologic history appears to be something like this. When the Illinoian ice-sheet crossed the Ohio there was present the predecessor of Bigbone Creek. Inasmuch as the glacial sheet did not remain there long, a rather thin deposit was laid down in the creek. This is probably represented by the bed of blue mud mentioned by Cooper. When the glacier retired, the locality became a swamp covered probably by vegetation and receiving mud and gravel brought there by the stream and washed down from the

surrounding hills. Doubtless the salt springs existed then as now and attracted thither elephants, mastodons, and other species. What were all the changes undergone there between the Illinoian and Wisconsin drift stages can not be guessed; but during the latter time, when the Ohio was carrying down vast quantities of detritus, some from the glaciated regions, some from the non-glaciated, its muddy waters were often backed up into Bigbone Creek, as they are sometimes now, and they left there the upper yellow clay described by Cooper, or at least most of it. When the Wisconsin stage had passed and Bigbone Creek was free to work in that valley, erosion began. As the creek was cutting down its bed to the present level it doubtless often changed its position, and in this way produced the irregularity of surface which both Cooper and Shaler mention.

Notwithstanding its widely extended reputation, Bigbone Lick has furnished relatively few species of vertebrates, and there is question regarding the antiquity of some of these. About the presence of *Mammut americanum* there is no doubt. About the presence of elephants also there can be no question; and the writer is quite certain that both *Elephas primigenius* and *E. columbi* occurred there. Undoubtedly *Equus complicatus* has been collected there; also *Boötherium bombifrons, Symbos cavifrons, Bison antiquus,* and *B. bison;* but it is not certain that the remains of the last-named species are not of Recent times. Shaler mentions the presence of *Bison latifrons,* but he probably had in mind *B. antiquus.* The type of *B. latifrons* was found in another creek valley. The occurrence of the *Cervus canadensis, Odocoileus virginianus,* and *Alces americanus* is mentioned by Cooper, who stated that he thought he had seen traces of all of them. Shaler was doubtful as to the elk. In Allen's monograph on American bison, on page 234, Shaler admits the moose. The following is a list of the species which have been reported from Bigbone Lick. References are made to pages where further information is given on the species.

Megalonyx jeffersonii (p. 44).
Mylodon harlani (p. 44).
Equus complicatus (p. 202).
?Tapirus haysii (p. 209).
Odocoileus virginianus (p. 234).
Cervus canadensis (p. 243).
Cervalces scotti.
Alces americanus.
Rangifer caribou (p. 247).
Boötherium bombifrons (p. 255).
Symbos cavifrons (p. 255).
Bison antiquus (p. 265).
Bison bison (p. 270).
Mammut americanum (p. 128).
Elephas primigenius (p. 146).
Elephas columbi (p. 160).
Ursus americanus.

It is proper now to determine, if possible, during which of the Pleistocene stages each of these species lived. It is quite probable that none of the individual animals that have been dug up at Bigbone Lick lived there before the Illinoian glacial stage. To find such, if they have been preserved there, the excavations would have to be carried much deeper. The writer assumes that any of the animals that lived there in the interval between the Illinoian and the Wisconsin stages lived, died, and were buried during the Sangamon stage. *Megalonyx jeffersonii* may belong to the Sangamon or to the Late Wisconsin, for we know nothing about the depth at which the bones and teeth were secured. *Mylodon harlani* is not known to have existed anywhere after the Wisconsin, and hence we may refer it to

the Sangamon. *Equus complicatus* also may with certainty be referred to the Sangamon; likewise *Tapirus haysii,* in case the type was not found in South Carolina. As to the cervids *Odocoileus virginianus, Cervus canadensis, Alces americanus,* their status is doubtful. They might go back to the Sangamon or have lived there at any time up to and during the Recent. The reindeer is most likely to have existed there during the Wisconsin ice-stage. The fine specimen of *Cervalces scotti* at Princeton University was found in New Jersey in deposits overlying Wisconsin drift, but it may be taken as certain that the species had existed before the time of the Wisconsin. There is no record of depth, matrix, or associated fossils in the case of the type of this species, which was found at Bigbone Lick. It is natural to refer the two species of musk-oxen to the Wisconsin stage; but there are indications that at least *Symbos cavifrons* has been found at other localities in pre-Wisconsin deposits. Shaler recorded it as being found near the bottom of his excavation with the horse and with the bison which he called *Bison latifrons,* but which is *Bison antiquus.* It and *Symbos cavifrons* probably belong to the Sangamon.

From the fact that bones of the mastodon and the two species of elephants were found by Shaler in the deeper deposits, it is probable that the individuals represented belonged to the Sangamon or some other pre-Wisconsin deposit; but, inasmuch as all three species lived after the Wisconsin, there seems to be no known reason why some of their bones may not have been buried in the late and superficial deposits at Bigbone Lick. As to the bones of the bear found at this place little can be said.

The numerous remains of *Bison bison* appear by all accounts to have been found only in the uppermost parts of the deposits. Shaler was of the opinion that the buffalo (Allen's "The American Bison," p. 234) had come to the region east of Mississippi River at a very late period, after the disappearance from Bigbone Lick of the elephants, the mastodon, and *Symbos.* It seems to the present writer that the presence of the existing buffalo east of the Mississippi only after the passing of the Wisconsin ice-sheet is quite certain; but that it came only after the extinction of the great proboscideans is hardly to be sustained. In many localities over the country remains of all three species have been found in swamps overlying the Wisconsin drift. In 1890 (Amer. Naturalist, vol. xxiv, p. 953), Professor Lucien Underwood described a fine skull of the American buffalo which had been found in making a sewer at Syracuse, New York. Underwood stated that it had been found in black muck, at a depth of 10 feet; but Mr. John Cunningham, superintendent of grounds at the university, who saw the place and secured the skull from the laborer who encountered it, told the present writer that the depth was 17 feet. It would seem that that bison had lived on the shores of Onondaga Lake not long after the Wisconsin glacier had withdrawn from the place.

We do not know under what geological conditions the type of *Bison latifrons* was found; but it pretty certainly came from post-Illinoian deposits, probably Sangamon, along possibly Woolper's Creek in Boone County. Proboscidean remains have been reported from the Kentucky

side of the Ohio in the region of Cincinnati, but it would be hazardous at present to assign them a geological age. The same may be said about the mastodon remains found in digging the canal around the falls, although the low level along the river seems to indicate the Late Wisconsin.

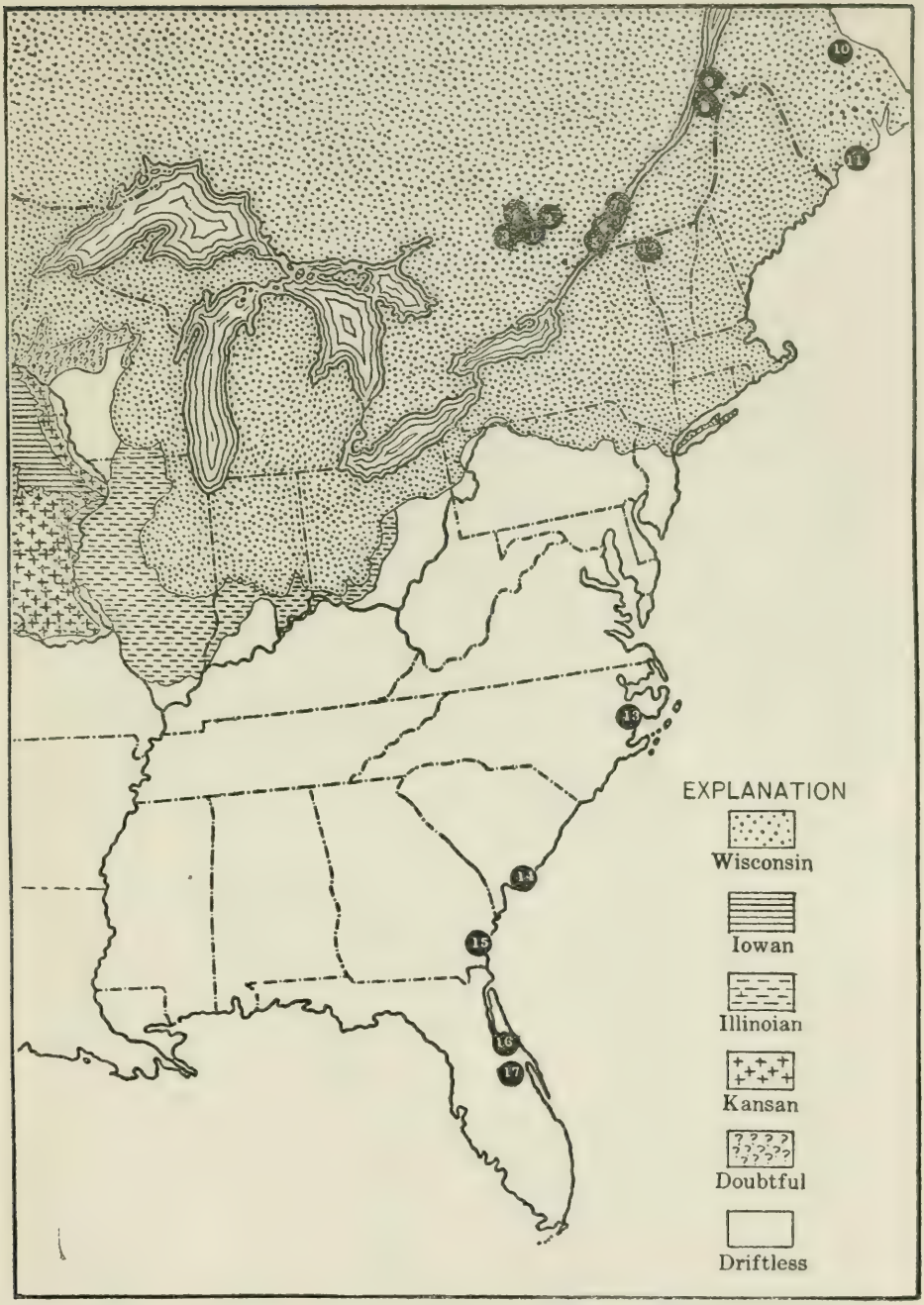
A collection, forming probably two farm-wagon loads, was made several years ago at Bluelick Springs, by Mr. Thomas W. Hunter. The springs having failed, Mr. Hunter undertook to dig down and restore the flow. In this he failed, but he did find great quantities of bones, mostly those of the mastodon, but also of elephants, buffaloes, and a few others (p. 129). There were about 100 mastodon teeth, many tusks, and large pieces of these; and of these pieces about 20 had been planed off so as to be flat on one or on two sides, as if they had lain in the bottom of a stream and the water and sand had worn them down on one side and then the tusks had been turned over and undergone a planing of the opposite side. Among the bones were two ungual phalanges of *Megalonyx jeffersonii* (p. 44), and remains of the elk (p. 243), and deer (p. 234). To none of the species found there need one assign a higher antiquity than late Pleistocene; but some might have been older. In Scott County, between Stamping Ground and Georgetown, there has been found, in the bottom of an old sink-hole, a part of a lower jaw with teeth of *Tapirus haysii* (p. 210). The time of existence of this animal is to be regarded as lying somewhere back of the Wisconsin glacial stage. With this jaw, Professor Arthur M. Miller sent to the writer some pieces of jaws of *Tapirus haysii* (p. 210) which had been found in an old stream-deposit at Yarnalltown, Fayette County. From a fissure filled with calcite, at Monday's Landing, Mercer County, there has been sent to the writer, by Professor Miller, a molar tooth of a horse (p. 202). Nothing more can be said of this horse than that it is older than the Wisconsin stage. It may be as old as the first interglacial.

About 5 or 6 miles below Henderson, on Ohio River, many years ago, considerable parts of the skeleton of *Megalonyx jeffersonii* were found (p. 44). With them were reported to have been discovered antlers and bones of the deer (p. 234). A description of the locality was sent to Joseph Leidy and published by him in his work on ground-sloths (Smiths. Contrib. Knowl., vol. VII, art. 5, p. 7). The bone-bed lay at an elevation of only 5 or 6 feet above an ordinary stage of low water. It was composed of a ferruginous sand and contained various species of fresh-water mollusks and stems and limbs of trees. This was underlain by a bluish clay, while above it, rising 40 or 50 feet, were beds of siliceous earth and widely spread marls. Neither the geology of the place, so far as the writer knows, nor the history of the animal requires us to believe that the geological age is beyond that of the Late Wisconsin or Wisconsin. However, a short time before, near Evansville, Indiana, at the mouth of Pigeon Creek, and apparently only about 10 miles away from where Owen found megalonyx bones, there had been discovered by Frances A. Lincke, and described by Leidy (Proc. Acad. Nat. Sci., Phila., vol. VII, 1854, pp.

199–200), a collection of vertebrate fossils. This included remains of megalonyx (p. 32), a cervical vertebra of a bison (p. 257), a vertebra of a horse (p. 186), a tooth of *Tapirus haysii* (p. 203), and a part of the upper jaw of the wolf known as *Ænocyon dirus* (p. 204). The horse was most probably *Equus complicatus,* while the bison was probably one of the extinct species. The wolf is regarded as being the same as that so abundantly found in the collections made at Rancho La Brea, near Los Angeles. The writer regards the fauna as belonging to the Sangamon, unless it is still older. The specimens were found sticking out of the river at low water, and it becomes quite probable that the Henderson beds and bones are of the same age as those at Evansville.

As mentioned on another page (p. 223) it is probable that the fine skull of *Platygonus compressus* that was sent many years ago to the Academy of Natural Sciences of Philadelphia by Dr. Samuel Brown, of Lexington, Kentucky, and described by Leidy (Trans. Amer. Philos. Soc., vol. x, p. 331, plates xxxv–xxxvii) had been found somewhere in Rock Castle County. It counts as another product of the caves which abound in the Alleghany range of mountains.

MAP 1.



Distribution of Pleistocene cetaceans in eastern North America. For explanation see page 408.

Explanation of Map 1.

Ontario:
1. Nepean Township, Carleton Co., Delphinapterus leucas (p. 17).
2. Ottawa East, Carleton Co., Delphinapterus leucas (p. 17).
3. Smith's Falls, Lanark Co., Megaptera boöps (p. 17).
4. Pakenham, Lanark Co., Delphinapterus leucas (p. 17).
5. Cornwall, Stormont Co., Delphinapterus leucas (p. 18).
6. Williamstown, Glengary Co., Delphinapterus vermontanus? (p. 18).
7. Quebec, Montreal, Delphinapterus leucas (p. 18).
8. Rivière du Loup, Temiscouata Co., Delphinapterus leucas (p. 18).
9. Metis, Rimouski Co., Megaptera boöps? (p. 19).
10. Jaquet River, Restigouche Co., Monodon monoceros (p. 19).
11. Mace's Bay, Charlotte Co., Delphinapterus? sp.? (p. 19).

Vermont:
12. Charlotte, Chittenden Co., Delphinapterus vermontanus (p. 19).

North Carolina:
13. Below Newbern, Craven Co., "cetaceans" (p. 20).

South Carolina:
14. Charleston, Charleston Co., Physeter vetus (p. 20).

Georgia:
15. Brunswick, Glynn Co., Physeter vetus? (p. 20).

Florida:
16. Daytona, Volusia Co., Balænoptera? sp.? (p. 20).
17. De Land, Volusia Co., Globicephala bæreckeii (p. 20).

Explanation of Map 2.

Grinnell Land, Dumbbell Harbor (locality not on the map). Phoca barbata P. hispida (p. 21).

Nova Scotia:
1. Sable Island, Odobenus rosmarus (p. 21).

New Brunswick:
2. Fairville, Charlotte Co., Phoca grœnlandica (p. 21).

Quebec:
3. Bic, Rimouski Co., Odobenus rosmarus (p. 21).
4. Montreal, Phoca grœnlandica (p. 22).
5. Tétreauville, Ottawa Co., Phoca vitulina (p. 22).

Ontario:
6. Ottawa, Phoca? sp.? (p. 23).

Maine:
7. Addison Point, Washington Co., Odobenus rosmarus (p. 23).
8. Andrews Island, Knox Co., O. rosmarus (p. 23).
9. Gardiner, Kennebec Co., O. rosmarus (p. 23).
10. Portland, Cumberland Co., O. rosmarus (p. 24).

New Hampshire:
11. Jeffries Reef, off Portsmouth, O. rosmarus (p. 25).

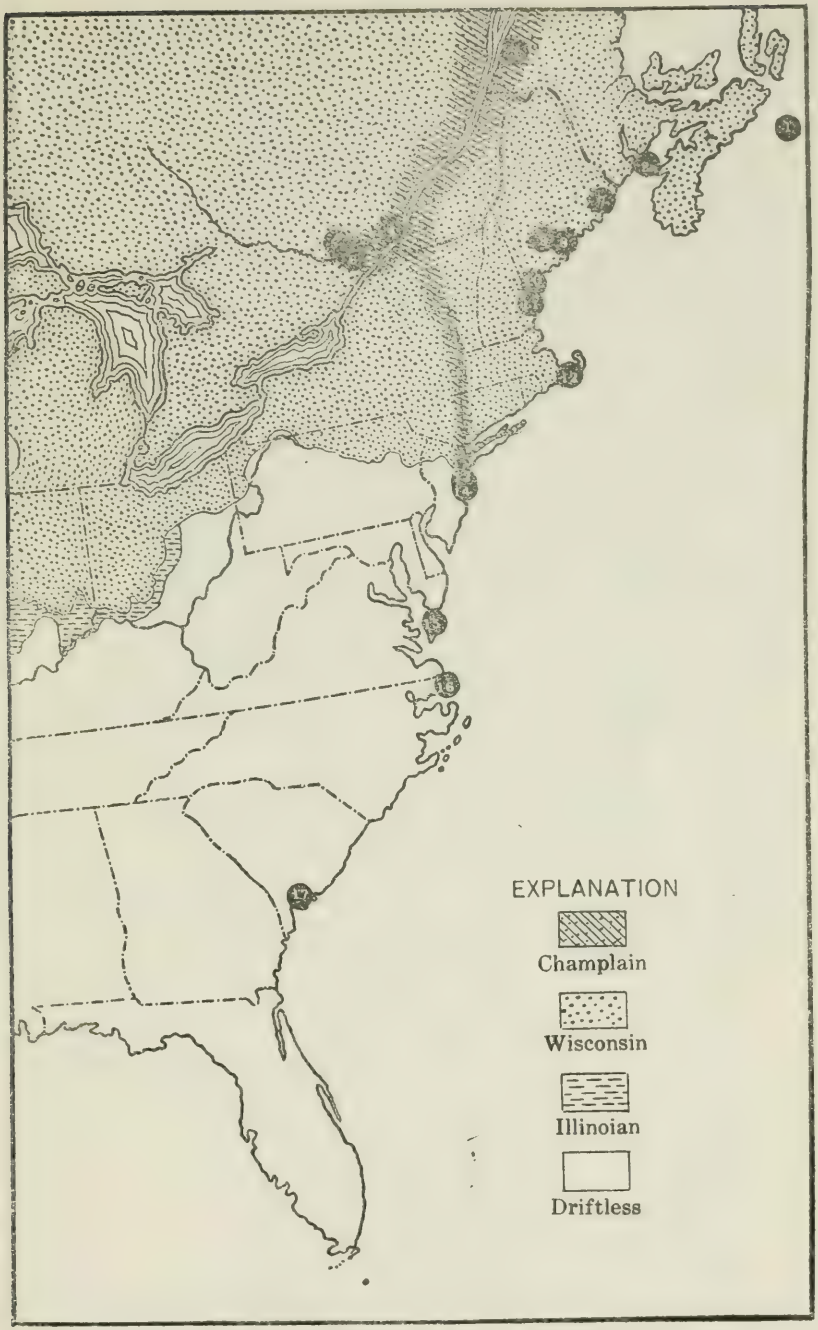
Massachusetts:
12. Gay Head, Martha's Vineyard, O. rosmarus (p. 25).

New Jersey:
13. Long Branch, Monmouth Co., O. rosmarus (p. 26).
14. Ocean Grove, Monmouth Co., O. rosmarus (p. 28).

Virginia:
15. Accomac Co., O. rosmarus (p. 28).
16. Kitty Hawk, Currituck Co., O. rosmarus (p. 29).

South Carolina:
17. Charleston Co., O. rosmarus (p. 29).

MAP 2.



Distribution of Pleistocene *Pinnipedia* in eastern North America.
For explanation see page 408.

EXPLANATION OF MAP 3.

NEW JERSEY:
1. Long Branch, Monmouth Co., Megatherium mirabile (p. 31).

PENNSYLVANIA:
1. Port Kennedy, Montgomery Co., Megalonyx wheatleyi, M. loxodon, M. tortulus, M. scalper, Mylodon harlani (p. 31).
2. Frankstown, Blair Co., Megalonyx sp. indet. (p. 31).

OHIO:
1. North Fairfield, Huron Co., Megalonyx jeffersonii (p. 31).
2. Millersburg, Holmes Co., Megalonyx jeffersonii (p. 32).

INDIANA:
1. Evansville, Vanderburg Co., Megalonyx jeffersonii (p. 32).

ILLINOIS:
1. Urbana, Champaign Co., Megalonyx jeffersonii (p. 33).
2. Alton, Madison Co., Megalonyx jeffersonii (p. 33).
3. Galena, Jo Daviess Co., Megalonyx jeffersonii (p. 34).

VIRGINIA:
1. Saltville, Smyth Co., Megalonyx dissimilis? (p. 34).
2. Ivanhoe, Wythe Co., Megalonyx sp. indet. (p. 34).

WEST VIRGINIA:
1. —— Greenbrier Co., Megalonyx jeffersonii (p. 34).

SOUTH CAROLINA:
1. Beaufort, Beaufort Co., Megalonyx jeffersonii (p. 35).
2. Charleston, Charleston Co., Megatherium mirabile, Mylodon harlani (p. 35).

GEORGIA:
1. Brunswick, Glynn Co., Megatherium mirabile (p. 36).
2. Skidaway Island, Chatham Co., Megatherium mirabile, Mylodon harlani (p. 36).

FLORIDA (See Map 4).

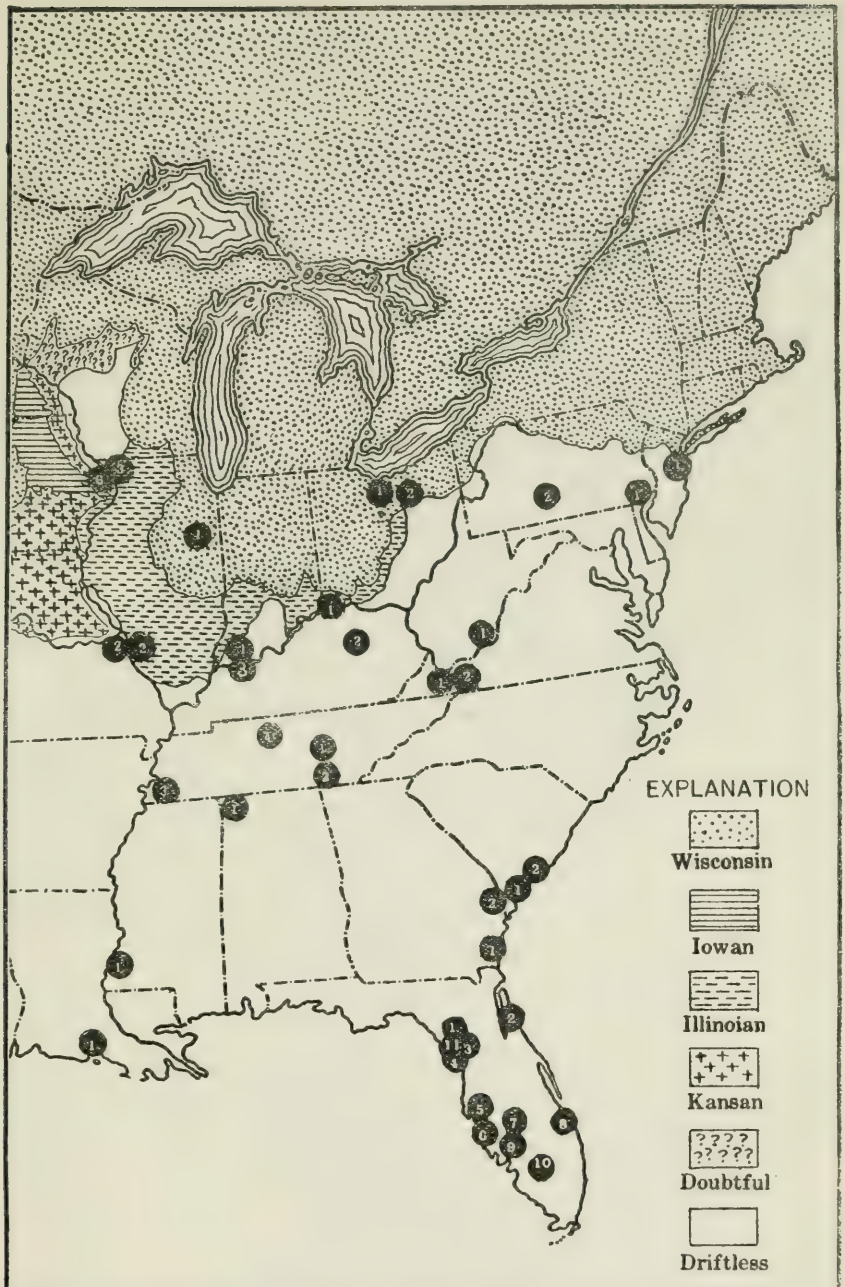
ALABAMA:
1. Tuscumbia, Colbert Co., Megalonyx sp. indet. (p. 40).

MISSISSIPPI:
1. Natchez, Adams Co., Megalonyx jeffersonii, M. dissimilis, Mylodon harlani, Ereptodon priscus (p. 40).

TENNESSEE:
1. Elroy, Van Buren Co., Megalonyx jeffersonii (p. 41).
2. Lookout Mountain, Hamilton Co., Mylodon? sp. indet. (p. 43).
3. Memphis, Shelby Co., Megalonyx jeffersonii (p. 43).
4. Nashville, Davidson Co., Mylodon harlani (p. 43).

KENTUCKY:
1. Bigbone Lick, Boone Co., Mylodon harlani, Megalonyx jeffersonii (p. 43).
2. Bluelick Springs, Nicholas Co., Megalonyx jeffersonii (p. 44).
3. Henderson, Henderson Co., Megalonyx jeffersonii (p. 44).

MAP 3.



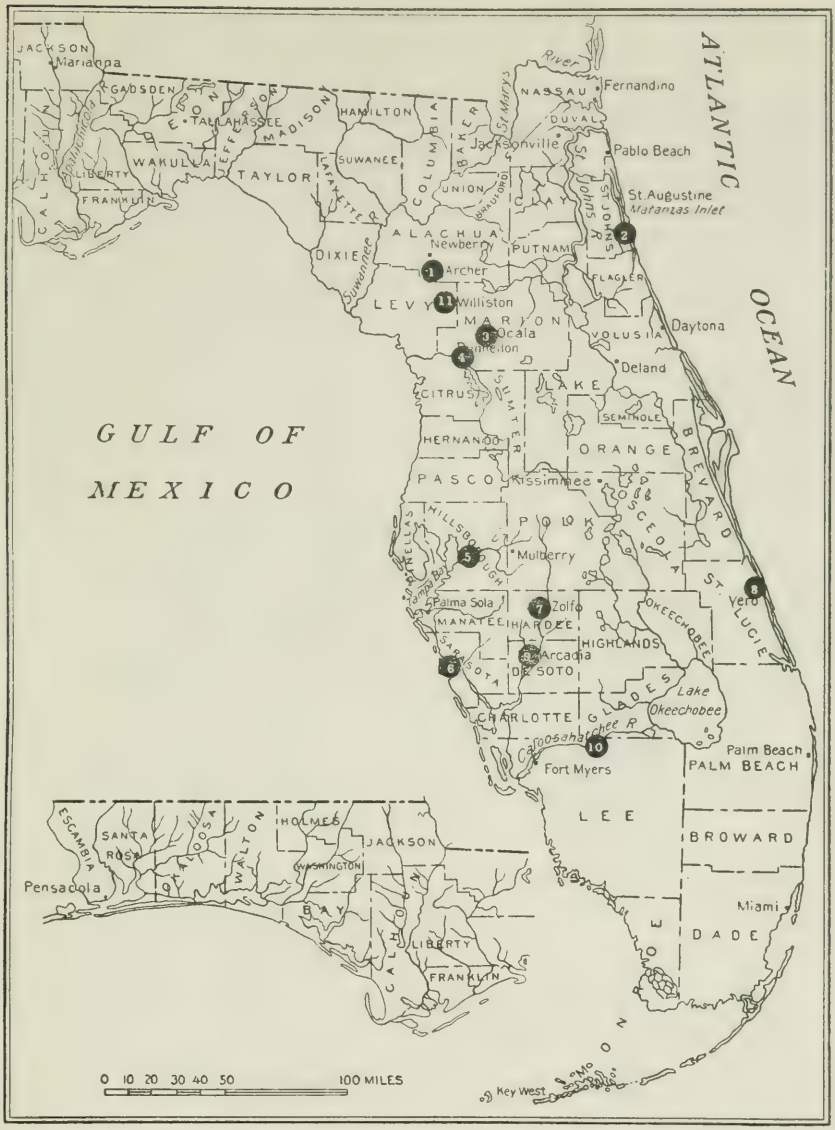
Distribution of Pleistocene *Xenarthra* in eastern North America. For explanation see page 410.

Explanation of Map 4.

Florida:

1. Archer, Alachua Co., Megatherium mirabile (p. 37).
2. Almero Farm, St. John Co., Mylodon harlani (p. 37).
3. Ocala, Marion Co., Dasypus sp. indet. (p. 38).
4. Dunnellon, Marion Co., Chlamytherium septentrionale, Megalonyx sp. indet. (p. 38).
5. Hillsboro River, Hillsboro Co., Chlamytherium septentrionale (p. 38).
6. Sarasota Bay, Sarasota Co., Chlamytherium septentrionale (p. 38).
7. Zolfo, Hardee Co., Megatherium mirabile (p. 38).
8. Vero, St. Lucie Co., Megalonyx jeffersonii, Mylodon harlani?, Chlamytherium septentrionale, Dasypus sp. indet. (p. 38).
9. Arcadia, De Soto Co., Megalonyx jeffersonii, Glyptodon rivipacis, Chlamytherium septentrionale (p. 39).
10. Labelle, Lee Co., Mylodon harlani (p. 40).
11. Williston Levy Co., Thinobadistes segnis (p. 37).

MAP 4.



Finds of Pleistocene *Xenarthra* in Florida. For explanation see page 412.

Explanation of Map 5.

Unless another name is used after the localities, Mammut americanum is to be understood.

Ontario:
1. —— Essex Co. (p. 45).
2. Morpeth and Highgate, Elgin Co. (p. 45).
3. St. Thomas, Elgin Co., M. progenium? (p. 45).
4. London, Middlesex Co. (p. 45).
5. Marburg, Norfolk Co. (p. 45).
6. Dunnville, Haldimand Co. (p. 46).
7. St. Catharines and Welland Port, Lincoln Co. (p. 46).
8. Toronto, York Co. (p. 46).
9. Junction of Missinaibi and Moose Rivers, Algoma Co. (p. 46).

Massachusetts:
1. Coleraine, Franklin Co. (p. 47).
2. Shrewsbury, Worcester Co. (p. 47).

Connecticut:
1. Cheshire, New Haven Co. (p. 47).
2. New Britain, Hartford Co. (p. 48).
3. Farmington, Hartford Co. (p. 48).
4. Bristol, Hartford Co. (p. 48).
5. Sharon, Litchfield Co. (p.48).

New York (See Maps 6 and 34).

New Jersey (See Map 6 A).

Pennsylvania:
1. Tunkhannock, Wyoming Co. (p. 68).
2. Pittston, Luzerne Co. (p. 68).
3. Berwick, Columbia Co. (p. 69).
4. Reading, Berks Co. (p. 69).
5. Port Kennedy, Montgomery Co. (p. 69).
6. Jackson Township, York Co. (p. 69).
7. Kishacoquillas Station, Mifflin Co. (p. 69).
8. Chambersburg, Franklin Co. (p. 69).
9. Frankstown, Blair Co. (p. 69).
10. Bedford, Bedford Co. (p. 69).
11. Pittsburgh, Allegheny Co. (p. 69).
12. Hickory, Washington Co. (p. 70).
13. Erie, Erie Co. (p. 70).

Ohio (See Map 7).

Michigan (See Map 8).

Indiana (See Map 9).

Illinois (See also Map 38):
1. Shawneetown, Gallatin Co. (p. 100).
2. Chester, Randolph Co. (p. 101).
3. Beaucoup, Washington Co. (p. 101).
4. East St. Louis, St. Clair Co. (p. 101).
5. Alton, Madison Co. (p. 102).
6. Sandoval, Marion Co. (p. 102).
7. Niantic, Macon Co. (p. 102).
8. Warsaw, Hancock Co. (p. 103).
9. Manito, Mason Co. (p. 103).
10. —— Knox Co. (p. 104).
11. Cambridge, Henry Co. (p. 104).
12. Rural Township, Rock Island Co. (p. 104).
13. Sterling, Whiteside Co. (p. 105).
14. New Milford, Winnebago Co. (p. 105).
15. Byron and Harper, Ogle Co. (p. 105).
16. Urbana and Pesotum, Champaign Co. (p. 106).
17. —— Edgar Co. (p. 106).
18. Fairmont, Vermillion Co. (p. 106).

Illinois—*continued:*
19. —— Iroquois Co., 6 miles northwest of Hoopeston, M. progenium (p. 106).
East Lynn and Rossville, Vermillion Co. (p. 107).
20. Beecher, Will Co. (p. 107).
21. Morris, Grundy Co. (p. 108).
22. Whitewillow, Kendall Co. (p. 109).
23. Yorkville, Kendall Co. (p. 109).
24. Aurora, Kane Co. (p. 109).
25. Batavia and Maple, Kane Co. (p. 110).
26. Glencoe, Cook Co. (p. 110).
27. Walnut, Bureau Co. (p. 105).

Wisconsin:
1. Dover, Racine Co. (p. 110).
2. Waukesha, Waukesha Co. (p. 110).
3. Madison, Dane Co. (p. 111).
4. Bluemounds, Dane Co. (p. 111).
5. Lone Rock, Richland Co. (p. 111).
6. Sinsinnawa, Grant Co. (p. 111).
7. Wauseka, Crawford Co. (p. 111).
8. Richland Center, Richland Co. (p. 111).
9. Menomonie, Dunn Co. (p. 111).

Maryland:
1. St. Marys City, St Marys Co. (p. 112).
2. St. Clements, St. Marys Co. (p. 112).
3. Towson, Baltimore Co. (p. 112).
4. Lane's Creek and Clear Spring, Washington Co. (pp. 112, 113).

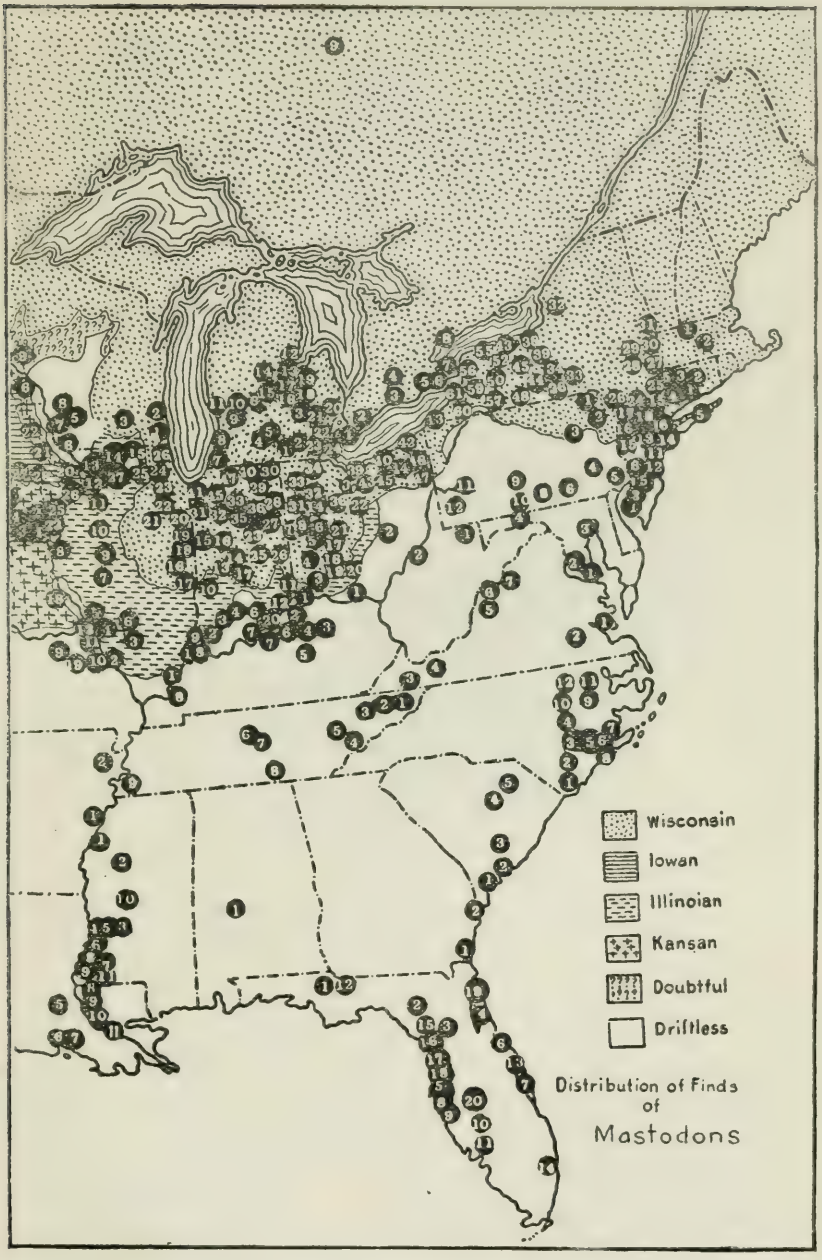
Virginia:
1. 6 miles east of Williamsburg, York Co. (p. 113).
2. City Point, Prince George Co. (p. 113).
3. Abingdon, Washington Co. (p. 113).
4. Saltville, Smyth Co. (p. 113).
5. Covington, Alleghany Co. (p. 114).
6. Hot Springs, Bath Co. (p. 114).
7. Edom, Rockingham Co. (p. 114).

West Virginia:
1. Stewartstown, Monongalia Co. (p. 115).
2. Parkersburg, Wood Co. (p. 115).

North Carolina (See also Map 39):
1. —— New Hanover Co. (p. 115).
2. —— Pender Co. (p. 115).
3. —— Duplin Co. (p. 115).
4. Goldsboro, Wayne Co., M. progenium (p. 115).
5. Jacksonville, Onslow Co. (p. 116).
6. Maysville, Jones Co. (p. 116).
7. —— Pamlico Co., 16 miles below Newbern (p. 116).
8. Harlowe, Carteret Co. (p. 117).
9. —— Pitt Co. (p. 117).
10. —— Wilson Co. (p. 117).
11. Tarboro, Edgecomb Co. (p. 117).
12. Rocky Mount, Nash Co. (p. 117).

South Carolina:
1. Beaufort, Beaufort Co. (p. 118).
2. Ashley River, Charleston Co. (p. 118).
3. Head of Cooper River, Berkeley Co. (p. 119).
4. —— Lee Co. (p. 119).
5. Darlington, Darlington Co. (p. 119).

MAP 5.



Distribution of Pleistocene mastodons in eastern North America. For explanation see pages 414, 416.

EXPLANATION OF MAP 5—*continued.*

Georgia:
1. Brunswick, Glynn Co. (p. 120).
2. Skidaway Island, Chatham Co. (p. 120).

Florida (See Map 10).

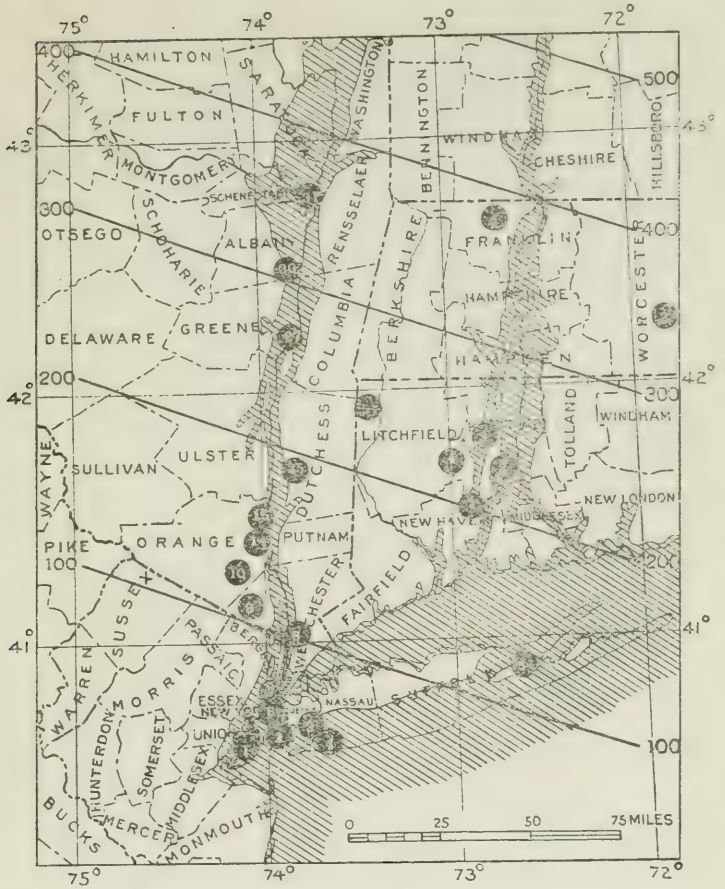
Alabama:
1. Bogue Chitto, Dallas Co. (p. 124).

Mississippi:
1. Perthshire, Bolivar Co. (p. 124).
2. Caseilla, Tallahatchie Co. (p. 124).
3. Jackson, Hinds Co. (p. 124).
4. Vicksburg, Warren Co. (p. 124).
5. Bovina?, Warren Co. (p. 125).
6. —— Claiborne Co. (p. 125).
7. —— Jefferson Co. (p. 125).
8. Natchez, Adams Co. (p. 125).
9. Pinckneyville, Wilkinson Co. (p. 126).
10. Between Zeiglerville and Pearce, Yazoo Co., M. progenium (p. 126).
11. Woodville, Wilkinson Co. (p. 126).

Tennessee (See also figure 23, p. 395):
1. Kingsport, Sullivan Co. (p. 127).
2. St. Clair, Hawkins Co. (p. 127).
3. Mossy Creek, Jefferson Co. (p. 127).
4. Dandridge, Jefferson Co. (p. 127).
5. Neuberts Springs, Knox Co. (p. 127).
6. 11 miles west of Nashville, Davidson Co. (p. 127).
7. 11 miles southeast of Nashville, Davidson Co. (p. 127).
8. Fayetteville, Lincoln Co. (p. 128).
9. Memphis, Shelby Co. (p. 128).

Kentucky:
1. Ludlow, Kenton Co. (p. 128).
2. Bigbone Lick, Boone Co. (p. 128).
3. Bluelick Springs, Nicholas Co. (p. 128).
4. Harrisonville, Harrison Co. (p. 129).
5. —— Fayette Co. (p. 129).
6. Drennon Springs, Henry Co. (p. 129).
7. Louisville, Jefferson Co. (p. 129).
8. Smithland?, Livingston Co. (p. 129).

MAP 6.



Eastern New York, western Massachusetts and Connecticut. Relation of mastodon localities to sea-level areas near end of Wisconsin stage.

EXPLANATION OF MAP 6.

Massachusetts:

1. Coleraine, Franklin Co. (p. 47).
2. Shrewsbury, Worcester Co. (p. 47).

Connecticut:

1. Cheshire, New Haven Co. (p. 47).
2. New Britain, Hartford Co. (p. 48).
3. Farmington, Hartford Co. (p. 48).
4. Bristol, Hartford Co. (p. 48).
5. Sharon, Litchfield Co. (p. 48).

New York:

1. New Dorp, Richmond Co. (p. 48).
2. Ridgewood, Kings Co. (p. 49).
3. Jamaica, Queens Co. (p. 49).
4. Inwood, Nassau Co. (p. 49).

New York—*continued:*

5. Riverhead, Suffolk Co. (p. 49).
6. Morrisania, New York Co. (p. 49).
7. New York City (p. 50).
8. Hartsdale, Westchester Co. (p. 50).
9. New Antrim, Rockland Co. (p. 50).
10. Arden, Orange Co. (p. 50).
14. New Windsor, Orange Co. (p. 51).
15. Newburgh, Orange Co. (p. 51).
25. Poughkeepsie, Dutchess Co. (p. 55).
27. Claverack, Columbia Co. (p. 55).
30. Coeymans, Albany Co. (p. 56).
31. Cohoes, Albany Co. (p. 56).

Explanation of Map 6 A.

New Jersey:

1. Mannington Township, Salem Co. (p. 63).
2. Harrisonville, Gloucester Co. (p. 63).
3. Mullica Hill, Gloucester Co. (p. 64).
4. Woodbury, Gloucester Co. (p. 64).
5. Pemberton, Burlington Co. (p. 64).
6. Trenton, Mercer Co. (p. 64).
7. Freehold, Monmouth Co. (p. 65).
8. Englishtown, Monmouth Co. (p. 65).
9. Marlboro, Monmouth Co. (p. 65).
10. Long Branch, Monmouth Co. (p. 65).
11. Navesink Hills, Monmouth Co. (p. 66).
12. Manasquan Inlet, Monmouth Co. (p. 66).
13. Verona, Essex Co. (p. 66).
14. Rockport, Warren Co. (p. 67).
15. Hackettstown, Warren Co. (p. 67).
16. Hope, Warren Co. (p. 68).
17. Greendell, Sussex Co. (p. 68).

MAP 6 A

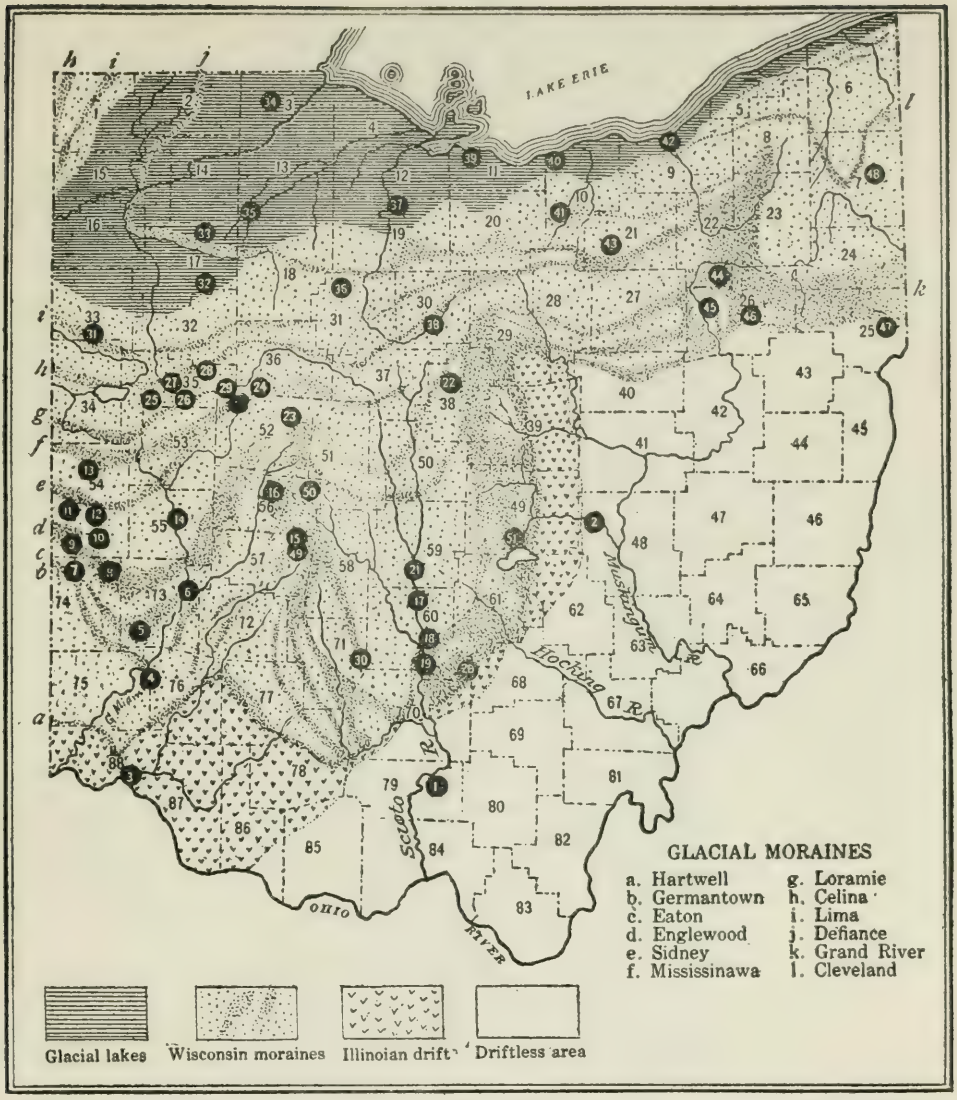
Distribution of mastodon localities in New Jersey. For explanation see page 418.

EXPLANATION OF MAP 7.

Ohio:

1. —— Pike Co. (p. 70).
2. Nashport, Muskingum Co. (p. 70).
3. Cincinnati, Hamilton Co. (p. 71).
4. Amanda, Butler Co. (p. 71).
5. Germantown, Montgomery Co. (p. 71).
6. Dayton, Montgomery Co. (p. 72).
7. New Paris, Preble Co. (p. 72).
8. West Sonora, Preble Co. (p. 73).
9. New Madison, Darke Co. (p. 73).
10. Fort Jefferson, Darke Co. (p. 73).
11. 6 miles west of Greenville, Darke Co. (p. 73).
12. Greenville, Darke Co. (p. 73).
13. Ansonia, Darke Co. (p. 74).
14. Troy, Miami Co. (p. 74).
15. Catawba, Clark Co. (p. 74).
16. Urbana, Champaign Co. (p. 74).
17. South Bloomfield, Pickaway Co. (p. 75).
18. Circleville, Pickaway Co. (p. 75).
19. Pickaway Plains, Pickaway Co. (p. 75).
20. Salt Creek Township, Pickaway Co. (p. 75).
21. Shadeville, Franklin Co. (p. 75).
22. Mount Gilead, Morrow Co. (p. 75).
23. Harper, Logan Co. (p. 76).
24. Roundhead, Hardin Co. (p. 76).
25. Washington Township, Auglaize Co. (p. 76).
26. Pusheta Township, Auglaize Co. (p. 76).
27. Wapakoneta, Auglaize Co. (p. 76).
28. Duchouquet Township, Auglaize Co. (p. 76).
29. St. Johns, Auglaize Co. (p. 76).
30. —— Fayette Co. (p. 75).
31. Ohio City, Van Wert Co. (p. 77).
32. Columbus Grove, Putnam Co. (p. 77).
33. Liberty Township, Putnam Co. (p. 77).
34. Springfield Township, Lucas Co. (p. 77).
35. Jackson Township, Wood Co. (p. 78).
36. Carey, Wyandot Co. (p. 78).
37. Old Fort, Seneca Co. (p. 78).
38. Bucyrus, Crawford Co. (p. 78).
39. Sandusky, Erie Co. (p. 78).
40. Brownhelm Township, Lorain Co. (p. 79).
41. Pittsfield Township, Lorain Co. (p. 79).
42. Cleveland, Cuyahoga Co. (p. 79).
43. —— Medina Co. (p. 79).
44. Green Township, Summit Co. (p. 80).
45. Massillon, Stark Co. (p. 80).
46. Canton, Stark Co. (p. 80).
47. Lisbon, Columbiana Co. (p. 70).
48. —— Trumbull Co. (p. 80).
49. Brighton, Clark Co. (p. 74).
50. Woodstock, Champaign Co. (p. 74).
51. Granville, Licking Co. (p. 75).

Map 7.

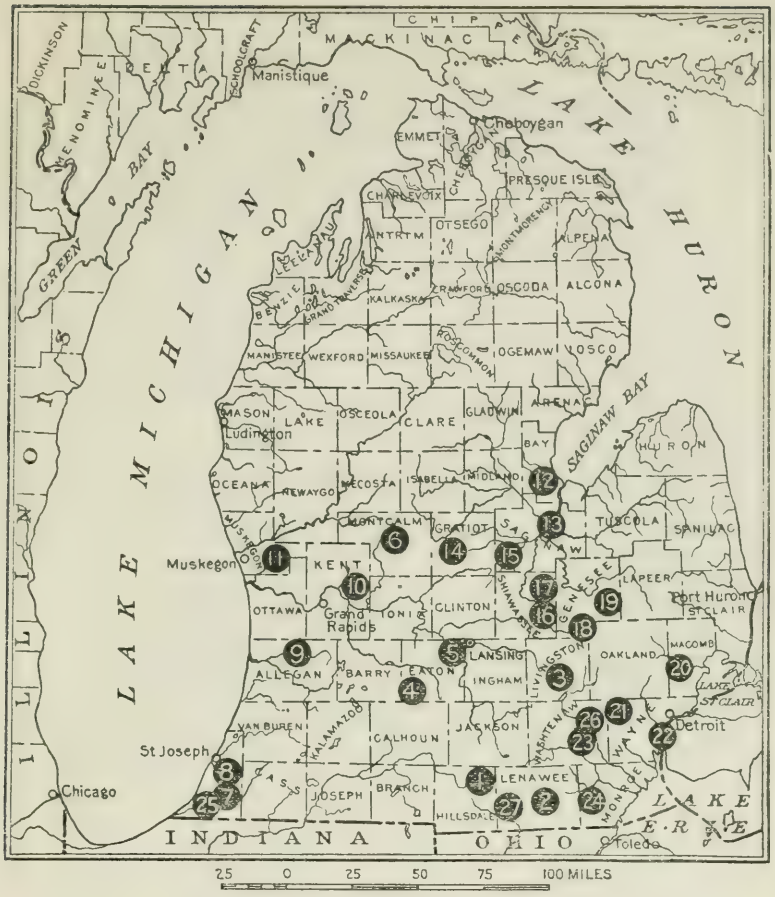


Distribution of Pleistocene mastodons in Ohio. For explanation see pages 420 and 422.

KEY TO NAMES OF COUNTIES IN OHIO.

1. Williams
2. Fulton
3. Lucas
4. Ottawa
5. Lake
6. Ashtabula
7. Trumbull
8. Geauga
9. Cuyahoga
10. Lorain
11. Erie
12. Sandusky
13. Wood
14. Henry
15. Defiance
16. Paulding
17. Putnam
18. Hancock
19. Seneca
20. Huron
21. Medina
22. Summit
23. Portage
24. Mahoning
25. Columbiana
26. Stark
27. Wayne
28. Ashland
29. Richland
30. Crawford
31. Wyandot
32. Allen
33. Van Wert
34. Mercer
35. Auglaize
36. Hardin
37. Marion
38. Morrow
39. Knox
40. Holmes
41. Coshocton
42. Tuscarawas
43. Carroll
44. Harrison
45. Jefferson
46. Belmont
47. Guernsey
48. Muskingum
49. Licking
50. Delaware
51. Union
52. Logan
53. Shelby
54. Darke
55. Miami
56. Champaign
57. Clark
58. Madison
59. Franklin
60. Pickaway
61. Fairfield
62. Perry
63. Morgan
64. Noble
65. Monroe
66. Washington
67. Athens
68. Hocking
69. Vinton
70. Ross
71. Fayette
72. Green
73. Montgomery
74. Preble
75. Butler
76. Warren
77. Clinton
78. Highland
79. Pike
80. Jackson
81. Meigs
82. Gallia
83. Lawrence
84. Scioto
85. Adams
86. Brown
87. Clermont
88. Hamilton

MAP 8.



Finds of Pleistocene mastodons in Michigan.

EXPLANATION OF MAP 8.

Michigan:

1. Church, Hillsdale Co. (p. 80).
2. Adrian, Lenawee Co. (p. 80).
3. Howell, Livingston Co. (p. 81).
4. Bellevue, Eaton Co. (p. 81).
5. Olivet, Eaton Co. (p. 82).
6. Stanton, Montcalm Co. (p. 82).
7. Buchanan, Berrien Co. (p. 82).
8. Eau Claire, Berrien Co. (p. 82).
9. Dorr, Allegan Co. (p. 83).
10. Cannonsburg, Kent Co. (p. 83).
11. Moorland, Muskegon Co. (p. 83).
12. Williams Township, Bay Co. (p. 84).
13. Near Saginaw, Saginaw Co. (p. 84).
14. Alma, Gratiot Co. (p. 85).

Michigan—*continued:*

15. —— Saginaw Co. (p. 84).
16. Bancroft, Shiawassee Co. (p. 86).
17. Venice, Shiawassee Co. (p. 86).
18. Fenton, Genesee Co. (p. 86).
19. Davison, Genesee Co. (p. 86).
20. Utica, Macomb Co. (p. 86).
21. Plymouth, Wayne Co. (p. 87).
22. Wyandotte, Wayne Co. (p. 87).
23. Saline, Washtenaw Co. (p. 88).
24. Petersburg, Monroe Co. (p. 87).
25. Galien, Berrien Co. (p. 83).
26. 7 miles southwest of Ypsalanti (p. 88).
27. Clayton, Lenawee Co. (p. 81).

Explanation of Map 9.

The names of the glacial moraines are given on Map 37.

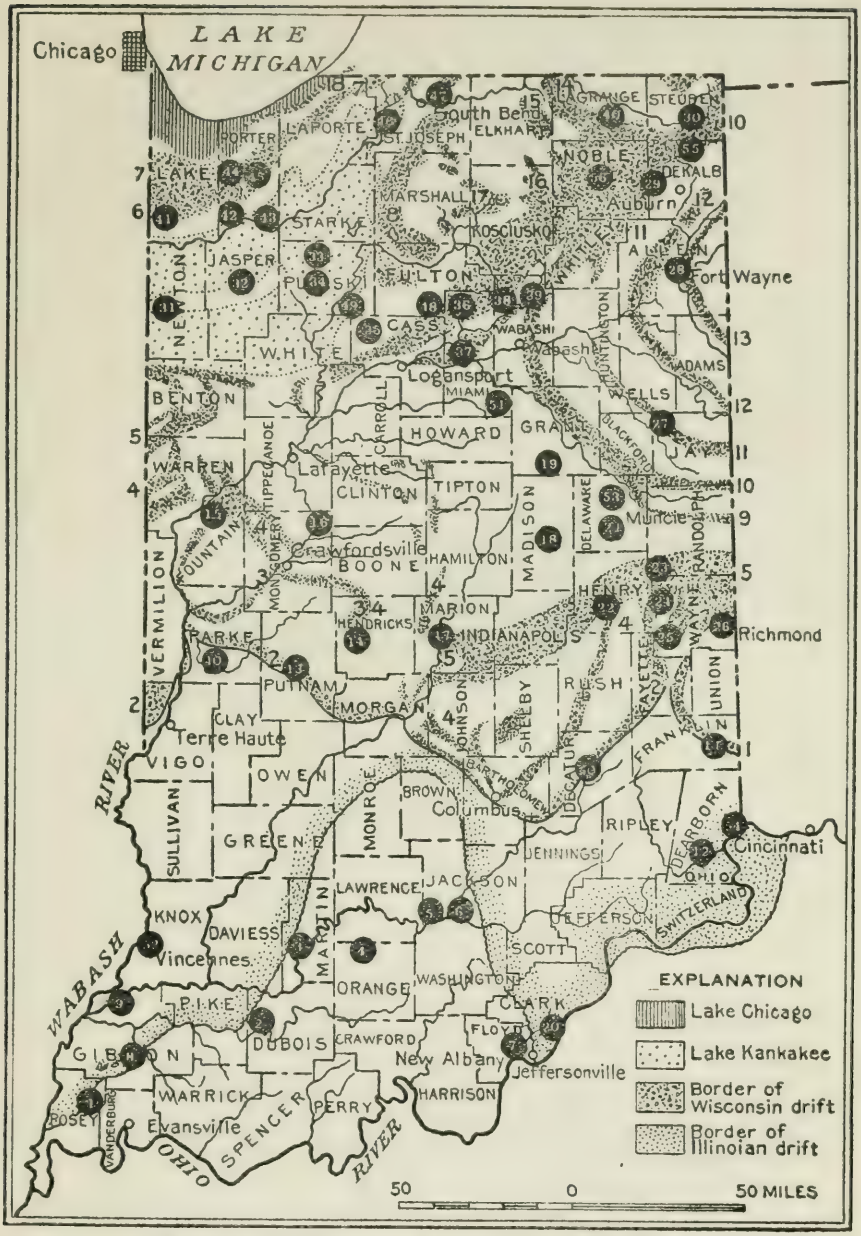
Indiana:

1. —— Posey Co. (p. 88).
2. —— Dubois Co. (p. 88).
3. Hindostan, Martin Co. (p. 89).
4. West of Orleans, Orange Co. (p. 89).
5. Sparksville, Jackson Co. (p. 89).
6. West of Tampico, Jackson Co. (p. 89).
7. New Albany, Floyd Co. (p. 89).
8. Princeton, Gibson Co. (p. 89).
9. —— Knox or Gibson Co. (p. 90).
10. —— Parke Co. (p. 90).
11. Brookville, Franklin Co. (p. 90).
12. —— Dearborn Co. (p. 91).
13. Greencastle, Putnam Co. (p. 91).
14. Danville, Hendricks Co. (p. 92).
15. Attica, Fountain Co. (p. 92).
16. Bowers, Montgomery Co. (p. 92).
17. Indianapolis, Marion Co. (p. 92).
18. Anderson, Madison Co. (p. 93).
19. Fairmount Township, Grant Co. (p. 93).
20. Charleston, Clarke Co. (p. 91).
21. Muncie, Delaware Co. (p. 93).
22. —— Henry Co. (p. 94).
23. Losantville, Randolph Co. (p. 94).
24. Dalton, Wayne Co. (p. 94).
25. Jacksonburg, Wayne Co. (p. 94).
26. Richmond, Wayne Co. (p. 94).
27. Penn Township, Jay Co. (p. 95).
28. Fort Wayne, Allen Co. (p. 95).
29. West of Waterloo, DeKalb Co. (p. 95).
30. Ashley, Steuben Co. (p. 96).

Indiana—*continued:*

31. Beaver Lake, Newton Co. (p. 96).
32. —— Jasper Co. (p. 96).
33. Denham, Pulaski Co. (p. 96).
34. Rich Grove Township, Pulaski Co. (p. 97).
35. Royal Center, Cass Co. (p. 97).
36. Macy, Miami Co. (p. 97).
37. Peru, Miami Co. (p. 98).
38. Laketon, Wabash Co. (p. 98).
39. North Manchester, Wabash Co. (p. 98).
40. Lagrange, Lagrange Co. (p. 99).
41. Lowell, Lake Co. (p. 99).
42. Hebron, Porter Co. (p. 99).
43. Kouts, Porter Co. (p. 100).
44. Valparaiso, Porter Co. (p. 100).
45. Southeast of Valparaiso, Porter Co. (p. 100).
46. Olive Township, St. Joseph Co. (p. 100).
47. Notre Dame, St. Joseph Co. (p. 100).
48. Fulton, Fulton Co. (p. 97).
49. Indian Creek Township, Pulaski Co. (p. 97).
50. Greensburg, Decatur Co. (p. 92).
51. Jackson Township, Miami Co. (p. 98).
52. Vincennes, Knox Co. (p. 90).
53. Royerton, Delaware Co. (p. 94).
54. Lawrenceburg, Dearborn Co. (p. 91).
55. Northwest of Waterloo, DeKalb Co. (p. 95).
56. —— Noble Co. (p. 95).

MAP 9.



Distribution of Pleistocene mastodons in Indiana. For explanation see page 424.

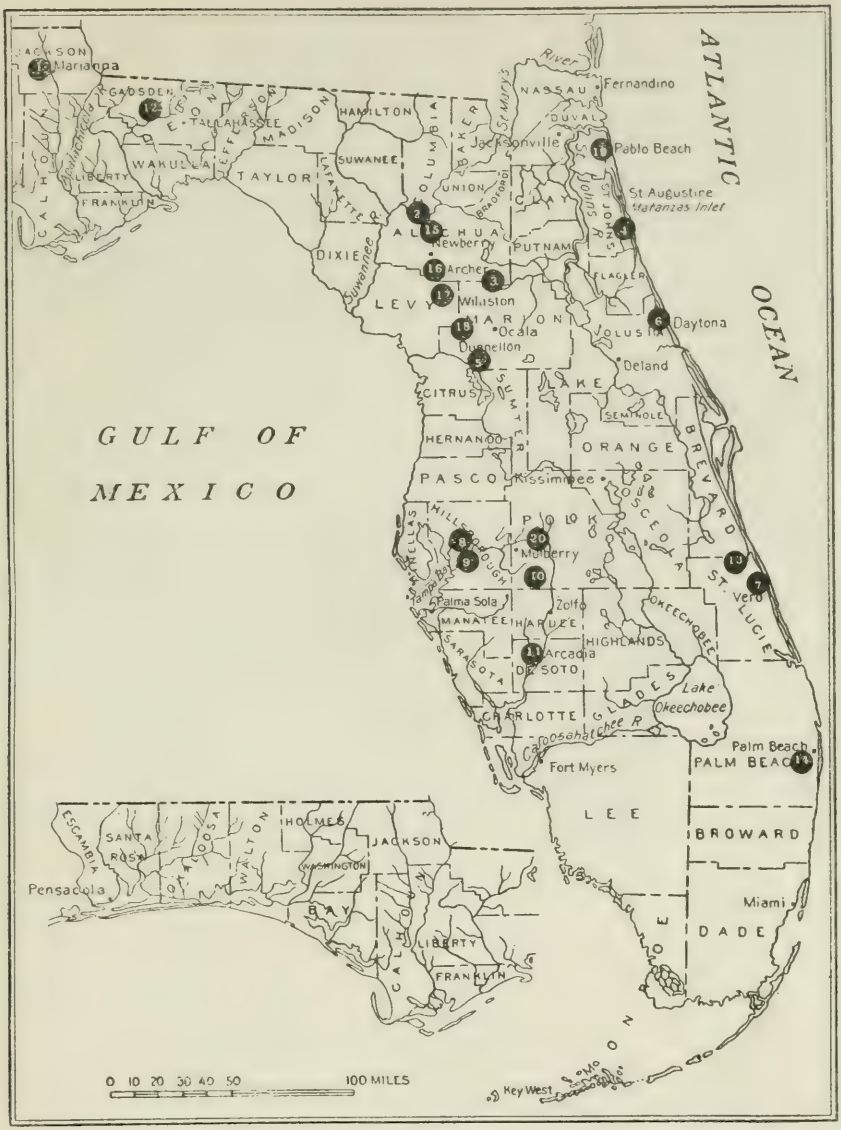
Explanation of Map 10.

If no name is given, Mammut americanum is understood.

Florida:

1. Marianna, Jackson Co. (p. 121).
2. Fort White, Columbia Co. (p. 121).
3. Citra, Marion Co. (p. 121).
4. Almero Farm, St. John Co. (p. 122).
5. Dunnellon, Marion Co. (p. 122).
6. Daytona, Volusia Co. (p. 122).
7. Vero, St. Lucie Co. (p. 122).
8. —— Hillsboro Co. (p. 123).
9. Alafia River, Hillsboro Co. (p. 123).
10. Pains Creek, Polk Co. (p. 123).
11. Peace Creek, De Soto Co. (p. 124).
12. Little River, Gadsden Co. (p. 121).
13. Fellsmere, St. Lucie Co. (p. 122).
14. Palm Beach, Palm Beach Co. (p. 123).
15. Neals, Alachua Co., Gomphotherium floridanum (p. 121).
16. Archer, Alachua Co., G. floridanum (p. 121).
17. Williston, Levy Co., G. floridanum (p. 121).
18. Juliette, Marion Co., G. floridanum (p. 121).
19. San Pablo Beach, Duval Co. (p. 122).
20. Brewster, Polk Co., Gomphotherium floridanum and Mammut progenium? (p. 123).

Map 10.



Distribution of Pleistocene mastodons in Florida. For explanation see page 426.

EXPLANATION OF MAP 11.

Ontario:
1. Toronto, York Co. (p. 130).
2. Amaranth, Dufferin Co. (p. 130).

New York:
1. Minoa, Onondaga Co. (p. 131).
2. Williamson, Wayne Co. (p. 131).
3. Pittsford, Monroe Co. (p. 131).
4. Buffalo, Erie Co. (p. 131).
5. Queensbury, Warren Co. (p. 132).
6. Lewiston, Niagara Co. (p. 132).

New Jersey:
1. Trenton, Mercer Co. (p. 132).
2. North Plainfield, Union Co. (p. 133).

Pennsylvania:
1. Brookfield, Tioga Co. (p. 133).
2. Chadds Ford, Delaware Co. (p. 133).
3. Harveys, Greene Co. (p. 133).
4. Lone Pine, Washington Co. (p. 133).
5. Beaver Dam, Erie Co. (p. 133).

Ohio:
1. Waverly, Pike Co. (p. 134).
2. Zanesville, Muskingum Co. (p. 134).
3. Duncan Falls, Muskingum Co. (p. 135).
4. Millport, Columbiana Co. (p. 135).
5. Mount Healthy, Hamilton Co. (p. 135).
6. Dayton, Montgomery Co. (p. 135).
7. Selma, Clark Co. (p. 136).
8. Versailles, Darke Co. (p. 136).
9. Jersey, Licking Co. (p. 136).
10. Chicago, Huron Co. (p. 136).
11. Kamms, Cuyahoga Co. (p. 136).
12. Cleveland, Cuyahoga Co. (p. 136).
13. New Berlin, Stark Co. (p. 136).
14. Amboy, Ashtabula Co. (p. 137).
15. —— Butler Co. (p. 135).

Michigan:
1. Three Oaks, Berrien Co. (p. 137).
2. Eaton Rapids, Eaton Co. (p. 137).

Indiana:
1. Otter Creek Township, Vigo Co. (p. 138).
2. Madison, Jefferson Co. (p. 138).
3. Vevay, Switzerland Co. (p. 138).
4. Windsor, Randolph Co. (p. 139).
5. Winchester, Randolph Co. (p. 139).
6. Fairmount, Grant Co. (p. 139).
7. Francisville, Pulaski Co. (p. 140).
8. Crown Point, Lake Co. (p. 140).
9. North Liberty, St. Joseph Co. (p. 139).
10. Webster, Wayne Co. (p. 138).
11. Rochester, Fulton Co. (p. 140).

Illinois:
1. Cairo, Alexander Co. (p. 140).
2. Ashland, Cass Co. (p. 141).
3. Kewanee, Henry Co. (p. 142).
4. Penny's Slough, Henry Co. (p. 142).
5. —— Kendall Co. (p. 143).

Wisconsin:
1. Milwaukee, Milwaukee Co. (p. 143).

Maryland:
1. Oxford Neck, Talbot Co. (p. 144).

Virginia:
1. Saltville, Smyth Co. (p. 145).

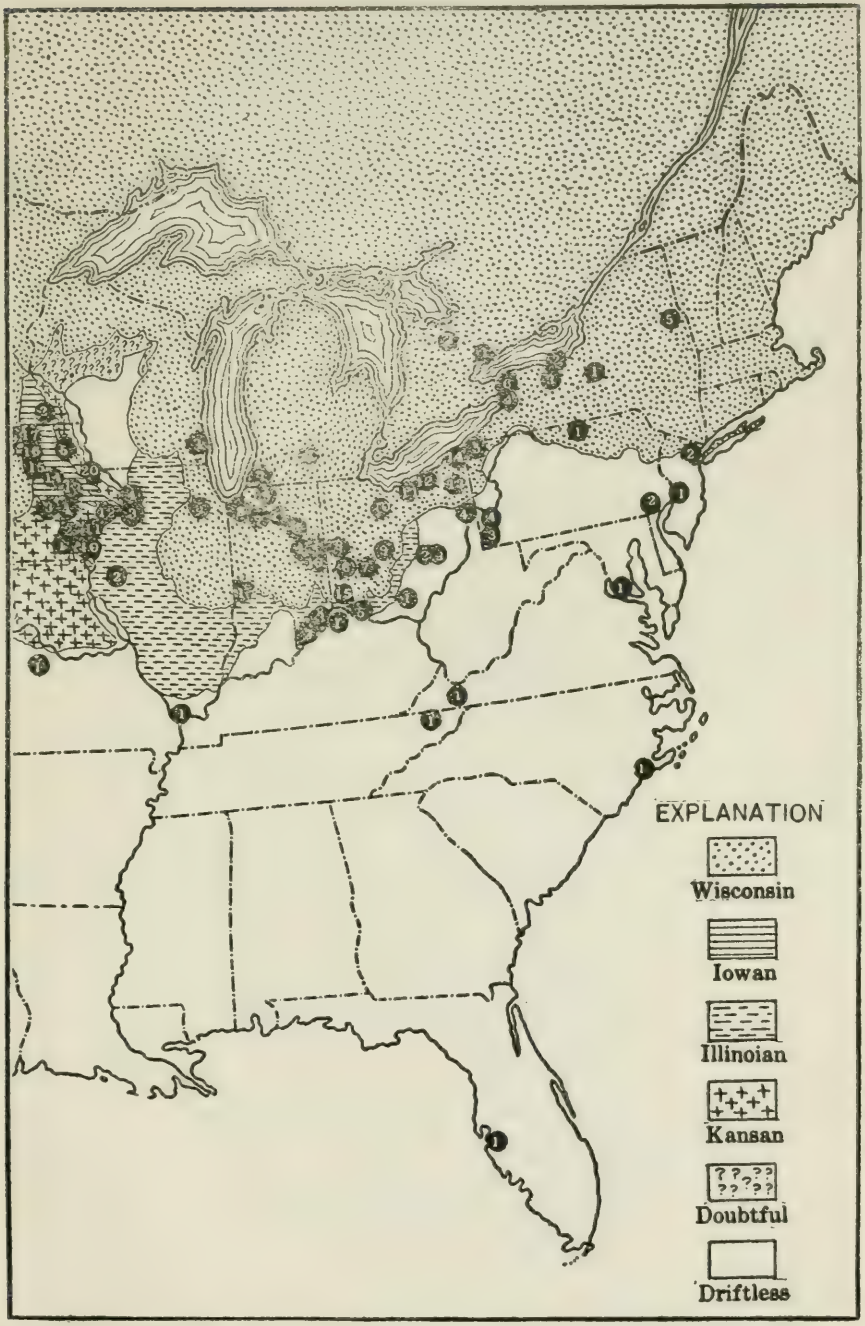
North Carolina:
1. Inland Waterway Canal, Carteret Co. (p. 145).

Florida:
1. Palma Sola, Manatee Co. (p. 145).

Tennessee:
1. Whitesburg, Hamblen Co. (p. 146).

Kentucky:
1. Bigbone Lick, Boone Co. (p. 14 .

MAP 11.



Distribution of *Elephas primigenius* in eastern North America. For explanation see page 428.

EXPLANATION OF MAP 12.

Ontario:
1. St. Catharines, Lincoln Co. (p. 147).
2. Hamilton, Wentworth Co. (p. 147).

Vermont:
1. Mount Holly, Rutland Co. (p. 148).

New York:
1. Homer, Cortland Co. (p. 149).
2. Elmira, Chemung Co. (p. 149).

New Jersey:
1. Middletown, Monmouth Co. (p. 149).

Pennsylvania:
1. Rogersville, Greene Co. (p. 150).
2. Pittsburgh, Allegheny Co. (p. 150).
3. Tryonville, Crawford Co. (p. 150).

Ohio:
1. —— Stark Co. (p. 150).
2. Amboy, Ashland Co. (p. 150).

Michigan:
1. —— Jackson Co. (p. 151).

Indiana:
1. Terre Haute, Vigo Co. (p. 151).
2. Monrovia, Morgan Co. (p. 152).
3. Windfall, Tipton Co. (p. 152).
4. Bringhurst, Carroll Co. (p. 152).

Illinois:
1. Staley, Champaign Co. (p. 152).
2. Stronghurst, Henderson Co. (p. 152).
3. Chillicothe, Peoria Co. (p. 153).
4. Chicago Heights, Cook Co. (p. 153).
5. Pawpaw, Lee Co. (p. 153).
6. Woodhull, Henry Co. (p. 154).

Maryland:
1. Oxford Neck, Talbot Co. (p. 154).
2. —— Queen Anne Co. (p. 154).

West Virginia:
1. Little Kanawha River, Wirt Co. (p. 155).

North Carolina:
1. 9 miles south of Wilmington, New Hanover Co. (p. 155).

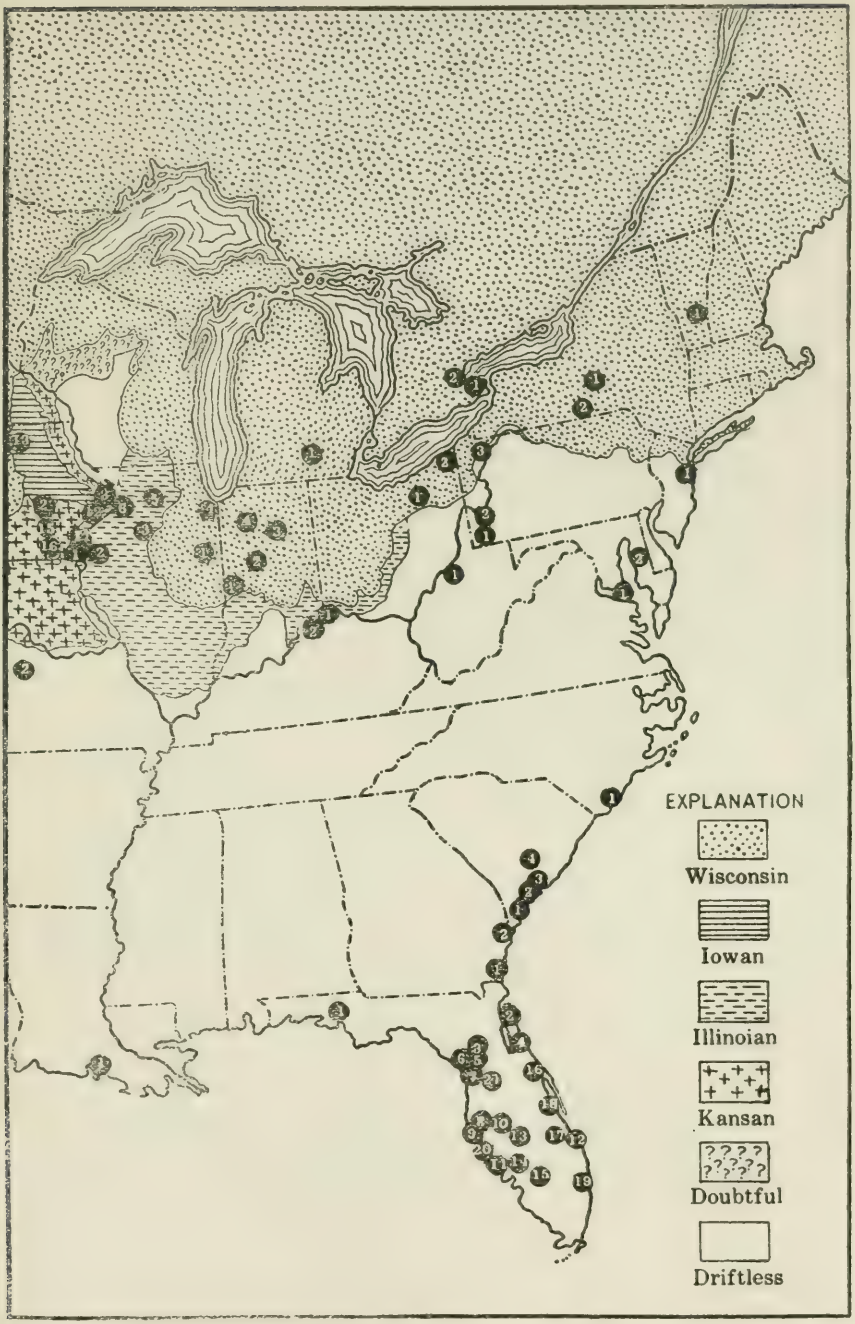
South Carolina:
1. Beaufort, Beaufort Co. (p. 155).
2. Edisto River, Charleston Co. (p. 155).
3. Charleston, Charleston Co. (p. 155).
4. Head of Cooper River, Berkeley Co. (p. 156).

Georgia:
1. Brunswick Canal, Glynn Co. (p. 157).
2. Skidaway Island, Chatham Co. (p. 157).

Florida (See Map 13).

Kentucky:
1. Bigbone Lick, Boone Co. (p. 160).
2. Mouth of Big Twin Creek, Owen Co. (p. 161).

MAP 12.

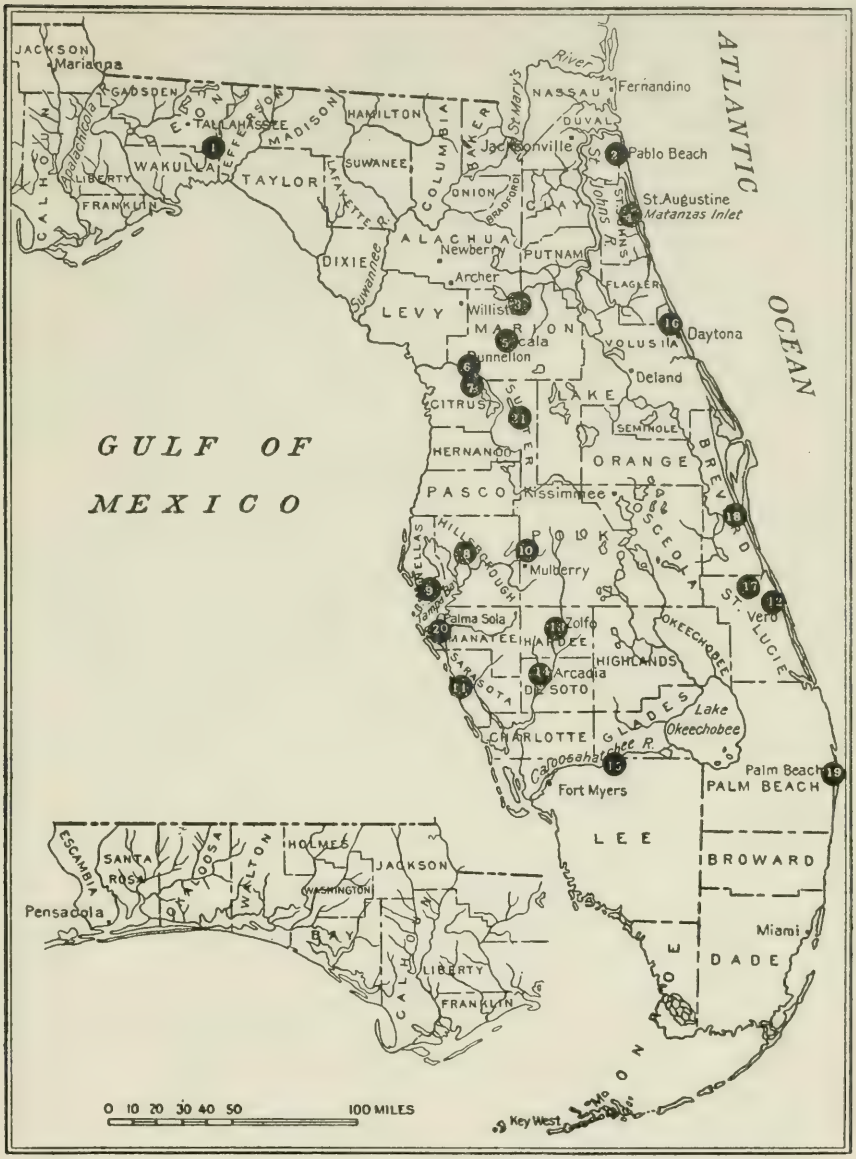


Distribution of *Elephas columbi* in eastern North America. For explanation see page 430.

Explanation of Map 13.

1. St. Marks River, Wakulla Co. (p. 157).
2. Station 120, Duval Co. (p. 157).
3. Citra, Marion Co. (p. 158).
4. Mantanzas, St. John Co. (p. 158).
5. Ocala, Marion Co. (p. 158).
6. Dunnellon, Marion Co. (p. 158).
7. Holder, Citrus Co. (p. 158).
8. Tampa, Hillsboro Co. (p. 159).
9. St. Petersburg, Pinellas Co. (p. 159).
10. Kingsford, Polk Co. (p. 159).
11. Sarasota, Sarasota Co. (p. 159).
12. Vero, St. Lucie Co. (p. 159).
13. Zolfo, Hardee Co. (p. 160).
14. Arcadia, DeSoto Co. (p. 160).
15. Tourners, Glades Co. (p. 160).
16. Daytona, Volusia Co. (p. 158).
17. Fellsmere, St. Lucie Co. (p. 159).
18. Eau Gallie, Brevard Co. (p. 159).
19. Palm Beach, Palm Beach Co. (p. 160).
20. Palma Sola, Manatee Co. (p. 159).
21. Sumpterville, Sumpter Co. (p. 158).

MAP 13.



Distribution of *Elephas columbi* in Florida. For explanation see page 432.

Explanation of Map 14.

South Carolina:

1. Charleston, Charleston Co. (p. 162).
2. Head of Cooper River, Berkeley Co. (p. 162).

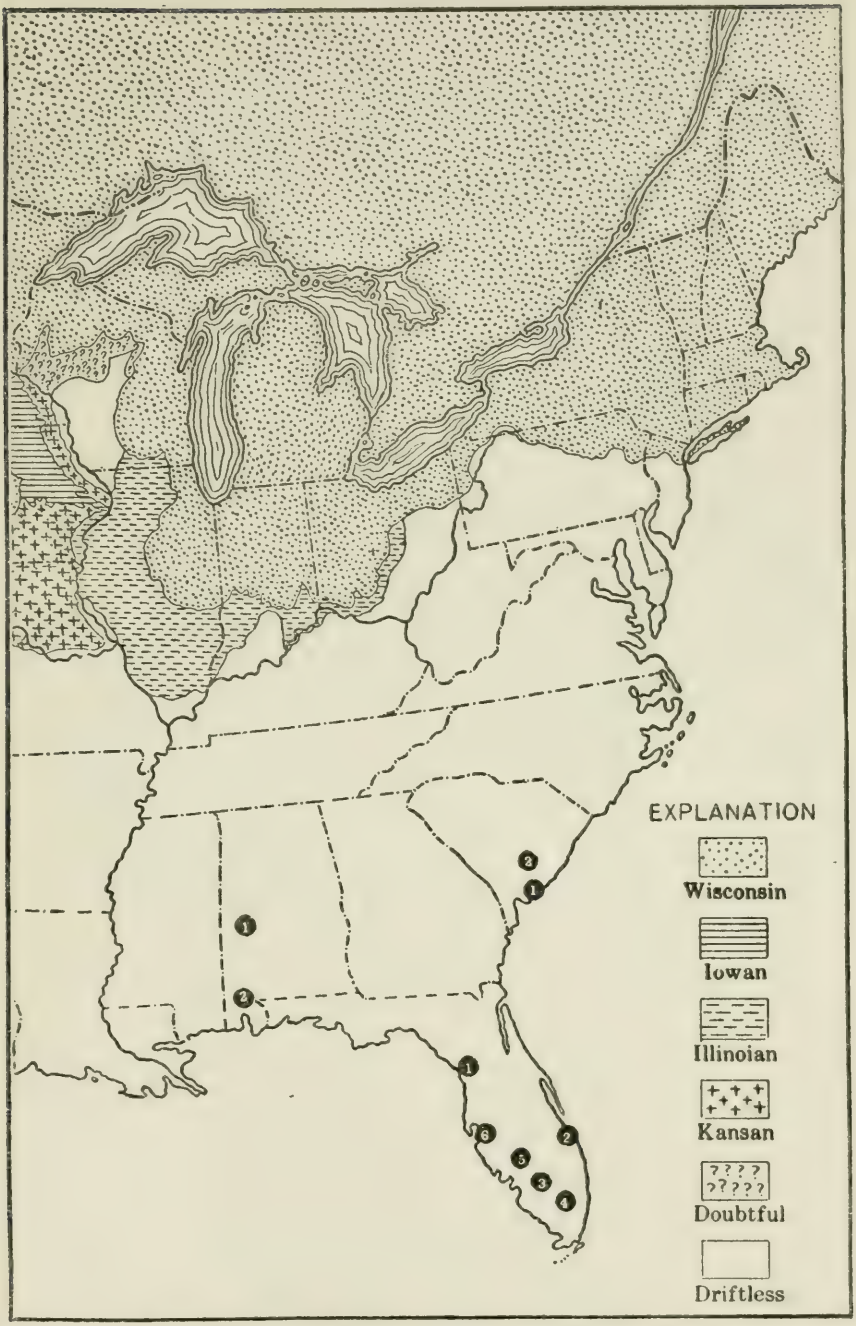
Florida:

1. Dunnellon, Marion Co. (p. 162).
2. Vero, St. Lucie Co. (p. 163).
3. Labelle, Lee Co. (p. 163).
4. Everglades, Palm Beach Co.? (p. 163).
5. Arcadia, DeSoto Co. (p. 163).
6. Palmetto, Manatee Co. (p. 164).

Alabama:

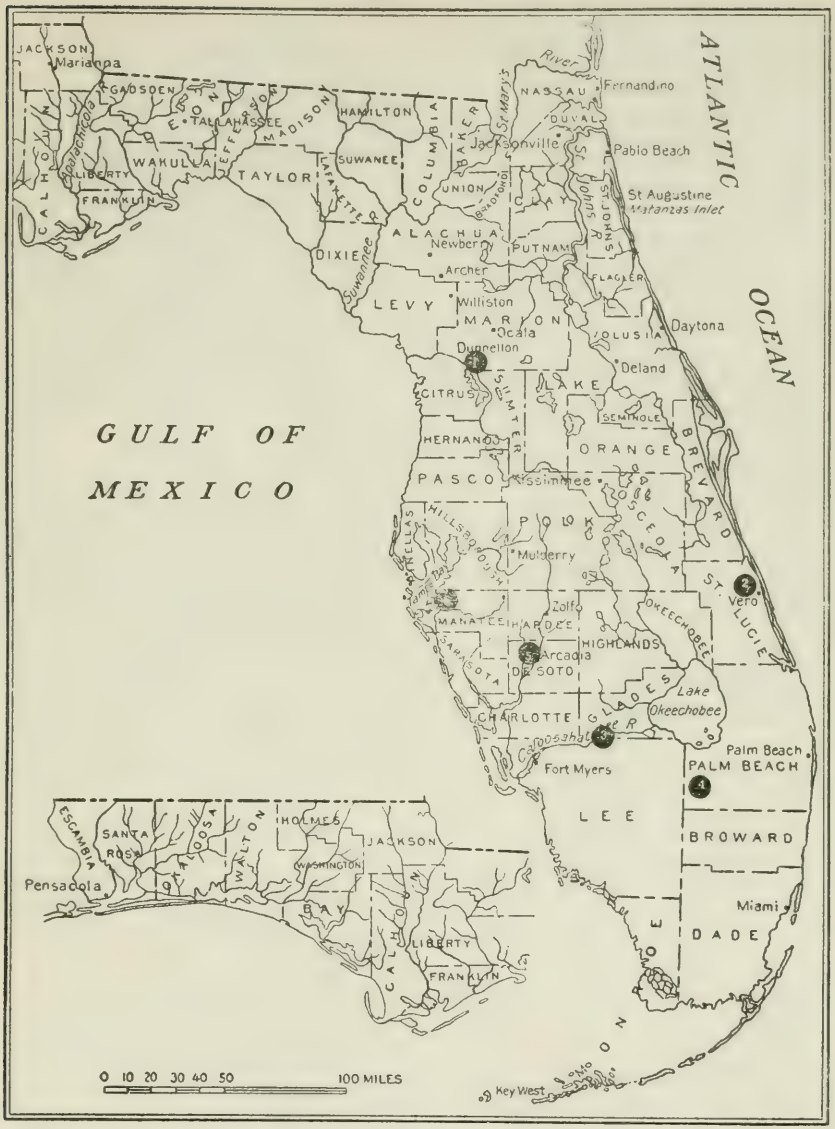
1. Bogue Chitto, Dallas Co. (p. 164).
2. "Near Gulf of Mexico" (p. 165).

MAP 14.



Distribution of *Elephas imperator* in southeastern United States. For explanation see page 434.

MAP 15.



Elephas imperator in Florida.

EXPLANATION OF MAP 15.

1. Dunnellon, Marion Co. (p. 162).
2. Vero, St. Lucie Co. (p. 163).
3. Labelle, Lee Co. (p. 163).
4. Everglades, Palm Beach Co.? (p. 163).
5. Arcadia, De Soto Co. (p. 163).
6. Palmetto, Manatee Co. (p. 164).

EXPLANATION OF MAP 16.

Ontario:
1. St. Catharines, Lincoln Co. (p. 166).
2. Hamilton, Wentworth Co. (p. 166).
3. Toronto, York Co. (p. 167).

Vermont:
1. Richmond, Chittenden Co. (p. 167).

New York:
1. Seneca Lake (p. 167).
2. Wellsburg, Chemung Co. (p. 167).

Pennsylvania:
1. Chambersburg, Franklin Co. (p. 168).
2. Pittsburgh, Allegheny Co. (p. 168).
3. Meadville, Crawford Co. (p. 168).
4. Girard, Erie Co. (p. 168).

Ohio:
1. Little Salt Creek, Jackson Co. (p. 168).
2. Beverly, Washington Co. (p. 169).
3. Nashport, Muskingum Co. (p. 169).
4. —— Ross Co. (p. 169).
5. Cincinnati, Hamilton Co. (p. 169).
6. Fort Jefferson, Darke Co. (p. 170).
7. Circleville, Pickaway Co. (p. 170).
8. South Bloomfield, Pickaway Co. (p. 170).
9. Cleveland, Cuyahoga Co. (p. 170).
10. Montville, Geauga Co. (p. 170).
11. Canton, Stark Co. (p. 170).

Michigan:
1. East Saginaw, Saginaw Co. (p. 171).
2. —— Macomb Co. (p. 171).
3. Grand Ledge, Eaton Co. (p. 171).
4. Buchanan, Berrien Co. (p. 171).

Indiana:
1. —— Vanderburg Co. (p. 171).
2. Shoals, Martin Co. (p. 172).
3. —— Vigo Co. (p. 172).
4. Gosport, Owen Co. (p. 172).
5. Brookville, Franklin Co. (p. 172).
6. Parke, Vermilion, and Putnam Co. (p. 173).
7. Northeast of Bowers, Montgomery Co. (p. 173).
8. —— Wayne Co. (p. 173).
9. Noblesville, Hamilton Co. (p. 173).
10. Dora, Wabash Co. (p. 174).
11. —— Jasper Co. (p. 174).
12. Pleasant Township, Wabash Co. (p. 174).
13. St. John's, Lake Co. (p. 174).
14. —— Allen Co. (p. 174).
15. Muncie, Delaware Co. (p. 174).
16. Connersville, Fayette Co. (p. 173).
17. Wailesboro, Bartholomew Co. (p. 172).

Illinois:
1. Equality, Gallatin Co. (p. 175).
2. Chester, Randolph Co. (p. 175).
3. —— Calhoun Co. (p. 175).
4. Sangamon River, Sangamon Co. (p. 176).
5. —— Fulton Co. (p. 176).
6. Galesburg, Knox Co. (p. 176).
7. Rock Island, Rock Island Co. (p. 176).
8. Atwood, Piatt Co. (p. 177).
9. Peoria, Peoria Co. (p. 176).
10. Evanston, Cook Co. (p. 177).
11. Rochelle, Ogle Co. (p. 177).
12. Galena, Jo Daviess Co. (p. 178).
13. Wheaton, Dupage County, and Oak Park, Cook Co. (p. 177).
14. Pekin, Tazewell Co. (p. 176).
15. South Fork of Sangamon River, Christian Co. (p. 175).

Wisconsin:
1. Stockholm, Pepin Co. (p. 178).

Maryland and District of Columbia:
1. Upper Marlboro, Prince George Co. (p. 178).
2. Washington, District of Columbia (p. 178).

Virginia:
1. Warrenton, Fauquier Co. (p. 178).

West Virginia:
1. Wheeling, Ohio Co. (p. 179).

North Carolina:
1. Pamlico Co., 16 miles below Newbern (p. 178).
2. Harlowe, Carteret Co. (p. 179).

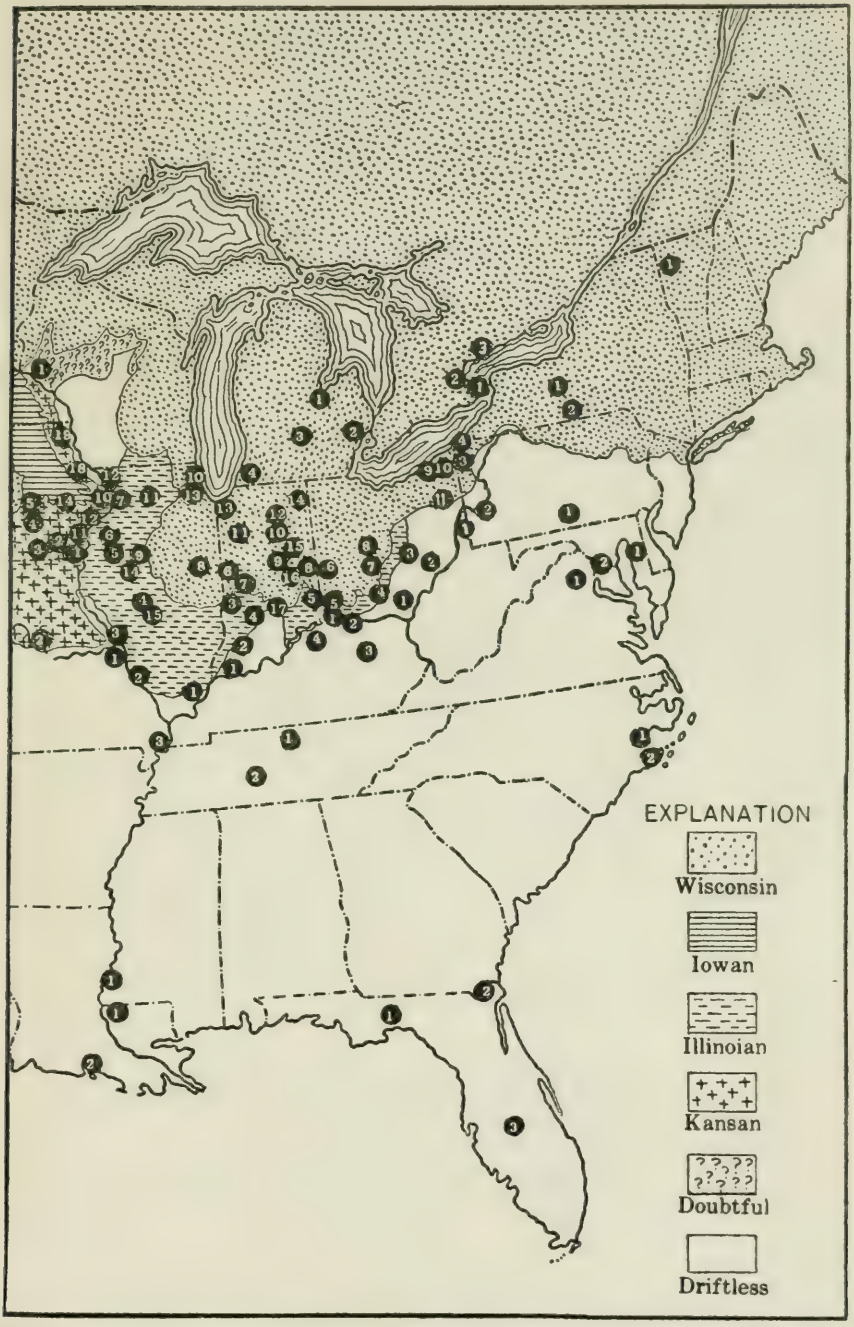
Florida:
1. Wakulla Springs, Wakulla Co. (p. 179).
2. Stokes Ferry, Nassau Co. (p. 180).
3. Bartow, Polk Co. (p. 180).

Mississippi:
1. Natchez, Adams Co. (p. 180).

Tennessee:
1. Gallatin, Sumner Co. (p. 181).
2. Columbia, Maury Co. (p. 181).

Kentucky:
1. Bigbone Lick, Boone Co. (p. 181).
2. Newport, Campbell Co. (p. 182).
3. Bluelick Springs, Nicholas Co. (p. 182).
4. Eminence, Henry Co. (p. 182).

MAP 16.



Distribution of elephants of undetermined species in eastern North America. For explanation see page 438.

EXPLANATION OF MAP 17.

MASSACHUSETTS:
1. Gay Head, Martha's Vineyard, Equus? sp. indet. (p. 183).

NEW YORK:
1. Throg's Neck, New York Co., Equus sp. indet. (p. 183).

NEW JERSEY:
1. Swedesboro, Gloucester Co., Equus sp. indet. (p. 184).
2. Fish House, Camden Co., E. complicatus (p. 184).
3. Navesink Hills, Monmouth Co., Equus sp. indet. (p. 184).

PENNSYLVANIA:
1. Pittston, Luzerne Co., E. complicatus (p. 184).
2. Stroudsburg, Monroe Co., Equus sp. indet. (p. 185).
3. Port Kennedy, Montgomery Co., E. complicatus, E. pectinatus (p. 185).
4. Rutherford, Dauphin Co., Equus sp. indet. (p. 185).
5. Frankstown, Blair Co., Equus sp. indet (p. 185).

OHIO:
1. Cincinnati, Hamilton Co., E. complicatus (p. 185).
2. Columbus, Franklin Co., E. complicatus (p. 186).
3. Salt Creek, Columbiana Co., Equus sp. indet. (p. 186).

INDIANA:
1. Evansville, Vanderburg Co., E. complicatus (p. 186).

ILLINOIS:
1. Bond or Fayette Co., Equus complicatus (p. 187).
2. Alton, Madison Co., Equus sp. indet. (p. 187).
3. Greene Co., Equus sp. indet. (p. 187).

MARYLAND AND DISTRICT OF COLUMBIA:
1. Marshall Hall, Charles Co., Equus leidyi? (p. 188).
2. Georgetown, D. C., Equus sp. indet. (p. 188).
3. Mitchellville, Prince George Co., Equus sp. indet. (p. 188).
4. Chesapeake Beach, Calvert Co., E. leidyi? (p. 189).
5. Cavetown, Washington Co., E. complicatus (p. 189).
6. Corriganville, Allegany Co., Equus sp. indet. (p.189).

VIRGINIA:
1. Abingdon, Washington Co., E. complicatus (p. 189).
2. Saltville, Smyth Co., Equus sp. indet. (p. 190).
3. Ivanhoe, Wythe Co., E. complicatus? (p. 190).
4. Staunton, Augusta Co., E. sp. indet. (p. 190).
5. Denniston, Halifax Co., Equus sp. indet. (p. 190).

WEST VIRGINIA:
1. Point Pleasant, Mason Co., E. niobrarensis? (p. 190).

NORTH CAROLINA:
1. Elizabethtown, Bladen Co., E. leidyi (p. 190).
2. Below Newbern, in Pamlico Co., Equus sp. indet. (p. 191).
3. Greenville, Pitt Co., E. complicatus (p. 191).
4. Plymouth Co., E. leidyi (p. 191).

SOUTH CAROLINA:
1. Beaufort, Beaufort Co., E. complicatus (p. 191).
2. Charleston, Charleston Co., E. complicatus, E. leidyi, E. littoralis (p. 192).
3. Richland Co., Equus sp. indet. (p. 193).
4. Darlington, Darlington Co., E. complicatus (p. 193).

GEORGIA:
1. Brunswick, Glynn Co., E. leidyi, E. complicatus, E. littoralis (p. 193).
2. Skidaway Island, Chatham Co., E. complicatus (p. 194).

FLORIDA (See Map 18).

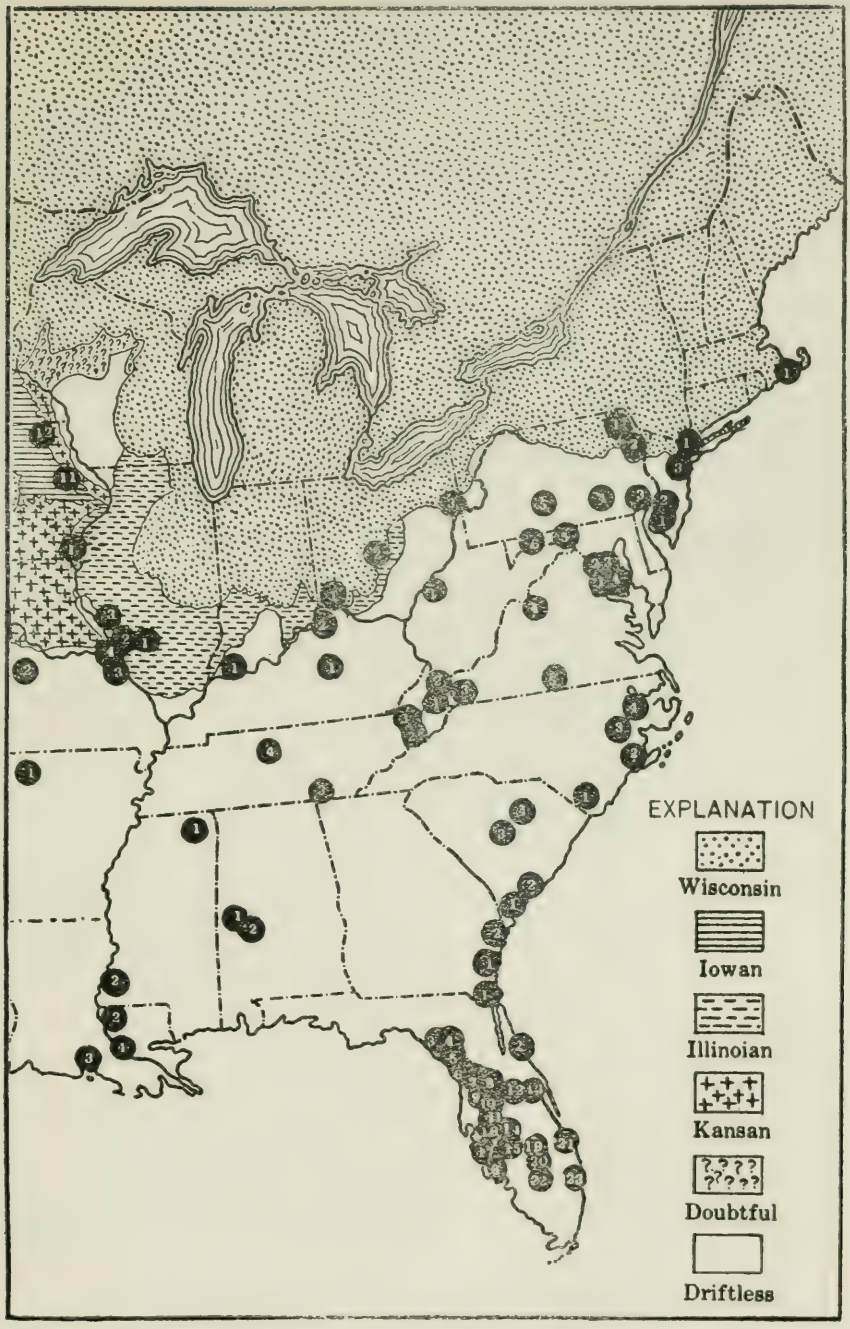
ALABAMA:
1. Newbern, Hale Co., Equus sp. indet. (p. 200).
2. Bogue Chitto, Dallas Co., E. leidyi (p. 200).

MISSISSIPPI:
1. Orizaba, Tippah Co., E. leidyi? (p. 200).
2. Natchez, Adams Co., E. complicatus (p. 200).

TENNESSEE:
1. Rogersville, Hawkins Co., E. leidyi (p. 201).
2. Whitesburg, Hamblen Co., E. leidyi (p. 201).
3. Lookout Mountain, Hamilton Co., E. littoralis (p. 201).
4. Nashville, Davidson Co., E. leidyi, E. complicatus (p. 201).

KENTUCKY:
1. Bigbone Lick, Boone Co., E. complicatus (p. 202).
2. Monday's Landing, Mercer Co., Equus sp. indet. (p. 202).

MAP 17.

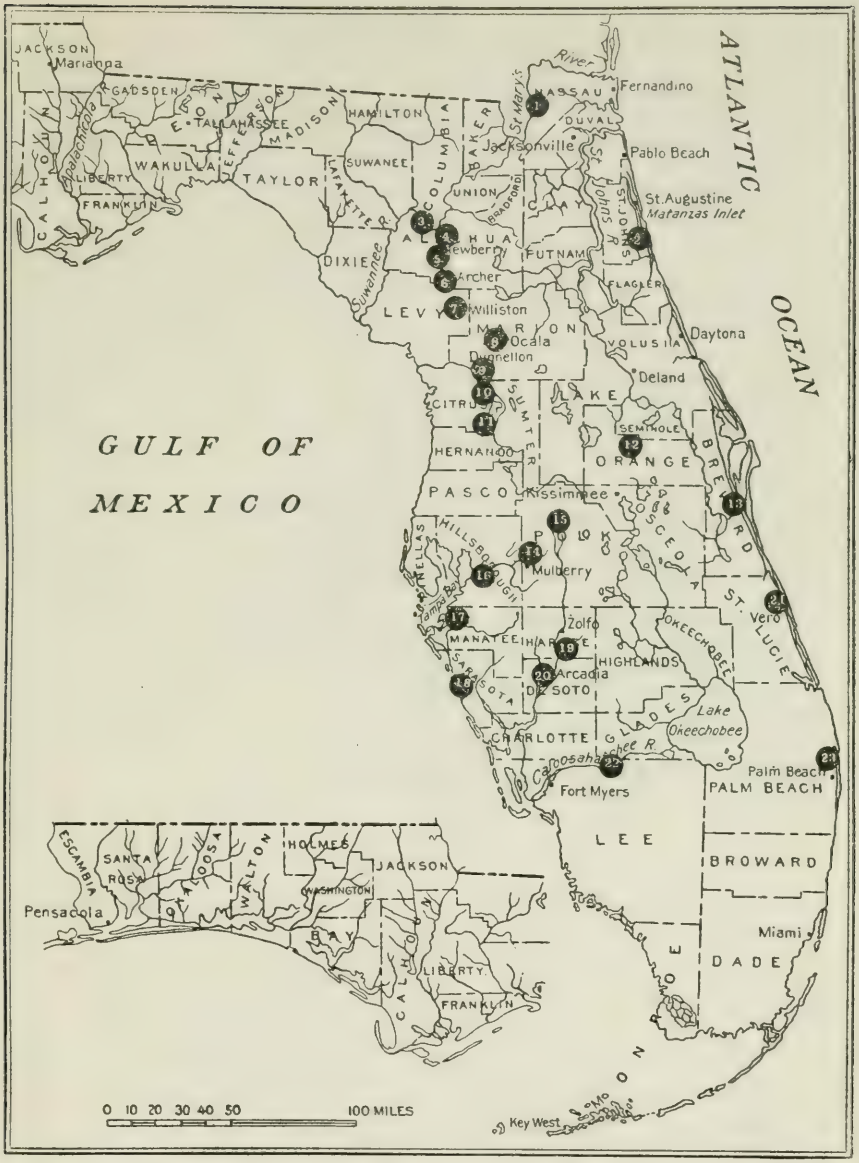


Distribution of Pleistocene horses, mostly *Equus*, in eastern North America. For explanation see page 440.

Explanation of Map 18.

1. Stokes Ferry, Nassau Co., Equus sp. indet. (p. 194).
2. Almero Farm, St. John Co., E. complicatus? (p. 194).
3. Neals, Alachua Co., Hipparion, sp. indet. (p. 195).
4. Wade, Alachua Co., E. leidyi? (p. 195).
5. Newberry, Alachua Co., Hipparion sp. indet., Parahippus sp. indet., Equus littoralis (p. 195).
6. Archer, Alachua Co., Hipparion ingenuum (p. 195).
7. Williston, Levy Co., Equus leidyi, Hipparion ingenuum, H. plicatile (p. 195).
8. Ocala, Marion Co., Equus leidyi (p. 196).
9. Dunnellon, Marion Co., Equus leidyi (p. 196).
10. Hernando, Citrus Co., Hipparion sp. indet. (p. 196).
11. Holder, Citrus Co., Equus sp. indet. (p. 196).
12. —— Orange Co., Equus sp. indet. (p. 196).
13. Eau Gallie, Brevard Co., E. complicatus (p. 196).
14. Kingsford, Polk Co., E. leidyi (p. 196).
15. Brewster, Polk Co., Hipparion minus (p. 197).
16. Alafia River, Hillsboro Co., E. leidyi, E. complicatus? (p. 197).
17. Palmetto, Manatee Co., E. leidyi, E. complicatus, E. littoralis (p. 197).
18. Sarasota Bay, Sarasota Co., E. leidyi, E. complicatus? (p. 198).
19. Calvenia, De Soto Co., E. leidyi (p. 198).
20. Arcadia, De Soto Co., E. leidyi, E. princeps, E. littoralis, Hipparion ingenuum (p. 198).
21. Vero, St. Lucie Co., E. complicatus, E. leidyi, E. littoralis (p. 199).
22. Labelle, Lee Co., E. leidyi (p. 199).
23. Palm Beach, Palm Beach Co., E. complicatus (p. 200).

MAP 18.



Distribution of Pleistocene horses, mostly *Equus*, in Florida. For explanation see page 442.

EXPLANATION OF MAP 19.

PENNSYLVANIA:
1. Port Kennedy, Montgomery Co., Tapirus haysii (p. 203).
2. Frankstown, Blair Co., Tapirus terrestris? (p. 203).

OHIO:
1. New Salisbury, Columbiana Co., Tapirus sp. indet. (p. 203).

INDIANA:
1. Evansville, Vanderburg Co., Tapirus haysii (p. 203).

MARYLAND:
1. Corrigansville, Allegany Co., Tapirus sp. indet. (p. 204).

VIRGINIA:
1. Ivanhoe, Wythe Co., T. haysii (p. 204).

SOUTH CAROLINA:
1. Charleston, Charleston Co., T. haysii, T. veroensis?, T. terrestris? (p. 204).

GEORGIA:
1. Brunswick, Glynn Co., T. haysii (p. 206).

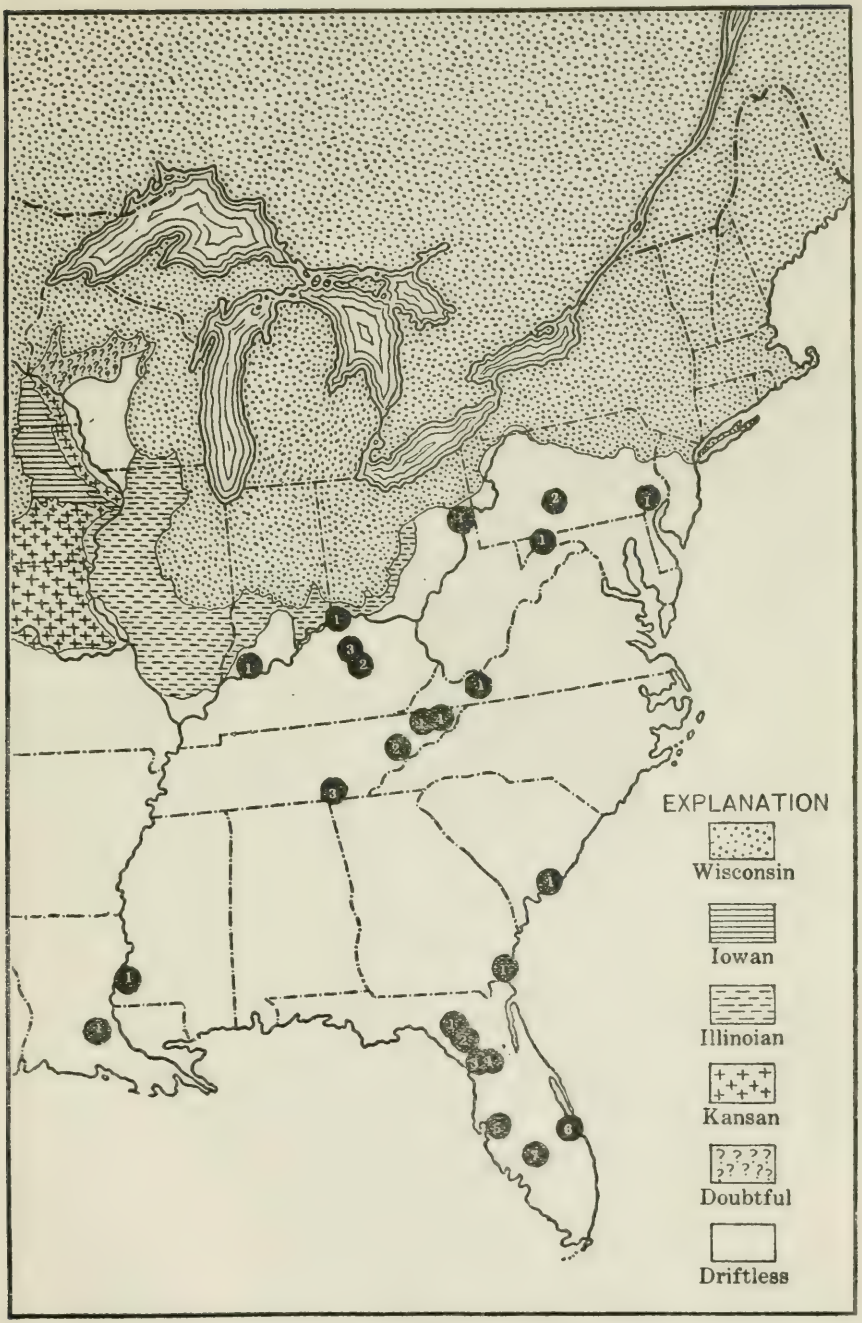
FLORIDA:
1. Neals, Alachua Co., T. terrestris? (p. 206).
2. Archer, Alachua Co., T. haysii? (p. 207).
3. Dunnellon, Marion Co., T. haysii ?,T. sp. indet. (p. 207).
4. Ocala, Marion Co., T. sp. indet. (p. 207).
5. Tampa, Hillsboro Co., T. veroensis? (p. 208).
6. Vero, St. Lucie Co., T. veroensis, T. haysii (p. 208).
7. Arcadia, De Soto Co., T. terrestris? (p. 208).

MISSISSIPPI:
1. Natchez, Adams Co., T. haysii, T. terrestris? (p. 208).

TENNESSEE:
1. Whitesburg, Hamblen Co., T. tennesseae (p. 209).
2. Dandridge, Jefferson Co., Tapirus sp. indet. (p. 209).
3. Lookout Mountain, Hamilton Co., T. haysii (p. 209).
4. Bristol, Sullivan Co., T. haysii (p. 209).

KENTUCKY:
1. Bigbone Lick, Boone Co., T. haysii (p. 209).
2. Stamping Ground, Scott Co., T. haysii (p. 210).
3. Yarnallton, Fayette Co., T. haysii (p. 210).

MAP 19.



Distribution of Pleistocene tapirs in eastern North America. For explanation see page 444.

EXPLANATION OF MAP 20.

NEW YORK:
1. Rochester, Monroe Co., Platygonus compressus (p. 212).
2. Gainesville, Wyoming Co., P. compressus (p. 212).

NEW JERSEY:
1. Shark River, Monmouth Co., Mylohyus nasutus? (p. 213).

PENNSYLVANIA:
1. Stroudsburg, Monroe Co., M. pennsylvanicus (p. 213).
2. Port Kennedy, Montgomery Co., M. pennsylvanicus, M. nasutus, Tagassu? tetragonus? (p. 213).
3. Milroy, Mifflin Co., Platygonus vetus (p. 213).
4. Frankstown, Blair Co., Mylohyus pennsylvanicus? (p. 214).

OHIO:
1. Wilmington, Clinton Co., Platygonus compressus (p. 214).
2. Columbus, Franklin Co., P. compressus (p. 214).
3. Chalfants, Perry Co., P. compressus (p. 215).
4. Lisbon, Columbiana Co., Mylohyus nasutus? (p. 215).

MICHIGAN:
1. Belding, Ionia Co., Platygonus compressus (p. 215).

INDIANA:
1. —— Gibson Co., Mylohyus nasutus (p. 216).
2. Williams, Lawrence Co., Platygonus vetus?, Tagassu lenis (p. 217).
3. Laketon, Wabash Co., Platygonus compressus (p. 218).

ILLINOIS:
1. Galena, Jo Daviess Co., Platygonus compressus (p. 218).
2. Alton, Madison Co., P. cumberlandensis? (p. 219).

WISCONSIN:
1. Blue Mounds, Dane Co., Tagassu lenis (p. 219).

MARYLAND:
1. Benedict, Charles Co., Tagassu lenis (p. 220).
2. Chesapeake Beach, Calvert Co., T. lenis (p. 220).
3. Corrigansville, Allegany Co., Mylohyus pennsylvanicus, M. exortivus, Platygonus cumberlandensis, P. intermedius (p. 220).
4. Cavetown, Washington Co., Mylohyus nasutus, M. exortivus, M. obtusidens, Platygonus vetus, P. cumberlandensis, Tagassu tetragonus (p. 220).

VIRGINIA:
1. Ivanhoe, Wythe Co., Mylohyus nasutus (p. 221).
2. —— Augusta Co., Platygonus compressus (p. 221).

WEST VIRGINIA:
1. Renicks, Greenbrier Co., P. intermedius (p. 221).

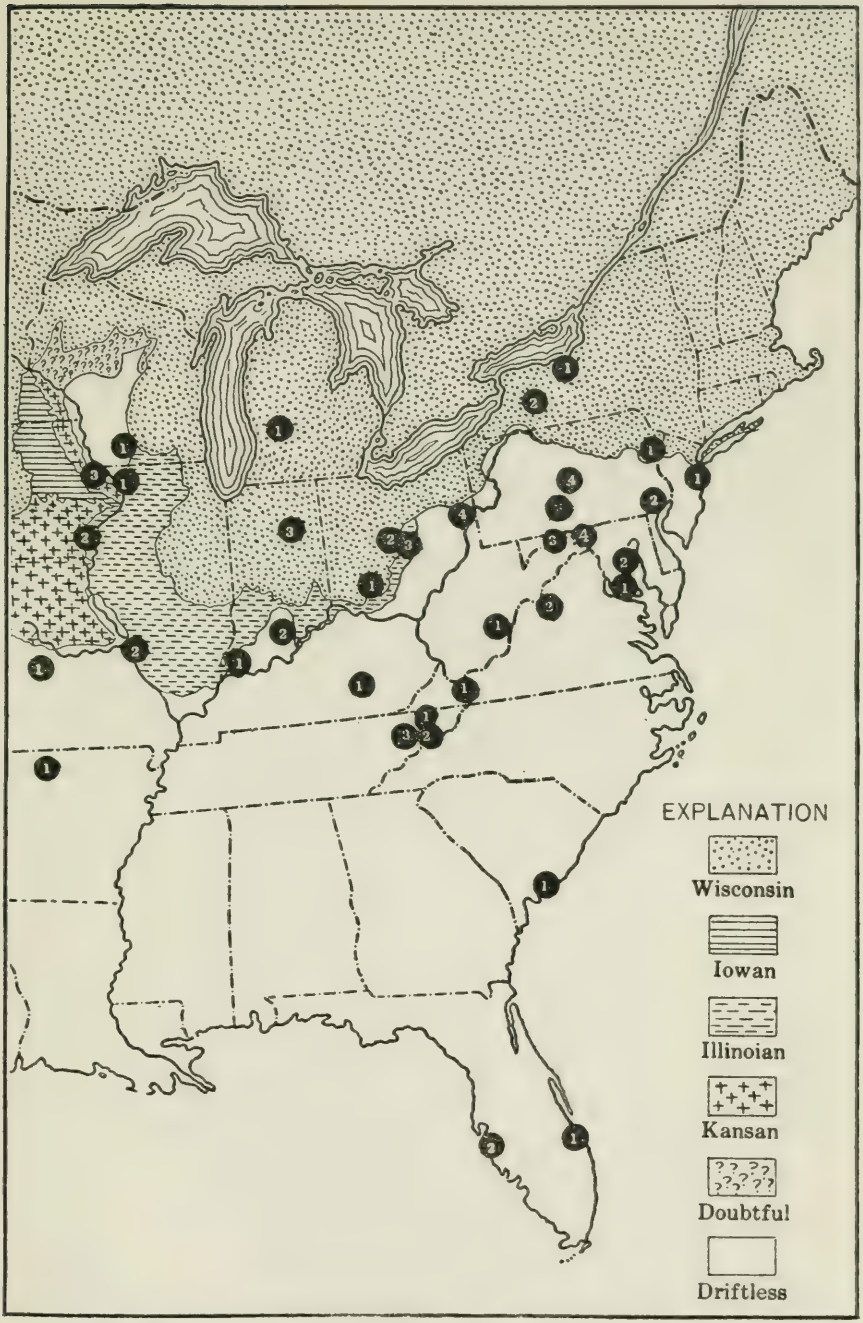
SOUTH CAROLINA:
1. Charleston, Charleston Co., Tagassu lenis (p. 221).

FLORIDA:
1. Vero, St. Lucie Co., Tagassu lenis (p. 222).
2. Palma Sola, Manatee Co., T. lenis (p. 222).

TENNESSEE:
1. Rogersville, Hawkins Co., Mylohyus setiger (p. 222).
2. Whitesburg, Hamblen Co., M. nasutus (p. 223).
3. Dandridge, Jefferson Co. "Peccary" (p. 223).

KENTUCKY:
1. Rock Castle Co., Platygonus compressus (p. 223).

MAP 20.



Distribution of Pleistocene peccaries in eastern North America. For explanation see page 446.

Explanation of Map 21.

Pennsylvania:

1. Port Kennedy, Montgomery Co., Teleopternus orientalis (p. 224).

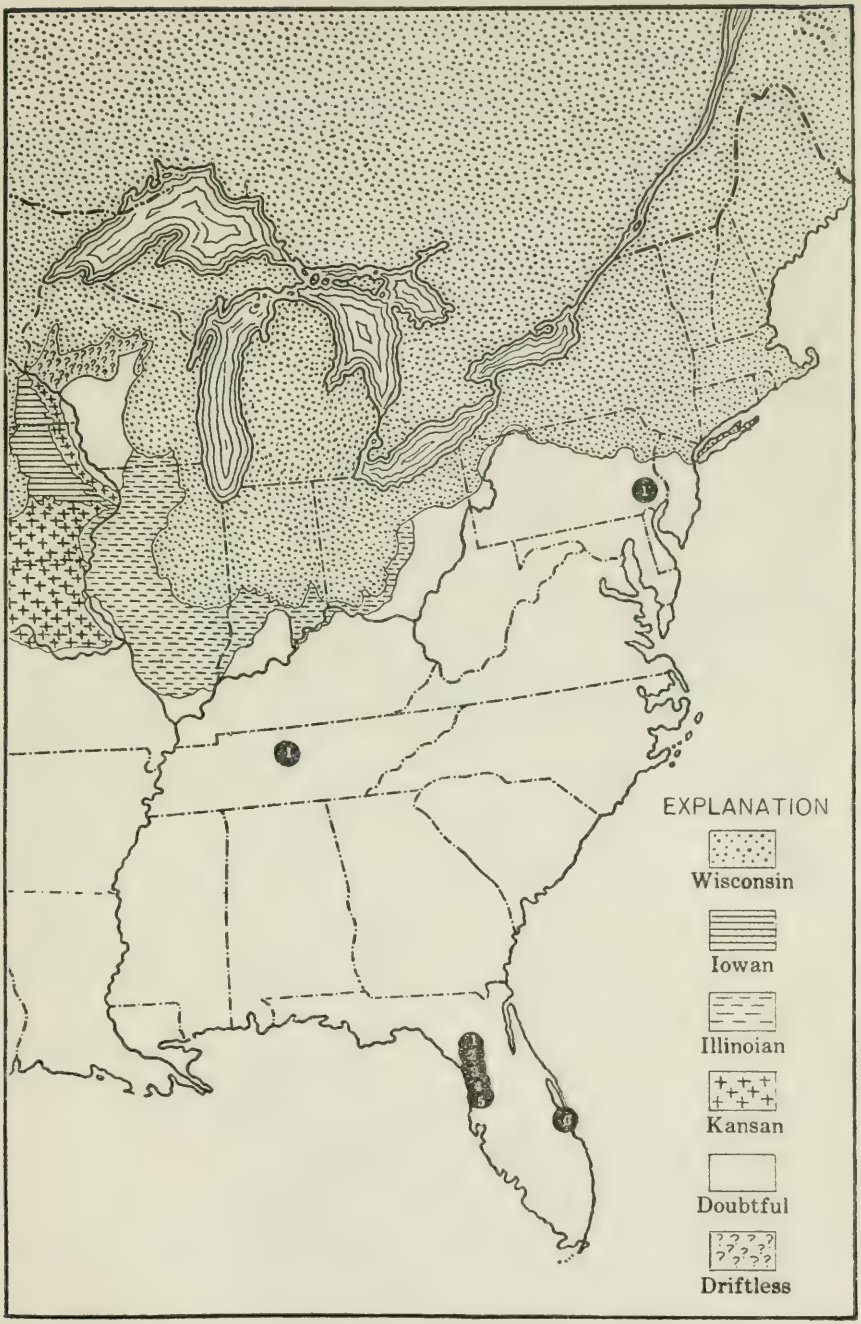
Florida:

1. Archer, Alachua Co., Procamelus major, P. minor, P. minimus (p. 224).
2. Williston, Levy Co., P. major (p. 224).
3. Ocala, Marion Co., P. minimus? (p. 224).
4. Dunnellon, Marion Co., P. minor (p. 225).
5. Hernando, Citrus Co., Procamelus? sp. indet. (p. 225).
6. Vero, St. Lucie Co., Camelops? sp. indet. (p. 225).

Tennessee:

1. Nashville, Davidson Co., Camelops? sp. indet. (p. 225).

MAP 21.



Distribution of Pleistocene camels in eastern North America. For explanation see page 448.

EXPLANATION OF MAP 22.

Ontario:
1. Toronto, York Co., Odocoileus virginianus (p. 226).

New York:
1. —— Orange Co., O. virginianus (p. 226).
2. Greenville, Greene Co., O. virginianus (p. 226).
3. Cuba, Allegany Co., O. virginianus (p. 226).
4. Hinsdale, Cattaraugus Co., O. virginianus (p. 226).

New Jersey:
1. Woodstown, Salem Co., O. virginianus (p. 226).
2. Vincentown, Burlington Co., O. virginianus (p. 227).
3. Deal, Monmouth Co., O. virginianus (p. 227).

Pennsylvania:
1. Stroudsburg, Monroe Co., O. virginianus (p. 227).
2. Frankstown, Blair Co., O. virginianus? (p. 227).

Ohio:
1. New Knoxville, Auglaize Co., O. virginianus (p. 227).

Michigan:
1. Adrian, Lenawee Co., O. virginianus (p. 227).
2. Ann Arbor, Washtenaw Co., O. virginianus (p. 228).

Indiana:
1. Evansville, Vanderburg Co., O. virginianus?, O. dolichopsis (p. 228).
2. Harrisville, Randolph Co., O. virginianus (p. 228).
3. Roann, Wabash Co., O. virginianus (p. 229).

Illinois:
1. Niantic, Macon Co., O. virginianus (p. 229).
2. Whitewillow, Kendall Co., O. virginianus (p. 229).
3. Ottawa, LaSalle Co., O. virginianus (p. 229).
4. Evanston, Cook Co., O. virginianus (p. 230).
5. Lemont, Cook Co., O. virginianus (p. 230).

Wisconsin:
1. Lead region, O. virginianus, O. whitneyi (p. 230).
2. Menomonie, Dunn Co., O. virginianus (p. 230).

Maryland:
1. Oxford Neck, Talbot Co., O. virginianus (p. 230).
2. Cavetown, Washington Co., O. virginianus (p. 231).

Virginia:
1. Saltville, Smyth Co., O.? sp. indet. (p. 231).
2. Ivanhoe, Wythe Co., O. virginianus (p. 231).

West Virginia:
1. —— Wood Co., O. virginianus? (p. 231).

North Carolina:
1. Pamlico Co., 16 miles below Newbern. O. virginianus? (p. 231).

South Carolina:
1. Charleston, Charleston Co., O. virginianus? (p. 231).
2. Darlington, Darlington Co., O. virginianus? (p. 232).

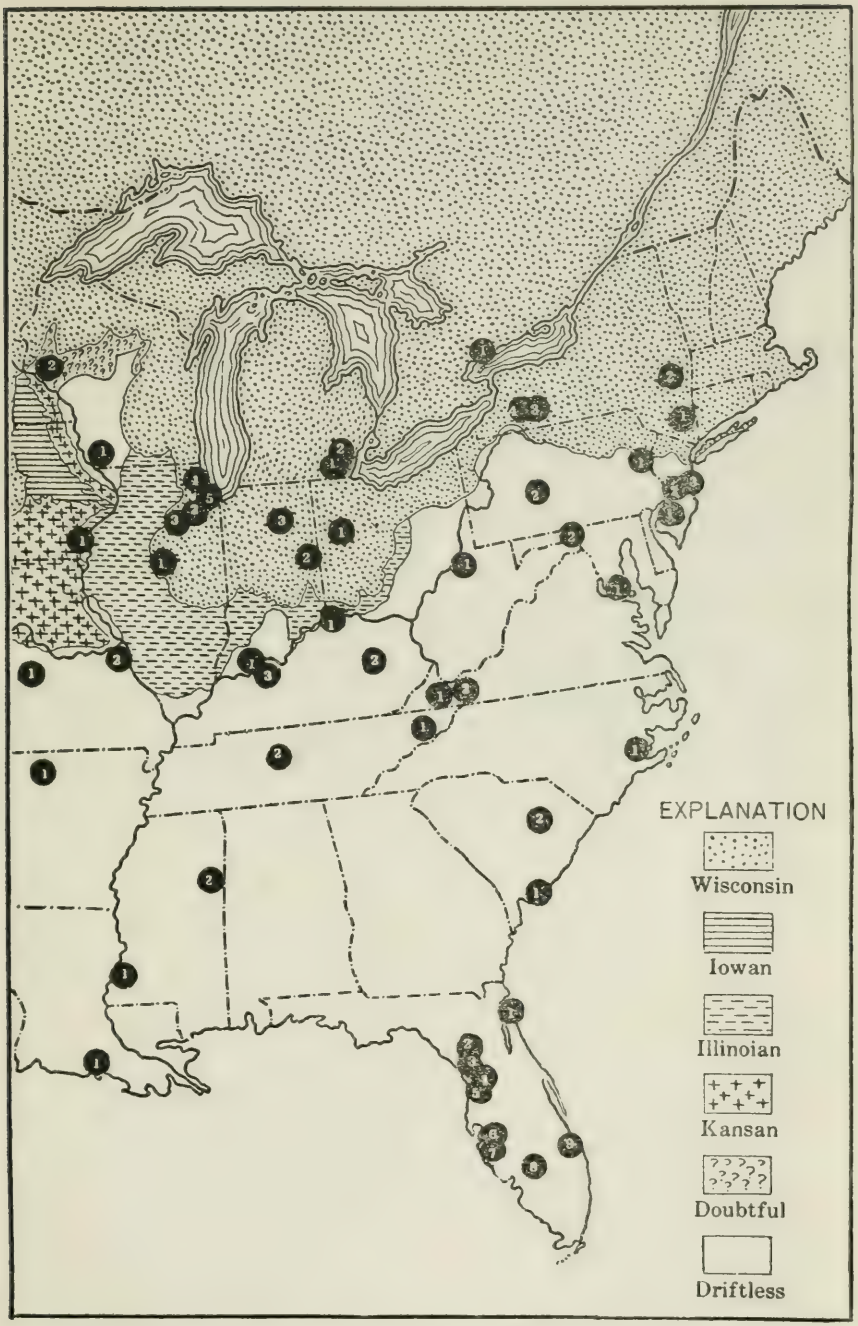
Florida:
1. Pablo Beach, Duval Co., O. virginianus? (p. 232).
2. Neals, Alachua Co., O. virginianus (p. 232).
3. Archer, Alachua Co., O. virginianus (p. 232).
4. Ocala, Marion Co., O. sp. indet. (p. 233).
5. Dunnellon, Marion Co., O. osceola? (p. 233).
6. Palmetto, Manatee Co., O. sp. indet. (p. 233).
7. Palma Sola, Manatee Co., O. virginianus? (p. 233).
8. Arcadia, De Soto Co., O. virginianus? (p. 234).
9. Vero, St. Lucie Co., O. sellardsiae, O. osceola? (p. 234).

Mississippi:
1. Natchez, Adams Co., O. virginianus? (p. 233).
2. Aberdeen, Monroe Co., O. virginianus? (p. 234).

Tennessee:
1. Whitesburg, Hamblen Co., O. virginianus (p. 234).
2. Nashville, Davidson Co., O. sp. indet. (p. 234).

Kentucky:
1. Bigbone Lick, Boone Co., O. virginianus (p. 234).
2. Bluelick Springs, Nicholas Co., O. virginianus (p. 234).
3. Henderson, Henderson Co., O. virginianus (p. 234).

MAP 22.



Distribution of the deer of the genus *Odocoileus* in the Pleistocene in eastern North America.
For explanation see page 450.

EXPLANATION OF MAP 23.

Ontario:
1. Hamilton, Wentworth Co. (p. 235).
2. Near Strathroy, Middlesex Co. (p. 235).
3. Kingston, Frontenac Co. (p. 235).

Vermont:
1. Grand Isle, Champlain Lake (p. 235).

New York:
1. Racket River, St. Lawrence Co. (p. 235).
2. Seneca Castle, Ontario Co. (p. 236).
3. Farmington, Ontario Co. (p. 236).
4. —— Livingston Co. (p. 236).
5. Cuba, Allegany Co. (p. 236).
6. Jamestown, Chautauqua Co. (p. 236).
7. Boonville, Oneida Co. (p. 236).
8. Third Lake, Herkimer Co. (p. 236).
9. Steele's Corners, St. Lawrence Co. (p. 236).

New Jersey:
1. Deal, Monmouth Co. (p. 237).
2. Trenton, Mercer Co. (p. 237).

Pennsylvania:
1. Stroudsburg, Monroe Co. (p. 237).
2. Riegelsville, Bucks Co. (p. 237).

Michigan:
1. Adrian, Lenawee Co. (p. 237).
2. Ann Arbor, Washtenaw Co. (p. 237).

Indiana:
1. Cambridge City, Wayne Co. (p. 238).
2. Fountain City, Wayne Co. (p. 238).
3. Harrisville, Randolph Co. (p. 238).
4. Pennville, Jay Co. (p. 238).
5. —— Wabash Co. (p. 239).
6. Foresman, Newton Co. (p. 239).

Indiana—*continued:*
7. Rensselaer, Jasper Co. (p. 239).
8. —— Lake Co. (p. 239).
9. Kouts, Porter Co. (p. 239).

Illinois:
1. Niantic, Macon Co. (p. 239).
2. Whitewillow, Kendall Co. (p. 240).
3. Palos Park, Cook Co. (p. 240).
4. Batavia, Kane Co. (p. 240).
5. Union Grove, Whiteside Co. (p. 240).
6. Lead Region, Jo Daviess Co. (p. 240).
7. Beecher, Will Co. (p. 241).

Wisconsin:
1. Wauwatosa, Milwaukee Co. (p. 241).
2. Pewaukee, Waukesha Co. (p. 241).
3. Whitehall, Trempealeau Co. (p. 241).

Maryland:
1. Oxford Neck, Talbot Co. (p. 242).

North Carolina:
1. Pamlico Co., 16 miles below Newbern (p. 242).

South Carolina:
1. Charleston, Charleston Co. (p. 242).

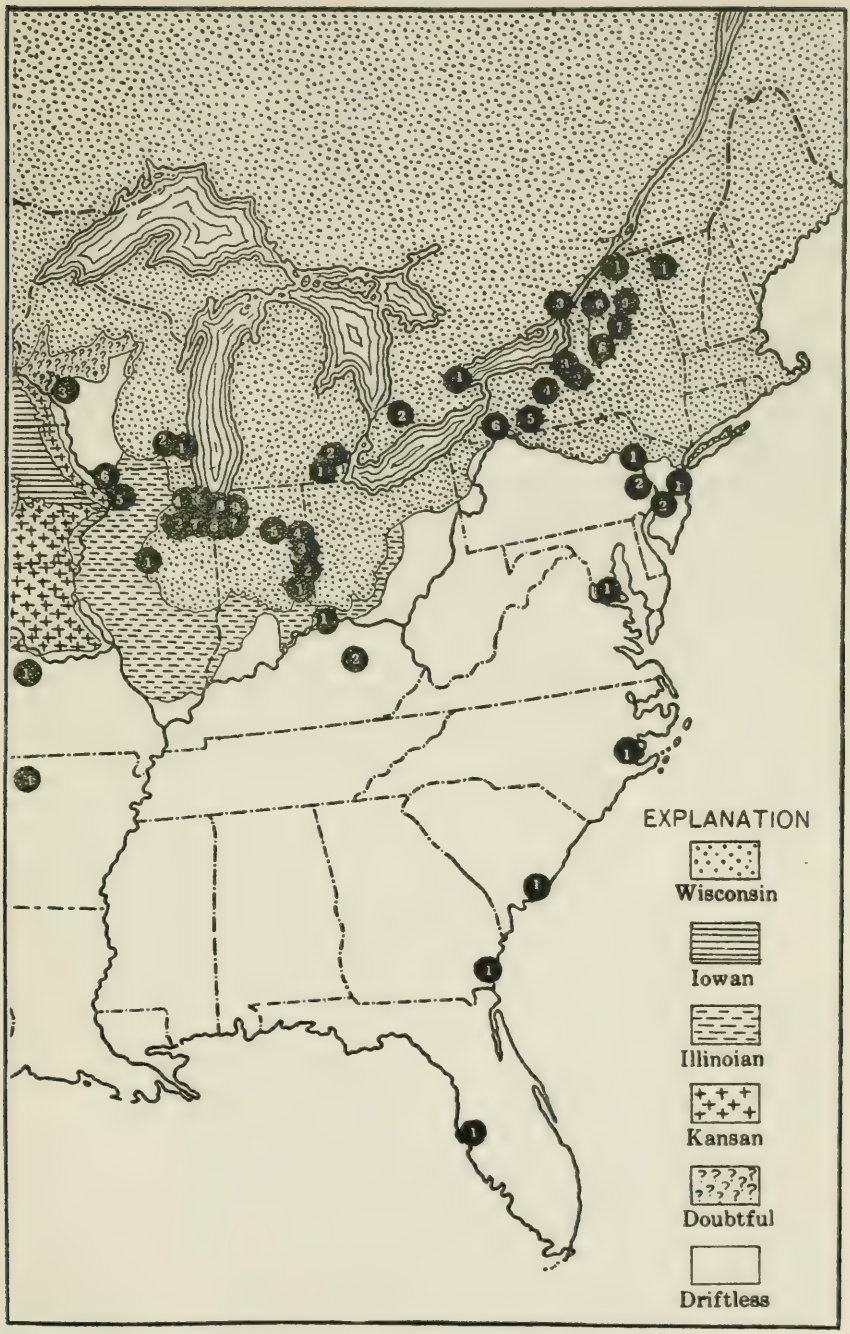
Georgia:
1. Brunswick, Glynn Co. (p. 243).

Florida:
1. Alafia River (p. 243).

Tennessee:
1. Whitesburg, Hamblen Co. (p. 243).

Kentucky:
1. Bigbone Lick, Boone Co. (p. 243).
2. Bluelick Springs, Nicholas Co. (p. 243)

MAP 23.



Distribution of *Cervus canadensis* in the Pleistocene of eastern North America.
For explanation see page 452.

Explanation of Map 24.

Ontario:
1. Toronto, York Co., Rangifer sp. indet. (p. 244).

Vermont:
1. Woodbury, Washington Co., R. caribou? (p. 244).

Connecticut:
1. New Haven, New Haven Co., R. caribou? (p. 244).

New York:
1. Ossining, Westchester Co., R. sp. indet. (p. 244).
2. Racket River, St. Lawrence Co., R.? sp. indet. (p. 244).

New Jersey:
1. Vincentown, Burlington Co., R. sp. indet. (p. 244).
2. Trenton, Mercer Co., R. sp. indet (p. 245).

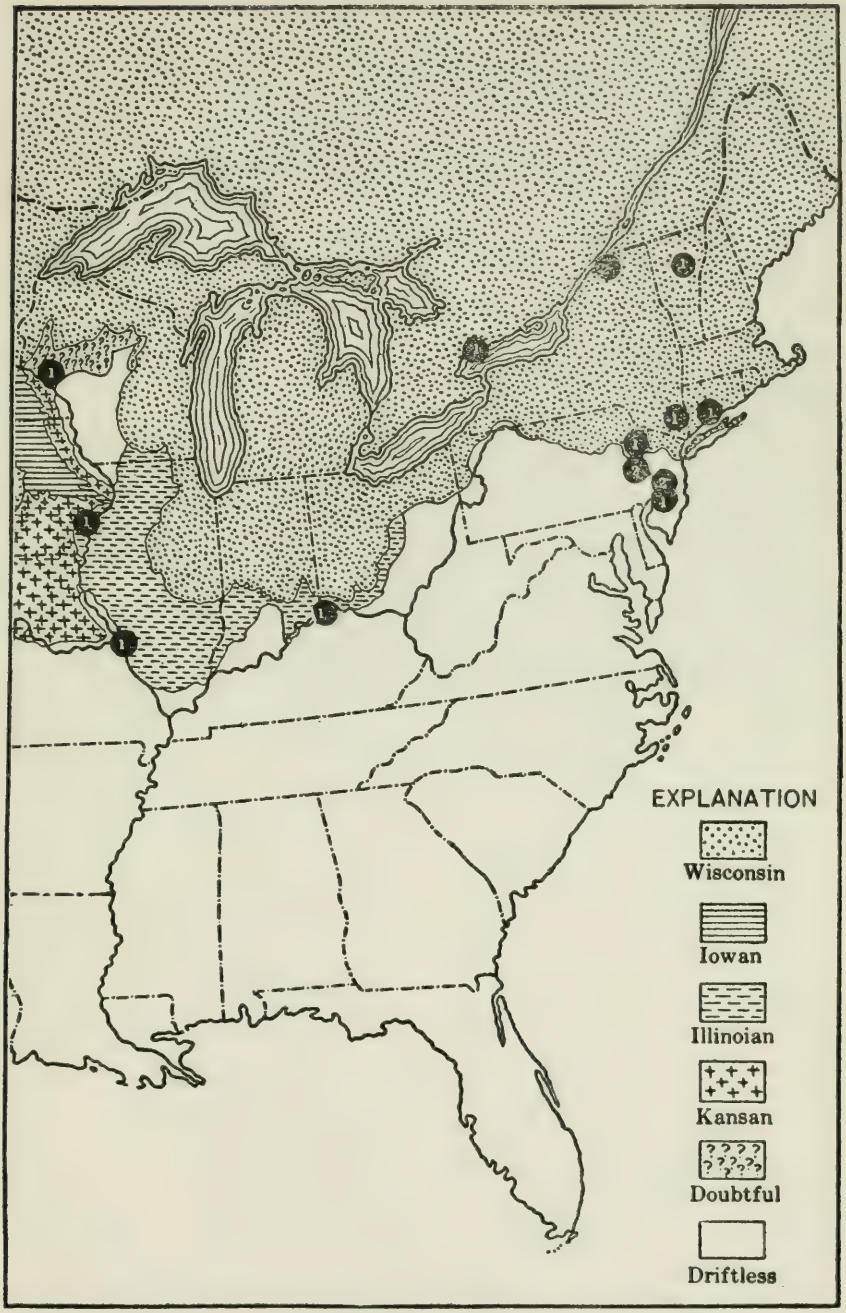
Pennsylvania:
1. Stroudsburg, Monroe Co., R. caribou (p. 246).
2. Riegelsville, Bucks Co., R. caribou (p. 246).

Illinois:
Alton, Madison Co., R. muscatinensis? (p. 246).

Wisconsin:
1. Menomonie, Dunn Co., R. sp. indet (p. 247).

Kentucky:
1. Bigbone Lick, Boone Co., R. sp. indet (p. 248).

MAP 24.



Distribution of Pleistocene species of *Rangifer* in eastern North America. For explanation see page 454.

Explanation of Map 25.

New Jersey:
1. Trenton, Mercer Co., Ovibos moschatus (p. 248).

Pennsylvania:
1. Pittston, Luzerne Co., Symbos cavifrons? (p. 248).
2. Riegelsville, Bucks Co., Ovibos appalachicolus (p. 249).

Ohio:
1. Urbana, Champaign Co., Symbos cavifrons (p. 249).
2. Youngstown, Mahoning Co., Ovibos moschatus (p. 249).
3. —— Trumbull Co., Symbos cavifrons (p. 249).

Michigan:
1. Manchester, Washtenaw Co., Symbos cavifrons (p. 250).
2. Moorland, Muskegon Co., Boötherium sargenti (p. 250).

Indiana:
1. Wailesboro, Bartholomew Co., Symbos cavifrons (p. 251).
2. Richmond, Wayne Co., Ovibos moschatus (p. 252).
3. —— Randolph Co., Symbos cavifrons (p. 252).
4. Beaver Lake, Newton Co., Symbos cavifrons? (p. 252).
5. Hebron, Porter Co., Symbos cavifrons (p. 252).

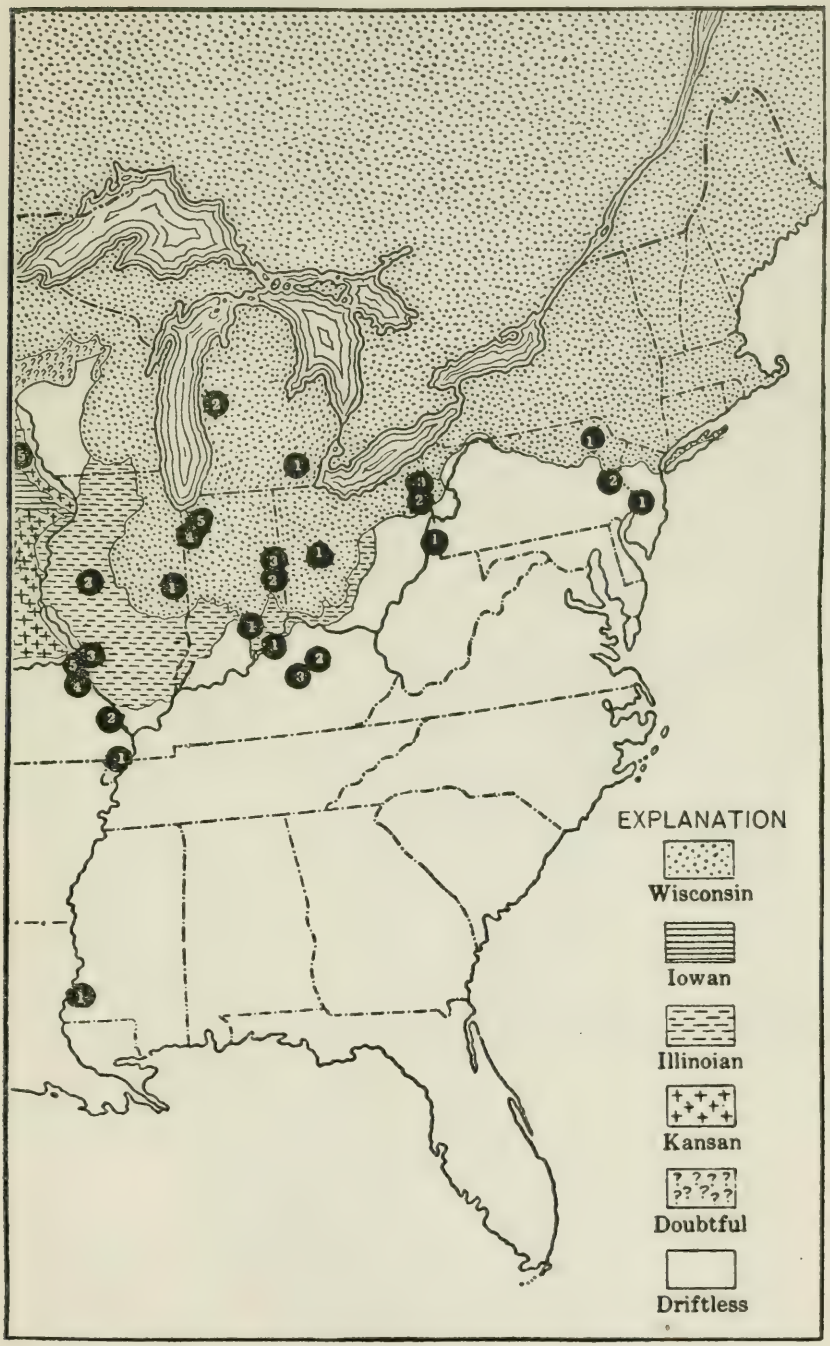
Illinois:
1. Bondville, Champaign Co., Symbos cavifrons (p. 253).
2. Manito, Mason Co., Symbos cavifrons (p. 253).
3. Alton, Madison Co., Symbos promptus? (p. 254).

West Virginia:
1. Mahan, Brooke Co., Symbos cavifrons (p. 254).

Mississippi:
1. Natchez, Adams Co., Symbos cavifrons (p. 254).

Kentucky:
1. Bigbone Lick, Boone Co., Boötherium bombifrons, Symbos cavifrons? (p. 255).
2. Bluelick Springs, Nicholas Co., Symbos cavifrons (p. 255).
3. Winchester, Clark Co., Symbos cavifrons (p. 255).

MAP 25.



Distribution of musk-oxen in eastern North America during the Pleistocene.
For explanation see page 456.

Explanation of Map 26.

Ontario:
1. Toronto, York Co., Bison sp. indet. (p. 256).

Pennsylvania:
1. Pittston, Luzerne Co., Bison? sp. indet. (p. 256).
2. Port Kennedy, Montgomery Co., Bison sp. indet. (p. 256).

Ohio:
1. Fincastle, Brown Co., B. latifrons (p. 257).
2. North Fairfield, Huron Co., B. sylvestris (p. 257).

Indiana:
1. Evansville, Vanderburg Co., Bison sp. indet. (p. 257).
2. Vincennes, Knox Co., B. antiquus (p. 258).

Illinois:
1. Alton, Madison Co., Bison sp. indet. (p. 259).

Wisconsin:
1. Coon Valley, Vernon Co., Bison sp. indet. (p. 259).

Maryland:
1. Chesapeake Beach, Calvert Co., Bison sp. indet. (p. 259).

Virginia:
1. Saltville, Smyth Co., Bison sp. indet. (p. 259).
2. Ivanhoe, Wythe Co., B. antiquus? (p. 260).

South Carolina:
1. Charleston, Charleston Co., B. latifrons (p. 260).

Georgia:
1. Brunswick, Glynn Co. (p. 261).
2. Skidaway Island, Chatham Co., Bison sp. indet. (p. 262).

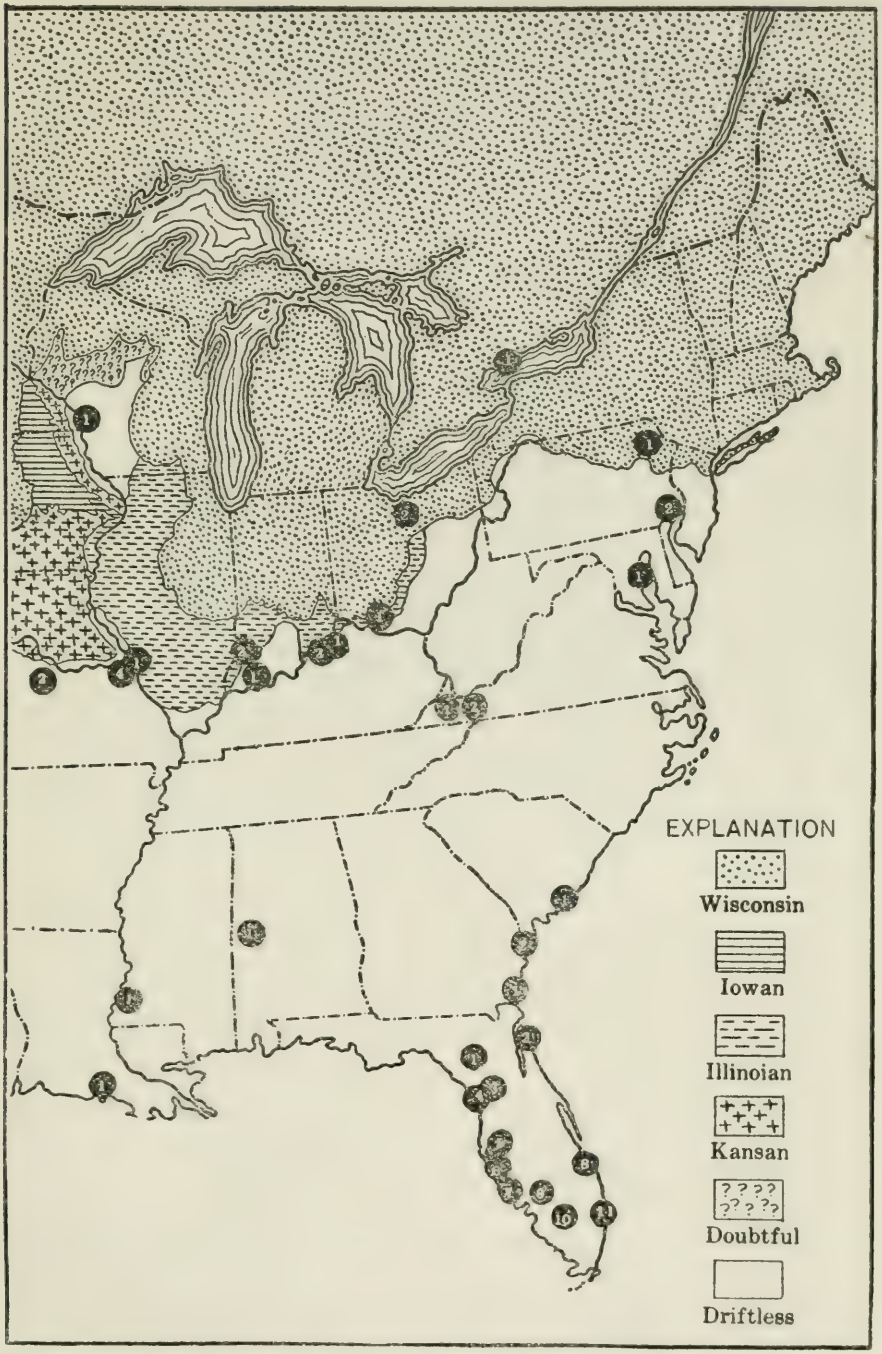
Florida:
1. Wade, Alachua Co., Bison sp. indet. (p. 262).
2. Pablo Beach, Duval Co., Bison sp. indet. (p. 262).
3. Ocala, Marion Co., B. latifrons (p. 262).
4. Dunnellon, Marion Co., Bison sp. indet. (p. 263).
5. Tampa, Manatee Co., Bison sp. indet. (p. 263).
6. Palmetto and Palma Sola, Manatee Co., Bison sp. indet. (p. 2
7. Grove City, Charlotte Co., B. latifrons (p. 263).
8. Vero, St. Lucie Co., Bison sp. indet. (p. 263).
9. Arcadia, De Soto Co., Bison sp. indet. (p. 264).
10. Labelle, Lee Co., B. latifrons? (p. 264).
11. Palm Beach, Palm Beach Co., B. latifrons? (p. 264).

Alabama:
1. Newbern, Hale Co., Bison sp. indet. (p. 264).

Mississippi:
1. Natchez, Adams Co., B. latifrons? (p. 264).

Kentucky:
1. Woolper Creek, Boone Co., B. latifrons (p. 264).
2. Bigbone Lick, Boone Co., B. antiquus (p. 264).

MAP 26.

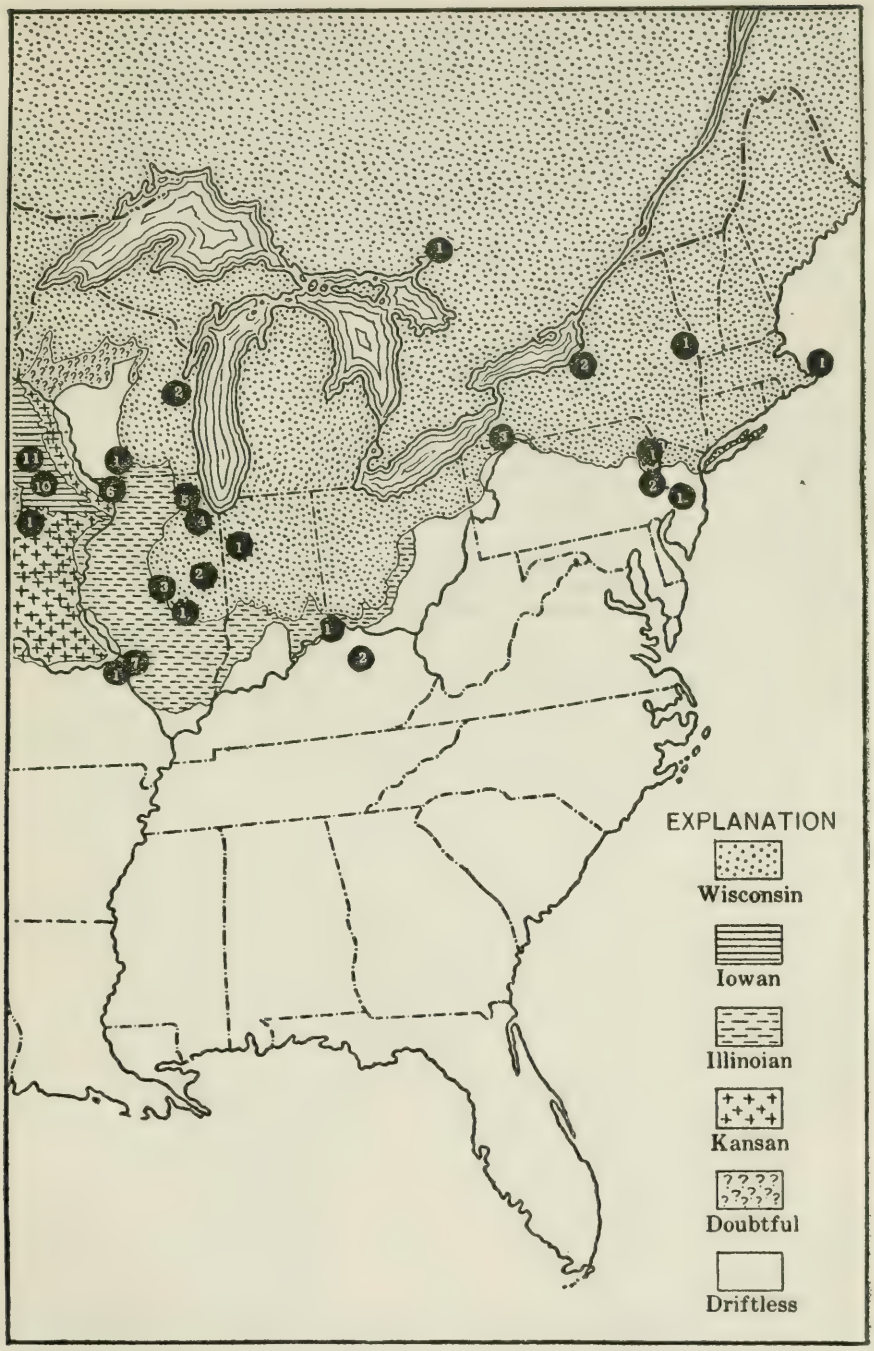


Distribution of extinct bisons in eastern North America during the Pleistocene.
For explanation see page 458.

EXPLANATION OF MAP 27.

Ontario:
1. North Bay, Nipissing Co. (p. 266).
Massachusetts:
1. Orleans, Barnstable Co. (p. 266).
New York:
1. Albany, Albany Co. (p. 266).
2. Syracuse, Onondaga Co. (p. 266).
3. Jamestown, Chautauqua Co. (p. 267).
New Jersey:
1. Trenton, Mercer Co. (p. 267).
Pennsylvania:
1. Stroudsburg, Monroe Co. (p. 267).
2. Riegelsville, Bucks Co. (p. 267).
Indiana:
1. —— Jasper Co. (p. 268).
Illinois:
1. Sullivan, Moultrie Co. (p. 268).
2. Homer, Champaign Co. (p. 268).
3. Niantic, Macon Co. (p. 269).
4. Whitewillow, Kendall Co. (p. 269).
5. Batavia, Kane Co. (p. 269).
6. Galena, Jo Daviess Co., this species? (p. 269).
Wisconsin:
1. Bluemounds, Dane Co. (p. 270).
2. Oshkosh, Winnebago Co. (p. 270).
Kentucky:
1. Bigbone Lick, Boone Co. (p. 270).
2. Bluelick Springs, Nicholas Co. (p. 271).

MAP 27.



Finds of the existing bison (*Bison bison*) in the Pleistocene of eastern North America
For explanation see page 460.

EXPLANATION OF MAP 28.

New York:
1. Clyde, Wayne Co. (p. 272).
2. Canastota, Madison Co. (p. 272).

Pennsylvania:
1. Stroudsburg, Monroe Co. (p. 272).

Ohio (See Map 29).

Michigan:
1. Berrien Co. (p. 275).
2. Adrian, Lenawee Co. (p. 275).
3. Ann Arbor, Washtenaw Co. (p. 275).
4. Attica, Lapeer Co. (p. 276).
5. Owosso, Shiawassee Co. (p. 276).

Indiana (See Map 30).

Illinois:
1. Shawneetown, Gallatin Co. (p. 278).
2. Alton, Madison Co. (p. 279).
3. Charleston, Coles Co. (p. 279).
4. Naperville, Dupage Co. (p. 279).

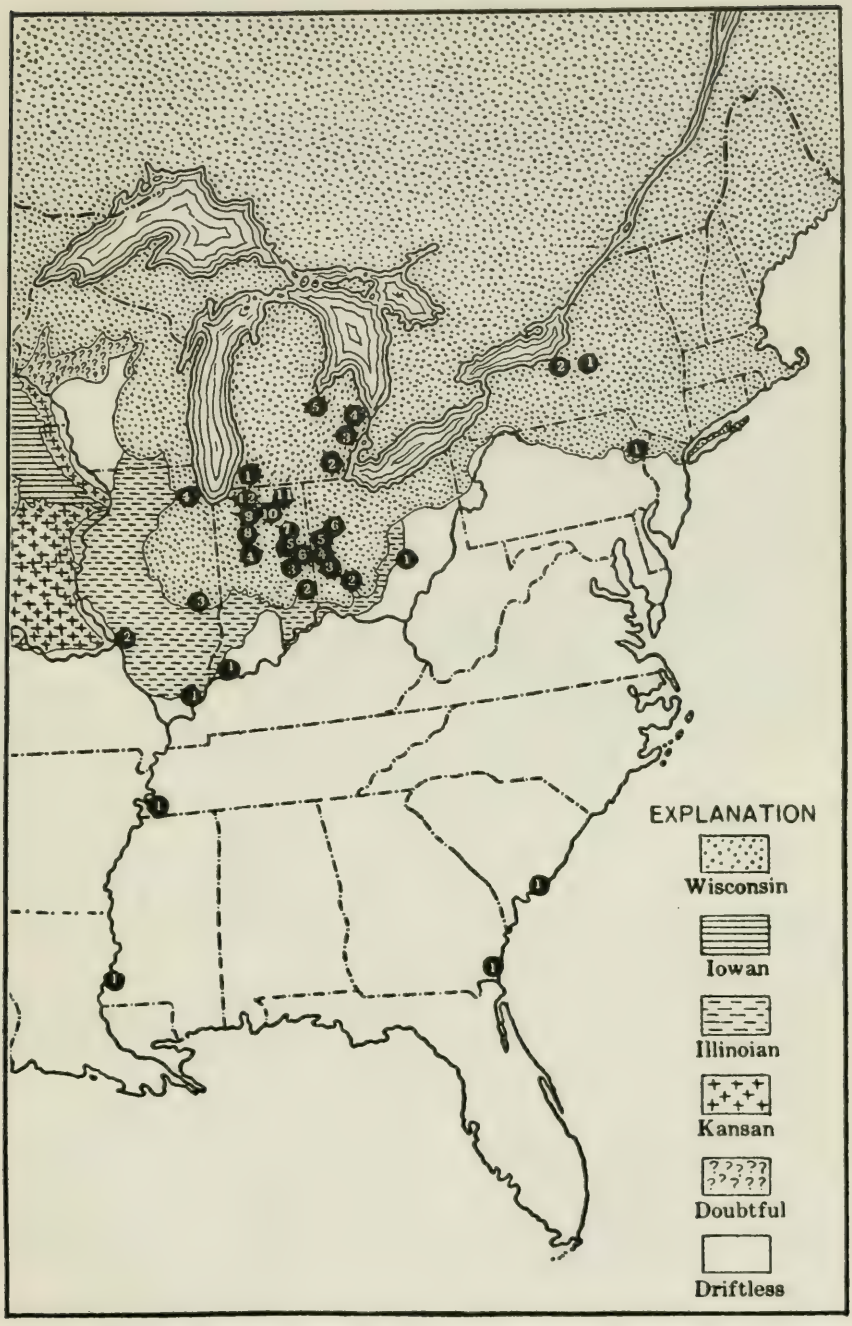
South Carolina:
1. Charleston, Charleston Co. (p. 279).

Georgia:
1. Brunswick, Glynn Co. (p. 280).

Mississippi:
1. Natchez, Adams Co. (p. 280).

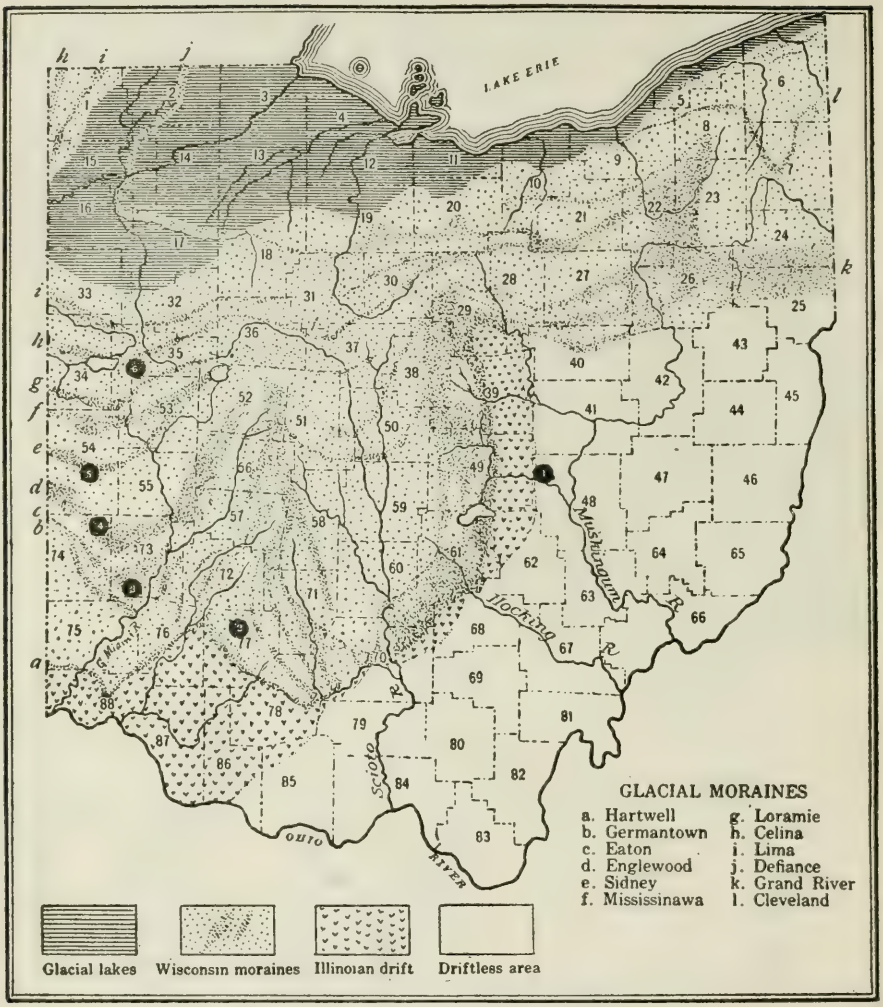
Tennessee:
1. Memphis, Shelby Co. (p. 280).

MAP 28.



Distribution of giant beavers, *Castoroides*, in eastern North America. For explanation see page 462.

Map 29.



Distribution of the giant beaver *Castoroides* in Ohio.

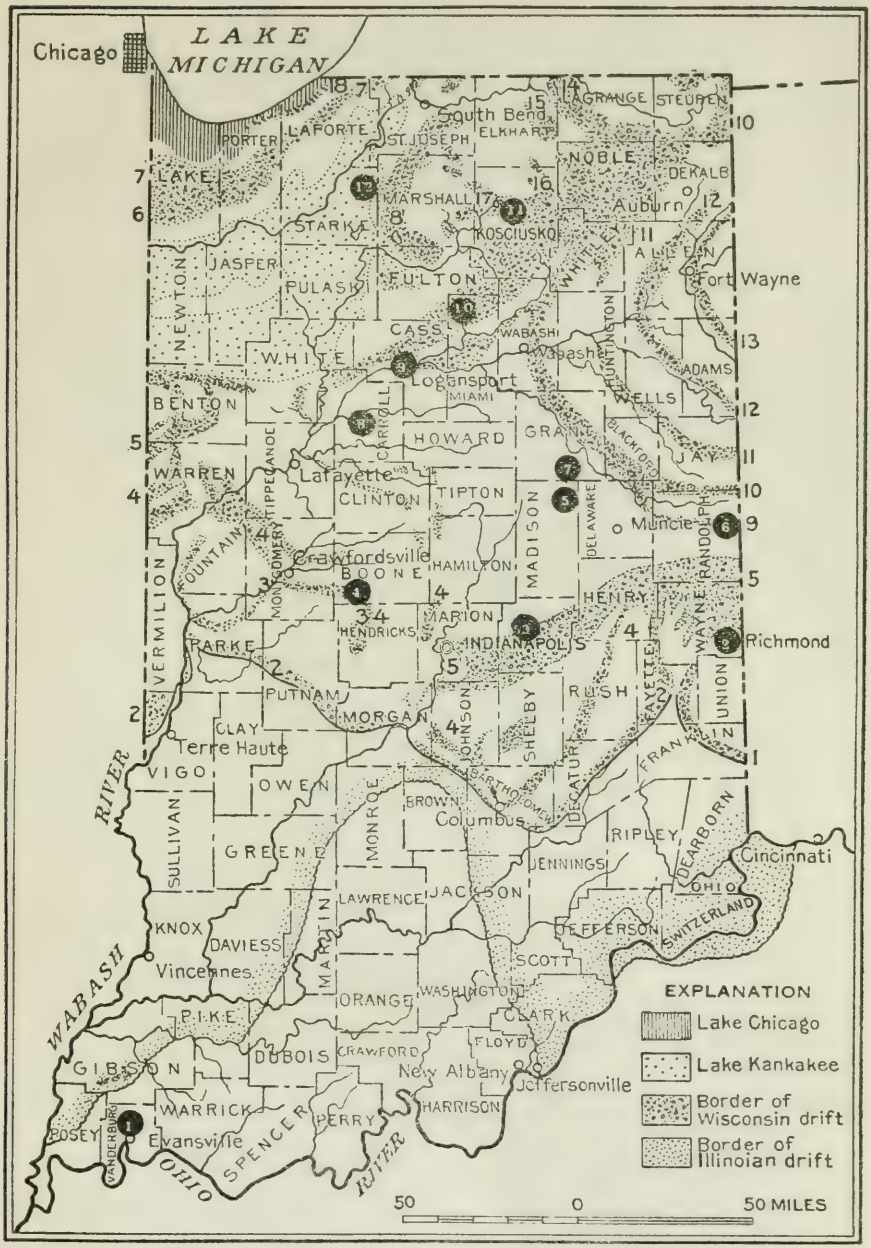
Explanation of Map 29.

Ohio:

1. Nashport, Muskingum Co.* (48) (p. 273).
2. Wilmington, Clinton Co.* (2) (p. 273).
3. Germantown, Montgomery Co.* (73) (p. 274).
4. West Sonora, Preble Co.* (74) (p. 274).
5. Greenville, Darke Co.* (54) (p. 274).
6. New Knoxville, Auglaize Co.* (35) (p. 274).

*These are the numbers which on the map are given to the counties.

MAP 30.



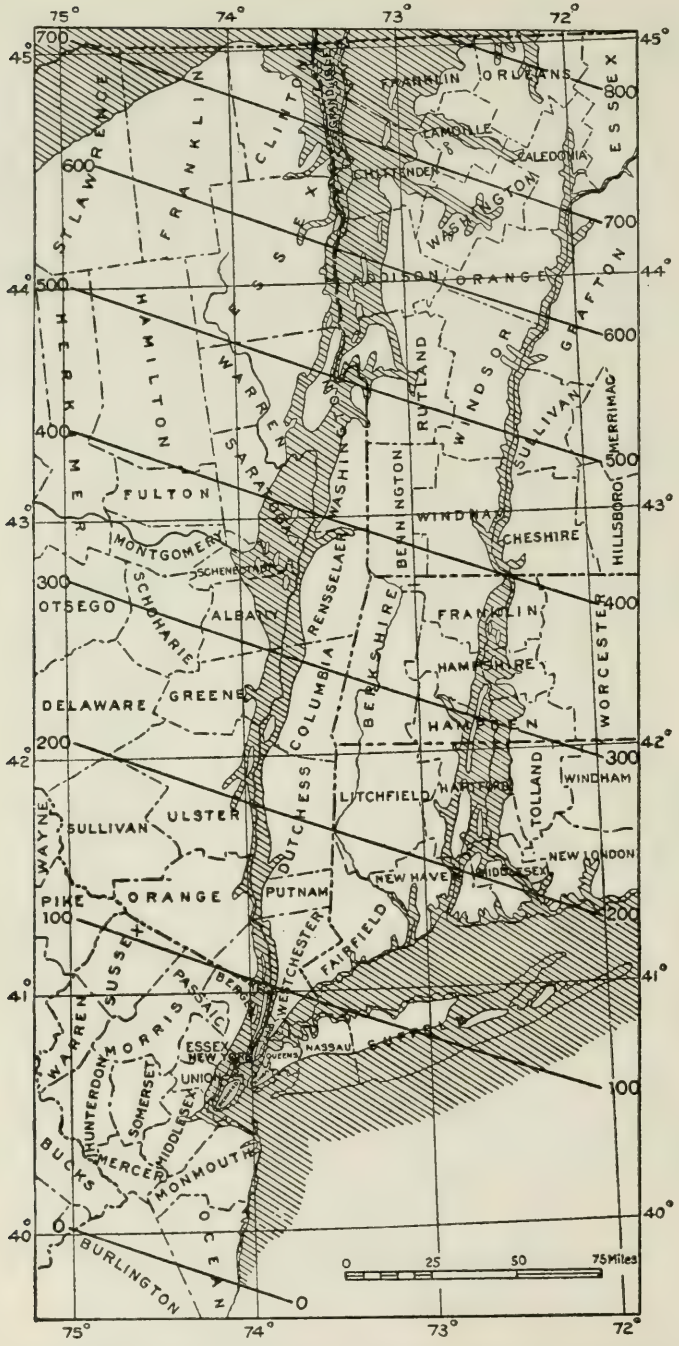
Distribution of the giant beaver *Castoroides* in Indiana.

EXPLANATION OF MAP 30.

1. Vanderburg Co. (p. 276).
2. Richmond, Wayne Co. (p. 276).
3. Greenfield, Hancock Co. (p. 277).
4. Jamestown, Boone Co. (p. 277).
5. Summitville, Madison Co. (p. 277).
6. Union City, Randolph Co. (p. 277).
7. Fairmount, Grant Co. (p. 277).
8. —— Carroll Co. (p. 278).
9. Logansport, Cass Co. (p. 278).
10. Macy, Miami Co. (p. 278).
11. —— Kosciusko Co. (p. 278).
12. Grovertown, Starke Co. (p. 278).

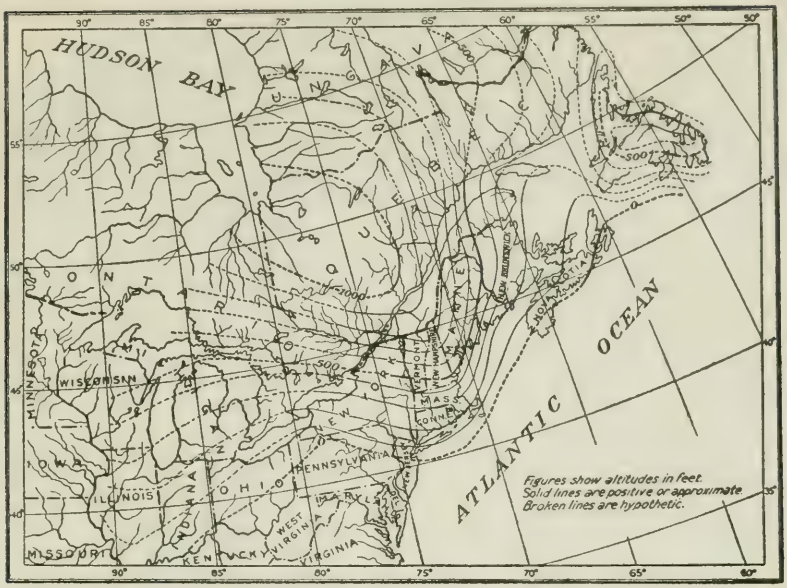
For explanation of the numerals on the margins see map 37.

MAP 31.



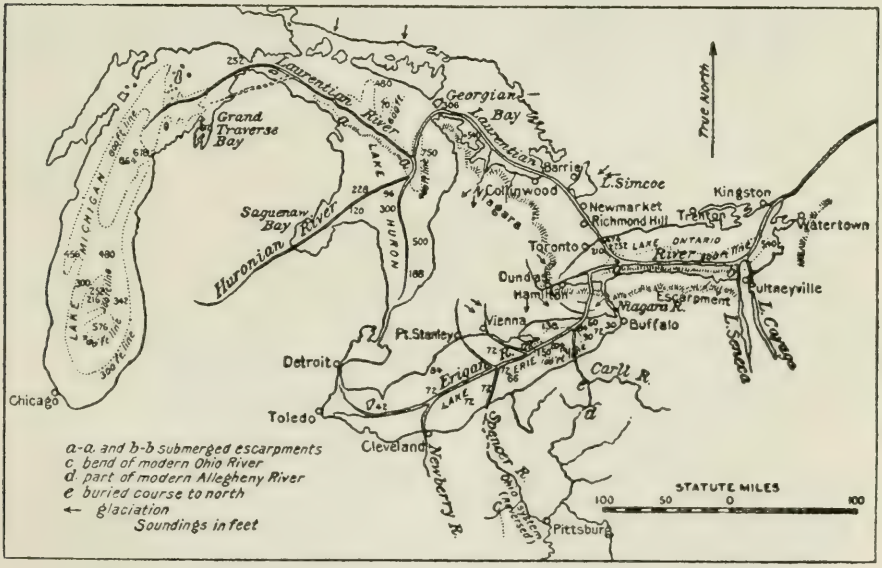
MAP 31.—Shows areas on Long Island and along Connecticut and Hudson Rivers at sea-level near the end of the Pleistocene. Ruled areas submerged. Amount of subsequent elevation indicated in feet at the end of the isobases. Redrawn from Fairchild.

MAP 32.



Isobases of Late Glacial uplift in eastern North America. After Fairchild.

MAP 33.



J. W. Spencer's view of preglacial drainage of the region of the Great Lakes. Redrawn from Spencer and Foshay.

EXPLANATION OF MAP 34.

Mastodon Localities.

New York:

1. New Dorp, Richmond Co. (p. 48).
2. Ridgewood, Kings Co. (p. 49).
3. Jamaica, Queens Co. (p. 49).
4. Inwood, Nassau Co. (p. 49).
5. Riverhead, Suffolk Co. (p. 49).
6. Morrisania, New York Co. (p. 49).
7. New York City (p. 50).
8. Hartsdale, Westchester Co. (p. 50).
9. New Antrim, Rockland Co. (p. 50).
10. Arden, Orange Co. (p. 50).
11. Monroe, Orange Co. (p. 50).
12. Chester, Orange Co. (p. 50).
13. Salisbury Mills, Orange Co. (p. 51).
14. New Windsor, Orange Co. (p. 51).
15. Newburgh, Orange Co. (p. 51).
16. Near Coldenham, Orange Co. (p. 52).
17. East Coldenham, Orange Co. (p. 53).
18. Montgomery, Orange Co. (p. 53).
19. Hamptonburg, Orange Co. (p. 53).
20. Bullville, Orange Co. (p. 53).
21. Scotchtown, Orange Co. (p. 54).
22. Otisville, Orange Co. (p. 54).
23. Shawangunk, Ulster Co. (p. 54).
24. Ellenville, Ulster Co. (p. 54).
25. Poughkeepsie, Dutchess Co. (p. 55).
26. Between Red Bridge and Wurtsboro, Sullivan Co. (p. 55).
27. Claverack, Columbia Co. (p. 55).
28. Freehold, Greene Co. (p. 55).
29. Greenville, Greene Co. (p. 56).
30. Coeymans, Albany Co. (p. 56).

New York—*continued:*

31. Cohoes, Albany Co. (p. 56).
32. Copenhagen, Lewis Co. (p. 56).
33. Center Lisle, Broome Co. (p. 57).
34. Brookton, Tompkins Co. (p. 57).
35. Pony Hollow, Tompkins Co. (p. 58).
36. Elmira, Chemung Co. (p. 58).
37. Lodi, Seneca Co. (p. 58).
38. Macedon, Wayne Co. (p. 58).
39. Seneca Castle, Ontario Co. (p. 58).
40. Perkinsville, Steuben Co. (p. 59).
41. Wayland, Steuben Co. (p. 59).
42. Pittsford, Monroe Co. (p. 59).
43. Rochester, Monroe Co. (p. 59).
44. Scottsburg, Livingston Co. (p. 60).
45. Fowlersville, Livingston Co. (p. 60).
46. Geneseo, Livingston Co. (p. 60).
47. Nunda, Livingston Co. (p. 60).
48. Belvidere, Allegany Co. (p. 60).
49. Pike, Wyoming Co. (p. 61).
50. Attica, Wyoming Co. (p. 61).
51. Leroy, Genesee Co. (p. 61).
52. Stafford, Genesee Co. (p. 61).
53. Batavia, Genesee Co. (p. 61).
54. Holley, Orleans Co. (p. 62).
55. Medina, Orleans Co. (p. 62).
56. Niagara, Niagara Co. (p. 62).
57. Hinsdale, Cattaraugus Co. (p. 62).
58. Conewango, Cattaraugus Co. (p. 62).
59. Buffalo, Erie Co. (p. 63).
60. Jamestown, Chautauqua Co. (p. 63).
61. Westfield, Chautauqua Co. (p. 63).

Map 34.

Map of New York showing the location of the Wisconsin ice not long after it began to retire; also Lakes Newberry and Maumee; also location of finds of mastodons. Geology after Fairchild. For explanation see page 468.

Counties

1. Albany
2. Allegany
3. Broome
4. Cattaraugus
5. Cayuga
6. Chautauqua
7. Chemung
8. Chenango
9. Clinton
10. Columbia
11. Cortland
12. Delaware
13. Dutchess
14. Erie
15. Essex
16. Franklin
17. Fulton
18. Genesee
19. Greene
20. Hamilton
21. Herkimer
22. Jefferson
23. Kings
24. Lewis
25. Livingston
26. Madison
27. Monroe
28. Montgomery
29. Nassau
30. New York
31. Niagara
32. Oneida
33. Onondaga
34. Ontario
35. Orange
36. Orleans
37. Oswego
38. Otsego
39. Putnam
40. Queens
41. Rensselaer
42. Richmond
43. Rockland
44. Saratoga
45. Schenectady
46. Schoharie
47. Schuyler
48. Seneca
49. Steuben
50. St. Lawrence
51. Suffolk
52. Sullivan
53. Tioga
54. Tompkins
55. Ulster
56. Warren
57. Washington
58. Wayne
59. Westchester
60. Wyoming
61. Yates

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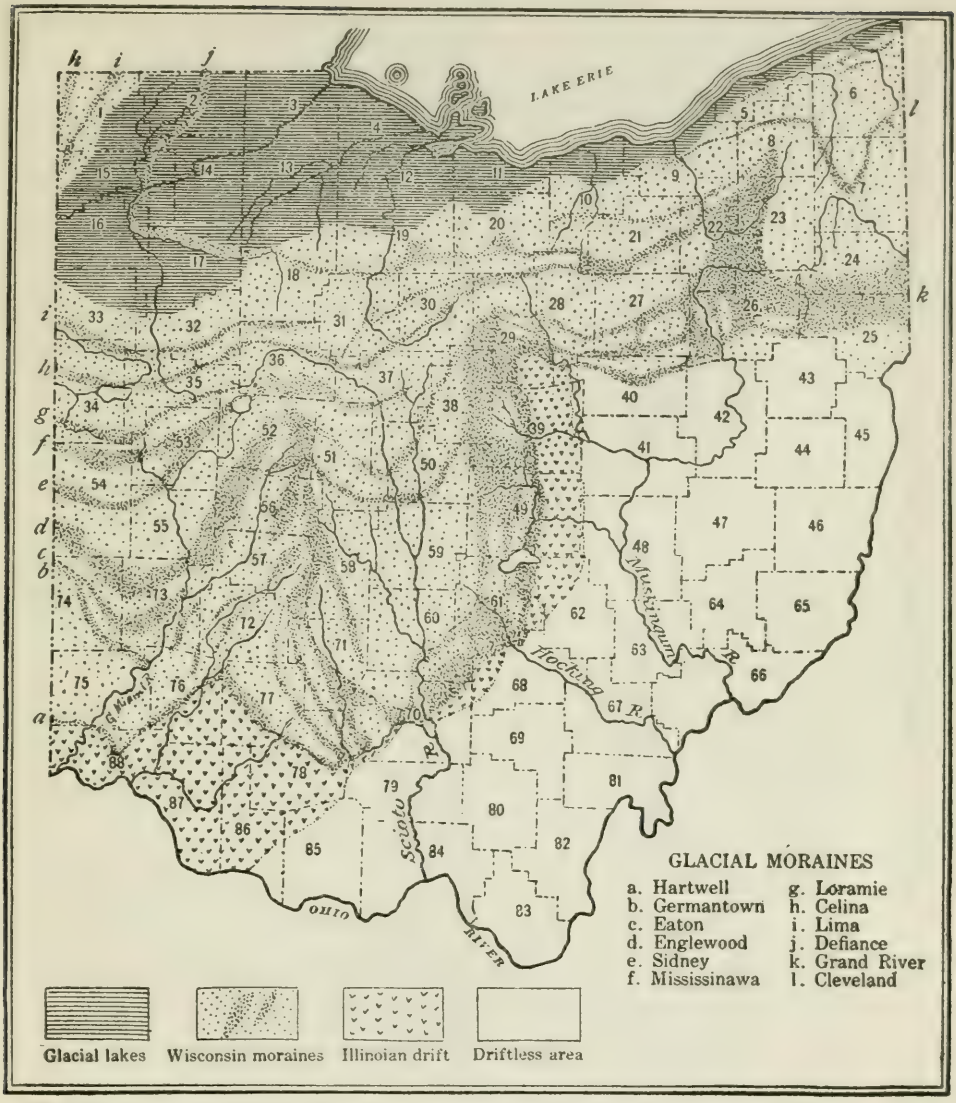
MAP 35.



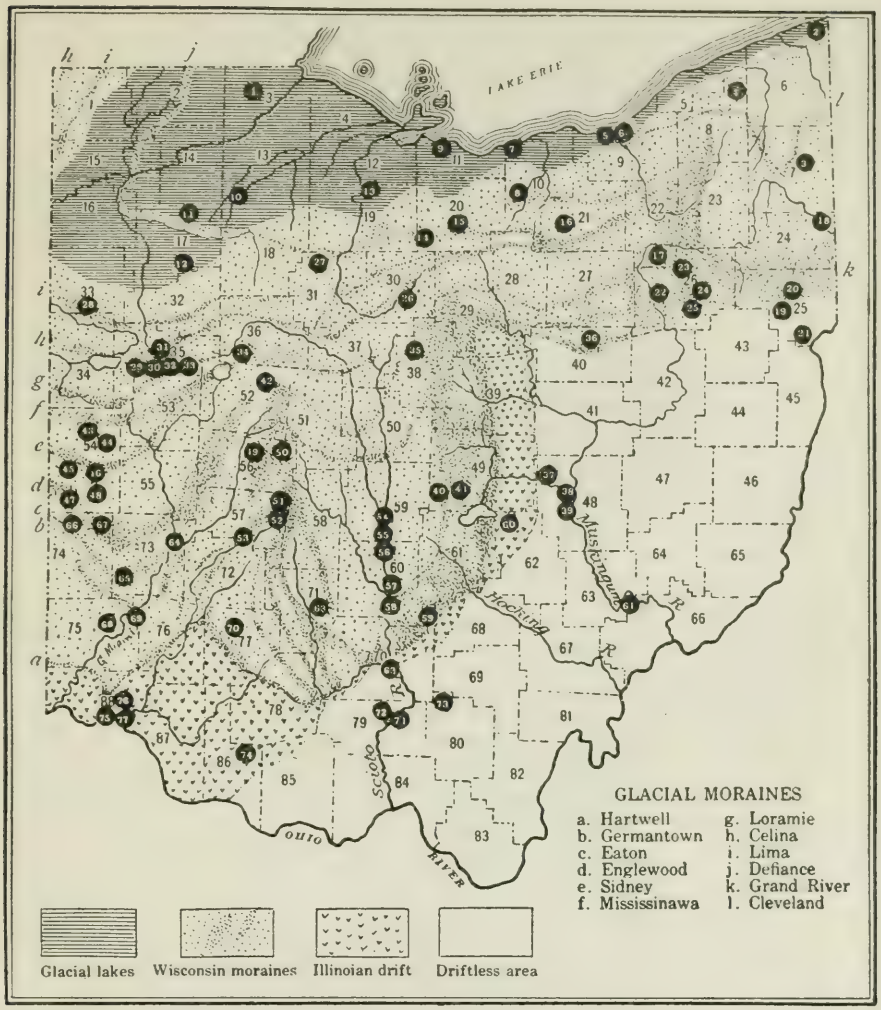
Glacial map of Ohio showing the areas occupied by the Wisconsin and Illinois drifts; also the unglaciated area; also the distribution of the Wisconsin moraines. For names of counties see page 470.

Explanation of Map 35.

Counties of Ohio.

1. Williams.
2. Fulton.
3. Lucas.
4. Ottawa.
5. Lake.
6. Ashtabula.
7. Trumbull.
8. Geauga.
9. Cuyahoga.
10. Lorain.
11. Erie.
12. Sandusky.
13. Wood.
14. Henry.
15. Defiance.
16. Paulding.
17. Putnam.
18. Hancock.
19. Seneca.
20. Huron.
21. Medina.
22. Summit.
23. Portage.
24. Mahoning.
25. Columbiana.
26. Stark.
27. Wayne.
28. Ashland.
29. Richland.
30. Crawford.
31. Wyandot.
32. Allen.
33. Van Wert.
34. Mercer.
35. Auglaize.
36. Hardin.
37. Marion.
38. Morrow.
39. Knox.
40. Holmes.
41. Coshocton.
42. Tuscarawas.
43. Carroll.
44. Harrison.
45. Jefferson.
46. Belmont.
47. Guernsey.
48. Muskingum.
49. Licking.
50. Delaware.
51. Union.
52. Logan.
53. Shelby.
54. Darke.
55. Miami.
56. Champaign.
57. Clark.
58. Madison.
59. Franklin.
60. Pickaway.
61. Fairfield.
62. Perry.
63. Morgan.
64. Noble.
65. Monroe.
66. Washington.
67. Athens.
68. Hocking.
69. Vinton.
70. Ross.
71. Fayette.
72. Greene.
73. Montgomery.
74. Preble.
75. Butler.
76. Warren.
77. Clinton.
78. Highland.
79. Pike.
80. Jackson.
81. Meigs.
82. Gallia.
83. Lawrence.
84. Scioto.
85. Adams.
86. Brown.
87. Clermont.
88. Hamilton.

MAP 36.



Distribution of Pleistocene mammals in Ohio. Glacial map of Ohio. Marks localities where Pleistocene mammals have been discovered.

EXPLANATION OF MAP 36.

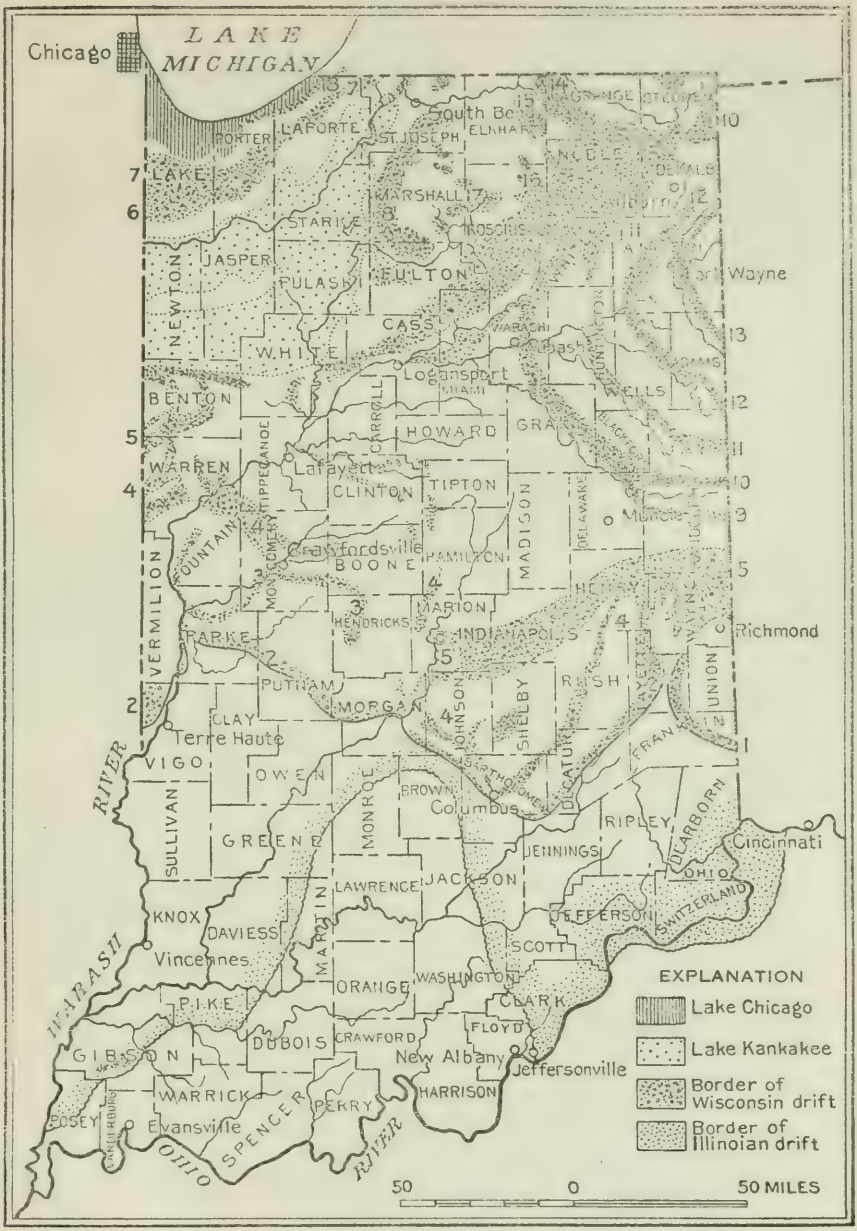
The numerals in the column at the left are those given to the counties on the map. The numerals in the second column are those found on the black circles.

3. Lucas Co.	1. Springfield Township, Mammut (p. 77).
6. Ashtabula Co.	2. Amboy, Elephas primigenius (p. 137); E. columbi (p. 150).
7. Trumbull Co.	3. —— Mammut (p. 80); Symbos (p. 249).
8. Geauga Co.	4. Montville, Elephas sp. indet. (p. 170).
9. Cuyahoga Co.	5. Kamms, Elephas primigenius (p. 136).
	6. Cleveland, Mammut (p. 79); E. primigenius (p. 136); E. sp. indet. (p. 170).
10. Lorain Co.	7. Brownhelm, Mammut (p. 79).
	8. Pittsfield, Mammut (p. 79).
11. Erie Co.	9. Sandusky, Mammut (p. 78).
13. Wood Co.	10. Jackson Township, Mammut (p. 78).
17. Putnam Co.	11. Liberty Township, Mammut (p. 77).
	12. Columbus Grove, Mammut (p. 77).
19. Seneca Co.	13. Old Fort, Mammut (p. 78).
20. Huron Co.	14. Chicago, Elephas primigenius (p. 136).
	15. North Fairfield, Megalonyx (p. 31).
21. Medina Co.	16. —— Mammut? (p. 79).

EXPLANATION OF MAP 36—*continued*

22. Summit Co.	17. Green Township, Mammut (p. 80).
24. Mahoning Co.	18. Youngstown, Symbos (p. 249).
25. Columbiana Co.	19. Millport, Elephas primigenius (p. 135); Equus (p. 186).
	20. Lisbon, Mylohyus (p. 215).
	21. New Salisbury, Tapirus (p. 203).
26. Stark Co.	22. Massillon, Mammut (p. 80).
	23. New Berlin, Elephas primigenius (p. 136).
	24. Canton, Mammut (p. 80); Elephas sp. indet. (p. 170).
	25. —— Elephas columbi (p. 150).
30. Crawford Co.	26. Bucyrus, Mammut (p. 78).
31. Wyandot Co.	27. Carey, Mammut (p. 78); Ursus (p. 78).
33. Van Wert Co.	28. Ohio City, Mammut (p. 77).
35. Auglaize Co.	29. New Knoxville, Mammut (p. 76); Odocoileus (p. 227); Castoroides (p. 274).
	30. Pusheta Township, Mammut (p. 76).
	31. Wapakoneta, Mammut? (p. 76).
	32. Duchouquet Township, Mammut (p. 76).
	33. St. Johns, Mammut? (p. 76).
36. Hardin Co.	34. Roundhead, Mammut (p. 76).
38. Morrow Co.	35. Mt. Gilead, Mammut (p. 75).
40. Holmes Co.	36. Millersburg, Megalonyx (p. 32).
48. Muskingum Co.	37. Nashport, Mammut (p. 70); Castoroides (p. 273); Elephas sp. indet. (p. 169).
	38. Zanesville, E. primigenius (p. 134).
	39. Duncan Falls, E. primigenius (p. 135).
49. Licking Co.	40. Jersey, E. primigenius (p. 136).
	41. Granville, Mammut (p. 75).
52. Logan Co.	42. Harper, Mammut (p. 76).
54. Darke Co.	43. Ansonia, Mammut (p. 74).
	44. Versailles, E. primigenius (p. 136).
	45. 6 miles west of Greenville, Mammut (p. 73).
	46. Greenville, Mammut (p. 73); Castoroides (p. 274).
	47. Fort Jefferson, Mammut (p. 73); Elephas sp. indet. (p. 170).
	48. New Madison, Mammut (p. 73).
56. Champaign Co.	49. Urbana, Mammut (p. 74); Symbos (p. 249).
	50. Woodstock, Mammut (p. 74).
57. Clark Co.	51. Catawba, Mammut (p. 74).
	52. Brighton, Mammut (p. 74).
	53. Selma, Elephas primigenius (p. 136).
59. Franklin Co.	54. Columbus, Equus (p. 186); Platygonus (p. 214).
	55. Shadeville, Mammut (p. 75).
60. Pickaway Co.	56. South Bloomfield, Mammut (p. 75); Elephas sp. indet. (p. 170).
	57. Circleville, Mammut? (p. 75); Elephas sp. indet. (p. 170).
	58. Pickaway Plains, Mammut (p. 75).
	59. Salt Creek, Mammut (p. 75).
62. Perry Co.	60. Chalfants, Platygonus (p. 215).
66. Washington Co.	61. Beverly, Elephas sp. indet. (p. 169).
70. Ross Co.	62. —— Elephas sp. indet. (p. 169).
71. Fayette Co.	63. New Holland, Mammut? (p. 75).
73. Montgomery Co.	64. Dayton, Mammut (p. 72); Elephas primigenius (p. 135).
	65. Germantown, Mammut (p. 71); Castoroides (p. 274).
74. Preble Co.	66. New Paris, Mammut (p. 72).
	67. West Sonora, Mammut (p. 73); Castoroides (p. 274).
75. Butler Co.	68. —— Mammut (p. 71); Elephas primigenius (p. 135).
	69. Overpeck, Ursus procerus (p. 329).
77. Clinton Co.	70. Wilmington, Platygonus (p. 214); Castoroides (p. 273).
79. Pike Co.	71. —— Mammut (p. 70).
	72. Waverly, Elephas primigenius (p. 134).
80. Jackson Co.	73. Little Salt Creek, Elephas sp. indet. (p. 168).
86. Brown Co.	74. Fincastle, Bison latifrons (p. 257).
88. Hamilton Co.	75. Cincinnati, Mammut (p. 71); Elephas sp. indet. (p. 169); Equus (p. 185).
	76. Mount Healthy, Elephas primigenius (p. 135).
	77. Mt. Washington, Mammut (p. 71).

MAP 37.



EXPLANATION OF MAP 37. GLACIAL GEOLOGY OF INDIANA.

The southern limit of the Illinoian drift, from Cincinnati to Jeffersonville, thence north to Brown County, thence southeast to Posey County, is shown by a wavy line limiting a stippled border. The southern limit of the Wisconsin drift is represented by a smooth line and a coarser stippling. North of this terminal moraine are represented important moraines developed during the recession of the Wisconsin ice-sheet.

1.2.2.	Shelbyville moraine	9.10.10.	Mississinawa moraine
3.3.4.4.4.	Champaign moraine	11.	Salamonie moraine
5.5.5.	Bloomington moraine	12.	Wabash moraine
6.7.7.	Valparaiso moraine	13.	Fort Wayne moraine.

Based on Leverett's Glacial Map of Indiana, Plate VI, Monograph LIII of the U. S. Geological Survey.

Explanation of Map 38. Glacial Map of Illinois.

Moraines.

1. Shelbyville moraine. From Indiana line in southern Edgar County runs westward, then northwestward to Peoria. Here it merges with the Bloomington moraine.

2. Champaign moraine. Radiates northwestward, southwestward, and eastward from Champaign.

3. Bloomington moraine. From Indiana line in Vermillion County passes westward through McLean County to Peoria, where it joins the Shelbyville moraine. Thence runs north to Lee County, northeastward to Kane County and north into Wisconsin.

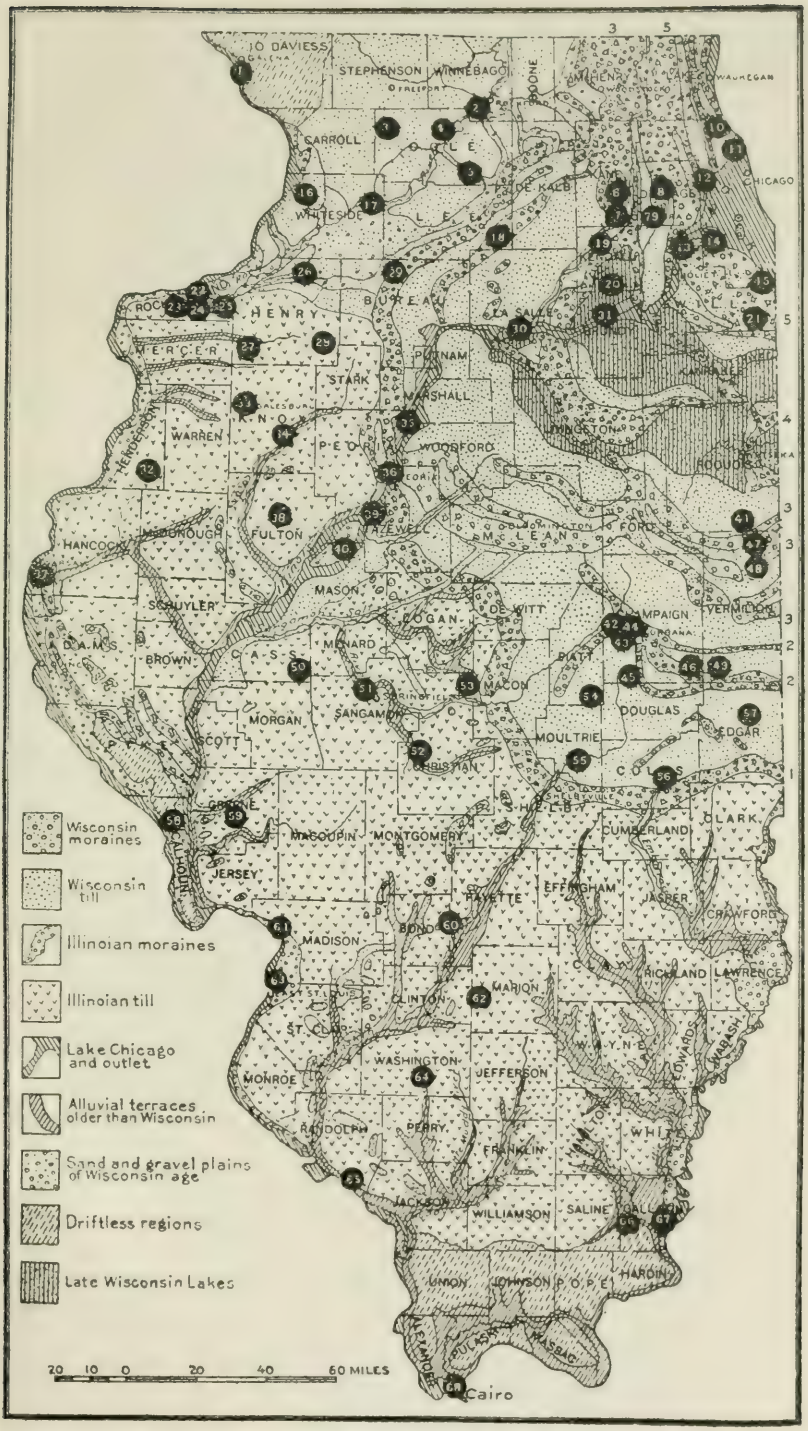
4. Marseilles moraine. Enters from Indiana in northern Iroquois County, passes across northeastern Livingston, eastern La Salle, to eastern Kane County and northward.

5. Valparaiso moraine. Embraces the southern end of Lake Michigan.

Vertebrate Fossils.

Jo Daviess Co.	1. Galena, Megalonyx (p. 34); Anomodon (p. 218); Elephas sp. indet. (p. 178); Platygonus (p. 218); Bison (p. 269).
Winnebago Co.	2. New Milford, Mammut (p. 105).
Ogle Co.	3. Harper, Mammut (p. 105).
	4. Byron, Mammut (p. 105).
	5. Rochelle, Elephas sp. indet. (p. 177).
Kane Co.	6. Batavia, Mammut (p. 110); Cervus (p. 240); Bison bison (p. 269).
	7. Aurora, Mammut (p. 109).
Dupage Co.	8. Wheaton, Elephas sp. indet. (p. 177).
	9. Naperville, Mammut (p. 109); Castoroides (p. 279).
Cook Co.	10. Glencoe, Mammut (p. 110).
	11. Evanston, Mammut (p. 177); Elephas sp. indet. (p. 177); Odocoileus (p. 230); Amiatus (p. 336); Lepomis (336); Merganser (p. 336).
	12. Oak Park, Elephas sp. indet. (p. 177).
	13. Lemont, Odocoileus (p. 230); Ondatra (p. 230).
	14. Palos Park, Cervus (p. 240).
	15. Chicago Heights, E. columbi (p. 153).
Whiteside Co.	16. Union Grove, Cervus (p. 240).
	17. Sterling, Mammut (p. 105).
Lee Co.	18. Pawpaw, Elephas columbi (p. 153).
Kendall Co.	19. Yorkville, Mammut (p. 109).
	20. Whitewillow, Mammut (p. 109); Odocoileus (p. 229);Cervus (p. 240); Alces (p. 240); Cervalces (p. 229); Ovis? (p. 338); Bison bison (p. 269).
Will Co.	21. Beecher, Mammut (p. 107); Cervalces (p. 107); Cervus (p. 241).
Rock Island Co.	22. Rock Island, Elephas sp. indet. (p. 176).
	23. Bowling Township, Mammut (p. 104).
	24. Milan, Mammut (p. 104).
	25. Rural, Mammut (p. 104).
Henry Co.	26. Penny's Slough, Elephas primigenius (p. 142).
	27. Woodhull, Elephas columbi (p. 154).
	28. Kewanee, Elephas primigenius (p. 142).
Bureau Co.	29. Walnut Township, Mammut (p. 105).
La Salle Co.	30. Ottawa, Odocoileus (p. 229).
Grundy Co.	31. Morris, Mammut (p. 108).
Henderson Co.	32. Stronghurst, Elephas primigenius (p. 152).
Knox Co.	33. Galesburg, Elephas sp. indet. (p. 176).
	34. On Spoon River, Mammut (p. 104).
Peoria Co.	35. Chillicothe, Elephas columbi (p. 153).
	36. Peoria, Elephas sp. indet. (p. 176).
Hancock Co.	37. Warsaw, Mammut (p. 103).
Fulton Co.	38. Elephas sp. indet. (p. 176).
Tazewell Co.	39. Pekin, Elephas sp. indet. (p. 176).
Mason Co.	40. Manito, Mammut (p. 103); Symbos (p. 253).

MAP 38.

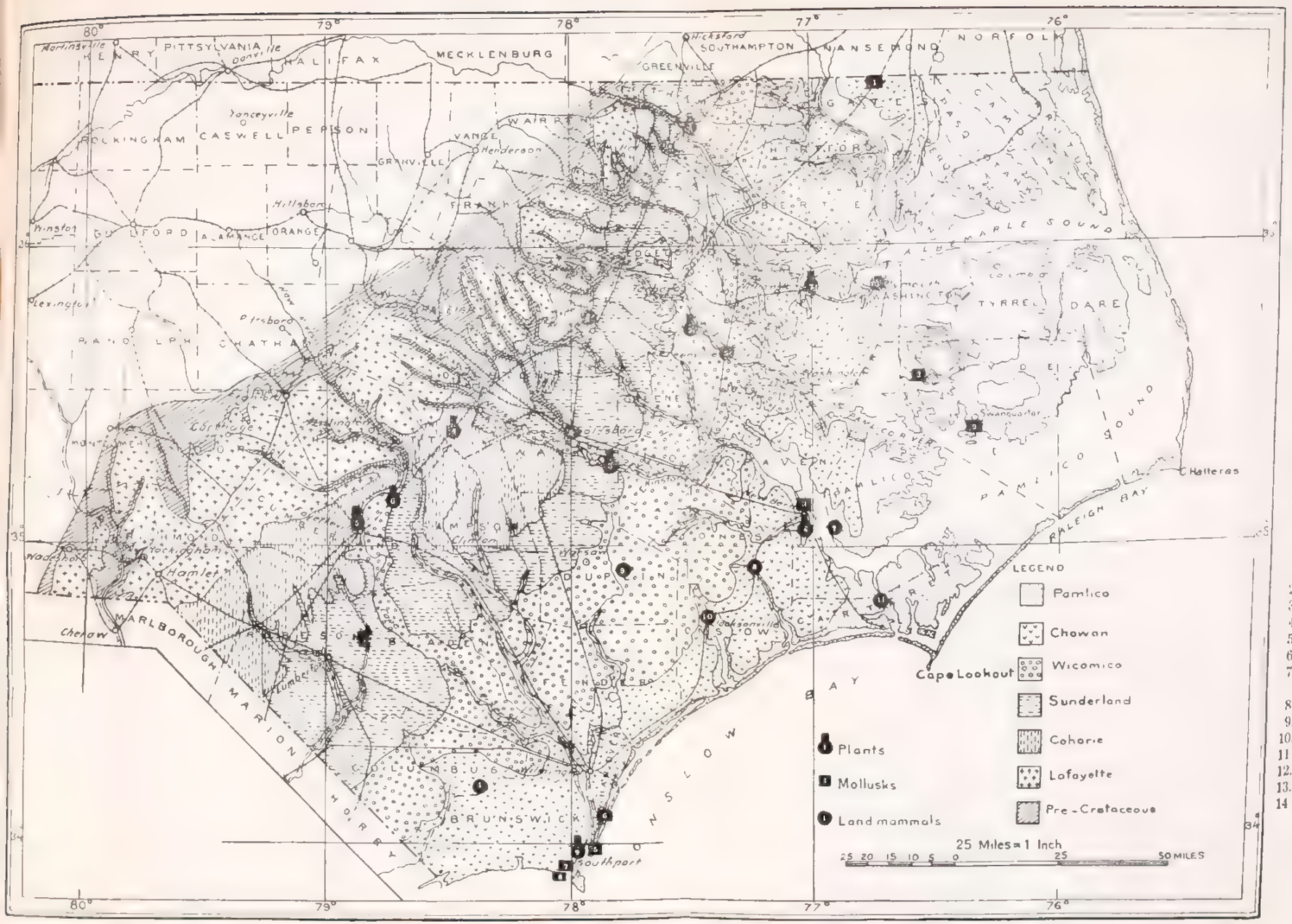


Glacial map of Illinois. Marks also the localities where Pleistocene vertebrates have been discovered. Based on Leverett's map, Plate VI, Monogr. XXXVIII, U. S. Geol. Survey. For explanation see pages 474 and 476.

EXPLANATION OF MAP 38—*continued.*

Iroquois Co.	41. Near Hoopeston, Vermillion Co., Mammut progenium (p. 106).
Champaign Co.	42. Bondville, Symbos (p. 253).
	43. Staley, Elephas columbi (p. 152).
	44. Urbana, Mammut (p. 106); Megalonyx (p. 33).
	45. Pesotum, Mammut (p. 106).
	46. Homer, Bison bison (p. 268).
Vermilion Co.	47. East Lynn, Mammut (p. 107).
	48. Rossville, Mammut (p. 107).
	49. Fairmount, Mammut (p. 106).
Cass Co.	50. Ashland, Elephas primigenius (p. 141).
Sangamon Co.	51. On Sangamon River, Elephas sp. indet. (p. 176)
Christian Co.	52. S. Fork Sangamon River, Elephas sp. indet. (p. 175).
Macon Co.	53. Niantic, Mammut (p. 102); Bison bison (p. 269); Cervus (p. 239); Odocoileus (p. 229).
Piatt Co.	54. Atwood, Elephas sp. indet. (p. 177).
Moultrie Co.	55. Sullivan, Bison bison (p. 268).
Coles Co.	56. Charleston, Castoroides (p. 279).
Edgar Co.	57. "Bloomfield," Mammut (p. 106).
Calhoun Co.	58. —— Elephas sp. indet. (p. 175).
Greene Co.	59. —— Equus (p. 187).
Fayette Co.	60. Line of Bond Co., Equus (p. 187).
Madison Co.	61. Alton, Megalonyx (p. 33); Mammut (p. 102); Equus (p. 187); Platygonus (p. 219); Rangifer (p. 246); Symbos (p. 254); Bison (p. 259); Castoroides (p. 279); Geomys, etc. (p. 339).
Marion Co.	62. Sandoval, Mammut (p. 102).
St. Clair Co.	63. East St. Louis, Mammut (p. 101).
Washington Co.	64. Beaucoup, Mammut (p. 101).
Randolph Co.	65. Chester, Mammut (p. 101); Elephas sp. indet. (p. 175).
Gallatin Co.	66. Equality, Elephas sp. indet. (p. 175).
	67. Shawneetown, Mastodon (p. 100); Castoroides (p. 278).
Alexander Co.	68. Cairo, Elephas primigenius (p. 140).

MAP 39.



PLANTS

1. Weldon, Northampton Co., Wicomico
2. Dupree Landing, Edgecombe Co., Chowan
3. Seven Springs, Wayne Co., Chowan?.
4. Four Oaks, Johnson Co., Coharie.
5. Fayetteville, Cumberland Co., Coharie
6. Wade, Cumberland Co., Sunderland?
7. Wilmington, Bertie Co., Pamlico
8. 10 miles below Newbern, Craven Co., Pamlico
9. Southport, New Hanover Co., Pamlico?.

MOLLUSKS

1. Dismal Swamp, Gates Co., Pamlico?
2. Belhaven, Beaufort Co., Pamlico?.
3. Newbern, Craven Co., Pamlico?.
4. 16 miles below Newbern, Craven Co., Pamlico?
5. Fort Fisher, New Hanover Co., Pamlico?.
6. Carolina Beach, New Hanover Co., Pamlico?
7. Near Southport, New Hanover Co., Pamlico?
8. Ft. Caswell, New Hanover Co., Pamlico?.
9. Swanquarter, Hyde Co., Pamlico?

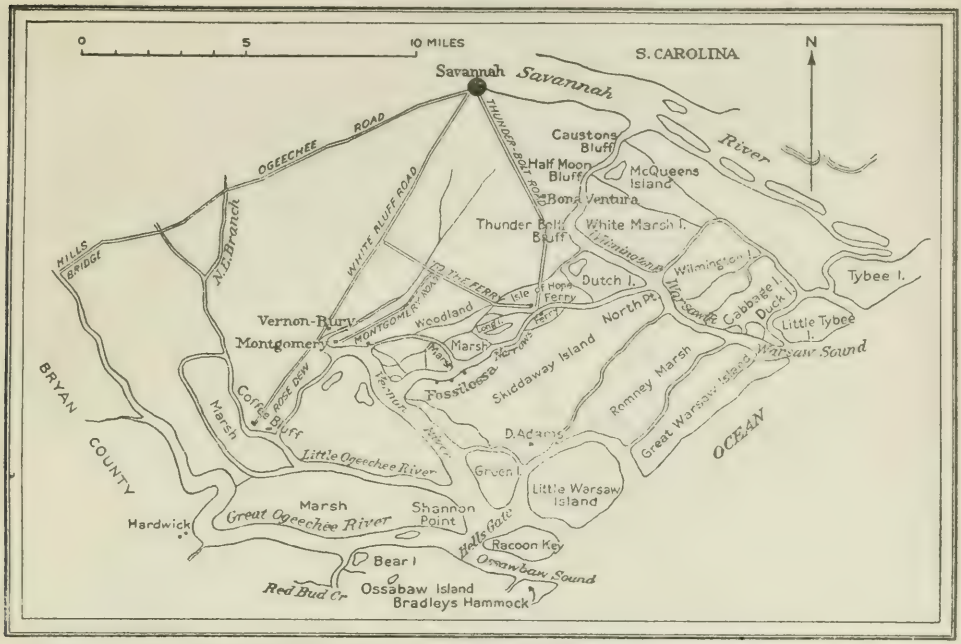
MAMMALS.

1. Rocky Mound, Nash Co., Sunderland Mastodon
2. Tarboro, Edgecombe Co., Wicomico Mastodon
3. Plymouth, Washington Co., Pamlico? Horse
4. — Wilson Co., — ? Mastodon
5. — Pitt Co., Wicomico? Mastodon, horse.
6. Goldsboro, Wayne Co., Sunderland or Wicomico Mastodon.
7. 16 miles below Newbern, Craven Co., Pamlico Horse, mastodon, etc
8. Mayesville, Jones Co., Pamlico. Mastodon.
9. Duplin Co., Wicomico or Sunderland. Mastodon
10. Jacksonville, Onslow Co., Chowan? Mastodon.
11. Harlowe, Carteret Co., Pamlico Co Mastodon, elephant.
12. Elizabethtown, Bladen Co., Sunderland or Wicomico. Horse.
13. — Pender Co., Chowan or Wicomico. Mastodon.
14. 10 miles below Wilmington, New Hanover Co., Chowan? Mastodon, elephant

EXPLANATION OF MAP 39.

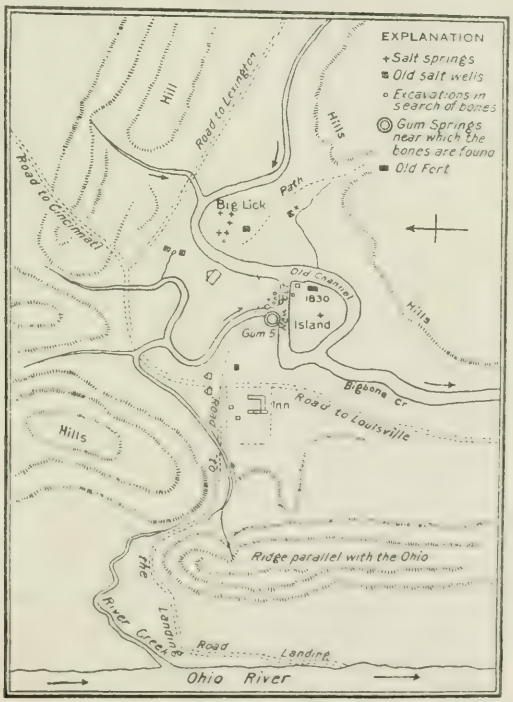
Map of Coastal Plain of North Carolina, showing the localities where fossil organisms have been found, what they are, and their relation to the terraces. The fossils consist of plants, mollusks, and mammals. Each group is indicated by a differently shaped black spot. The information regarding the plants and mollusks has been obtained from Dr. L. W. Stephenson's report on the geology of North Carolina, volume III, 1912, pages 266–303.

MAP 40.



Region about Savannah, Georgia, and Skidaway Island. Redrawn from Hodgson's Memoir.

MAP 41.



Bigbone Lick and vicinity, Kentucky. After Cooper.

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