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The Evolution of the Horse

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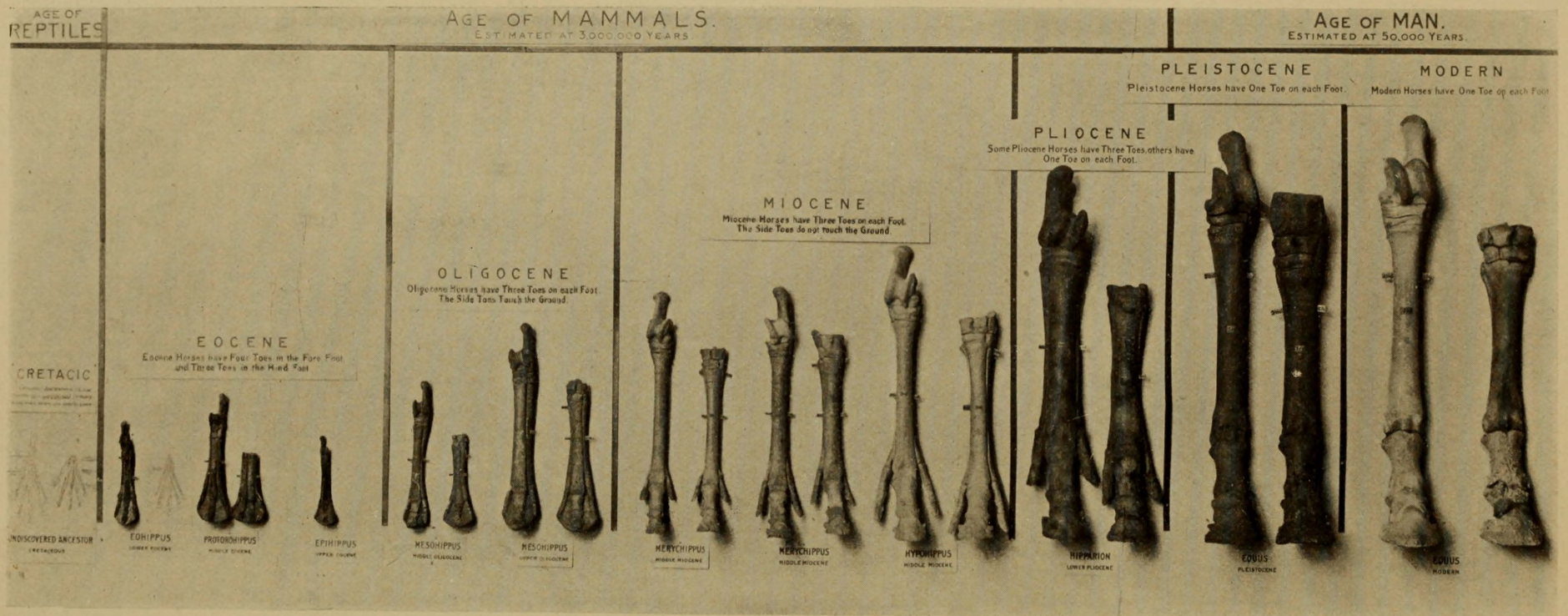


EVOLUTION OF THE HORSE. FEET

Series on exhibition in the American Museum

ILLUSTRATIONS OF EVOLUTION AMONG FOSSIL MAMMALS.

A.— The Horse.

By W. D. Matthew, Ph.D.,
Associate Curator, Department of Vertebrate Palæontology.

As a domestic animal the Horse is to be found almost everywhere that man can live. He is spread all over the world — from torrid to arctic climates, in all the continents, in remote oceanic islands — he is completely cosmopolitan. But as a wild animal the Horse is at present limited to the Old World, and is found there only in the open arid or desert plains of Central Asia and Africa. There are two species in Asia, the Asiatic Wild Ass (*Equus hemionus*), and the little known Przewalsky's Horse (*E. przewalskii*), while in Africa there are the African Wild Ass (*E. asinus*) and the several species of Zebra (*E. zebra*, *E. burchelli*, *E. quagga*). In the Americas and Australia there are no true wild horses, the mustangs and broncos of the Western Plains and South America being *feral* (domesticated animals run wild) and descended from the horses brought over from Europe by the early white settlers. When the Spaniards first explored the New World they found no horses on either continent. The Indians were quite unfamiliar with them and at first regarded the strange animal which the newcomers rode with wonder and terror, like that of the ancient Romans when Pyrrhus and his Greeks brought elephants—"the huge earth-shaking beast"[1] —to fight against them.

The Horse is distinguished from all other animals now living by the fact that he has but one toe on each foot. Comparison with other animals shows that this toe is the third or middle digit of the foot. The hoof corresponds to the nail of a man or the claw of a dog or cat, and is broadened out to afford a firm, strong support on which the whole weight of the animal rests. Behind the "cannon-bone" of the foot are two slender little

[1] Macaulay —"The Battle of Lake Regillus."

bones, one on each side, called *splint-bones*. These represent the second and fourth digits of other animals, but they do not show on the surface, and there is nothing like a separate toe. So that the horse may be said to be an animal that walks on its middle finger-nail, all the other fingers having disappeared.

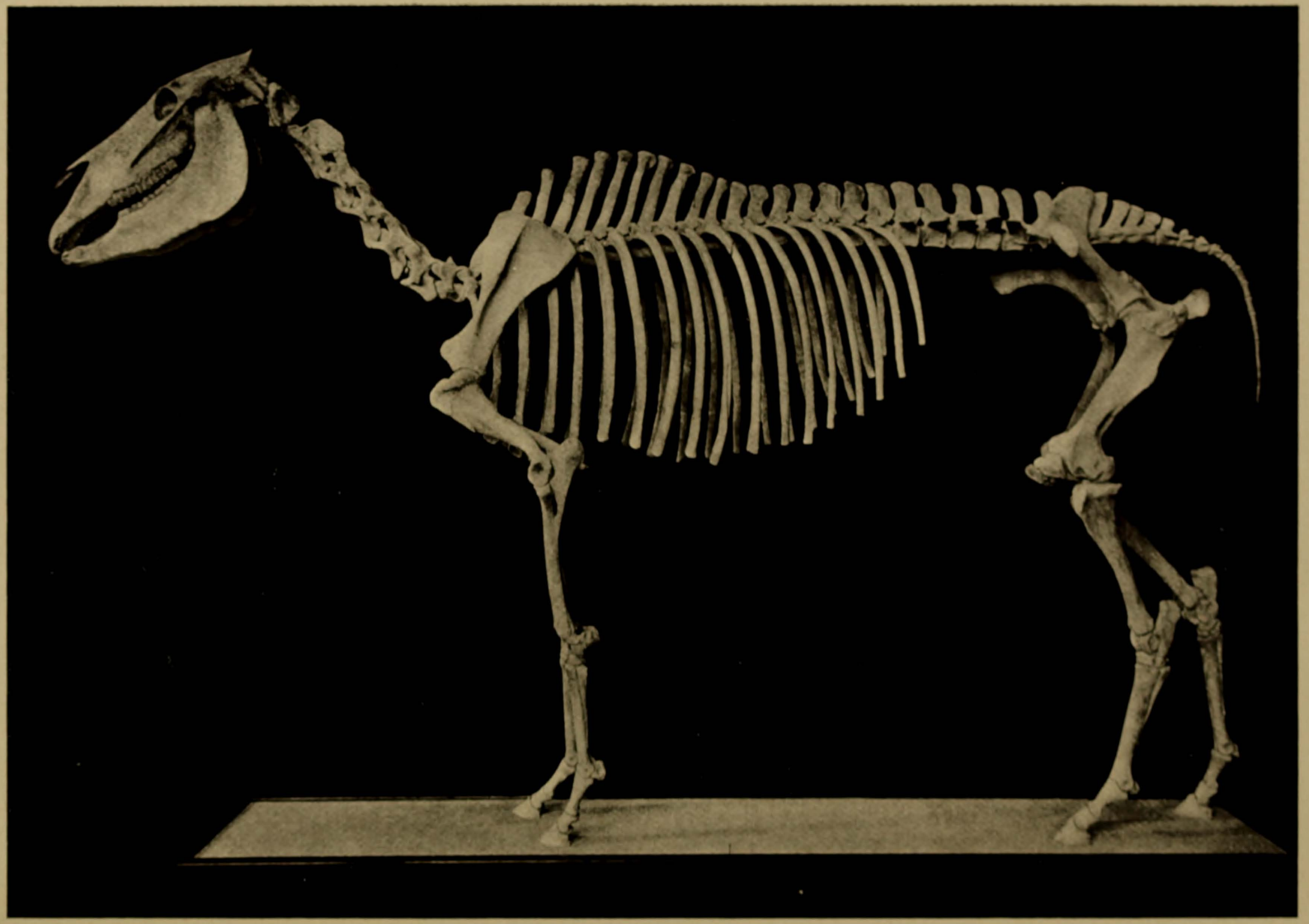
The teeth of the horse are almost equally peculiar. The molars are long, square prisms which grow up from the gums as fast as they wear off on the crowns. Their grinding surface exhibits a peculiar and complicated pattern of edges of hard enamel between which are softer spaces composed of dentine and of a material called "cement," much like the dentine in quality but formed in a different way. The dentine is formed on the inside surfaces of the enamel while the tooth is still within the jaw-bone; the cement is deposited on the outside surfaces of the enamel after the tooth has broken through the jaw-bone and before it appears above the gums.

Various other peculiarities distinguish the Horse from most other animals; some of these are shared by other hoofed animals. The two long bones of the fore-arm (*radius* and *ulna*) are separate in the greater number of animals, but in the Horse, and in many other hoofed animals they are consolidated into a single bone. The same consolidation is seen in the bones of the lower leg (*tibia* and *fibula*). The lengthening of the foot and stepping on the end of the toe raises the heel in the Horse, as in many other animals, to a considerable height above the ground, where it forms the hock joint, bending backward, as the knee bends forward. In these as in various other ways the legs of the horse are especially fitted for swift running over hard and level ground, just as its teeth are for grinding the wiry grasses which grow on the open plain.

The Zebra and the Ass have the same peculiar structure of teeth and feet as the Domestic Horse, and differ only in the color of the skin, proportions of various parts of the body etc.

Fossil Horses of the Age of Man.

The Age of Man, or Quaternary Period, is the last and by far the shortest of the great divisions of geological time. It includes the Great Ice Age or Glacial epoch (Pleistocene), when heavy



SKELETON OF "EQUUS SCOTTI," FROM THE LOWER PLEISTOCENE OF TEXAS

Mounted in the American Museum

continental glaciers covered the northern parts of Europe and North America, and the Recent Epoch, of more moderate climate during which civilization has arisen.

In the early part of the Quaternary Period, wild species of Horse were to be found on every continent except Australia. Remains of these true native horses have been found buried in strata of this age in all parts of the United States, in Alaska, in Mexico, in Ecuador, Brazil and Argentina, as well as in Europe, Asia and Africa. All these horses were much like the living species and most of them are included in the genus *Equus*. A complete skeleton of one of them (*Equus scotti*) found by the American Museum expedition of 1899 in Northern Texas, is mounted in the large wall-case. The difference between it and the Domestic Horse (see framed diagram of modern horse skeleton) is chiefly in proportions, the skull shorter with deeper jaws, the legs rather short and feet small in proportion to the body. In these characters this fossil horse resembles an overgrown zebra rather than a domestic horse. We know nothing of its coloring. It may have been striped, and in this case would have been very zebra-like; but there are some reasons for believing that it was not prominently striped. The bones are petrified, brittle and heavy, the animal matter of the bone having entirely disappeared and having been partly replaced by mineral matter. They are not much changed in color, however, and are so perfectly preserved that they look almost like recent bone.

All the remains of these native horses which have been found in America have been petrified more or less completely; this means that they have been buried for many thousands of years, for petrifaction is an exceedingly slow process.[1] It serves as an easy method of distinguishing them from bones of the Domestic Horse, found buried in the earth. These cannot in any case have been buried for more than four or five centuries, and have not had time to petrify.

Remains of these fossil horses from various parts of the United States are shown in the counter-case. One very rich

[1] The so-called petrifaction which occurs in some hot springs, coating objects dipped into them with a white, stony coat of lime is not true petrifaction. In true petrifaction the substance of the bone is replaced particle by particle with mineral matter.

locality is on the Niobrara river in Nebraska, another in central Oregon. Many separate teeth and bones have been found in the phosphate mines near Charlestown, S. C.; other specimens have come from central Florida, from southern Texas, Arizona, Kansas, Louisiana and even from Alaska. They are, in fact, so often found in deposits of rivers and lakes of the latest geological epoch (the Pleistocene) that the formation in the western United States has received the name of Equus Beds.

In South America, in strata of the Pleistocene Epoch, there occurs, besides several extinct species of the genus *Equus*, the *Hippidium*, a peculiar kind of Horse characterized by very short legs and feet, and some peculiarities about the muzzle and the grinding teeth. The legs were hardly as long as those of a cow, while the head was as large as that of a racehorse or other small breed of the Domestic Horse.

All these horses became extinct, both in North and South America. Why, we do not know. It may have been that they were unable to stand the cold of the winters, probably longer continued and much more severe during the Ice Age than now. It is very probable that man — the early tribes of prehistoric hunters — played a large part in extinguishing the race. The competition with the bison and the antelope, which had recently migrated to America — may have made it more difficult than formerly for the American Horse to get a living. Or, finally, some unknown disease or prolonged season of drought may have exterminated the race. Whatever the cause, the Horse had disappeared from the New World when the white man invaded it (unless a few individuals still lingered on the remote plains of South America), and in his place the bison had come and spread over the prairies of the North.

In Central Asia, two wild races persist to the present day; others were domesticated by man in the earliest times, and their use in Chaldæa and Egypt for draught and riding is depicted in the ancient mural paintings. In Africa the larger species became extinct in prehistoric times, as in America, but the smaller zebras still survive in the southern part of the continent (one species, the Quagga, abundant fifty years ago, is now probably extinct), and the African Wild Ass is found in the fauna of the northern

THE EVOLUTION OF THE HORSE.

		Formations in Western United States and Characteristic Type of Horse in Each	Fore Foot	Hind Foot	Teeth
Quaternary or Age of Man	Recent, Pleistocene	SHERIDAN — Equus	One Toe. Splints of 2nd and 4th digits	One Toe. Splints of 2nd and 4th digits	Long-Crowned, Cement-covered
Tertiary or Age of Mammals	Pliocene	BLANCO			
	Miocene	LOUP FORK — Protohippus	Three Toes. Side toes not touching the ground	Three Toes. Side toes not touching the ground	
	Oligocene	JOHN DAY — Mesohippus	Three Toes. Side toes touching the ground; splint of 5th digit	Three Toes. Side toes touching the ground	Short-Crowned, without Cement
		WHITE RIVER			
	Eocene	UINTA	Four Toes		
		BRIDGER — Protorohippus			
		WIND RIVER			
		WASATCH — Hyracotherium (Eohippus)	Four Toes. Splint of 1st digit	Three Toes. Splint of 5th digit.	
		PUERCO AND TORREJON			
Age of Reptiles	Cretaceous, Jurassic, Triassic				

Hypothetical Ancestors with Five Toes on Each Foot and Teeth like those of Monkeys etc.

part. The Wild Horse of prehistoric Europe, a small race, short-legged and shaggy-haired, was domesticated by man, a fact that is known from the rude drawings scratched on bone or ivory by men of the Neolithic or Polished Stone Age. But the Domestic Horse now in use is derived chiefly from the Asiatic race, although it is probable that in some breeds there is a considerable strain of this shaggy, short-legged European race, and it is possible also that African races may have been domesticated and to some extent mixed with the Asiatic species. The domesticated Ass is a descendant of the African species.

The Evolution of the Horse.

The history of the evolution of the Horse through the Tertiary period or Age of Mammals affords the best known illustration in existence of the doctrine of evolution by means of natural selection and the adaptation of a race of animals to its environment. The ancestry of this family has been traced back to nearly the beginning of the Tertiary without a single important break. During this long period of time, estimated at nearly three millions of years, these animals passed through important changes in all parts of the body, but especially in the teeth and feet, adapting them more and more perfectly to their particular environment, namely the open plains of a great plateau region with their scanty stunted herbage, which is the natural habitat of the Horse.

In the series of ancestors of the Horse we can trace every step in the evolution of those marked peculiarities of teeth and feet which distinguish the modern Horse from an ancestor which so little suggests a horse that, when its remains were first found forty years ago, the animal was named by the great palæontologist Richard Owen, the *Hyracotherium* or "Coney-like Beast." Its relation to the Horse was not at that time suspected by Professor Owen, and was recognized by scientific men only when several of the intermediate stages between it and its modern descendant had been discovered. On the other hand this first ancestor of the Horse line is very difficult to distinguish from the contemporary ancestors of tapirs and rhinoceroses, and indicates how all the

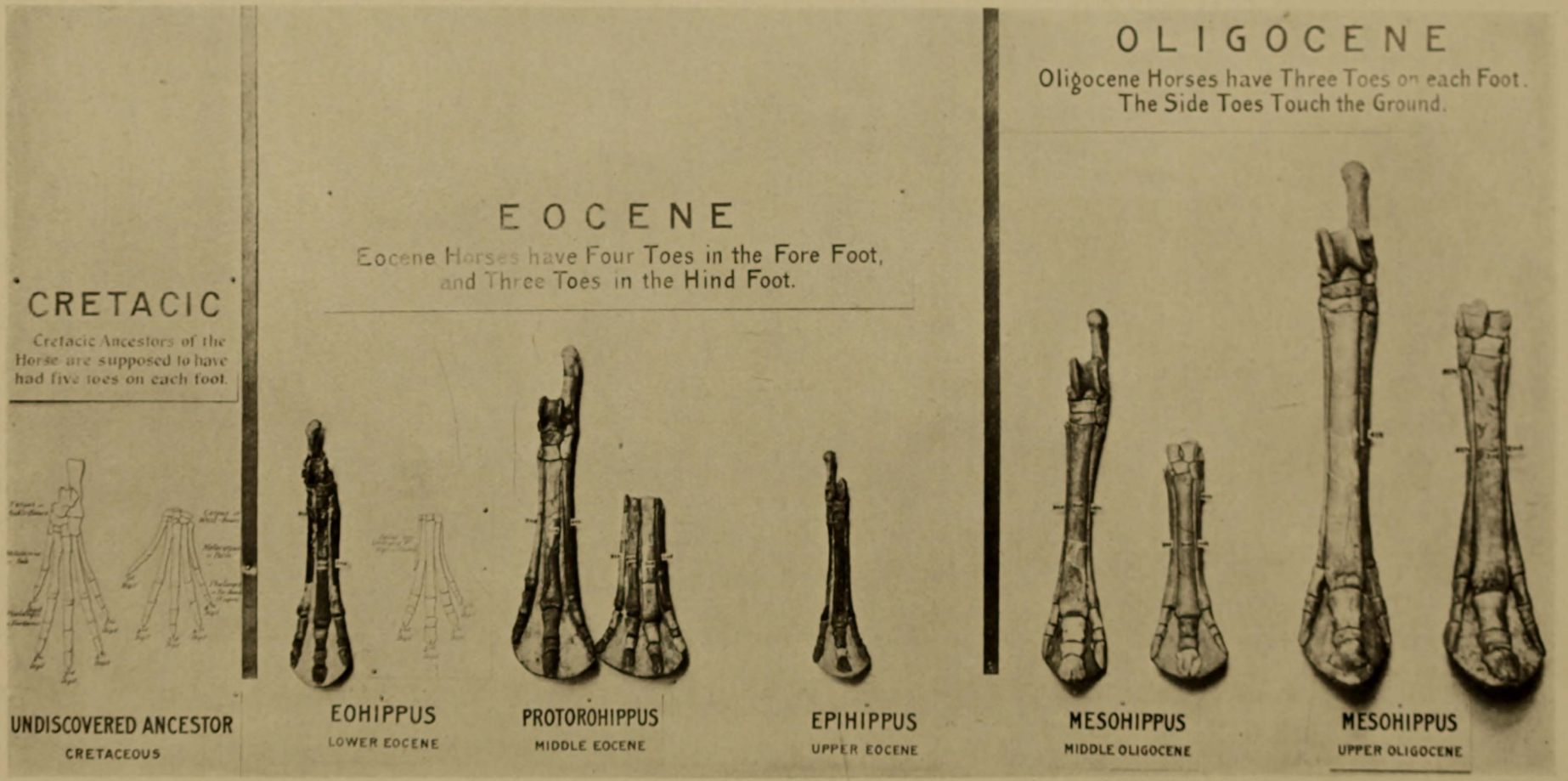
modern quadrupeds have diverged from a single type, each becoming adapted to the needs of its especial mode of life.

The earliest known ancestors of the Horse were small animals not larger than the domestic cat, with four complete toes on each forefoot and three on each hindfoot. There is reason to believe that the still more ancient ancestors of this and all other mammals had five toes on each foot. In the forefoot of the earliest known stage we find a splint-bone or small, slender rudiment representing the missing first digit or thumb, which no longer appears on the surface of the foot, while in the hindfoot there is a similar rudiment representing the outer or fifth digit, but no trace is left of the innermost or first digit. The proportions of the skull, the short neck and arched back and the limbs of moderate length, were very little horse-like; recalling, on the contrary, some modern carnivorous animals, especially the civets (*Viverridæ*). The teeth were short-crowned and covered with low rounded knobs of enamel, suggesting those of monkeys and of pigs or other omnivorous animals, but not at all like the long-crowned complicated grinders of the Horse.

Commencing with the *Hyracotherium*, twelve stages have been recognized from as many successive formations, showing the gradual evolution of the race into its modern form, and each stage is characteristic of its particular geological horizon. Some of the stages have been found in several parts of the world, but by far the most complete and best known series comes from the Tertiary Badlands of the Western States. Besides the main line of descent which led into the modern horses, asses and zebras, there were several collateral branches which have left no descendants. Of some stages all parts of the skeleton have been found; of others only the jaws, or jaws and feet, are known. We can mention only the more important stages.

1 and 2.[1] **Hyracotherium** and **Eohippus.** LOWER EOCENE. The *Hyracotherium* is the most primitive stage known, but only the skull has been found, so that it has not been determined exactly what the feet were like. The teeth display six rounded knobs or cusps on the upper molars and four on the lower ones,

[1] These numbers refer to the stages in the direct line of descent of the modern Horse; see frontispiece.



EARLY STAGES IN THE EVOLUTION OF THE FEET

From the series on exhibition in the American Museum

and these are just beginning to show signs of fusing into cross-crests. The premolar teeth have only one main cusp, except the third and fourth premolars (next the molars) in each jaw, which have two and three, respectively. The only specimens which have been found were in the London Clay or Lower Eocene of England and are preserved in the British Museum.

The *Eohippus* is much better known. It comes from the Lower Eocene of Wyoming and New Mexico, and is very like the *Hy-*

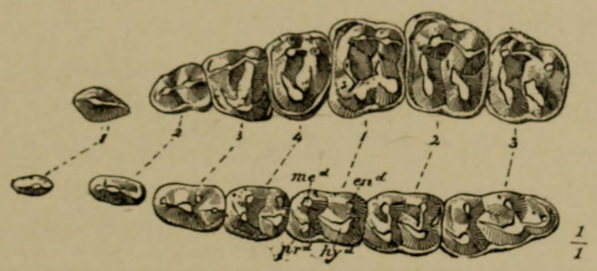


FIG. 1.—UPPER AND LOWER TEETH OF "EOHIPPUS," FROM THE LOWER EOCENE OF WYOMING. NATURAL SIZE

racotherium except that the molar teeth have the cusps more clearly fusing into cross-crests, and the last premolar is beginning to look like one of the true molars. The forefoot of this animal has four complete toes and the splint of a fifth. The hindfoot has three complete toes and the splint of another. A specimen of the hindfoot is shown in the series in the A-case and many incomplete specimens, skulls, jaws etc., of several species in the counter-case.

3 and 4. **Protorohippus** and **Orohippus.** MIDDLE EOCENE. In these animals the splint of the first digit in the forefoot and the splint of the fifth digit of the hindfoot have disappeared, but there are still four complete toes in the fore- and three in the hind-foot. The crests on the molars are a little clearer and the last premolar has become almost like the molars, while the next to the last premolar is beginning to become so. A skeleton of *Protorohippus* is mounted in the wall-case. It shows an animal of the size of a small dog, and proportioned much like the breed known as the *whippet*, of which a skeleton has been placed near by for comparison with the *Protorohippus* skeleton. The *Protoro-hippus* was found by Dr. J. L. Wortman in 1880 in the Wind

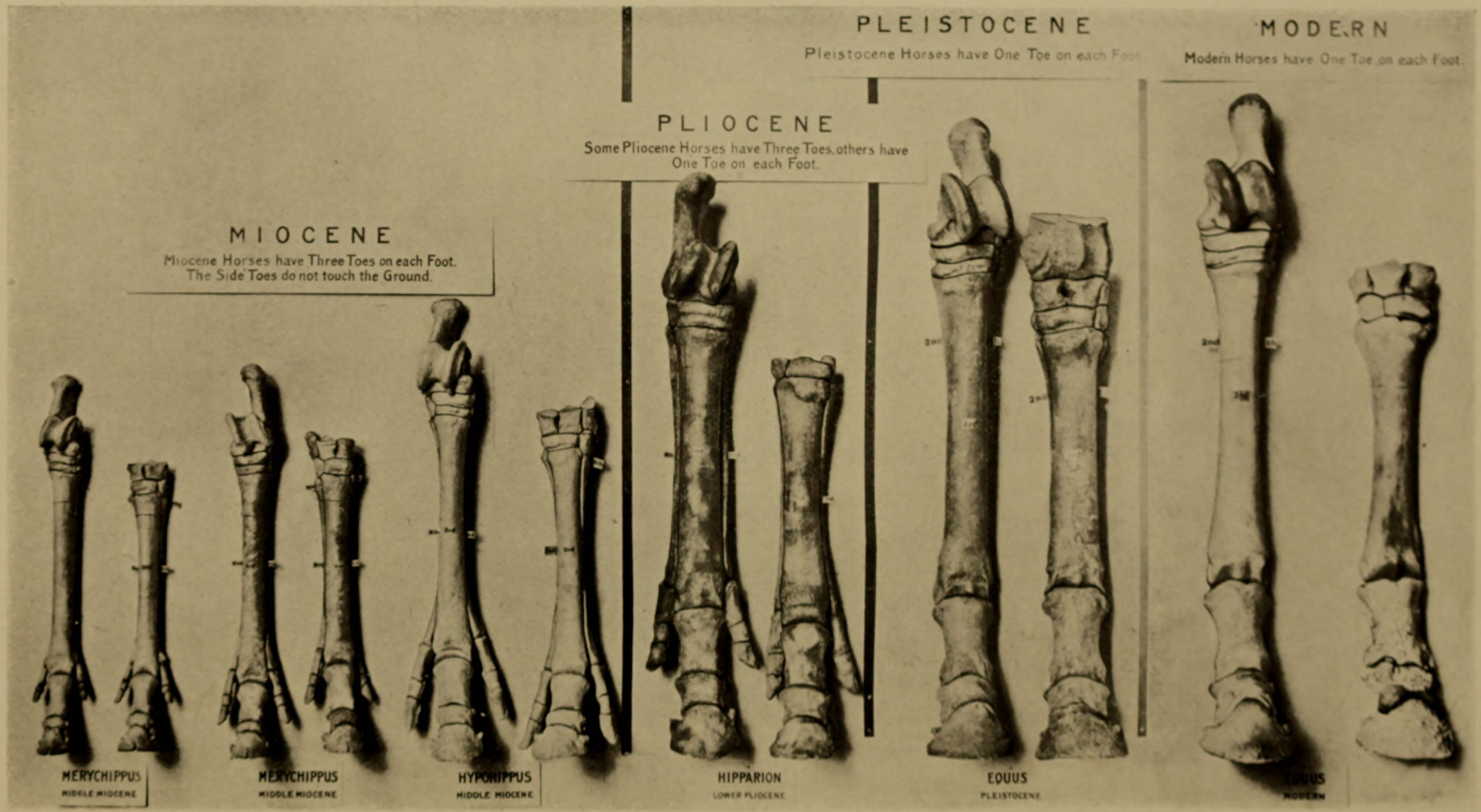
River Badlands of Wyoming, and was described by Professor Cope and others under the name of the "Four-Toed Horse."

Of *Orohippus* we have only parts of jaws and teeth. A specimen of the forefoot is exhibited in the Museum of Yale University.

5. **Epihippus.** Upper Eocene. Of this stage of the evolution of the Horse only incomplete specimens have been found. The molar teeth have the once round cusps almost completely converted into crescents and crests, while another tooth of the premolar series has become like the molars. The toes are still four in the forefoot and three in the hindfoot, but the central toe in each foot is becoming much larger than the side toes, a feature which may be seen in the hindfoot shown in the series in the case. (This species happens to be somewhat smaller than those found in the Middle Eocene stage, but no doubt there were others of larger size living at the same time.)

Palæotherium and *Paloplotherium* of the Upper Eocene of Europe form a side branch of the Horse line. They were very abundant in Europe, but have not been found in the New World. On each foot they had three toes of nearly equal size, and the teeth show a rather peculiar pattern. One of these animals was thought by Professor Huxley to be a direct ancestor of the Horse, but it now is considered to be merely a collateral relative. Some species of *Palæotherium* were of large size, equal to a tapir. They were first described in the year 1804 by the celebrated Baron Cuvier from remains found in the gypsum quarries of Montmartre, Paris. A large series of skulls, jaws, foot-bones etc., from the Upper Eocene of France, is exhibited in one of the counter-cases.

6 and 7. **Mesohippus.** Oligocene (*White River Formation*). In this stage there are three toes on each foot, a splint representing the fifth digit of the forefoot of the Eocene ancestors. The middle toe is now much larger than the side toes, which bear very little of the weight of the animal. Three of the premolars have now become entirely like the molar teeth, the crests on the crown are completely formed, and the outside crest in the upper molars has taken the shape of two crescents. In the Middle Oligocene is found *Mesohippus bairdi* about the size of a coyote,



LATER STAGES IN THE EVOLUTION OF THE FEET

From the series on exhibition in the American Museum

while in the Upper Oligocene occurs *Mesohippus intermedius* as large as a sheep. Of both these animals all parts of the skeleton are known, and a good series of skulls, feet, jaws, palates etc. is

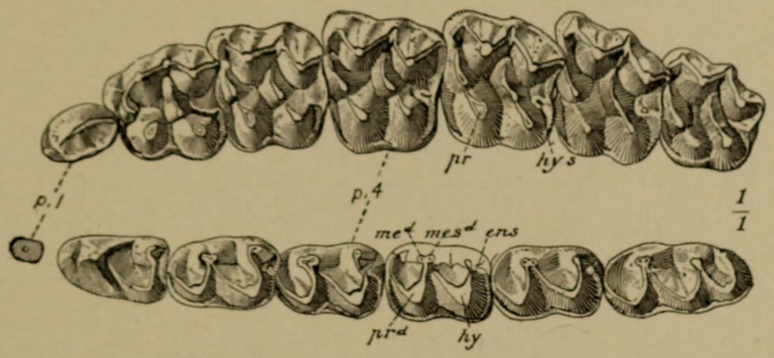


FIG. 2.—UPPER AND LOWER TEETH OF "MESOHIPPUS BAIRDI," FROM THE MIDDLE OLIGOCENE OF SOUTH DAKOTA. NATURAL SIZE

exhibited in the counter-case, besides the specimens shown in the series of feet and in the series of skulls.

8. **Anchitherium.** LOWER MIOCENE. This stage has been found both in Europe and in America. It is much like its predecessor, but is larger and has the crests of the teeth somewhat higher and more complete. It probably is not in the direct line of descent of the horses, but is on a side branch. A palate, jaws, teeth and foot-bones are exhibited here.

9. **Parahippus** and **Hypohippus.** MIDDLE MIOCENE. In *Parahippus* the tooth-crests are much higher, and the transverse ridges on the upper molars are beginning to change shape so as to become a second pair of crescents inside the outer pair. *Hypohippus* is off the direct line of descent; its teeth are like those of *Anchitherium*, by which name it has been generally called, but the animal was much larger, equalling a Shetland pony in size. A complete skeleton of the *Hypohippus* is shown in wall-case 15, and illustrates very well the general characters of the Three-Toed Horses, although it is not in the direct line. This specimen was found near Pawnee Buttes, Colorado, in 1901 by Barnum Brown, of the Whitney expedition. Other incomplete specimens of *Hypohippus*, *Parahippus* and *Merychippus* are shown in the counter-case, and casts of the feet and skull in the evolution series in A-Case 49. It may be observed that in the forefoot of

Hypohippus small rudiments still remain representing the first and fifth digits, but there is no splint of the fifth, as in *Mesohippus*. The second and fourth digits still touch the ground, though lightly.

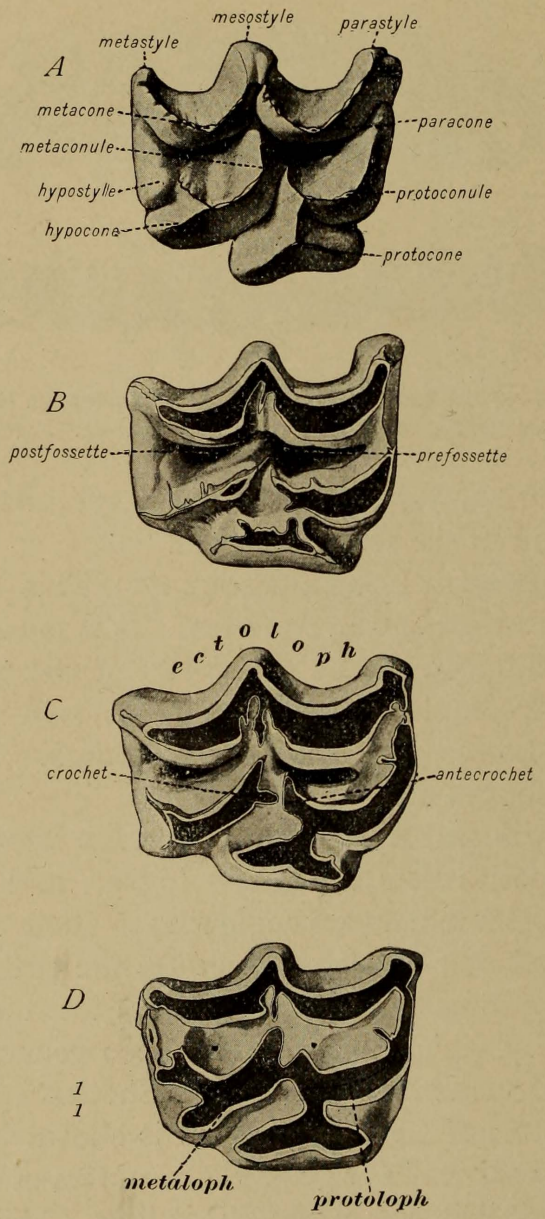


FIG. 3.—UPPER MOLAR OF MODERN HORSE, SHOWING EARLY STAGES OF WEAR OF THE TOOTH. CROWN VIEW. NATURAL SIZE

The feet of *Parahippus* were much like those of *Hypohippus*, but the side toes were smaller.

10 and 11. **Protohippus** and **Pliohippus.** MIDDLE and

THREE-TOED HORSE "HYPOHIPPUS," FROM THE MIDDLE MIOCENE OF COLORADO

Rear view of skeleton, showing small side toes

Upper Miocene. In this stage the crowns of the upper molars have become much longer, the two pairs of crescents on the upper molars are complete, with two half-separated cusps within the inner pair. And the valleys between the crests have become filled with cement, so that with the wear of the teeth the edges of hard enamel are backed inside by dentine and outside by cement. In this way the surface of the tooth has a series of enamel ridges always projecting a little above the grinding surface, because the softer material on each side wears down into hollows, yet never breaking off, because they are braced so thoroughly on each side. This is a very efficient instrument for grinding hard grasses. In *Protohippus* and *Pliohippus*, especially in the former, the crowns of the teeth are by no means as long as in the modern horses; they must therefore wear more slowly or wear out at an earlier age.

The feet in these two genera have but one toe touching the ground. The side toes (second and fourth digits) are complete, but much more slender than in the earlier stages and are apparently useless, as they cannot reach the ground. In some species of *Pliohippus* they have almost disappeared. The forefoot of *Protohippus* still retains tiny nodules of bone at the back of the "wrist" (sometimes improperly called in the Horse the "knee-joint"), which are the remains of the first and fifth digits.

Hipparion. Pliocene. This genus, probably also a side branch of the genealogical tree of the horse family, is much like *Protohippus*, but larger and with more complication about the tooth pattern. It is common in the European Pliocene beds and has been found in America also. The feet are still three-toed, the side toes as large as those of the older *Protohippus*.

12. **Equus.** Pleistocene and Recent. In this stage, that of the modern Horse, the side toes have entirely disappeared and are represented by splints on the fore- and hind-foot. No trace remains on the forefoot of the little nodules which in *Protohippus* represented the first and fifth digits. The crowns of the teeth are much longer than in the last stage, and of the two half-separated inner columns on the upper molars, one has disappeared, the other has increased in size and changed in form. The skull has lengthened and the animal is much larger.

Hippidium. Pleistocene. South America. The feet are like those of *Equus*, except that they were short and stout. The teeth are like those of *Pliohippus*, from which it is supposed to be descended. The skull is large and long with very long slender nasal bones. Casts of the skull and limbs presented by the Museo Nacional of Buenos Ayres, Argentine Republic, are exhibited here.

Meaning of the Change in Feet and Teeth.

Along with the disappearance of the side toes in the evolution of the Horse there is a considerable increase in the proportionate length of the limbs, and especially of the lower part of the leg and foot. The surfaces of the joints, at first more or less of the ball-and-socket kind, which allows free motion of the limb in all directions, become keeled and grooved like a pulley-wheel, permitting free motion forward and backward, but limiting the motion in all other directions and increasing considerably the strength of the joint. By this means the foot is made more efficient for locomotion over a smooth regular surface, but less so for traveling over very rough ground, and it becomes of little use for striking or grasping or the varied purposes for which the feet of polydactyl animals are used.

The increased length in the lower leg and foot increases the length of the stride without decreasing its quickness. The heavy muscles of the leg are chiefly in the upper part, and to increase the length of the lower part changes the centre of gravity of the limb very little. Consequently the leg swings to and fro from the socket nearly as fast as before, since in an ordinary step the action of the leg is like that of a pendulum and the speed of the swing is regulated by the distance of the centre of gravity from the point of attachment, as that of a pendulum is by the height of the bob. To increase the length of lower leg and foot therefore gives the animal greater speed; but it puts an increased strain on the ankles and toe-joints, and these must be strengthened correspondingly by converting them from ball-and-socket joints to "ginglymoid" or pulley joints. Additional strength, likewise at the expense of flexibility, is obtained by the consolidation of the two bones of the fore-arm (*ulna* and

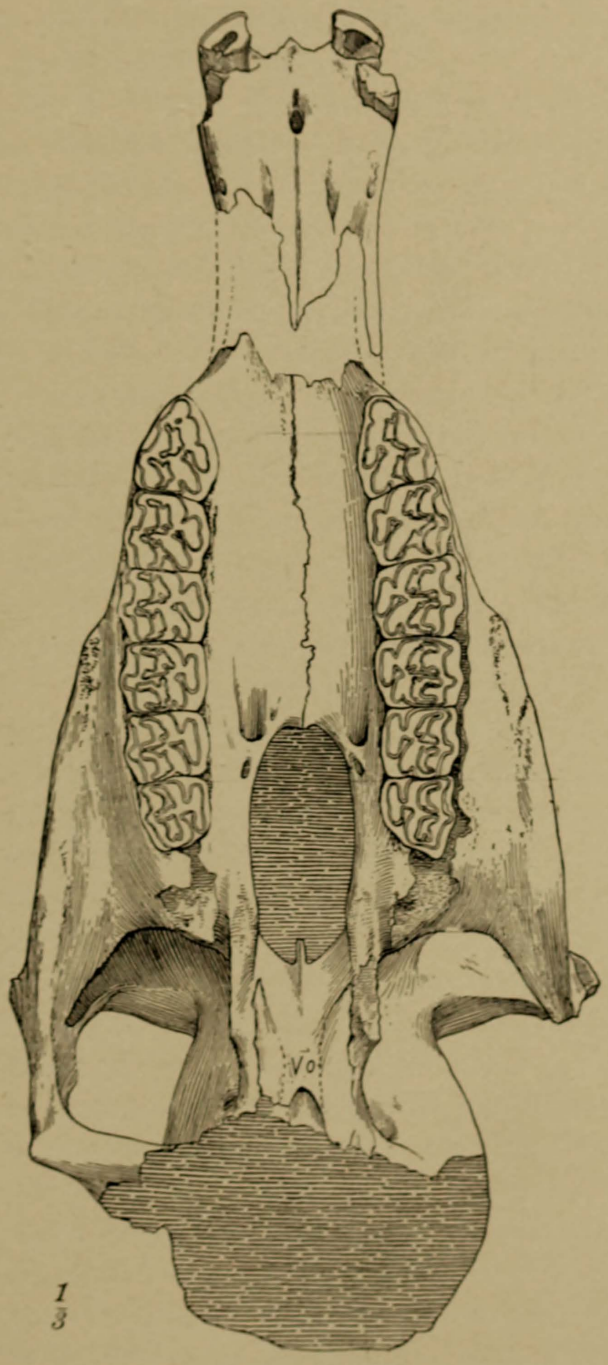


FIG. 4.—PALATE AND UPPER TEETH OF "EQUUS INTERMEDIUS," FROM THE LOWER PLEISTOCENE OF TEXAS. ONE-THIRD NATURAL SIZE

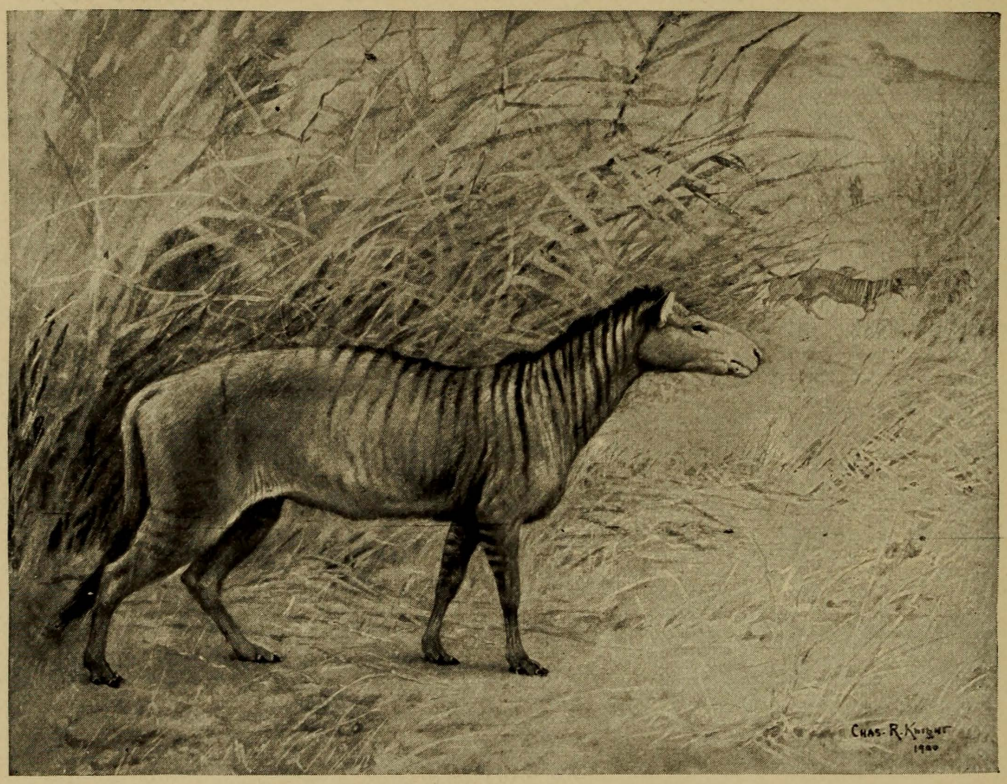
radius) and of the leg (*tibia* and *fibula*) into one, the shaft of the smaller bone practically disappearing, while its ends become fused solidly to its larger neighbor.

The increase in length of limb renders it necessary for the grazing animal that the head and neck should increase in length in order to enable the mouth to reach the ground. An example of these changes is the modern Horse, in which we find the neck and head much elongated when compared with the little *Hyracotherium* and this elongation has taken place *pari passu* with the elongation of the legs. The reduction and disappearance of the side toes and the concentration of the step on the single central toe serve likewise to increase the speed over smooth ground. The soft yielding surface of the polydactyl foot is able to accommodate itself to a rough irregular surface, but on smooth ground the yielding step entails a certain loss of speed. A somewhat similar case is seen in the pneumatic tire of a bicycle; a "soft" tire accommodates itself to a rough road and makes easier riding, but a "hard" tire is faster, especially on a smooth road. Similarly, the hard, firm step from the single toe allows of more speed over a smooth surface, although it compels the animal to pick its way slowly and with care on rough, irregular ground.

The change in the character of the teeth from "brachydont" or short-crowned to "hypsodont" or long-crowned enables the animal to subsist on the hard, comparatively innutritious grasses of the dry plains, which require much more thorough mastication before they can be of any use as food than do the softer green foods of the swamps and forests.

All these changes in the evolution of the Horse are adaptations to a life in a region of the level, smooth and open grassy plains which are now its natural habitat. At first the race was better fitted for a forest life, but it has become more and more completely adapted to live and compete with its enemies or rivals under the conditions which prevail in the high dry plains of the interior of the great continents. The great increase in size, which has occurred in almost all races of animals whose evolution we can trace, is dependent on abundance of food. A large animal, as may be shown on ordinary principles of mechanics, requires more food in proportion to its size than does a

small one, in order to keep up a proper amount of activity. On the other hand a large animal is better able than a small one to defend itself against its enemies and rivals. Consequently, as long as food is abundant, the larger animals have the advantage over their smaller brethren, and by the laws of natural selection the race tends to become continually larger until a limit is reached, when sufficient food becomes difficult to obtain, the



RESTORATION OF THE FOUR-TOED HORSE

Oldest known Ancestor of the Modern Horse; only 16 inches high

Photo from original watercolor by C. R. Knight, based on mounted skeleton in American Museum

animal being compelled to devote nearly all its time to getting enough to eat.

Cause of the Evolution.

The evolution of the Horse, adapting it to live on the dry plains, probably went hand in hand with the evolution of the plains themselves. At the commencement of the Age of Mam-

mals the western part of the North American continent was by no means as high above sea-level as now. Great parts of it had but recently emerged and the Gulf of Mexico still stretched far up the valley of the Mississippi. The climate at that time was probably very moist, warm and tropical, as is shown by the tropical forest trees, found fossil even as far as Greenland. Such a climate, with the low elevation of the land, would favor the growth of dense forests all over the country, and to such conditions of life the animals of the beginning of the mammalian period must have been adapted. During the Tertiary the continent was steadily rising above the ocean-level, and at the same time other influences were at work to make the climate continually colder and drier. The coming on of a cold, dry climate restricted and thinned the forests and caused the appearance and extension of open, grassy plains. The ancient forest inhabitants were forced either to retreat and disappear with the forests, or to adapt themselves to the new conditions of life. The ancestors of the Horse, following the latter course, changed with the changing conditions, and the race became finally as we see it to-day, one of the most highly specialized of animals in its adaptation to its peculiar environment. At the end of the Age of Mammals the continents stood at a higher elevation than at present, and there was a broad land connection between Asia and North America, as well as those now existing. At this time the Horse became cosmopolitan, and inhabited the plains of all the great continents, excepting Australia.

It is a question whether the direct ancestry of the modern Horse is to be searched for in Western America or in the little known interior plains of Eastern Asia. It is also unknown why the various species which inhabited North and South America and Europe during the early part of the Age of Man should have become extinct, while those of Asia (Horse and Wild Ass) and of Africa (Wild Ass and Zebra) still survive. Man, since his appearance, has played an important part in the extermination of the larger animals; but there is nothing to show how far he is responsible for the disappearance of the native American species of horse.

Parallel Evolution in Other Races.

It is interesting to observe that while the evolution of the Horse was progressing during the Tertiary period in North America another group of hoofed animals, the *Litopterna*, now extinct, in South America evolved a race adapted to the broad plains of Argentina and Patagonia and singularly like the Horse in many ways (see exhibit in A-case in centre of hall). These animals likewise lost the lateral toes one after another, and concentrated the step on the central toe; they also changed the form of the joint-surfaces from ball-and-socket to pulley-wheel joints; they also lengthened the limbs and the neck; and they also lengthened the teeth, and complicated their pattern. Unlike the true Horse, they did not form cement on the tooth, so that it was by no means so efficient a grinder. This group of animals native to South America became totally extinct, and were succeeded by the horses, immigrants from North America, which in their turn became extinct before the appearance of civilized man.

Many of the contemporaries of the Horse in the northern hemisphere were likewise lengthening the limbs, lightening and strengthening the feet, elongating the tooth-crowns to adapt themselves to the changing conditions around them, but none paralleled the Horse Evolution quite so closely as did the pseudo-horses of South America. But the camels in America, the deer, antelope, sheep and cattle in the Old World progressed on much the same lines of evolution, although their adaptation was not to just the same conditions of life.

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Means for collecting and preserving representative examples of animals on the verge of extinction.

Means for collecting fossils and geological specimens.

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