

Article XIII.—A NEW THREE-TOED HORSE.

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The Expedition of 1902, sent out by Prof. Henry F. Osborn to explore the Miocene exposures in South Dakota, had the good fortune to obtain, besides other material, a complete skeleton of a large three-toed horse (Amer. Mus. Coll. No. 9815), associated with incomplete skeletons of five other individuals, undoubtedly of the same species.

This splendid specimen, which represents an undescribed genus and species, was discovered by Mr. H. F. Wells, a member of the party, in the upper Miocene deposits on Little White River, near Rosebud Agency, South Dakota.

The characters presented, especially in the teeth, if interpreted according to former authors, would undoubtedly place the present species in the genus *Hipparion*. However, as indicated by a careful study of this new material, and of the abundant material of other Miocene horses in the American Museum collection, together with a comparison with specimens and descriptions of the European forms, it seems probable that the genus *Hipparion* is limited in distribution entirely to the Old World, and that the American species formerly referred to this genus should be placed in a group distinct from *Hipparion*.

Before describing the new skeleton, therefore, the writer wishes to point out the chief characters which distinguish the Old World from the New World forms.

The characters common to both groups are as follows: (1) Column of protocone of the upper molariform teeth entirely surrounded by cement; (2) the lower molars of the milk dentition possess a median external basal tubercle; (3) each foot possesses three complete toes, the lateral ones being much reduced.

The characters which especially distinguish the true *Hipparion* are: (1) Protocone cylindric or subcylindric throughout the greater part of its length. (2) Enamel borders of the

fossettes of the upper molariform teeth very elaborately folded. (3) The middle portion of the external walls of the meta- and paracones is flat or slightly convex. (4) The external median tubercle in the lower milk molars is relatively high and circular in cross-section.

The American group differs from *Hipparion* in the following characters: (1) The protocone is relatively larger and elliptical in cross-section, or with the outer wall flat to concave. (2) The enamel foldings are in general comparatively simple. (3) The external walls of the meta- and paracones are concave. (4) The external median tubercle of the lower milk molars is elliptical in cross-section and less prominent than in *Hipparion*. (5) The limbs and feet, so far as known, indicate a comparatively more slender construction of the long bones and especially longer proportions of the metapodials. There is also apparently a relatively greater reduction of the lateral digits in the American genus.

These characters, as stated above, have the more significance from the fact that nearly all the American species are Miocene, while those of the Old World are of Pliocene age. It will be seen that in the development of the protocone and the ectoloph in the upper teeth, and the proportions of the feet and limbs, the American species, though coming from an older formation, are more progressive than the Pliocene species of Europe; while in some other respects, especially the complicated foldings of enamel in the upper teeth, the Old World species are more progressive. The reasons for separating these two groups are further strengthened by the fact that there are apparently no species common to both hemispheres.

From the foregoing it seems apparent that a new term is necessary for the American species hitherto referred to *Hipparion*, and they may be distinguished by the name **Neohipparion**.

The following description is based on the complete skeleton above referred to and is named in honor of Mr. William C. Whitney, whose generosity made possible the expedition which secured this very valuable acquisition to the present knowledge of American fossil horses.

Neohipparion whitneyi, gen. et sp. nov.

Generic characters.—Protocone free, except at base, as in *Hipparion*. Protocone comparatively large and much expanded anteroposteriorly. Enamel foldings simple. The median external basal column present in the lower milk molars as in *Hipparion*, but much shorter and more expanded anteroposteriorly. Lateral digits much reduced.

Specific characters.—Size about equal to *Neohipparion occidentale*, but enamel foldings much more simple, even more simple than in *N. affine*. *N. whitneyi* further differs from *N. affine* in the much stronger development of the styles of the ectoloph. Protocone relatively large and very much elongated in cross-section anteroposteriorly. Outer wall of the protocone flat and slightly folded inward, as is usual in *Equus caballus*. Metapodials very long and slender. Lateral digits greatly reduced, their terminal phalanges not extending to the distal end of the first phalanx of the median digit.

Although the collected material representing the Miocene horses of America is very abundant, it is, for the most part, so fragmentary and the different parts of the skeleton so uncertainly associated that most of the species are known only from the teeth. Hence the present specimen, though not in the line of ancestry of any of the living horses, may serve as a standard for comparison of equal value with *Mesohippus bairdii*, so fully described by Scott,¹ and may be described in detail as follows:

I. THE DENTITION.

Dental formula $I.\frac{3}{3}$, $C.\frac{1}{1}$, $P.\frac{4}{3}$, $M.\frac{3}{3}$. In proportion to the other parts of the skeleton the teeth are very large compared with those of *Equus caballus*. The molars and premolars of both jaws are heavily cemented.

The Upper Jaw.—The tooth-crowns, though strongly hypsodont, are of moderate length. Incisors much shorter than in *Equus*. P^1 is placed well back, extending but little forward of the anterior lobe of p^2 to which it is closely appressed on the inner side. This position brings it in opposition with the anterior lobe of p_2 of the lower jaw.

The external styles of the molars and premolars are as

¹ Journal of Morphology, Vol. V, 1891, pp. 301-342.

strongly developed as in *Equus caballus* and there is no trace of the external median ribs of the meta- and paracones. These last two characters are apparently common to all the species of *Neohipparion* and may be of generic importance.

Though the teeth in the present specimen are worn just to the stage when they present the most complicated pattern of enamel folding, they are very simple in this respect.

The Lower Jaw. — The incisors, like those of the upper jaw, are only moderately long-crowned, and are all fully cupped. The external pair is smaller than the others. The first premolar (p_1) is entirely wanting. The molars and premolars show an advanced stage of progression in the greatly flattened external walls of the para- and hypoconids. The antero-external enamel fold of the protoconid, except in p_2 , is strongly developed. The lower border of the jaw is very much curved.

The Milk Dentition. — There is no trace of p^1 in the milk series of one of the specimens, but another associated specimen possesses this tooth reduced to a mere vestige. In the upper molars the protocones are strongly developed and free as in the adult. They are elongated in cross-section, though not to the degree shown in the permanent series. The lower molars possess a little tubercle arising from the cingulum between the para- and hypoconids. This conule is much shorter than in the *Hipparion* of Europe, but broader antero-posteriorly, being elliptical in cross-section. The outer walls of the para- and hypoconules are flattened, but in less degree than in the permanent series.

II. THE SKULL.

There are many primitive characters observable in the skull, the most prominent of which are the vertical thickness, general shortness, and consequently the relatively large space occupied by the molar-premolar series. The orbit is placed well forward, its anterior border being above the posterior half of p^2 . The anterior projection of the masseter ridge extends forward to the middle of m^1 . The position of the infraorbital foramen is between p^3 and p^4 . The facial pit is

broad and its borders are not clearly defined. The anterior palatal foramina are small and do not extend back of the canines. The anterior border of the posterior narial notch is opposite the middle of m^2 . The vomer overlaps the anterior end of the basisphenoid.

Measurements of Teeth.

	Anteroposterior.	Transverse.
Diameters of p^1	9.5 mm.	7 mm.
" " p^2	29.5 "	23.5 "
" " p^3	25 "	25 "
" " p^4	25 "	25.5 "
" " m^1	22 "	23 "
" " m^2	24 "	23 "
" " m^3		
Total length of series.....		152 mm.
Width across external incisors.....		55 "
Anteroposterior diameter of protocone, p^3		8 mm.
" " " " p^3		9.5 "
" " " " p^4		10.5 "
" " " " m^1		9 "
" " " " m^2		9.5 "
" " " " m^3		10.5 "

	Anteroposterior.	Transverse.
Diameters of p_2	24 mm.	11.5 mm.
" " p_3	25 "	13 "
" " p_4	25 "	12 "
" " m_1	24 "	10 "
" " m_2	25.5 "	9.5 "
" " m_3	22 "	7.5 "

Milk dentition (Upper)

	Anteroposterior.	Transverse.
Diameters of dp^2	31.5 mm.	21.5 mm.
" " dp^3	26 "	21 "
" " dp^4	29 "	20 "

Skull Measurements.

Total length of skull.....	378 mm.
" " " palate.....	205 "
Width of palate between first molars.....	44 "
" " " at narrowest point.....	29 "
Length of diastema between canine and external incisor	20 "
" " " external incisor and p^1 ...	67.5 "
Greatest width of posterior nares.....	28 "
Width of skull.....	128 "
" " condyles.....	54 "

III. THE VERTEBRAL COLUMN.

The vertebral column of the type specimen was found completely articulated, even to the tip of the tail, hence the formula can be given without a possibility of error. It is as follows: Cervicals, 7; dorsals, 18; lumbar, 6; sacral, 6; caudal, 17 + (?) 1.

The *cervicals* are long and slender and are horse-like in general appearance. They resemble much more those of *Equus* than those of *Mesohippus*, but show some intermediate characters.

The *atlas* differs from *Equus* in the following characters: The exterior pair of anterior foramina observed in the atlas of the horse are not bridged over in *Neohipparion*, but are represented by open notches at the anterior borders of the transverse processes. The median ventral tubercle, for the attachment of the longus colli muscle, is very strongly developed.

The *axis* is comparatively longer and of less vertical thickness than in either *Mesohippus* or *Equus*. Compared with *Equus* the odontoid process is not so deeply spout-like, and is proportionately narrower. The anterior vertebral foramina are comparatively large, opening directly into the side of the neural canal, and are not directed forward as in *Equus*. In *Mesohippus* the foramen seems not to be inclosed, but is open anteriorly. The spine is divided posteriorly into two diverging ridges which, extending backward and downward, merge into the posterior zygapophyses on either side. In *Mesohippus* the spine is not divided posteriorly, but extends backward, ending in a strong high tubercle.

The 3rd, 4th, and 5th cervicals, except for their greater comparative length and more delicately formed processes, differ but little from those of the modern horse.

The ventral surface of the 6th cervical is flat, turning downward laterally into the wing-like transverse processes, which are more strongly developed than in *Equus*. There is only a trace of the median keel, so well developed in both *Mesohippus* and *Equus*.

The spine of the 7th cervical is comparatively higher than in *Equus*, but more reduced than in *Mesohippus*.

The spines of the anterior *dorsals* are long and slope backward at a greater angle than in *Equus*.

The spines of the *lumbar* vertebræ are comparatively high and narrow. The transverse processes of the third lumbar from the sacrum are comparatively long and do not articulate with those of the second lumbar from the sacrum.

The *ribs* are remarkably like those of the zebra in form, except the more posterior ones, which are proportionately longer and have a greater curvature.

The *sternum*, which is well preserved in the type specimen, is very characteristic. It is composed of six bony segments, as is usual in the horse, but the ventral keel, so highly developed in the living horses, is entirely wanting, except in the two anterior segments, and it is only weakly developed in these. The ventral surfaces of the third, fourth, and fifth sections are flat and are widest transversely. The xiphisternum is the largest of the series. The anterior portion of the ventral surface is broad, concave, becoming narrower posteriorly where the edges turn upward, making the posterior third of the ventral surface convex.

The *cartilaginous ribs* are composed mainly of spongy bone as in the horse, hence are preserved in the type specimen.

IV. THE FORE LIMB.

The *scapula* is distinguished from *Equus* by: (1) relatively narrow prespinous fossa; (2) the narrowness of the neck; (3) the prominent vertical ridge or thickening of the subscapular area beneath the postscapular border.

The *humerus* is widely distinguished from that of *Equus* by: (1) the depth and narrowness at the proximal and distal extremities; (2) the shallowness of the bicipital groove; (3) the absence of the groove in the lesser tuberosity; (4) the sharp definition of the grooves and convexities of the ulno-radial trochlea.

The *radius* is proportionately long and slender and, except

for modifications of the shaft, is much like that of *Equus*. The shaft of the radius, in its median portion, is concave behind, forming a sharp angle with the posterior border of the inner face.

The shaft of the *ulna* is continuous, but very much reduced, and firmly coalesced with the radius.

The *carpus* as a whole is more rounded in contour, and the transverse diameter is proportionately less than in *Equus*. The articulation of the scaphoid and magnum is peculiar. On the distal face of the scaphoid the facets for the articulation of the trapezoid and magnum are in form and position practically the same as in *Equus*, except that the magnum facet extends further backward and curving downward ends in a conical tooth-like process, which in the flexed position of the carpus fits into a corresponding depression in the magnum. In *Equus* the scaphoid and magnum do not touch each other when the foot is fully flexed.

The convex portions of the radial facets of the scaphoid and lunar occupy a relatively larger part of their proximal surfaces than in *Equus*. The cuneiform is proportionately smaller than in either *Mesohippus* or *Equus*. The pisiform is short, thin, and broad, resembling that of *Equus* in proportions. The trapezium is very small and rudimentary, and articulates principally with the trapezoid, though there are two other small facets which indicate that the trapezium articulates slightly with the scaphoid proximally and with the rudimentary metacarpal I distally. The unciform is relatively high and narrow, and projects below the distal face of the magnum.

The *metacarpus* consists of one principal and two much reduced lateral members, metacarpals III, II, and IV, and two rudimentary bones representing metacarpals I and V. These rudimentary metacarpals are about equal in size and are reduced to mere nodules of bone, which articulate principally with the second and fourth metacarpals respectively. Metacarpals II and IV are nearly as much reduced in size as the splint bones in *Equus*. Their proximal ends and the greater part of their shafts are placed well behind metacarpal

III. Their shafts taper to very slender proportions, but expand again distally, forming articular ends which support small lateral toes. Compared with *Mesohippus* and *Equus*, metacarpal III is very long and slender. The distal end is keeled entirely around, but is not so strongly developed on the distal surface as in *Equus*. The lateral toes are much shorter than the median toe, their extreme points reaching only to about four fifths the length of the first phalanx of the latter. The terminal phalanx of the median toe, compared with that of *Equus*, is proportionately longer and more compressed laterally in front. The palmar surface is heart-shaped in outline, with the apex deeply cleft. The proximal end is moderately high. The articular facet is placed at about the same angle as in *Equus*. Two processes extend outward and backward, one on either side of the articular face. These processes are thin, with rounded edges, and each is perforated by an arterial foramen.

V. THE HIND LIMB.

The *femur* is slender and the shaft is relatively long. The second and third trochanters are placed relatively nearer the proximal end of the shaft than in either *Mesohippus* or *Equus*. The groove for the ligamentum patellæ is comparatively longer and narrower than in *Equus*. The *tibia* exceeds the femur in length, but in other respects is like that of *Equus*. The *fibula* is as much reduced as in *Equus*. The remnant of the distal end is entirely fused with the distal end of the tibia.

The *tarsus* is relatively deeper anteroposteriorly than in *Equus*, but is essentially the same in other proportions. The shallow, irregular pits are beginning to form on the broad, flat facets of the astragalus, navicular, cuneiforms, and the proximal end of metatarsal III, but are, for the most part, only indicated by slight depressions and roughened patches on the bone surface. In *Equus* these pits are deeper and their boundaries are well defined, though varying greatly in size and form in different individuals.

The *metatarsals* are very long and slender, metatarsal III equaling the femur in length. The lateral digits are reduced

in about the same proportion as those of the fore-foot. The phalanges are much like those of the fore-foot, except that the terminal phalanx of the third digit is somewhat smaller and comparatively narrower than that of the fore-foot.

VI. PELVIS.

The *pelvis* shows a marked stage of advancement. It differs in no essential way from that of *Equus*, the proportions throughout being about the same as in *Equus caballus*.

As the comparisons in the foregoing description have been mainly with *Mesohippus bairdii* and *Equus caballus*, it may prove instructive to give here a comparative table of measurements taken from skeletons representing the three genera, and tables showing comparative proportions. In the latter the Virginia deer is included.

COMPARATIVE SKELETAL PROPORTIONS.

DORSO-LUMBAR SERIES TAKEN AS STANDARD.

<i>Mesohippus bairdii</i> .	
Length of skull and neck	.80
“ “ back	1.
“ “ fore limb	1.10
“ “ hind “	1.12

<i>Neohipparion whitneyi</i> .	
Length of skull and neck	.95
“ “ back	1.
“ “ fore limb	1.16
“ “ hind “	1.10

<i>Equus caballus</i> .	
Length of skull and neck	1.03
“ “ back	1.
“ “ fore limb	1.30
“ “ hind “	1.11

<i>Virginia Deer</i> .	
Length of skull and neck	1.
“ “ back	1.
“ “ fore limb	1.46
“ “ hind “	1.30.

COMPARATIVE PROPORTIONS OF LIMBS.

Mesohippus bairdii.

Length of fore limb	Fore I. limb.
" " humerus	.23
" " radius	.24
" " metacarpal III	.16

Neohipparion whitneyi.

Length of fore limb	I.
" " humerus	.19
" " radius	.24
" " metacarpal III	.21

Equus caballus.

Length of fore limb	I.
" " humerus	.21
" " radius	.22
" " metacarpal III	.16

Virginia Deer.

Length of fore limb	I.
" " humerus	.19
" " radius	.23
" " metacarpals	.22

Mesohippus bairdii.

Length of hind limb	Hind I. limb.
" " femur	.34
" " tibia	.34
" " metatarsal III	.17

Neohipparion whitneyi.

Length of hind limb	I.
" " femur	.27
" " tibia	.31
" " metatarsal III	.27

Equus caballus.

Length of hind limb	I.
" " femur	.31
" " tibia	.28
" " metatarsal III	.21

Virginia Deer.

Length of hind limb	I.
" " femur	.27
" " tibia	.31
" " metatarsals	.26

