Art. IX.— *Vertebrate Fossils from Ayusbamba, Peru;* by George F. Eaton.* With Plates V, VI, VII.

While engaged upon the field-work of the Peruvian Expedition of 1912, I had the pleasure of accompanying Dr. Albert Giesecke, President of the University of Cuzco, on a hasty visit to a locality near Ayusbamba, among the mountains about thirty miles south of Cuzco, where he had previously obtained some fragmentary vertebrate fossils. On this occasion a few hours only could be spent in the field; but as it seemed probable that by going over the ground carefully, further material might be secured, Professor Bingham, the Director of the Expedition, gave his consent to my making another visit to the locality, this time in company with Professor Gregory, the geologist, Mr. K. C. Heald, assistant topographer, and Mr. C. Duque. Although other important work caused the postponement of this trip until the middle of November, when the rainy season, unfavorable to fossil-hunting in the mountains, had set in, we were able to obtain material of considerable value during the brief time our party was in the field. To Sr. Emeterio Calvo, the master of the delightful hacienda Ayusbamba, I owe my sincere thanks, not only for permission to collect upon his land, but also for the generous hospitality extended to our party.

The fossils that form the subject of these notes occurred at an altitude of about 12,400 feet, in gravel and clay beds and in surface-wash along the southern margin of a small lake, the original contours of which are partially indicated in the map (fig. 8) accompanying the preceding article by Professor Gregory. An excellent view, looking southerly across the fossil grounds, appears as fig. 6 of Professor Gregory's report. Very nearly the reverse view (N. 5° E. Mag.) taken from the south rim of the basin, is shown in text-figure 1 of the present article. After taking this photograph the camera was turned a little to the right (N. 30° E.) and the view shown in text-figure 2 was taken. These two views together cover practically all of the fossil grounds. Almost at the exact center of Professor Gregory's fig. 6, a mastodon's blade bone was found. The nearer view of this spot (text-figure 3) is equally characteristic of several other places where fossils occurred. In this photograph, taken while waiting for the protective jacket of burlap and plaster to dry, appears one of our faithful arrieros whose interest in collecting fossils made him very helpful.

With few exceptions, fractured and dissociated material only

* Osteologist of the Peruvian Expedition of 1912.

was found. This indicates clearly that, in most cases, the bones of animals, perishing near the borders of this ancient lake, were widely scattered before being finally covered by alluvium from the neighboring heights. It is possible that

FIG. 1.

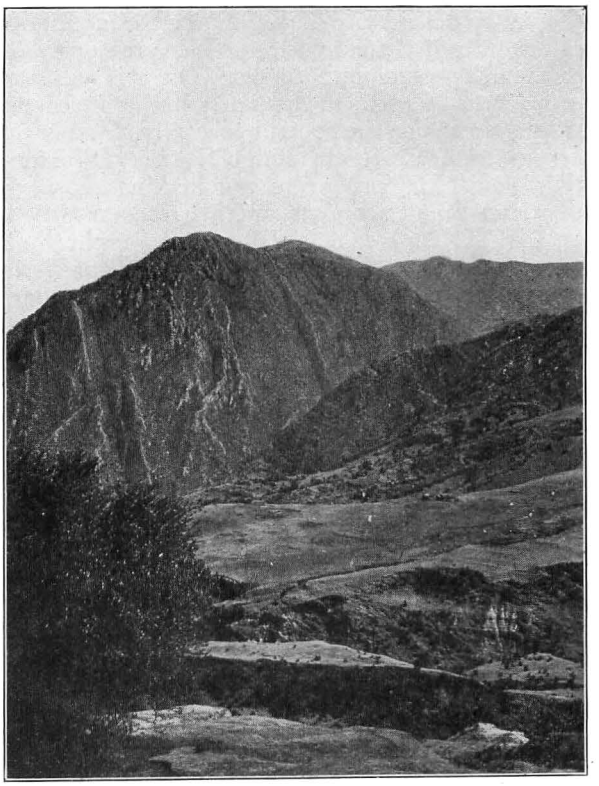

FIG. 1. View N. 5° E. over Ayusbamba fossil beds from the southern margin of the basin.

some of this vertebrate material may have been originally embedded at a slightly higher level. I see no reason, however, to question the contemporaneity of the extinct species of animals represented in this collection. No vertebrate fossils had been previously described from this part of the Peruvian Andes. Therefore every recognizable specimen, that might add to our

knowledge of the extinct fauna of the region, was collected, without regard to its perfection and availability for exhibition. Nearly all of this material has now been identified, and it is found that specimens can be referred to five mammalian

FIG. 2.

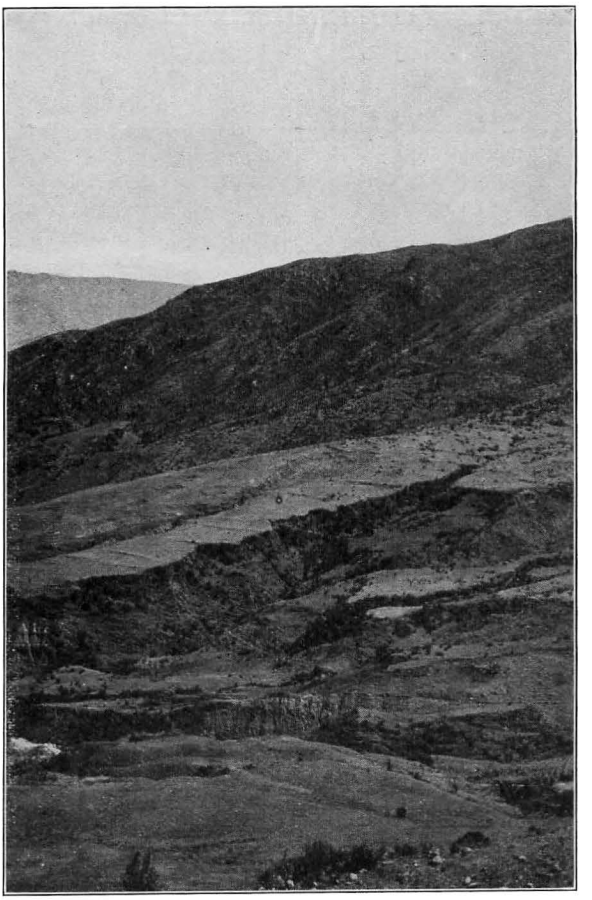

FIG. 2. View N. 30° E. over Ayusbamba fossil beds from the southern margin of the basin.

families, the Camelidæ, Cervidæ, Equidæ, Elephantidæ, and Mylodontidæ. No fossil remains of Rodents and Carnivores were observed. The material may be assigned to the following genera:

Lama sp.

The fifth lumbar vertebra and portions of the right ilium and ischium. The specimens compare closely with the corresponding skeletal parts of a medium-sized animal of the recent species, *Lama huanachus*. It is, of course, impossible to assign the present specimens definitely to any one of the several species of this genus that have been described from the Pliocene and Pleistocene of Argentina and Brazil.

FIG. 3.

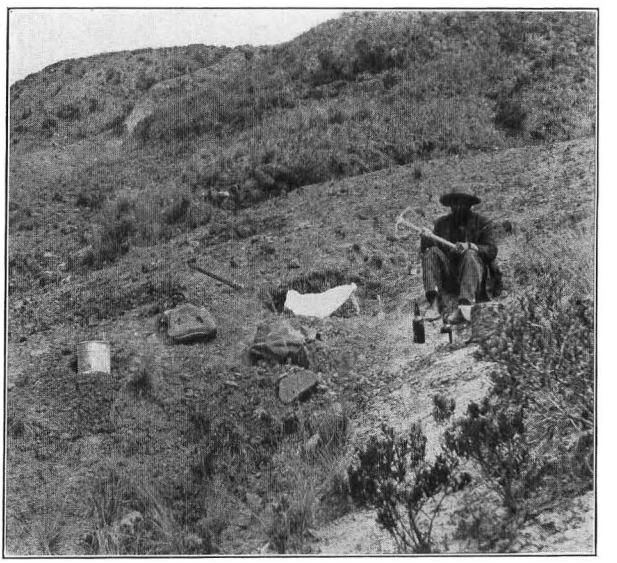

FIG. 3. A mastodon's scapula ready for removal, Ayusbamba.

Odocoileus brachyceros.

The material from Ayusbamba referable to this genus and species includes a fifth cervical vertebra belonging to an animal considerably smaller than a full-grown Virginia deer, and also a number of fragments of antlers, picked up on the surface of the lake-beds. Fortunately the basal portion of one of the antlers has been preserved. No upright snag rises from the base of the inner side of the beam, and the antlers fork near the burr, the basal portion being extremely short. These characters, together with the texture of the surface, serve to identify the Ayusbamba specimens with *Odocoileus*

brachyceros as defined by Professor Lydekker,* who states: "It does not appear that this deer comes close to any existing species."

Philippi has caused some confusion by giving the name *Cervus brachyceros* to three individuals of the Venado de Cajamarca, which he proposed to separate, under this name, from the recent species of Andean deer, *Odocoileus antisiensis* = *Cervus antisiensis*.† It is apparently far from Philippi's intention to convey the idea that the Pleistocene *Odocoileus brachyceros* has persisted until the present time. The antlers of this fossil species are quite different from those of the recent deer to which a similar specific name has been thus unfortunately assigned.

Dibelodon bolivianus.

Remains of *Dibelodon* were the most abundant fossils at Ayusbamba, bones and teeth, usually dissociated and incomplete, occurring at various places in the beds of clay and gravel, and also superficially. It is significant of the history of these deposits that only small and compact bones should have been preserved entire. The individuals of the species, whose remains were found here, differed considerably in size, and it appears from the dentition and from the condition of the epiphyses that many of these animals had not attained their full growth. An accurate comparison of their mature size with that of other mastodons cannot therefore be made. The maximum stature indicated by the largest bones is not more than three-quarters as great as that of the medium-sized example of *Mammut americanum*, whose mounted skeleton is exhibited in the Peabody Museum of Yale University. The height of this animal, taken at the shoulder, is about 8 feet and 3 inches.

Of the six South American species of *Mastodon* described by Ameghino,‡ the two most generally recognized are *M. andium*, Cuv., and *M. humboldti*, Cuv. According to Pompeckj§ there are two other valid species, namely, *M. bolivianus*, Philippi (emend. Pompeckj), and *M. chilensis*, Philippi. While Pompeckj does not adopt Cope's separation of *Dibelodon* and *Tetrabelodon* from *Mastodon*, it should be understood that both *M. bolivianus* and *M. chilensis*, as well as *M. andium* and *M. humboldti*, belong to the Dibelodont division of the original genus.

* Paleontologia Argentina, II, p. 79.

† Anales del Museo Nacional de Chili, 1894, Entr. 7, Primera Seccion, p. 5.

‡ Mamiferos Fosiles de la Republica Argentina.

§ Mastodon-Reste aus dem inter-andinen Hochland von Bolivia. Palæontographica, vol. lii, 1905.

Most of the mastodon bones found at Ayusbamba present no characters that can be utilized in the identification of the species. As might be expected, it is best to rely principally upon the form and structure of the teeth. Two specimens have therefore been selected to illustrate the type of dentition. From the piece of a right (upper) tusk shown in Plate V, figures 1 and 2, the following measurements have been taken:

Circumference of proximal end	354mm
Breadth of enamel band	90
Maximum diameter at proximal end	117
Minimum diameter at proximal end	104
Angle of torsion	12°

The last of these measurements requires a few words of explanation. A mastodon's tusk upon which the enamel band, or other line of growth, describes a helix, presents a certain analogy to a screw; and the torsion of such a tusk may properly be regarded as a pitch angle. The angle of torsion, used here, is defined as the angle that a tangent to the spiral enamel band, at any point, makes with the adjacent axial line of the tusk. This measurement is easily taken. It has the further advantage of being independent of length, diameter and circumference; and may prove to be of considerable taxonomic value. The mere statement that an enamel band makes one revolution, or one-half revolution, about the axis, without any record of length and diameter, does not adequately describe the torsion.

The form of the tusk of *M. bolivianus* is described by Pompeckj* as follows: "Der Querschnitt ist vollkommen elliptisch; die Durchmesser sind an der hinteren Bruchfläche 8·9 : 6·2cm, an der vordere 6·2 : 4·7cm. Das z. T. abgefallene Schmelzband hat vorne eine Breite von 5·65cm." In another place† he compares this tusk with that of *M. andium*: "Die schlanken, sehr wenig gekrümmten, in Schraubenspirale von ungefähr 1/2 Windung gedrehten Stosszähne haben bei *Mastodon bolivianus* stark komprimierten elliptischen Querschnitt, nicht den kreisrunden der Zähne von *Mastodon Andium*."

That the enamel band is very broad in *M. bolivianus* is evident from Pompeckj's measurements of the anterior portion of a tusk and also from his illustration of a basal fragment,‡ where the enamel appears to cover one-third of the circumference. The band is a trifle narrower in the fragment of tusk from Ayusbamba, which differs also from *M. bolivianus* in the ratio of the maximum and minimum diameters. To comply with the diametric ratio (8·9 : 6·2) obtained from *M. bolivianus*, the

* Op. cit., p. 38.
† Op. cit., p. 44.
‡ Op. cit., Taf. IV, Fig. 56.

Ayusbamba specimen having a maximum diameter of 117^{mm}, would require a minimum diameter of only 82^{mm}, instead of 104^{mm}, as recorded. Yet its section, as shown in fig. 5, is still very far from circular, and cannot be described by the same terms that Pompeckj uses in reference to the tusks of *M. andium*. The tusk of the latter species, figured by Ameghino,* greatly exceeds the Ayusbamba specimen in diameter, and possesses an enamel band relatively much narrower. Its curvature and the angle of torsion of the enamel band are approximately the same as those of the Ayusbamba specimen. The torsion of the tusk of *M. bolivianus* is not recorded in such a way as to be available for comparison.

Views of the grinding and labial surfaces of an unworn molar from Ayusbamba are shown in Plate V, figures 3 and 4. This tooth, imperfect anteriorly, is presumably a lower molar of the left side. Large accessory tubercles rest like buttresses against the outer columns, but the tubercles that flank the inner columns, and those that lie in the depths of the inner valleys, are so small as to be almost hidden beneath the thin layer of cement. As a result of this arrangement, the tooth would be characterized, during early stages of wear, by the presence of trefoils on the outer columns only, while the inner valleys would remain open. Although this tooth agrees, in the foregoing characters, with the specific definitions of *M. andium* given by Lydekker† and by Ameghino in his work already cited, the correspondence fails entirely when the contours of the inner columns are considered. Lydekker states that "The form of the dentine-disk on the columns which do not bear trefoils is pear-shaped, with the apex directed toward the adjacent column." The inner columns of the Ayusbamba molar are as stout where they approach the median cleft as at their lingual borders, and would not, at any stage of wear, assume a pear-shaped outline. In view of this essential difference, I do not think that the Ayusbamba molar should be referred to *M. andium*. It compares much more closely with the lower molar of *M. bolivianus* figured by Pompeckj.‡ The small accessory tubercles that flank the inner columns and line the inner valleys of this tooth find their counterparts half-concealed beneath the cement layer of the Ayusbamba molar. The transverse measurements of the tooth of *M. bolivianus*, taken at the base of the crown, viz., for the 1st cross cusp 7·4^{cm}, for the 2nd 7·75^{cm}, for the 3rd 8·0^{cm}, for the 4th 7·8, for the 5th 7·4^{cm}, correspond very nearly with the following transverse measurements taken in the same way from the Ayusbamba

* Mam. Fos. de la Repub. Argent., p. 640.
† Cat. Foss. Mam. Brit. Mus., 1886.
‡ Op. cit., Taf. III, Fig. 1a.

molar: for the first cross cusp 7·3^{cm}, for the 2nd 7·4^{cm}, for the 3rd 7·2^{cm}. Taking into consideration the characters of this molar tooth and also those of the fragment of tusk, previously described, I am confident that both of these specimens should be referred to *Mastodon bolivianus*, or *Dibelodon bolivianus*, if it is best to use the generic name proposed by Cope.

It is not surprising that remains of this species should be found at Ayusbamba, for Ulloma, where the type material of *D. bolivianus* was obtained, is less than 350 miles distant, being situated at an altitude of about 3,800 meters, in the high Bolivian table-land south of Lake Titicaca. There seems to be no reason to doubt that the same climatic conditions prevailed in these two localities during the early Pleistocene.

Mylodon sp.

The Gravigrade Edentates hold such an important place in the Pleistocene fauna of South America, and have been so closely associated, in their distribution, with the Elephantidæ and Equidæ, that one might expect to find the group represented in the collection from Ayusbamba. Vertebræ, pieces of the ribs, including an ossified sternal section with its characteristic double articulation, and an ungual phalanx, from this locality, should be referred provisionally to the genus *Mylodon*, so closely do they resemble the corresponding parts of the mounted skeletons of *M. robustus* and *M. myloides* in the American Museum of Natural History. I have no means of determining the species. In this connection may be mentioned a humerus of *Mylodon* that was found, not at Ayusbamba, but within two miles of Cuzco, where the road to Ayusbamba ascends from the Huancaro Valley. The location of the bone beneath well-defined beds of fine and coarse alluvium, about 28 feet in thickness, is marked in text-figure 4 by the point of an arrow. This humerus, shown in Plate V, figures 5 and 6, differs from the humeri of *M. robustus* and *M. myloides* at the American Museum in not having so prominent a deltoidal tract. The outer tuberosity is also smaller, and the posterior outline, immediately below the head, is more deeply concave. These differences, while slight, are sufficient to indicate that some species of *Mylodon* other than *M. robustus* and *M. myloides* occurred in this part of the Cordillera. Potsherds and bones of llamas were observed at a depth of 2½ feet in the surface stratum at the top of the bank where this humerus was found; but no objects were seen in the lower strata that could, in any way, associate the *Mylodon* bone with the period of human inhabitation.

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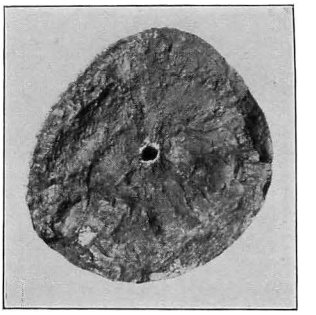

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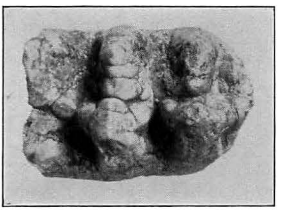

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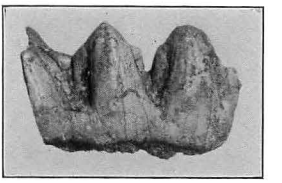

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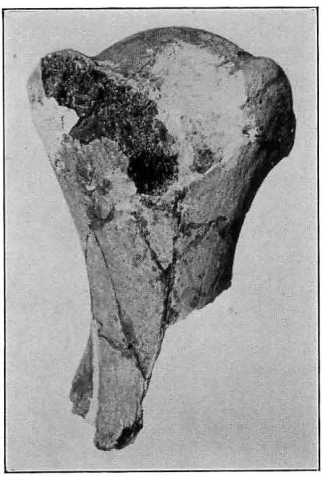

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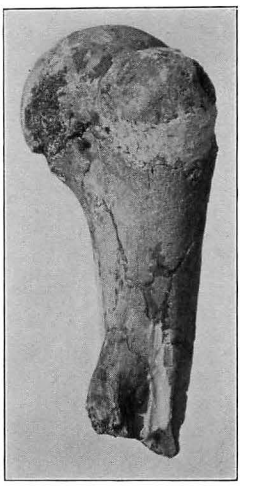

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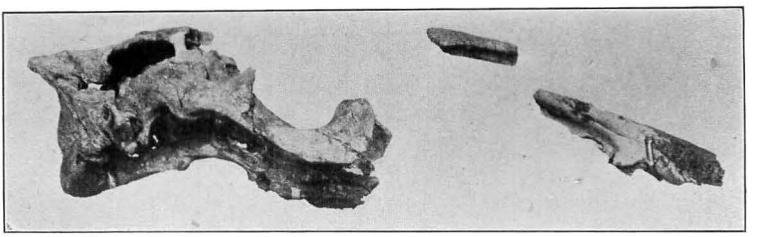
FIG. 1. *Dibelodon bolivianus*, fragment of right tusk. × 0·26.
FIG. 2. The same fragment, proximal end. × 0·29.
FIG. 3. *Dibelodon bolivianus*, left lower molar. × 0·29.
FIG. 4. The same tooth, labial surface. × 0·26.
FIG. 5. *Mylodon* sp., right humerus, anterior view. × 0·25.
FIG. 6. The same specimen, external view. × 0·25.



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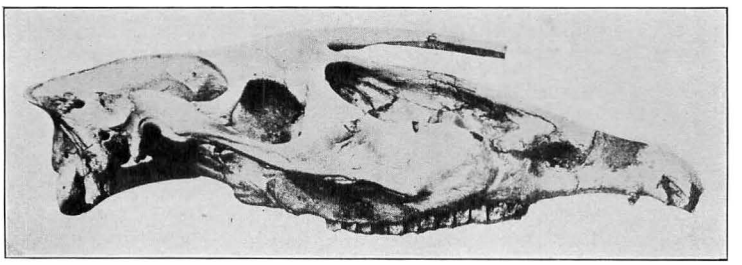

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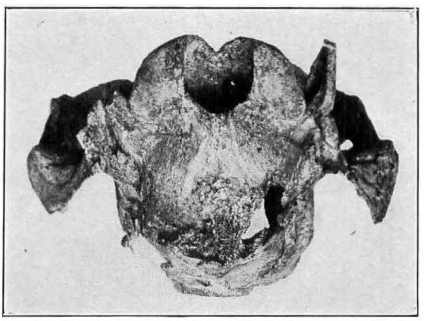

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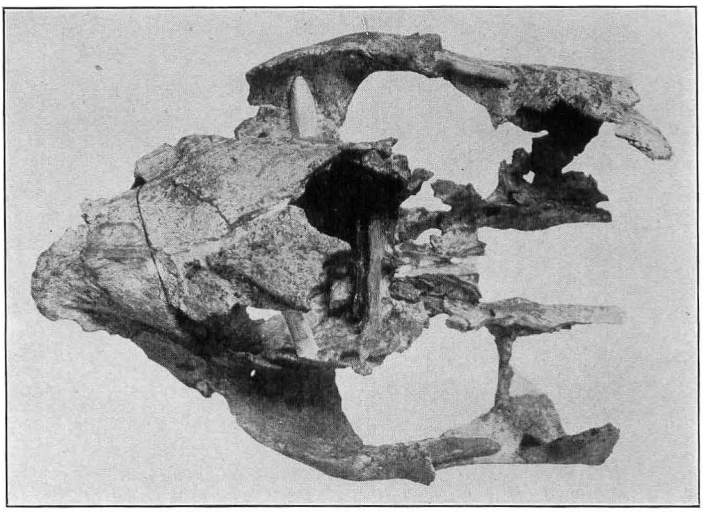
FIG. 1. Skull of *Parahipparion* sp., from Ayusbamba, lateral view. × 0·18.
FIG. 2. Skull of *Onohippidium compressidens* in the Museum of La Plata, after Lydekker. × 0·15.
FIG. 3. Skull of *Parahipparion* sp., from Ayusbamba, posterior view. × 0·25.



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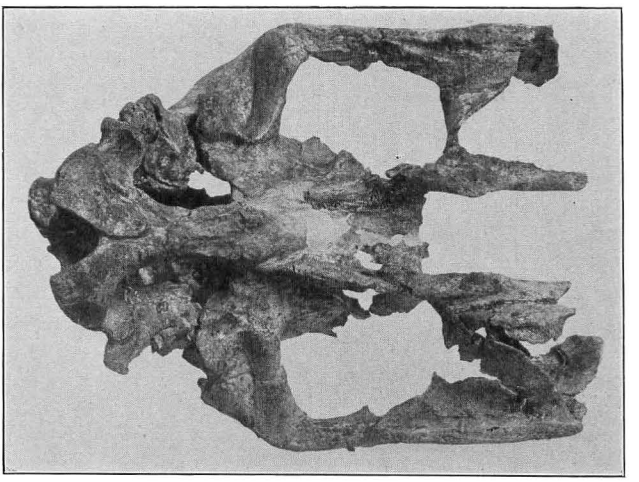

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FIG. 1. Skull of *Parahipparion* sp., from Ayusbamba, superior view. × 0·30.

FIG. 2. Skull of *Parahipparion* sp., from Ayusbamba, inferior view. × 0·28.

Parahipparion.

Equine remains collected at Ayusbamba include several teeth, a fragmentary skull and a portion of the distal end of a femur. The teeth were all surface specimens, and there was nothing about the manner of their occurrence to prove that any of them belonged to the same individual as the skull. Two of

FIG. 4.

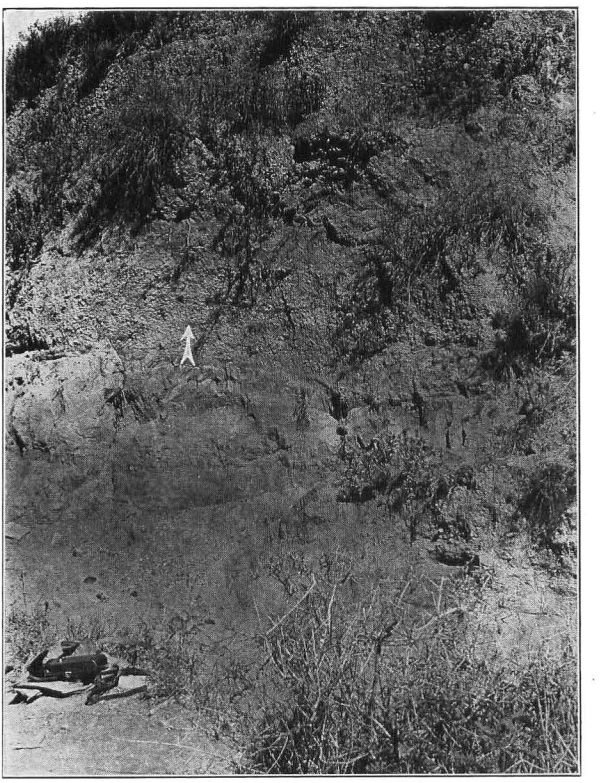

FIG. 4. Location of *Mylodon* humerus (indicated by arrow-point) by the side of the road from Cuzco to Ayusbamba.

them, however, may be from one individual, not necessarily because they were picked up within a few rods of each other, but because they show equivalent structure, size and stage of wear. These two teeth, first and second functional lower

cheek teeth (p_2 and p_3) are accordingly represented together in text-figure 5. Owing to their imperfection exact measurements cannot be taken; but the length and width of their crowns appear to have been approximately as follows: p_2, length 29mm, width 14·2mm; p_3, length 27mm, width 16mm. These dimensions and the pattern of the enamel foldings show that the teeth cannot be referred either to *Equus curvidens* or to any of the three species of *Hippidium* whose teeth have been minutely described and figured by Sefve.* Their affinity lies rather with the genus *Parahipparion*. In view of the difficulties that beset the study of isolated equine teeth, especially those of the lower series, it would perhaps be unwise to attempt the specific identification of these two lower premolars; but it is significant that among all the teeth with which they have been compared, they most nearly find their counterparts in the first and second lower deciduous molars, and the first molar, of *Parahipparion peruanum* from Tirapata, Peru, figured by Sefve.† The united length of the first two milk molars of this last mentioned specimen amounts to approximately 56mm; and this measurement exceeds the restored united length‡ of the two teeth under discussion by 2mm, which is very nearly the difference in length that one might expect to find between the first and second lower deciduous teeth and their permanent successors. So many variable and uncertain factors enter into these measurements that the comparison should not be carried too far.

In another lower cheek-tooth (p_2) from Ayusbamba the forms of the inner valleys (text-figure 6) are simpler than in the teeth last described, the contrast in this respect being almost too marked to be readily accounted for by the fact that the teeth present different stages of wear. It should be noted that the teeth shown in text-figures 5 and 6 possess, in common, a very deep outer valley that penetrates between the inner valleys and nearly traverses the crown. The deepening of the outer valley, according to Sefve's observation, characterizes *P. devillei* and *P. peruanum*, and distinguishes them from *P. saldiasi*. The premolar of text-figure 6 measures, on the crown, 29mm x 14mm. In its enamel pattern, as well as in its size, it is remarkably like the p_2 of *P. devillei*,‡ which has a length of 28mm and a width of 13mm. Although the species of the Ayusbamba specimen is not determined by the above com-

* Die Fossilen Pferde SüdAmerikas; Kungl. Svenska Vet. Hand., 1912, Band 48, No. 6.

† Hyperhippidium; Kungl. Svenska Vet. Hand., 1910, Band 46, No. 2, Taf. 2, Fig. 4.

‡ The united length of overlapping teeth is less than the sum of their individual lengths.

‡ Sefve, 1912; Taf. 2, Fig. 21.

parison, there is no doubt that it belongs under the genus *Parahipparion*.

Examination of an upper molar (text-figure 7) leads to about the same conclusions as were obtained from the study of the lower teeth already described. This tooth appears to be either the first or the second upper molar of the right side. Probably it is the first. The length is 21·5^{mm} and the width 22^{mm}. The depth of the crown is greatly reduced, only about 30^{mm} of the prism being left. In fact, it is so low as to present an almost senile stage of wear. Under these circumstances not only would the pattern of the enamel foldings be simplified,

FIG. 5. FIG. 6. FIG. 7.

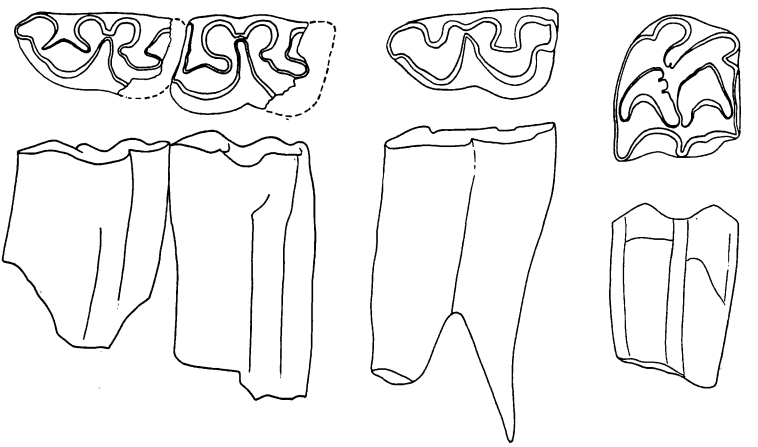

FIG. 5. Pm_2 and Pm_3, *Parahipparion* sp., Ayusbamba. ×0·80.
FIG. 6. Pm_2, *Parahipparion* sp., Ayusbamba. ×0·80.
FIG. 7. M^1, *Parahipparion* sp., Ayusbamba. ×0·80.

as compared with the condition at four or five years of age, but the antero-posterior diameter, or length, of the crown would be considerably reduced. The width of the crown has probably been a little reduced also, but judging from the very slight convergence of the labial and lingual sides of the prism, this transverse reduction is very small, probably not exceeding 1^{mm}. Making due allowance for advanced stage of wear and for individual variation, it is conceivable that the enamel pattern of this tooth might have been derived from the pattern exhibited by the first upper molar of any one of the species of *Parahipparion* in which the true molars have been observed. These teeth have not been observed in *P. peruanum*, the species that from its occurrence at Tirapata would seem most

likely to be found in Pleistocene formations at Ayusbamba. On the whole it appears that very little progress toward the specific identification of the upper molar of text-figure 7 is to be made through the study of its enamel pattern alone. Much better results can be obtained by comparing its dimensions with those of the various species of *Parahipparion*. Accordingly the length and width of the upper true molars of *P. saldiasi*, *P. bolivianum*, and *P. devillei* and the same dimensions of the upper milk molars of *P. peruanum* are quoted from Sefve and arranged in the following table.

Dimensions of Molars of *Parahipparion* in millimeters.

	M^1		M^2		M^3	
	Length.	Width.	Length.	Width.	Length.	Width.
Parahipparion burmeisteri	29·5	30·	29·	29·5	27·	24·
P. saldiasi	29·	29·	26·	26·	32·5	22·
P. bolivianum	25·	27·	--	--	--	--
P. devillei	27·	25·	--	--	--	--
P. devillei	24·	25·	23·	23·	24·	21·
	D^1		D^2		D^3	
P. peruanum	35·7	23·	28·	22·5	29·2	22·

The width of the crown of the upper molar from Ayusbamba, viz., 22^{mm}, is less than that recorded, in the table, for m^1 of any species of *Parahipparion*. *P. devillei* comes nearest, with a width of 25^{mm} for m^1, while *P. saldiasi* and *P. bolivianum* are much farther removed. A direct comparison with the first molar of *P. peruanum* is impossible, the permanent upper molars of that species being unknown; but as far as any inference can be drawn from the transverse dimensions of the deciduous teeth, I should expect to find the width of m^1 of *P. peruanum* about equal to that of *P. saldiasi*. Whether this inference is correct or not, the isolated upper molar from Ayusbamba is evidently from some small-sized species of *Parahipparion*.

The posterior portion of the skull of *Parahipparion* has never been described, although five species of the genus have been recognized. The only cranial parts, besides the teeth, that have previously been collected, are the maxillary, premaxillary and palatine elements, and the mandible. Therefore the Yale Expedition was fortunate in securing at Ayusbamba a skull apparently belonging to this genus. This specimen, though far from complete, is composed largely of parts regarding which we have had no definite knowledge. A careful

search was made along the bottom and sides of a small ravine where this specimen occurred, but the rest of the skull was not found.

There was, in the possession of Dr. Romualdo Aguilar of Cuzco, a fragment of a small equine skull with several teeth, that came from very near this same place. Although I have had no opportunity to examine this specimen closely, its general appearance and the circumstances under which it was collected lead me to believe that it may be from the same skull as the portion taken later by the Yale Expedition. I trust that Dr. Aguilar will soon publish views and a description of his specimen.

The posterior part of the skull is shown in Plate VI, figure 1, together with two disconnected but important pieces of the nasal and premaxillary bones that are placed, as nearly as possible, in their true relative positions. Compared with the view of the skull of *Onohippidium compressidens* (fig. 2), it is at once seen that the skull from Ayusbamba was characterized by slender, freely projecting nasal bones, very similar to those of *Onohippidium* and *Hippidium bonaerense*. A conspicuous cheek-groove, beneath the elongated ascending process of the premaxilla, corresponds in part to the anterior chamber of the "fossa lacrymalis" of *Onohippidium*. It is the latter genus that this skull approaches most nearly in the form of the nasal bones, in the cheek-grooves of the maxillae, and in the depth of the alveolar portions of the maxillæ below the facial crests. In the shape of the zygomata and in the narrower preorbital breadth of the skull, as seen in Plate VII, figure 1, the resemblance is rather with *Hippidium bonaerense*. The posterior view of the skull is shown in Plate VI, figure 3, and its palatal or lower surface in Plate VII, figure 2. The skull, while indicated by the sutures to be that of a full-grown animal, is smaller in nearly every dimension than that of *Hippidium bonaerense*, especially in the transverse measurements. The contrast in size with the skull of *Onohippidium* is even greater. To compare the skull from Ayusbamba with those of *Onohippidium compressidens* and *Hippidium bonaerense* as fully as possible, I have made use of valuable data recorded by Sefve, and have arranged some of the principal measurements of these three crania in the accompanying table.

Although the skull from Ayusbamba and that of *Onohippidium compressidens* differ greatly in actual size, their proportions are so nearly alike that their generic separation by cranial characters alone, irrespective of size, would be difficult and unsatisfactory. In referring the Ayusbamba skull provisionally to *Parahipparion* I am influenced not only by the slight differences in cranial form, but also by what is known of the geographic distribution of the genera *Parahipparion* and *Onohippidium*.

Dimensions of skulls in millimeters.	Onohippidium compressidens.	Hippidium bonaerense.	Parahipparion sp. from Ayusbamba.
Length, total	588	580	--
From posterior margin of foramen magnum to anterior border of p^2	430	410	--
From posterior margin of foramen magnum to posterior border of m^3	244	231	228*
From posterior margin of foramen magnum to anterior border of orbit	241	230	222
From occipital point to anterior border of orbit	268	248·5	248
Maximum zygomatic breadth	220	213	200
Zygomatic breadth across glenoid surfaces	216	207	191
Occipital condyles, maximum height	46	40	39
Occipital condyles, maximum breadth	33	26	25
Breadth across outer margins of condyles	102·5	90	84
Breadth of os occipitale	129†	115	110
Breadth of os occipitale + os petrosum	141	134	125
Height of occipital region	126	108	110
Maximum height of foramen magnum	47·5	34	37
Maximum breadth of foramen magnum	45	45	32

The fossil horses that have been found in the mountains of Peru and Bolivia apparently belong to small short-legged species of *Parahipparion*, while *Onohippidium compressidens*, an animal with larger head and longer limbs, has been found only in the pampas formation of the Province of Buenos Ayres, near the Atlantic coast.

* Taken to the alveolus.

† Sefve gives 219^{mm}. According to the context this should read 129^{mm}.