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ART. XLIII.—*The Vertebrate Fossils of Rock Creek, Texas;* by EDWARD L. TROXELL.* With Plate IX.

[Contributions from the Marsh Publication Fund, Peabody Museum, Yale University.]

OUTLINE.

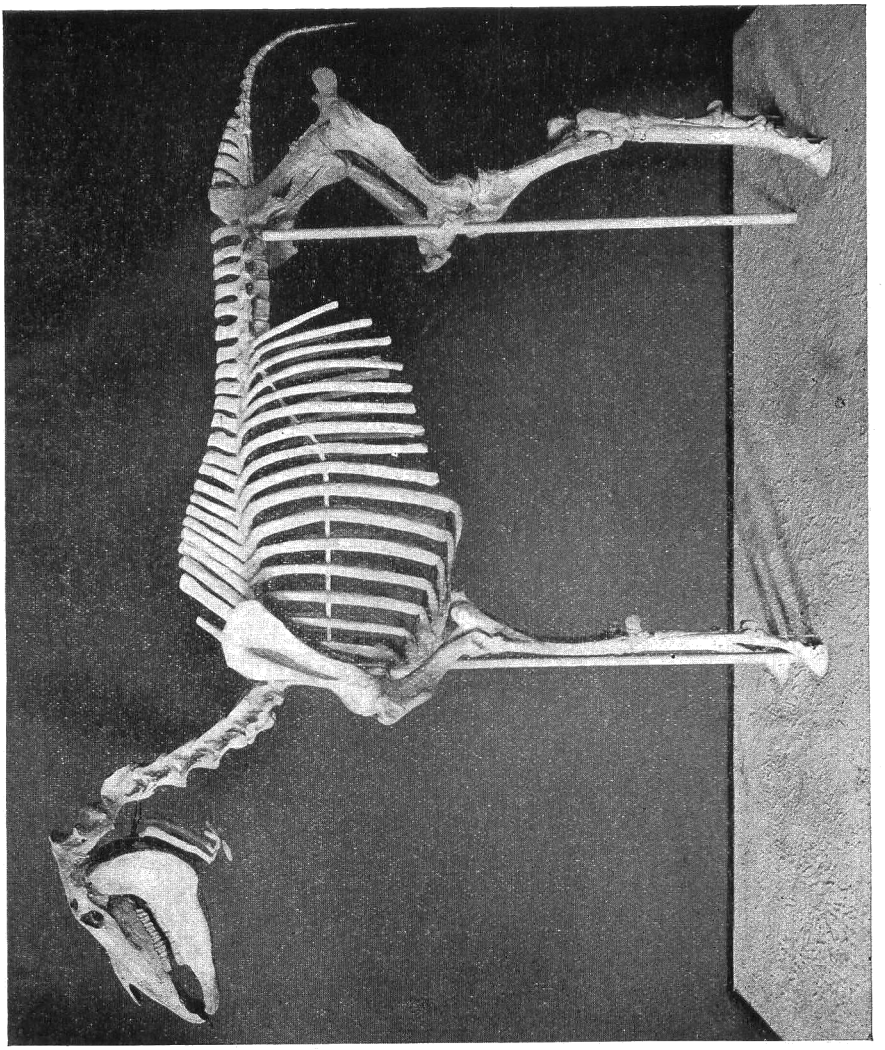
Introduction.

IN the field season of 1912 Peabody Museum of Yale University sent out an expedition to the Panhandle region of Texas under the charge of Professor R. S. Lull. The party spent about six weeks at the head of Rock Creek (see map, fig. 1) in Briscoe County searching for vertebrate fossils, and from this locality were secured the specimens described in this paper.

About thirteen species were found, consisting of seven different families represented to-day by the living forms of camel, dog, horse, elephant, sloth, peccary, and turtle.

Besides the two principal deposits, various fragments and isolated bones were found along Rock Creek and Tule Canyon.

* Abstract of a thesis presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Yale University, 1914.



Equus scotti, mounted specimen, Yale Collection.

FIG. 1.

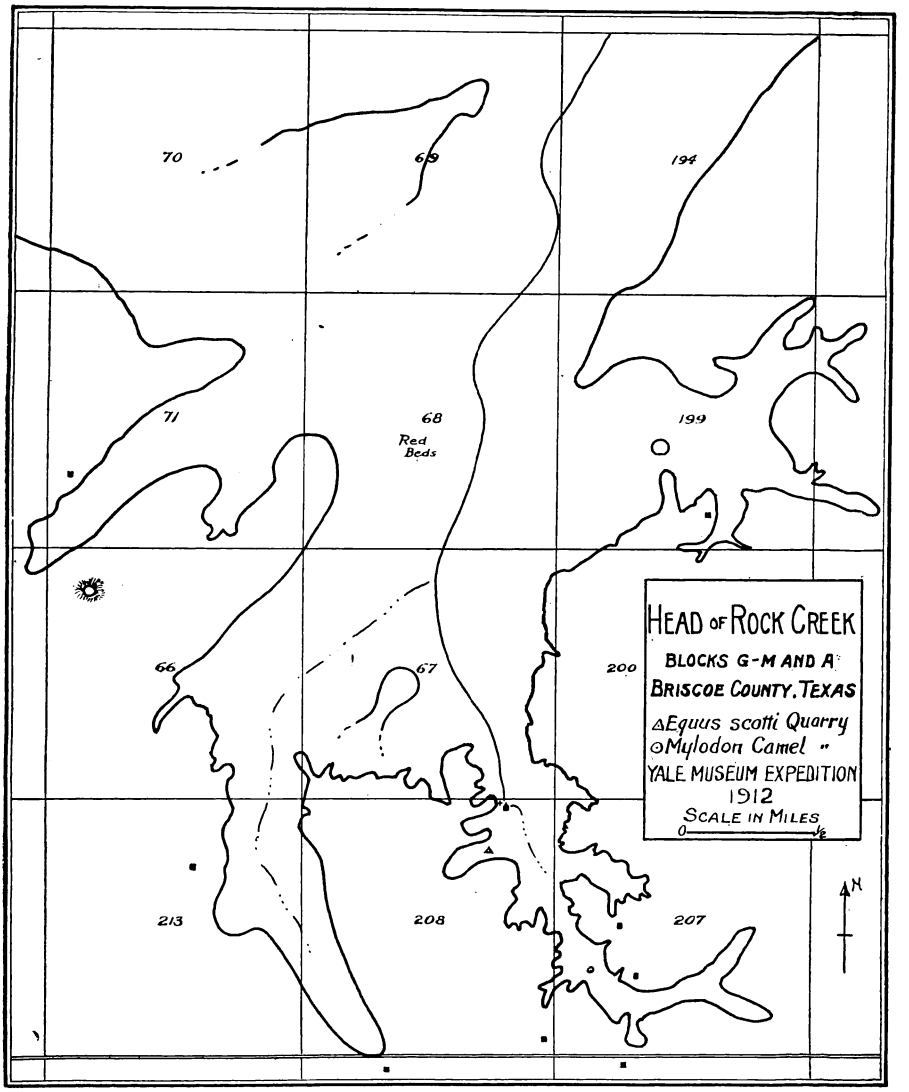


FIG. 1. Outline map of Rock Creek.

From the *Equus scotti* quarry of J. W. Gidley additional specimens of the horse were found, one of which is now mounted in Peabody Museum, making in all about eight skeletons taken from this one hill during a period of thirteen years. The Mylodon-camel quarry yielded all the other material listed, but the skeletons were never so perfectly preserved as those of *Equus scotti.*

The use of ratios.—The results of this paper are derived mostly from the use of "ratios." Apparently nowhere in the literature has such an application been made of "ratios," comparing one type to another. Osborn in his "Craniometry of the Equidæ," and other writers, have used ratios of one dimension to another, on the same skull, calling such a "ratio" an "index." The "index of slenderness" or of "elongation" had already been devised to meet the needs in describing the long slim cannon-bones of *Equus calobatus*, n. sp. (fig. 4), when in conversation Professor Osborn suggested the value of the "speed index." He also said that the ratios between homologous parts were useful in showing specific differences, and it is probable that this principle has been applied in his study of the Titanotheres soon to be published.

Professor Lull has frequently suggested the great constancy of the relation between the teeth and limb bones. This idea was utilized, not by a direct comparison of the teeth to the skeleton, thus getting an *index*, but by comparing the teeth and skeleton of the fossil to be studied to the teeth and skeleton, respectively, of a known recent animal, thus getting a *ratio.* This not only serves to separate out the individuals, but also indicates specific and generic characters.

The use of "ratios" and "indices" will be more fully illustrated in the description of the various forms.

I take pleasure in expressing my gratitude to Professors Schuchert and Lull for their generous assistance in the preparation of this paper. Professor Schuchert made it possible for me to go with the Yale Expedition in 1912, and has done me many other favors. To Professor Lull, through whose inspiring personality and interesting courses I was led to take up the study of vertebrate paleontology, I am indebted for criticisms which were of great aid in my work on the material treated in this paper.

List of Species.

Class Mammalia.

Equidæ.

1. *Equus scotti* (separate quarry)
2. *E.* (*Asinus*) *calobatus*, n. sp.

Camelidæ.

3. *Auchenia hesterna*
4. *Eschatius conidens*
5. *? E. macrocephalus*

Canidæ.

6. *Canis dirus*
7. *C. texanus*, n. sp., cf. *mississippiensis*
8. *C. ? sævus*
9. *C. temerarius*

Elephantidæ.

10. *Elephas columbi* (or a young *imperator*)

Megalonychidæ.

11. *Mylodon harlani*

Suidæ.

12. *Platygonus compressus*

Class Reptilia.

Testudinidæ.

13. *Testudo campester*

FIG. 2.

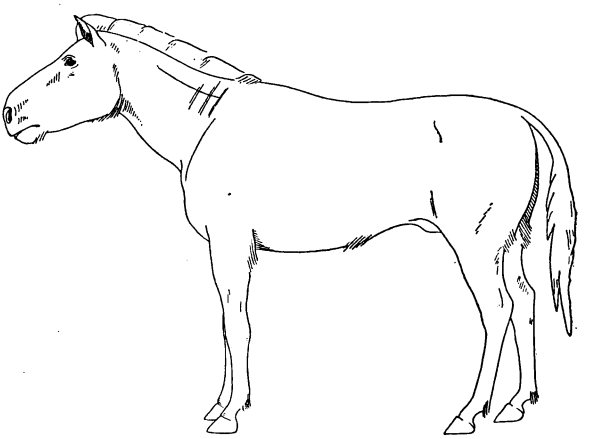


FIG. 2. Restoration of *Equus scotti*, by R. S. Lull.

Equidæ.

E. scotti Gidley.—The type specimen of this species was found in 1899 by J. W. Gidley (6.111) at the head of Rock Creek; the more mature specimen (Plate IX and fig. 2) found by the Yale Expedition furnishes a few points of added interest. The skeleton is that of a female five or six years of age and as now mounted stands about fifteen hands high.

The limbs of the Yale specimen are heavy; the hoofs are about a sixth broader than those of the Arabian horse of to-day. The skull is heavy. *E. scotti* was a ponderous animal, a form not suited to rapid movements but one probably living in a region surrounded by luxuriant vegetation with plenty of food and water and close in its habits to the mammoth and ground-sloth with which it may have been associated. Gidley has ascribed to the type specimen certain characters which would link it with *Equus asinus* or *E. quagga*, especially in the longer body, much larger head, shorter back and steeply sloping

FIG. 3.

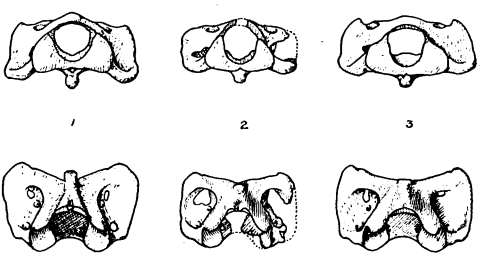


FIG. 3. Posterior and ventral anterior views of atlases. 1, *Equus caballus;* 2, *E. calobatus*, n. sp.; 3, *E. scotti*. About one-sixth nat. size.

sides. The type was a young animal and therefore may show characters and proportions differing from the more mature Yale specimen, thus more closely resembling the ass and quagga.

There are, however, a number of characters shown by the Yale specimen which indicate a very close relation to *Equus caballus* and a distinct separation from *Equus asinus*. The ratios between *Equus scotti* and the smaller Arabian horse run with unusual constancy and give the average of 88·8 per cent. The characters of the sacrum, especially in the manner in which the dorsal and ventral foramina enter the neural canal (fig. 5), the general form of the atlas (fig. 3) and the ratios of the skeletal parts, all show a great similarity of *E. scotti* to *E. caballus*. The width of the muzzle measured across the alveoli of incisors number three is greater than the width across the premaxilla over the canines. This is a horse character, distinguishing it from the ass.

Applying the principles of Craniometry, the skull is shown to be exceedingly like that of the recent horse, *E. caballus*, sometimes surpassing the average horse in the extreme of horse eccentricities, and again showing a slight tendency to some of the characters of the mule.

The cephalic index is:

E. scotti	38·4 per cent
Horse	40* to 44 per cent
Ass	46* to 49 per cent

An average of the palatocranial angle for nine horses was *22·5°, for two asses it was *20·9°, and for five zebras *21·75°. This angle as found in *E. scotti* is 20°, considerably less than that of the average zebra or ass and even less than that of the average horse. Due to a slight crushing of the horizontal part of the palate the angle is made even greater than it should be.

FIG. 4.

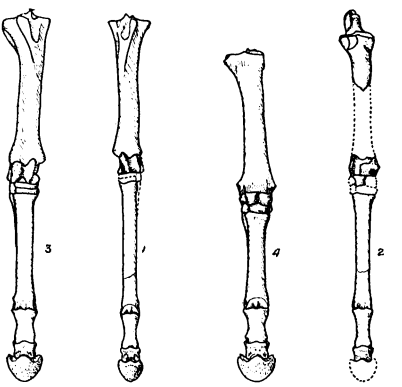


FIG. 4. Limb bones. 1, *Equus calobatus*, n. sp., hind limb; 2, *E. calobatus*, n. sp., fore limb; 3, *E. scotti*, hind limb; 4, *E. scotti*. fore limb. One-sixteenth nat. size.

This angle in *E. scotti* seems to contradict the statement by Professor Osborn (*loc. cit.*) that: "In *Neohipparion* of the Miocene, *Hipparion* of the Pliocene and *E. scotti* of the Pleistocene the face is strongly bent down on the cranium," for *E. scotti* shows less tendency than *E. caballus* toward cytocephaly.

In the form of the orbits, *E. scotti* departs widely from the ass and even goes beyond the horse in the horizontal elongation. The orbital indices are:

E. scotti	69·7 per cent
Horse	*84·2 to 93·5 per cent
Ass	*96·0 to 104·2 per cent

The horizontal diameter is slightly increased in *E. scotti* because of fracture.

NOTE: All measurements indicated thus * are taken from Osborn (15·85).

Equus calobatus, n. sp.—In the quarry which produced the greater variety of specimens, limb bones of *Equus* (fig. 4) were found which were unusually long and slender. Associated with these were various parts of the skeleton which correspond closely in size. This specimen, so unique in the form of the limbs, and so distinct from *E. scotti* and *E. caballus*, may well constitute a new species. Because of the close similarity to the recent ass, fossil specimens of which are almost unknown, this type will be designated *Equus* (*Asinus*) *calobatus*, n. sp., the specific name meaning "he who walks on stilts."

The limbs of the new type offer a most interesting study, and it is upon these that the species is founded. The cannon-bones in particular are most unusual in the development of their great length. The tibia is not so long, but in general it is more slender than that of *E. caballus*, although the latter, as represented by the Arabian horse, has a higher speed index.

The cannon-bone of the fore limb is 19·4 per cent longer than that of the Arab horse, and it is over a half longer than that of *Equus asinus*. The length of this cannon-bone in *E. calobatus*, whose diameters give an average ratio of 85·4 per cent of that of *E. scotti*, is actually greater in length by more than 4^{cm}.

Of all the species studied, the speed index is highest in the cannon-bone of the ass (8·68); next to it is that of the new species, in which the index is 8·57. It is very high in either, but considering the greater size of the fossil (a half taller, and therefore probably over three and a third times as heavy), its index is exceedingly high. Compared to the Arabian horse, a good cursorial type, the slim fossil shows an index 18 per cent higher, and compared to the ponderous *E. scotti*, it is 44 per cent higher.

The speed index is found by dividing the length by the transverse dimensions of the shaft. The shaft measure in *E. asinus* is particularly small; this makes the speed index correspondingly high. If the average of all the diameters (see table, page 620) be taken and divided by the length, the ratio may be called the "index of slenderness." This index shows that *E. calobatus* has the slenderest cannon-bone of all, the order of slenderness being:

E. calobatus	14·3 per cent
E. asinus	15·7 "
E. caballus	17·0 "
E. scotti	19·0 "

The reciprocal of the "index of slenderness" may be taken as the "index of elongation."

Metacarpal	Equus				Ratios				
	Calobatus n. sp.	Caballus	Scotti	Asinus	$\frac{Cal}{C}$	$\frac{Cal}{S}$	$\frac{C}{S}$	$\frac{A}{Cal}$	$\frac{A}{S}$
1. Width of distal end	4·56	4·91	5·77	3·58	92·9	79·0	85·2	78·5	62·0
2. Diameter of keel	3·54	3·59	4·27	2·78	98·6	83·0	84·0	78·5	65·1
3. Shaft, transverse diam.	3·35	3·32	4·10	2·20	101·0	81·7	81·0	65·7	53·6
4. Proximal end transverse diam.	5·39	5·27	5·73	3·85	102·4	94·0	91·8	71·4	67·2
5. Proximal end ant.-post. diam.	3·70	3·42	4·15	2·53	108·2	89·1	82·4	68·4	61·0
6. Averages of cross dimensions	4·11	4·10	4·80	2·99					
7. Length	28·70	24·10	24·4	19·1	119·4	117·7	98·8	66·5	78·3
8. Average ratios					103·8	90·8	87·2	71·5	64·5
9. Speed index $\frac{No.\ 7}{No.\ 3}$	8·57	7·26	5·95	8·68	118·0	144·0	122·0	101·3	146·0
10. Index of slenderness $\frac{No.\ 6}{No.\ 7}$	14·8	17·0	19·7	15·7					

In spite of the fact that the "speed index" generally indicates a cursorial adaptation, it is quite probable that the slenderness and elongation have gone too far in this fossil type for the best speed development.

The ungual phalanx of *E. calobatus*, compared to that of *E. scotti*, is very narrow, as shown by the low ratio of 71·8 per cent. Compared to *E. caballus africanus*, it shows low ratios in the transverse dimensions, but a higher ratio in the altitude, corresponding to the greater height of the animal. This hoof

FIG. 5.

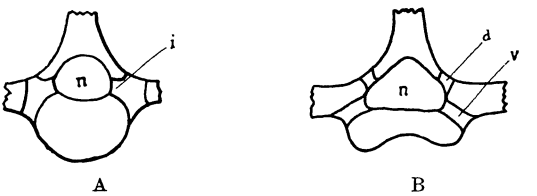


FIG. 5. Cross sections of sacra. A, *Equus calobatus*, n. sp.; B, *E. scotti* and *E. caballus*. One-fourth nat. size.

bone of the new species is very much like the narrow hoof of the modern ass.

An additional similarity between *E. calobatus* and *E. asinus* is shown in the atlas, which in its general form, the shape of its wings, the internal sulcus, the ventral tubercle, the foramen transversarium, and the anterior ventral groove, shows a great resemblance between the two.

E. calobatus, n. sp., shows a marked contrast to *E. scotti* and *E. caballus* in the form of the sacrum. In the last two species, the dorsal (*d*, fig. 5) and ventral (*v*) sacral foramina enter the neural canal (*n*) quite independently, their confluence being in a wide space or vestibule on the wall of the canal. This is due to the fact that the centra and thus the canal are wider than the space between the dorsal foramina; the latter therefore enter the roof of the canal. On the other hand, because of the narrowness of the neural cavity in *E. calobatus*, the dorsal foramen as well as the ventral lies outside the border of the neural canal. They therefore join to form the true intervertebral foramen (*i*) which in turn opens into the sacral canal.

Certain similarities between the sacrum of *E. calobatus* and that of *E. asinus* are notable, most of which are due to the coössification of the spines. In *E. calobatus* they form a solid plate with but a single foramen, representing all of the interarcuate spaces. Such a solid fusion of the neural spines is an adaptation of nature to meet the needs of a great stress in the

direction of the median plane, or else is simply an old age character.

Very little is known of the fossil ancestors of *E. asinus.* According to Flower and Lydekker (5.383), teeth and bones from the Pleistocene deposits in Madras are considered to be of that species. Specimens related to the ass and quagga have been reported from America, but the resemblance is based on seemingly meager evidence. Nearly every part of the skeleton of *E. calobatus* which is known, however, shows a closer relation to *E. asinus* than to either *E. caballus* or *E. scotti.*

Camelidæ.

From quarry number one camel material was found, consisting of fragments and small bones. By the method of ratios, comparison was made with a recent form, and from the relative size it was found that there were three different individuals, probably representing as many species.

FIG. 6.

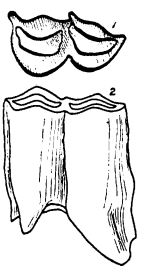


FIG. 6. *Auchenia hesterna*, third upper molar. 1, crown, and 2, side views. One-third nat. size.

Auchenia hesterna. — The parts which were larger than the standard *Camelus bactrianus* No. 1551 of Peabody Museum showed very definite characters which undoubtedly correlate the specimen with the South American llama. The morphology of the larger bones as well as the constancy of ratio to the llama emphasizes this close relation, although the fossil is two or two and one-half times as large as the recent South American form.

The large third upper molar (fig. 6) when compared to the standard gave a ratio considerably over 100 per cent, identifying it as belonging to the largest animal. This large tooth, with its broad grinding surface, cement-filled lakes, and hypsodont crown, indicates the grazing habit of its owner. Because of this and because of the good cursorial adaptation, as shown by the high speed index of the limb bones (fig. 7), the animal is judged to have been a plains dweller in a semi-arid climate, traveling far for food and water.

Eschatius conidens.—There were found parts of the skeleton of a camel of moderate size, giving an average ratio less than 90 per cent that of the standard. With this group was a fragment of the maxillary (fig. 8) containing two molar teeth, whose average ratio is 84 per cent. Especial interest is attached to this portion of skull because it shows, in front of the first molar, a small round alveolus representing a conical tooth, the

only remnant of the premolar dentition. The only specimens similar to it are those of *Eschatius conidens* (2·16) from the valley of Mexico and another much broken specimen from Oregon.

The teeth of the Yale specimen, by their setting at an angle trending backward, their lack of cement filling, narrow short crowns, and sharp cusps, indicate the browsing character of the animal.

FIG. 7.

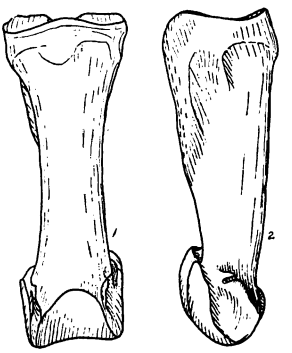


FIG. 7. *Auchenia hesterna*, first phalanx. 1, front, and 2, side views. One-third nat. size.

A moderate-sized scapula (ratio 84 per cent) (fig. 10) probably belongs with the teeth just mentioned. The bone is light, it has a good coracoid for leverage, a broad articulation not easily dislocated, and is, undoubtedly, possessed of universal

FIG. 8.

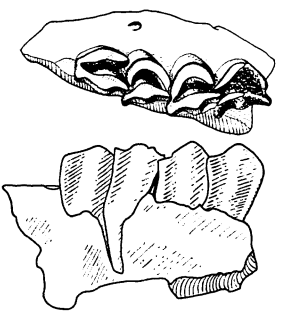


FIG. 8. *Eschatius conidens*, maxillary with alveolus of P^4, the sole remnant of the premolar dentition, and M^1 and M^2. One-third nat. size.

movement, so far as such is to be found in ungulates. Such an animal should be fleet and agile, capable of scrambling about over a wooded, hilly country.

With the fragment of maxillary and its teeth and the scapula just mentioned, there were other parts such as a cervical vertebra, the proximal end of a cannon-bone (fig. 12) and a

FIG. 9.

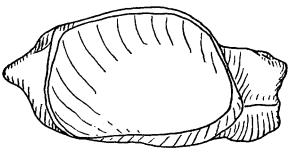


FIG. 10.

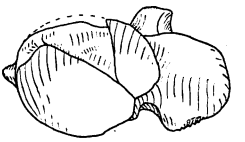


FIG. 9. *Auchenia hesterna*. glenoid aspect of scapula. One-third nat. size.
FIG. 10. *Eschatius conidens*, glenoid aspect of scapula. One-third nat. size.

small phalanx (fig. 13), which seemed further to indicate a rather slender agile animal with the browsing adaptation.

The small phalanx is specifically distinct from the larger phalanges. It may belong to *Eschatius conidens*, since its ratio is but 6 per cent lower than that of the *Eschatius* teeth.

FIG. 11.

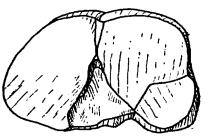


FIG. 12.

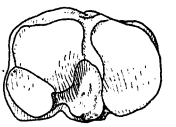


FIG. 11. *Auchenia hesterna*, head of cannon-bone. One-third nat. size.
FIG. 12. *Eschatius conidens*, head of cannon-bone. One-third nat. size.

Measurements and Ratios of Phalanx No. 200.

Phalanx (considered as hind)	Recent No. 1551 Hind	Ratio	Fossil No. 200
Length over all	9·0	108	9·7
Prox. width transverse	3·8	66	2·5
Prox. thickness ant.-post.	3·2	88	2·8
Distal width	3·5	60	2·1
Distal thickness	2·6	77	2·0
Shaft, least trans. diam.	2·1	67	1·4
Shaft, least ant.-post. diam.	1·6	88	1·4
Speed index	4·29		6·96
		79	

The bone is long and slender, the ratio of its length to that of the recent camel is 108 per cent, while the next highest ratio is only 88 per cent. The phalanx is exceedingly narrow, giving a ratio of 42 to 48 per cent less than that of the length. The speed index is very high. The lateral roughenings found in the other bones are absent in this phalanx, but the posterior tuberosity is very prominent; it has a peculiar V-shaped notch in the lower half.

The narrowness of the bone, the lack of symmetry, the flat inner surface, all indicate a close proximity to its fellow. The

FIG. 13.

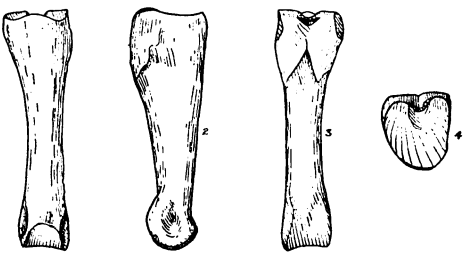


FIG. 13. *?Eschatius conidens*, first phalanx of camel, showing unusual slenderness and dissymmetry. 1, anterior; 2, external; 3, posterior; 4, proximal aspects. One-third nat. size.

toes did not have a great spread. The bone stood quite erect and probably belonged to an animal not semi-digitigrade as the camel generally is, but more truly unguligrade and a good cursorial type.

Certain rather inconspicuous characters of the bones correlated with *E. conidens* show a closer relation to the Old World type of *Camelus* than they do to *Auchenia*. The dental formula, however, shows the genus *Eschatius* to be much more specialized than any other of the group.

Extinction of Camels.—The camels, though indigenous to North America, became entirely extinct in this country. As early as the Lower Pliocene we find fossils in the Old World, showing that one branch had migrated, probably across "Bering Land," giving rise to the genus *Camelus*.

In South America the earliest cameloids are found in the Pliocene. These were ancestral to the South American genus *Auchenia* represented by the llama, alpaca, guanaco, etc. It seems probable that in the late Tertiary some forms allied to *Auchenia* became adapted to mountain life, and either as a cause or result were smaller. The smaller animal could cross the barriers impassable to the larger *Auchenia* and early

moved southward across the newly formed isthmus and was probably already established at the beginning of the Glacial Period. The larger *Auchenia*, not fitted for other than plains habitation, continued within the barriers which were passable to its smaller cousin and hence became extinct. Its extermination resulted, in a more or less direct way, from the advance of the great ice sheet, though the cold itself would not necessarily have accomplished the destruction. It is estimated that a drop of 7° in yearly average temperature would be sufficient to restore Glacial conditions in Europe (16.134). With the ice there came a change of vegetation; incident to its approach there would be greater precipitation, then swollen

FIG. 14. FIG. 15.

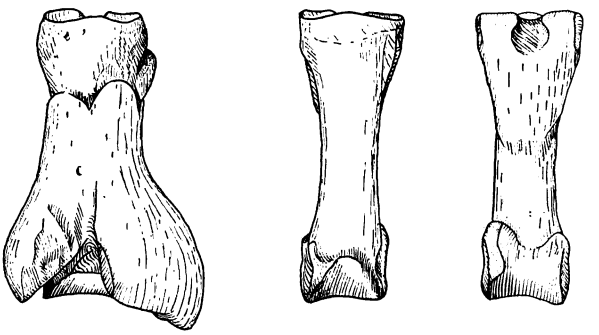


FIG. 14. Pathologic camel phalanx. Anterior view. One-third nat. size.
FIG. 15. Normal camel phalanx, front and rear views. One-third nat. size.

streams, floods and swampy lands. The region thus became uninhabitable to the animals of arid land adaptation and their extinction followed. So to-day the North American *Auchenia* is known only by its very abundant fossil remains.

Much has been said about the effect of diseases in causing the extermination of races. The interesting pathologic phalanx (fig. 14) is probably a result of exostosis or uncontrolled deposition of bony material. The bone was not broken, because it shows the same length as the normal one (fig. 15) of the same size. Possibly the disease which caused the death of the individual also contributed to the destruction of the species.

Canidæ.

There were found with the Rock Creek material parts of dog-like animals belonging apparently to four individuals.

The study of these specimens offers an interesting test of the use of "ratios," by which the parts are separated into well defined groups. Each bone is compared in as many dimensions as possible with the corresponding part of *Canis familiaris* No. 1077 of the Peabody Museum Osteological Collection and its average is tabulated in the index list.

FIG. 16.

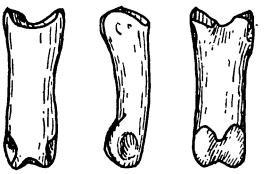


FIG. 17.

FIG. 18.

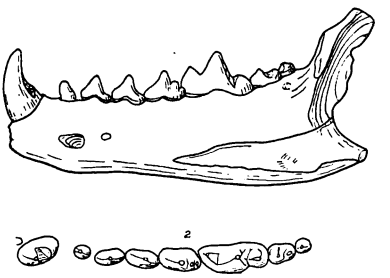


FIG. 16. *Canis dirus*, proximal phalanx. Anterior, lateral, and posterior views. One-half nat. size.

FIG. 17. *Canis dirus*, tibia, posterior view. One-third nat. size.

FIG. 18. *Canis texanus*, n. sp., holotype, ramus and dentition. One-third nat. size.

The largest animal, of which there are four parts (group I), gives an average ratio of 151 per cent; the second, group II, which includes the type of *C. texanus*, n. sp., and seven parts constituting the paratype, gives an average of 114 per cent.

The third group, a single tooth, M¹, gives a ratio of 86 per cent. This tooth, in addition to its small size, is duplicated in group II, thus eliminating the possibility of its belonging with the type of *C. texanus*.

FIG. 19. FIG. 20.

FIG. 19. *Canis ? priscolatrans*, first upper molar. One-third nat. size.
FIG. 20. *Canis texanus*, n. sp., paratype, first upper molar. One-third nat. size.

The last group consists of but two bones which belonged to a small animal 65 per cent of the size of the recent dog.

FIG. 22.

FIG. 21.

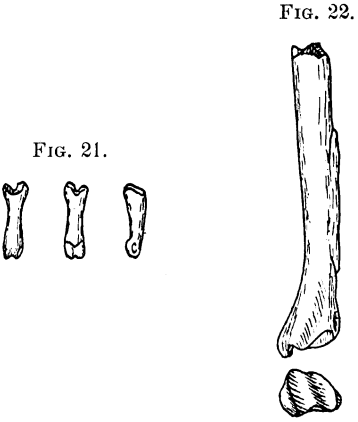


FIG. 21. *Canis temerarius*, first phalanx. One-half nat. size.
FIG. 22. *Canis temerarius*, tibia. One-half nat. size.

Index list.

Group I	No. 10079 Field number	Ratio	Figure
Phalanx	145	163	16
Tibia	41	148	17
Rib	354	143	
Premolar P^3	12	150	
Average		151	

Group II	No. 10058 Field number	Ratio	Figure
Molar M^1	83	119	20
Humerus	246	117	23
Ramus	69	117	18
Magnum	432	113	
Scapula	325	112	
Cuboid	308	110	
Metatarsal	319	109	
Average		114	
Canis familiaris	*No. 1077*	*100*	Used for comparison
Group III	No. 10080		
Molar M^1		86	19
Group IV	No. 10077		
Phalanx	12	67	21
Tibia distal	244	62	22
Average		65	

FIG. 23.

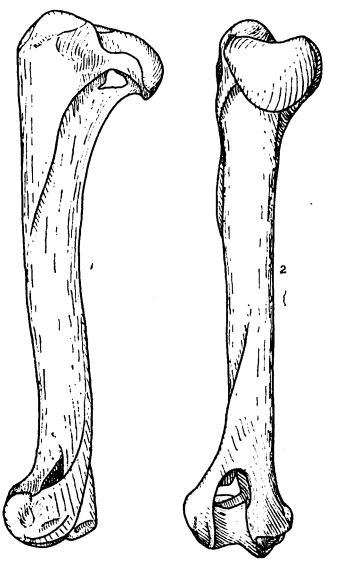


FIG. 23. *Canis texanus*, n. sp., paratype, humerus. 1, side, and 2, rear views. One-third nat. size.

The detailed measurements of the bones and the ratios of each dimension to that of the recent dog, *Canis familiaris* No. 1077, are given in the following tables. Sometimes the

ratios are quite constant and again there is a great variation,— significant of the specific differences in the two types compared.

GROUP I.

Description	Fossil No. 10079	Ratio	Recent No. 1077
Phalanx	No. 145		
Length	4·3	143	3·0
Prox. diam. trans.	1·6	160	1·0
Prox. diam. ant.-post.	1·3	144	0·9
Distal diam. trans.	1·4	175	0·8
Distal diam. ant.-post.	1·0	167	0·6
Shaft, diam. trans.	1·2	171	0·7
Shaft, diam. ant.-post.	0·9	180	0·5
		163	
Speed index $\frac{L}{W}$	3·58		4·29
Tibia	No. 41		
Length	26·2	119	22·0
Width, prox. trans.	5·6	137	4·1
Distal ant.-post. diam.	3·6	171	2·1
Shaft, trans. diam.	2·2	137	1·6
Shaft, ant.-post. diam.	2·6	173	1·5
Shaft, distal trans. diam.	4·2	150	2·8
		148	
Speed index $\frac{L}{W}$	11·9		15·0
Rib	No. 354		
Across tubercle	1·4	127	1·1
Radius of curvature	9·5	158	6·0
		143	
P^3	No. 12		
Antero-posterior diameter	1·8	150	1·2

GROUP II.

Description	Fossil No. 10058	Ratio	Recent No. 1077
M^1 (Large)	No. 83		
Ant.-post. diam. over middle	1·3	118	1·1
Grinding surface, transverse diam.	1·2	133	0·9
		125	

Description	Fossil No. 10058	Ratio	Recent No. 1077
Humerus	No. 246		
Length	21·1	111	19·0
Shaft, diam. ant.-post.	2·1	123	1·7
Shaft., diam. trans.	1·7	106	1·6
Diam. prox. end ant.-post.	5·8	121	4·8
Diam. prox. end trans.	4·2	114	3·7
Diam. distal end ant.-post.	3·6	124	2·9
Diam. of trochlea	1·9	127	1·5
Distal end trans. diam.	4·4	107	4·1
		117	
Speed index $\frac{L}{W}$	12·4		11·9
Jaw	No. 69		
Length, M_3 over C_1	11·6	125	9·3
M_1, diam. ant.-post.	2·8	117	2·4
M_1, diam. trans.	1·1	110	1·0
		117	
Magnum	No. 423		
Length	2·4	114	2·1
Breadth	1·4	108	1·3
Thickness	0·7	117	0·6
		113	
Scapula head	No. 325		
Width over coracoid	4·2	111	3·8
Glenoid cavity, width	2·6	118	2·2
Neck, diam. ant.-post.	3·3	103	3·2
Glenoid cavity, length	3·5	116	3·0
		112	
Cuboid (L.)	No. 308		
Length	2·3	128	1·8
Diam. of shaft	1·1	110	1·0
Diam. of shaft, small	0·6	75	0·8
Diam. prox.	1·5	115	1·3
Diam. prox., small	1·2	120	1·0
		110	
Speed index	3·03		2·25
Metatarsal	No. 319		
Length	9·3	107	8·7
Diam. prox. ant.-post.	1·7	121	1·4
Shaft, diam.	1·8	106	1·7
Dist. ant.-post. keel	1·1	100	1·1
		109	
Speed index $\frac{L}{W}$	5·17		5·12

GROUP III.

Description	Fossil No. 10080	Ratio	Recent No. 1077
M^1 (small)			
Greatest trans. diam.	1·7	94	1·8
Across metacone trans. diam.	1·5	88	1·7
Ant.-post. diam. parametacone	1·2	80	1·5
Ant.-post. diam. over middle	0·8	82	1·1
		86	

GROUP IV.

Description	Fossil No. 10077	Ratio	Recent No. 1077
Phalanx	No. 12		Small toe
Length	2·0	77	2·6
Prox. diam. trans.	0·7	70	1·0
Prox. diam. ant.-post.	0·6	66	0·9
Dist. diam. trans.	0·5	63	0·8
Dist. diam. ant.-post.	0·4	66	0·6
Shaft, diam. trans.	0·4	66	0·6
Shaft, diam. ant.-post.	0·3	60	0·5
		67	
Speed index $\frac{L}{W}$	5·00		4·33
Small tibia	No. 244		
Thickness, dist. ant.-post.	1·2	57	2·1
Shaft, diam. trans.	1·0	63	1·6
Shaft, diam. ant.-post.	1·0	67	1·5
Width, dist. trans.	1·7	61	2·8
		62	

The foregoing tables furnish the basis for classifying the bones into groups representing the separate individuals, and further serve, as already suggested, to point out specific characters. A still further use of ratios in an attempt to identify the different animals with known types results in the following tables. The dimensions of the different specimens were taken from the descriptions in the literature, and the ratios to the recent *C. familiaris* No. 1077 were computed. From the ratios of all the available dimensions of each type, only the average ratio is given in the table below.

Ratios of Specimens in the Literature.

	Per cent
Canis haydeni Leidy (9.21)	159
Canis dirus Leidy (8.167)	152
Group I. Peabody specimens	151
Canis indianensis (*dirus*) (3.458). Cope's Texas specimen, about	150

	Per cent
Canis dirus (13.244). Rancho La Brea specimen of Merriam	141
Canis indianensis (12.288). Rancho La Brea specimen of Merriam	138
Canis indianensis Leidy (11.230). California	137
Canis (*Ælurodon*) *sævus* Leidy (9.21)	115
Canis mississippiensis Allen (1.49)	114
Group II. Canis texanus, n. sp. *Peabody specimens*	114
Canis priscolatrans Cope (4.227)	106
Standard *Canis familiaris* No. 1077	100
Group III. M¹. *Peabody specimens*	86
Canis temerarius Leidy (9.21)	69
Group IV. Peabody specimens	65
Canis vafer Leidy (9.21)	49

The general tendency is to put the larger specimens of *Canis* with the species *C. dirus* Leidy.* Prof. W. B. Scott in his new book (16.204) mentions *C. dirus* and *C. indianensis*, which he considers synonymous. It seems quite fitting, therefore, that the first seven specimens, including group I of the Peabody Museum fossils, be placed under *C. dirus* Leidy.

Measurements of C. texanus n. sp.

	Fossil No. 69	Ratio	Eskimo dog in Amherst College Museum
Depth of jaw at P_1	3·0	78	2·35
Depth of jaw ant. to M_1	3·25	75	2·45
Depth of jaw post. to M_1	3·8	68	2·6
Depth of jaw post. to M_3	4·25	78	3·33

Description Inferior dentition	*Canis texanus* n. sp No. 10058	Ratio	*C. dirus* Rancho La Brea (13.232)
C_1 ant.-post. edge of enamel	1·4	80	1·75
P_1 ant.-post. diam. greatest	0·6	78	0·77
P_2 ant.-post. diam. greatest	1·15	75	1·54
P_3 ant.-post. diam. greatest	1·4	84	1·67
P_4 ant.-post. diam. greatest	1·6	80	2·00
M_1 ant.-post. diam. greatest	2·75	77	3·57
M_1 trans. diam. of heel	1·0	74	1·35
M_1 trans. diam. of trigonid	1·15	80	1·43
M_2 ant.-post. diam. greatest	1·1	86	1·28
M_2 trans. diam. greatest	0·8	80	1·0
M_3 ant.-post. diam. greatest	0·65	100	0·65
Average		81·3	

*J. A. Allen (1.49) was probably the first to point out the precedence of the name *C. dirus* over *C. indianensis* (10.368), which was a later name applied to the type to which the preoccupied name of *C. primævus* (7.200) was first given by Leidy.

Canis sævus Leidy has recently (13.219) been classed under *Ælurodon sævus.*

Canis mississippiensis Allen is based on a tibia and humerus; only the latter is capable of comparison with the paratype humerus (fig. 23) of *C. texanus.* Group II, which includes the type of *C. texanus,* is very near *C. mississippiensis* in size, but the character of the dentition cannot be compared.

Canis texanus as a new species is distinguished from the wolf in the greater curve and twist of the ramus and in its greater depth; in the prominent cusps of P_4, which slope inward and backward; in the talonid of M_1, which has a single large cusp; and in the weak metaconid of M_2.

C. priscolatrans, giving a ratio of 106, is 22 per cent larger than the molar (fig. 19) of group III, but the written description conforms well with this tooth. *C. priscolatrans* may not be distinct from *C. mississippiensis* nor *C. texanus,* n. sp.

The group IV, which is composed of two bones (figs. 21, 22), shows an average ratio of 65 per cent; this is nearest *C. temerarius* Leidy, which gives a ratio of 69 per cent to the recent dog.

C. vafer Leidy, with a ratio of 49 per cent, seems too small to be referred even to the small bones of group IV.

The phylogeny of the Canidæ is not well known, even though this group is native to North America. The ancestry is traced back through *Tephrocyon* to *Cynodesmus* and then lost in primordial obscurity. The descendants of these early forms are represented to-day by our dogs, wolves, and foxes, and the recent animals are almost indistinguishable from the fossils.

Carnivores are much more difficult of preservation than other animals, and it is quite unusual for fossil remains of this order to be found. They usually roam about singly or in small groups. They are wary animals, with a keen sense of danger, and are necessarily much fewer in number than the herbivores on which they feed.

The fossil dogs give us little knowledge of their environment. The large heavy beast referred to *C. dirus* may be the analogue of our timber wolf; the smallest, identified as *C. temerarius,* may represent the fox. Either would be best adapted to a timbered country. *C. texanus,* n. sp., and *C. priscolatrans,* represented by the single molar, may be analogous to the prairie wolf or coyote, a swifter type preying upon the cursorial plains dwellers. It is not strange that we should find the species commingled, since even to-day, in the Panhandle of Texas, we find the great Lobo or timber wolf and also the coyote.

Suidæ.

In the Mylodon-camel quarry at Rock Creek there were two parts (fig. 24) of an animal allied to the modern peccary. In some of the characters, especially the form of the cusps, there is a resemblance to *Dicotyles torquatus*. Most of the fossil Suidæ of the Pleistocene have been referred to the genus *Platygonus*, especially to *P. compressus*, but Flower and Lydekker (5.291) state that: "Large peccaries also occur in the Pleistocene of the United States, which, although they have been referred to a distinct genus, *Platygonus*, on account of

FIG. 24.

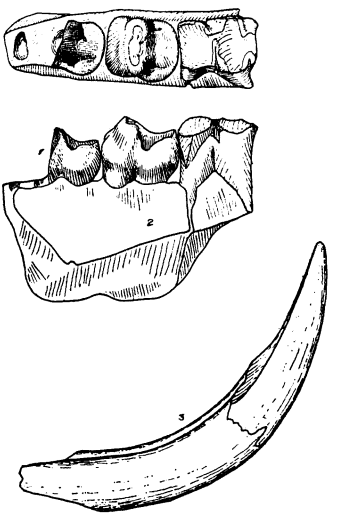


FIG. 24. *Platygonus compressus*, fragment of ramus. 1, crown, 2, side view; 3, tusk. Two-thirds nat. size.

their relatively smaller incisors and somewhat simpler premolars, may well be included in *Dicotyles*."

The range of the ratios between the Rock Creek specimen and one of *P. compressus* is very small, 125 to 136 per cent, while there is a greater variation with the recent specimen of *Dicotyles torquatus*.

Platygonus, indigenous to North America, appears first in the Middle Pliocene and disappears with the Equus zone of the early Pleistocene.

Testudinidæ.

Testudo, sp. ind.—The presence of a turtle in the quarry, though giving no definite clue to the age of the beds, yet tells us of undoubted river conditions.

Megalonychidæ.

Mylodon harlani.—The duplication of parts indicates the presence of at least three individuals of the edentate *Mylodon** in quarry number one. Only broken parts of the skulls were found and a few isolated teeth, but there seems to be almost a complete specimen represented by the vertebræ and the limbs. The huge pelvis, measuring about three and one-half feet across, was, strangely enough, preserved in a sand bed, where other bones were considerably worn by water action.

Though a leaf-feeder, *Mylodon* is native to a semi-arid climate. A late South American immigrant, its presence in the quarry cannot be later than the earliest Pleistocene.

Elephantidæ.

Elephas ?columbi.—A tooth, the proximal end of a femur, and the middle portion of a tusk were found. These parts are small, probably not more than two-thirds the size of a full-grown elephant. The lamellæ of the molar as well as the smaller size indicate the Columbian or a young Imperial mammoth.

Elephas columbi does not appear until the early Pleistocene; if the identification of the species be correct, and it be taken in connection with *Platygonus* and *Mylodon*, it indicates that the layers of quarry number one are no earlier nor later than the Equus beds.

Summary.

The material collected by the Yale Expedition of 1912 at Rock Creek, Texas, included thirteen different species, representing seven families. The living types to which they are most nearly allied are the camel, dog, horse, elephant, sloth, peccary, and turtle.

Very satisfactory results were obtainable, especially in the study of fragmentary material, by the use of "ratios." This device, little used heretofore, not only served to associate the parts of an individual according to size, but also pointed out differences in proportion which were indicative of the variations between the species.

An additional specimen of *Equus scotti* Gidley was found, which is now mounted in the Peabody Museum. It seems quite probable that *E. scotti* is a true horse and is not allied to the ass or quagga, as was formerly supposed.

Equus (*Asinus*) *calobatus*, n. sp., the holotype of which is among the Rock Creek material, is distinguished by the unusually long and slender limb bones. Of the modern types, it is nearest to the ass, which it resembles very much.

* Described by Professor Lull in this Journal for April, 1915.

Two distinct types of camel were found. The large *Auchenia hesterna*, showing characters closely relating it to the South American species, is a plains or desert form, as indicated by its grazing and cursorial adaptations. *Eschatius conidens* is of moderate size. This genus is characterized by the loss of all the premolars but one, which is a simple cone. The teeth indicate the browsing habit of this animal, while the associated limb bones are probably those of an agile form, adapted to hilly country.

By "ratios" the canid material was easily separated into four distinct groups, which were judged to represent as many different species. The largest is *Canis dirus*, which Professor Cope had already found at Rock Creek. The second animal is designated *C. texanus*, n. sp., cf. *mississippiensis*. Of the latter only two limb bones are known, while the new species is based on the left ramus with all its teeth, and on five parts of the skeleton. The third group consists of but a single upper molar. The fourth group comprises two bones which by reason of their small size were identified as *C. temerarius*.

A tusk and a fragment of the ramus of *Platygonus compressus* was discovered. Parts of three or more individuals of the tribe of giant sloths were found. These, with *P. compressus*, indicate the early Pleistocene age of the fauna.

The identification of the elephant material is doubtful, but because of its association and small size, it is judged to be a young imperial mammoth.

The extinction of this entire fauna, except the dogs and turtles, was probably brought about in a more or less direct way by the advance of the early Pleistocene glaciers, causing a change in the environment and rendering it uninhabitable.

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LIST OF ILLUSTRATIONS.

PLATE IX. *Equus scotti*, mounted specimen, Yale Collection.

FIG. 1. Outline map of Rock Creek. 2 in. = 1½ miles.
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3. Posterior and ventral anterior views of atlases of
   1. *Equus caballus*.
   2. *Equus calobatus*, n. sp.
   3. *Equus scotti*.
   About one-sixth natural size.
4. Limb bones.
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   2. *Equus calobatus*, n. sp., fore limb.
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   4. *Equus scotti*, fore limb.
   One-sixteenth natural size.
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   A. *Equus calobatus*.
   B. *Equus scotti* and *E. caballus*.
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7. *Auchenia hesterna*, 1st phalanx, front and side view.
8. *Eschatius conidens*, maxillary with alveolus of P^4, the sole remnant of the premolar dentition, and M^1 and M^2.
9. *Auchenia hesterna*, scapula head.
10. *Eschatius conidens*, scapula head.
11. *Auchenia hesterna*, head of cannon-bone.
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22. *C. temerarius*, tibia. One-half natural size.
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24. *Platygonus compressus*, fragment of ramus and tusk. Two-thirds natural size.

All figures one-third natural size, unless otherwise indicated.