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A STATISTICAL STUDY OF THE METAPODIALS OF EQUUS OCCIDENTALIS LEIDY

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Introduction

A survey and statistical analysis of most of the skeletal elements of the Rancho La Brea horse (*E. occidentalis* Leidy) and of other equine species living and extinct, is being made by the author. In the present paper the only bones of *E. occidentalis* to be dealt with are the fore and hind metapodials. Although skeletal remains of this species of horse occur likewise in the Pleistocene asphalt of McKittrick, California, only the metapodials of the Rancho La Brea horse are here treated statistically. The skeletal elements of *Equus occidentalis* in the Rancho La Brea collection of the Los Angeles Museum were generously made available for measurement and study. It is a pleasure to acknowledge the opportunity to analyze these specimens.

Remarks concerning Equus occidentalis

The name *Equus occidentalis* (Leidy, 1865) is used in reference particularly to the equine skeletal remains recovered from the Pleistocene tar deposits of Rancho La Brea and McKittrick, in California. The possibility that the name should be replaced by the prior designation *Equus excelsus* (Leidy, 1858) depends upon whether *E. occidentalis* is to be considered a synonym of *E. excelsus* or a distinct species. Since, however, identification of *E. excelsus* is uncertain because of insufficient material; and in view of its wide geographical separation (Nebraska) from the Pacific coast Pleistocene horses, it is probably best to regard *E. occidentalis* as a species distinct from *E. excelsus*. The Californian species, *E. pacificus*, has also been confused with *E. occidentalis*. A detailed study of the teeth, metapodials, and phalanges of the latter

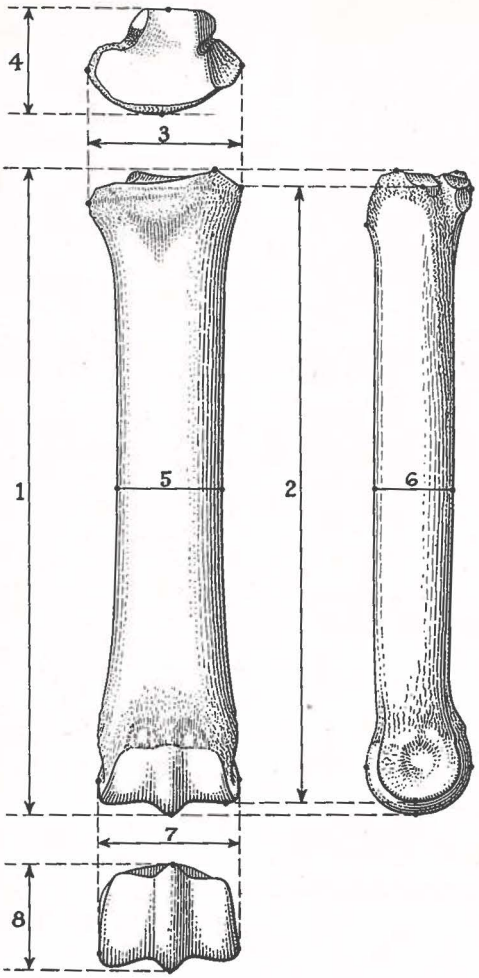

PLATE 17

Scale drawing, 1/3 natural size, of left metacarpal III of *Equus occidentalis* (average-sized specimen). The measurements indicated, and the technique of taking them, are explained in the text.

shows, however, that *E. pacificus* stood in life no less than 64 inches at the shoulder and was proportionately larger than *E. occidentalis* in almost every respect; the enamel pattern of its teeth was distinctly more complicated; and its horse-like hoofs, unusual among wild Equidæ, were much broader and less asinine than those of *E. occidentalis*. Thus there can be no doubt as to the specific differentation of these two Pleistocene equine types.

Such a large amount of skeletal material, particularly of the limb bones, of *E. occidentalis* has been recovered, perfectly preserved, from the asphalt localities of Rancho La Brea and McKittrick that the characteristics of this species in every detail are now either known or are determinable. No other species of fossil horses have been found either at Rancho La Brea or McKittrick. Therefore, unless a future revision of the entire list of Pleistocene horses renders the name *Equus occidentalis* untenable, the author shall continue to apply it to the equine material found, in particular, at Rancho La Brea and at McKittrick.

Equus occidentalis, or the fossil "western horse," was from a morphological point of view a disharmonic and distinctive equine type. If it should be discovered that other Pleistocene horses tended to the same conformation, it can be said that all such "horses" differed decidedly in their head, body and limb proportions from any single breed of domesticated horse of the present time. In shoulder height an average-sized *E. occidentalis* stood about the same as an average-sized Arab horse, namely 58 inches or 14½ hands. Its limb-bone lengths and proportions, and its small hoofs, were characteristic of those of a present-day Burchell's zebra. Yet oddly enough it combined with these cursorial features a robustness of build comparable to that of a draft horse. Its large skull was suggestive of the head-to-body proportions of a zebra. Its strongly-formed pelvis, while quite variable individually, tended more toward the high and narrow asinine type than the broad and low equine type. Thus, to repeat, *E. occidentalis,* was physically a "horse" of very heterogeneous characters.

PROCEDURE

Eight separate measurements were recorded of 74 metacarpals and of 112 metatarsals belonging to *E. occidentalis* of Rancho La Brea and including specimens of both right and left feet. From these eight dimensions seven indices were computed. A statistical presentation of these dimensions and indices is given in Tables 1 and 2. The measurements used, and the measuring technique employed, were as follows (see Plates 17 and 18).

Measurement 1. Maximum length. This is the greatest length of the bone, parallel to its long axis, inclusive of the proximal lateral spine and the distal sagittal ridge.

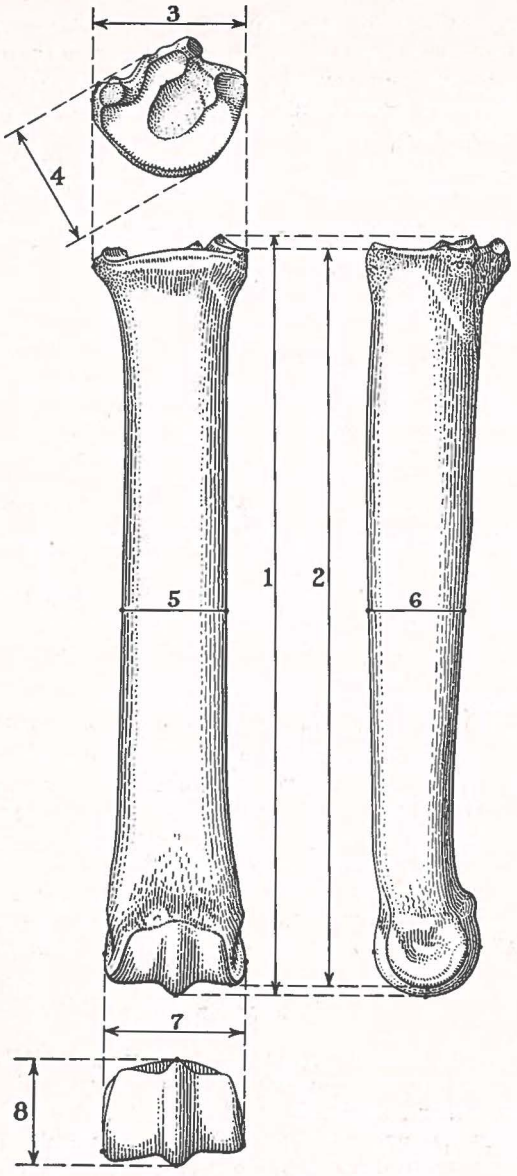

PLATE 18

Scale drawing, 1/3 natural size, of left metatarsal III of *Equus occidentalis* (average-sized specimen). The measurements indicated, and the technique of taking them, are explained in the text.

Measurement 2. Articular length. From the lateral edge of the facet adjoining the fourth carpal bone to the lateral distal edge of the trochlea, in line with the long axis of the shaft.

Measurement 3. Maximum proximal width. The greatest lateral width of the top of the bone, roughly parallel to the lateral axis of the shaft.

Measurement 4. Maximum proximal antero-posterior depth. The greatest sagittal diameter at the upper end, including the anterior tubercle. In the metacarpal this diameter is approximately parallel with the sagittal axis of the shaft. In the metatarsal, however, the measurement is taken with the bone rotated about thirty degrees from the sagittal plane, as shown in the top view in Plate 18.

Measurement 5. Minimum width of shaft. The least lateral diameter of the shaft, approximately at the middle of the length of the bone.

Measurement 6. Minimum antero-posterior depth of shaft. Taken approximately at the middle of the length of the bone and including any volar ridges.

Measurement 7. Maximum distal articular width. The greatest lateral diameter across the volar surface of the trochlea. (The width across the apophyses is, on the average, about the same as the articular width.)

Measurement 8. Maximum distal antero-posterior depth. The greatest diameter antero-posteriorly of the distal sagittal ridge.

Plate 19 shows the frequency distribution of the maximum lengths of 74 metacarpals. Also plotted on the graph in a dotted line is a normal frequency curve. Although the frequencies in the observed distribution fluctuate widely, they appear to conform reasonably well with the theoretical curve. It is apparent that the distribution is unimodal. The mean length (maximum) of the third metacarpal is 252.5 mm., ranging in 74 specimens from 237 mm. to 269 mm. As a matter of interest, the length was computed separately for the right and left sides, but no significant difference was found. The average of the right metacarpal series is 251.5 mm.; that of the left metacarpal series is 253.5 mm. There is probably a sex-differentiation of about 3 mm., the male metacarpals averaging 254 mm. in length and the female metacarpals 251 mm.

Plate 20 similarly is a plotting of 112 metatarsals. Again the dotted line indicates the normal frequency curve, and to it the observed data conform. The mean length (maximum) of the third metatarsal is 292.4 mm., ranging in 112 specimens from 279 to 311 mm. It thus exceeds the length of the metacarpus by 15.8 per cent, or roughly 40 mm. This ratio between the length of the

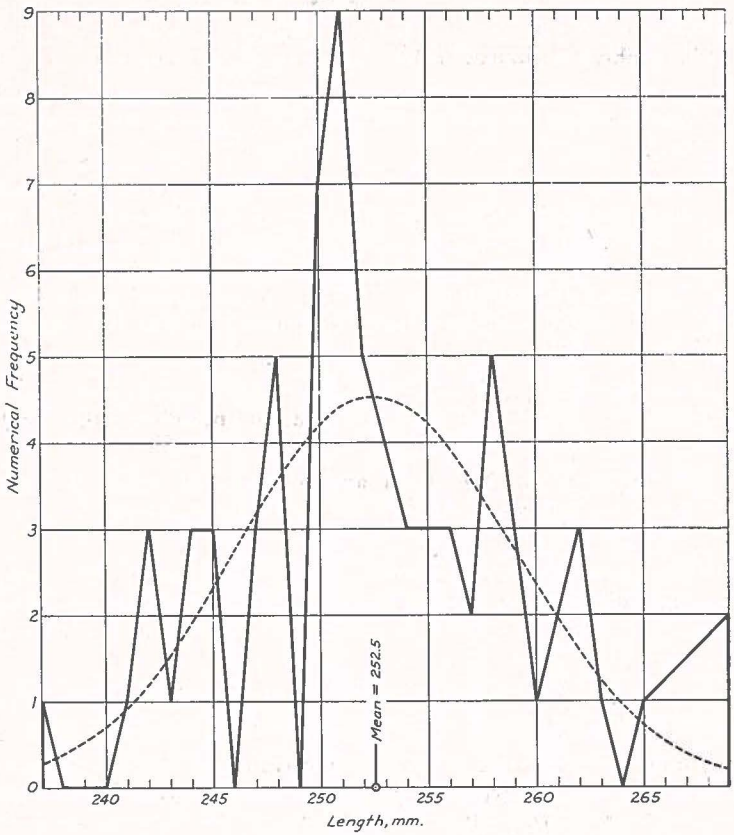

PLATE 19

Frequency distribution of the lengths (maximum) of 74 metacarpals of *Equus occidentalis*, ranging in length from 237 mm. to 269 mm.

metatarsus and the metacarpus approximates closely that which exists in the modern domesticated horse.

In comparison with the metapodials of modern horses, those of *E. occidentalis* are noteworthy in their general appearance mainly for their massiveness and robustness. Certain details of the bones, in their size and proportions, differ appreciably in the typical *E. occidentalis* from those most typical of living horses. Yet certain individual specimens of *E. caballus*, particularly those of semi-draft build, may have metapodials which are practically indistinguishable from those of certain individual Rancho La Brea horses. As a single instance of this variation, it may be

noted that on the proximal surface of the third metatarsal bone the posterior facet for the third tarsal (ectocuneiform) is, in present-day domestic horses, commonly separated from the large anterior U-shaped facet by a distinct depression or trough. In most specimens of *E. occidentalis* this separating trough is absent, as is shown in the top view of the third metatarsal in Plate 18.

In *E. occidentalis* the minimum caliber index (no. 4 in Table 1, under Indices) for the metacarpus is 16.9 in the male. The average value of this index in Thoroughbred stallions is 13.85, and in Percheron (draft) stallions, 18.5. Thus, in this particular index, *E. occidentalis* stood much closer to a draft horse than to a racehorse. If the width of the proximal end of the third metacarpal be taken in comparison with the length of the bone, *E. occidentalis* stood exactly half-way between the draft and the speed types of modern horses. By any standard the metapodials are relatively *thick,* and indicate, together with other bones of the limbs, an equine type of comparatively heavy build.

A graphic plotting of the metacarpal caliber index of *E. occidentalis* shows clearly a bimodal distribution and suggests sexual differentiation. This is indicated also by the relatively high value (6.08) of the coefficient of variation for measurement number 5 in Table 1. If a C.V. of 3.80 (a good average value for other width and depth measurements) be applied to the minimum width of shaft, the range of this dimension in 74 specimens would be from 36.2 mm. to 43.4 mm., whereas actually it ranged from 33.7 mm. to 44.6 mm., a range over 50 per cent greater. The same sex difference is shown in the minimum width of the metatarsus. Since all immature bones were excluded from consideration, the difference is mainly or wholly sexual rather than due to age, although it is possible that the metapodial caliber index does increase slightly with age. That there probably existed in the metapodial caliber index a sex difference of the degree we have assumed is interestingly suggested by measurements of the girth of the fore and hind cannons in living horses. If an index be made by relating shoulder height to girth of the fore cannon, in Percheron horses the average value of this index is 16.05 for stallions and 15.05 for mares. In the Argentine Criollo horse, the index is 13.60 for stallions and 12.96 for mares. Thus, the relative girth of the cannon (and presumably of the underlying metacarpal bone) is in the Percheron horse 6.6 per cent greater, and in the Criollo horse about 5 per cent greater, in stallions than in mares.

The corresponding difference deduced from the metacarpal caliber index in *E. occidentalis* is a male superiority of 6.5 per cent. Curiously, this sex differentiation, while of marked degree in the caliber of the middle of the metapodials, is only slight in the proximal and distal ends. This is true both of the bones of *E. occidentalis* and of modern horses. Finally, the superiority ex-

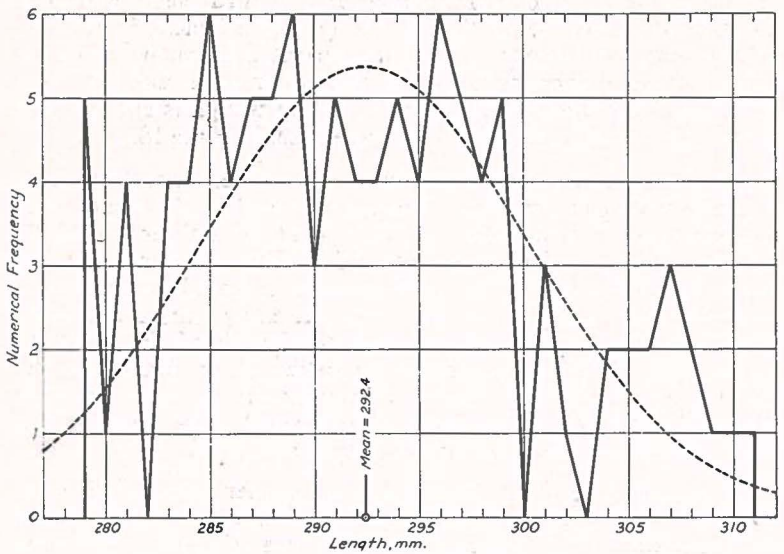

PLATE 20

Frequency distribution of the lengths (maximum) of 112 metatarsals of *Equus occidentalis*, ranging in length from 279 mm. to 311 mm.

isting in the caliber of the metapodials in the male horse is not generally evident in the other long bones of the limbs, with the possible exception of the phalanges. In the draft horse, at least, the hoof bones are distinctly broader in stallions than in mares. No attempt has been made to determine the sex of the bones of the third or ungual phalanx in *E. occidentalis*, since the coefficients of variation for measurements of this element show only moderately high values.

An index useful in showing further the sexual differentiation of the metapodials in *E. occidentalis* is the ratio of measurement number 3 to measurement number 5. If the maximum proximal width of the metacarpus be assumed as 100.0, the minimum width of the shaft in males is, on the average, 68.7, ranging in 37 specimens from 64.8 to 73.2. In female the average index is only 65.6, ranging in 37 specimens from 59.5 to 72.6. The same male superiority in the thickness of the shaft relative to the ends of the bone is presented in metapodials of modern domestic horses. This thickness of the mid-shaft relative to the widths of the ends is, however, noticeably greater in *E. occidentalis* than in most specimens of living horses. Thus the metapodials of the Rancho La Brea horse may be described as of more uniform caliber, with less

flaring of the ends, than those characteristic of modern horses. Particularly is the distal width of the metapodials in *E. occidentalis* relatively narrow, and this conformation possibly is correlated with the small, zebra-like hoofs typical of this species.

No specimens of the second and fourth metapodials, or "splint" bones, were studied. The extent of the two longitudinal roughened areas on the volar surface of the third metapodials, and the width across the articulating facets, indicate, however, that the splint bones were of about the same proportionate length and caliber as those existing in modern horses.

The range in length of the metapodials and of other long bones signifies that the largest individual animals in an entire equine population are about 10 per cent larger in linear dimensions than the average-sized specimen. Thus the largest individuals of *E. occidentalis* would stand at the shoulder about 64 inches.

SUMMARY

Eight measurements and seven indices of the middle metapodials of *E. occidentalis* are recorded and the data compared with similar information on living domestic horses of various breeds. These measurements and indices, taken together with those of other long bones of the skeleton, permit an osteometric restoration of *E. occidentalis*. Tentatively, this fossil horse of Rancho La Brea may be described as of moderately-large size (58 inches in shoulder height) and fairly heavy build, with long head, sturdy limbs, and small, zebra-like hoofs.

The mid-width caliber indices of the metapodials of *E. occidentalis* indicate a sexual differentiation. The metapodial bones of males, for a given length, average 6.5 per cent thicker in the middle than those of females. The sex difference in the relative caliber of the ends of the bones, although suggested, is slight. These differences in relative caliber appear to be substantiated by similar metapodial indices recorded of modern domestic horses, as well as by girth measurements of the cannons of living horses made on both sexes of given breeds.

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Contribution No. 464

TABLE 1

Dimensions and proportions of metapodials of Equus occidentalis from Rancho La Brea

74 Specimens of Metacarpal III

Measurements	Mean	S.D.	C.V.	Range	
				Observed	Standard (1000)
1. Maximum length	252.5±0.8	6.52	2.58	237—269	231—274
2. Articular length	242.4±0.8	6.69	2.76	228—259	221—264
3. Maximum proximal width ♂	59.7±0.3	2.28	3.84	54.5—65	52 — 67
Maximum proximal width ♀	59.1±0.3				
4. Maximum proximal A-P depth	41.6±0.2	1.58	3.80	38 —45	37 — 47
5. Minimum width shaft ♂	41.1±0.3	2.42	6.08	35 —44.6	33 —47.6
Minimum width shaft ♀	38.6±0.3				
6. Minimum antero-posterior depth	31.5±0.1	1.10	3.49	29 —34	28 —35
7. Maximum distal articular width ♂	54.9±0.2	2.08	3.81	49 —59	48 —61
Maximum distal articular width ♀	54.5±0.2				
8. Maximum distal A-P depth	41.5±0.2	1.50	3.62	38 —45	37 —46

INDICES

1. Maximum length / articular length x 100	104.2
2. Maximum proximal width / articular length x 100 ♂	24.6
Maximum proximal width / articular length x 100 ♀	24.4
3. Maximum proximal A-P depth / articular length x 100	17.2
4. Minimum width shaft / articular length x 100 ♂	16.9 (16.0 — 18.0)
Minimum width shaft / articular length x 100 ♀	15.9 (13.8 — 17.4)
5. Minimum A-P depth, shaft / articular length x 100	13.0
6. Maximum distal articular width / articular length x 100 ♂	22.7
Maximum distal articular width / articular length x 100 ♀	22.5
7. Maximum distal A-P depth / articular length x 100	17.1

TABLE 2

Dimensions and proportions of metapodials of Equus occidentalis from Rancho La Brea

112 Specimens of Metatarsal III

Measurements	Mean	S.D.	C.V.	Range	
				Observed	Standard (1000)
1. Maximum length	292.4±0.8	7.81	2.67	279—311	267—317
2. Articular length	285.4±0.8	7.81	2.74	272—303	260—310
3. Maximum proximal width ♂	59.1±0.2	2.25	3.83	53.7—65.0	51.5—66.1
Maximum proximal width ♀	58.5±0.2				
4. Maximum proximal A-P depth	48.5±0.2	1.83	3.78	44 —53.4	42.6—54.5
5. Minimum width shaft ♂	40.2±0.3	2.76	7.09	33 —47	32.3—46.6
Minimum width shaft ♀	37.7±0.3				
6. Minimum antero-posterior depth	37.1±0.2	1.51	4.08	33.4—41	32.2—42
7. Maximum distal articular width ♂	54.4±0.2	2.06	3.80	51.9—59.8	47.5—60.9
Maximum distal articular width ♀	54.0±0.2				
8. Maximum distal A-P depth	40.6±0.1	1.46	3.60	36.8—45	35.8—45.3

INDICES

1. Maximum length / articular length x 100	102.5
2. Maximum proximal width / articular length x 100 ♂	20.7
Maximum proximal width / articular length x 100 ♀	20.5
3. Maximum proximal A-P depth / articular length x 100	17.0
4. Minimum width shaft / articular length x 100 ♂	14.1 (13.2 — 16.5)
Minimum width shaft / articular length x 100 ♀	13.2 (11.6 — 14.7)
5. Minimum A-P depth, shaft / articular length x 100	13.0
6. Maximum distal articular width / articular length x 100 ♂	19.1
Maximum distal articular width / articular length x 100 ♀	18.9
7. Maximum distal A-P depth / articular length x 100	14.2