POST-CRANIAL SKELETAL CHARACTERS
OF BISON AND BOS

BY

STANLEY J. OLSEN

PUBLISHED BY THE PEABODY MUSEUM
CAMBRIDGE, MASSACHUSETTS, U.S.A.
1960
VOLUME I complete.
No. 1. Standard or Headman of Texas. By Albert S. and map. $1.00. Notes Alice W. Oliver, and a Alice W. Oliver. Signature.
No. 2. The Karankawa of Texas. By Albert S. and map. $1.00. Notes Alice W. Oliver, and a Alice W. Oliver. Signature.
No. 3. The Atlantic or Speerican Mayas. By Zel and 2 plates. 55 cents. S
No. 4. Report upon Pike Creek, near Claymont, T. Cresson. 1892. 24 pages. 25 cents. Signature.
No. 5. A Study of Omaha Transcriptions of 92 By Alice C. Fletcher, and 1893. 152 pages. $2.25. V
tural peculiarities of the Fillmore. Out of print.
No. 6. Prehistoric Burial of Willoughby. 1898. 52 p;
trations in the text. 75 cents.
No. 7. A Penitential Rite of the Ancient Mexicans. By Zelia Nuttall. 1904. 26 pages, 5 plates, and 8 illas in the text. 50 cents.
VOLUME II complete, $3.50; bound in cloth, $5.00.
The Fundamental Principles of Old and New World Civilization. By Zelia Nuttall. 1901. 602 pages, 7 plates, and 73 illustrations in the text, and Index. Signatures only.
VOLUME III complete.
No. 1. The Cahokia and Surrounding Mound Groups. By D. I. Bushnell, Jr. 1904. 20 pages, 5 plates, map, and 7 illustrations in the text. 50 cents.
No. 2. Exploration of Mounds, Coahoma County, Mississipp. By Charles Peabody. 1904. 44 pages and 17 plates. $1.00.
No. 5. Discovery of a Fragment of the Printed Copy of the Work on the Millcayac Language of Chile by Lui De Valdivia. By Rudolph R. Schuller. 1913. 37 pages. 50 cents. Photographic reproduction of 4 pages of the work, with Bibliographic Notice.
VOLUME IV complete.

J. Spinden. 1924. 286 pages, 4 plates, and 62 illustrations in the text. $3.50.

VOLUME VII complete, $2.40; bound in cloth, $5.40.

VOLUME VIII complete.

VOLUME IX complete, $3.25; bound in cloth, $6.25.

VOLUME X complete, $3.20; bound in cloth, $5.05.

VOLUME XI complete, $4.70; bound in cloth, $7.75.
No. 1. Indian Burial Place at Winthrop, Massachusetts. By C. C. Willoughby. 1924. 37 pages, 4 plates, and 20 illustrations in the text. 75 cents. Notes on the skeletal remains by E. A. Hooton.
POST-CRANIAL SKELETAL CHARACTERS
OF BISON AND BOS
POST-CRANIAL SKELETAL CHARACTERS
OF BISON AND BOS

BY

STANLEY J. OLSEN

PUBLISHED BY THE PEABODY MUSEUM
CAMBRIDGE, MASSACHUSETTS, U.S.A.

1960
ACKNOWLEDGMENTS

MY FIRST and foremost acknowledgment of thanks and appreciation is to Miss Barbara Lawrence, of Harvard University's Museum of Comparative Zoology, for her aid and continual encouragement to carry out this study which was started several years ago.

Dr. Richard Van Gelder of the American Museum of Natural History and Dr. James Bump of the South Dakota School of Mines were most helpful in allowing the writer access to skeletal material that was needed for comparative purposes.

Mr. Morris Skinner of the American Museum of Natural History and Dr. G. Edward Lewis of the Paleontology and Stratigraphy Branch of the United States Geological Survey were kind enough to offer suggestions relating to morphological characters of *Bison* skeletons that were observed during the many comparisons of *Bison* and *Bos* that they have made.

Dr. Charles Reed, of the University of Illinois, and Dr. V. Lehmann, of Hamburg's Geologisches Staatsinstitut, brought to the writer's attention foreign publications that might otherwise have been neglected.

Dr. Emil Haury, of the University of Arizona, furnished additional data bearing on the range of the buffalo in the southwest enabling the drafting of a more up-to-date map of the distribution of these animals.

Dr. Robert O. Vernon, Director of the Florida Geological Survey, was more than generous in allowing research time so that this work might be brought to completion.

The original drawings were made by the writer with the aid of a camera lucida. The finished and scientifically accurate art work is the product of Mr. Andrew Janson, staff artist for the Florida Geological Survey, and his excellent work speaks for itself.

This study was materially aided by Grant No. 454 of the National Academy of Sciences' Bache Fund for which the writer is most appreciative. Assistance was also generously given through Research Grant National Science Foundation—G9802.

Stanley J. Olsen
CONTENTS

ACKNOWLEDGMENTS ........................................ v

DISCUSSION ............................................... 3

SKELETAL CHARACTERS OF BISON AND BOS .................. 7

  Cervical vertebrae ....................................... 7
  Thoracic vertebrae ....................................... 7
  Lumbar vertebrae ......................................... 8
  Sacrum .................................................. 8
  Scapula ................................................ 9
  Articulated forelimb ..................................... 9

Humerus .................................................. 9
Radius and ulna ......................................... 10
Metacarpal and metatarsal ............................... 10
Phalanges ................................................ 10
Os coxae .................................................. 11
Articulated hindlimb ..................................... 11
Femur ..................................................... 11
Tibia ...................................................... 12
Fused central and fourth tarsal and tibial tarsal ...... 12
Fibular tarsal ............................................ 12

REFERENCES ............................................... 15

LIST OF LINE-CUT FIGURES

1. Map showing distribution of North American Buffalo. Skull symbols, outside of cross-hatched area, indicate probable range of Bison bison athabasca during prehistoric times ......................................................... 2
2. Proportional linear measurements of scapula of Bison and Bos ..................................... 5
4. Articulated skeletons of Bison bison, Bos indicus and Bos taurus illustrating general proportions and length of neural spines.
5. Axis of Bison bison, Bos indicus and Bos taurus showing lateral surface; atlas showing anterior and dorsal surfaces.
6. Fifth cervical vertebra of Bison bison, Bos indicus and Bos taurus showing anterior, right lateral and dorsal surfaces.
7. Second thoracic vertebra of Bison bison, Bos indicus and Bos taurus showing lateral surface; eighth thoracic vertebra showing lateral surface and anterior surface.
8. Lumbar vertebrae of Bison bison, Bos indicus and Bos taurus showing left lateral surface and dorsal surface.
9. Sacrum of Bison bison, Bos indicus and Bos taurus showing dorsal, ventral, anterior and articular surfaces.
10. Right scapula of Bison bison, Bos indicus and Bos taurus showing articular and lateral surfaces.
11. Articulated left forelimb of Bison or Bos showing anterior and medial views.
12. Articulated left forelimb of Bison or Bos showing posterior and lateral views.
13. Right humerus of Bison bison, Bos indicus and Bos taurus showing proximal end, anterior surface; proximal end, three-quarter lateral view; distal end, lateral surface; and distal end, medial surface.
14. Right radius and ulna of Bison bison, Bos indicus and Bos taurus showing three-quarter view, proximal articular surface; transverse section showing relation of fused shafts of radius and ulna; medial surface, proximal end of radius; and articular surface, distal end of radius.
15. Right metacarpal of Bison bison, Bos indicus and Bos taurus showing proximal articular surface; right metatarsal showing proximal articular surface; anterior surface, proximal end; posterior surface, distal end; and anterior surface, distal end.
16. Second phalanx of Bison bison, Bos indicus and Bos taurus showing dorsal and lateral surfaces; first phalanx showing dorsal and ventral surfaces.
17. Hoof bone or third phalanx of Bison bison, Bos indicus and Bos taurus showing lateral, dorsal, articular, plantar and medial surfaces.
18. Left os coxae of Bison bison, Bos indicus and Bos taurus showing lateral surface.
19. Articulated left hindlimb of Bison or Bos showing anterior and medial views.
20. Articulated left hindlimb of Bison or Bos showing posterior and lateral views.
21. Right femur of Bison bison, Bos indicus and Bos taurus showing proximal end, posterior surface; proximal end, anterior surface; distal end, lateral surface; and distal end, medial surface.
22. Left tibia of Bison bison, Bos indicus and Bos taurus showing proximal end, posterior surface; proximal end, lateral surface; distal end, posterior surface; distal end, articular surface.
23. Right fused central and fourth tarsal of Bison bison, Bos indicus and Bos taurus showing proximal articular surface and distal articular surface; left tibial tarsal showing anterior and posterior surfaces.
24. Left fibular tarsal of Bison bison, Bos indicus and Bos taurus showing anterior, lateral, superior, inferior, posterior and medial views.
POST-CRANIAL SKELETAL CHARACTERS
OF BISON AND BOS
Fig. 1. Map showing distribution of North American Buffalo. Skull symbols, outside of cross-hatched area, indicate probable range of Bison bison athabascae during prehistoric times.
**DISCUSSION**

Perhaps no forms of life are as symbolic of a free and wild continent as are the Indian and the North American buffalo. Due to the buffalo's wide distribution, great numbers and its importance as a major food source of the Indian, its skeletal remains have been found in almost every important archaeological site within the animal's known range (fig. 1). Mr. G. Catlin, prophesying the future of the Indian and the buffalo, declared "... they have taken up their last abode, where their race will expire, and their bones will bleach together" (Catlin, 1844, vol. 1).

The introduction of domestic cattle into North America took place at two widely separated points at about the same time. Dr. A. H. Sanders (1925, p. 709) summarizes these landings as follows:

The first reliable data as to cattle are contained in a written report found in the Spanish Archives at Madrid, to the effect that Gregorio Villalobos in 1521 went to New Spain (now Mexico) as governor-general or viceroy. Villalobos landed near the present town of Vera Cruz, Mexico, and according to the manuscript "brought a number of calves from Santo Domingo, he being the first to bring them to New Spain." ...

Four years later, in 1525, Portuguese fishermen landed a few cattle and some hogs on Cape Breton Island, from which they were soon carried to Newfoundland and the adjacent mainland.

The conquistadores, Coronado, Fray Marcos de Niza, Oñate and others who explored the southwestern United States undoubtedly took with them cattle which were the basic stock of the southwest, including Old Mexico, Arizona, New Mexico and Texas. These animals were designated in the reports of the time as "droves of big cattle" with no mention being made of breed. However, they were probably of Andalusian stock, with heavy forequarters and light hindquarters, thick necks, large coarse heads, and possessing unusually long horns. From this first stock came the longhorns of Texas and ultimately the cattle industry of the West. The cattle that were peculiar to Spain in the sixteenth century were neither as fine as the British breeds nor were they exceptional as either beef or dairy cattle. This is understandable since they were a product of a land where forage was not especially abundant. Hardiness and ability to thrive under primitive conditions were their chief recommendations and they were admirably suited to the new territory taken over by the Spanish Crown in the early sixteenth century.

There is little skepticism among workers having contact with *Bison* and *Bos* remains as to their similarity; in fact, Dr. C. Linnaeus (1788), in the type description of the plains bison, placed the species *bison* in the same genus as the present day domestic cattle, *Bos taurus*. This is due in part to the distinguishing differences between the skeletons of *Bison* and *Bos* which are so subtle that only a combination of these characters make certain bones identifiable and separable (figs. 3 and 4).

Archaeologists have long felt the need for osteological keys to aid in determining the various problematical animals that turn up in their excavations, with special emphasis on those fragments that are labeled "cf. *Bison* or *Bos*." This has been pointed out in particular by Dr. J. O. Brew in the introduction to Miss Barbara Lawrence's fine paper on the mammals found at the Awatovi site (Lawrence, 1951) and by many of the people who were present at the discussions held by the Committee on Archeological Identifications of the National Academy of Sciences (Taylor, 1957). Several volumes are available for the student of mammalian osteology (Cornwall, 1956; Flower, 1876; Reynolds, 1913) but, in all instances, these are general texts and are not suited to the special problems or the authors of these works assume that a sufficient library or reference collection is at hand.

Illustrated keys of a sort to be used by archaeologists dealing with the skulls and dentitions of mammals, including *Bison*, are rather numerous (Brown, 1952; Burt, 1948; Glass, 1951) but only a few illustrating post-cranial...
skeletons have been published (Brainerd, 1939; Hildebrand, 1954, 1955; Hue, 1907) and none of these are concerned with a detailed study of the vertebral column or appendicular skeleton of the *Bison*. Dr. J. A. Allen (1876) in the introduction of his bison monograph states, in relation to the text that follows, "... it cannot be considered as an exhaustive essay on the subject, but it is believed that the conclusions reached will not be much affected by future investigations, though many important details respecting particular districts may yet be added." However, Allen does not include any plates illustrating a complete or partially articulated bison skeleton. He devotes all of the figures to illustrating the skulls and dentitions of both fossil and Recent forms, with the exception of a few limited views of metacarpals which appear on plate XI and 3 metatarsals as a part of plate VII. This same criticism holds true for the more recent publication which deals with the revision of the genus *Bison* (Skinner and Kaisen, 1947). This contribution certainly represents a detailed study of the skull and dentition but lists only comparative measurements of some of the elements of the lower limbs, without any figures being given. Mr. F. G. Roe (1951) in his study of the North American buffalo covers nearly every aspect of the history that pertains to this animal, including an appendix on such fringe topics as "Indian Cannibalism," yet only one plate, the frontispiece depicting a buffalo, is included in the nearly 1000 pages of text that constitute this volume and even this meager representation of the buffalo is credited to a worker in Berlin.

Although the North American buffalo was figured by J. Thevet in 1558 and much has been said during the intervening years concerning this animal, no illustrated osteological discussion comparing *Bison* and *Bos* has appeared among the many contributions to the recorded literature. There is little doubt that a published comparative study of the skeletons of the American buffalo, *Bison bison*, and the domestic cattle, *Bos taurus*, is needed by those workers who are engaged in interpreting sites that fall within the ecological range of both of these animals.

The skeletal remains of the Brahman cattle, *Bos indicus*, are very similar to those of the bison and in some cases may be found under conditions which could lead to confusion when attempting a hasty identification of these remains (Olsen, 1959). A small herd of Asiatic humped cattle or Zebus (*Bos indicus*) were landed in South Carolina in 1849, to be used for domestic purposes. Zebu is a universal term used to designate the numerous breeds of humped cattle as found in southern Asia. This expression includes many breeds of Nellore, Gyr, Guzerat, Krishna Valley, etc. The term Brahman, as applied to cattle, is strictly of U.S. origin and is used to designate the breeds of Zebu or *Bos indicus* that are developed in this country. These breeds are many and varied but tend to be larger, heavier and shorter limbed than do their counterparts of Asia. The descriptions and comparisons of those elements that were deemed diagnostic in the Brahman have been included in this study. Some of the smaller elements such as carpals, tarsals, or caudal vertebrae are usually poorly preserved or exhibit little in the way of morphological features which aid in separating these three similarly developed animals and their descriptions have been omitted.

A field manual of this sort, in order to be of real service, must be well illustrated and nearly self-explanatory so that the archaeologist can identify incomplete specimens with a minimum of additional research into other literature or reference collections. This contribution has been designed with this in mind and it is hoped that it will fulfill the needs of the archaeologist who has to identify those tantalizing fragments that are usually categorized cf. *Bison* or *Bos*.

When a large series of either *Bos* or *Bison* is examined, individual variations can be noted in the separate elements, particularly between a large bull and a small cow of the same species. However, as Barbara Lawrence (1951) determined, on examination of different breeds of domestic cattle, these differences show up in relative length and diameter of the various bones, but the epiphyseal muscle scar characters and articular surfaces are the same for all of them. When muscle scars are used as key characters (fig. 21, A-1), it is important to remember that the rugosity of the ridges and prominence of the surface for muscle attachment may be age or sex characters, the specific characters being the actual shape or outline of the muscle scar.
Although single individual “key characters” may vary and intergrade when a large series of skeletons is examined, making the separation of Bison and Bos difficult, in no instance was it observed that all key characters followed this course and prevented positive separation of the 2 genera. There are sufficient features in a partial skeleton (other than a single bone) to differentiate between the animals in question.

The terminology used by writers in their osteological discussions varies considerably, sometimes very confusingly. For instance, Flower (1876) used astragalus, Sisson (1953) used tibial tarsal bone, and Ellenberger, et al (1949) used os tarsi tibiale, all for the same bone of the hind foot. Since this paper is a discussion of only the skeletons of the animals concerned, the nomenclature used by Sisson will be followed, as this work is a widely accepted mammalian anatomy, still in print, and those readers wishing to refer to the musculature or soft anatomy of the bovids may consult this volume. Although the writer believes that the terminology used by Sisson is perhaps not that which is generally used by palaeontologists or archaeologists, it is perhaps better to follow this text and be consistent rather than to have the more interested readers convert the terms each time the musculature is referred to.

Albeit, after handling a number of skeletons of each of the compared animals, a certain “feel” for the heavier bison bones is acquired, it is essential that at least one skeleton of each of the 3 forms be at hand for the proper understanding of the points discussed. At the present time, it is possible to obtain buffaloes from the Federal government herds when they are thinned out, usually each year, and good domestic cow skeletons (Brahmans included) can be secured from many of the ranches in this country merely for the asking.

There are 2 recognized subspecies of North American buffalo, the plains bison, Bison bison bison and the woodland or “woods” bison, Bison bison athabascae (Miller and Kellogg, 1955; Skinner and Kaisen, 1947). The plains bison was a former inhabitant of the Great Plains area and the woodland race was found...
farther north as dwellers of the mountainous country. This last named form was darker in color and grew to a larger size than did those of the plains race (fig. 2).

However, for this osteological study no particular emphasis is given size alone; rather, the articular surfaces, muscle scars and proportional measurements are shown to be the diagnostic reference points and, consequently, no attempt will be made to isolate these 2 subspecies on osteological evidence alone. It is seriously doubted if, in many cases, these subspecies could be separated where identifications were based on living animals, particularly in those areas where the habitats of the 2 groups overlapped.

The 18 specimens of *Bison bison* which were available for comparison were animals collected from the wild herds of the 1870's. Nine skeletons of *Bos indicus* (Zebu) were also checked and compared. These were of undesignated breed and represented the smaller types of Asiatic cattle (fig. 2). Skeletons of *Bos taurus* representing the breeds of Holstein, Jersey, Alderney, Shorthorn, Devon and Aberdeen-Angus were used in this study.

One of the discouraging things that came to light during the course of this study was the absence of an adequate representation of domestic animal skeletons in the collections of our larger museums. None of the collections examined contained skeletons of the North American Brahman. The specimens used for comparison and illustration were collected in Florida and are representatives of the Guzerat breed, one of the largest animals maintained in this country.
SKELETAL CHARACTERS OF BISON AND BOS

CERVICAL VERTEBRAE

Atlas and Axis (fig. 5). The first 2 cervical vertebrae display several differentiating characters that key out or separate these elements as belonging either to Bison or Bos. When viewing the anterior notch, from a ventral aspect, the atlas of Bison presents a curved or cup-shaped margin (A-3). In both Bos indicus and Bos taurus this same edge tends to square up and form right angles (B-3 and C-3). The wings of the atlas in the buffalo form a square outline at their terminus (A-3) while these same processes in the Brahman are more rounded (B-3) and those in the domestic cow have a tendency to be pointed (C-3). In the specimens of old adult buffalo bulls that were compared, the vertebral foramen of the atlas approached a triangle in outline (A-2) when viewed anteriorly, as compared with the more rounded or oval form of this same opening in the specimens of Bos that were examined (B-2 and C-2).

The axis of the buffalo has a dens (A-1) that differs from that of Bos indicus (B-1) and Bos taurus (C-1) in that it forms an acute angle when viewed laterally. In both species of Bos this same margin has a definite break or angle occurring between the anteroventral angle of the dens and its terminus at the anterior base of the spinous process. The lateral margin of the anterior articular process also forms a nearly right angle with the long axis of the body of this second cervical in both species of Bos (B-1 and C-1), a condition not present in the buffalo (A-1). In old adult buffalo bulls the dorsoanterior angle of the spinous process assumes a position directly over the forward tip of the dens (A-1). This latter process in the examined species of Bos was observed to be well in advance of the spinous process.

Fifth Cervical (fig. 6). The outline formed by the tips of the anterior articular processes and the ventral branches of the transverse processes of the cervicals, when viewed from a posterior position, is rectangular in shape in the Bison (A-1) and more nearly square in both species of Bos (C-1). The lateral branch of the transverse process in Bos indicus has a ridge connecting it with the ventral branch of the transverse process (B-1 and B-2), a condition at times present in Bos taurus but not so in the examined skeletons of Bison bison. The summits of the spinous processes of the cervical vertebrae of the buffalo are very little expanded (A-1) as compared with a definite flaring of these same processes in both Bos indicus and Bos taurus (B-1 and C-1).

THORACIC VERTEBRAE

The vertebrae in a given region have characters by which they may be distinguished from those of other regions and individual vertebrae have special characters which are more or less clearly recognizable. There are 14 thoracic vertebrae (fig. 7) in the bison and 13 in each of the 2 species of Bos. This is usually a constant number in Bos but 14 may be present or more rarely, only 12. The number remained constant in the examined specimens of Bison bison.

The second and third thoracic vertebrae are usually the longest, reaching a length of 20 inches in a large buffalo bull but rarely over 13 inches in Bos indicus or over 10 inches in Bos taurus. There is a gradual diminution in height of the spines from the third thoracic to the thirteenth or fourteenth with an increase of backward slope. The spinous process of the second thoracic vertebra differs in the bison from those of Bos indicus and Bos taurus by being more restricted on the anterior outer
edge of the middle of the spine (A-1) and by having a pointed or sometimes squared summit, with no overhang, to this process. In *Bos indicus* this summit has a definite posteriorly curved overhang (B-1) while that of *Bos taurus* has an angle at the anterodorsal margin and is in line with the forward face of the main body of the spine (C-1). The postero- dorsal margin of the summit has a pronounced overhang as in *Bos indicus*.

The eighth thoracic vertebra of the buffalo exhibits a forward swelling at the summit (A-2) as opposed to a definite dished margin as is present in *Bos indicus* (B-2) or a pointed tip as found in *Bos taurus* (C-2). *Bos indicus* alone, of the three compared forms, has a notched summit on the eighth thoracic (B-3). This is at times grown over on the dorsal surface to form an eye rather than the bifurcate tip. Both *Bison bison* and *Bos taurus* have the characteristic widening at the tips of these spines as found in many of the bovids. The last thoracic vertebra is distinguished by the absence of the posterior pair of costal facets, and the confluence of the anterior pair with those of the transverse processes.

The spinous processes of the anterior thoracic vertebrae are largest in the bison due to the position of the animals head in relation to its spinal column. A. B. Howell (1944) observed that high spinous processes over the anterior thorax are characteristic of those mammals with extremely large heads.

Because of the angle of leverage that the supporting muscles must maintain, this feature is more pronounced in those forms, such as the buffalo, in which the head is habitually held low. The length and flatness of these spines prompted the buffalo hunters to refer to them as “hump ribs.”

**LUMBAR VERTEBRAE**

The lumbar vertebrae (fig. 8) disclose the same instability in number in *Bos* as do the thoracic series. The usual count is 6 in both *Bos indicus* and *Bos taurus* but may occasionally number 5 (B-1 and C-1). The lumbar series in all of the examined specimens of *Bison bison* remained constant and totaled 5 (A-1). The summits of the spinous processes of the 3 animals exhibit considerable variation as to the amount of overhang which is present, so that no diagnostic features were observed or recorded for these spines. In the buffalo the transverse processes have a tendency toward finishing off in tapered points (A-2) as compared with a nearly uniform anteroposterior width along the entire length of these processes as observed for both species of *Bos* (B-2 and C-2). The transverse process of the first lumbar vertebra in *Bison* usually has a small pointed projection situated on the anterior margin of the process and is inclined in an anteromedial direction. This spike is not generally as pronounced or is entirely lacking in *Bos* (A-2, B-2 and C-2).

**SACRUM**

The sacrum (fig. 9) is merely a composite bone formed by the fusion of certain vertebrae. The vertebra number 5 (A-2, B-2 and C-2) in all 3 animals and form a compact unit having nearly parallel lateral margins. In both *Bos indicus* and *Bos taurus* the lateral border of the anterior end of the body of the first sacral vertebra reaches a point which is in line with the parallel margins of the main body of the sacrum (B-2 and C-2). These same borders of the anterior vertebral end in the bison are located at a considerable distance medially to the parallel margins of the main sacral element (A-2). The end of the body of the first sacral vertebra, when viewed anteriorly, is more triangular in outline in the buffalo (A-3) while it approaches an ovaloid form in both species of *Bos* (B-3 and C-3). The wings of the sacrum in *Bison* (A-1) are more sharply inclined in a forward direction than are those found in *Bos taurus* (C-1). The sacral wings of *Bos indicus* project laterally with no noticeable forward curve (C-1). In *Bos indicus* the last sacral vertebra may undergo only partial
fusion and terminate in a spool-shaped posterior sacral projection (B-2) unlike those found in *Bison bison* or *Bos taurus* (A-2 and C-2).

**SCAPULA**

*The scapula* (fig. 10) of the buffalo is most readily separated from the other 2 forms by comparative measurements of the blade. In the bison the length from the glenoid fossa to the anterior angle is considerably greater proportionally in relation to the measurement from the posterior angle to the anterior angle (fig. 2). Even in a young adult bison, where the measurement of length approaches that of *Bos taurus*, the width is noticeably less in the bison. In the examined specimens of *Bos indicus* the anterior angle is nearly a right angle in contrast to a rounded contour as found in the scapula of the other 2 animals. The articular surface of the glenoid cavity is nearly round in *Bos taurus* (A-1) while this same surface is more oval in form in both *Bos indicus* and *Bison bison* (B-1 and C-1).

**ARTICULATED FORELIMB**

*The forelimb* (figs. 11 and 12) has been figured in articulated, anterior, medial, posterior, and lateral views to enable the reader to compare relative size and position of the various elements comprising this member of the post-cranial skeleton. Some of the smaller bones such as carpals and sesamoids contribute little in the way of morphological separation of these 3 animals and they have not been separately described or illustrated.

**HUMERUS**

*The humerus* (fig. 13) in *Bos* is readily distinguished from that of *Bison* by observing the relationship of the medial and lateral tuberosities to the bicipital groove of the proximal end of the bone (A-1, B-1 and C-1). In *Bos* the medial point of the lateral tuberosity overhangs the bicipital groove (C-1) while in the bison this same projection is directed to form an obtuse angle of the bicipital groove and has no noticeable overhang (A-1). The floor of the bicipital groove, in *Bison*, slopes evenly from the medial wall of the groove to the base of the lateral tuberosity while in *Bos* the bases of the medial and lateral tuberosities are separated by a pronounced swelling (B-1 and C-1). When viewed laterally the larger tuberosity has a single deep notch on the outer margin of this element in *Bison* (A-2) but this same area in *Bos* is not as deeply notched or in most cases has 2 lesser grooves occupying this same ridge (B-2 and C-2). The distal end of the humerus in the buffalo and Brahman have a continuous gentle curve along the ridge connecting the main shaft of the humerus with the lateral condyle (A-3 and B-3). In *Bos taurus* this ridge has a decided break or angle at its junction with the main shaft (C-3). The fossa for muscle attachment on the lateral condyle is larger and more irregularly shaped in *Bison* (A-3) as compared to nearly round pits for these same excavations in the other 2 animals. The ridge of the medial epicondyle in *Bison* forms a nearly right angle with the most distal margin of the humerus when viewed from a medial plane. The medial epicondylar ridge in *Bos indicus* has a decided outward deflection at its most distal point (B-4) while this same condyle projects well below the distal limit of the medial condyle and in line with the main margin of the humeral shaft in *Bos taurus*.

As stated at the beginning of this summary, most of the morphological differences found in these 3 compared forms are a matter of degree of variation rather than radical, easily seen characters and it is necessary to have at least one skeleton of each of the 3 forms at hand in order to make the final decisive comparisons.
RADIUS AND ULNA

The radius and ulna (fig. 14) of the 3 animals are fused at various points along their surface of contact so that when found they usually comprise a single unit and are discussed here as such. The proximal articular surfaces show too great a variation and change to be considered for key characters. However, scars for muscle attachment on both the lateral and medial sides of the radius have diagnostically separating features. In Bison the tuberosity for the attachment of the ligament of the elbow joint (A-1) is less pronounced and more cupped than the knoblike projection found in Bos (B-1 and C-1). The scar for the brachialis muscle, though roughened in Bos (B-3 and C-3), is far smaller and less excavated than the large rectangular surface which is present on the proximal end of the radius of the buffalo (A-3). The shaft of the ulna, when considered as a cross section medially, forms a nearly right angle with that of the radius in Bison (A-2) while in both species of Bos this surface of contact is present as a gently curved plane having no decided break or angle (B-2 and C-2). The distal end of the radius in Bos taurus can be separated from Bison and Bos indicus by noting the relative position of the 2 margins that define the facet for the radial carpal. In Bos taurus these margins tend to converge in a posteromedial direction (C-4) while they remain nearly parallel in Bison bison and Bos indicus (A-4 and B-4).

METACARPAL AND METATARSAL

The metacarpal (fig. 15) of the bison is generally separable from those of Bos indicus and Bos taurus by noting the degree of fusion between the tubercle and the posterior margin of the articular surface for the fused second and third carpals (A-1). In the buffalo the point of contact is slight, leaving the 2 surfaces nearly separate while in both Bos indicus and Bos taurus the tubercles are completely fused to the main bone (B-1 and C-1).

The metatarsals are distinguished in each of the forms by observing the relative positions of the articular facets on the proximal surfaces of these elements. In Bison bison the articular surfaces for the first tarsal bone are joined to the posterior articular surface for the fused central and fourth tarsal bones by a narrow neck or ridge (A-2) but in both Bos indicus and Bos taurus the posterior articular surface for the fused central and fourth tarsal bone is present as a separate raised island (B-2 and C-2). When viewed from an anterior plane, with the bone held in a vertical position, the margin of the anterior articular surface for the fused central and fourth tarsal bones exhibits a curved or at most a widely obtuse angular margin in the buffalo (A-3) while this same edge has a sharp step or break in both Bos indicus and Bos taurus (B-3 and C-3).

The distal ends of both the metacarpals and the metatarsals in the bison have heavier or more swollen surfaces at the area of contact between the shaft and the articular condyles (A-4). The nutrient foramina are, by comparison, larger and more prominent in the buffalo (A-4).

PHALANGES

The phalanges (figs. 16 and 17) for both the forelimb and hindlimb do not show separable characters so are treated together rather than separately for each limb.

The first phalanx in the buffalo has more of a curved lateral margin along the distal two-thirds of its length, when viewed anteriorly (A-3). This same margin has a straighter edge beginning at the distal condyle and continuing toward the medial edge of the proxi-
mal articular surface (B–3 and C–3). The dorsal surface of this element, in the buffalo, has a heavier and more pronounced muscle scar on the medial edge of the center of this bone and a more conspicuous tuberosity present on the medial face of the proximal end of the toe, below the articular surface (A–4). Both *Bos indicus* and *Bos taurus* have noticeably deeper pits on the dorsal faces of the proximal ends of these bones (B–4 and C–4).

The second phalanx has a straighter dorsal margin, when viewed laterally, in the buffalo (A–2) while the dorsal prominences on these bones as seen in *Bos indicus* (B–1 and B–2) and *Bos taurus* (C–1 and C–2) give a decided dished appearance to this same surface. The imprint for the tendon on the anterior surface of the second phalanx of the bison (A–1) is comparatively deeper than this same scar for the 2 species of *Bos*.

The third phalanx or hoof has a straighter planter margin in the buffalo (A–1) as compared with the broken or curved outline of this same edge in *Bos indicus* (B–1) or *Bos taurus* (C–1). The outer planter margin of the hoof of *Bos taurus* as well as the inner surface below the anterior articular margin is heavily sculptured or deeply eroded (C–1 and C–2), a condition not found in either the buffalo or *Bos indicus* (B–2). The inner margin of this third element in the bison (A–2 and A–4) is concave in appearance as opposed to a convex margin in the other 2 animals (B–2, B–4, C–2 and C–4).

**OS COXÆ**

The *os coxae* (fig. 18) in all three compared forms is separated with difficulty except for noting the marginal outline of the ilium in the vicinity of the tuber coxae. This margin in the buffalo terminates as a highly rounded point with its apex at the tuber coxae. This same tip is a nearly right angle as seen in *Bos indicus* or is present as a roughened margin having many steplike projections as observed in *Bos taurus*.

**ARTICULATED HINDLIMB**

The articulated hindlimb (figs. 19 and 20) has been shown in anterior, medial, posterior and lateral views to facilitate the comparisons of the various elements which make up this member of the post-cranial skeleton. The metatarsals are treated in the section dealing with the metacarpals and the diagnostic key characters are shown on figure 15.

**FEMUR**

The femur (fig. 21) in *Bison* has no noticeable ridge on the surface of the shaft between the head and the trochanter minor (A–1). In both *Bos indicus* and *Bos taurus* there is a definite raised area separating the trochanteric fossa from the neck of the femur (B–1 and C–1). The trochanter major in *Bos taurus* has more of a lateral projection when viewed from a posterior angle (C–1). The head of the femur in the bison has a slight tendency to form a lip at its junction with the neck (A–2) rather than a blending of these 2 areas as observed for *Bos* (B–2 and C–2). The complex of proximal anterior muscle scars is quite distinct and separate in the buffalo (A–2) as compared with a fusing of these scar patches in *Bos* (B–2 and C–2). The distal end of the femur is separable by noting the relative positions of the condyles in relation to each other when viewed medially with the shaft held in a vertical position. Seen in profile the medial condyle and the medial patellar ridge extend in a distal direction to the same degree in *Bos* (B–4 and C–4). In *Bison* the epicondyle and the medial patellar ridge extend considerably farther in distal direction than does the medial condyle (A–4).
TIBIA

The tibia (fig. 22) differs in the buffalo by having a lateral condyle that extends farther around on the posterior side of the shaft and ending in a drawn-down point at the posterolateral corner (A-1), whereas in Bos this area is finished as a rounded projection (B-1 and C-1). The lateral condyle, when viewed from a lateral direction with the shaft of the tibia held in a vertical position, has a continuous curved margin in Bison (A-2) as compared with an angular edge in Bos indicus (B-2) or a nearly straight surface in Bos taurus (C-2). The muscle scars which are prominent on the dorsal side of the tibia below the articular surfaces are quite stable characters in all of the examined forms. In both Bos indicus and Bos taurus the first 3 scars, numbering from the lateral border, terminate near a common point below the proximal articular surface (B-1 and C-1). In the buffalo the third scar is considerably shorter when compared with the other 3 scars (A-1). The distal end of the bison tibia is separable from those of Bos indicus and Bos taurus by noting the absence of the groove for the flexor digitalis longus (A-3 and A-4). This groove is well developed in both Bos indicus (B-3 and B-4) and Bos taurus (C-3 and C-4).

FUSED CENTRAL AND FOURTH TARSAL AND TIBIAL TARSAL

The fused central and fourth tarsal (fig. 23) is a difficult bone to separate. Only one character was observed in all of the examined specimens which was constant enough to be used as a key. This character was noted in Bison bison as the continuous surface connecting the distal articular surface for the first tarsal and that of the fused second and third tarsals (A-2). In both species of Bos the articular surface for the first tarsal has a tendency for being a separate surface and in most cases was separated from the surface for the fused second and third tarsals by a well-defined gap (B-2 and C-2). The tibial tarsal (fig. 23) in Bos taurus is separable from those of Bos indicus and Bison bison by noting the position of the medial tubercle in relation to a line drawn across the proximal margins of the distal trochlea. In Bos taurus the medial tubercle falls well below this line (C-3), whereas in Bos indicus or Bison bison the tubercle is in line with or is above this same line (A-3 and B-3). The old adult bison that were examined had an excavated area on the distal posterior articular surface that was not observed in the skeletons of Bos which were compared (A-4).

FIBULAR TARSAL

The fibular tarsal (fig. 24) tends to be characteristic for Bos taurus and Bison bison but this same element in Bos indicus is difficult to separate from that of the buffalo. The sustentaculum, when viewed from a posterior plane, has a definite downward deflection in Bison and Bos indicus (A-5 and B-5). However, in Bos taurus the sulcus for the deep flexor tendon causes this surface to be dished and to protrude at a lateral right angle (C-5). When seen from a medial view the margin of the sustentaculum exhibits a continuous curved outline in both Bison and Bos indicus (A-6 and B-6). This margin in Bos taurus forms a right angle with its edges (C-6). The anterior edge of the body of the fibular tarsal is quite dished in many of the examined Brahman specimens (B-2), a condition not observed in the other 2 animals (A-2 and C-2). Although not a constant character, it is worth noting that generally speaking the facet for the tibia is round in the buffalo (B-3) while it is oval in the majority of skeletons of Bos taurus.
REFERENCES
REFERENCES

ALLEN, J. A.

BRAINERD, G. W.

BROWN, G. H.

BURT, W. H.

CATLIN, G.

CORNWALL, I. W.

ELENENBERGER, W., BAUM, H., AND DITTRICH, H.

FLOWER, W. H.

GLASS, B. P.

GMELIN, Jo. Frid. (Editor)

HILDEBRAND, M.
1954. Comparative morphology of the body skeleton in Recent Canidae. *University of California, Publications in Zoology*, vol. 52, no. 5, pp. 399-470.


HOUFL, A. B.
1944. Speed in animals. Chicago.

HUE, E.

LAWRENCE, B.

LINNAEUS, CAROLUS
See Gmelin, Jo. Frid. (Editor)

MILLER, G. S. AND KELLOGG, R.

OLSEN, S. J.

REYNOLDS, S. H.

ROE, F. G.

SANDERS, A. H.

SISSON, S. AND GROSSMAN, J. D.

SKINNER, M. F. AND KAISEN, O. C.

TAYLOR, W. W.

THEVES, ANDRÉ
1558. Les singularitez de la France antartique, avivement nommée Americque, & de plusieurs terres & iles decouvertes de nostre temps. Antwerp.
FIGURES 3–24
Body forms of living *Bison bison*, *Bos indicus* and *Bos taurus* illustrating relative proportions.
**Bison bison**

**Bos indicus**

**Bos taurus**
Figure 4

Articulated skeletons of *Bison bison*, *Bos indicus* and *Bos taurus* illustrating general body proportions and length of neural spines.
**Figure 5**


*Bos indicus.* B-1 to B-3, same views as for *Bison.*

*Bos taurus.* C-1 to C-3, same views as for *Bison.*
Figure 6

*Bison bison.* Fifth cervical vertebra: A-1, anterior surface; A-2, right lateral surface; A-3, dorsal surface. Differentiating characters indicated by heavy dashed line.

*Bos indicus.* B-1 to B-3, same views as for *Bison.*

*Bos taurus.* C-1 to C-3, same views as for *Bison.*
Foramen transversarium

Anterior articular process

Posterior articular process

Vertebral foramen

Body

Ventral branch of transverse process

Spinous process

Arch

Lateral branch of transverse process

Ventral spine

Head

Bison bison

Bos indicus

Bos taurus
Figure 7


*Bos indicus.* B-1 to B-3, same views as for *Bison.*

*Bos taurus.* C-1 to C-3, same views as for *Bison.*
Occasionally summit is finished at this suture. Summit of spine
Spinous process
Anterior border
Posterior border
Body

Bison bison
Bos indicus
Bos taurus
Figure 8

*Bison bison*. Lumbar vertebra: A-1, left lateral surface; A-2, dorsal surface. Differentiating characters indicated by heavy dashed line.

*Bos indicus*. B-1 and B-2, same views as for *Bison*.

*Bos taurus*. C-1 and C-2, same views as for *Bison*. 
Anterior

Bison bison

Bos indicus

Bos taurus
Figure 9

*Bison bison*. Sacrum: A-1, dorsal surface; A-2, ventral surface; A-3, anterior, articular surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus*. B-1 to B-3, same views as for *Bison*.

*Bos taurus*. C-1 to C-3, same views as for *Bison*. 
Figure 10

*Bos taurus.* Right scapula: A-1, articular surface; A-2, lateral surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B-1 and B-2, same views as for *Bos taurus.*

*Bison bison.* C-1 and C-2, same views as for *Bos taurus.*
**Figure 11**

*Bison or Bos.* Articulated left forelimb: A, anterior view; B, medial view.
Humerus
Ulna
Radius
Radial carpal
Fused 2nd and 3rd carpals
Carpals
Accessory carpal
Radial carpal
5th metacarpal
Fused 2nd and 3rd carpals
Metacarpal
Proximal sesamoids
1st phalanx
2nd phalanx
3rd phalanx (Hoof)

A
Bison or Bos
B
Figure 12

*Bison* or *Bos*. Articulated left forelimb: A, posterior view; B, lateral view.
**Figure 13**

*Bison bison.* Right humerus: A-1, proximal end, anterior surface; A-2, proximal end, three-quarter lateral view; A-3, distal end, lateral surface; A-4, distal end, medial surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B-1 to B-4, same views as for *Bison.*

*Bos taurus.* C-1 to C-4, same views as for *Bison.*
Figure 14

*Bison bison.* Right radius and ulna: A-1, three-quarter view of proximal articular surface; A-2, transverse section showing relation of fused shafts of radius and ulna; A-3, medial surface of proximal end of radius; A-4, articular surface of distal end of radius. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B-1 to B-4, same views as for *Bison.*

*Bos taurus.* C-1 to C-4, same views as for *Bison.*
Olecranon

Tuberosity for ligament of elbow joint

Shaft of ulna

Shaft of radius

A-1

A-2

A-3

A-4

Bison bison

B-1

B-2

B-3

B-4

Bos indicus

C-1

C-2

C-3

C-4

Bos taurus

Facet for ulnar carpal

Facet for intermediate carpal

Facet for radial carpal
Figure 15

*Bison bison.* Right metacarpal: A-1, proximal articular surface. Right metatarsal: A-2, proximal articular surface; A-3, anterior surface of proximal end; A-4, posterior surface of distal end; A-5, anterior surface of distal end. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B-1 to B-5, same views as for *Bison.*

*Bos taurus.* C-1 to C-5, same views as for *Bison.*
Articular surface for fourth carpal

Articular surface for fused second and third carpals

Articular surface for first tarsal bone

Articular surface for fused second and third tarsal bones

Nutrient foramen

Articular condyles

Vascular groove

Bison bison

Bos indicus

Bos taurus

Tubercle
Figure 16


*Bos indicus.* B-1 to B-4, same views as for *Bison.*

*Bos taurus.* C-1 to C-4, same views as for *Bison.*
Proximal articular surface

Imprint for tendon

Dorsal prominence

Distal condyle

Dorsal prominence

Dorsal margin

Lateral margin

Tuberosity

Heavier muscle scar on old individual

Deeper pit

Deeper pit

Bison bison

Bos indicus

Bos taurus
**Figure 17**

*Bison bison.* Hoof bone or third phalanx: A-1, lateral surface; A-2, dorsal surface; A-3, articular surface; A-4, plantar surface; A-5, medial surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B-1 to B-5, same views as for *Bison*.

*Bos taurus.* C-1 to C-5, same views as for *Bison*. 
**Figure 18**

*Bison bison.* Left os coxa, lateral surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* Same view as for *Bison.*

*Bos taurus.* Same view as for *Bison.*
**Figure 19**

*Bison* or *Bos*. Articulated left hindlimb: A, anterior view; B, medial view.
Fused 2nd and 3rd tarsals

Femur

Patella

Tibia

Fibular tarsal

Lateral malleolus

Tibial tarsal

Fused central and 4th tarsals

Fused 2nd and 3rd tarsals

Metatarsal

Proximal sesamoids

1st phalanx

2nd phalanx

Distal sesamoids

3rd phalanx (Hoof)

Bison or Bos

A

B
Figure 20

_Bison or Bos_. Articulated left hindlimb: A, posterior view; B, lateral view.
Distal sesamoids

Proximal sesamoids

1st Phalanx

2nd Phalanx

3rd Phalanx (Hoof)

Bison or Bos
FIGURE 21

*Bison bison*. Right femur: A-1, proximal end, posterior surface; A-2, proximal end, anterior surface; A-3, distal end, lateral surface; A-4, distal end, medial surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus*. B-1 to B-4, same views as for *Bison*.

*Bos taurus*. C-1 to C-4, same views as for *Bison*. 
Trochanteric fossa
Trochanter major
Trochanteric ridge
Trochanter minor
Head
Complex of proximal anterior muscle scars
Neck
Lateral condyle
Trochlea
Lateral epicondyle
Medial condyle
Medial patellar ridge
Bison bison
Bos indicus
Bos taurus
Figure 22

*Bison bison.* Left tibia: A–1, proximal end, posterior surface; A–2, proximal end, lateral surface; A–3, distal end, posterior surface; A–4, distal end, articular surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B–1 to B–4, same views as for *Bison.*

*Bos taurus.* C–1 to C–4, same views as for *Bison.*
Figure 23

*Bison bison.* Right fused central and fourth tarsal: A–1, proximal articular surface; A–2, distal articular surface. Left tibial tarsal: A–3, anterior surface; A–4, posterior surface. Differentiating characters indicated by heavy dashed lines.

*Bos indicus.* B–1 to B–4, same views as for *Bison.*

*Bos taurus.* C–1 to C–4, same views as for *Bison.*
Figure 24

*Bison bison.* Left fibular tarsal bone: A-1, anterior view; A-2, lateral view; A-3, superior view; A-4, inferior view; A-5, posterior view; A-6, medial view. Differentiating characters indicated by heavy dashed lines.

* Bos indicus.* B-1 to B-6, same views as for *Bison.*

* Bos taurus.* C-1 to C-6, same views as for *Bison.*
PAPERS OF THE PEABODY MUSEUM


No. 5. The Evolution of the Human Pelvis in Relation to the Mechanics of the Erect Posture. By Edward Reynolds. 1931. 100 pages, 3 plates, and 10 illustrations in the text. $1.60.

VOLUME XII complete, $6.80; bound in cloth, $9.80.
No. 1. Explorations in Northeastern Arizona. By S. J. Guernsey. 1931. 120 pages, 1 color plate, 65 plates, map, and 30 illustrations in the text. $3.50.

No. 2. Notes on the Archaeology of the Kaibito and Rainbow Plateaus in Arizona. By Noel Mott. 1931. 28 pages and 7 plates. 50 cents.

No. 3. The Ancient Culture of the Fremont River in Utah. By Noel Mott. 1931. 112 pages, 43 plates, and 5 illustrations in the text. $2.80.

VOLUME XIII complete, $5.25; bound in cloth, $8.25.
No. 1. Maya-Spanish Crosses in Yucatan. By George D. Williams. 1931. 150 pages, 47 plates, and tables. $3.50.

No. 2. The Phonetic Value of Certain Characters in Maya Writing. By B. L. Whorf. 1933. 48 pages, frontispiece, and 13 illustrations in the text. 75 cents.

No. 3. The Racial Characteristics of Syrians and Armenians. By Carl C. Seltzer. 1936. 77 pages, 2 maps, and tables. $1.00.

VOLUME XIV complete, $6.00; bound in cloth, $9.00.
No. 1. The Stalling's Island Mound, Columbia County, Georgia. By William H. Claffin, Jr. 1931. 60 pages and 72 plates. $2.75.

No. 2. The Barama River Caribs of British Guiana. By John Gillin. 1936. 188 pages, 30 half-tones, and 13 illustrations in the text. $3.25.

VOLUME XV complete, $5.85; bound in cloth, $8.85.

VOLUME XVI complete, $5.75; bound in cloth, $8.75.
No. 2. Contributions to the Racial Anthropology of the Near East. By Carl C. Seltzer. Based on data collected by Henry M. Huxley. 1940. 72 pages, 8 plates, and tables. $1.00.

No. 3. Fossil Man in Tangier. By Muzaffer Süleyman Senyurek. Introduction by Carleton S. Coon. 1940. 35 pages, 3 plates, and tables. 50 cents.
The page size of Volumes I-XVI is 6½ × 9½ inches, trimmed; beginning with Volume XVII, 7½ × 10¾ inches, trimmed.

VOLUME XVII complete, $5.25; bound in cloth, $8.25.
No. 1. Navaho Pottery Making. By Hatty Tschopik, Jr. 1941. 85 pages, 16 plates, and 7 illustrations in the text. $1.75.


No. 3. Flint Quarries — the sources of tools and, at the same time, the factories of the American Indian. By Kirk Bryan. 1950. 40 pages, 1 plate, and 20 illustrations in the text. $2.00.

VOLUME XVIII complete, $5.85; bound in cloth, $8.85.

VOLUME XIX complete.
No. 1. The Prehistoric Archaeology of Northwest Africa. By Frederick R. Wulsin. 1941. 173 pages and 92 illustrations in the text. $3.25.


VOLUME XX complete, $4.25; bound in cloth, $7.25.

VOLUME XXI complete.

VOLUME XXII complete.

available through University Microfilms, Inc., 313 N. First Street, Ann Arbor, Michigan.

VOLUME XXIII, complete, $9.25; bound in cloth, $12.25.

No. 2. Hyperbrachycephaly as Influenced by Cultural Conditioning. By J. Franklin Ewing, S.J. 1950. 100 pages, 2 half-tones, and 6 illustrations in the text. $5.75.


VOLUME XXIV, complete, $12.10; bound in cloth, $15.10.


VOLUME XXV, complete, $8.50; bound in cloth, $11.50.

VOLUME XXVI, complete, $6.25; bound in cloth, $9.25.
No. 1. Archaeology of Northwestern Venezuela. By Alfred Kidder, II. 1944. 178 pages, 18 plates, 3 tables, and 54 illustrations in the text. $4.75.


VOLUME XXVII, complete, $7.15; bound in cloth, $10.15.
No. 1. Some Early Sites in the Northern Lake Titicaca Basin. By Alfred Kidder, II. (Research project no. 7 of the Institute of Andean Research under the sponsorship of the Co-ordinator of Inter-American Affairs.) 1943. 48 pages, 7 plates, frontispiece, and 7 illustrations in the text. $1.25.

No. 2. An Introduction to the Archaeology of Cuzco. By John H. Rowe. (Research project no. 7 of the Institute of Andean Research under the sponsorship of the Co-ordinator of Inter-American Affairs.) 1944. 70 pages, 8 plates, and 19 illustrations in the text. $1.75.

No. 3. Some Notes on the Archaeology of the Department of Puno, Peru. By Marion H. Tschopik. (Research project no. 7 of the Institute of Andean Research under the sponsorship of the Co-ordinator of Inter-American Affairs.) 1946. 18 pages, 10 plates, and 34 illustrations in the text. $1.65.

No. 4. Indian Skeletal Material from the Central Coast of Peru. By Marshall T. Newman. (Research project no. 8 of the Institute of Andean Research under the sponsorship of the Co-ordinator of Inter-American Affairs.) 1947. 72 pages, frontispiece, 7 plates, and 26 tables. $2.50.

VOLUME XXVIII, complete, $8.85; bound in cloth, $11.85.
No. 1. A Stone Age Cave Site in Tangier. By Bruce Howe and Hallam L. Movius, Jr. 1947. 32 pages, 7 plates, and 1 illustration in the text. $1.00.

No. 2. The Living Races of the Sahara Desert. By L. Cabot Briggs. 1958. 217 pages, 103 tables, colored frontispiece, 68 offset half-tone plates, and 5 illustrations in the text. $7.85.

VOLUME XXIX, complete, $5.85; bound in cloth, $8.85.
Studies in the Anthropology of Bougainville, Solomon Islands. 1949. By Douglas L. Oliver. (Nos. 1-4 bound under one cover.)

No. 1. The Peabody Museum Expedition to Bougainville, Solomon Islands, 1938-39. 28 pages, 6 collotype figures, and 9 illustrations in the text.

No. 2. Human Relations and Language in a Papuan-speaking Tribe of Southern Bougainville, Solomon Islands. 38 pages, 2 collotype figures, and 1 illustration in the text.

No. 3. Economic and Social Uses of Domestic Pigs in Suiu, Southern Bougainville, Solomon Islands. 30 pages, 4 collotype figures, and 3 illustrations in the text.

No. 4. Land Tenure in Northeast Suiu, Southern Bougainville, Solomon Islands. 98 pages, 8 collotype figures, and 7 illustrations in the text.

VOLUME XXX, complete, $10.00; bound in cloth, $13.00.

VOLUME XXXI complete.

VOLUME XXXII
No. 1. The Cowrie Shell Miao of Kweichow. By Margaret Portia Mickey. 1947. 84 pages, 8 plates, and 12 illustrations in the text. $2.50.


No. 3. A Study of Navajo Symbolism. Part I: Navajo Symbols in Sandpaintings and Ritual Objects, by Franc Johnson Newcomb; Part II: Navaho Picture Writing, by Stanley A. Fishler; Part III: Notes on Corresponding Symbols in Various...
Parts of the World, by Mary C. Wheelwright. 1956. 100 pages, 4 half-tones, 12 color plates, and 87 illustrations in the text. $5.00.  

VOLUME XXXIII  

VOLUME XXXIV complete, $7.50; bound in cloth, $10.50.  

VOLUME XXXV  
No. 1. THE CHANGING PHYSICAL ENVIRONMENT OF THE HOPI INDIANS OF ARIZONA. By John T. Hack. 1942. 86 pages, 12 plates, frontispiece, and 54 illustrations in the text. $1.75.  
No. 2. PREHISTORIC COAL MINING IN THE JEDDITO VALLEY, ARIZONA. By John T. Hack. 1942. 24 pages, 5 plates, and 10 illustrations in the text. 75 cents.  
No. 3. PART I: MAMMALS FOUND AT THE AWATAVI SITE; PART II: POST-CRANIAL SKELETAL CHARACTERS OF DEER, PRONGHORN, AND SHEEP-GOAT, WITH NOTES ON BOS AND BISON. By Barbara Lawtence. 1951. 44 pages and 20 illustrations in the text. $2.00.  
No. 4. POST-CRANIAL SKELETAL CHARACTERS OF BISON AND BOV. By Stanley J. Olsen. 1960. 61 pages, 24 illustrations. $1.75.  

VOLUME XXXVI complete, $5.85; bound in cloth, $8.85.  

VOLUME XXXVII complete, $7.50; bound in cloth, $10.50.  

(VOLUMES XXXVIII, XXXIX reserved for the Awatovi Series.)  

VOLUME XL complete.  
No. 2. SOME SEX BELIEFS AND PRACTICES IN A NAVAHO COMMUNITY, with comparative material from other Navaho areas. By Flora L. Bailey. 1950. 108 pages. $3.00.  
No. 3. THREE NAVAHO HOUSEHOLDS: A COMPARATIVE STUDY IN SMALL GROUP CULTURE. By John M. Roberts. 1951. 88 pages, 6 tables, and 14 collotype figures. $3.00. Out of print.  
No. 4. EMBRYOLOGY OF THE RAMAH NAVAHO. By Paul A. Vestal. 1952. 94 pages. $2.50.  

VOLUME XLI complete, $8.65; bound in cloth, $11.65.  
No. 1. NAVAHO VETERANS: A STUDY OF CHANGING VALUES. By Evon Z. Vogt. 1951. 224 pages, 3 tables, and 11 charts. $1.00.  
No. 3. ENEMY WAY MUSIC: a study of social and esthetic values as seen in Navaho music. By David P. McAlister. 1954. 96 pages, 53 pages of music, and 6 illustrations in the text. $2.65.  

VOLUME XLII complete.  
No. 3. NAVAHO ACQUISITIVE VALUES. By Richard Hobson. 1954. 38 pages and 6 tables. $1.10. Out of print.  

VOLUME XLIII  

VOLUME XLIV  
No. 1. AN ARCHAEOLOGICAL SURVEY OF WEST CENTRAL NEW MEXICO AND EAST CENTRAL ARIZONA. By Edward Bridge Danson. 1951. 153 pages, 23 tables, 8 collotype figures, and 10 illustrations in the text. $4.50.  

VOLUME XLV complete, $14.75; bound in cloth, $17.75.  
No. 1. BODY-MARKING IN SOUTHWESTERN ASIA. By Henry Field. 1958. 162 pages, 54 tables, 37 illustrations. $6.50.  

VOLUME XLVI complete, $13.35; bound in cloth, $16.35.  
THE ANTHROPOLOGY OF IRAQ. By Henry Field.  
No. 1. THE NORTHERN JAZIRA. 1951. 176 pages, 49 tables, 49 collotype figures, and 5 illustrations in the text. $6.50.  

VOLUME XLVII complete.  
MEMOIRS OF THE PEABODY MUSEUM

(Quarto)

VOLUME I (including nos. 2-6) complete, with Index, $8.00; bound in cloth, $12.00. Complete (including no. 1, photostat edition), bound in cloth, $4.00.


No. 2. Explorations of the Cave of Loltun, Yucatan. By E. H. Thompson. 1897. 22 pages, 8 plates, and illustrations in the text. $1.50.


No. 4. Researches in the Uloa Valley. By George Byron Gordon. 1898. 44 pages, map, 12 plates, and illustrations in the text. (Under same cover with No. 5.)

No. 5. Caverns of Copan. By George Byron Gordon. 1898. 12 pages, map, and 1 plate. Nos. 4 and 5 under one cover, $2.25.


VOLUME II complete, with Index, $11.75; bound in cloth, $16.75.

No. 1. Researches in the Central Portion of the Usumacinta Valley. By Teobert Maler. 1901. 75 pages, 33 plates, and 26 illustrations in the text. $4.50.

No. 2. Researches in the Usumacinta Valley, Part II. By Teobert Maler. 1903. 130 pages, 47 plates, and 42 illustrations in the text. $7.25.
Antique tables, Alice the Spinden. By Historical. 1913. 60 pages, 23 plates, and 54 illustrations in the text. $4.00.

VOLUME VI complete, out of print.
Maya Art. By Herbert J. Spinden. 1913. 308 pages, 19 plates, map, and 586 illustrations in the text.

VOLUME VII complete, $10.00; bound in cloth, $15.00.

VOLUME VIII complete, $10.00; bound in cloth, $15.00.

VOLUME IX complete, $16.75; bound in cloth, $21.75.
No. 1. Archaeology of the North Coast of Honduras. By Doris Z. Stone. 1941. 103 pages and 99 illustrations in the text. $3.00.
No. 2. Archaeological Investigations in El Salvador. By John M. Longyear, III. (Research project no. 10 of the Institute of Andean Research under the sponsorship of the Co-ordinator of Inter-American Affairs.) 1944. 90 pages, 15 plates, and 30 illustrations in the text. $3.75.
No. 3. Archaeology of Southern Veraguas, Panama. By Samuel K. Lothrop. 1950. 116 pages, 10 tables, and 150 illustrations in the text. $10.00.

VOLUME X
No. 2. Metals from the Cenote of Sacrifice. (Part II.) By Samuel K. Lothrop. 1952. 140 pages, 39 tables, and 114 illustrations in the text. $10.00.

VOLUMES XI and XII complete with Index, $25.00; bound in cloth, $35.00.

ANNUAL REPORTS OF THE PEABODY MUSEUM

Reports of the Peabody Museum's activities have been published annually since the year 1868. From that date through 1890, 24 Annual Reports were printed, embodying not only the routine accounts and summaries but also the expedition and research reports of the type which since that time has been incorporated in the Papers and Memoirs. The 8th, 11th, and 15th are now out of print. The others are available at 75 cents each with the exception of the following:

TENTH REPORT, containing the following articles:
Discovery of supposed Palaeolithic Implements from Glacial Drift in Delaware Valley, near Tren- ton, New Jersey, by C. C. Abbott. (Illustrated); Age of Delaware Gravel Bed Containing Chipped Pebbles, by N. S. Shaler; Exploration of Ash Cave in Benton Township, Hocking County, Ohio, by E. B. Andrews; Exploration of Mounds in South-eastern Ohio, by E. B. Andrews. (Illustrated); Exploration of Mound in Lee County, Virginia, by Lucien Carr. (Illustrated); Art of War and Mode of Warfare of the Ancient Mexicans, by A. F. Bandelier. $2.00.

TWELFTH AND THIRTEENTH REPORTS (under one cover), containing the following articles:
Measurements of Crania from California, by Lucien Carr; Flint Chips, by C. C. Abbott. (Illustrated); Method of Manufacturing Pottery and Baskets among Indians of Southern California, by Paul Schumacher; Aboriginal Soapstone Quarries in District of Columbia, by Elmer R. Reynolds; Ruins of Stone Pueblo on Animas River, New Mexico, by Lewis H. Morgan. (Illustrated); Social Organization and Mode of Government of the Ancient Mexicans, by A. F. Bandelier. $2.00.

SIXTEENTH AND SEVENTEENTH REPORTS (under one cover), containing the following articles:
Social and Political Position of Woman among Huron-Iroquois Tribes, by Lucien Carr; Notes upon Human Remains from Coahuila Caves, by Cordelia A. Studley: White Buffalo Festival of Uncapapas, by Alice C. Fletcher; Elk Mystery or Festival, Ogallala Sioux, by Alice C. Fletcher; Religious Ceremony of the Four Winds or Quarters, as observed by the Santee Sioux, by Alice C. Fletcher. (Illustrated); The "Wawan" or Pipe Dance of the Omahas, by Alice C. Fletcher. (Illustrated); Report on Meteoric Iron from Altar Mounds, Little Miami Valley, by Leonard P. Kinnicutt. $1.00. (Signatures only.)

EIGHTEENTH AND NINETEENTH REPORTS (under one cover), containing the following articles:
Notes on the Anomalies, Injuries, and Diseases of Bones of the Native Races of North America, by William F. Whitney; Marriott Mound and its Contents, by F. W. Putnam. (Illustrated.) $2.00.

The 25th and following brief Reports are printed in the Annual Reports of the President of Harvard University. Reprints of all but the 25th, 26th and 27th may be obtained by applying to the Peabody Museum. Price, 35 cents each.
HARVARD AFRICAN STUDIES

(Octavo)

VOLUME I, $7.00.


VOLUME II, $7.50.


VOLUME III, $6.50.


VOLUME IV, $3.50.


VOLUME V, $6.00.


VOLUME VI, $6.00.


VOLUME VII, $7.50.


VOLUME VIII, $9.00.

VARI AFRICANA IV. Edited by E. A. Hooton and Natica I. Bates. 1928. O. Bates and Dows Dunham, Excavations at Gammai; O. Bates, Excavations at Marsa Matruh; D. E. Derry, A study of the crania from the Oasis of Siwha; H. H. Kidder, Notes on the pigmentation of the skin, hair, and eyes of the Kabyles.

VOLUME IX, $10.00.

TRIBES OF THE RIF. By Carleton S. Coon. 1931.

VOLUME X, $7.00.


AMERICAN SCHOOL OF PREHISTORIC RESEARCH PUBLICATIONS


Part II: Bronze Age Cultures in Russia and the Baltic Area. By Marija Gimbutas. In preparation.

Old World Bibliographies. Hallam L. Movius, Jr. (Compiler). Recent Publications, mainly in Old World Palaeolithic Archaeology and Palaeo-Anthropology. No. 1 (1948), out of print; No. 2 (1949), out of print; No. 3 (1950); No. 4 (1951); No. 5 (1952); No. 6 (1953), out of print; No. 7 (1954) (with Rosamond R. Field), out of print; No. 8 (1955) (with Rosamond R. Field), out of print. $1.00 each.

RUSSIAN TRANSLATION SERIES

VOLUME I
No. 1. ANCIENT POPULATION OF SIBERIA AND ITS CULTURES. By A. P. Okladnikov. Translated by Vladimir M. Maurin. Edited by Henry Field. 1939. 96 pages, 24 plates, 7 maps. $3.50.

SPECIAL PUBLICATIONS OF THE PEABODY MUSEUM

NOT AVAILABLE FOR EXCHANGE

The following works, some of which were not originally published by the Peabody Museum, are for sale but are not available for exchange.

A JOURNAL OF AMERICAN ETHNOLOGY AND ARCHAEOLOGY. Containing Papers of the Hemenway Southwestern Archaeological Expedition. The Mary Hemenway Collection is exhibited in the Museum. Square octavo. Maps and illustrations. (Discontinued after Vol. V.)


VOLUME III. 1. An Outline of the Documentary History of the Zuñi Tribe. By A. F. Bandelier. 2. Somatological Observations on Indians of the Southwest. By H. F. C. Ten Kate. $2.25. (No. 1. of this volume may be obtained separately. $1.75.)

VOLUME IV. The Snake Ceremonials at Walpi. By J. Walter Fewkes, assisted by A. M. Stephen and J. G. Owens. $1.00.


HUMAN BONES IN HEMENWAY COLLECTION (SOUTHWESTERN ARCHAEOLOGICAL EXPLORATION). Described by D. Washington Matthews. 1890. Quarto. 288 pages, 59 plates, and illustrations in the text. $3.25. (Reprint from Vol. VI, Memoirs of the National Academy of Science.)


THE ARCHAIC MAYA INSCRIPTIONS. By J. T. Goodman. 1897. Quarto. 149 pages. $4.25. (Appendix to Biologia Central-Americana.) The Archaic Annual Calendar with tables for 52 years; Archaic Chronological Calendar with 77 pages of tables; Perpetual Chronological Calendar with table; Working Chart.


CONTRIBUTIONS TO THE ARCHAEOLOGY OF MISSOURI. By Professor W. B. Potter and Dr. Edward Evers, 1880. Quarto. 30 pages, 5 plans, and 24 plates containing 148 figures of ancient Missouri pottery. $2.35.
CODEX NUTTALL.
1901. (Small edition.) In sheets only. $30.00.
An ancient Mexican Codex (84 pages of facsimile reproductions of the manuscript in its original colors (by Zelia Nuttall). Illustrations only. Explanatory notes out of print but photostat copies available for $9.00.

PAPERS BY LUCIEN CARR. (Assistant Curator of the Peabody Museum, 1877-1894.)

PAPERS BY CHARLES P. BOWDITCH. Three Papers Relating to Maya Subjects: 1. Was the Beginning Day of the Maya Month Numbered Zero (or Twenty) or One? (1901.) Out of print. 2. A Method which may have been used by the Mayas in Calculating Time. (1901.) 50 cents. 3. Maya Nomenclature. (1906.) Out of print.


Navajo Creation Chants. From the collection recorded for the Museum of Navajo Ceremonial Art, Santa Fe, New Mexico. An album containing recordings of sixteen chants from Navajo cosmogony. Five ten-inch unbreakable records, including a pamphlet containing translations by Dr. Harry Hoijer of the texts, notes on the myth by Mary C. Wheelwright, and descriptive and analytical notes on the music by Dr. David P. McAllester. $10.00, postpaid.

The Hunters. Ethnological motion picture of primitive hunting among the !Kung Bushmen of the Kalahari Desert in Southwest Africa. Available in color and black-and-white for rental or purchase from Contemporary Films, 267 West 25th Street, New York 1, New York.

PHOTOSTAT REPRODUCTIONS OF OLD MANUSCRIPTS

NOT AVAILABLE FOR EXCHANGE
These relate principally to the native languages of Middle America. Reproduced under the direction and through the generosity of the late Charles P. Bowditch. The edition of these reproductions is limited to a few copies.

Doctrina en Lengua Quiche. Catechism in Quiché. 165 pages. Out of print. (Original in the library of Professor M. H. Saville, New York.)


Series publications, with the exception of out of print numbers, may be bought as complete sets, either paper or cloth bound. Write to the Museum for current prices.