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THE ANTIQUITY OF *BISON LATIFRONS* (HARLAN) IN THE GREAT PLAINS OF NORTH AMERICA

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There is abundant evidence available which strongly supports the Middle Pleistocene (Sheridanian) stratigraphic position of the fossilized remains of *Bison latifrons* (Harlan) in the Great Plains of North America. This would place the geologic age of this giant beast as post-Kansas to Early Illinoian. Fourteen localities, where the bones of *B. latifrons* have been found in the central part of North America, have been examined for stratigraphic and geomorphologic evidence.

† † †

INTRODUCTION

The antiquity of the remains of *Bison latifrons* in the Quaternary deposits of North America has long been controversial. During the early part of the century, Henry Fairfield Osborn (1910) and O.P. Hay (1913, 1914, 1930) considered many of the Medial and Late Pleistocene faunas to be Aftonian in age, basing their beliefs on the research of Samuel Calvin (1909, 1911) and Buhumil Shimek (1908, 1909) in Iowa. Thus *B. latifrons* became known as "the Aftonian bison" (Hay, 1914:327). Various other workers, including W.D. Matthew (1918), also accepted this "Aftonian" age determination for faunas of various Quaternary ages, and this concept was not challenged for many years. As a result, many workers considered that there was little, if any, evidence of evolution during the Pleistocene. The remains of *Bison bison*, *B. antiquus*, and *B. latifrons* were commonly thought to be associated together at Big Bone Lick, Kentucky (Lucas, 1899; Osborn, 1910; Jillson, 1936), and, to date, there is no evidence in favor of this assumption but there is considerable evidence against it.

Most of the "Aftonian" vertebrate fossils of Calvin and Shimek from Iowa actually are Medial to Late Pleistocene in age. This was pointed out by Lugn and Schultz (1934), Lugn

(1935), and by Barbour and Schultz (1937), and a preliminary stratigraphic sequence of fossil mammals based on geologic evidence, was presented for the first time in 1934. Reed *et al.* (1965) summarized continuing efforts to refine the stratigraphic sequence of the Quaternary initiated by Lugn (1935) and his colleagues. Later, Frankforter (1971) furnished additional information on the age of the "Aftonian" vertebrates in Iowa. There has been an increasing effort to establish a more precise stratigraphic sequence of the fossil mammals as new geologic and geomorphologic data become available.

During the past forty years, it has become evident that the remains of *Bison bison*, *B. antiquus*, and *B. latifrons* do not occur in sediments of the same geologic age. Although the osteological and historical information on bison published by Skinner and Kaisen (1947) has provided an excellent foundation for further revision, these researchers, unfortunately, did not have adequate stratigraphic and geomorphological data available at the time they revised the bison nomenclature. Flerov and Zablotski (1961) pointed out that the classification of the bison by Skinner and Kaisen "does not, in our opinion, correspond to reality." Thus, there is a definite need for a revision of the classification of the bison, and it can now be attempted, based on more refined stratigraphic and geomorphologic evidence. In addition, knowledge of the stratigraphic distribution of bison remains is necessary for an understanding and proper interpretation of the morphological differences among the specimens attributed to the various genera, subgenera, species, and subspecies now used in the literature.

Precise geologic data associated with fossil mammal specimens provided Schultz and Falkenbach (1968) with

scientific information necessary for the revision of the oreodonts (another group of artiodactyls which also had long needed to be reclassified). The extensive work with the oreodonts (1934-1968) has provided an insight into the problems of bison taxonomy. The same approach has been used in determining phylogenies of the beavers and the mylagaulids (Stout, unpublished), and for other groups as well.

Such a study has also been done on the general stratigraphic distribution of bison remains (*Bison latifrons*, *B. alleni*, *B. antiquus*, and *B. bison*) and is elsewhere presented by the authors (Schultz and Hillerud, 1977a, 1977b). We now are in the process of publishing a series of eight papers under one cover on the bison of the Great Plains. These manuscripts have been in preparation for the past eight years and include computer analyses and statistical parameters which describe quantitatively a number of Pleistocene and Holocene fossil-bison samples.

Recently, there has been an increasing number of workers who have suggested that bison (including *Bison latifrons*) did not reach North America until as late as the Sangamon interglacial or even during Early Wisconsinan glacial times. For example, Robertson (1974) reported that "it is generally agreed that *Bison* probably reached North America in Early Rancholabrean times," i.e. Sangamon (last interglacial) or Early Wisconsinan (last glacial). He quoted Hibbard, *et al.* (1965), Guthrie (1970), and Sher (1971) for documentation, but he did not provide geologic evidence, and also overlooked published data from the Central Great Plains (Schultz and Frankforter, 1946; Schultz and Stout, 1948; Schultz, Tanner, and Martin, 1972). Miller (1968) presented measurements on postcranial bison elements which he identified as *B. latifrons* from Rancho La Brea. Recent studies, however, suggest that his "*latifrons*" material is only slightly larger than *B. antiquus* and is probably referable to a larger subspecies similar to *B. antiquus barbouri* (Schultz, Tanner and Martin, 1972).

Conversely, Flerov (1971) noted that he believed the bison, the mammoth, and other large mammals dispersed from Asia into America "before the maximum glaciation (Illinoian)." Our evidence certainly confirms this. P  w   (1975) reports that he has collected Alaskan specimens of mammoth and *Bison* (*Superbison*) from gravels that underlie Illinoian and Yarmouth (?) beds. Mammoth remains are plentiful in Nebraska in deposits of post-Kansan to Early Illinoian age. Other bovids also are known from these same sediments, but *B. latifrons* remains are rare. These giant forms apparently did not come to North America in as large numbers as the mammoths.

PRE-SANGAMON BISON

There are two well-known localities (Fig. 2, sites B and X on map) which should be listed to demonstrate the occurrence of pre-Sangamon bison in Nebraska. Both of these

localities contain fossil bison bones which are Illinoian in age, but are post-*Bison latifrons*. The two localities are as follows:

- (B) The presence of pre-Sangamon bison remains is well known from the Terrace-4 fill complex at the Bartek Brothers farm (University of Nebraska State Museum [U.N.S.M.] Coll. Loc. Sd-15), 26 miles N. of Lincoln, center of NE¼, sec. 12, T.14N., R.5E., Saunders County, Nebraska (Schultz and Frankforter, 1946; Lueninghoener, 1947; Schultz and Tanner, 1957; Kreycik, 1969). At this locality (see Fig. 2,B) two partial skulls (U.N.S.M. 30356 and 30358) of *Bison alleni* have been recorded from the sands (Crete Formation) below the Loveland Loess (Schultz and Frankforter, 1946). Various skeletal elements of *Bison* sp. also have been recorded from pre-Sangamon sediments at this faunal locality (Kreycik, 1969; Schultz, Tanner, and Martin, 1972). These fossils are all considered to be of Illinoian age. No *B. latifrons* remains, however, have been recorded from this locality, despite thirty years of continuing extensive study.
- (X) The occurrence of pre-Sangamon bison remains has been recorded also in the Terrace-4 complex at Buzzard's Roost (U.N.S.M. Coll. Loc. Ln-103) south and east of Brady, in W¼, SE¼, sec. 7, T.10N., R.26W., Lincoln County, Nebraska (see Fig. 2,X). A large bison radius-ulna (U.N.S.M. 45639) was found *in situ* in the Ingham Paleosol (Schultz and Martin, 1970) approximately fifty feet below the base of the Sangamon Paleosol complex and some forty-five feet above a layer of Pearllette Ash (Frankel, 1956; Schultz and Tanner, 1957, Fig. 7; see also Fig. 3, present paper). The specimen was found on August 23 at Stop 10-5 of the 1965 INQUA (International Union for Quaternary Research) Field Conference D, "Central Great Plains" (Stout, Dreeszen, and Caldwell, 1965), when the participants of the conference were visiting the Buzzard's Roost section (also known as Gilman Canyon). There can not be any question concerning the association of the radius-ulna with the Ingham Paleosol. This paleosol is in the lower portion of the Loveland (Illinoian) loess. The size of the bones would indicate the animal was within the size range of *Bison antiquus*, but larger than average. The bones instead may represent a small *B. alleni*, but a radius-ulna of the latter species was not available to us for comparison. This Loveland Loess section is one of the best known in Nebraska, and, indeed, in the Great Plains (Reed and Dreeszen, 1965; Dreeszen, 1970; Stout, *et al.*, 1971).

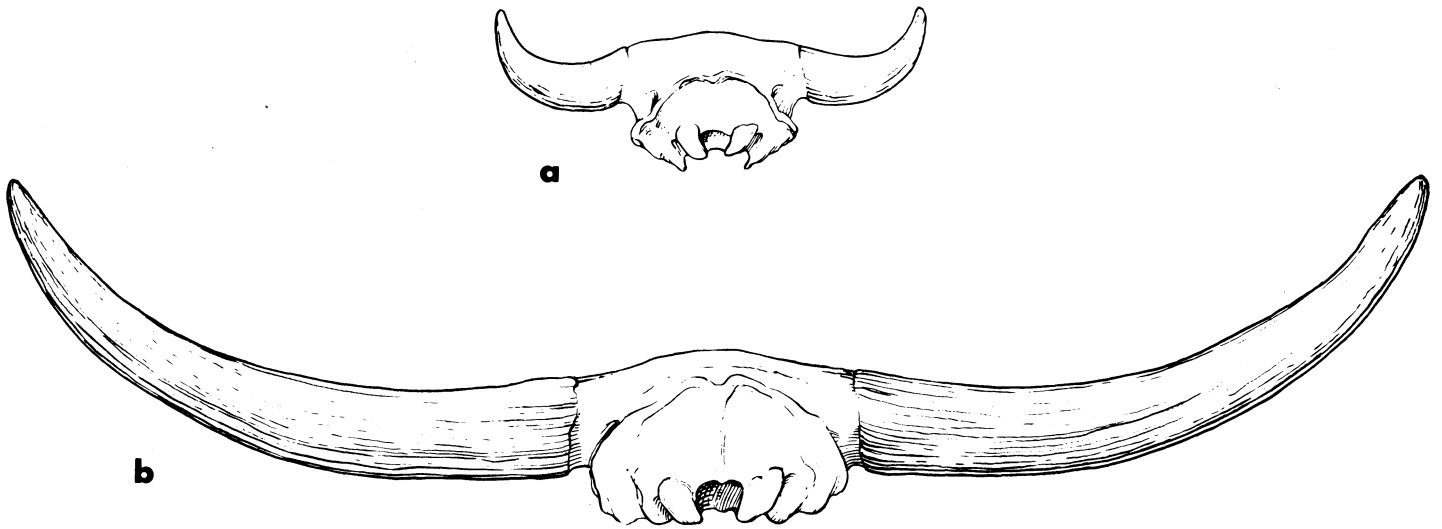


Figure 1. Comparative sizes of *Bison bison* Linnaeus (above) from the Late Holocene and *B. latifrons* (Harlan) (below) from the Medial Pleistocene of the Central Great Plains and adjacent areas.

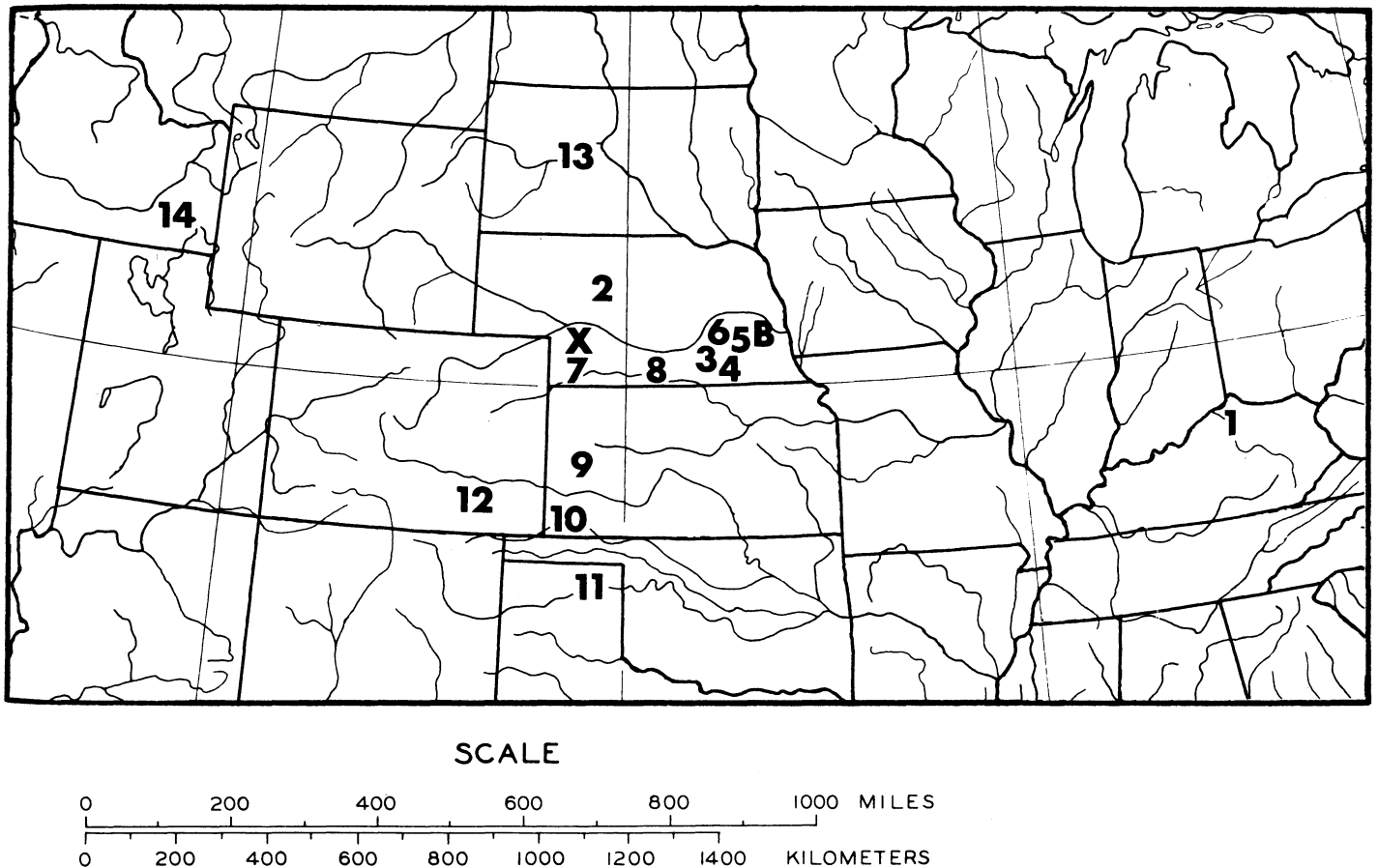
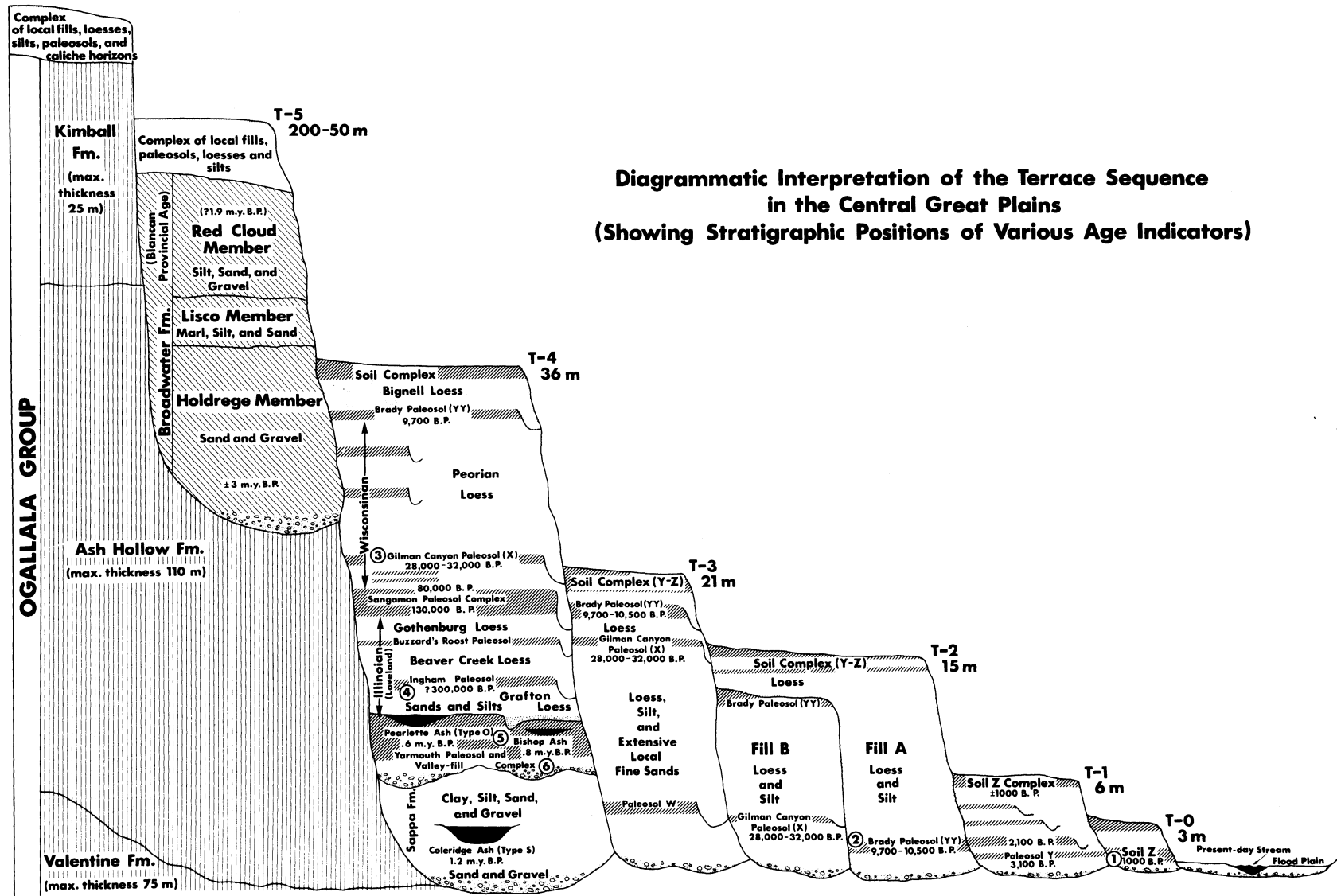


Figure 2. Map of the central portion of North America, showing approximate locations of *Bison latifrons* sites (1 through 14) which are cited in the text. Locality B: Bartek Brothers farm, Saunders County, Nebraska, where bison bones of Illinoian age have been found below the Sangamon Paleosol complex. Locality X: Buzzard's Roost (Gilman Canyon), Lincoln County, Nebraska, where bison remains have been found in the Ingham Paleosol (Illinoian, interstadial).



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Figure 3. Diagrammatic interpretation of the sequence of post-Kimballian terrace-fills as developed in the Central Great Plains (from Schultz and Hillerud, 1977b; modified from Schultz and Stout, 1945, 1948, 1961; Schultz, Lueninghoener, and Frankforter, 1951; Schultz and Tanner, 1957; Schultz, 1968, 1976, 1977; Schultz and Martin, 1970, 1976; Schultz, Schultz, and Martin, 1970; Schultz, Tanner, and Martin, 1969, 1972). The placement of the complex Terrace-4 (Sheridan) fill is shown in relation to the other terrace-fills (5, 3, 2B, 2A, 1, and 0). No *Bison latifrons* remains are known from any of the post-Illinoian deposits in the areas thus far studied. Radiogenic dates from Boellstorff (1973), Izett *et al.* (1970), Izett *et al.* (1971), Izett *et al.* (1972). The geologic studies of Frye *et al.* (1968), Frye (1969), Wilman and Frye (1970), and Kukla (1970) have emphasized the importance of paleosols, loesses, tills and stratigraphic sequences in terrace fills in the correlation of Quaternary sediments.

CRITICAL LOCALITIES OF *BISON LATIFRONS* (HARLAN)

There are fourteen localities (Fig. 2) in the Central Great Plains and other areas which are critical to the understanding of the antiquity of *Bison latifrons*. These localities are in Kentucky (type locality of *B. latifrons*), Nebraska, Kansas, Texas, Colorado, South Dakota and Idaho. Locational and stratigraphic data for each specimen involved are summarized below:

(1) Boone County, Kentucky

Holotype of *Bison latifrons* (Harlan, 1825), partial cranium with occiput and base of left horncore, Academy of Natural Sciences of Philadelphia, 12993 (cast, U.N.S.M. 2496C).

Location.—Apparently from Woolper Creek ("in the bed of a creek falling into the Ohio River, a dozen or more miles north of Big-bone-lick, Kentucky," Leidy, 1869:372).

Stratigraphy.—Probably from the blue lacustrine clay under the Split Rock Conglomerate. Ray (1974:48), who studied the geology of the lower Ohio River valley from 1956 to 1967, stated, "... the Split Rock Conglomerate is here interpreted to be a kame terrace ... below the mouth of a short, now-abandoned valley that once served as a marginal sluiceway for melt-water torrents and debris from the Illinoian ice."

Discussion.—The holotype of *Bison latifrons* is not from Big Bone Lick, although many workers (Leidy, 1869:372; Lucas, 1899:769; Osborn, 1910; Hay, 1913, 1914:327; Frick, 1937:578; and others) have inferred that it was. Hay (1923:265), however, recognized the locality to be "Woolper Creek?, Boone County," which is some 12 to 14 miles north of Big Bone Lick. He also stated (p. 265) that "the presence of the species with the widely-spread horns at Big Bone Lick is doubtful." Jillson (1936:116), who did considerable research on Big Bone Lick, followed Hay and recorded only *Bison bison* and *B. antiquus* from this historic fossil locality. He did quote from other authors who had listed *B. latifrons*, but apparently assumed that the identifications were incorrect. Alfred Romer (in Jillson, p. 68) listed eight molars of *B. latifrons* from Big Bone Lick in the collections of the Museum of Comparative Zoology at Harvard College. These specimens, however, are considered by us to be referable to large individuals of *B. bison*, or possibly to small examples of *B. antiquus*. Although Romer listed fifteen separate species from Big Bone Lick based on the Harvard collection, he did not list *B. antiquus*. The holotype and other examples of *B. antiquus* Leidy are from the Big Bone Lick locality, but they are not associated with the remains of *B. bison*, except in reworked deposits (Schultz, Tanner, Whitmore, Ray, and Crawford, 1963, 1967). The bison jaws and teeth from Big Bone Lick in the British Museum (Natural History) in London,

which have been catalogued as *B. latifrons*, were examined, measured, and photographed by Schultz in 1964 and 1969. The measurements of these specimens proved to be within the range of those of *B. bison*.

Schultz, Tanner, Whitmore, Ray, and Crawford (1963: 1167; 1967:5) spent five field seasons (1962-1966) in the Big Bone Lick area deciphering the paleontology and stratigraphy of the fossil locality. Prior to this, very little attention had been given to the stratigraphic association of specimens obtained there. No examples of *Bison latifrons* were found in the extensive excavations at Big Bone Lick, and it was the consensus of the workers that the Woolper Creek area was the most probable locality for the holotype of this species. Bone fragments were found in the blue clay under the Split Rock Conglomerate exposed near the mouth of Woolper Creek; these show the same kind of preservation as the holotype of *B. latifrons*. This type of fossilization is not seen in specimens from the Wisconsinan and Holocene deposits at Big Bone Lick. Ray's extensive studies (1974:48) of the Woolper Creek area indicate that the Split Rock Conglomerate is of Illinoian age.

The widely-known fossils and deposits from Big Bone Lick have contributed much to the myth of bison variation and lack of evolution. Many earlier workers did not recognize that a number of strata of varying ages were present and, therefore, assumed that all the fossils obtained from an excavation were of the same age. This fact has colored the conclusions of many commentators on bison phylogeny. We consider that the holotype of *B. latifrons* came from deposits which are of post-Kansas to Early Illinoian age.

(2) Hooker and Cherry Counties Area, Nebraska

Bison latifrons, referred (holotype of *B. ferox* Marsh, 1877), partial horncore, Yale Peabody Museum 10910 (cast, U.N.S.M. 55164C).

Location.—Recorded in the Yale Peabody Museum catalogue as having been found along the Niobrara River of Nebraska in 1870 (see Schultz and Frankforter, 1946:5, for discussion of location). The Yale Expedition of 1870, which obtained the specimen, did not reach the Niobrara River, but did go to the "Loup Fork of the Platte," which is the area of the fossiliferous Middle Loup River valley in Hooker and Cherry counties. Marsh's expedition appears to have been seeking the fossiliferous locality discovered by the F.V. Hayden - G.K. Warren exploration party of 1857 (Hayden, 1858; Leidy, 1869). The color and preservation of Marsh's example of *B. latifrons* compare favorably with those of some of the fossilized remains from the U.N.S.M. collecting localities along the Middle Loup River and the North Prong of the Middle Loup.

Stratigraphy.—We consider that the holotype of Marsh's *B. "ferox"* came from the post-Kansas to Early Illinoian

fossiliferous deposits which are well developed along the Middle Loup River, but definitely not associated with the Blancan faunas (Broadwater) which are derived from underlying sediments.

Discussion.—A distal portion of a radius-ulna (U.N.S.M. 30360) was found by a U.N.S.M. field party in 1930 north of Mullen, Hooker County, on the north side of the Middle Loup River. This specimen was derived from sediments which are of post-Kansan to Illinoian age. The preservation of the Yale specimen (Y.P.M. 10910) would suggest that it was obtained from the same sediments. Smith (1965, 1968) and Lugen (1968) considered the sand dunes of Nebraska to have originated during Illinoian and Wisconsin time. It should be noted that no *B. latifrons* remains have ever been recovered from the aeolian sands or their associated paleosols in the Sandhills region.

(3) Clay County, Nebraska

Bison latifrons, referred (holotype of *B. "angularis"* Figgins, 1933), partial skull with horncores, Hastings Museum 4710 (cast, U.N.S.M. 30326C).

Location.—1½ miles east and 3½ miles north of Sutton, Clay County, on north side of School Creek drainage, near center of N½, SE¼, sec. 13, T.3N., R.5W.

Stratigraphy.—From gravels below Loveland Loess (Illinoian) in the Terrace-4 (Sheridan) fill. The skull was found in a dry-gravel pit, in strata well exposed at the time of the discovery. Lugen and Schultz (1934:390) considered the gravels to be "Grand Island (Kansan)," but these deposits are now considered to be of post-Kansan to Illinoian age (Schultz and Stout, 1948).

Discussion.—This example of *B. latifrons* is smaller than the holotype and other examples of the classical phase. Perhaps it could be considered a geologic variety.

(4) Saline County, Nebraska

Bison latifrons, referred (holotype of *B. "rotundus"* Figgins, 1933), partial skull with horncores, Colorado Museum of Natural History 1187, and associated radius-ulna, U.N.S.M. 5476 (both specimens associated with the holotype, left ramus, of *Castoroides ohioensis nebraskensis* Barbour, 1931, U.N.S.M. 2538).

Location.—U.N.S.M. Coll. Loc. Sa-102, 2 miles south and 4+ miles west of Dorchester, Saline County, in a dry-gravel pit on north side of Turkey Creek near center of E½, NW¼, sec. 33, T.8N., R.2E.

Stratigraphy.—All specimens mentioned above were collected by Otto Chubb, and the locality was investigated by Lugen and Schultz (1934:390-391) when the gravel pit was

being worked. They concluded that the gravels were "Grand Island (Kansan)." These fossil-bearing sediments underlie the Sangamon Paleosol and Loveland Loess (Illinoian). The site has been studied many times since then, and the conclusions remain the same, but these sediments now are considered to be post-Kansan to Early Illinoian age rather than Kansan.

Discussion.—Thompson M. Stout (oral communication) states that the holotype of *Castoroides ohioensis nebraskensis* Barbour (1931), which was associated with the holotype of *Bison "angularis"* (= *B. latifrons*), is in the same stage of evolution as shown in examples of "*Castoroides*" from the well-known Sheridanian fossil quarries south of Hay Springs and Rushville in Sheridan County, Nebraska. Stout reports that the Saline County fossil locality is "definitely pre-Sangamon and pre-Loveland, and surely equivalent to the Grand Island and Crete deposits (post-Kansan to Illinoian) or Terrace-4 (Sheridan) valley-fill of the Central Great Plains."

(5) Lancaster County, Nebraska

Bison latifrons, referred, two partial horncores belonging to the same individual, U.N.S.M. 30956.

Location.—U.N.S.M. Coll. Loc. Lc-101, 3 1/8 miles west and 3/4 miles south of Emerald, Lancaster County, in a dry-gravel pit in the center of SE¼, sec. 30, T.10N., R.5E.; collected by Lloyd G. Tanner, Marian Schultz, and Bertrand Schultz (1954).

Stratigraphy.—From sands and gravels below fine sands of Illinoian age.

Discussion.—The specimen was obtained from the U.S. Army Engineers Borrow Pit, which also was known as the Pickle Farm Pit. This gravel and said pit was extensively used by the U.S. Army Engineers for borrow material for construction at the Lincoln Air Force Base during the Korean War. As a result, some splendid geologic exposures were made available. Eugene Reed, State Geologist, and Thompson M. Stout, Lloyd G. Tanner, and C. Bertrand Schultz of the University of Nebraska State Museum and Department of Geology staffs spent considerable time studying the stratigraphy of the area. The sediments appear to be part of the Terrace-4 (Sheridan) fill, which is well developed in the area. The operators of the pit had been instructed to watch out for fossils, and the discovery of a skull of *Bison latifrons* resulted. Unfortunately, the bulldozers destroyed much of the skull, but portions of both horncores were salvaged.

(6) Hamilton County, Nebraska

Bison latifrons, referred, portion of horncore, U.N.S.M. 30324.

Location.—Near Giltner in SW. Hamilton County, Nebraska.

Stratigraphy.—Lugn and Schultz (1934:391) considered the dry-gravel pits in the vicinity of Giltner to be “Grand Island (Kansan),” but we now consider them to be of post-Kansas to Early Illinoian age.

Discussion.—The horncore, U.N.S.M. 30324, was collected in 1928 by C.E. Dawson, and the gravels from which the specimen was derived were well exposed when Lugn and Schultz visited the locality. The gravels definitely underlie Loveland Loess.

(7) Hitchcock County, Nebraska

Bison latifrons, referred, partial right horncore, U.N.S.M. 30359.

Location.—Near Trenton in Hitchcock County, Nebraska.

Stratigraphy.—Lugn and Schultz (1934:391) had difficulty in establishing the exact site where the specimen had been collected. The horncore had been found in a dry-gravel pit north of the Republican River, according to the meager records available. Gravels in the area which produced fossils of the same type of mineralization as the horncore were considered by Lugn and Schultz (1934:391) to be “probably Early Pleistocene,” but these deposits are now thought to be post-Kansan to Early Illinoian since they are mantled with Loveland (Illinoian) Loess in the Terrace-4 (Sheridan) fill.

Discussion.—The horncore, U.N.S.M. 30359, was discovered by former Governor R.W. Furnas in 1892 in a dry-gravel pit. The late Paul Edwards, a native of Benkelman, a former graduate student in the Department of Geology, University of Nebraska-Lincoln and a graduate assistant in the University of Nebraska State Museum, spent considerable time from 1970 to 1975 trying to find more evidence of *B. latifrons* in the Trenton and Benkelman areas. However, no further examples of the giant bison were uncovered, but additional stratigraphic evidence was obtained (personal communication with C. Bertrand Schultz).

George Corner (1977) has undertaken the salvage of a considerable number of vertebrate fossils from various sand-and-gravel borrow pits in both Red Willow and Hitchcock counties. These borrow pits are of the wet-gravel type along the Republican River, and the fossils are pumped out along with the sand and gravel. The fossils are primarily Rancho-labrean and Holocene (Sangamonian, Wisconsinian, and Recent) in age, and the preservation of the bones from these sands and gravels is distinctly different from the mineralization of the horncore of *B. latifrons* from Hitchcock County (U.N.S.M. 30359).

(8) Franklin County, Nebraska

Bison latifrons, referred, partial horncore, U.N.S.M. 55181.

Location.—2½ miles west and 2½ miles south of Napoleon, Franklin County, on west side of Rebecca Creek in SE¼, NW¼, sec. 23, T.1N., R.16W.; collected by King A. Richey, 1971.

Stratigraphy.—Specimen found in the basal sediments of a Pleistocene fill overlying clay and Niobrara (Cretaceous) chalk.

Discussion.—The lithology and geomorphology of the locality indicate that the horncore was buried in a meander-core of a Terrace-4 (Sheridan) fill. Terrace-4 is well developed in this area. The specimen is considered to be of post-Kansan to Early Illinoian age.

(9) Scott County, Kansas

Bison latifrons, referred, partial skull with horncores, U.N.S.M. 30361.

Location.—5 miles north and 3½ miles west of Scott City, Scott County, from Geist (Christy) Gravel Pit in NE¼, SW¼, sec. 21, T.17S., R.33W. (Waite, 1947, p. 128).

Stratigraphy.—From terrace deposits of Beaver (Ladder) Creek Valley in gravels intermixed with sand, silt, and clay (Waite, 1947). Waite reported that the terraces are of cut-and-fill origin, and the trough was cut to its maximum depth early in the Pleistocene, after which several successive periods of channel-filling resulted in great thickness of undifferentiated Pleistocene deposits in the buried trough.

Discussion.—Schultz, who obtained the partial skull from Scott City for the University of Nebraska State Museum, has visited the fossil locality several times and has studied the terrace fills in the area. On one occasion he accompanied M.K. Elias, John C. Frye, Claude W. Hibbard, and Eugene C. Reed on a field trip (Elias, *et al.*, 1945) and a stop was made at the Scott City bison site. Reed and Schultz concluded that the stratigraphic and geomorphologic evidence at the Geist (Christy) Gravel Pit indicated that the gravels were a part of the Terrace-4 fill, which is well exposed in the area. Thompson M. Stout (oral communication), who also has examined the site, agrees with this conclusion. Two mammoth teeth (Waite, 1947, Pl. 15, B-C, D-E) were found at the Geist (Christy) Gravel Pit and were identified as “*Parelephas columbi*,” but we question this identification. The enamel is much too heavy for this Late Pleistocene species, and the teeth compare favorably with these from the Medial Pleistocene examples from the Sheridan County, Nebraska fossil mammal localities at Hay Springs and Rushville (see Schultz, Tanner, and Martin, 1972, on the evolutionary importance of enamel thickness). Hence, this is additional evidence for the antiquity of *Bison latifrons* at this locality.

(10) Meade County, Kansas

Bison latifrons, referred, partial skull, University of

Location.—“Along the banks and bed of Shorts Creek (locally known as Lone Tree Arroyo) in SW¼, sec. 32, T.33S., R.29W.” (Hibbard, 1955, p. 194), on “the Jinglebob pasture of XI Ranch,” Meade County, Kansas.

Stratigraphy.—The stratigraphy of this site has been controversial, but with the evidence at hand we regard the Jinglebob Local Fauna to be of post-Kansan to Early Illinoian age.

Discussion.—Hibbard (1955) regarded the Jinglebob Local Fauna as “inter-glacial (Sangamon?)” but used paleoclimatic and invertebrate faunal evidence to reach this assumption. We feel that this is excellent supportive evidence but it can be questioned if used as primary documentation. Hibbard and Taylor (1960:62) stated that “the Jinglebob sediments were deposited . . . after dissection of the High Plains surface . . . this dissection can be dated no older than late Yarmouth. The oldest fossils found in sediments younger than this dissection are Illinoian.” The High Plains surface, however, had been dissected during the post-Kimblian and pre-Blancan, and again during the post-Kansan and pre-Illinoian times (Schultz and Stout, 1945, 1948; Schultz, Lueninghoener, and Frankforter, 1951). Thompson M. Stout (Stout, *et al.*, 1965, p. 69) in correlating this Meade County locality with Nebraska localities states, “It is to be noted that the Jinglebob Site is not Sangamon, as claimed, but pre-Loveland, in the lower part of a Terrace-4 valley fill.” Stout had studied the stratigraphy of the site on various occasions and arrived at his conclusions on geomorphologic, stratigraphic, and lithologic, as well as faunal evidence. Schultz also has visited the Jinglebob Locality with Hibbard and others, and independently arrived at the same conclusions as Stout. We therefore consider the example of *Bison latifrons* from this locality to be of post-Kansan to Early Illinoian age.

(11) Lipscomb County, Texas

Bison latifrons, referred, skull, Panhandle-Plains Historical Museum, 2315-1 (G.E. Schultz and C.H. Lansdown, 1972).

Location.—“Along the north bank of Sand Creek, one quarter mile east of Farm-to-Market Road 1920 in the SW¼, SE¼, NW¼, sec. 421, Blk. 43, H. and T T.C. Ry. Co. Survey, Lipscomb County, Texas” (Schultz and Lansdown, 1972), on the ranch of Sam Waters.

Stratigraphy.—From medium to coarse-grained, gray to brown sand in the base of a “Late Pleistocene terrace” (Schultz and Lansdown, 1972). Evidence, however, obtained by University of Nebraska State Museum field parties in 1939, 1946, 1955, and 1956 on Sand Creek at the Sam Waters ranch and adjacent areas indicates that sands are at the base of a Terrace-4 (Sheridan) fill, and thus the age would be post-

Kansan to Illinoian.

Discussion.—Members of the University of Nebraska State Museum field parties studied the stratigraphy and geomorphology of the Sam Waters ranch area in conjunction with the excavation of the *Lipscomb Bison Quarry* in 1939, 1946, 1954, and 1955. The bison quarry (U.N.S.M. Coll. Loc. TEX-1) is located near the head of Sand Creek, a branch of Wolf Creek, on the Sam Waters ranch to the west of the *Bison latifrons* site. The *Lipscomb Bison Quarry* site was reported to the University of Nebraska by Charles H. Falkenbach in 1938, and excavating privileges were obtained in 1939 from the Frick Laboratory, American Museum of Natural History in exchange for similar rights at certain Nebraska fossil quarries. The ranch was owned by Commodore Hopper, who later sold it to Sam Waters. The quarry was first worked from June 10 to August 26, 1939 (Schultz, 1943), and thirty-eight boxes and crates of *B. antiquus taylori* remains, associated with twenty-nine Folsom artifacts (projectile points, knives, scrapers, etc.) were recovered. The quarry was worked again by a U.N.S.M. field party in the summer of 1946, and it was also visited in 1954 and 1955 in order to obtain additional geologic evidence. In 1939 a topographic map showing the relation of the quarry site to the region along Sand Creek was made by members of the field party. Several Holocene and Pleistocene terraces, including Terrace-4, are well developed along the creek. The 1939 field party included the following: John Adams, James Crosby, William Hendy, and Marian Schultz, and the excavation was accomplished under the direction of Bertrand Schultz. Robert Kubicek and Harry Tourtelot joined the field party for the month of August.

Weldon Frankforter and Bertrand Schultz supervised the 1946 excavations and studied the stratigraphy and geomorphology of the Sand Creek and Canadian River areas. During the summers of 1954 and 1955, Lloyd Tanner and Bertrand Schultz continued the study of the terrace fills at the Waters Ranch and adjacent areas. The locality where the *B. latifrons* skull was found also was studied, and it was the consensus of Frankforter, Tanner, and Schultz that the sands at the base of the high terrace were associated with the Terrace-4 (Sheridan) fill.

(12) Fremont County, Colorado

Bison latifrons, referred, partial horncore, U.S. Geology Survey Denver-720 (U.S. National Museum 25912; cast, U.N.S.M. 55168C. The U.N.S.M. cast was obtained by courtesy of Dr. G. Edward Lewis, U.S.G.S., Denver).

Location.—Fremont County Highway Department gravel pit in SW¼, NE¼, sec. 26, T.18S., R.70W., Fremont County, Colorado (Lewis, 1970; Scott and Lindvall, 1970).

Stratigraphy.—From Slocum Alluvium, Canon City section. Specimen was found “in a sand lense 5 ft. above the base” of the section (Scott and Lindvall, 1970).

Discussion.—Scott and Lindvall have suggested that the sediments of the Slocum Alluvium, “which contained the *B. latifrons*, probably are Sangamon in age.” We must question this dating on the basis of the interpretation of the geomorphic evidence. In this area the geomorphology and stratigraphy are extremely complex, and have been studied intensively by many workers. Schultz has visited the section on several occasions and also has discussed these problems with Scott and others. A case for an earlier date can be defended and further study may resolve the question of the dating of *B. latifrons* at this locality.

Scott and Lindvall do quote B.J. Szabo (personal communication, 1968) as obtaining a date of 160,000 years B.P. on a sample of bone from the bison horncore. However, they question the validity of this date because a new radiogenic method (using protactinium) was used. Such a date would indicate a pre-Sangamon origin of the Canon City specimen.

(13) Haakon County, South Dakota

Bison latifrons, referred, skull with left P^4-M^3 , right P^3-M^3 , left horncore complete, and right horncore tip abraded, South Dakota School of Mines 5889 (Green and Martin, 1960).

Location.—From the Ralph Jones quarry, 1.2 miles north of Midland, South Dakota, in SW $\frac{1}{4}$, SW $\frac{1}{4}$, sec. 31, T.2N., R.25E., Midland Quadrangle, Haakon County.

Stratigraphy.—From a cross-bedded sand and gravel deposit.

Discussion.—Green and Martin define the specimen as Late Pleistocene in age: “The SDSM specimen comes from the highest of several terraces in the area and the oldest possible dating is Iowan.” The authors cite Flint (1955) and interpret Crandell’s 1954 geological map (1:62500) of the area to determine the age of the Pleistocene terraces along the Bad River.

We disagree with the conclusions of these writers that “*B. latifrons* is found only in deposits of Late Pleistocene Age.” Data presented earlier in this paper have totally refuted this sweeping generalization. Field studies of terrace stratigraphy, which culminated in a paper by Schultz, Lueninghoener, and Frankforter (1951), included extended visits to the terrace deposits along the White, Bad, and Missouri Rivers, during the field seasons from 1946 through 1949. Much of the work was accomplished in company with R.F. Flint, D.R. Crandell, H.E. Simpson, and C.R. Warren. Frankforter and Schultz identified the majority of the vertebrate fossils recovered by the field parties from the various terrace fills (Flint, 1955). Contrary to the conclusion of Green and Martin mentioned above, Flint has stated (p. 161) that sediments older than “Late Pleistocene” are present. The highest terrace, Terrace-4 (Sheridan) is well developed along the White River,

only 20 miles south of the Haakon County *B. latifrons* site. These high terrace fills and others near Chamberlain, South Dakota, have yielded local vertebrate faunas of undoubted Sheridanian age. Therefore, we can assume that the Haakon County sand and gravel deposits which produced the *B. latifrons* specimen may be of Illinoian or earlier age, and need not be younger than Iowan, and “Late Pleistocene,” as Green and Martin concluded.

(14) Bingham County, Idaho

Bison latifrons, referred, five cranial specimens and associated postcranial material, reported by Hopkins (1951) and Hopkins, Bonnicksen and Fortsch (1969): the “Whitlow specimen,” found in 1933 by Wayne B. Whitlow, now apparently displayed at Pocatello High School; the “Hopkins specimen” (“*B. latifrons* I”); “*B. latifrons* II”; “*B. latifrons* III”; Idaho State University Museum 2252, with which is associated a partial tibia (I.S.U.M. 2633) and other skeletal elements. A number of other cranial specimens have been recovered since 1969 (George E. Jakway, personal communication, 1976).

Location.—The “Whitlow specimen”: from the east beach of American Falls Reservoir, SE $\frac{1}{4}$, SE $\frac{1}{4}$, sec. 9, T.6S., R.32E. (Hopkins, 1951); the specimens “*B. latifrons* I” and “II,” apparently from the same site, “. . . toward the north-east end of the fairly large bay in the SE $\frac{1}{4}$, sec. 3, T.6S, R.32E . . . from the lower beach . . .”; “*B. latifrons* III” and I.S.U.M. 2252 from “. . . a short distance up reservoir from, but within sight of, this same bay. . . from the upper beach. . .” (Hopkins, Bonnicksen and Fortsch, 1969).

Stratigraphy.—From *Bed E* (cobble gravel with layers of sand). “The known stratigraphic range of *Bison latifrons* is restricted to *Bed E*.” (Hopkins, Bonnicksen and Fortsch, 1969). These writers note that a 30-foot difference in elevation exists between the “lower beach” and the “upper beach” sites. *Bed E* is overlain by “alternating beds of silt and sand” capped by a possible fossil soil and more beds of “diatomaceous blocky clay” (*Beds D* and *C*). These three strata are assigned by Carr and Trimble (1963:G34) to the “American Falls Lake Beds.” They correlate *Bed E* with the basal gravel, “probably Illinoian in age,” which is exposed in a section in the Snake River Bluffs near Neeley, Idaho.

Discussion.—Hopkins, Bonnicksen and Fortsch (1969) quote Trimble’s conclusion (personal communication) that the *Bed B*, overlying the “American Falls Lake Beds” is a part of the fill of the “Aberdeen Terrace.” These writers accept with reluctance the Illinoian age of the lowest *Bed E*, apparently influenced by the affinities of their associated faunas with the Jinglebob Local Fauna, which Hibbard (1955) had tentatively considered to be “interglacial (Sangamon?)” in age.

We suggest that the beds containing the *B. latifrons*

specimens at American Falls Reservoir may be of Early Illinoian, or even pre-Illinoian, age. We attach great significance to the presence of a prominent paleosol complex capping the *Bed D* (see "Fossil soil?," Fig. 1, Hopkins *et al.*, 1969). It is very apparent that the sedimentary mechanism in this area is not a simple lacustrine basin infilling. Numerous rodent burrows associated with the paleosol, and containing fossil remains of *Spermophilus* (= *Citellus*) and other microvertebrates, clearly indicate a terrestrial environment for at least a portion of the time of deposition.

A radiogenic date (W-358, Rubin and Alexander, 1958: 10) from a sample of charcoal taken from beneath the facial portion of a *B. latifrons* skull by Marie Hopkins prior to November, 1956 indicates an age of "greater than 32,000" years B.P. We would suggest "much greater than . . .", perhaps by a factor of ten or more.

Various members of the University of Nebraska State Museum paleontological and geological field staff have independently visited the Idaho *B. latifrons* locality in company with Marie Hopkins. On one occasion (1958), Schultz spent ten field days at the American Falls reservoir sites (including both the *B. latifrons* and *B. alleni* localities) in company with G. Edward Lewis, Marie Hopkins, Dwight Taylor, Claude Hibbard, Harold E. Malde and other workers, and made extensive field sections, measurements, and observations on the geomorphology of the region. The Nebraska workers (T.M. Stout, W.D. Frankforter, G.C. Lueninghoener, L.G. Tanner, and C.B. Schultz) have all been strongly impressed by the striking similarities of the section at the American Falls Reservoir with Terrace-4 (Sheridan) fill complexes in the Great Plains. The Terrace-4 fill, as well as the fills of Terraces -5, -3, -2, and -1, have been found to be of regional extent in the Interior Plains (Schultz and Stout, 1948; Schultz, Lueninghoener, and Frankforter, 1951; and subsequent publications), and it is not unlikely that similar terrace fill complexes would occur to the west of the Rocky Mountains, since the sedimentary mechanism was primarily climatically controlled.

We think that it is significant that the remains of *Bison latifrons* (Hopkins, 1951) and *B. alleni* (Gazin, 1935; Hopkins, 1951), although found in the same vicinity east of the American Falls Reservoir, do not occur in the same stratum. The *B. alleni* remains are from higher sands and gravels in the terrace fill complex, and Hopkins (1951) concludes that "*B. (Gigantobison) latifrons* seemingly occurs at a lower stratigraphic level in Southern Idaho than does *B. alleni*." This datum confirms evidence previously reported from Great Plains sites.

CONCLUSIONS

Evidence at hand indicates that *Bison latifrons* remains are derived from deposits of post-Kansan to Early Illinoian age. We are aware of at least 13 other sites from which this

species has been reported, but we have not considered them in this paper because there have been no precise stratigraphic data associated with the specimen(s).

Although we have suggested that there was a sequential evolution of bison forms from the largest (*B. latifrons*) through *B. alleni* and *B. antiquus* to the present plains bison (*B. bison*) we cannot accept the concept of a monophyletic lineage of bison in North America. We believe that after *B. latifrons* became established in North America there evolved a number of different contemporary "paleospecies" which inhabited areas with different ecological conditions. Some of these "paleospecies" may have been ancestral to several phylogenetic lineages which continued throughout portions of Late Quaternary time.

The general tendency toward smaller size was a gradual one requiring considerable time (probably at least one-half million years), and was not saltatorial. Possibly the evolution was influenced by periodic invasions of small numbers of bison from Asia, but there can be no acceptance of the extinction-and-invasion mechanism suggested by Skinner and Kaisen (1947) as a possible explanation for the apparent "macro-evolution" which they hypothesized.

We present the data in this paper to aid in the documentation of the early history of the bison in North America. Misidentification of numerous specimens and misinterpretation of stratigraphy has clouded the general understanding of the bison phylogeny. The hypothesis here presented regarding the post-Kansan to Early Illinoian age of *B. latifrons* is properly subject to continued testing. We plan to do this and hope that other workers will extend their research into the stratigraphic documentation of *B. latifrons* specimens.

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