A record of *Bos primigenius* from the Quaternary of the Aba Tibetan Autonomous Region

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Abstract

The text describes a specimen of *Bos primigenius* recovered from a terrace of the Heihe River at an elevation of 2400 m, which was dated at 26,620 ± 600 BP by C^{14} analysis.

Introduction

In the Summer of 1982, the Vertebrate Paleontological Unit of the Qinghai-Tibetan General Research Coalition (Hengduan Mountains sector), Academia Sinica, conducted systematic observations in the Aba vicinity of the Tibetan Autonomous Region. A fossil of *Bos* was discovered in association with stratigraphic data from the Heihe River Pasture of Zoigai County by members of the Sixth Regiment of the Sichuan Regional Geologic Investigation Brigade (Fig. 1). The Heihe River Pasture is situated at the upper reaches of the Heihe River, which flows south to north, and constitutes an important tributary to the Yellow (Huanghe) River. Their confluence is located in Maqu County, Gansu Province. Field observations suggest the fossiliferous Heihe River valley is basically consistent lithologically and petrographically to the major terrace deposits of the Yellow River in the Maqu-Tanke region. C^{14} analysis provides a date of 26620 ± 600 BP for the sediments, further confirming an age correlation of Late Pleistocene to the Yellow River terrace deposits in the vicinity of Suogezangsi Temple, Tanke, which produce *Coelodonta*, *Equus*, and a limb bone of *Bos* similar to the Heihe specimen (Pl. II, Fig. 3), among other paleontological data. This young date facilitates regional paleogeographic, paleoclimatologic, and paleoenvironmental reconstruction of the deeply entrenched valley regions along the eastern border of the Qinghai-Tibetan Plateau.

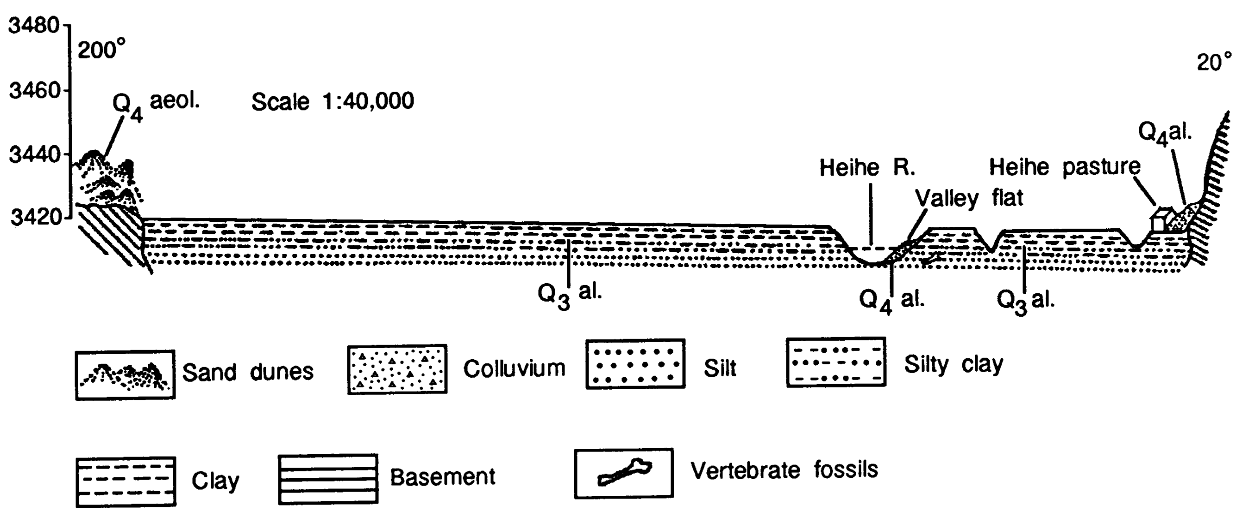

Figure 1. Cross-section of the Heihe River Pasture fossil locality.

I Specimen Description

Artiodactyla Owen, 1848

Bovinae Gill, 1872

***Bos* Linnaeus, 1758**

***Bos primigenius* Bojanus, 1827**

Material: Includes the skull of a juvenile with both horncores (preserving only 20-30 cm of the basal section), with the anterior section of the frontal lost. Specimen number is Sichuan Regional Geological Investigation Brigade field number: Heihe H_{16} (as with the following specimen). Also collected is the skull of an adult individual with broken anterior frontals. The right horncore was reconstructed after breakage, while the left horncore preserves only the basal 40 cm remaining. The specimen number is Heihe H_1 (Fig. 2). Also collected were a number of postcranial elements probably from the same individuals, including a sixth cervical vertebrae, third and fourth thoracic vertebra, a pair of scapulae, and a pair of radii and ulnae.

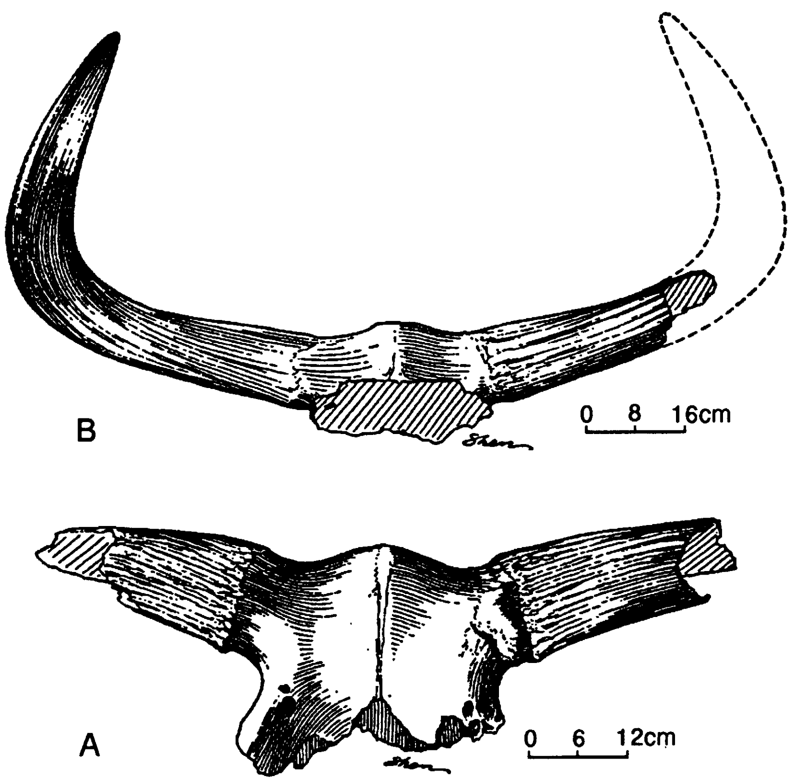

Figure 2. Skulls of *Bos primigenius* H_{16} (A); H_1 (B).

Description and comparison: The frontals are broad and large, but the anterior sections that house the orbits are lacking on both specimens. The parietal is extremely short, and does not expand onto the top of the cranium, but is suspended just dorsal to the occiput. The center of the parietal is projected upward to become the highest point of the skull. Its summit, however, is not great, but on the juvenile skull it is higher than on the adult. Specimen H_{16} is regarded as a juvenile, for compared to specimen H_1, the parietal suture lines are poorly fused. Completely preserved on both specimens are the foramen magnum, occipital condyles, paroccipital processes, and the basioccipital.

These specimens of *B. primigenius* are relatively gigantic from the perspective of limb bone and skull proportions. Based upon estimations of forelimb measurements, the scapula would exceed over 2 m in height. The horn cores are also rather robust, as on specimen H_1 the basal circumference is 445 mm, exceeding the size of all others known in China (the Datong specimen is 425 mm, Dongbei specimen 410 mm, Peking specimen 355 mm, and Gansu specimen 435 mm). This is smaller, however, than the largest specimens from England and France (470-480 mm). The horncores extend horizontally from the posterodorsolateral angle of the parietal to the posterior margin of the cranium, then recurve anterodorsally. It is estimated the distance between the tips of the horns reached approximately 800 mm. The greatest distance within the horncore curvature lies at the center, where the horns are slightly laterally compressed and may reach 1300 mm. The horncore curvature is very similar to the specimen derived from the western outskirts of Peking (Hu, 1959).

The cross-section of the Heihe River horn cores is elliptical, with the diameters gradually decreasing from the base to the horn tips. The long axis of the basal horncore ellipse is parallel to the longitudinal axis of the skull, while the distal sections of the horncores are aligned with the longitudinal axis. There are many extremely delicate nutrient foramina ornamenting the horncore surface in addition to shallow or deep, coarse and fine unconnected longitudinally directed grooves. Diagnostic characters of this specimen are as in *Bos primigenius* derived from other Chinese localities such as in Inner Mongolia, Hebei and Shanxi provinces, Peking, and the northwest section of the country. Comparative cranial measurements are listed in Table 1 (measurements from the Peking specimen and the Soviet Union are derived from Hu, 1959).

Table 1. Comparative cranial measurements (mm).

	Aba	Peking	Soviet Union
Distance between horncore tips	1300	1070	497-802
Length of upper horncore concavity	934		
Length of lower horncore convexity	1180		
Distance between horn tip and dorsal margin of bracelet	660	458	277-476
Largest anteroposterior diameter of horncore base	133-148	119	98.5-132
Smallest dorsoventral diameter of horncore base	109-122	99	79-105
Circumference of horncore base	380-445	355	275-370
Distance between external auditory meatus	234-343	148	263.5-275
Breadth of occipital condyles	148		
Distance between neuchal crest and top of foramen magnum	120-130	157	140-185
Distance between neuchal crest and bottom of foramen magnum	170-180	195	182-233
Distance between horncore bases	280-313	281	138-252
Smallest breadth of frontal between horncores and orbits	264-302	260	213-256
Breadth of frontal at posterior margin of orbit	300-360	331	293.5-316
Angle at posterior side of horncore	80°		
Ventral inclination of horncore	0°		
Horncore curvature rate	178		
Horncore compression rate	123.6		
Horncore ratio	210		
Horncore extension rate	309		

The post-cranial material recovered is probably associated with the skulls. This material includes a sixth cervical vertebra (H_8), third and fourth thoracic vertebra (H_3, H_{10}), scapulae (H_6), radii/ulnae (H_7), and a left femur (H_5).

The distal end of the suprascapular spine has been broken off the right scapula. The left scapula is complete, except for the cartilage (Plate II, Fig. 1).

The left and right ulnae are both in tight association with their corresponding radii (Plate III, Figs. 1 and 5).

The left femur is complete (Plate II, Fig. 2). Its center section is a circular shaft. The distal end is triangular in shape with an extremely large greater trochanter exhibiting a coarse lateral surface. The trochanteric fossa is deep but extends distally for only a short space. The medial and particularly the lateral condyles are small, and there is an extremely deep intercondylar fossa.

Table 2. Sixth cervical vertebra (mm).

Breadth of centrum at transverse process region	204
Breadth of centrum at anterior articular process	118
Greatest distance between transverse processes ventrally	156
Length of centrum	100
Greatest height x breadth of centrum's anterior process	58.2 x 42
Height x breadth of posterior fossa on centrum	71.0 x 54.5
Height of neural spine (from the dorsal margin of the neural arch's anterior mouth) x breadth of base x thickness	154 x 48 x 18
Height x breadth of neural canal	25 x 29
Height x breadth of transverse foramen	17 x 13
Breadth of transverse process (from the anterolateral margin of transverse foramen)	76
Length of ventral process (from the anterolateral margin of transverse foramen)	105

Table 3. Thoracic vertebrae (mm).

	Third	Fourth
Breadth of centrum at transverse processes	134	117
Breadth of transverse process (anterolateral side of neural canal)	51	45
Ventral length of centrum	72	71
Height (ventral to neural canal) x breadth of anterior centrum	56.4 x58.0	61.5 x71.0
Height of dorsal spine (from anterodorsal side of neural canal)	570	469
Breadth x thickness of dorsal spine at base	47 x 42	67 x 38
Height x breadth of neural canal at anterior mouth	22.3 x 29.5	20.4 x 26.3

Table 4. Scapula (mm).

Greatest height of scapular body	585
Breadth at distal end	325
Breadth at proximal end	100
Greatest breadth of supraspinatus fossa	79
Greatest breadth of infraspinatus fossa	256
Breadth x thickness of scapular neck	91 x 38
Length x breadth of glenoid cavity	84 x 77
Greatest height of scapular spine	91
Greatest length of scapular spine (including acromion process)	496

Table 5. Radius (mm).

Greatest length of radius	378
Greatest breadth and thickness at proximal end	123 x 62
Greatest breadth and thickness at distal end	113 x 63
Breadth and thickness at center of shaft	69 x 40
Breadth of articular surface at distal end	99

Table 6. Ulna (mm).

Length	504
Greatest height of olecranon	160
Greatest thickness of olecranon	45
Length of trochlear notch	43
Breadth of articular facet for humerus	71
Greatest breadth of distal end	37

Table 7. Femur (mm).

Length	522
Smallest diameter of shaft	56
Diameter of femur head	66
Greatest breadth of proximal end	165
Breadth of distal condyles	138
Greatest breadth at distal end	118

The robust nature of these skeletal elements is comparable in the extant *Bos gaurus*; however, the Aba specimen is undoubtedly a member of *B. primigenius* due to diagnostic cranial characteristics, particularly the articulation of the frontal posterior to the horns, the extremely short parietal that does not attain the top of the cranium, and finally the elliptically shaped horn cores that have their inception from the posterolateral margin of the frontal.

II Historical Geology and Geographic Distribution

It is possible that *Bos primigenius* arose out of the South Asian taxon *B. namadicus* which, itself, may have been a descendant of the Early or Middle Pleistocene *B. planifrons* from the Siwaliks of India and Pakistan. In the late Quaternary, *B. primigenius* became extensively distributed throughout the Eurasian continent and North Africa. The earliest occurrence of this taxon is from Europe prior to the D-Holsteinian interglacial stage at 230,000 years. Many occurrences appear in the European Holocene directly into the 4-Wurm Glacial Stage where they inhabited the southern regions of the Alps. The last European cow died in 1627 A.D. (Kurten, 1968). From the perspective of current data, it appears the geologic history of *B. primigenius* in China began later than in Europe, as there is still no Middle Pleistocene record of this taxon, although it is a frequently found biostratigraphic indicator for Late Pleistocene sediments. Previously, *B. primigenius* was recognized not only for its late appearance, but also for its short duration, being restricted to the Late Pleistocene. In 1980, however, paleontologists Lanpo Jia and Qi Wei made the discovery of a Holocene fauna in which *B. primigenius* occurred at the Dingjiabao Reservoir in Yangyuan County, along the Sanganhe River. The discovery illustrated the survival of this taxon in the Late Pleistocene, and confirmed its continuation into the Holocene at least prior to 3,000 years ago.

This species is a large grazer not adapted to traversing long distances, but accustomed to relatively stable cool-temperate grassy plains, or grasslands bording woodlands or dense forests. It is possible that during historical times in Europe, these animals were driven into the forests by human activity, such that by the beginning of the seventeenth century the small population fortunate enough to survive existed in the dense southwestern forests near Warsaw, Poland. The assumption of this taxon's preferred habitat appears to be corroborated by paleobiogeographic analysis of several Chinese Late Pleistocene faunal units containing *B. primigenius*, where pollen analysis of the fossiliferous sediments bearing *B. primigenius* in Huanxian County, Gansu Province, displays nonarboreal pollen and small shrubs constituting 73-90 percent of the assemblage, while arboreal taxa constitute 4.3-18.3 percent (He, 1977). This is basically consistent with the ecological conditions represented in the early periods of *B. primigenius* in Europe.

The currently known geographic distribution of *B. primigenius* in China includes an extensive distribution of localities that lie east of longitude 105° and north of latitude 35°, with the exception of the Tibetan record in this text that lies west of east longitude 105°, and the record from Xinhua, Tainan, on Taiwan, which lies south of north latitude 35°. These localities include Heilongjiang (Tokunaga, 1933), and Yushu, Jilin (Chow et al., 1959) in northeast Manchuria; Sjara-osso-gol, Inner Mongolia (Boule and Teilhard, 1928), the western outskirts of Peking (Hu, 1959); Yangyuan, Hebei (Jia and Wei, 1980); Datong (Chow, 1953) and Dingcun (Pei, 1958); Huanxian (Wang et al., 1982) and Qingyan, Gansu (Ding et al., 1965), in addition to other localities. Moreover, the statistics regarding the stratigraphic positions of *B. primigenius* in China indicate their presence in broad plains at elevations below 1,000 m, with the exception of the two localities in Gansu Province (Huanxian and Qingyang) on the Loess Plateau. This apparently indicates that *B. primigenius* not only inhabited grassland-woodland regions, but also low-elevation piedmont plain habitats. Therefore, the discovery of this animal's remains in the Heihe River bed at an elevation exceeding 3400 m suggests the regional effect of the Himalayan orogeny with a relatively large range of uplift that rather radically changed the appearance of the paleogeographic environment. With the increase of climatic cooling came the loss of dense grasslands and spacious woodlands, and hence led to the concurrent regional extinction of the large grazers including *B. primigenius* and the wooly rhinoceros *Coelodonta*.

The C^{14} age analysis derived from the femur of the Tibetan specimen provides a date of 26,620 ± 600 years. The sediments producing this specimen are identical in age and very similar in both petrographic and lithologic character to the same region's Yellow River terrace deposits that produce *Coelodonta* in the vicinity of Suogezangsi Temple, Tanke (Zhou, 1959). These sediments consist of fine-grained fluviolacustrine deposits and are regionally extensively distributed within the Yellow River, the Heihe River, and their tributaries. They overlie nearly the entire center of the narrow and long Hongyuan Plateau-Maqupendi Basin. Preliminary field observations indicate that both Yellow River tributaries, the Miquhe River, and the Heihe River are entrenched within this package of sediments and frequently produce fossils within the river beds due to fluvial erosion. Consequently, the history of this river system is constrained by the 26,620 ± 600 date. Over 20,000 years ago the Hongyuan-Maqu region feceived sediment from broad river valleys. Subsequently, orogenic effects caused base level to fall gradually, reducing water flow until paludification occurred, where, to date, on the Hongyuan Plateau the process continues with the development of grassland plateaus from the still-existing marshlands. These marshes diminish proportionally to orogenic activity.

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* The specimen described in the text is housed at the Peking Geological Museum.

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