

# TAPHONOMIC PARAMETERS OF PLEISTOCENE HOMINID SITES IN CHINA

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## ABSTRACT

*China possesses abundant evidence of hominid occupation spanning the Pleistocene. As such, the region provides an excellent opportunity to examine both the early environmental adaptations and the subsistence strategies of hominids in an extra-African environment. Hominid finds outside Africa have taken on special importance in view of the current controversy concerning the geographic and temporal origins of anatomically modern humans. Although the hominid record in China has been studied intensively with regard to hominid morphology and lithic technology, the associated faunal assemblages have been assessed primarily in terms of their palaeontological and zoogeographical significance. The identification of both taphonomic processes and patterning in the faunal record has not been the focus of investigations of either individual assemblages or cross-site assemblage comparisons. This paper presents research based on faunal analytic techniques and taphonomic indicators to address issues of site comparability and early hominid adaptation and subsistence.*

*Defining faunal patterns provides a potential means of differentiating long term hominid site use from sites containing hominids due to other collecting agents. Toward this goal, a series of hominid sites are compared both with each other and with a palaeontological control site to assess patterns in the associated faunal assemblages. Results indicate that the majority of sites studied do not represent long term hominid occupation. These sites do, however, document the presence of hominids and reflect short term occupational events. Specifically, analyses of stone tool cutmarks and faunal element profiles suggest that these assemblages resulted from a complex series of site formation processes. Taphonomic indicators argue for overlapping periods of occupation among carnivores, hominids and other bone collectors.*

## INTRODUCTION

The Far East possesses a significant record of hominid occupation that dates from at least one million years ago, and potentially even earlier (Bakken 1994; Huang *et al.* 1995; Pope 1988, 1992; Swisher *et al.* 1994). This region contains perhaps the largest sample of *Homo erectus* specimens available to date, as well as numerous examples of later hominids. Within the Far East, hominid material from China is both abundant and intriguing. Chinese hominid populations can be seen to be distinct in morphology, lithic traditions and land use (Pope 1988). Recently the Pleistocene record has become increasingly important to an understanding of the later stages of hominid evolution (Huang *et al.* 1995; Pope 1992; Swisher *et al.* 1994; Wolpoff *et al.* 1984). Hominid and associated site materials from Asia provide an excellent opportunity for examining hominid site use strategies and adaptations (Bakken 1994).

The primary evidence for hominid adaptational strategies comes from analysis of faunal and lithic assemblages. There are also some well-studied living floors or home bases from which additional interpretations can be made. These sites, however, are primarily African or Near Eastern/Mediterranean. Very few sites from the Middle East or the Far East that preserve this kind of information have been studied intensively. Also, the patterns seen in these sites are often expected to hold, unaltered, in quite different environmental settings. This would presuppose, however, no differences in the subsistence strategies or overall adaptations between groups of hominids regardless of local environment.

Asian hominid sites are often rich in vertebrate faunal material. While there is some level of difficulty in determining the degree of association between faunal material and hominid material at many sites (Pope 1992), the bulk of faunal remains from hominid cave contexts

provide keys to understanding both local palaeoenvironments and the accumulation of site deposits (Bakken 1994). Faunal remains, especially, may provide much additional information concerning hominid adaptation and subsistence (Binford 1981; Lyman 1987). This also includes taphonomic information on site formation and use.

Faunal analysis in China, though always a part of site studies, has traditionally focused more on biostratigraphy, zoogeography and palaeontology than on quantitative analysis or taphonomy. The identification of biostratigraphic and zoogeographic guide fossils has been a primary focus of previous research. Faunal material has also been used to argue directly for the hunting and dietary preferences of early hominids based on specific assumptions concerning hominid subsistence strategies (Wu and Lin 1983; Wu and Wang 1985). Interpretations of the original excavators are now being reassessed in light of new advances in palaeoanthropology (Binford and Ho 1985; Binford and Stone 1986). New techniques and methods of analysis, as well as a clearer understanding of natural patterning in the fossil record, greatly expand the amount of information available from faunal materials.

An examination of faunal material from sites in Asia can be used to develop a deeper understanding of hominid subsistence strategies in this region throughout the Pleistocene. Tangible evidence comes from zooarchaeological data such as skeletal part representation. Taphonomic data such as the degree of bone weathering and bone modification may also be used to address aspects of site formation and use.

#### HOMINID AND PALAEOONTOLOGICAL SITE ASSEMBLAGES

Faunal assemblages discussed here are derived from six hominid sites and one palaeontological site in the People's Republic of China (Figure 1). These are Miaohoushan and Jinniushan in Liaoning province; Zhoukoudian locality 1 and Zhoukoudian locality 4 with New Cave in Hebei province; Hexian in Anhui province; and Wushan and Yanjinggou (Yenchingkou) in Sichuan province. These sites incorporate different formation histories ranging from Yanjinggou, a palaeontological fissure assemblage with no evidence of hominid involvement, to sites such as Zhoukoudian locality 1 where evidence of hominid involvement is both apparent and abundant. Between these two categories lie a number of localities in which the nature of hominid activity at the site remains unclear. Some, such as Jinniushan, are most likely catchment areas that happen to include hominids

as part of the faunal assemblage. Others, such as Hexian, show evidence of short-term occupation and the active presence of other collecting agents. All have abundant faunal components that bear further investigation.

#### Wushan

The site of Wushan, or Longgupo Cave, was excavated between 1985 and 1988 by a team headed by Huang Wanpo of the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP) (Bakken 1994; Huang and Fang 1991; Huang *et al.* 1995). It is located on the south bank of the Yangzi river at 830 m above sea level.

Longgupo is a collapsed karst cave situated in the Triassic Jialingjiang Limestone Formation, and the deposits are a 29 m thick accumulation of breccias, clays and gravels (Bakken 1994; Huang and Fang 1991; Olsen and Miller-Antonio 1992). The section that contains hominid specimens, the middle zone, is about 7 m thick and is divided into layers 2-12. Hominid and lithic specimens derive from layers 5, 7 and 8 (Huang and Fang 1991; Huang *et al.* 1995).

The faunal assemblage recovered from Wushan is both large and diverse. Several new species have been described from this assemblage, and along with Jianshi it is one of only two sites in China at which an overlap between *Gigantopithecus* and *Homo* has been demonstrated. The diversity of recovered mammalian taxa at Wushan establish it as the most extensive Plio-Pleistocene assemblage in China (Ciochon 1993; Ciochon *et al.* 1993; Huang and Fang 1991; Huang *et al.* 1995).

Palaeomagnetic data place the hominid-bearing layers of the middle zone within the Olduvai event, 1.96-1.78 mya (Huang *et al.* 1995). The large mammalian fauna that is present is correlated with the Liucheng *Gigantopithecus* fauna, which has been dated to the early Pleistocene (Huang and Fang 1991). Taxa that are shared in common with Liucheng include *Gigantopithecus blacki*, *Macaca* sp., *Sinomastodon* sp., *Stegodon preorientalis*, *Cuon dubius*, *Ailuropoda microta*, *Ursus* aff. *tibetanus*, *Meles* cf. *chiai*, *Arctonyx* cf. *minor*, *Pachycrocuta licenti*, *Felis teilhardi*, *F. microtus*, *Panthera* cf. *pardus*, *Cynailurus pleistocaenicus*, *Equus* aff. *yunnanensis*, *Tapirus* sp., *Dicoryphochoerus ultimus*, *Sus xiaozhu*, *S. liuchengensis*, *S. peii*, *Cervavitus ultimus* and *Megalovis guangxiensis* (Bakken 1994; Huang and Fang 1991).

Micromammals from Wushan include *Miomys peii*, which co-occurs with *Myospalax omegodon* in the

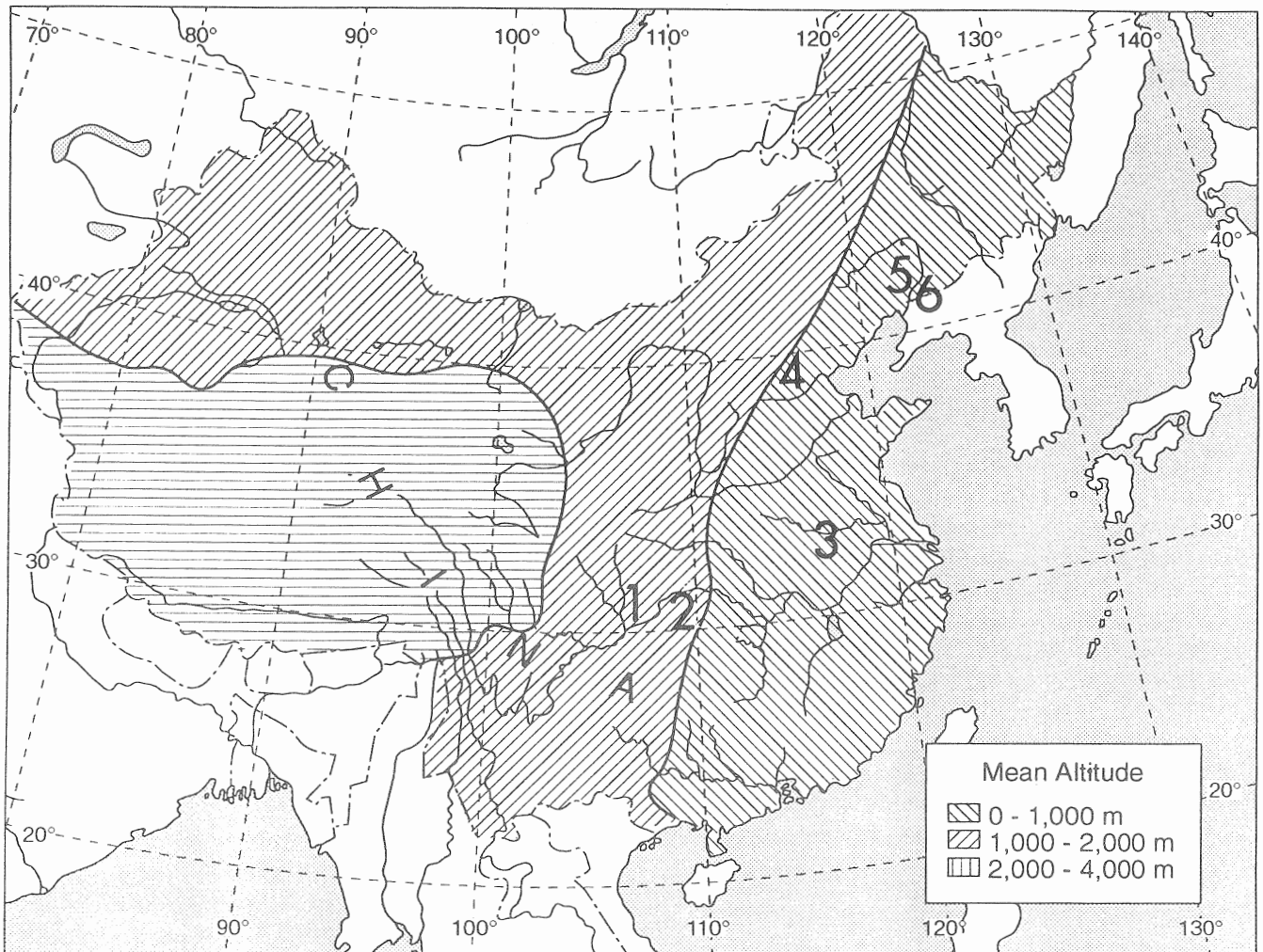


Figure 1: Map of China with localities and mean elevations. 1, Yanjinggou; 2, Wushan; 3, Hexian; 4, Zhoukoudian localities 1 and 4/New Cave; 5, Miaohoushan; 6, Jinniushan. (after Tong and Shao 1991).

Wucheng loess of north China (Huang *et al.* 1995; Xue and Zhang 1991). A new species from Wushan, *Rhizomys brachyrhizomyoides*, is considered to be more primitive than *R. troglodytes* but similar to *Brachyrhizomys shansius* from the upper travertine of Zhoukoudian. Huang and Fang (1991) suggest that these two occurrences are indicative of an early Pleistocene date for the middle zone.

Hominid (and possibly hominoid) specimens from Wushan include an isolated central incisor from layer 7 and a mandibular fragment from layer 8. The incisor is a permanent tooth but not yet fully erupted so the root is incomplete. The crown is shovel-shaped, and a lingual tubercle is present at the base of the lingual surface (Huang and Fang 1991; Huang *et al.* 1995). The mandibular

fragment contains both P<sub>4</sub> and M<sub>1</sub>, and it is from an adult individual. Both teeth are low-crowned, and the M<sub>1</sub> is somewhat worn. Huang *et al.* (1995) state that the incisor and mandibular fragment are from different individuals, and that they represent early examples of the genus *Homo* in Asia.

There are only two stone artifacts from Wushan; one is a thick flake, and the other is a rounded cobble. Both are composed of andesite-porphyrite raw material (Bakken 1994; Huang and Fang 1991; Olsen and Miller-Antonio 1992). The flake, found in layer 8, has two striking platforms, percussion rings on the lateral surface, limited alternate retouch, and overlapping step fractures indicative of use wear. The other artifact is a cobble, or

hammerstone, from layer 5. It displays extensive pitting from use on three discrete areas of the artifact.

#### Hexian

The site of Hexian is situated in Longtandong (Dragon Pool Cave). It was excavated in 1980 by an IVPP team led by Huang Wanpo (Han and Xu 1989). The majority of the deposits are composed of sands and clays; the cave remains are located above a canal on a ridge of Ordovician limestone (Huang *et al.* 1982).

There are five stratigraphic units, or layers, at the site. The hominid remains and the bulk of the faunal remains were recovered from layer 2, a 0.7-1.4 m thick series of yellow/brown sands and clays (Han and Xu 1989; Huang *et al.* 1982).

A thermoluminescence date of  $191,000 \pm 21,000$  years B.P. has been reported for the sedimentation of the cave deposits (Bakken 1994; Olsen and Miller-Antonio 1992). Han and Xu (1989) argue that the deposits are referable to the middle Pleistocene based on faunal composition, and, more specifically, that they are closest to Zhoukoudian layer 5. Xu and You (1984) give Hexian a date of 0.24-0.28 mya based on faunal composition, which they consider most closely related to Zhoukoudian layers 3-4, in correlation with Oxygen Isotope Stage 8.

Hominid specimens from Hexian include a well-preserved calvarium, a left mandibular body fragment containing M<sub>2</sub> and M<sub>3</sub>, and five isolated teeth (right P<sup>4</sup>, left M<sup>1</sup>, left M<sub>1</sub>, left M<sub>2</sub>, left M<sub>3</sub>) from the 1980 excavation and a frontal fragment with partial supraorbital, a right parietal fragment, and five isolated teeth (right I<sup>1</sup>, left M<sup>1</sup>, right M<sup>2</sup>, two left M<sub>2</sub>) from the 1981 excavation (Bakken 1994; Day 1986; Dong 1989; Huang *et al.* 1982; Pope 1992; Wu 1983; Wu and Dong 1985). This sample is thought to represent at least three individuals (Day 1986; Huang *et al.* 1982; Wu 1983). Wu and Dong (1982, 1985) state that the Hexian individual exhibits several progressive features such as a postorbital constriction which is less than that of the Zhoukoudian specimens and less than Dali, an archaic *Homo sapiens*.

Stone artifacts have not been recovered from Hexian. Possible bone implements, however, have been found (Bakken 1994; Huang *et al.* 1982). These include a bone point formed from a mammalian longbone shaft fragment and a rhinoceros molar that shows extensive wear on the occlusal surface of the buccal section of the enamel. The rhinoceros molar may have been used as a scraper (Huang, personal communication).

The faunal assemblage from Hexian is rich and relatively diverse (Han and Xu 1989; Xue and Zhang 1991).

It is representative of the mixed faunal province that occurs along the coastal plains to the east of the Qinling Mountains. The assemblage shares many taxa in common with Zhoukoudian, but it also contains several taxa from the south Chinese *Stegodon-Ailuropoda* fauna as well (Han and Xu 1985, 1989). Members of the northern fauna include *Trogotherium* sp., *Hyaena brevirostris sinensis*, *Ursus arctos*, *Megaloceros pachyosteus*, and *Pseudaxis grayi* (Han and Xu 1985, 1989; Huang *et al.* 1982; Olsen and Miller-Antonio 1992; Xue and Zhang 1991). Southern taxa include *Stegodon* sp., *Tapirus sinensis* and *Rhinoceros sinensis*. Taxa that are indicative of the eastern plains include *Alligator* sp. and *Elaphurus davidianus* (Huang and Huang 1985).

#### Yanjinggou

Yanjinggou is a palaeontological fissure-fill site located on the north bank of the Yangzi river near Wanxian. The site is a series of fossil-bearing fissures, actually vertical caves, that acted as natural traps (Granger 1932, 1938). Yanjinggou does not contain any hominid material. The faunal profiles and taphonomic patterns reflected in this assemblage, therefore, are not the products of hominid subsistence or carnivore bone collecting behavior (Bakken 1994).

This assemblage, also known as the Wanxian fauna, is the type collection for the south Chinese *Stegodon-Ailuropoda* fauna (Colbert and Hooijer 1953; Granger 1932; Han and Xu 1985). This fauna is currently considered to be middle Pleistocene in age, and most taxa are recent or referable to the middle Pleistocene (Colbert and Hooijer 1953; Granger 1932; Mathew and Granger 1923; Pope 1982; Young and Liu 1950). Representative taxa include *Ailuropoda* sp., *Megatapirus* sp., *Cuon* sp., *Arc-tonyx* sp., *Hystrix* sp., *Rhizomys troglodytes*, *Stegodon orientalis*, *Hylobates* sp., *Moschus* sp., and *Muntiacus* sp. (Han and Xu 1985; Pei 1957; Pope 1982). Most of these genera are extant; however, *Megatapirus* sp., *Stegodon* sp. and *Nestoritherium* sp. are extinct (Colbert and Hooijer 1953; Savage and Russell 1983). Additional micromammals from Yanjinggou recovered by Young (1935) include *Scaptochirus* sp., *Anourosorex squamipes* and *Eothenomys melanogaster*. Early estimates of the date for Yanjinggou were consistently too old based on the presence of taxa such as *Nestoritherium*. Vertebrate taxa survive longer in Asia than in other areas, however, and middle Pleistocene faunas often retain Pliocene taxa as indicated by the presence of *Megantereon* at Zhoukoudian locality 1 (Han and Xu 1985; Xue and Zhang 1991).

## Zhoukoudian locality 1

The site of Zhoukoudian is located about 50 km southwest of Beijing in a ridge of Ordovician limestone. Zhoukoudian is the most well-known and productive palaeoanthropological site in China. The remains of at least 40 individuals representing females, males, adults and juveniles have been recovered (Black 1926, 1927a and b, 1929; Black *et al.* 1933; Weidenreich 1939, 1941; Wu and Dong 1985). In addition, 44 varieties of raw material have been identified in the locality 1 assemblage. Vein quartz is the most common with rock quartz, sandstone and flint following in abundance (Zhang 1985). All raw materials at Zhoukoudian are local, but many had to be transported from some distance away (Black *et al.* 1933; Pei 1931, 1932; Zhang 1985).

The Zhoukoudian deposits are subdivided into a series of layers numbered from the surface down. The first three layers are dated to the late Pleistocene; they are composed of breccia, yellow and red loam, fractured limestone and lenses of travertine (Binford and Ho 1985; Black *et al.* 1933; Jia and Huang 1990; Teilhard de Chardin 1941). Excavations in these layers in 1966 produced additional remains of Skull V, initially recovered in 1936 (Jia and Huang 1990). Two mandibular fragments and nine isolated teeth are also known from this area. Stone tools, faunal materials and hackberry seeds have been recovered as well (Black *et al.* 1933; Huang 1960; Pei 1931, 1934a).

Layers 4-10 (Jia 1983), or Huang's (1960) layers 5-2, date to the middle Pleistocene. A roof fall event is recorded at the beginning of this section (Black *et al.* 1933; Jia 1983). Layer 4 contains the majority of the quartz tools along with burnt bone and ash (Black *et al.* 1933; Pei 1931; Zhang 1985; but see Binford and Ho 1985 and Binford and Stone 1986). Layer 4 also contained the locus B hominid specimens, which included 39 isolated teeth, 5 mandibular fragments, Skull I, a humerus and a lunate fragment (Black *et al.* 1933).

Layer 5 (Black *et al.* 1933; Jia 1983) is discontinuous; apparently, there are no stone tools from layer 5 (see Binford and Ho 1985 for a discussion of discrepancies in the original published stratigraphic sections). Faunal material is abundant, however, and it has been reported that there are more carnivores in this layer relative to ungulates than in other layers (Li and Ji 1981).

The lower layers, layers 6-10, are brecciated; they extend to the base of the main vault of the cave and include deep fissures extending below this area. A large sample of faunal material derives from layer 7 (Teilhard de Chardin and Pei 1932). Stone tools are present; however, Binford and Ho (1985) report that these are prob-

lematic and may be redeposited from earlier layers. Also, there was initially some disagreement over the interpretation of this layer as a cultural layer. Breuil was convinced this layer was cultural while Teilhard and Pei were not (Binford and Ho 1985; Teilhard de Chardin and Pei 1932).

Layer 8 is one of the most important strata within the entire sequence. Ash and quartz tools are in association with a large faunal component (Black 1931; Black *et al.* 1933; Teilhard de Chardin and Pei 1932). Hominid materials include a mandible, 11 isolated teeth, Skull IV, and a clavicle (locus G) (Black *et al.* 1933). Lower layer 8 and layer 9 do not contain stone tools, but Skulls X, XI, XII, 30 isolated teeth, two mandibular fragments and four femoral fragments were recovered from this section (Loci L and M) (Binford and Ho 1985; Huang 1960; Pei 1930, 1931). Layer 10 contains Skull XIII and seven isolated teeth (Pei 1930).

Biostratigraphically, the deposits from Zhoukoudian locality 1 date to the middle Pleistocene (Bakken 1994; Han and Xu 1985; Wu and Wang 1985). Wu and Wang (1985) argue for a date of 0.50 mya for the lower deposits at Zhoukoudian and 0.20 mya for the upper deposits. Absolute dates include a  $^{238}\text{U}$  fission track date of  $0.462 \pm 0.045$  mya taken from ash in layer 10. Three uranium series dates yield results of  $0.23 \pm 0.030/0.023$  mya for layers 1-3,  $0.042 \pm 0.18/0.10$  mya for layers 8-9, both based on mammalian dentine samples, and  $0.256 \pm 0.062/0.040$  mya for layers 1-3 based on deer antlers (Wu and Wang 1985). Amino acid racemization dates yield results of 0.37 mya for layer 3, 0.39 mya for layers 8-9 and 0.46 mya for levels 29-30 in layer 11 (Wu and Wang 1985). Palaeomagnetic dating indicates that layers 1-13 lie within the Brunhes Normal Epoch while all layers below layer 13 lie within the Matuyama Reversed Epoch.

The faunal assemblage from locality 1 is, or was, immense. Zhoukoudian is the type locality for the middle Pleistocene of north China (the Zhoukoudianian fauna) (Pei 1957; Han and Xu 1985; Qi 1989; Xue and Zhang 1991). Large numbers of both species and individuals were recovered from various layers within the site (Pei 1934a and b, 1938; Teilhard de Chardin 1941). This faunal assemblage has also been used to argue directly for a hunting lifestyle that may or may not be supportable (Binford and Ho 1985). Unfortunately this sample has undergone significant attrition in the years since its excavation.

## Zhoukoudian locality 4

The New Cave deposits, with those of Zhoukoudian locality 4, contain a collection of middle Palaeolithic artifacts, fauna, and ash deposits as well as a single hominid tooth (Bakken 1994; Gu 1978; Pei 1939; Wu and Lin 1985). Locality 4 is located close to localities 1 and 3, but the cave is much smaller than locality 1 (Gu 1978). Locality 4 was initially excavated between 1937 and 1938 until excavations ceased in 1938 (Pei 1939). An adjacent cave, the New Cave, was discovered in 1967, and in 1972 and 1973 the New Cave and locality 4 were again excavated. The locality 4 deposits can be traced into the New Cave deposits, and the two areas are now considered to be the same site composed of the cave and cave mouth deposits (Gu 1978; Jia and Huang 1990).

The New Cave deposits are composed of yellow sands, breccias and clays with interspersed limestone spalls from the cave roof and walls (Gu 1978). There is an extensive ash layer 1.1 m wide and 19 cm thick that dips from layer 1 to layer 7 and contains ash, charcoal, burnt bone, burnt artifacts and fire-cracked rock (Gu 1978).

The faunal assemblage dates to the late Pleistocene (Gu 1978; Pei 1939). Pei (1939) argued that the locality 4 faunal assemblage was younger than locality 1. Gu (1978), in an analysis of the complete (locality 4 and New Cave) fauna, placed it in the early late Pleistocene. This is due to the presence of *Myospalax* sp. and *Megaloceros pachyosteus*. These middle Pleistocene taxa, in addition to late Pleistocene *Cervus elaphus*, *Sciurotamias davidianus* and modern taxa all indicate a relatively recent date for this assemblage (Bakken 1994; Gu 1978).

The only recovered hominid specimen is an upper left P<sup>3</sup> found in layer 5 (Gu 1978). Wu and Wu (1985) indicate that there are significant differences between this premolar and premolars from the locality 1 sample, and that the individual from locality 4 is transitional between *Homo erectus pekinensis* and modern Chinese populations. Gu (1978) states that this premolar definitely represents *Homo sapiens*. The premolar is larger than locality 1 female teeth and smaller than modern male teeth; Gu (1978) argues that it belongs to a male.

Initially there was only one stone tool recovered from locality 4, a "beak-like" scraper made of vein quartz (Pei 1939). In the later excavations several stone artifacts were identified from the ash layers, but none of these was considered a tool (Gu 1978). Pei (1939) also noted the presence of at least one bone tool at the site, a polished section of bone with a distinct point.

The faunal assemblage from locality 4 contains a large sample of micromammals as well as larger fauna. It contains many taxa that are considered representative of the early late Pleistocene such as *Sciurotamias davidianus*, *Cuon cf. alpinus*, *Cervus elaphus*, and *Pseudaxis* sp. (Bakken 1994; Gu 1978; Pei 1939). Characteristic middle Pleistocene taxa that remain include *Megaloceros pachyosteus*, *Myospalax* sp. and *Coelodonta* sp. (Gu 1978). The bulk of the assemblage, though, is composed of modern taxa (Gu 1978). New Cave/Localities 4 is thought to be younger than locality 1, but older than Upper Cave.

## Jinniushan

The site of Jinniushan is located in southern Liaoning province. It, along with Miaohoushan, lies further north than any other early hominid site in China (Pope 1992). The site itself occurs in an isolated hill of dolomitic limestone, a karst feature on an otherwise flat plain (Zhang 1985, 1989). There are three Jinniushan localities (A, B, and C). Site A is the original location of the Jinniushan hominid (but see Zhang 1989).

Jinniushan contains the remains of a single individual with an almost complete cranium and much of the post-cranial skeleton as well (Wu 1988). The cranium exhibits an interesting suite of characters, and this specimen has been placed in premodern (archaic) *Homo sapiens* (Pope 1988; Wu 1988; Wu and Lin 1985). Wu (1988) states that the skull belongs to a male older than 30 years.

Site A is divided into eight layers. Layers 4-6 contain an abundant faunal assemblage, early Palaeolithic artifacts and, in layer 6, the hominid specimen with several thin lenses of ash (Liaoning Provincial Cultural Relics and Archaeology Research Institute, 1990; Zhang 1985, 1989). The stratigraphy has recently been revised, however, and the hominid is now referred to layer 7 (Pope 1992). The sequence of deposits at Jinniushan suggests a similar situation as Yanjinggou, a vertical fissure site that acted as a natural trap (Huang and You 1987; Pope 1992).

Absolute dates for Jinniushan are somewhat problematic. Uranium series dates of 0.28-0.1 mya have been obtained (Huang and You 1987; Liaoning Provincial Cultural Relics and Archaeology Research Institute 1990; Pope 1988). Layer 6 (currently 7) is thought to be older than 0.28 mya (Liaoning Provincial Cultural Relics and Archaeology Research Institute 1990; Lü 1990), however, Wu (1988) states that this is doubtful, and layer 6 may actually be somewhat younger. Chen *et al.* (1994) argue for a date of 0.2 mya based on a comparative study using both U-series and ESR dating techniques.

The Jinniushan fauna contains many middle Pleistocene taxa. These include *Megaloceros pachyosteus*, *Trogotherium* sp., *Homotherium ultima*, *Crocota ultima*, *Felis chinensis* and *Microtus brandtioides* (Bakken 1994; Jinniushan Combined Excavation Team 1976; Pope 1992; Qi 1989). These taxa correlate well with Zhoukoudian layers 3-4, and they also agree with uranium dates of between 0.24 to 0.28 mya taken from layers 4 through 6 (currently 7) (Bakken 1994; Pope 1992).

Early Palaeolithic artifacts include 15 stone artifacts, two limestone fragments and a series of possible bone flakes with one perforated bone, all recovered from layers 4-6 (Zhang 1985, 1989). Eight of these are considered finished tools, which include six scrapers, one point and one graver. Bone artifacts make up less than 1% of the faunal assemblage (Lü 1990; Zhang 1989). These are generally made from longbone shafts or scapulae and are flaked from both the inner and outer table (Zhang 1989). Some show the equivalent of alternate retouch. The specimens are not, however, convincing to all researchers (Pope 1992).

The evidence for fire at Jinniushan is composed of several thin lenses of ash in layer 6 that also contain bits of charcoal and burned bone remains (Zhang 1989). Burned bone specimens are generally small, broken pieces of limb bones from large taxa (Zhang 1989). Zhang (1989) states that chemical analyses of the burned samples indicate that they are not the result of mineral deposition or staining but are instead the result of burning. Zhang (1989) argues that there is convincing evidence for hominid control and use of fire at Jinniushan, and he reconstructs the site as a hominid living floor.

#### Miaohoushan

Miaohoushan, also in Liaoning province, is a middle Pleistocene site containing a small collection of hominid fossils and a series of stone artifacts (Bakken 1994; Liaoning Provincial Museum 1986). Miaohoushan was discovered in 1978 and excavated between 1979 and 1980 by a team from the Liaoning Provincial Museum. There are two caves at the site, cave A and cave B; both are located in a ridge of Ordovician limestone. Cave A contains the earlier Pleistocene layers; cave B is Holocene in age.

The deposits from cave A are divided into eight layers. These are numbered from the base up; all contain mammalian fossils, while layers 4-7 also contain stone tools. Layer 6 is the hominid-bearing layer (Liaoning Provincial Museum 1986).

Palaeomagnetic and potassium-argon tests date the site to 0.40-0.14 mya. Uranium series dating yields re-

sults ranging from 0.14±0.013/-0.012 mya from layer 6 to 0.34±0.093/-0.054 mya from layer 4 (Liaoning Provincial Museum 1986). Palaeomagnetic correlation is difficult due to interruption of the erosional surface. However, layers 1-3 show reversed polarity and layers 4-8 show normal polarity. These data, in combination with faunal correlation and absolute dating methods, are interpreted as representing the Matuyama Reversed Epoch and Brunhes Normal Epoch respectively (Liaoning Provincial Museum 1986).

Hominid fossils include a lower first molar and fragmentary juvenile left femur from layer 6 and an upper right canine from layer 5 (Liaoning Provincial Museum 1986). The canine is referred to *Homo erectus* while the other two specimens are referred to *Homo* sp. (the femur) and *Homo sapiens* (the molar). While the hominid material is scarce, it does confirm hominid activity in the area as early as the middle Pleistocene.

Lithic materials have been recovered from layers 4-7. The majority of the material derives from layer 6; only five artifacts derive from layer 7 and nine artifacts from layers 4-5. Black quartzite sandstone is the primary raw material with a few examples of andesite and vein quartz (Liaoning Provincial Museum 1986; Zhang 1989). Stone tools from Miaohoushan include scrapers, chopper-chopping tools and stone balls. The assemblage most closely resembles the "Kehe-Dingcun" tradition in morphology (Liaoning Provincial Museum 1986; Zhang 1989).

The taxa recovered from Miaohoushan can be roughly grouped into two units (Bakken 1994; Qi 1989). One unit corresponds to layers 4-6 and contains middle Pleistocene taxa with a few surviving early Pleistocene forms. The second unit includes layers 7 and 8 and contains primarily late Pleistocene taxa (Liaoning Provincial Museum 1986; Qi 1989).

The researchers indicate that many of the faunal specimens showed evidence of "hacking" (Liaoning Provincial Museum 1986). Three of the faunal specimens are thought to be bone tools based primarily on breakage patterns (Liaoning Provincial Museum 1986).

#### ZOOARCHAEOLOGY AND TAPHONOMY

The mammalian faunal assemblages from these sites are large and diverse samples of Pleistocene taxa. The condition of the assemblages reveals abundant information concerning both site formation and use (Bakken 1994).

Table 1 provides summary data on groups of taxa present, broken down by cranial and post-cranial body part representation. Counts are given as numbers of identified specimens (see Brewer 1992; Grayson 1984; and Lyman

1984 for a discussion of quantification of elements and issues of sample bias). Hexian and Jinniushan both contain large numbers of carnivores and, with Zhoukoudian locality 1, abundant cervid remains. Zhoukoudian locality 1, Hexian, and Zhoukoudian locality 4 all have abundant large bovid remains (Bakken 1994). This may in part be due to the overall large size of the cave/shelter enclosures of Hexian and Zhoukoudian locality 1, thus creating a large catchment area.

Table 1: Mammalian remains from the sites of Wushan (WS), Hexian (HX), Zhoukoudian locality 1 (ZKD 1), Zhoukoudian locality 4/New Cave (ZKD 4), Miaohoushan (MHS), Jinniushan (JNS), and Yanjinggou (YJG). Values are numbers of identified specimens.

Group:	Site:	WS	HX	ZKD 1	ZKD 4	MHS	JNS	YJG
Small Carnivore	Cranial	-	12	-	4	14	18	22
	Post-Cranial	10	15	-	1	-	43	1
Large Carnivore	Cranial	9	52	2	1	16	18	62
	Post-Cranial	47	162	48	53	-	273	69
Proboscidea	Cranial	-	-	-	-	-	-	36
	Post-Cranial	2	18	-	-	-	-	5
Perissodactyla	Cranial	4	-	3	-	1	6	73
	Post-Cranial	25	92	10	-	3	120	40
Cervid/Moschid	Anhc	11	690	45	1	3	12	22
	Cranial	14	347	371	14	17	101	102
	Post-Cranial	123	401	254	148	-	423	15
Small Bovid/Suid	Anhc	-	-	-	-	5	1	2
	Cranial	-	8	40	1	2	4	60
	Post-Cranial	4	42	41	-	-	126	11
Large Bovid	Anhc	-	4	2	-	-	-	3
	Cranial	-	30	2	-	1	-	26
	Post-Cranial	68	181	29	264	3	11	93
Column Totals		317	2054	847	487	65	1156	642

Anhc = antler/horncore  
Counts exclude isolated teeth

Several sites display a pattern in which cranial elements are more numerous than post-cranial elements. This is especially apparent within the cervid populations. Cervids are well represented in many of the samples, and they are extremely abundant at Hexian, Zhoukoudian locality 1, and Jinniushan. Carnivore remains and other large-bodied taxa, however, display a pattern in which post-cranial elements are more numerous than cranial elements. This characterizes most groups of taxa in this table. This pattern is especially apparent at Hexian, Zhoukoudian locality 1, and Miaohoushan and it is apparent, but less striking, at Wushan. The prevalence of cranial elements in comparison to post-cranial elements among the larger taxa is one way of assessing the poten-

tial amount of scavenging in an assemblage (Stiner 1990). An abundance of cranial elements is often indicative of scavenging; these assemblages support scavenging as the agent of accumulation for the deer. The predominance of post-cranial material among the carnivores and other herbivores is consistent with the addition of whole individuals to the assemblages.

Jinniushan, however, displays a slightly different pattern. This assemblage contains more post-cranial elements than cranial elements for all groups. This could result from the addition of complete individuals into the site, rather than an accumulation of selected parts of individuals. In fact, this site has been reconstructed by several researchers as a natural pit trap rather than a cave in the usual sense (Bakken 1994; Pope 1992). The pattern at Yanjinggou, which is also a pit trap, is very different from Jinniushan and was initially very surprising. Cranial elements are far more abundant than post-cranial elements in the Yanjinggou assemblage. Relatively little scavenging could occur, however, simply due to the constrained nature of the pits. Complete individuals would have to have been added to the site due to the depth of the fissures, only small taxa would perhaps have had free access into and out of the open fissures (Granger 1932). A look at the field notes of the excavator indicates the nature of the problem. The goals of the initial researcher (Walter Granger) were palaeontological, not zooarchaeological; elements that were more diagnostic of taxonomic affiliation, such as the cranial elements, were collected preferentially.

Only among the large bovids are there more post-cranial elements than there are cranial elements. This is in large part due to the recovery of a virtually complete skeleton of a gaur, *Bibos gaurus* (Bakken 1994; Colbert and Hooijer 1953). This is a sample bias issue which, to greater or lesser extent, affects all of the assemblages discussed here. Though general patterns would most likely remain similar, it is also possible that the magnitude of the difference between numbers of cranial and post-cranial elements would be less if all assemblages had been excavated with a view towards zooarchaeological analysis.

### Weathering

Taphonomic information available from these assemblages is abundant and varied. The amount of bone weathering is one aspect of the taphonomy of these assemblages. Weathering is a highly environmentally dependent feature of the taphonomy of bone (Behrensmeyer 1982; Gifford 1981; Lyman and Fox 1989). The six qualitative weathering stages defined by Behrensmeyer



(1978) were determined for recent, not fossilized, material. It is apparent, however, that the stages themselves provide excellent descriptive categories for the overall condition of the recovered assemblages; the stages are used here to describe the gross condition of the faunal suites. Weathering is known to be inhibited, but not altogether stopped, by burial (Behrensmeyer 1978; Lyman and Fox 1989). No attempt has been made here, however, to differentiate total weathering into pre- and post-burial categories.

In general, there is little evidence for appreciable amounts of weathering at any of the assemblages discussed here. The majority of the faunal samples fall into Behrensmeyer's stages 1 and 2, with smaller subsets in stages 0 and 3 (Bakken 1994). All except one of the sites show a median value of weathering stage 1. Zhoukoudian locality 4 shows a median of weathering stage 0 (Bakken 1994). All sites, then, are exhibiting evidence of short surface exposure times for bone elements or local climatic conditions that do not produce large amounts of weathering unless elements are exposed over long periods of time. The low weathering values seen here do correspond to the expected for a series of cave sites in a relatively humid zone where direct exposure to the sun and dry heat would be low in comparison to an open site. Also, the sedimentation rate in caves is generally higher than in surrounding open areas, especially when there is the possibility of seasonal flooding reaching the cave site.

The broadest range in values occurs at Hexian and Zhoukoudian locality 1, which have values ranging from 0-3 for Hexian and 0-2 for Zhoukoudian locality 1 (Bakken 1994). These may be in part due to the overall size of these sites. They are both large, and elements would be expected to become more weathered if exposed closer to the mouth of the cave than further away. Another possibility is that these sites are attritional and record continuous additions to the assemblage through time (Behrensmeyer 1978). This is plausible given the thickness of excavated layers and the size of the deposits. None of the sites, however, shows a pattern of weathering that would indicate either strong climatic conditions or long surface exposure times. This is true even at areas such as Yanjinggou, at which longer surface exposure times and subsequent addition to the deposits through runoff or erosion is highly likely.

#### Bone Modification

Bone modification, in the form of gnawing by rodents and carnivores or cutmarks from stone tools, affects individual elements within the fossil assemblage

(Behrensmeyer *et al.* 1986; Brain 1981; Hill 1984; Shipman and Rose 1983a and b, 1984; Sutcliffe 1970). Many rodents habitually collect and gnaw bone for nutrients or to maintain incisors at their correct length and sharpness. Carnivores gnaw bones as a part of their regular diet. Also, many species of carnivore either occasionally or habitually use caves and rock shelters, and their role as bone collecting agents is the subject of a great deal of ethological research (Binford 1981; Brain 1981; Dart 1956; Sutcliffe 1970, 1973). Hominid bone modification in the form of stone tool cutmarks may, with appropriate care, be differentiated from other agents of taphonomic damage (Behrensmeyer *et al.* 1986; Potts and Shipman 1981; Shipman and Rose 1983a and b, 1984).

Table 2 indicates the total numbers of stone tool cutmarks, rodent gnawing, carnivore and rodent gnawing present on the same element, and carnivore gnawing grouped by site. Carnivore gnawing is present at all assemblages, and rodent gnawing is present at all assemblages with the exception of Miaohoushan. Hexian and Zhoukoudian locality 1 both indicate significant amounts of carnivore bone modification. Wushan and Yanjinggou reflect moderate amounts of carnivore and rodent use of bony elements, and Jinniushan, Zhoukoudian locality 4 and Miaohoushan all reflect very little gnawing damage.

Table 2: Incidence of hominid cutmarks, rodent gnawing, rodent and carnivore gnawing (same element), and carnivore gnawing grouped by site. Categories are mutually exclusive.

	Cutmarks	Rodent	Carnivore & rodent	Carnivore	Total
Hexian	25	190	15	151	381
Zhoukoudian 1	12	20	-	63	95
Wushan	-	51	1	20	72
Yanjinggou	-	9	1	17	27
Jinniushan	1	2	-	13	16
Zhoukoudian 4	1	6	-	2	9
Miaohoushan	-	-	-	6	6
	39	278	17	272	606

Hominid cutmarks are present in four of these assemblages (Bakken 1994). They are rare, but present, at Jinniushan and Zhoukoudian locality 4. They occur at more significant levels at Zhoukoudian locality 1 and Hexian. Zhoukoudian locality 1 contains abundant stone tools, as do Jinniushan and Zhoukoudian locality 4. Hexian, however, does not contain any stone tools and only two purported bone tools. While this is curious it is not without precedent. Cutmarks have been found at African hominid sites such as FLK NN Level 2 (Olduvai Gorge) in which no stone tools have been recovered, and New World Palaeoindian sites have also yielded assem-

blages of cut and processed bone in the absence of any discarded stone tools (Johnson 1983; Potts and Shipman 1981).

Categories of bone modification are all but mutually exclusive. There are very few specimens in which rodent gnawing occurs on the same element as carnivore gnawing (Table 2). Hominid cutmarks present the same pattern; there is virtually no overlapping of cutmark damage and gnawmark damage (Bakken 1994). This may indicate that site use episodes were discrete such that carnivores using a site displaced bone collecting rodents from that site. Lack of overlap in gnawing damage combined with very little surface weathering may also indicate that the sedimentation rate was high enough to cover the elements relatively quickly.

Bone element preferences vary somewhat according to group in these assemblages. Rodents most commonly attack antlers or horncores and appendicular elements of the herbivores. These are also common sites for carnivore gnawing, with the addition of the mandible. Cutmarks are found most often on the mandible and appendicular elements of the herbivores (Bakken 1994). Mandibular cutmarks most often occur on the lingual surface of the body, while appendicular cutmarks occur close to either the distal or proximal epiphysis. This is in many ways the expected pattern, but cutmarks in these assemblages do not form classic butchery marks. Instead they appear as single, deep gashes rather than as clusters of short, sharp cuts (Bakken 1994).

#### DISCUSSION AND CONCLUSIONS

Data from the faunal assemblages in combination with other sources of data indicate a series of patterns that characterize the Chinese hominid record. During the early Pleistocene, the climate over most of the region was warm and temperate to sub-tropical (Liu and Ding 1984; Liu *et al.* 1985; Tong and Shao 1991). Wushan is indicative of this climate phase (Bakken 1994; Huang and Fang 1991). The faunal assemblage is characteristic of south China, and it contains several early taxa that do not survive beyond the middle Pleistocene. This site, and the associated faunal assemblage, is most similar to Yanjinggou, which displays a southern fauna with many extinct taxa in common (Colbert and Hooijer 1953; Huang and Fang 1991).

The middle Pleistocene in China was characterized by shifting cooler/drier and warmer/wetter periods, but it was on the whole cooler than the early Pleistocene (Liu and Ding 1984; Liu *et al.* 1985; Tong and Shao 1991). Middle Pleistocene sites documenting cool phases include Jinniushan, the later layers of Zhoukoudian locality

1, and Hexian (Bakken 1994). Jinniushan records a Palearctic fauna rich in boreal taxa; Miaohoushan, an earlier site, displays a fauna transitional between a warm phase and a cooler and damper phase during the middle Pleistocene. The lower layers at Zhoukoudian locality 1 contain taxa indicative of warmer, wetter conditions. Jinniushan, Miaohoushan, and Zhoukoudian locality 1 all argue for the successful adaptation of hominids to cool and temperate seasonal climates in north China beginning in the later middle Pleistocene.

The Hexian assemblage, also a middle Pleistocene site, records a cool spell during the later middle Pleistocene. Hexian's location along the East China Plain situates it in a more open area with abundant mixing of southern and northern faunal and floral taxa. For this reason, and for its position closer to south China, the Hexian fauna displays many subtropical taxa (Huang and Huang, 1985; Huang *et al.* 1982).

The late Pleistocene was the coldest and driest period recorded by these assemblages (Tong and Shao 1991). Zhoukoudian locality 4/New Cave is a late Pleistocene site exhibiting a suite of boreal taxa.

Comparisons of taxonomic abundances are suggestive of the collection agents at work on site contents. A combination of skeletal part representation patterns is indicative of a combination of scavenging, hunting and accidental entrapment. Both Jinniushan and Yanjinggou are most plausibly reconstructed as entrapment sites. A predominance of cranial to post-cranial elements is characteristic for the cervids from Hexian, Zhoukoudian locality 1 and Miaohoushan. This is consistent with abundant scavenging of these animals. Hunting, and the addition of whole carcasses to assemblages is also consistent with patterns seen in other groups of taxa (large bovids, carnivores, perissodactyls) at all sites with the exception of Yanjinggou.

Taphonomic data also add to an understanding of site formation and history. Weathering rates are stable and low, indicating relatively high rates of sedimentation combined with lack of direct, strong sunlight. For the most part there is little evidence of extensive root etching on element surfaces, indicative of an environment that could not support large numbers of rooting plants. This also would argue for low light conditions.

Bone modification is present in varying amounts throughout these assemblages. Some level of carnivore gnawing is ubiquitous. Rodent gnawing is apparent, but not at high levels outside of Hexian and Wushan. Hominid cutmarks occur primarily at Hexian and Zhoukoudian locality 1. These are indications of the activities of local

hominid groups, and they record the direct impact of hominids upon the accumulation of site contents.

Most cave sites in China suffer from an either/or interpretation. Either the site is reconstructed as showing virtually no evidence for hominid behavior or the site is considered the cave home and home base of the recovered hominids. This includes the interpretation that hominids were the primary agent of accumulation for the site assemblage. Neither is likely to be an accurate reconstruction. Caves are attractive areas for many taxa, and by the middle Pleistocene there is abundant evidence for hominid use of caves and rock shelters. Other taxa, especially the larger carnivores, also make frequent use of caves; their impact on these assemblages is apparent. The wealth of recovered materials that include hominid elements, stone tools, ash and charcoal, and elements with cutmarks indicate that hominids were making use of these sites and procuring necessary resources. The remains of carnivores and the evidence of carnivore gnawing damage also indicates the use of these sites by carnivores. In sum, there is abundant evidence for an overlapping sequence of occupational events involving both hominids and carnivores throughout the Pleistocene in China.

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