



Universiteit
Leiden

The Netherlands

The Middle Palaeolithic site Lingjing (Xuchang, Henan, China): preliminary new results.

Kolfschoten, T. van; Li, Z.; Wang, H.; Doyon, L.; Klinkenberg, V.; Oosten, R. van; Driel-Murray, C. van

Citation

Kolfschoten, T. van, Li, Z., Wang, H., & Doyon, L. (2020). The Middle Palaeolithic site Lingjing (Xuchang, Henan, China): preliminary new results. In V. Klinkenberg, R. van Oosten, & C. van Driel-Murray (Eds.), *Analecta Praehistorica Leidensia* (Vol. 50, pp. 21-28). Sidestone Press. Retrieved from <https://hdl.handle.net/1887/3175517>

Version: Publisher's Version
License: [Creative Commons CC BY 4.0 license](https://creativecommons.org/licenses/by/4.0/)
Downloaded from: <https://hdl.handle.net/1887/3175517>

Note: To cite this publication please use the final published version (if applicable).

A HUMAN ENVIRONMENT

Studies in honour of 20 years *Analecta*
editorship by prof. dr. Corrie Bakels



50

ANALECTA
PRAEHISTORICA
LEIDENSIA

edited by

VICTOR KLINKENBERG, ROOS VAN OOSTEN
AND CAROL VAN DRIEL-MURRAY



This is a free offprint – as with all our publications the entire book is freely accessible on our website, and is available in print or as PDF e-book.

www.sidestone.com

A HUMAN ENVIRONMENT

STUDIES IN HONOUR OF 20
YEARS ANALECTA EDITORSHIP
BY PROF. DR. CORRIE BAKELS

edited by
VICTOR KLINKENBERG, ROOS VAN OOSTEN
AND CAROL VAN DRIEL-MURRAY

ANALECTA
PRAEHISTORICA
LEIDENSIA 50

© 2020 the Faculty of Archaeology, Leiden

Published by Sidestone Press, Leiden
www.sidestone.com

Series: *Analecta Praehistorica Leidensia* (APL)
Series editors: M.V. Klinkenberg, R.M.R. van Oosten
and C. van Driel-Murray

Lay-out & cover design: Sidestone Press
Cover photograph: Ermelose Heide
Photograph by K. Wentink

ISBN 978-90-8890-906-1 (softcover)
ISBN 978-90-8890-907-8 (hardcover)
ISBN 978-90-8890-908-5 (PDF e-book)

ISSN 0169-7447



Universiteit Leiden

Contents

- 9 **Editorial**
- 11 **A life dedicated to science. Portrait of professor emerita Corrie Bakels, pioneer of paleoeconomy**
Monique van den Dries and Harry Fokkens
- 21 **The Middle Palaeolithic site Lingjing (Xuchang, Henan, China): preliminary new results**
Thijs van Kolfschoten, Zhanyang Li, Hua Wang and Luc Doyon
- 29 **Neandertal advice for improving your tinder profile: A pilot study using experimental archaeology to test the usefulness of manganese dioxide (MnO₂) in Palaeolithic fire-making**
Andrew C. Sorensen
- 39 **Landscape dynamics near the late Middle Palaeolithic and Early Upper Palaeolithic cave site of Les Cottés (France)**
Joanne Mol, Lars den Boef and Marie Soressi
- 49 **Een ziltige geur – halophytic macroscopic plant remains from Happisburgh Site 1, UK indicating Middle Pleistocene hominin activity in an estuary prior to the Anglian Stage (MIS 12) ice advance**
Michael H. Field
- 55 **Palaeoenvironment and human occupation patterns: a case study for the first half of the Holocene at Cova Fosca (Eastern Spain)**
Laura Llorente-Rodríguez, Arturo Morales-Muñiz, María-Teresa Aparicio, Salvador Bailón, Paloma Sevilla and Carmen Sesé
- 73 **Exploring the archaeological heritage of the Uddeler Heegde: an experiment**
Alexander Verpoorte, David Fontijn and Arjan Louwen
- 89 **Walking and marking the desert: Geoglyphs in arid South America**
Karsten Lambers
- 107 **Pre-Hispanic and contemporary raw materials use in earthenware production in the Río Mayales subbasin, Chontales, central Nicaragua**
Simone Casale, Natalia R. Donner, Dennis Braekmans and Alexander Geurds

- 121 **A long slow goodbye – Re-examining the Mesolithic – Neolithic transition (5500 – 2500 BCE) in the Dutch delta**
Gerrit L. Dusseldorp and Luc W.S.W. Amkreutz
- 143 **House Societies or societies with houses? Bandkeramik kinship and settlement structure from a Dutch perspective**
Ivo M. van Wijk and Pieter van de Velde
- 153 **Reflections on an Environmental History of Resistance: State Space and Shatter Zones in Late Antique North Africa**
Jip Barreveld
- 167 **Fiery forest management: an anthracological approach on the charred remains of medieval Noord-Brabant in Tilburg-Udenhout-Den Bogerd**
Erica van Hees, Jorinde Pijnnaken-Vroeijenstijn and Marleen van Zon
- 177 **Mysterious medieval manure pits: an indication of urban horticulture?**
Roos van Oosten, Sander Aerts, Jantine Hos and Erica van Hees

The Middle Palaeolithic site Lingjing (Xuchang, Henan, China): preliminary new results

Thijs van Kolfschoten, Zhanyang Li, Hua Wang and
Luc Doyon

Thijs van Kolfschoten
Faculty of Archaeology
Leiden University
P.O. Box 9514
2300RA Leiden, The Netherlands
T.van.Kolfschoten@arch.
leidenuniv.nl
also:
Institute of Cultural Heritage
Shandong University

Zhanyang Li
Institute of Cultural Heritage
Shandong University
72 Binhai Highway
Qingdao, 266237
People's Republic of China
lizhanyang2622@sina.com

Hua Wang
Institute of Cultural Heritage
Shandong University
wanghua99@sdu.edu.cn

Luc Doyon
Centre National de la Recherche
Scientifique
UMR 5199 PACEA
Université de Bordeaux
Pessac, Cedex, France
luc.doyon@umontreal.ca
also:
Institute of Cultural Heritage
Shandong University

*Lingjing is an open-air archaic hominin site in northern China where, apart from two incomplete human skulls, thousands of lithic artefacts as well as abundant, well-preserved mammalian remains with OSL ages ranging between ≈ 105 ka and ≈ 125 ka. It has been excavated yearly since 2005. The mammalian faunal assemblage from the site is very diverse with 22 different taxa. Equids and a large bovid *Bos primigenius* dominate the fauna; the mortality profiles of these herbivores indicate hominin/human hunting. Detailed taphonomic analyses demonstrate that Lingjing is a kill-butchery site and not a base camp.*

The Lingjing fauna and bone tool record shows remarkable similarities with the archaeological record from the Lower Paleolithic site of Schöningen 13 II-4, Germany, i.e., the Schöningen Spear Horizon, which is ca. 200 ka older than the Lingjing site. Both sites yielded well-preserved material, a very diverse fauna and a large amount of bone tools with identical features.

Keywords: Stone tools, bone tools, mammalian fauna, kill-butchery site

1. INTRODUCTION

In 1965, the Middle Palaeolithic site of Lingjing was discovered when microblades and microcores, as well as mammalian fossils were collected on the surface of an open-air site (Zhou 1974) and, in 2005, researchers from the Henan Provincial Institute of Cultural Relics and Archaeology started to excavate the site. The site is situated in a transitional area between the eastern foot of the Songshan Mountains and the Huang-Huai Plain, at the southern end of the North China Plain, about 120 south of the Yellow River; it is located in the western part of Lingjing town, ca. 15 km to the northwest of Xuchang, Henan Province, $34^{\circ}04'N$, $113^{\circ}41'E$ (figure 1) at an elevation of 121 meters above sea level (Li *et al.* 2017a).

Since 2005, more than 550 m² were excavated; most of the area to a depth of ca. 9 meters. Eleven geological layers are identified (figure 1) (Li *et al.* 2017a) and three archaeological horizons yielded cultural remains. Layers 1-4 (Holocene in age) yielded cultural materials representing the Neolithic to the Shang-Zhou Bronze Age. Layer 5, dated to ca. 13,500 \pm 406 BP, contains microblade technology, microcores, bone artefacts, perforated ostrich eggshells, ochre, faunal remains, and the first evidence of pottery appearing in the region (Li and Ma 2016; Li *et al.* 2017a; 2017b). Layers 6-9 are sterile; they do not yield stone artefacts or bone material. Layers 10 and 11 were deposited during the early Late Pleistocene. At the base of layer 10, a relatively small number of lithic artefacts, animal bones and small pebbles were

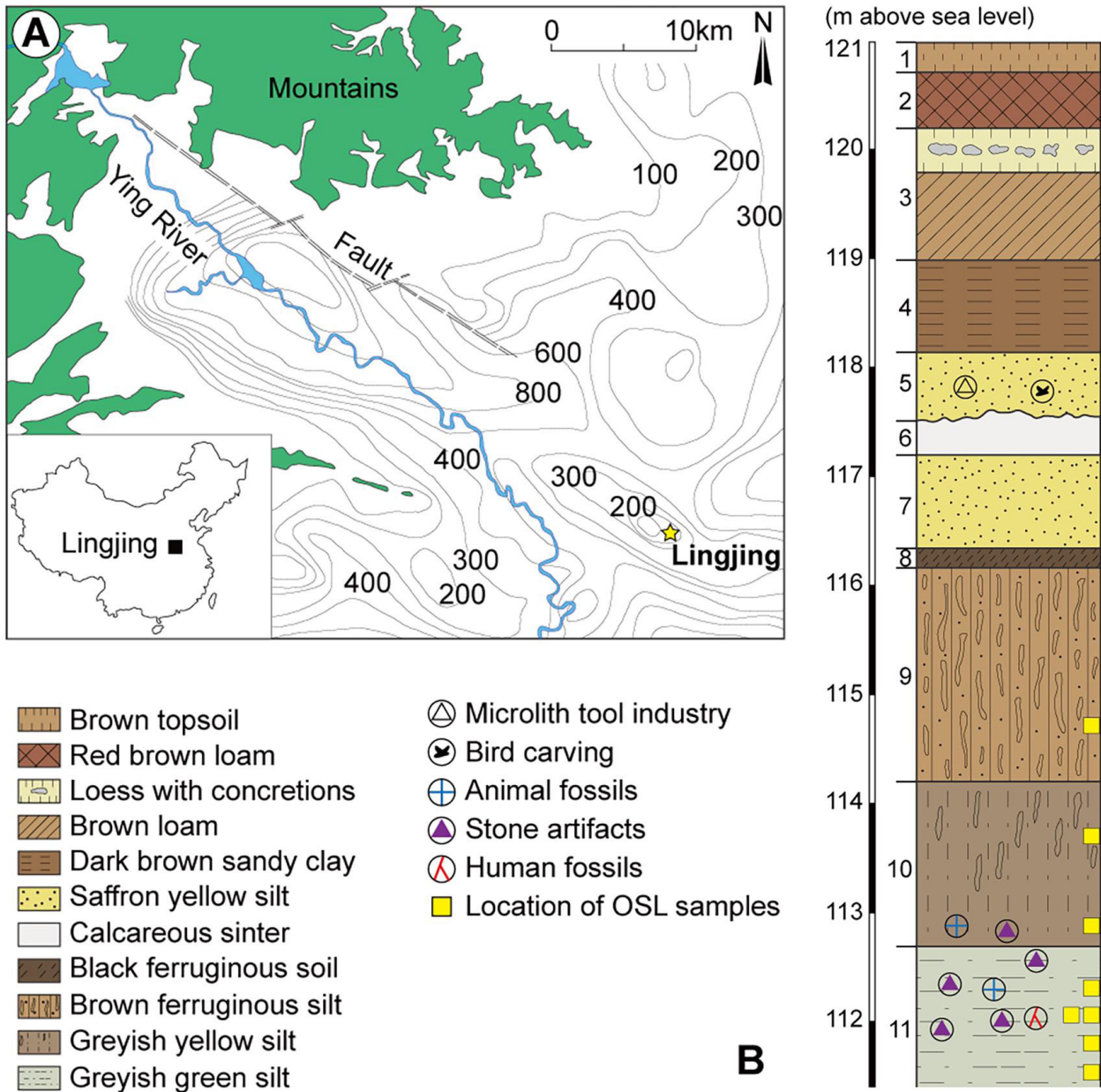


Figure 1: (a) Location of Lingjing (Henan, China); (b) Stratigraphy indicating the geological and cultural layers (after Doyon *et al.* 2018).

unearthed. Two OSL samples collected from layer 10 were dated between $\sim 96 \pm 6$ ka and $\sim 102 \pm 2$ ka (Nian *et al.* 2009). Layer 11 yielded so far more than 50,000 finds, the largest archaeological assemblage, and includes archaic human remains, abundant lithic artefacts and animal bones, some of which were used as tools (Li *et al.* 2017a; Doyon *et al.* 2018, 2019). OSL samples from Layer 11 are dated to between ~ 105 ka

and ~ 125 ka, corresponding to the early Marine Isotope Stage 5 (MIS 5; MIS 5e to 5d) and the last interglacial paleosol S1 in the Loess Plateau of China (Nian *et al.* 2009; Li *et al.* 2017a).

This paper focusses on the finds from Layer 11 excavated since 2005. The faunal assemblages excavated in 2005 and 2006 were studied in detail and the results are presented in a number of publications

(a.o. Li and Dong 2007; Dong and Li 2009; Wang *et al.* 2015; Zhang 2009; Zhang *et al.* 2009; 2011a; 2011b; 2012). The hominin remains were described in *Science* in 2017 (Li *et al.* 2017a). Recently, a detailed investigation of material excavated during the period 2007 – 2017 has started. The aim of the present paper is to provide an overview of the published (archaeological as well as palaeontological) data from Layer 11, and supplement it with preliminary new data obtained during the latest investigations of the faunal remains. Data that will, after detailed analyses, give a better idea about: a) the age of the archaic human remains, b) the environment in which Xuchang Man operated and c) Xuchang Man's subsistence and behaviour.

2. THE ARCHAEOLOGICAL RECORD FROM LINGJING – LAYER 11 AND THE BASE OF LAYER 10

Layers 10 and 11 (figure 2) yielded more than 50,000 finds (bones and lithic artefacts) distributed over an area of ca 550 m². Li *et al.* (2016) presented the spatial distribution of the 2014 excavations of Layer 11, which covered a 36 m² area. Refits are documented with a distance up to more than 5 meters. The vertical distribution of the finds in that specific area is about 15 cm. Li *et al.* (2018) studied the site formation process of an area of 9 m² during the 2017 excavation and spatially recorded 3894 specimens (2148 animal bones and 1746 stone artefacts) from layers 10 and 11. The vertical distribution of the finds is ca. 1 meter.

Based on their analyses of the processes that might have influenced the site formation, employing sedimentary indicators, they concluded that disturbance is limited and the assemblage integrity at the Lingjing site is high, which entails that human behavioural information is well preserved (Li *et al.* 2018).

2.1 Human remains

Two fragmented, incomplete human skulls (Xuchang 1 and Xuchang 2) were excavated in Layer 11, in situ between 2007 and 2014 (Li *et al.* 2017a; Trinkhaus and Wu 2017). Xuchang 1 (26 pieces) is the most complete; it retains most of the neurocranial vault and portions of the cranial base, as well as part of the left frontal bone. Xuchang 2 (16 pieces) is less complete with large part of the occipital bone and the temporal bones (see Li *et al.* 2017a). The Xuchang Man skulls derive from young adults and exhibit a mosaic of morphological features with differences from and similarities with their western contemporaries, which suggests complex dynamics between Eastern and Western Eurasian populations at the time. Given their low and broad neurocrania with the maximum breadth inferiorly, they are considered as eastern Eurasian late archaic hominins (Li *et al.* 2017a; Trinkhaus and Wu 2017). Both skulls exhibit external auditory exostoses most pronounced in Xuchang 2 implying conductive hearing loss (Trinkhaus and Wu 2017).



Figure 2: The 2011 excavation at Lingjing (Xuchang, Henan, China): Layer 11, Trench 11.

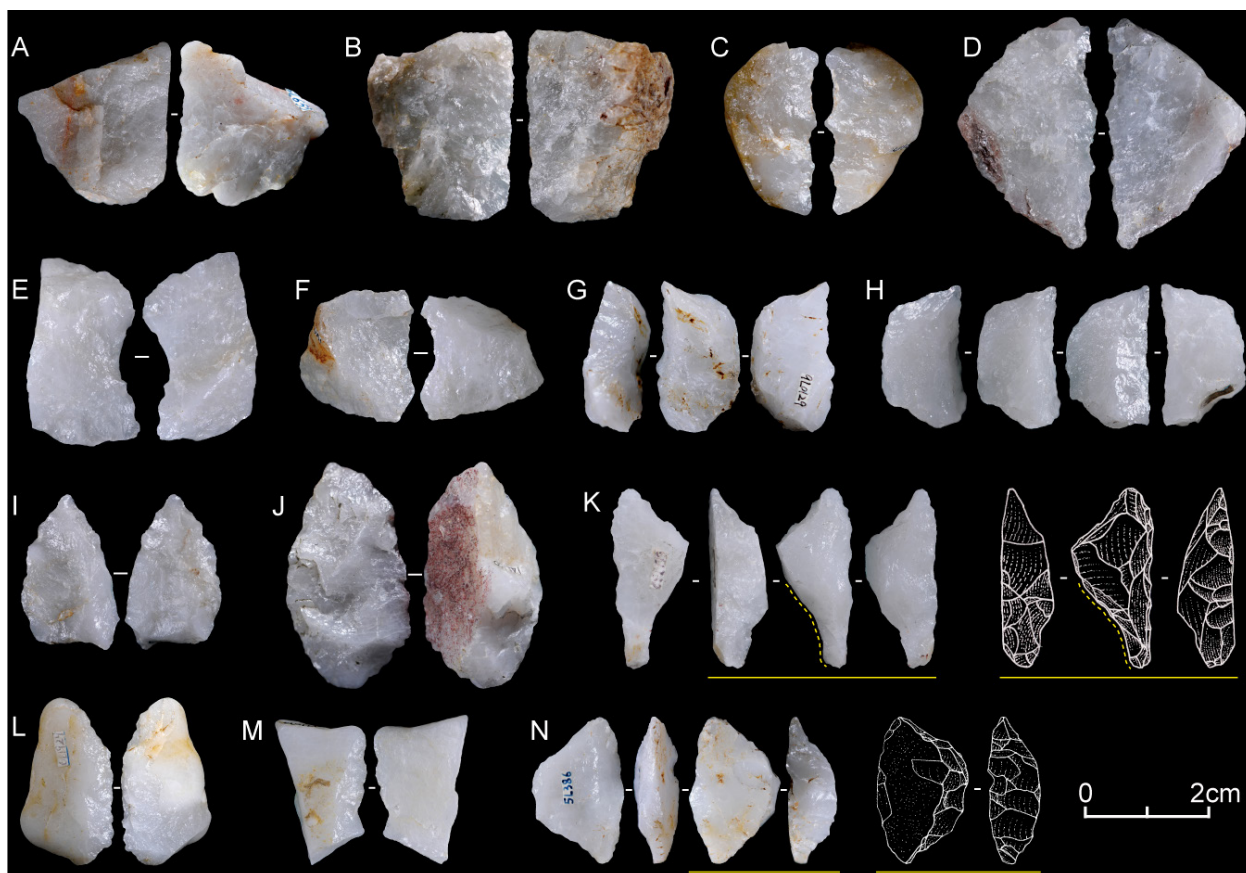


Figure 3: Formal tools at Lingjing. Examples of scrapers (a, b), denticulates (c, d), notches (e, f), borers (g, h), points (i-k), tools made on pebble blanks (l, m), and an example of a backed tool (n). Yellow underlines show specimens with drawings, dashed yellow lines indicate the likely basal retouch for hafting. (after Li *et al.* 2019).

2.2 Lithics

Stone artefacts including cores, flakes, formal tools (i.e., scrapers, notches, denticulates, borers, points, choppers, etc.) made of quartz and quartzite dominate (>99%) the lithic assemblage (figure 3) (Li *et al.* 2019). Chert is marginally represented (<1%). The abundance of debitage flakes and evidence for use wear on lithic artefacts suggests that the manufacture, use, re-sharpening and discard of lithic tools occurred at the site (Doyon *et al.* 2019; Li 2007; Li *et al.* 2019). Despite the absence of Levallois debitage, discoidal core preparation akin to the penecontemporaneous Western Eurasian assemblages is documented in layer 11 which, combined with the presence of bone tools, allows its attribution to Chinese Middle Palaeolithic (Doyon *et al.* 2018; 2019; Li *et al.* 2019).

2.3 Animal bones

The more than 40,000 faunal remains from the lower part of Level 10 and from Level 11 represent a variety of mammalian species (table 1). The faunal analyses of the finds excavated in 2005 and 2006 (Li and Dong 2007; Zhang 2009) resulted in an extensive list of 18 taxa; recently three “new” taxa could be added after a quick scan of the finds excavated since 2006. The carnivore guild from Lingjing is diverse. The larger carnivores *Ursus* sp., *Panthera* cf., *Tigris* and *Pachycrocuta* cf. *sinensis* are represented by cranial/dental as well as post-cranial material. Dozens of coprolites from a medium-sized carnivore, most likely a hyaena, have been recovered from the site. Wang *et al.* (2015) describe the identification of microbiological remains (parasites, fungi and hairs) preserved in the coprolites. This data provides information on the diet and health of ancient hyaena species.

Rodentia	
Rodentia fam. gen. et sp. indet. 1	x
Rodentia fam. gen. et sp. indet. 2	x
Lagomorpha	
Lagomorpha fam. gen. et sp. indet.*	x
Carnivora	
<i>Canis</i> cf. <i>lupus</i> *	xx
<i>Vulpes</i> sp.*	xx
<i>Ursus</i> sp.	xx
<i>Meles</i> sp.*	x
<i>Panthera</i> cf. <i>tigris</i> *	xx
<i>Pachycrocuta</i> cf. <i>sinensis</i>	xxx
Proboscidea	
<i>Palaeoloxodon</i> sp.	x
Perissodactyla	
<i>Coelodonta antiquitatis</i>	xxxx
<i>Dicerorhinus mercki</i>	x
<i>Equus przewalskii</i>	xxx
<i>Equus hemionus</i>	xxxxx
Artiodactyla	
<i>Sus lydekkeri</i>	xxx
<i>Hydropotes pleistocenica</i>	x
<i>Cervus</i> (<i>Sika</i>) sp.*	xx
<i>Cervus</i> (<i>E.</i>) <i>elaphus</i>	xxx
<i>Elaphurus davidianus</i> *	x
<i>Sinomegaceros ordosianus</i>	x
<i>Bos primigenius</i>	xxxxx
<i>Procapra przewalskii</i>	xxx

Table 1: List of mammalian taxa represented in the faunal assemblage from Lingjing Layer 11 and the base of Layer 10. The list is based on the faunal analyses of the finds excavated in 2005 and 2006 (Li and Dong 2007; Zhang 2009). In more recent excavations additional species, indicated with a *, are represented. x=1-5 specimen; xx=6-20 specimen; xxx=21-100 specimen; xxxx=201-500 specimen; xxxxx=more than 501 specimen.

A limited number of remains (a molar as well as tusk and bone fragments) of the elephant *Palaeoloxodon* sp. have been identified so far. The Perissodactyla are represented by four different taxa: *Coelodonta antiquitatis*, *Dicerorhinus mercki*, *Equus przewalskii* and *Equus hemionus*. The woolly rhinoceros *Coelodonta antiquitatis* remains include at least 9 different individuals (the majority juvenile). The occurrence of *Dicerorhinus mercki* is based on the identification of a single lower molar (Li and Dong 2007). The equids, together with the bovid *Bos primigenius*, dominate the faunal assemblage. Dental as well as postcranial remains of *Equus przewalskii* and *Equus hemionus* are abundant. Based on the dimensions of the fossil remains it is apparent that the majority of the equid remains correspond to the more slender Onager or Asiatic wild ass *Equus hemionus*.

The group of Artiodactyla is very diverse with eight species (*Sus lydekkeri*, *Hydropotes pleistocenica*, *Cervus* (*Sika*) sp., *Cervus* (*E.*) *elaphus*, *Elaphurus davidianus*, *Sinomegaceros ordosianus*, *Bos primigenius*, *Procapra przewalskii*). The aurochs *Bos primigenius* is by far the most dominant species. Hundreds of molars, horn cores as well as abundant cranial and postcranial remains have been excavated. Other taxa, e.g., the suid *Sus lydekkeri*, the red deer *Cervus* (*E.*) *elaphus* and the gazelle *Procapra przewalskii*, are also well represented but less abundant. The remaining Artiodactyla taxa are relatively rare.

3. HUMAN IMPACT

Given the mortality patterns, skeletal element profiles, and bone surface-modifications, it is obvious that humans have an important impact on the Lingjing assemblage from Layer 11 and the base of Layer 10 (Zhang *et al.* 2009; 2011a; 2011b; 2012). The fossil assemblage is dominated by bone elements from body parts with lower nutritional value, such as teeth and lower limb bones (Zhang *et al.* 2011a; 2011b). Finally, the mortality profile of the two dominant prey species, i.e., the Onager *Equus hemionus* and the Aurochs *Bos primigenius*, is almost exclusively represented by prime-adult individuals (Zhang *et al.* 2009; 2011a; 2011b), a feature that demonstrates the focussed hunting strategy of Xuchang Man.

Zhang *et al.* (2011a; 2011b) concluded based on the analyses of the 2005 and 2006 record that the Lingjing site was a kill-butchery site rather than a home base for early humans. The taphonomic and zooarchaeological characteristics of the animal remains, i.e. species richness, mortality patterns,

skeletal element profiles, and bone surface-modifications support this conclusion. The natural component in the accumulation of the faunal material is most probably very limited.

Li *et al.* (2018) concluded, based on their studies of the formation processes of the site, that the uninterrupted vertical distribution (up to >1 m) of the remains throughout the sequence along with the large number of faunal remains representing different taxa, demonstrates that the site was occupied by humans repeatedly over a relatively long period.

Cut marks are very abundant, in particular on the upper and lower limb bones, indicating disarticulation and meat exploitation. There are no scraping marks on the bones of the 2005 and 2006 excavations, which indicates a non-intensive processing technique (Zhang *et al.* 2011a). The number of complete bones in the Lingjing assemblage is very limited. The vast majority of the bones are fragmented and the breakage pattern shows that we are dealing with green-bone fractures, which suggests the human exploitation of marrow. However, it is well-known that hyenas also have the capacity to break bones. Future analyses of the faunal assemblage, focussing on the bone breakage patterns and the occurrence of surface modifications by carnivores should clarify the role of the large carnivores in the fragmentation of the Lingjing bone assemblage.

In the Lingjing assemblage there is convincing evidence that bones and bone fragments are used as tools. Luc Doyon investigated a randomly selected sample of 4,604 bone fragments from Layer 11 and the base of Layer 10 (the 2005-2017 excavations), and he discovered 10 bone retouchers; one organic soft hammer, one active as well as one passive pressure flakers used to shape stone tools (Doyon *et al.* 2018; 2019). In addition to representing the earliest evidence for pressure flaking in the world, these tools indicate the Lingjing hominin possessed an extensive knowledge of the mechanical properties of bone materials, and knew how to take advantage of them in their knapping activities. This conclusion is further supported by a recent screening of a larger sample of the excavated bone material, which indicates that the actual number of bone retouchers in the Lingjing assemblage is much higher than originally described by Doyon *et al.* (2018; 2019). This is also supported by the more recent discovery of a large number of metapodial bone hammers. Aurochs metapodials, but also a restricted number of equid metapodials, show unusual flaking and percussion damage on the distal ends. The metapodials with flaked and rounded

epiphyses are interpreted as hammers used to break marrow bones akin to those from Schöningen 13 II-4 (van Kolfschoten *et al.* 2015a).

Finally, layer 11 has also yielded two bone fragment, probably ribs of large-sized mammals, bearing each 10 and 13 sub-parallel lines. The morphology of the bone surface and of the incisions indicate that the two fragments were engraved with a sharp point on weathered bone. On one of the two, residue analyses identified the presence of hematite, which suggests the Lingjing hominin smeared ochre to highlight the engraved pattern (Li *et al.* 2019). This discovery represents the oldest known engravings and the earliest use of ochre for non-utilitarian purposes in East Asia.

4. DISCUSSION AND CONCLUSIONS

The Middle Palaeolithic site of Lingjing is unique not only because of the discovery of the human skulls but also for the richness of its faunal and lithic assemblages. The surface of the bones is, in most cases, very well preserved and shows a variety of anthropogenic modifications (*e.g.* cutmarks) that give insights in past hominin/human behaviours and subsistence activities.

The Lingjing site has much in common with the Lower Palaeolithic site Schöningen 13 II-4, the so-called Schöningen Spear Horizon (Germany), with an age of ca. 300 ka (van Kolfschoten 2014; Serangeli *et al.* 2015). The preservation of the material at both sites is excellent, the encountered faunas at both sites show many similarities. The faunal lists of both sites include a diverse carnivore guild, an elephant, two different rhinoceros species, two different equids, different cervids and large bovids (van Kolfschoten *et al.* 2015b). Both sites also yield a large amount of bone retouchers as well as a unique amount of bone hammers that show identical, unusual flaking and percussion damage. These similarities are remarkable if one takes into account the difference in age (ca. 200 ka) and the geographical distance of ca. 8000 km between the two. Detailed investigation of the battering damage observed at the distal ends of the metapodials from Schöningen indicated that the bone tools have not been used for the percussion of stones; stone (flint) particles are not embedded in the damaged bone cortex (van Kolfschoten *et al.* 2015a). The authors suggest that the damage reflect the use of bone hammers to extract marrow from the limb bones and the mandibles. The battering damage at the Lingjing bone hammers show almost identical features for example the lack of stone particle in the damaged bone cortex. We, therefore, assume that the Lingjing bone hammers are also used

in the marrow exploitation process. We assume that the observed similarities show more or less identical, opportunistic behaviour at both sites. This, combined with the comparable taphonomic circumstances of the two sites, results in the fact that Lingjing and Schöningen have so much in common.

Most of the data published on Lingjing are based on faunal remains excavated in 2005 and 2006. The analyses of the more recently excavated finds are in progress and the combined old and new data will result in a large dataset that will surely result in making Lingjing a site of reference for Middle Palaeolithic research in East Asia. The analyses of the data will also result in detailed knowledge of human behaviours and subsistence in northern China during the earliest Late Pleistocene, a period that is linked to the dispersal of modern humans out of Africa (Bae *et al.* 2017). This makes the Lingjing site significant in the discussion of the evolutionary background of modern humans in northern China (Li *et al.* 2018).

ACKNOWLEDGMENTS

LD acknowledges the financial support of the China/Shandong University International Postdoctoral Exchange Program and of the PHC Xu Guangqi Program (grant number 41230RB).

REFERENCES

- Bae, C.J., K. Douka and M.D. Petraglia 2017. On the origin of modern humans: Asian perspectives. *Science* 358 (6368), 1269-1275.
- Dong, W. and Z. Li. 2009. New Cervids (Artiodactyla, Mammalia) from the Late Pleistocene of Lingjing Site in Henan Province, China, *Acta Anthropologica Sinica* 28, 319-326.
- Doyon, L., Z. Li, H. Li and F. d'Errico 2018. Discovery of circa 115,000-year-old bone retouchers at Lingjing, Henan, China, *PLOS ONE* 13, e0194318.
- Doyon, L., H. Li, Z. Li, H. Wang and Q. Zhao 2019. Further Evidence of Organic Soft Hammer Percussion and Pressure Retouch from Lingjing (Xuchang, Henan, China), *Lithic Technology* 44:2, 100-117.
- Li, Z. 2007. A primary study on the stone artifacts of Lingjing site excavated in 2005, *Acta Anthropologica Sinica* 26, 138-154.
- Li, Z., and W. Dong. 2007. Mammalian fauna from the Lingjing Paleolithic site in Xuchang, Henan Province, *Acta Anthropologica Sinica* 26, 345-360.
- Li, Z., Q.B. Zhao and Y.N. Li 2016. 2014-year excavation on the site of Xuchang Man in Lingjing [in Chinese], *Huaxia Archaeol.* 1, 3-25.
- Li, Z. and H. Ma 2016. Techno-typological analysis of the microlithic assemblage at the Xuchang Man site, Lingjing, central China, *Quaternary International* 400, 120-129.
- Li, Z., X. Wu, L. Zhou, W. Liu, X. Gao, X. Nian and E. Trinkhaus 2017a. Late Pleistocene archaic human crania from Xuchang, China, *Science* 355, 969-972.
- Li, Z., D. Kunikita and S. Kato 2017b. Early pottery from the Lingjing site and the emergence of pottery in northern China, *Quaternary International* 441, 49-61.
- Li, H., Z. Li, M.G. Lotter and K. Kuman 2018. Formation processes at the early Late Pleistocene archaic human site of Lingjing, China, *Journal of Archaeological Science* 96, 73-84.
- Li, H., Z. Li, X. Gao, K. Kuman and A. Sumner 2019. Technological behavior of the early Late Pleistocene archaic humans at Lingjing (Xuchang, China), *Archaeological and Anthropological Sciences* <https://doi.org/10.1007/s12520-018-0759-7>.
- Li, Z., L. Doyon, H. Li, Q. Wang, Z. Zhang, Q. Zhao and F. d'Errico 2019. Engravings on bone from the archaic hominin site of Lingjing 1 (Xuchang, Henan, China), *Antiquity*.
- Nian, X.M., L.P. Zhou and J.T. Qin 2009. Comparisons of equivalent dose values obtained with different protocols using a lacustrine sediment sample from Xuchang, China, *Radiat Meas* 44, 512-516.
- Serangeli, J., U. Böhner, T. van Kolfschoten and N.J. Conard 2015. New results from large-scale excavations in Schöningen, *Journal of Human Evolution* 89, 27-45.
- Trinkaus, E. and X.-J. Wu 2017. External auditory exostoses in the Xuchang and Xujiayao human remains: Patterns and implications among eastern Eurasian Middle and Late Pleistocene crania, *PLOS ONE* 12, e0189390.
- Van Kolfschoten, T. 2014. The Palaeolithic locality Schöningen (Germany): A review of the mammalian record, *Quaternary International* 326-327, 469-480.
- Van Kolfschoten, T., S.A. Parfitt, J. Serangeli and S.M. Bello 2015a. Lower Paleolithic bone tools from the 'Spear Horizon' at Schöningen (Germany), *Journal of Human Evolution* 89, 226-263.

- Van Kolfshoten, T., E. Buhrs and I. Verheijen 2015b. The larger mammal fauna from the Lower Paleolithic Schöningen, *Journal of Human Evolution* 89, 138-153.
- Wang, W., Z. Li, G. Song, G. and Y. Wu 2015. A study of possible hyaena coprolites from the Lingjing site, Central China, *Acta Anthropologica Sinica* 34, 117-125.
- Zhang, S. Q. 2009. *Taphonomic study of the faunal remains from the Lingjing Site, Xuchang, Henan Province (in Chinese)*, Dissertation for the Doctoral Degree. Beijing: Institute of Vertebrate Paleontology and Paleoanthropology, the Chinese Academy of Sciences, 1—216
- Zhang, S., Z. Li, Y. Zhang and X. Gao 2009. Mortality profiles of the large herbivores from Lingjing Xuchang Man Site, Henan Province and the early emergence of the modern human behaviours in East Asia, *Chin Sci Bull* 54, 3857-3863.
- Zhang, S., Z. Li, Y. Zhang and X. Gao 2011a. Cultural Modifications on the Animal Bones from the Lingjing Site, Henan Province, *Acta Anthropologica Sinica* 30, 313-326.
- Zhang, S, X. Gao, Y. Zhang and Z. Li 2011b. Taphonomic analysis of the Lingjing fauna and the first report of a Middle Paleolithic kill-butchery site in North China, *Chin Sci Bull* 56, 3213-3219.
- Zhang, S., Z. Li, Y. Zhang and X. Gao 2012. Skeletal element distributions of the large herbivores from the Lingjing site, Henan Province, China, *Sci China Earth Sci* 55, 246-253.
- Zhou, G.X. 1974. Stone age remains from Lingjing, Xuchang of Henan province [in Chinese], *Archaeol* 2, 91-108.