PALEOANTHROPOLOGY

Late Pleistocene archaic human crania from Xuchang, China

Zhan-Yang Li,1,2 Xiu-Jie Wu,1,2 Li-Ping Zhou,3 Wu Liu,1 Xing Gao,1,4 Xiao-Mei Nian,3,5 Erik Trinkaus6

Two early Late Pleistocene (~105,000- to 125,000-year-old) crania from Lingjing, Xuchang, China, exhibit a morphological mosaic with differences from and similarities to their western contemporaries. They share pan–Old World trends in encephalization and in supraorbital, neurocranial vault, and nuchal gracilization. They reflect eastern Eurasian ancestry in having low, sagittally flat, and inferiorly broad neurocrania. They share occipital (supraoccipital and nuchal torus) and temporal labyrinthine (semicircular canal) morphology with the Neandertals. This morphological combination reflects Pleistocene human evolutionary patterns in general biology, as well as both regional continuity and interregional population dynamics.

The period between ~200,000 and ~50,000 years ago saw the amplification across the Old World of regional diversity in human biology, which provided both the background for the pan–Old World spread (after 40,000 years ago) of modern human biology and the evolutionary background for recent human diversity (1, 2). Eastern and northeastern Africa saw the emergence of the earliest modern humans, spreading briefly into southwestern Asia and then across southern Asia. Western Eurasia saw the continuing emergence of the Neandertals. Other forms of late archaic humans emerged elsewhere in Africa. Until recently, the nature of these late Middle and early Late Pleistocene humans in the more northern portions of eastern Eurasia has been unclear; given the fragmentary nature of that human fossil record (3).

From their fossil record, eastern Asian late archaic humans have been interpreted to resemble their Neandertal contemporaries to some degree (4–6), with considerations of whether the fragmentary remains of the former exhibit features characteristic of the latter. Yet it is only with the discovery of two human crania (plus additional elements) from the Lingjing site in Xuchang County, Henan Province, China, that the nature of these eastern Eurasian early Late Pleistocene archaic humans is becoming clear. Excavated in situ between 2007 and 2014, the Xuchang 1 and 2 crania exhibit a distinctive morphological pattern combined with paleobiological trends that appear to have been pan–Old World.

The open-air Lingjing site consists of a series of horizontal strata around a spring, extending from the earliest Late Pleistocene to the early Holocene (Fig. 1 and supplementary materials, section I). The Xuchang 1 and 2 crania were found broken, each cranium dispersed within a circumscribed horizontal area within layer 11. They were associated with a diverse macromammalian faunal assemblage, rich in Equus, Bos, Megaloceros, Procapra, Cervus, and Coelodonta. The layer contains a Middle Paleolithic lithic industry, mostly on quartz, along with bone tools on diaphyseal splinters (7). Layer 11 has produced a consistent series of optically stimulated luminescence (OSL) ages (supplementary materials, section II), placing the human remains between about 105,000 and 125,000 years, and the overlying layers 10 and 9 have provided ages of about 100,000 and 90,000 years (Fig. 1). The human crania are therefore securely dated to middle Pleistocene (late MIS 5c), rather than being longer and more vertical, as in modern humans and some Neandertals. They reflect eastern Eurasian ancestry in having low, sagittally flat, and inferiorly broad neurocrania. They share occipital (supraoccipital and nuchal torus) and temporal labyrinthine (semicircular canal) morphology with the Neandertals. This morphological combination reflects Pleistocene human evolutionary patterns in general biology, as well as both regional continuity and interregional population dynamics.

The Xuchang 1 neurocranial vault is approximately the shapes of those of Middle Pleistocene crania, especially eastern Eurasians (Fig. 2 and fig. S15). The vault height is low, similar to those of the Neandertals and the later Middle Pleistocene vaults, and the low vault height is reflected in a low temporal squamosal portion (figs. S27 and S28). It is also produced by the very flat midsagittal parietal arc. In contrast, the maximum cranial breadth is the largest known in the later Pleistocene (Fig. S15), and it is secured based on an undistorted posterior cranium. Moreover, the widest point is low, on the temporal bones (fig. S17), rather than being longer and more vertical, as in modern humans and some Neandertals. These features combine to provide the cranium with an occipital pattern similar to those of earlier human crania, contrasting with the rounded profiles of Neandertals and the laterally vertical ones of modern humans. In contrast to these derived and ancestral features, the Xuchang crania display two complexes that primarily align them with the Neandertals (9, 10); their midoccipital areas and temporal lobes. The occipital bones exhibit a modest or minimal nuchal torus limited to the middle two-thirds of the superior nuchal line, an absence of an external occipital protuberance, a
Fig. 1. The Lingjing site. (A) Location of the Lingjing site in Xuchang county, Henan Province, China. (B) Schematic stratigraphy of the Lingjing site, with the locations of the OSL samples indicated. (C) The OSL ages of the samples, obtained with two protocols (supplementary materials, section II) and plotted with a 1σ error range. (D) The scatters of the Xuchang (XUC) 1 and 2 cranial remains in excavation area T9. AMS, accelerator mass spectrometry; ka, thousand years.

Fig. 2. Virtual reassembly of the Xuchang 1 cranium. (A) Anterior, (B) right lateral, (C) posterior, (D) superior, (E) left lateral, and (F) inferior views. Gray, filled-in absent portions and mirror-imaged right frontal squamous portion.
distinct suprainiac fossa, and a continuous external table thickness through the inion region (Fig. 4 and fig. S26). Although aspects of this complex are evident in non-Neandertals (17), the full set is known only in Neandertals and the Xuchang crania (9). The temporal semicircular canals in both crania exhibit relatively small anterior canal radii and more superior lateral versus posterior canals (Fig. 4 and figs. S29 and S30), a pattern evident in most Neandertals (10) and known elsewhere only in the early Late Pleistocene eastern Asian Xujiayao 15 temporal bone (6).

The Xuchang early Late Pleistocene archaic human crania therefore exhibit features that are (i) ancestral and reminiscent particularly of early Middle Pleistocene eastern Eurasian humans; (ii) derived and shared by earlier Late Pleistocene humans elsewhere, whether morphologically archaic or modern; and (iii) distinctive of the Neandertals. This morphological combination, and particularly the presence of a mosaic not known among early Late Pleistocene humans in the western Old World, suggests a complex interaction of directional paleobiological changes and intra- and interregional population dynamics.

With respect to directional changes, the presence of marked encephalization, at least in Xuchang 1, conforms to the trend of major increases in brain size (and encephalization) through the Middle Pleistocene, culminating in recent human brain sizes by the earlier Late Pleistocene (12). Given the costs, as well as benefits, of larger brains (13, 14), the Xuchang ECVs reinforce the uniform levels of behavioral elaboration evident through this time period across the Old World (15, 16). Although its broader implications are unclear, the gracilization of the Xuchang crania relative to Middle Pleistocene fossils follows similar patterns to those evident further west.

At the same time, the overall cranial shape, and especially the combination of the wide cranial base and low neurocranial vault, indicates a pattern of continuity with the earlier, Middle Pleistocene eastern Eurasian humans. Yet the presence of two distinctive Neandertal features—one (iniac and nuchal morphology) unknown among earlier eastern crania, and the other (labyrinthine proportions) evident in only one similarly aged eastern Eurasian fossil—argues for population interactions across Eurasia during the late Middle and early Late Pleistocene. Similar interactions can be inferred from the presence of Neandertal ancient DNA in western Siberia (17) and in the Tianyuan 1 early modern human from northern China (18). These data therefore argue both for substantial regional continuity in eastern Eurasia into the early Late Pleistocene and for some level of east-west population interaction across Eurasia.

The Xuchang crania therefore provide an important window into the biology and population history of early Late Pleistocene eastern Eurasian people. As such, they are a critical piece in our understanding of the human evolutionary background to the subsequent establishment of modern human biology across the Old World, a process that was already under way in
eastern Africa and (apparently) further south in eastern Asia (19–22).

REFERENCES AND NOTES

ACKNOWLEDGMENTS
This work was supported by the National Natural Science Foundation of China (grants 41672020, 41630102, and 41672024), the Chinese Academy of Sciences (grant 132311KYSB20160004), 111Project (grant 111-2-09), and the Chinese Academy of Sciences President’s International Fellowship Initiative (award 2016D60001). We are grateful to X. M. Sun, L. M. Jia, Q. B. Zhao, S. Q. Zhang, W. Dong, Z. Y. Zhao, Q. M. Fu, J. T. Qin, R. L. Holloway, M. H. Wolpoff, L. L. Shackelford, and J. C. Willman for their help in the excavations, sharing comparative data, and/or manuscript preparation. We are also grateful to the administrative departments of the Xuchang County Cultural Relics for their help with the excavations. The data reported in this paper are tabulated in the supplementary materials. The human fossils are in the Henan Provincial Institute of Cultural Relics and Archeology, Zhengzhou, China. Z.-Y. L. directed the Lingjing research project, organized fieldwork, and conducted the geological studies of the Lingjing site. X.-J.W. and E.T. performed the anthropological study of the Xuchang human fossils. L.-P.Z. designed the OSL dating analysis. L.-P.Z. and X.-M.N. undertook the fieldwork and OSL analysis. X.-J.W., W.L., X.G., L.-P.Z., X.-M.N., and E.T. analyzed the data and prepared the paper.

SUPPLEMENTARY MATERIALS
www.sciencemag.org/content/355/6328/969/suppl/DC1
Supplementary Text
Figs. S1 to S30
Tables S1 to S14
References (23–93)

19 October 2016; accepted 9 February 2017
10.1126/science.aal2482
Editor's Summary

Morphological mosaics in early Asian humans

Excavations in eastern Asia are yielding information on human evolution and migration. Li et al. analyzed two fossil human skulls from central China, dated to 100,000 to 130,000 years ago. The crania elucidate the pattern of human morphological evolution in eastern Eurasia. Some features are ancestral and similar to those of earlier eastern Eurasian humans, some are derived and shared with contemporaneous or later humans elsewhere, and some are closer to those of Neandertals. The analysis illuminates shared long-term trends in human adaptive biology and suggests the existence of interconnections between populations across Eurasia during the later Pleistocene. 

Science, this issue p. 969