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Palaeo-demography, climatic instability and hominin variability in Middle Pleistocene China and Europe

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FIRST PARAGRAPH: In a recent paper [1], we attempted to explain how how the variability of the fossil hominin sample in Early and Middle Pleistocene Europe could be largely explained as a result of repeated population dispersals, fragmentation, and re-combinations of surviving populations inside Europe in response to both long-term (Milankovich-length) and shorter, millennia-length (sub-Milankovich) climatic fluctuations, and also as a result of repeated episodes of immigration from Southwest Asia. We proposed a model based on population "sinks" and "sources": "source" populations would have lived in those parts of southern Europe where hominins could have survived glacial periods, and "sink" populations would have been those where occupation was possible in temperate and interglacial intervals, such as in northern Europe. Spain and Britain are two examples of where "source" and "sink" populations may have been located. On our model, many "sink" populations would have become extinct when environmental conditions deteriorated. We suggested that local extinctions outside refugia would have been frequent, as an alternative to an "ebb and flow" model in which groups retreated to refugia when conditions worsened. In extreme situations (such as the maxima of glacial periods, when populations were at their lowest), even southern Europe may have been a population "sink" that was replenished from source populations in Southwest Asia.

中更新世中国和欧洲的古人口学、气候多变性和古人类的多样性

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首节：在最近的一篇文章中[1]，我们试图解释欧洲早中更新世的古人类化石多样性的成因，这种多样性很大程度上源于或长(米兰科维奇周期)或短(亚米兰科维奇千年周期)的气候波动影响下幸存的人类群体的不断扩散、分化和融合，同时也源于西亚移民的不断迁入。我们建立了一个基于群体"汇聚"和"发源"的模型，"发源"群体生活在南欧那些在冰川期仍可能有人类存活的地区，而"汇聚"群体则生活在如北欧那些只有在气候温和时期和间冰期人类才有可能存活的地区，西班牙和英国正好分别对应群体"发源"地和"汇聚"地。在我们的模型中，当气候变得恶劣的时候，许多"汇聚"地群体会面临灭绝。我们认为避难所以外地区的灭绝会很频繁，当环境更加恶化时，群体撤退到避难所作为应对"消长"模式的一种选择。在极端的情况下(例如最大冰川期)，甚至南欧也变成了一个群体"汇聚"地，由西亚的"发源"群体对其进行补充。

We also suggested that this model could be applied to the fossil and archaeological record of China before the last interglacial, ca. 125 ka. There are several points of similarity between China and Europe. First, the northern margins (Britain and northern Europe, northern China) are very vulnerable to reductions in temperature and precipitation, and are unlikely to have been inhabited continuously throughout the Early and Middle Pleistocene. Secondly, those parts of southern regions that were not densely forested (the Mediterranean basin, China south of the Yangtse River) are more likely to have sustained populations throughout most, and possibly all, climatic cycles. Thirdly, neither Europe nor China were "closed" systems that were totally isolated from neighbouring regions, so some population exchange through immigration and possibly emigration might be expected. Fourthly, there are general similarities in the degree of variability in the Middle Pleistocene fossil hominin record. In Europe, the main resident was *H. heidelbergensis*, which might not have

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been derived from the Early Pleistocene *H. antecessor* and was ancestral to the Neanderthal, *H. neanderthalensis*. In China, the primary Middle Pleistocene inhabitant was *H. erectus*, which may (or may not) have been derived from the Early Pleistocene populations represented by Lantian (Gongwangling), and was ancestral to later Middle Pleistocene Chinese hominins that are usually classified as "archaic" *H. sapiens*[2]. Both *H. heidelbergensis* and Chinese *H. erectus* are variable taxa, and it is not clear if this variability is consistent over space and time. On our model, we suggest that at least some of this variability in China may result from repeated fragmentation, local extinction and recombination of groups over several glacial-interglacial cycles.

Our suggestion is that assessments of hominin variability in the Middle Pleistocene need to greater take account of demographic factors. The most obvious are the ways that population levels would have fluctuated over time during glacial-interglacial cycles, and spatially from north to south. A useful beginning would be to identify on ecological and climatic grounds those regions most likely to have contained permanent "source" populations, and those (especially at the northern limits of occupation, or in upland regions) most likely to have contained population "sinks" that were transient. To achieve this, we need much clearer indications of the climatic and environmental contexts of hominin specimens.

我们认为这个模型也可以应用于12.5万年前间冰期时的中国的化石和考古学材料。中国和欧洲有如下几个相似之处:首先，北部边缘(英国-北欧，中国北方)都很易受到气温和降水量下降的影响，并且在早中更新世时期都不大可能有人类的持续居住。其次，这两个地区的南部(地中海盆地，中国长江流域)都没有茂密的森林植被，在大部分甚至整个气候循环周期中，这些地区极可能有人群持续地居住。第三，不管是欧洲还是中国，都没有与邻近地区完全隔绝，因此群体之间也会有发生交流的可能。最后，两个地区中更新世时期的古人类化石的多样性程度也大致相同。在欧洲，主要的居民海德堡人是尼安德特人的直接祖先，但海德堡人也许并不是早更新世的先驱人的后代。在中国，中更新世时期的主要居民是直立人，是中更新世晚期早期智人的祖先[2]，而直立人有可能是(或者不是)早更新世时期的以蓝田人为代表的古人类的后代。海德堡人和中国直立人都是多样性高的类群，这些多样性在空间和时间上是否一致还未能确定。在我们的模型中，我们认为至少中国的一部分多样性是群体在多个冰川-次冰川的气候变化周期中，经历多次分化，本土灭绝和融合后的结果。

我们建议对于中更新世时期的古人类的多样性的评估应该更多的考虑到人口统计学因素的影响。最明显的就是群体水平在由南向北的空间上和在冰川期-间冰期的循环周期中是波动的。因此，可行的开始是识别那些有永久"发源"群体的地区和有短暂"汇聚"群体的地区(特别是北部有限的人口居住地区)的生态和气候的背景知识。为此，我们需要更清晰的掌握气候环境与古人类的关联。(陆艳 译)

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