GIS Simulation of the Earliest Hominid Colonisation of Eurasia

Kathryn Holmes

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Reviewed by ISABELLE WINDER
Department of Archaeology, University of York, King's Manor, York YO1 7EP, UNITED KINGDOM; icw503@york.ac.uk

Attempts to reconstruct hominid dispersals have been hampered by problems of scarce archaeological evidence and methodological uncertainty, but have taken off in recent years as both the resolution of the fossil record and our capacity to use computers to reconstruct environmental scenarios have improved. Today, computer modelling is one of the most powerful tools available for biogeographic reconstruction, although it remains underused in paleoanthropology (Hughes et al. 2008). Partly as a result of similar problems both with observing ongoing dispersals and in reconstructing events in the past, dispersal remains one of the least understood biological processes even in neoecology (Wiens 2001). There are a number of reasons for this lack of understanding. Perhaps most prominently for those studying hominids, there are problems with using paleoanthropological data in computer modelling associated with the traditional bugbears of taphonomic bias, taxonomic uncertainty, and low spatial and temporal resolution. These problems are common to all paleontological endeavours, however, and cannot be allowed to prohibit new lines of research when their impacts have yet to be fully assessed. Unfortunately, though, modelling also suffers from a general lack of competency; few paleoanthropologists have the technical and GIS abilities required to develop predictive models. As a result, most of the models developed to date in paleoanthropology have been the work of just a few research groups, with the authors typically omitting details of model development from publications as a result of constraints on space and a lack of interest among readers. Happily, *GIS Simulation of the Earliest Hominid Colonisation of Eurasia*, being published by the British Archaeological Reports (International Series), is able to provide a comprehensive presentation of both the data and methods used in developing the first GIS-based predictive model of Plio-Pleistocene hominid dispersal, without being penalized for length or technical complexity. This represents a useful resource for workers in the field, and, as such, the book provides an example not only of what can be achieved by paleoanthropological modelling but also of good practice in its presentation and dissemination.

The book begins with introductory chapters on the importance and visibility of dispersal in the fossil record, the use of GIS models in reconstructing dispersal, and predictive site modelling in archaeology and paleoanthropology. These chapters also present the theoretical perspective employed in the work, namely that "environmental factors such as vegetation distribution and the location of food and water resources would have had the most impact on the distribution of early hominid species" (p. 1). Although this is only one hypothesis of hominid dispersal, with other authors emphasising instead technological change like the emergence of the Acheulean (Carbonell et al. 1999) or biological innovations like increasingly efficient bipedalism or thermoregulation (Aiello and Wells 2002), it does serve to limit the scope of what would otherwise be an unmanageable task, especially given our current inability to reconstruct and understand the impacts of either biological or technological changes in ways suitable for modelling exercises. Environmental factors also are demonstrably important in the dispersals of other large mammals (Foley 1987), while other hypotheses remain largely speculative.

The introductory discussions also emphasise one of Holmes' own priorities when it comes to research—that both the use of paleontological and paleoenvironmental data and the development of computer models must be carried out transparently as "[i]t is only as the result of such clarity that the benefits of any predictive site model can be appreciated" (p. 11). This statement is one that many paleoanthropologists would agree with, and prefaces three additional chapters dealing explicitly with the limitations of paleoenvironmental and paleoecological data (Chapter Four), the inherent problems with reconstructions based on these data (Chapter Five) and the PRISM global paleoenvironmental model (Chapter Six). Following some critique, the PRISM data is employed as a global reconstruction of conditions at the Plio-Pleistocene boundary against which the data used in Holmes' model are assessed and evaluated. These chapters, moreover, explore a wide range of factors influencing the quality of paleoenvironmental data, including several often ignored by physical scientists. In particular, Holmes' discussion of the importance of foreign policy, war, logistics, and historical events in determining paleoanthropologists' access to relevant deposits, and the role of scientific philosophies and traditions as controls on the nature and perceived quality of published data, are highly enlightening.

The purpose of Holmes' critique of paleoenvironmental data, however, refreshingly is not to argue against the use of particular sources or types of evidence (a trend which, although undoubtedly based on sound assessments of data quality, may restrict paleoanthropological enquiry so much that new insights are jeopardized). Instead, Holmes argues for the importance of explicit discussion of all biasing factors, to enable readers to properly assess the risks associ-

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ated with the use of particular data. Despite her recognition of the imperfections and biases of paleoenvironmental evidence, therefore, Holmes provides a convincing argument for the development of geographically explicit models of hominid dispersal and clearly justifies her choice of techniques and data.

Having developed this argument, Holmes continues to emphasise the detailed evaluation of paleoenvironmental records throughout her work, making the following chapters—on the geography and climate of her study region, the Old World—not only a valuable synthesis of the paleoenvironmental evidence but also an extensive critical discussion of the overall quality of the available records. Chapters Seven and Eight present the conditions across most of the Old World, organised by region, but Holmes also has a chapter dedicated specifically to Indonesia and the Siwaliks, as these represent both an important paleoanthropological region—the area with some of the earliest non-African hominid remains—and one that is particularly poorly understood. All three chapters, however, draw upon a huge range of sources of floral, faunal, and geological records and provide an extensively referenced guidebook to Plio-Pleistocene Eurasia which will be invaluable to many researchers otherwise faced with a bewildering and extensive literature on the conditions of particular sites or records. In particular, Chapter Seven is noteworthy for its in-depth discussion of the evolution of key geographical features like the Tibetan Plateau, the Zagros and Caucasian mountains, and the Nile River. These landscape features are often considered to be temporally invariant in models of past conditions, with many (like the PRISM model used in this work) simply substituting current topographic maps for attempted reconstructions. As Holmes points out, such substitution can have severe consequences for the accuracy of models, with the Himalayas, for example, potentially only half their current height during the early Pleistocene—a difference with implications not only for vegetation and water resources, but also regional monsoon circulations.

Sadly, however, the book is poorly illustrated. Despite a focus on spatial and temporal pattern in environmental parameters (subjects which instinctively seem to demand illustration) the entire 154 page book includes only 20 figures, with just one each in Chapters Seven and Eight. These chapters instead rely upon highly detailed written accounts of paleoenvironmental records and make reference to geographical features and points which those who are non-specialists in a particular region will likely find unfamiliar. Furthermore, some of those illustrations which were included, particularly those relating to the distribution of Pliocene vegetation (Chapter Six) and the GIS model results (Chapter Ten) suffer noticeably from conversion to the black and white format typical of British Archaeological Reports. Many journals now require that adjacent color-categories in shaded diagrams differ by 15%, and the figures presented here (with eight vegetation categories and backgrounds to display) are difficult to interpret as a result of not following similar conventions.

The model mentioned in the book's title is presented in the final three chapters of Holmes' work, along with a set of statistical analyses using the same environmental data which serve to test the results. The chief virtue of these chapters will lie in their detailed discussion of these processes of analysis, which will prove valuable to anyone interested in developing similar models or evaluating this one in more depth. In line with earlier emphases on data quality and checking is the fact that Holmes' GIS results include not only a graphical representation of possible hominid dispersal pathways but also a confidence map to allow evaluation of the likely reliability of those results. The accompanying statistical analyses build upon these results and confidence intervals to identify locations where hominids might be expected to survive (and hence confirm the GIS results) as well as locating regions and areas where further research might be beneficial. These chapters therefore not only support the utility of Holmes' model (even if specific results are necessarily tentative), but also present new hypotheses about the timing and route of hominid dispersals which can be evaluated by future research, providing a robust platform for paleoanthropologists to build upon the model's results.

To summarize, this book clearly represents an important contribution to the emerging fields of paleoanthropological modelling and dispersal research, being both one of the earliest and most comprehensively reported studies of its type. It is well written and extremely well-referenced, and the author has clearly given much thought to the layout and structure of the book, much to the benefit of her readers, who might otherwise easily get lost in the volume of data presented. My main comment, in fact, is that the title and abstract of this book do not fully convey its relevance to the wider field of hominid paleoecology and paleoenvironmental science in providing a clear, in-depth, and critical synthesis of paleoenvironmental records across the Old World. The book's first nine chapters, presented as the background to the model developed in Chapters Ten through Twelve, are of relevance to paleoanthropological research in their own right, and will provide a useful reference source for researchers interested in hominid paleoenvironments, paleoecology, and the nature of the fossil and paleoenvironmental records. While the field of paleoanthropological modelling is relatively small, this relevance expands the potential readership of Holmes' book substantially, and it will likely prove a useful addition to the bookshelves both of those specifically interested in modelling hominid dispersal and those with a general interest in the techniques and data used in the study of hominid paleoenvironments.

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