CHAPTER 8

Out of Africa, into South Asia: A Review of Archaeological and Genetic Evidence for the Dispersal of *Homo sapiens* into the Indian Subcontinent

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Introduction

The Indian subcontinent was one of the first major geographic areas occupied by anatomically modern humans (AMH), following south coastal dispersal from our African homeland sometime in the Late Pleistocene.[1-3] Genetic reconstructions suggest that between about 45 and 20 thousand years ago (ka), the majority of *Homo sapiens* may have lived in India and Southeast Asia.[4] Understanding this dispersal process more clearly would therefore help us resolve critical questions over: (i) the timing of human dispersal to other parts of the globe (including Europe and Australasia); (ii) the technologies that accompanied the dispersing groups, and subsequent cultural evolution; (iii) the environments that were initially favoured, adapted to and modified by these groups; and (iv) the physical characteristics of the dispersing humans, including anatomical and cognitive configurations.[5]

Unfortunately, the paucity of reliably dated archaeological evidence from the subcontinent, and especially an absence of skeletal elements from the relevant period, has resulted in widely divergent perspectives on the initial colonization of this region. Even with an unprecedented wealth of ancient genomic material now emerging, and ever-increasing chronological resolution for AMH occupation of regions such as western Europe,[6,7] the Indian subcontinent remains something of an enigma. This problem has been compounded in recent years by reviews that either (a) conflate key aspects of the initial movement of *H. sapiens* out of the African continent – into the Levant and Arabia – with the timing and characteristics of subsequent, related AMH dispersals into the subcontinent and beyond, or (b) link evidence from widely separated times and places into overly simplistic scenarios.[8-12] Here, we highlight the problems with these existing models, and instead suggest that the AMH dispersal towards and past India was a regionally diverse process. We illustrate our ideas using the intensively-studied and often-discussed sites around Jwalapuram in the Jurreru Valley, southern India.

Early Dispersals – A Clarification

A critical distinction is needed between ephemeral movements of people outside Africa and successful dispersals that result in the founding of long-term lineages.[3,8,13] Ephemeral AMH dispersals could, in theory, have occurred at any time since the emergence of our species, but the patchy nature of the archaeological record and paucity of diagnostic fossils means that many or most of these processes will be undetectable. In fact, when we find coherent and widespread evidence for human occupation of an area we should assume that we are seeing a reasonably successful and long-lived settlement, simply because of the time and repeated activity needed for material to accumulate to the point where we can locate and recognize it. For example, the early Levantine occupation by hominins assigned to *H. sapiens*, which occurred prior to 75 ka,[14] likely lasted tens of thousands of years before humans were locally extirpated.[6] An Arabian occupation during Marine Isotope Stage 5, possibly attributable to *H. sapiens* on the basis of lithic typology, may have done the same.[15]

Because ephemeral movements will most often leave either equivocal or no evidence, we may never know with absolute certainty whether isolated *H. sapiens* groups wandered into areas far from Africa, for example Australia or western Europe, at such early times as 150 or 100 ka. Currently we have no evidence for such occupation, but it remains theoretically possible. In searching for early dispersals, however, two points need to be kept in mind. The first point is practical, in that the further we move from the origin point, the more likely it is that a buildup of detectable occupation would have occurred in the intermediate zone, in order to sustain the minimum population size required to permit further expansion. We are, therefore, unlikely to discover evidence that Australasia was occupied 50,000 years ago,[16] without also recovering data from further west on the dispersal route – in India and/or Southeast Asia – and further back in time. However, the reverse is not necessarily true. Early occupation evidence from the Levant or Arabia tells us nothing unequivocal about either the timing or characteristics of future events further east on the dispersal route. Such evidence only tells us that there must have been viable human populations west or south of these findspots (i.e., in East or North Africa).

The second point is theoretical, and relates to the reasons we search for early dispersals in the first place. If we aim to address broad questions of the kind posed in the introduction, then ephemeral movements are irrelevant, in a real and important way. They cannot tell us why or how successful human global colonization began, or continued, because they are by definition disconnected from that larger process. Rightly or wrongly, therefore, there is less academic interest in discovering (or claiming to discover) ephemeral events, with the result that findings are often tied to larger processes by default. For example, the authors of the MIS 5 Arabian study cited earlier,[15] suggest that their evidence may imply AMH presence in India prior to the Toba eruption around 74,000 years ago. However, the study's Arabian findings, while critical to debates about early movements of humans outside the African continent, do not provide any data that support this wider claim.

Furthermore the lack of diagnostic fossils at sites like Jebel Faya[15] or further north in the Arabian Peninsula offers no physical confidence in those Jebel Faya tool-makers being AMH rather than archaic *Homo*. Indeed, although no Neanderthal (or any other human) fossil remains have been identified in the Arabian Peninsula for the relevant periods, there is notable evidence for adaptive introgression of two different putative Neanderthal HLA loci into the ancestors of modern human populations now living in the Arabian Peninsula region, specifically in Oman and UAE (figures 3E & S6A in Abi-Rached et al.[17]), also with significant rates of one of these loci throughout the subcontinent particularly in Tamil Nadu. Though unconfirmed and thus circumstantial, these local genetic anomalies raise the alternative scenario of local AMH admixture with already-resident Neanderthal-related Archaics, occurring in the same regions as Jebel Faya and south-eastern India, following the initial AMH African exit. At the least, they do not rule out this possibility.

This example is not intended to single out one research site, but to highlight the fact that similar, often premature, attempts to address wide-ranging questions from isolated pieces of evidence are found in many recent studies.[8, 9, 12, 18-24,79] In some cases reality is severely distorted in the process: for example, one recent discussion[25,26] of the potential climatic impact of the 74 ka Toba volcanic event - a key reference point for many debates over human dispersal into the subcontinent - presents an upside-down graph of the well-known Hulu Cave climate sequence from China.[27] This error turns cold stadials into warm interstadials in Mark et al.'s[25] analysis (for example, their placement of Greenland interstadial 21 is actually the stadial between interstadials 20 and 19 in the Hulu record), resulting in a highly inaccurate 'correlation' between climate records.[22] Mark et al.,[25] therefore distort, by several millennia, the climate background against which human evolution in southern Asia can be assessed. It is obvious that the perpetuation of error over fact cannot advance our understanding of past events, and it is likely that a focus on more local rather than global processes, as well as more careful use of existing datasets, will be necessary to improve analytical rigour in the Out of Africa debate.

Into the Indian Subcontinent : the evidence

The two most prominent current models for modern human colonization of Southern Asia have been termed the *Microlithic First* (MLF) and the *Middle Palaeolithic First* (MPF) hypotheses based on the type of artefacts proposed to have been carried by the dispersing groups.[28] Recent syntheses succinctly outline both the MLF and MPF models and their flaws, and the reader is directed to those reviews, as well as Table 1, for further details.[21,12,29,28,3] As it stands, the comprehensive and often convincing nature of rebuttal provided by opposing scholars strongly suggests that neither the MLF nor MPF models are adequate alone in their current forms. Both of these models are associated with their chief archaeological proponents in English universities.[8-10,18,12] We acknowledge, however, that these models have clear antecedents and draw on important data from proposals by South Asian archaeologists such as H.D. Sankalia,[30,31,33] S.A. Sali,[34] S.U. Deraniyagala,[35] N. Perera,[36] and S. Mishra,[38] and these scholars deserve recognition rather than the marginalization that appears to have extended to recent times.[37] In a relevant recent example, Mishra et al.,[38] present an alternate two-stage dispersal (TSD) model for colonization of India, which incorporates elements of both the MLF and MPF scenarios and adds welcome flexibility and new data to the debate (Table 1).

Here, we outline the available evidence from the subcontinent, concentrating on the first two of the four questions raised in the introduction: when did AMH first successfully colonize the subcontinent, and what technologies did they bring with them?

Table 1. Characteristics of models for initial, successful, Anatomically Modern Human (AMH) dispersal into South Asia

	MLF[1]	**MPF**[2]	**TSD**[3]	**ISD**[4]
Date of earliest AMH arrival in South Asia	MIS4/3, after the Toba eruption	MIS5, before the Toba eruption	MIS 4, after the Toba eruption	MIS 4, after the Toba eruption
Colonization route	Southern, coastal	Southern, riverine	MIS 5 through Central Asia; MIS 4 through South Asia	Initially northern across South Asia, later expansion south
Lithic technology	Microlithic, including backed blades and microblade cores	Middle Stone Age (MSA), with prepared cores, scrapers, points	MIS 5: Middle Stone Age; MIS 4: microlithic	Variable, including derived MSA and later microlithic
Technology similar to	South and East African MSA	South AfricanMSA; SE Asia; Australia	South and East African MSA	African MSA, with convergent and independent traditions
Accompanying artefacts	Ostrich eggshell beads, bone tools	Not specified	Not specified	Unknown
Technological discontinuity caused by AMH arrival	Between Middle Palaeolithic and microlithic	Between Acheulean and Middle Palaeolithic	Between Middle Palaeolithic and microlithic	Between Middle Palaeolithic and microlithic
Contact with archaic hominins in South Asia	Potential interbreeding in South Asia	Replacement of archaic hominins by AMH in MIS 5	Archaic hominins prevent AMH dispersal until MIS 4	Interbreeding, late survival of archaic hominins in refugia
Effect of Toba on AMH in South Asia	None, no AMH in South Asia at the time	None, AMH technology shows continuity pre- and post-Toba	None, no AMH in South Asia at the time	None, no AMH in South Asia at the time
AMH populations continue from first arrival to present day	Yes, as seen in genetic data	Yes, but later expansion hides early genetic signal	Yes, as seen in genetic data	Yes, as seen in genetic data

[1]*Microlithic first model;* [2,8 12] *Middle Palaeolithic first model;* [10, 2,-29,] [3] *Two-stage dispersal model* [38]; [4]*Indian Staged Dispersal model* (this study).

When did H. sapiens *First Successfully Disperse into the subcontinent?*

The known fossil record of the subcontinent is unable to tell us when AMH reached the region,[39] or whether it was as early as elsewhere in Asia, with the earliest unequivocal *H. sapiens* skeletal material found in Sri Lanka after 40 ka.[40] We are unfortunately reliant therefore on evidence from further east acting as a *terminus ante quem*. In this regard, skeletal evidence of AMH presence in Sahul and East Asia by 40 ka,[41,42] in North Borneo, Southeast Asia by at least 46 ka;[43] and Laos by 63-46 ka,[44] along with archaeological evidence for human presence in these regions from at least 60-50 ka gives us an initial conservative baseline.[41,16,45] Closer to the upper bracket, suggested above by genetic founding date estimates, are two old fossil dates: a 3rd metatarsal (of uncertain hominin species) dated to c. 67 ka from Callao Cave, Luzon, the northern Philippines[46] and the Liujiang complete AMH cranium found by fertilizer collectors in a cave in south China with a minimum date of 68–67 ka, based on the flowstone previously overlying the breccia in which the skeleton lay. Older dates suggested from unrelated objects within the breccia (139-111ka and even $\geq$153 ka) could just be coincidental. Sadly the skull has not been directly dated.[47] The lower date of 67 ka for the Liujiang skull would be well within the range of the Far Eastern mtDNA M-lineage age estimate (60.5 ka; 47.3-74.3).[48]

To help fill the fossil lacunae, previous authors have used Indian stone typologies as proxies for population movements, which was a reasonable strategy when stone tools were the only available evidence. This practice is reflected in the labels given to the MLF and MPF models by Clarkson,[28] both of which reference lithic traditions. Australia, which has direct AMH fossil evidence at 41ka,[49] offers a special case for the specificity of even *older* cultural dates, since there is general archaeological agreement that no other humans reached that far. Most recently, Clarkson et al.[45] have reviewed the evidence of the earliest visible evidence of human colonization (Malakunanja II in Australia's north) in detail; and have vindicated a previous luminescence-based dating report in 1990 for human occupation there by 60-50 ka. This date bracket is consistent with several ages for Australian and Melanesian mtDNA founders.[50] Although stone tools are poor indicators of biological affinity, as discussed at length below, relative concordance near the terminus of AMH spread around the Indian Ocean could possibly offer some perspective further back in India and Southwest Asia, where fossil evidence is lacking.*

Genetic and genomic approaches introduced from the late twentieth century onwards have greatly improved our understanding of population movements, particularly when used with fossil and cultural evidence such as stone tool types and technology from a multidisciplinary perspective. As summarized by Oppenheimer,[2,51-53] genetic data (both from uniparental and autosomal loci, and from modern and ancient DNA) are proving extremely useful, independent sources of evidence for ancient population founding extensions. Uniparental loci provide both specific phylogeographic and temporal information on lineage founding dates (particularly for mtDNA) as a proxy for population arrivals, so far largely confirmed by new work on autosomal loci. Autosomal loci make up for their lack of phylogeographic depth and specificity (resulting from recombination), by far greater sensitivity for archaic markers identified from aDNA, and thus uniquely provide quantitative point mutational evidence for interbreeding between modern and archaic *Homo* taxa as well (*through comparisons of Single Nucleotide Polymorphisms – SNPs e.g., Reich et al.[54]). 'Conversely, uniparental genetic lineage data, sourced from either mitochondria (female ancestry) or the Y-chromosome (male ancestry), having greater drift are insensitive to the point of blindness to small archaic admixtures. However, they are extremely powerful and specific phylogeographically, and thus particularly useful for mapping dispersal routes and times, since they give unambiguous tree-like ancestral histories for diverging lineages, the mutation-defined founding nodes of which are datable and have highly specific geographic distributions. This allows unique lineage-based migration-modelling, relatively free from the prehistoric fuzzyness of population-based autosomal-marker modeling. The chief limitation of mtDNA founding age estimates are their comparatively wide confidence intervals (as is found in all direct age estimates based on genetic markers).

From a logical perspective, the single dispersal that led to the successful AMH colonization of Eurasia, cannot credibly predate the upper confidence limit (78.95 ka)of the estimated age (corrected for non-linearity) of the African root source ancestor for all non-Africans: the mitochondrial L3 lineage (70.2 ka; 61.6-78.95, see Soares et al.,[48] contra uncorrected 78.3 ka: see Fu et al.[42]). A similar, less well-constrained estimate has been made for the derived L3-195 branch (71.5 ka;57.1; 86.6, see Soares et al.[48]), which is directly ancestral to all non-African lineages (i.e. its two ex-African-L3 daughter lineages M and N, and their descendants).

It has been argued, as sample sizes and corrective methods have improved, that initial estimates for an AMH out of Africa expansion that overlapped with the Toba eruption at their upper limits are no longer tenable,[55,12] undermining arguments for the MPF model that relied on those upper limits for credibility.[18] However, the corrected confidence intervals used for this relative argument indicate that, while the age estimates for N in west Eurasia[48]and of L3 in Africa[45]are respectively ~72 ka and ~70 ka, i.e. slightly younger than Toba, the upper confidence limits for both estimates are much older than Toba, respectively by ~16ka and ~5 ka–i.e. thus not absolutely excluding the possibility of the African exit preceding Toba(which point they do acknowledge). These upper confidence limits, however, do post-date MIS5 ages in Arabia (Jebel Faya), which are attributed to *H. sapiens* on the basis of lithic typology,[15] and also post-date AMH fossils from Skhul and Qafzeh in the Levant.[77]

A key point to reiterate here is that the dates for an AMH exit from Africa, and the dates for AMH occupation of any given part of India, are not in any way necessarily linked. We do not particularly argue for the pre-Toba Out of Africa scenario and do, incidentally, agree that a post-Toba exit appears more likely. But we feel that the closeness of the genetic Out of Africa estimate and Toba-ash dates and the apparent similarity of lithic traditions either side of the fossil-free Indian ash layer in sites around Jwalapuram (see below), could be somewhat of a red herring in the context of AMH arrival there. Indeed, given the absence of any fossils, the Jwalapuram/Toba discussion may be addressing the wrong hominin *and* date question (i.e. the AMH Out of Africa date), vs an alternative date scenario already suggested by some South Asian archaeologists,[38] namely limited Archaic persistence and continuity in Central (i.e. inland) India, which was by-passed by AMH *en route* to East Asia. In other words the full AMH occupation of inland peninsular India might have been delayed.

Is there any other archaeological or genetic parallel for delayed or piece-meal occupation of Eurasia by AMH vs the sudden takeover that might be inferred from the relatively early dates (above) for East Asian AMH occupation? Europe is certainly a good parallel example of occupation delay, both from archaeological[57] and genetic evidence.[58]It should be noted that like India, and unlike the rest of western Eurasia, southern Europe had a relatively wet Late Pleistocene climate and might have supported substantial hominin populations. Indeed, while AMH presence in the Near East by 55 ka is evidenced from a cranial fossil in the Levant[59] and supported by genetic coalescent ages for N in the Near East and west Eurasia at around 62 ka,[48,60] both genetic and archaeological evidence indicate a delay before progression to Europe,[57,58] with founding European genetic dates at ~50 ka[58] and archaeological evidence of arrival at ~ 45 ka.[57] Such a delay of AMH extension from the Levant into Europe might be consistent with the substantial presence of Neanderthals in Europe at the time.[57]

The successful movement of AMH into peninsular India should be constrained at its upper limit by the documentation of lineages known to have arisen in the region. These are surprisingly young. They do in fact offer genetic evidence that would be consistent, with a scenario of delayed occupation in southern India. This can be inferred from the distributions and founding ages of the Indian derivatives of the three main founding mtDNA lineages in Eurasia (M, N and N's oldest offshoot lineage R).

We can start with M lineages, which are far more numerous than N/R lineages in India, both in relative frequency and in absolute numbers of lineages, unique to that region.[61,62] M is absent from the Near East and Europe and, going east from Africa, first appears on the map in India. So, it might be expected that secondary founding M sub-lineages should be older in India than anywhere further east. The puzzle is that it is the other way round. The numerous unique *indigenous* M lineages found in modern peninsular India, although being predominantly distributed in India, Bangladesh and southeastern Pakistan, are systematically younger than calibrated founding N, M & R ages anywhere else in Asia and, correspondingly, show evidence of early drift from the M root. The overall coalescent age of indigenous Indian M lineages is 49.4 ka; (CI 39.0-60.2[48]).The overall Indian M coalescent is thus 12.5 ka younger in comparison to west Eurasian N (61.9 ka; CI: 49.2-75.0;[48] see also N-xR ~61.1 ka, 50.4-72.1,Figs. 1 & S1 in Fernandes et al.[60]) and 11.1 ka younger than the M coalescent in East Asia (60.5 ka; CI 47.3-74.3[48]). These regional discrepancies in M ages have been remarked on by several authors (figure 3 in Oppenheimer;[51] and Table 3 in Soares et al.[48]).Individual ages of the numerous indigenous, founding Indian M branches (e.g. M: 2-6, 18, 30, 33-41as dated in Soares et al.[48]) are variably younger than the ~49 ka of their combined coalescent, mostly ranging between 30 - 40 ka, the oldest being M33 at ~45 ka.

Given that individual M lineages are older in East Asia than India, particularly Southeast Asia, and are not found west of India, questions arise as to where the young 'India-specific' M branches derived from. This means surveying for Indian M lineages that have shared *deep* ancestry in non-Indian regions, other than just the shared M root or recent gene flow. With increasing complete sequence mtDNA surveys published, such deep links are appearing and most seem to be coming from further east.

South of the Himalayas, the closest potential M-source region is indeed Southeast Asia, in particular Myanmar and MSEA. Firstly, M-lineage backflow west from Southeast Asia *does* occur and has been recorded as far west as East Africa, famous for its unique, large, African M1 branch, which belongs to M1'20'51defined by 14110ns,[61]which, although absent in India, has its deepest branches in Southeast Asia and dates to ~60 ka.[63] The oldest two of the three sub-clades are M51(~37 ka) and M20 (~40) which are widespread in MSEA and less common in ISEA.[63-66]A recently identified M1'20'51 branch 'M84' is also specifically from Myanmar.[67]

Other M branches shared around the Indian Ocean include super-group M4''67 (~48 ka[63]), which has multiple named root branches (~9), found in India, and two root haplotypes unique to MSEA and also two Indian branches M30 (~26 ka) and M37 (~38 ka), which both have non-recent MSEA representatives.[63]Recently multiple M4''67 sub-clades, M4, M30, M38, M45, M54 and M63(~ 44 ka) have also been identified as deeply shared, from their roots, between Myanmar and India, as also is M58.[67]

Further afield Kumar et al.[68] noted that Australian M42 (~55 ka) was shared with India, respectively as M42a (~45 ka)and M42b (~41 ka), suggesting an expansion split somewhere between SEA and Australia. A related branch of M42'74, namely M74 (~47 ka[63])has been identified, both in East Asia[66] and widely in SEA; a pre-M42'74ancestral haplotype has also been identified in Vietnam.[63]

Finally, the enigmatic M31 and M32a lineages of the Negrito Andaman Islanders have specific links with the both the Indian subcontinent and SE Asia. M31 is shared with Northeastern India[69] and the Tharus of Nepal[70] and M32c is found in Malays and Madagascar. Furthermore, M32 (~56 ka[63]) is part of super-group M32 '56, and M56 is found among the Austro-Asiatic-speaking Korku tribe in India.[69]

This evidence suggestive of M-colonisation of India backwards from Southeast Asia concurs with the overall relative distribution of Indian M towards the east when compared with that of Indian N (e.g. see Metspalu 2004; Figs 1-3).[62]

N has a slightly different distribution pattern from M in India, tending towards the west. N, in Indian overall, is represented mainly by R lineages with older overall age coalescent estimates for both N and R than in the Arabian Peninsula, being respectively ~71 ka and ~67 ka.[48] This overall relative antiquity, may, however, only reflect that both the relevant N and R lineages likely originally emerged further west, somewhere around Southwest Asia or the Persian Gulf, and not in South Asia.[71,60] Indeed, by comparing Indian and Iranian populations, Metspalu et al.[62] argued that the initial split between West and East Eurasian mtDNA haplogroups was located between the Indus Valley and Southwest Asia.

The overall Indian N antiquity of 71 ka is not, however, reflected in the much younger founding ages of indigenous N/R lineages of the Indian Peninsula, where Nis again almost entirely represented by R. Furthermore, there is a clear north-south distinction between, on the one hand, ages of two uncommon, elderly, northern Indian branches R30 and R31,[62,72] which age respectively ~64 ka and 64.5 ka[48] andthe 7 indigenous R branches of the Indian Peninsula, R5-R8 and U2a-c, which date between ~27.5kaand ~51.1ka.[62,72,,48]

R30 is commonest in Nepal and a neighbouring part of north India, the Punjab,[70,72-74] although its basal deep-branch R30ais also found as single complete-sequence instances in Sri Lanka,[72] Nepal,[70] and Sumatra, Southeast Asia.[63] R31 is rare and found in Rajasthan and the Punjab in northwest India, Sri Lanka and the northeast coast of peninsular India (Li et al. 2015, Fig.3).[67] In the northwest, two other N branches U7 (21.8 ka11.5:32.6) and W, a branch of N2 (20.1ka)[60] achieve relatively high frequencies in northwest India (Gujarat), Iran, Pakistan and southwest Asia and consequently have not been regarded as India-specific[62] or even South Asia specific.[48]

In contrast to the rest of the subcontinent, India-specific N branches (R5-R8 and R/U2) constitute the bulk of peninsular Indian N[62,72] and, like Indian M branches, are surprisingly young and drifted, when compared with their regional parent N and R ages estimated overall for the subcontinent (~71 ka and ~67 ka, see above). Haplogroups R5-R8 range in age from 36-51 ka (R5~38 ka; R6~51 ka; R7~36 ka; R8~42 ka).[48] The India-specific U2 lineages U2a,b & c[62] have a young coalescent of ~53.5ka(CI 40.3-67.2,[48]), in a similar range to Indian M (49.4, 39.0; 60.2) and, individually, are even more drifted and younger in range than R5-R8 (U2a~28 ka; U2b~34 ka; U2c~35 ka[48]).

The U haplogroup likely originated in Southwest Asia (~55.8 ka;[48,58] see also Metspalu[62]) and spread west into Europe later (as the oldest European mtDNA lineage U8 (~51.3 ka[58]) and to the southeast towards India as Indian-founding U2 (~53.5 ka), suggesting a common Southwest Asian origin and a 2-way expansion. Indian U2 was previously known as U2ito distinguish it from the related, younger and more numerous South west Asia and European U branches (including European U2e). U2 includes two much younger derivative European branches: U2e (derived from U2c'd'e aged ~17 ka) and U2d (derived from U2c'd) which likely migrated there from South Asia in the Medieval period.[75]

To summarize, a pattern can be discerned for the main indigenous peninsular Indian mtDNA lineages derived from M, N and R, in that their local founding ages in the peninsula are considerably younger than those of their ancestral lineages either in West or East Eurasia. This pattern not only shows similarity with the delay demonstrated in the age of the oldest European genetic founding branch (U8: 51.3ka,CI 44.0; 58.8), but also in a common age and ancestry (i.e. from southwest Asia) of that founding European branch with Indian-founding U2.

These postulated late AMH expansions in opposite directions towards Europe and India at around 50 ka, might not be coincidental, given the shared lineages and climatic amelioration in the region at that time (see T.H. van Andel and P.C.Tzedakis,[76] Chapter III in Oppenheimer[2]). Are there any archaeological event-parallels for such delayed AMH expansions? For Europe there are blade technologies such as the Emiran in the Levant from around 47 ka, e.g. Boker Tachtit[77] followed by the spread of Aurignacian technologies into Europe around 45 ka.[57]It is tempting to suggest the appearance of the earliest microlithic in India from 45 ka followed by continuity and spread[38,36]as a cultural parallel to the European sequence. This model, however, would demote the Indian microlithic from a *Microlithic First* role used in dating Out of Africa[8] to a local, Indian colonising event, arriving later and perhaps from the Levant. The same model would also undermine the MPF model, which posits the in situ AMH development of the Indian microlithic out of the preceding Middle Palaeolithic.[18,19,32]

This tentative *Indian Staged Dispersal* (ISD) model could fit with the genetic evidence given above for a late movement of AMH into the Indian Peninsula and the European Aurignacian, but it also raises two related questions: why were peninsular India and Europe so much more difficult for

AMH to penetrate and consequently, which route did AMH take to by-pass India en route to Southeast Asia in order to demonstrate their much earlier presence there as discussed above?

The answer to the former can only be speculated, but the relatively favourable Pleistocene climate and environment of both peninsular regions (India and Europe), presumably supported sizable and vigorous local populations of archaic humans, when compared with mostly arid Southwest Asia and the Middle East, which would have been the first bleak home of AMH outside Africa. The larger pre-resident population might have been tougher to overcome than small isolated desert populations. Two parallel but different-pronged later clashes between AMH and different resident archaic populations in India and Europe might predict discrete and distinct regional admixture events in the respective subcontinents. There is some suggestive specific HLA genetic-admixture evidence for this scenario in a single report by Abi-Rached et al. (see figure 2 for Denisovan admixture and figure 3 for Neanderthal admixture).[17]

The second question comes down to which by pass route to Southeast Asia, AMH might have taken: going north of peninsular India (either north or south of the Himalayas) or round the Indian Peninsula via the coast as previously suggested by default on the southern coastal-route theory.[2] For the latter, there is no local fossil or cultural evidence above present sea level nor genetic evidence of sufficient antiquity. For the northern by-pass route, possibly following the Indus River then northwards via the Khyber Pass, there is no direct evidence of AMH north of the Himalayas before 45 ka.[42]

Facilitating a route just to the south of the Himalayas, several by-pass river routes do exist, going north of Rajasthan and the Thar Desert, up the Indus River and then downstream via the Ganga Valley to the Bay of Bengal. Again there is no direct fossil nor cultural evidence of sufficient antiquity, except for the afore-mentioned presence of mtDNA R30 in Nepal and northern India (e.g. the Punjab) and R31 in Rajasthan (NW India), Sri Lanka and NE India, dating as mentioned above respectively to ~64 ka and 64.5 ka,[48] thus of reasonable unique antiquity to mark a conduit to Southeast Asia.

Collectively, a realistic estimate for the initial dispersal of modern humans into India is therefore around 60,000 years ago, and perhaps a little earlier (i.e., MIS 4). This is not a revolutionary conclusion; genetic and archaeological evidence has converged on this figure over the past few decades.[8,53] A minority view that modern humans successfully colonized the subcontinent during MIS

5, prior to the 74 ka Toba eruption, now looks increasingly untenable,[12,38] whether or not AMH had moved out of Africa and into its immediate surrounds (e.g., Arabia) by that time. As an exercise, it is instructive to return to the first major statement of the *Middle Paleolithic First* model,[18] which posited that:

> '(i) evidence of hominins flexible enough to exhibit continuity through a major eruptive event, (ii) technology more similar to the Middle Stone Age than the Middle Paleolithic, and (iii) overlap of the Jwalapuram artefact ages with the earlier end of the most commonly cited genetic coalescence dates may suggest the presence of modern humans in India at the time of the YTT [Toba] event.'

The third of these reasons may plausibly apply to sites in or just outside Africa, but there is no firm evidence that warrants bringing India into the same picture. The first reason is ambiguous as to its meaning, but given that Neanderthals, Denisovans and *Homo floresiensis* all survived Toba and its outfall, along with a wide variety of other Southeast Asian mammals, it also appears an unreliable crutch for the MPF model to lean on.[78,79] The second reason is considered in the next section, which surveys the material culture accompanying the dispersing groups.

What Material Culture did the Dispersing Groups Possess?

The question of which tool types the dispersing groups carried is a perennial one, and as noted, stone tools provide typically the only available data on when and where Indian hominins were living. However, practically all researchers involved in Late Pleistocene hominin dispersal or contact debates explicitly dismiss the equation of stone tool types with biological groups.[77,80-82,6,38,29,28,3] A possible exception is microlithic traditions in India, where apparent continuity from at least 45 ka to historical times, and association with AMH skeletons after 40 ka, provide a justification for considering at least some of these traditions to be the product of *H. sapiens* behaviour.[83,36,12,38] To be considered reliable, however, the microlith-AMH link needs to be explicitly argued rather than assumed for each local area in India, a process yet to occur. Of course, even if acceptance of that link would help resolve the latter part of the Indian record, it does not presently clarify the initial AMH dispersal through the region around 60 ka.

Having cautioned against reliance on stone tool forms or technology as a guide, it is therefore surprising that the same authors continue to suggest lithic markers as biological proxies in India.[84] A large amount of the heat in the debate over a MIS5 or MIS4 *H. sapiens* dispersal derives from precisely the contention that stone tool forms characterize the dispersing groups. Compounding matters further, India lithic technology is argued to have a direct and demonstrable connection to technologies thousands of kilometers away, either in South or East Africa,[18,81,12] despite a lack of supporting finds in the intervening regions. It should be noted also that while the MLF and MPF models both stress a link to southern African stone technology, the available genetic evidence does not support a movement or expansion of people from southern to eastern Africa at any time close to the MIS4 or MIS5 dates suggested by these models for the out of Africa AMH dispersal.[55]

It is not only lithic technology in general, but key components of the assemblages relied on by contributors to the AMH dispersal debate, that have demonstrably failed as markers of cultural continuity. For example, so-called Nubian core reduction has been suggested to mark *H. sapiens* early movements from northeast Africa, through Arabia, to India.[85,86] Yet Nubian cores also occur convergently in South Africa,[82] greatly disconnected from the other occurrences in time and space. Independent convergence has also been shown for Levallois technologies,[87] one of the primary methods of core reduction that has been associated with AMH dispersal.[88] As noted below, the same problems beset any argument that relies on microliths as a marker of long-range dispersal,[12] rather than as more localized and repeatedly discovered innovations.

The equivocal nature of the lithic evidence means that researchers are free to express contradictory opinions: for example, Mishra et al.[38] note that, 'The transition from Acheulian/Middle Paleolithic to microblade technology is the only abrupt transition in the Indian Palaeolithic'. In contrast, Blinkhorn and Petraglia[29] suggest that there is 'clear evidence for the local development of Microlithic industries from the Middle Palaeolithic at Jwalapuram by 35 ka'. The same Jwalapuram data as that used by Blinkhorn and Petraglia[29] was earlier considered by Clarkson et al.[88] to show that, 'the only major transition took place at *c.*35 ka with the introduction of the microlithic'. The problem is exacerbated by special pleading, such as when Petraglia's favoured MPF model predicts a discontinuity between archaic late Acheulian technology and the Middle Palaeolithic carried by AMH arriving in the Indian subcontinent. In the absence of a clear discontinuity between these two traditions (a point also noted by Mishra et al.[38]), Blinkhorn and Petraglia[29] claim that the failure is in current approaches, which are insufficiently 'nuanced'. In fact, a series of discriminant function analyses conducted by Clarkson,[18,24,88] and relied on by Petraglia to support the MPF scenario, consistently differentiate the Indian Late Acheulian from the Middle Palaeolithic. Unfortunately for that model, however, the same analyses also consistently separate the Indian microlithic, undermining claims of continuity of that tradition and the Indian Middle Palaeolithic. In one analysis[18] the Indian microlithic even clusters with the Levantine Early Aurignacian, seemingly offering support to the rival MLF model.

By incorporating the consensus timing of dispersal into India, derived primarily from genetic data, the MLF and TSD models avoid some of the problems faced by the MPF model (including a lack of any definitive genetic, archaeological or skeletal evidence supporting it). However, they continue to rely on a supposed close link between African stone tools and those from the Indian subcontinent. There is no solid evidence to support that view, and convergence of microlithic traditions at different times in different parts of the world, likely for different underlying reasons,[89] indicates that their emergence in India may indeed be 'entirely coincidental'[8] when compared to the African record. As noted, the initial development of microlithic technology in India has now been pushed back to at least 45 ka at Mehtakheri.[38] However, rather than take that date as a new starting point of relevance to the whole of the subcontinent, we suggest that it is better treated initially as a phenomenon local to that region of the Narmada River. Such an approach allows for examination of the local adoption of the new technology, as well as identifying last occurrences of the previous stone traditions (Middle Palaeolithic or late Acheulian) in the area, without needing to resort to vague, subcontinent-wide processes such as demographic pressure.[19,29]

If we consider each part of the subcontinent as not necessarily representing the whole, it is clear that, even from the limited data we now have, there are regional differences in the chronological patterning of different stone technologies. This pattern should not be surprising, as the best comparative sample we currently have for AMH technological expression across a wide geographic area – the African continent – shows considerable regionalization at this time.[90] It would be highly surprising if India AMH did not have diverse behavioural responses to the very diverse environments within the region (see the maps in Boivin et al.,[84] for example), both in terms of tool forms and the gain and loss of such forms over time. The adaptations needed to survive in the Thar

Desert, even during wetter periods, can from the outset be considered necessarily different from those needed in other parts of Gujarat, or Madhya Pradesh, or Andhra Pradesh, or Sri Lanka.[91,40,21,92,12] Just what those different adaptations were and how they arose remains unclear for most regions – Clarkson's discussion of cultural founder effects is welcome in this regard – but that is no reason to ignore them.[28] Until Indian human dispersal models accept and explore the variable timing of material culture change across the subcontinent (as archaeologists have in Europe and Africa for example), they will continue to obfuscate more than illuminate.

Ultimately, it appears clear that stone typology should be relegated to a lesser role in current discussions of the initial dispersal of humans into India. Detailed technological studies, pioneered by Clarkson,[88,28] provide a more objective method for assessing the relationship between regional assemblages than typological categories, but they still require more objective interpretation than is possible under the MLF/MPF regime. Critically, they also require more in-depth discussion of claimed connections, and the mechanisms that support long-distance material culture parallels. The chief benefit of an alternate *Indian Staged Dispersal* model, as proposed here, is that it removes the imperative to make sweeping generalizations and explicitly allows for the diversity that we know exists in the Indian archaeological record.

For example, Petraglia and colleagues have used Clarkson's work to repeatedly claim that finds from the southern Indian Jurreru Valley, dated to a few thousand years prior to the 74 ka Toba eruption, have close 'affinities' to South African Middle Stone Age sites.[18,29] These include the Howieson's Poort, an industry dated 65-59 ka,[93] some 10-15,000 years after Toba erupted. It has not been explained how humans dispersing through India possessed a Howieson's Poort-like technology many millennia before the South Africans did. Do both technological suites derive from a precursor? If so, where did that precursor emerge? Did Indian techniques diffuse back along the dispersal path to the southernmost tip of Africa? Is it a response to environment, or population size, and if so why? And if the analyses document a connected and widespread technical tradition, why do East African Middle Stone Age sites not also cluster with the Indian and South African data?[18,88] While such fundamental issues unaddressed, the practice of identifying regional connections through stone traditions contributes less than it might to resolving debates.

Discussion

To summarize, we follow previous authors in proposing a successful 'Into South Asia' dispersal 65-60 ka. This dispersal post-dates the first movement of people out of Africa by an unknown amount of time, likely rather later into the Indian Peninsula and the staged processes should not be conflated. Based on AMH dispersals elsewhere, particularly in Europe but also Southeast Asia and Australia, we expect the colonisation routes to have included both coastal and riverine pathways, reaching different parts of the subcontinent at different times.[94,95,44] The fact that AMH elsewhere exhibited regional cultural diversity at this time period, and earlier, means that we should anticipate spatial and temporal unpredictability in the technology used by early dispersing groups. There is no reason at present to assume a necessary close link between Indian and Arabian, Levantine or African tool forms, and the default position should be that any resemblances between widely separated areas are convergent until proven otherwise. This applies as much to Middle Palaeolithic as it does to microlithic tools – the early AMH occupants of the subcontinent may have produced both, and finding early examples of one tells us nothing about whether the other was in use elsewhere in the region.

While there was undoubtedly substantial population growth following AMH colonization, it is not clear which areas within the subcontinent were involved, and precisely when. There is also no doubt that microlithic traditions have a long history in parts of the subcontinent, but the two processes are not necessarily linked.[38] Population expansion would have resulted a patchwork of densely clustered and scattered groups faced with varied environments (from deserts to rainforests to grasslands to coasts) employing different social and technological strategies to survive, occupying parts of the subcontinent but likely leaving other areas unoccupied by AMH. The archaeological record demonstrates that prior to AMH arrival much of the subcontinent was occupied by archaic hominins, which may have included Neanderthals and/or Denisovans, late *Homo erectus*, or related taxa.[96,6,38] By analogy with the rest of the Eurasian archaeological and genetic record, it is reasonable to assume that these populations (i) interbred to a limited extent with the arriving modern humans, and (ii) survived in different parts of the subcontinent for different lengths of time, including possibly well after the initial AMH dispersal wave arrived.

The Jurreru Valley – A Case Study

To explore these issues in a more concrete manner, we consider here a case study from perhaps the best-dated Late Pleistocene locality in India: Jwalapuram (15°19'23.9"N, 8°07'48.5"E) in the Jurreru Valley of Andhra Pradesh (Fig.1 and 2). A series of studies led by R. Korisettar and colleagues has identified Acheulian, Middle Palaeolithic and microlithic habitation sites in around the valley, and produced a series of optically stimulated luminescence and radiocarbon dates for those sites.[83,32,81,88,21] Although these finds have typically been viewed through the lens of the MPF model, it is instructive to consider them instead from a more nuanced and objective perspective, in light of the discussion in this paper.

Figure 1. In 2003 Ravi Korisettar discovered a series of Stone Age sites associated with Youngest Toba Tuff in the Jurreru Valley on the southern side of the Errajari plateau and numerous rock art sites on and around the slopes of the plateau. These discoveries led to a paradigm in the prehistory of the Indian subcontinent and ushered to the India to the forefront of ongoing global debate on out of Africa expansion of modern humans.

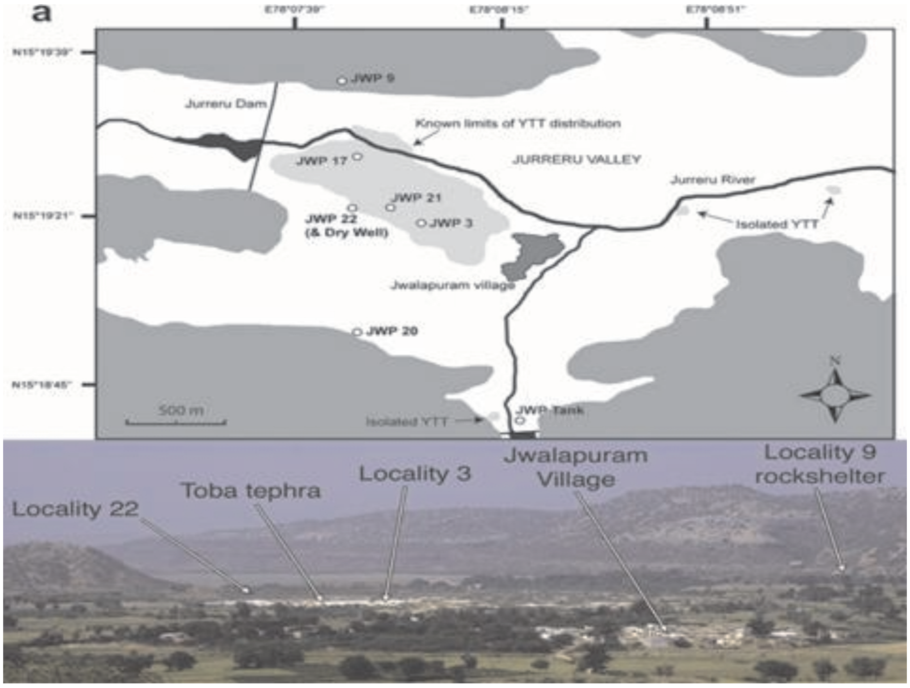

Figure 2. Toba ash and Middle Palaeolithic localities in the Jurreru Valley, Kurnool District, Andhra Pradesh.

The Jurreru Acheulian artefacts are undoubtedly the product of archaic settlement in the valley, and likely date some time prior to 85 ka, based on a small number of finds from near the base of the JWP22 excavation (Haslam et al.;[21] R. Korisettar unpublished data). Middle Palaeolithic artefacts made on tabular local limestone are found across the valley bottomlands, including beneath a distinct layer of tephra from the 74 ka Toba eruption,[18,81,24,21,] and available dates indicate artefact deposition within a few thousand years before that eruption (Fig. 3). These artefacts are similar in manufacturing techniques, materials used and sites of occupation to Middle Palaeolithic forms found above the Toba tephra, which primarily date to around 45-35 ka,[24] and not to closely after the eruption as initially claimed.[18,24] If the argument that the below-ash and above-ash artefacts are the product of the same biological taxon is accepted, based on local continuity,[88] the genetic dates rule out modern humans as their creator. Both the pre- and post-Toba Middle Paleolithic artefacts in the Jurreru Valley are therefore most likely the product of archaic hominins, which survived in the area – albeit with an apparent large hiatus after the Toba eruption – until around 40-35 ka. Such survival may have involved a relatively small population, if the decline reconstructed for Late Pleistocene Neanderthal and Denisovan populations[98] is reflected by Indian archaic groups.

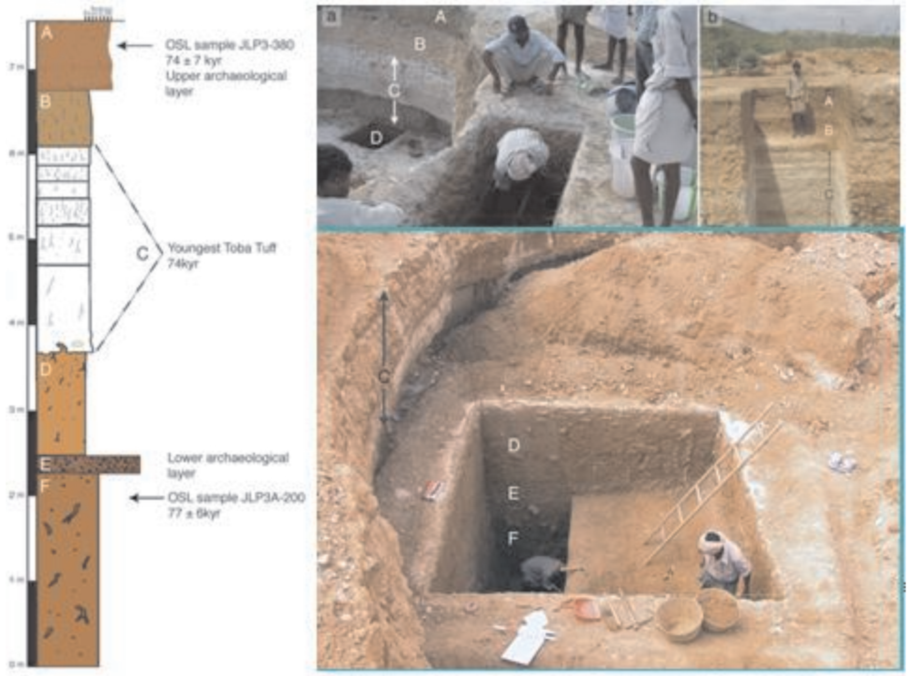

Figure 3. Stratigraphic context of the Jurreru Valley sites at Jwalapuram, Kurnool District, Andhra Pradesh.

Interestingly, the initial appearance of microblades occurs at around 38 ka in the Jurreru Valley, both at the JWP9 rockshelter site and at the open-air JWP22 site, where a single microblade core was found dating to this time period.[88,21] Microblades, including backed forms, then persist in the JWP9 record into the Holocene,[83] with associated AMH skeletal remains bracketed by dates of 20-12 ka. As noted earlier, the introduction of microlithic techniques to the Jurreru Valley was considered by Clarkson et al.[88] to represent the only major transition seen in the material culture record, although they do not see it as a sign of population replacement but of *in situ* development. Nevertheless, we see the most parsimonious explanation for the Jurreru material record to be the movement of AMH groups into the area 40-35,000 years ago, well after other modern humans had reached Southeast Asia and Australia. The replacement process in the Jurreru Valley may have taken place over a period of time rather than suddenly, based on limited evidence for technological continuity in the period ~38-35 ka, but that aspect is uncertain. If regional population increases occurred somewhere geographically close to the Jurreru at this time, as argued by Petraglia et al.,[19] then rather than prompting the invention of microlithic technology they may instead have marked modern human expansion into previously archaic territory. Under this scenario, the Jwalapuram area acts as a southern refugium for the archaic populations, much as southern European refugia saw late Neanderthal survival.[6] The existence of refugia in the subcontinent has already been noted by Korisettar.[108]

This focus on one local sequence allows us to make concrete predictions, not about global dispersals but about actual interactions and adaptations during one part of the dispersal, at one well-studied locality. For example, we propose that any hominin skeletal material in the Jurreru Valley prior to 45-40 ka will be archaic, not modern human. We also predict that microlithic technology pre-dating 38 ka (i.e., predating the widespread use of microliths in the Jurreru Valley) will be found in the regions from which the Jwalapuram AMH colonisers derived, and that archaeological evidence for population increase in the surrounding region will also date to around 40 ka. Further, we expect that South Indian Middle Palaeolithic sites with occupation characteristics similar to those in the Jurreru Valley - (i) use of riverine and floodplain open sites, (ii) heavy reliance on a single lithic material sourced from local hillslopes, and (iii) limited retouching of flakes and prominent use of discoidal and Levallois techniques – will also be the product of archaic hominins. One such potential region is the Kortalaiyyar Basin in Tamil Nadu.[99] As this latter prediction includes an element of lithic-biological equivalence, however, alongside aspects of landscape use, we recognize that it should first be tested in areas close to the Jurreru Valley rather than mapped widely within South Asia. As part of that testing process, we stress that it is only by thoroughly characterizing South Asian archaic hominin behavior that we can begin to differentiate it from that of modern humans, whenever they arrived.[100-106,20]

Conclusion

Our review highlights a need for an increased focus on the behaviour of the last archaic hominins of India, if we are to understand and identify early modern human arrivals. It is very likely that we already have samples of archaic Indian DNA, buried amongst that of living humans,[17] but it is difficult to recognize without the kind of guide provided in recent years by Neanderthal and Denisovan discoveries. That said, evidence of genetic input into the Denisovan lineage by an unknown archaic hominin,[98] and gene flow from another unknown archaic hominin into modern Africans as recently as ~35 ka,[107] raises the hope that techniques to identify South Asian archaic introgression may soon be available.

We require region-specific behavioural studies within South Asia, and for the findings of those studies to be not automatically assimilated into simplistic narratives of modern human dispersal. We suggest that in the absence of such studies, any model that attempts to explain the complete eastward AMH dispersal in a simple manner is almost certainly wrong, and ignoring important details. Human evolution has been shown to be a reticulate process,[108] and the biological and cultural effects of that process will have acted to promote both spatial and temporal variability as modern humans moved into South Asia.

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