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Cracks in the cradle? On the quest for the origins of humankind

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Knowledge in Ferment

Knowledge in Ferment

Dilemmas in Science, Scholarship and Society

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Preface

Dilemmas, fundamental controversies, basic oppositions between methods and approaches, occur in all fields of science and scholarship. Often dilemmas arise at the interface where science and society meet, or whenever several sciences or disciplines clash. The paradox of dilemmas is that although one might prefer to do without them, they are nevertheless indispensable. Without dilemmas progress in science and scholarship would be unthinkable. New paradigms come into existence and compete with the old for acceptance. Thus, by inciting researchers to make new efforts and pose new questions, dilemmas reveal new insights and sustain the ferment of knowledge.

As the Rector Magnificus of Leiden University for six years, from 2001 to 2007, Professor Douwe Breimer devoted his great talents and his best endeavours to developing and improving teaching and research inside and outside Leiden. As Professor of Pharmacology in Leiden from 1975, of Pharmacology and Pharmacotherapy from 1981, Breimer was the architect of, first, the Center for Biopharmaceutical Sciences (1983), then the Center for Human Drug Research (1987) and finally the research school, the Leiden/Amsterdam Center for Drug Research (1992). In 1984 he became Dean of the Faculty of Mathematics and Natural Sciences. Breimer's meritorious services to scientific research and to the organisation and development of science have been recognised in the seven honorary doctorates which he has received from universities all

over the world. But as Rector Magnificus, Douwe Breimer has been much more than the champion of the natural and life sciences, for he has also upheld Leiden's pre-eminence in the humanities, jurisprudence and the social and behavioural sciences. As a scientist, an administrator and especially as Rector Magnificus Breimer has been accustomed to act with circumspection, but also with decisive vigour. He has always shown himself to be one of the *esprits préparés* of Louis Pasteur's dictum, 'Le hasard ne favorise que les esprits préparés', a saying very dear to his heart. But he is also the embodiment of a proverb in his own mother-tongue, Frisian, 'Sizzen is neat, mar dwaen is in ding' (talk is nothing, but doing is something). He always was, and is, a man with style.

During his rectorship Douwe Breimer has enjoyed the deep respect and warm sympathy of the whole University. The University continues to regard him with pride and admiration. On his retirement as Rector Magnificus his friends and colleagues wished to demonstrate their gratitude by offering him this volume of studies. They have chosen as its theme 'Knowledge in ferment: dilemmas in science, scholarship and society'. In the word 'ferment' one may detect an allusion to a phenomenon in Breimer's own field of study; but it also refers to the catalytic role that dilemmas play in the development of science and scholarship. Colleagues from all Faculties and many departments of the University have contributed with enthusiasm to this volume. Authors and editors offer it to Douwe Breimer as a tribute of their gratitude, respect and friendship.

Leiden, 8 February 2007

Adriaan in 't Groen
Henk Jan de Jonge
Eduard Klasen
Hilje Papma
Piet van Slooten
Editors

To Douwe Breimer

on the occasion of his retirement as Rector Magnificus
of Leiden University

after a six-year term of office (2001-2007).

During these years he has inspired the University through
the example of his exceptional scientific achievements and his ideal
of the university
as promoter of welfare, well-being and culture.

He has exercised his office with unflagging energy, uncontested authority,
a rigorous insistence on the highest academic standards,
the wisdom of his judgement and experience,
his profound humanity
and grand style.

II

Cracks in the cradle?

On the quest for the origins of humankind

Wil Roebroeks

East Africa, two and a half million years ago: the distinctive sound of one stone being hit against another has been around for ages. Debris of this production of crude but very efficient stone tools is littered over the vast African plains, mostly around the edges of bodies of water, such as the shores of lakes and the banks of rivers. Water is a key resource in the African landscape, attracting a colourful variety of animals, both carnivores and herbivores, both hunters and prey. The tool-makers use razor-sharp flakes struck from cobbles of stone to butcher the large mammals that they managed to get access to, either by scavenging the remains of the kills of carnivores or by hunting small and/or weakened individuals. Their tools give them a cutting edge advantage over other meat eaters: when large carnivores have finished eating their prey, hominins can come in and use their heavy, sharply edged stone tools, from the cores of which they have struck the cutting flakes, to crack open the bones and feast on the nutritious marrow.

The earliest stone artifacts recovered thus far date to around 2.6 million years ago, when tool-making became an archaeologically visible part of the hominin behavioral repertoire. Tools did not make us 'human' though: when the first stone knapping debris was dropping to the ground, the last common ancestor of chimpanzees and humans had already disappeared from the globe about four million years earlier. As far as the evidence goes, the first stone artifacts – sharp-edged flakes and the cores from

which they came – were produced in Africa, but we have little idea which hominin species was (or even: were) responsible for the manufacture of these simple but efficient cutting implements. At the present state of our knowledge, at least two genera of hominins were present in East Africa at 2.6 Ma, encompassing at least six species.¹

These stone artifacts are associated with the broken up and cut-marked remains of large mammals. The tools provided their makers with easier access to meat, fat and bone marrow, the food that was locked up in the bodies of large mammals roaming the grasslands of East Africa. These grasslands had emerged in Africa as a result of the gradual global cooling down of the earth, which began millions of years before the split between humans and chimpanzees.

At about 1.8 million years ago, the variety of African hominin species can be organised into two groups, which differ from each other in a number of aspects. It is in the second group that the ancestor of modern humankind is situated: this group displays a large body mass, a more modern human-like physique adapted to open types of environments, walks fully upright on two feet and has teeth whose shape are indicative of a modern human-like diet. The first group, that of the Australopithecines, is more ‘ape’-like, the second is more ‘like us’ and is commonly referred to as *Homo ergaster*. This hominin was a proficient tool-maker and meat and animal fat formed an important part of its diet.

The first good evidence of this species comes from exposures near Lake Turkana, in northern Kenya, and dates to about 1.8 million years ago (but see below). The best example of this new body form is somewhat younger, and is provided by a 1.6 million years old skeleton of an adolescent known as Turkana boy. If this individual had reached maturity, he would have stood six feet tall, his brain would have been twice that of a chimpanzee and something over half of the modern human average.

Because of its large energy-demanding body and its higher position in the food chain, *Homo ergaster* needed significantly larger home ranges than its predecessors with more ‘ape’-like, vegetarian diets. And as individuals needed larger home ranges, extension of the range of the species was to be expected.² Individuals of this species, large-bodied, big-brained and all tooled up, were ready to hit the road and leave Africa by about 1.8 million years ago, starting a tour that led to the colonization of major parts of the

Old World, of Eurasia. While early *Homo*, endowed with a typically insatiable human *Wanderlust*,³ was conquering the world, *Australopithecus* stayed at home, in Africa, where its last representatives petered out around one and a half million years ago. Humanity's origin lies in Africa, the cradle of humankind, and from there our earliest ancestors dispersed all over the world.

Origins attract

At least, this is one of the main narratives of the field of palaeoanthropology and archaeology, commonly known as *Out of Africa 1* (as opposed to *Out of Africa 2*, the model according to which our own species, *H. sapiens*, evolved in Africa by about 150,000 to 200,000 years ago and then migrated outwards into Asia and Europe, replacing all the indigenous populations there and eventually colonizing the whole world). In western society, we have become so accustomed to these major stories in the domain of human evolution that they have become part of our cultural heritage. *Out of Africa 1*, or in more general terms: humanity's African roots, is certainly amongst these. In a world that is wrestling with many of its traditional grand stories, including biblical and other creation myths, these scientific narratives have a great appeal, and constitute one of the reasons why each year so many young students are ready to delve into the early humankind business. It is through these students that our discipline reproduces itself, and having attractive stories certainly increases the discipline's fitness. However, we do not create such narratives (or as we prefer to call them: hypotheses) to attract students, but in order to give meaning to the patterns we discern in our data, and this is not an easy enterprise, for a variety of reasons.

Palaeoanthropology and archaeology are not experimental disciplines. The fossil record is a very fragmentary one, biased by the complex interaction of haphazard geological preservation and accessibility, and by historical developments enabling research in some areas and prohibiting it in others. Spectacular finds in one fieldwork area can draw in large numbers of teams into that same region at the expense of other areas. Our sample size of past populations is extremely small in both time and space, as illustrated by the increase in the number of palaeospecies in the last two decades in Africa, as well as by the surprising archaeological discoveries

that have recently changed our view of the earliest occupation history of the Old World, including Europe.⁴ Despite significant progress in dating techniques, our chronological resolution is usually pretty low, making it difficult to sort out what is cause and what is effect. Nor do these combined factors make it easy to identify core areas in which species originated and, by implication, the peripheries to which they subsequently spread. Hence, many of our theories are not easily refutable, and our literature is abounding in ‘might have been’ style models, narratives or stories, that try to give meaning to the stones and bones we unearth.

The *Out of Africa 1* narrative very much operates on one important assumption: that the fossil record is sufficiently robust to enable us to distinguish core from marginal areas, and to demonstrate adequately both the origin and subsequent dispersal of species. But is this a reasonable assumption? How strong is this narrative, how strong is its empirical backing? Could we have become so used to it through the mere power of repetition, that we forget that we are dealing with a *hypothesis* that needs to be continually tested? After all, for the first half of last century, eastern Asia was considered to be the cradle of humankind, and the *Homo erectus* fossils from Java (including Eugène Dubois’ famous *Pithecanthropus*, see box) were seen as the first representatives of the genus *Homo*. The origin of humankind was relocated to Africa in the 1960s; around that time fieldwork in East Africa started yielding significant amounts of early hominin material, which was triggered by the pioneering activities of Louis and Mary Leakey in Olduvai Gorge, Tanzania. This relocation of the centre of human origins made the French prehistorian Abbé Henri Breuil comment that the cradle of humankind has above all to be seen as a cradle on wheels (‘Le berceau de l’humanité est un berceau à roulettes’).

In a recent review of the *Out of Africa 1* model, my colleague Robin Dennell and I have highlighted the main weaknesses of this particular hypothesis.⁵ Since that review paper was published, two important studies have appeared which further undermine major pillars of *Out of Africa 1*. In this paper, I will review the weak points of this pet story of human evolution, and address whether there is a good alternative scenario available at this moment. While focusing on *Out of Africa 1*, what follows has to some degree implications for other fields of archaeology and

palaeoanthropology that deal with ‘origin’ studies, be it of early humans, of art, agriculture or whatever other phenomenon: what are the problems one encounters when trying to identify centres and peripheries in the deep prehistoric past?

Absence of evidence and evidence of absence

In order to designate one area as the centre of origin of a species (or for that matter: of a specific type of behaviour, or of an artifact) and another as peripheral, we need to be reasonably sure that both areas have seen a comparable intensity of research, that both are adequately sampled and the regional records are balanced enough to make meaningful comparisons. Absence of evidence is not enough: if we postulate that species A migrated into area B, we need comparable datasets in order to legitimately infer that the species was indeed *absent* before its first *appearance* in the fossil record from Area B. In other words: we not only need the *first appearance date* of a taxon in a new area, but also information on its *last probable absence* (see Figure 1). This is more easily said than done, because absence can never be ‘demonstrated’ in the fossil record. We can, however, at least put some constraints on its probability by comparing the quality of the record from the inferred core and its peripheries. Only then can we at least be reasonably sure that the absence of evidence can be read as evidence of absence. Again, that is a tricky matter when one is working with the fossil record.

A nice example of the problematic nature of the fossil record in this domain comes from a recent study⁶ of the Latitudinal Diversity Gradient - a term for the fact that most organisms show a distinct decrease in biodiversity from the tropics to the poles. The authors did a comprehensive global analysis of taxa of marine bivalves over the past 11 million years in an attempt to document their patterns of origination, extinction and migration. Their results support an ‘out of the tropics’ model, in which taxa preferentially originate in the tropics and expand to the poles. However, the authors could not use the fossil record in a straightforward way for these centres and origins questions: the bivalve record in the tropics is relatively poor, because of lack of outcrops, deep tropical weathering of sediments and the limited amount of research. As an estimate, at the very least 25 times as many bivalve fossils have been

recovered from areas outside the tropics as from within the tropics. Using the biased fossil record in a straightforward way would mean that even if a genus originated in the tropics and then expanded into temperate latitudes, the fossil record would very probably indicate the opposite signal, i.e. an extra-tropical origin followed by a range expansion towards the Equator (Jablonski and co-authors were able to work their way around this bias, by using genera from only the best-preserved families, see their paper for details).

Now this is a problem that is familiar to palaeoanthropologists and archaeologists, as we too work with a strongly biased record. On top of that, we study the record of a species which, compared to bivalves, was very thin on the ground and whose traces, fossils and artifacts, need specific types of environments to be preserved and specific geological circumstances for them to be accessible for research. As the species we are interested in were not very abundant in their world and hence in the fossil record, knowledge of biasing factors is a prerequisite for the study of their past distributions. The higher the trophic level of a species, the smaller its abundance in the real world and hence in the fossil record (for the whole of the Asian Late Pliocene [the period between 3.6 to 1.8 million years ago], we have, for example, only two records of a puma, from two locations separated by more than 3,000 air miles).⁷ Open, mesic-to-arid environments tend to preserve fossils better than do forested and wetter environments, which is probably why the first Pleistocene ancestor of extant chimps was only reported very recently.⁸ Should faunal remains become buried by sediments, those sediments obviously have to survive and be accessible for researchers – a condition that is rarely met for sediments from the time range at stake here. The African Rift Valley constitutes a unique exception by its sheer size and the exposure of fine-grained sediments of the relevant age. It includes the majority of the African hominin flagship sites, as well as some of the earliest sites outside of Africa, in the Jordan Valley in Israel, which is a continuation of the Rift Valley.

Apart from accessibility of sediments from the right time range, current large-scale imbalances between regional records are often the result of differences in research history and intensity. To some degree the Javan and Levantine records result from research initiated during colonial times,

and the East African record likewise owes a great deal of its incipient (and prolific) research to the consequences of its colonial history. In contrast, most parts of Asia have experienced only a very limited survey of relevant exposures, compared to the heavy palaeoanthropological investments made in East Africa during the last four decades. These regional imbalances are crucial. After all, in the early twentieth century East Asia was thought to have been the centre of human origins because it had the oldest fossils, and one of the marginal areas, Africa, had not seen any significant fieldwork yet. For Africa and Asia comparability is still many generations of research grants away. Nevertheless, we could do much more to reduce the level of uncertainty over when hominins were last absent in Asia by increasing the number and quality of fossil assemblages immediately prior to their first alleged appearance. Current palaeontological fieldwork in Georgia tries to do exactly this, by focusing on faunal assemblages that date a bit earlier than the approximately 1.75 million years old assemblage from Dmanisi, which have yielded five hominin crania thus far (see below).

To an important degree our distribution maps of human fossils and sites often reflect colonial history, and in our interpretation of distribution maps we need to be more aware of this bias. The recent suggestion that Gibraltar was the last stronghold of Neanderthals in a Pleistocene Europe conquered by anatomically modern humans⁹ provides a good example of this: the intensity of (British) Palaeolithic research in that tiny part of the Iberian peninsula is very high, and the resulting pattern of ‘the Neanderthal stronghold’ is probably more related to the fact that the ‘Rock’ is one of the last strongholds of the British empire, than to the range of the latest Neanderthals.

Many factors are at stake in the formation of a fossil, its survival over hundreds of thousands of years of geological histories of sedimentation and erosion, political turmoil and scientific fieldwork campaigns. A good way to appreciate the complexity of fossilization and the recovery of a fossil is to start from one’s own body: in your opinion, what would you have to do to enhance your chances of being preserved for future palaeontologists in about 500,000 years from now? Where would you like your body to be covered by sediments, what type of sediment and in which country? Remember, countless Turkana boy-like adolescents must

have died at the margins of former lakes, but only a tiny fraction of those will have ended up fossilized; and only a fraction of those will feature in museums and text books.

Asian signals

Despite the imbalance in research intensity (and hence the number of sites), Asia has produced a number of major surprises in recent years. Until the last decade of the previous century, the earliest traces of human presence outside of Africa were located in 'Ubeidiya (Israel), in the continuation of the African Rift Valley, and dated to about 1.3 million years ago, roughly 300,000 years older than those from the eastern parts of Asia, China and Java. That was the situation only one and a half decade ago. Now, the first appearance dates of hominins in Asia are significantly older, a testimony to its palaeoanthropological potential. As an example, the recent political developments in China and the concomitant palaeoanthropological research have resulted in an extension of its earliest hominin presence up to 1.66 million years ago.¹⁰ These traces consist of simple stone tools associated with broken up faunal remains, recovered from lake sediments in the Nihewan basin in northern China. The archaeological excavations there have not reached the lower fossiliferous layers yet. The evidence for the presence of Early Pleistocene hominins in China and Java stretches the limits of current thinking on hominin evolution, as do the approximately 2 million year old stone artifacts from Riwat, Pakistan. When Robin Dennell reported these in the late 1980s he caused quite a stir as they were clearly in the wrong place and from the wrong time; now they start to fit into a sparse pattern of early traces of hominin activities in Asia. In Ian Tattersall's words: 'Their great age is now looking decreasingly anomalous'.¹¹

The most spectacular developments in Asia, however, result from excavations in the tiny medieval town of Dmanisi, Georgia, where a real treasure trove of early hominin fossils, associated faunal remains and stone artifacts has been excavated. The finds date to about 1.75 million years ago, with the hominins being referred to a primitive form of *Homo ergaster/erectus* (see below). These Asian discoveries underscore our poor ability to discern, let alone, predict, the design on the picture we try to piece together from the few pieces of the jig saw that we have.

Biogeography and our classical heritage

Since the Greeks and Romans, we have become used to referring to 'Africa' and 'Asia' as separate continents, each somehow homogenous and distinct from the other (Pliny the Elder's comment, *Ex Africa semper aliquid novi* (From Africa there is always something new), did help to keep Africa a special entity). Plants and animals are less respectful of our Graeco-Roman heritage: the landmasses we now call Africa and Asia are very diverse, but they also have many plants, animals and environments in common. In recent decades, palaeoanthropologists have emphasized the importance of open environments and especially savannah grasslands in hominin evolution, both as a place where many hominin species (including *Homo ergaster*) lived in the Late Pliocene and Early Pleistocene, but also as having played an important role in influencing hominin brain size, post-cranial anatomy, and diet (the slender physique of Turkana boy, the adolescent *Homo ergaster* mentioned above, has for instance been interpreted as an adaptation to the hot and arid African open savanna).

In the Pliocene (roughly between 5.5 and 1.8 million years ago), grassland-like environments extended all the way from West Africa to North China. Robin Dennell and I have somewhat provocingly suggested that the concept 'Savannahstan' might prove a more useful spatial unit for modelling early hominin adaptations and dispersals within and between these continents than simply an undifferentiated 'Africa' or 'Asia'. For example, the African hominins at Koobi Fora (Kenya) and their slightly later (but: see below!) counterparts in Asia at 'Ubeidiya (Israel), and in the Nihewan basin (northern China) were all living in broadly comparable grassland environments, and it makes sense to place them within the same frame of reference. This might also highlight the significant variation that is sometimes buried under a blanket term such as 'Asia'. For example, the hominins in the Nihewan basin, northern China, and those in Java are both clearly in East Asia, but those in Java inhabited a region that was more densely wooded. It is not the continent that matters in studying human origins so much as the type(s) of environment with which early hominins were associated, and hence we should stop using continents as proxies for biogeographic units.

Furthermore, Asia might not simply have been the passive recipient of whatever *aliquid novi* migrated out of Africa, but could have been a donor to speciation events, as well as dispersals back into Africa. Such two-way traffic is well documented for other mammals in the Pliocene and Early Pleistocene, such as for horses and bovids, with more taxa migrating into than out of Africa.¹² There is no reason why hominin migrations were always from Africa into Asia; movements in the opposite direction may also have occurred, as has been suggested for some of the African fossil material as well as, independently of this, on the basis of genetic evidence (see below).

***Homo ergaster*: a hominin without an ancestor?**

The view that *Homo ergaster* originated in East Africa has not gone without question marks. *Homo ergaster* marks a radical departure from previous hominins in Africa, including *Homo habilis*. *Homo ergaster* is taller, differences between males and females are smaller (reduced sexual dimorphism – mainly because females have increased in size), it has long limbs and modern body proportions. At present it is hard to identify its immediate ancestry in East Africa. It is not without reason that *Homo ergaster* has been described as a hominin ‘... without an ancestor, without a clear past’.¹³ One should even allow for the possibility that *Homo ergaster* originated in Asia and perhaps explain its lack of an obvious East African ancestry as the result of immigration. Indeed, Tim White considers it: ‘more likely that *Homo erectus* is an immigrant from Asia to the eastern African area than an anagenetic, *in situ* derivative from *Homo habilis*’.¹⁴ (Granted, he published this somewhat heretic vision in an endnote of a paper on Pliocene pigs ...).

We should bear in mind that these interpretations of the record were made before the Georgian site of Dmanisi yielded the hominin remains that are now in the centre of the debate on the origins of *Homo ergaster/erectus*.¹⁵ Five skulls, and a wide range of postcranial remains have made Dmanisi into one of the richest hominin-bearing localities worldwide. The taxonomic status of the hominin remains has been heavily debated. The bottom line is that we are dealing with an assemblage that is variable, but which unambiguously shows that these early Asians were small-brained and short in stature, probably more like *Australopithecus* than *Homo ergaster* in these regards (140 cm vs 180 cm for Nariokotome boy).

The reason why *Homo ergaster* was assumed to be uniquely capable of migrating out of Africa into the Asian grasslands was because of its long limbs, human-like body proportions and a sufficiently large brain to deal with the challenges of a more carnivorous niche. Dmanisi almost single-handedly showed that this argument is flawed. A comprehensive study of the Dmanisi cranial remains by Rightmire and colleagues¹⁶ now concludes that the Dmanisi material is very close to the stem of *Homo erectus* (*sensu lato*, see box), and that ‘... dating does not presently rule out the possibility that *H. erectus* originated in Eurasia and that some groups then returned to Africa, where they evolved towards *H. ergaster*’.¹⁷

Although Darwin’s (1871) suggestion that ‘... it is somewhat more probable that our early progenitors lived on the African continent than elsewhere’ is widely quoted, it is worth noting his following sentence: ‘But it is useless to speculate on this subject ... since so remote a period the earth has certainly undergone many great revolutions, and there has been ample time for migration on the largest scale’.¹⁸

Order, order!

Much of the fossil evidence for hominin evolution between seven and one million years ago has been unearthed in the African Rift Valley. One of the richest fossiliferous areas in the Rift is the Turkana Basin, situated in north-western Kenya and southern Ethiopia. Here, around Lake Turkana, fossil-rich lake and river sediments extend far inland and are accessible in badland-types of environment. East of the lake is the Koobi Fora area, well-known for its wealth of Plio-Pleistocene fossils (including hominins) and early archaeological sites. These have been recovered from the upper half of a sedimentary sequence of about 560 metres thick, and outcropping east of Lake Turkana. The almost ubiquitous presence of volcanic ash layers in this sequence has provided an excellent basis for stratigraphic subdivision as well as absolute dating of the hominin-bearing deposits. Individual crystals from volcanic deposits can be dated from the radioactive decay of Argon isotopes, and the dated horizons have a unique chemical composition which allows geologists to follow such layers over large distances. This has been instrumental in correlating find-bearing deposits and building a precise and accurate time scale for human evolution, and for the hypothesis that the earliest *Homo* emerged in East Africa.

However, in a recent series of papers, Frank Brown and colleagues have come up with a new chronology for early hominins from this very area. In their view, virtually all key fossils attributed to *Homo* in Koobi Fora, previously thought to be around 1.8 million years old, are in fact approximately a quarter of a million years younger than Brown and others previously thought:

‘Indeed, all specimens from Koobi Fora assigned to *H. aff. erectus* by Wood (1991), many of which are now referred to *H. ergaster* (Wood and Richmond, 2000), are now estimated to be 1.45 to 1.65 myr old with the exception of KNM-ER 2598’.¹⁹

We have an interesting problem here, as the earliest *Homo* in this core area of human evolution is now younger than its inferred descendant in the periphery (Dmanisi)! The new chronology for this key area in human evolution studies will be heavily scrutinized by other earth scientists. Should the interpretation by the team of Frank Brown survive rigorous testing (and should the current 1.75 Ma date for Dmanisi prevail) we would have the situation visualised in Figure 1-4, where the inferred ancestor of a species that colonized a new area turns out to be younger than its descendant. Obviously, there is something wrong here. These new data from the inferred core area bring very strong grist to the mill of those who doubt the classic version of *Out of Africa*: there is virtually no *erectus*-like hominin left in the African record prior to 1.65 million years before present, i.e. around the time when the skeleton of the boy from Lake Turkana became enveloped in lake sediments.

As far as the dating evidence goes, the primitive *erectus/ergaster*-like hominins known from Dmanisi, Georgia, are now very probably older than their inferred African ancestors.

Discussion

To conclude, the classic version of *Out of Africa 1* suffers from some major weaknesses, some of which were already pointed out in the *Nature* review mentioned above.²⁰ Robin Dennell’s and my earlier review of *Out of Africa 1* could not benefit from the studies by Rightmire *et al.* and from the results recently obtained by the Frank Brown team. These heavy blows

to *Out of Africa 1* were only just submitted for publication when we came up with a few alternatives to the *Out of Africa 1*-model. One alternative is that hominins of the genus *Australopithecus*, the first group mentioned in the introduction to this paper, might have left Africa before about 1.8 million years ago. The surprising presence of *Australopithecus* in Chad, 2500 km west of the Rift Valley, shows that hominins were distributed over very large parts of Africa at 3 to 3.5 million years ago, i.e. in a much larger area of Africa than adequately sampled.²¹ This raises the interesting question whether it is possible that some hominins had adapted to other environments than the ones we know from work in the East African Rift Valley? Where else could hominins have been living when *Australopithecus bahrelghazali* became fossilized in Chad? Some of these ‘unknown’ ecologies, such as coastal environments with their often abundant resources,²² would make an early (and fast) dispersal very plausible.

As environments broadly comparable to the Chad and East African grasslands were present in Asia around that time, hominins could have expanded their range in a north-eastern direction too (in fact grasslands, the inferred preferred original environment for *Homo*, were well established over major parts of Asia from around 5 million years ago, i.e. a few million years before they became dominant in Africa). Once in Asia, these (or later variants of) hominins could have developed into an Asian ancestor for both the Dmanisi, Java and east African *Homo erectus/ergaster* populations.

This hypothesis is, however, very difficult to test, for the reasons discussed above. We simply do not have *Australopithecus*-fossils outside Africa, and given the current locations and pace of fieldwork it will take some time before such a theoretical find might be unearthed, if *Australopithecus* was ever there at all. Fossil and archaeological discoveries do not constitute the only data in this debate though. The geneticist Alan Templeton has suggested that the prospects for testing our hypothesis with molecular genetic data will be excellent in the near future.²³ Templeton claims genetic evidence for an expansion out of Africa at around 1.9 million years ago and infers that a two-directional gene flow between Asian and African populations was established by 1.5 million years ago.²⁴ His findings do suggest that migration began earlier than commonly thought and that hominins were moving back and forth between the two continents, as did other mammals.

Given the imperfections of the fossil record, the chances of being able to identify core areas seem very remote. The point has already been made with respect to African Australopithecines, following the discovery of the above mentioned *Australopithecus bahrelghazali* in Chad: ‘... if the origins of hominids occurred rapidly, followed by rapid range extension, as seems likely, it may be as futile to seek a specific and localised place of origin for hominids as it is for any other group’.²⁵ If the origin of *Homo ergaster* was also followed by rapid range extension, it likewise follows that it might be futile to postulate its place of origin, Asian or African.

A recent paper on this issue²⁶ suggests that ‘Made in Savannahstan’ would make a good alternative to ‘Out of Africa 1’. It is certainly a catchy phrase. But rather than replacing one sound bite with another, I prefer to stick to what is observable, as building our hypotheses on what is possible and plausible would open up a virtually endless array of untestable scenarios. What is clearly observable is that the *Out of Africa 1* narrative does not work any more as a good explanation for the patterns in the fossil and archaeological record. Given the difficulties of testing alternatives, we just may have to live with ambiguity in this domain, with a full awareness of our current state of ignorance, focusing on the discrepancies and conflicting data, as these are the domains where we can make significant progress in our studies of our early past.

Box

Homo erectus and Homo ergaster

H. erectus - or more properly, *Pithecanthropus erectus* - was first discovered at Trinil in Java by Eugène Dubois in 1891 (these key fossils are now stored – and on display – in Museum Naturalis at Leiden). In the 1930s, further discoveries of hominin remains elsewhere in Indonesia and at Chou-kou-tien (now Zhoukoudian) in China were seen as broadly similar, even if initially given their own generic names (such as *Meganthropus* and *Sinanthropus*). In 1950, Ernst Mayr re-classified all this material as *Homo erectus*, with the Trinil specimens as the type fossils. Subsequent African specimens were also called *Homo erectus*, as were much later specimens from Europe. *Homo erectus* thus became for a while the earliest hominin that was thought to have lived in Asia, Africa and Europe. In the last few years, some experts have doubted that the East African specimens should be placed within the same palaeospecies as the Asian ones. It has been suggested that the earliest African examples should be called *Homo ergaster*, after the specimens found at Koobi Fora, including WT15000, the magnificent 1.6 million years old skeleton of a young boy from Nariokotome that was initially published as *Homo erectus*. Consequently, it is the African *Homo ergaster* that is now seen by many as the hominin that expanded Out of Africa, colonized Asia and formed the founding population of what later became *Homo erectus* in China and Southeast Asia.

European specimens once regarded as late examples of *Homo erectus* or ‘archaic *Homo sapiens*’ are now increasingly classed under the taxon of *Homo heidelbergensis*, a term first used to classify the mandible from Mauer, Germany, found in 1907, and now estimated to be half a million years old. To avoid ambiguity, the term *Homo erectus* is used here *sensu stricto* to denote only the specimens from eastern Asia.

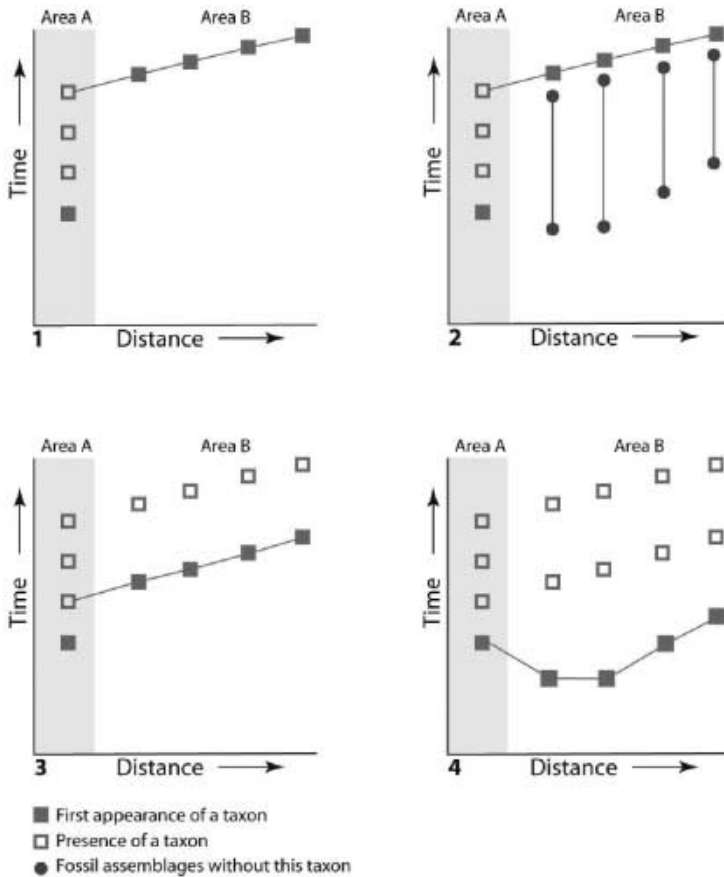


Figure 1 (From: Dennell and Roebroeks 2005): Dispersals, cores and peripheries. The dangers of over-reliance on First Appearance Dates of when a taxon migrated from its core area (A) into new territory (B): (1) shows a hypothetical situation in which a taxon originated in area A, and then migrated into a new territory (B). In (2), the reliability of these First Appearance Dates is considerably strengthened by the numerous well-dated instances when its Last Probable Absence can be documented. Without these, future discoveries might indicate (3) that previous estimates of when a taxon first appeared were too recent, as happened when the earliest Javan hominins were redated from ca. 1 million years old to ≥ 1.6 million years before present. Even more alarmingly (4), future discoveries might show that the taxon probably originated in the area that it was supposed to have colonized – as happened when the cradle of humankind was relocated from Asia to Africa in the 1960s.

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