Human origin sites and the World Heritage Convention in Africa

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Human origin sites and the World Heritage Convention in Africa

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Forewords

Africa is synonymous with the origins of humankind. As a continent, it contains a record of our ancestors over the past 6–8 million years and is the home of some of the most marked discoveries of humanity, which has expanded – and continues to expand – our knowledge of our first relatives and their environments. In this way, it has a special significance in our cultural development, as the very origins of culture and of the early humans that developed that culture can be traced back to Africa. Its place in human evolution is determined by its related geography and environmental variations – an environment that sustains our first steps of cultural diversity.

This publication not only represents an interdisciplinary approach to the identification, study, management and evaluation of human-origin related sites, but also the involvement of communities: communities in terms of the local communities living in and around sites, as well as the international community that should enhance cooperation to preserve this invaluable heritage.

Heritage is a shared responsibility, bridging our past to the future. This emphasis on a common past and destiny implicates a joint responsibility. The challenges that we are faced with today involve finding ways to ensure its sustainability and make it accessible to all humankind.

Since its inception in 2008, the World Heritage Thematic Programme ‘Human Evolution: Adaptations, Dispersals and Social Developments (HEADS)’ has successfully demonstrated its capacity to bring together scientific knowledge, national capacities for protection and the commitment of the World Heritage community.

Building and strengthening the World Heritage community has remained a focus of the HEADS Programme. This is essential in terms of conservation, management, research and awareness-raising efforts, incorporating the knowledge of local communities as well as national and international expertise in challenging and refining our understanding of our origins, and the communities that continue to live in these areas in the framework of the World Heritage Convention. This cooperation is vital in ensuring the continued significance of the Convention and creating and maintaining links with the people and the land. The involvement of communities is even more resonant in 2012 as the Convention celebrates its 40th Anniversary with the theme ‘World Heritage and Sustainable Development: The Role of Local Communities’.

This publication reviews the interdisciplinary and forward-looking approaches which have dominated research and conservation methodologies in Africa in recent decades, as well as their associated challenges, and makes recommendations for ideas and strategies for their continued success. It draws on discussions that took place at the international meeting, ‘African human origin sites and the World Heritage Convention’, held at the National Museum of Ethiopia, Addis Ababa, and organized by the UNESCO World Heritage Centre, the Spanish Funds-in-Trust for World Heritage, the African World Heritage Fund (through the contribution of AECID), the Government of Ethiopia and the UNESCO Office in Addis Ababa. I wish to thank the Government of Ethiopia for generously hosting the meeting, which offered the platform from which we can begin to establish a road map in support of future conservation, research, and recognition of human origin sites in the region. More broadly, I extend my appreciation to all the participating site managers, experts, institutions and government representatives for their commitment and dedication to the protection of these areas for future generations.

Kishore Rao
Director of the UNESCO World Heritage Centre

‘African human origin sites and the World Heritage Convention’, held at the Conservatory Laboratory of the National Museum of Ethiopia in Addis Ababa on 8 to 11 February 2011, was the first meeting to be held with UNESCO on human evolution sites in Africa. It was significant not only as it brought together a vast spectrum of delegates including site managers, experts, institutions, and policy-makers, but also as it had a focus on Africa, and provided the prospect for greater regional cooperation in this field. This breadth of cooperation involved the important participation of the Agencia Española de Cooperación Internacional para el Desarrollo (AECID), the African World Heritage Fund, the Authority for Research and Conservation of Cultural Heritage (ARCCH) and coordination by the World Heritage Centre of UNESCO, all of whom contributed to ensuring its success.

The meeting proposed forward-thinking strategies for ensuring the sustainability of these vulnerable sites, and the application of an interdisciplinary approach to research and continued scientific reflexion. It discussed and proposed new strategies for ensuring the sustainability of these sites, to better assess authenticity and their integrity, and to inform ongoing and future conservation efforts.

Ethiopia has demonstrated an active involvement in recognizing the intrinsic value of human evolution related sites to humankind, and its utmost importance in developing our understanding of the evolutionary process. We are also proud to have nurtured some of the most well-known researchers in human evolution who have produced – and are still producing – groundbreaking research that has challenged and broadened the knowledge of our origins. And particularly during the past 50 years there has been a greater international focus on Ethiopia. Today, a great number of interdisciplinary research projects are carried out in the field, combining the expertise of Ethiopian and international experts. This is a tradition I hope Ethiopia will continue to foster, and we remain committed to continuing an active involvement in the support of conserving these vulnerable sites for future generations.

Since Ethiopia ratified the World Heritage Convention in 1977, nine sites in Ethiopia have been inscribed on the World Heritage List, two of which are related to human evolution. Ethiopia began its four-year mandate to the World Heritage Committee in 2009, which further presents an excellent opportunity for Ethiopia to bring to the forefront the vast riches of potential human evolution-related sites in Ethiopia.

H. E. Mr Amin Abdulkadir
Minister, Ministry of Culture and Tourism
Federal Democratic Republic of Ethiopia
Introduction

Since the launch of the HEADS programme in 2008, the academic community, national experts, Advisory Bodies and the World Heritage Centre have met on six occasions to work towards developing the part of the Action Plan relating to Human Evolution. The analysis dates back to the period between 8 and 6 Ma ago and studies the way in which the our first ancestors began to appear in the fossil record, up until when, at least 2.6 Ma ago, it showed that they were capable of producing tools, as archaeological records today prove. This is an extraordinary and valuable universal knowledge resource, since it represents the inherited accumulation of our knowledge about the diversity of human life, the first cultural experiences and their associated social behaviour. It links together the signs that can explain how natural and cultural developments are connected as part of the record of life in the Earth’s history. Processes related to human evolution that are studied include biological and cultural changes which bear witness to the evident success with which our predecessors were consistently able to adapt to the circumstances of their surroundings. Their geographical dispersal over the whole planet also testifies to their migratory and adaptive abilities. Since mankind’s earliest existence our ancestors were able to reach the most extreme corners of the globe, evidence of which is still being discovered in equatorial and Arctic regions, on islands and continents, at sea level and at high altitudes, in deserts and in swamp areas. These pages provide a clear testimony of the current state of research and the importance of gaining knowledge to be able to implement the World Heritage Convention. They include a good sample of evidence about the origins and diversity of the Homo genus (genetic, biological and anatomical), as well as some of most important cognitive milestones and technological innovations disclosed throughout this investigation so far.

Thanks to the conclusions of the International Experts Meeting, held at UNESCO, in November 2008, and to the progress made during the meeting organized in Burgos and Atapuerca, Spain, in March 2009, the basis for constructing a work programme on human evolution within the framework of the HEADS Action Plan was established. This was approved by the World Heritage Committee during its 33rd Session in Seville, Spain, in July 2009. The scientific standards necessary for providing a definition of Outstanding Universal Value (OUV) were discussed; the need to develop research applied to the preservation of these extremely vulnerable sites was highlighted; courses of action were identified which would enhance international cooperation in the procedures for submitting candidatures for the World Heritage List; the most exceptional thematic narratives for improving the representation of these sites within the framework of the World Heritage Global Strategy were established; and recommendations were made to the States Parties to the Convention, to ensure the setting up of multidisciplinary teams and tasks in order to establish an adequate justification of criteria and conditions of authenticity and integrity of paleoecological/archaeological/environments. After careful analysis of already inscribed sites as well as those on the Tentative List relating to human evolution, the experts defined the following priorities: to move forward in our reflection about humankind’s oldest ancestors; and our adaptive ability to harsh environmental and climate changes, especially between 2.6, 1.8 and 0.13 Ma ago and the evidence regarding adaptation to the last glacial maximum (LGM). Both of these aspects called for us to think of Africa as the obligatory basis for the next discussion, and consequently to initiate a series of continental meetings with the objective to analyse and obtain a full picture of all the forms of colonization of ecological niches in Eurasia, Asia, America and the Pacific.

From 8 to 11 February 2011, 46 participants of 13 different nationalities and representatives of 24 international institutions met in Addis Ababa, Ethiopia for the international meeting, ‘African human origin sites and the UNESCO World Heritage Convention’. This took place at the National Museum of Ethiopia, and was organized by the Authority for Research and Conservation of Cultural Heritage of Ethiopia (ARCCH) and the UNESCO World Heritage Centre, thanks to the generous contribution of the Spanish Funds-in-Trust. The participants also had the opportunity to examine Ethiopian paleoanthropological collections, and visited Melka Kunture, whose description and importance has been clearly endorsed in past and present research and by some of the contributions included in this volume.

We cannot end this introduction without expressing our deepest thanks to the institutions and experts of Ethiopia for their hospitality, and for the privilege of working with both junior and senior generations of eminent Ethiopian researchers who have played a leading role in how the sciences have progressed, and whose work is internationally recognized by the scientific community. Likewise we wish to express our appreciation to the HEADS Scientific Committee for the effective and constant effort they have put in to our ongoing discussions and for helping us, in such a generous way, to build bridges between research and our day-to-day work in World Heritage. We are also grateful to all participating experts for having demonstrated such an ample adaptive capacity for thinking within the parameters of the Convention’s criteria. And to the Advisory Bodies for building a framework of enquiry which has permitted all of us to progress in the challenging task of identifying in the Operational Guidelines the most appropriate channels for defining and preserving the OUV's pertaining to sites related to human evolution. The testimonies of the representatives of national institutions are particularly deserving of our gratitude, as they are responsible for the day-to-day implementation of the World Heritage Convention in their respective countries, guiding the thought process in a specific and realistic context, and presenting a thorough and illuminating analysis of the challenges of the preservation and development of paleoanthropological sites in Africa.

Coordination of the HEADS Programme
UNESCO World Heritage Centre
Outstanding Universal Value of human evolution in Africa
Outstanding Universal Value of Human Evolution in Africa

Yves Coppens – Collège de France

Monsieur le Ministre,
Monsieur le Directeur de l’ARCCH,
Madame la représentante de l’Ambassade d’Espagne,
Mesdames les représentantes de l’UNESCO,
Dear colleagues, dear friends,

 Probably because I am almost a fossil – but a hominid fossil – Nuria Sanz and the UNESCO World Heritage Centre asked me to give what they call a keynote speech, which received the beautiful suggested title of ‘Outstanding Universal Value of human evolution in Africa’.

I would like to thank Nuria Sanz and UNESCO for their invitation, and the Ethiopian Authority for Research and Conservation of Cultural Heritage (ARCCH) and the National Museum of Ethiopia for their help and hospitality.

I am personally very happy to be in Ethiopia again (I was here a year ago) and happy as well to be in this Museum that I have known for 45 years. My first visit would have been in 1967, when the Director was Ato Mammo Tesemma. And in the sixties and seventies I brought to this institution from Gemu Goffa and from Wololo something like eighty tons of fossil bones!

I don’t want to be nostalgic. I am not.

It was just to confirm to you that I am a fossil.

We are here not (only) to think about surveys and research but to think about the protection and the conservation of the existing paleontological and archaeological sites, their promotion, and the promotion of the knowledge they provide.

Africa is, of course, as everyone knows, particularly important for paleontology and archaeology, as Africa is the ‘Cradle of Mankind’, possibly the cradle of modern man as well as the place where man’s expansion began, and the birthplace of mankind’s tools, the first symmetric stone tools, and the nest of so many discoveries, inventions, creations and cultures.

Let us start by the beginning.

Ten million years ago or so - maybe less maybe more - the population of primates, common ancestors of Paninae, pre-chimps and Homininae, pre-humans and humans (us), split for environmental reasons into two branches, and this split happened in tropical Africa. As it would be difficult to consider the entirety of tropical Africa, from western to southern Africa, we have to then consider many very important sites of that period in North Africa, but also almost everywhere in the continent.

And then the genus Homo moved, enlarged his territory and reached North Africa, the Mediterranean shore and, for the first time, beyond Africa, to the Middle East, as soon as 2 million years ago, at least, probably more (2.5 million years ago). We will have to then consider many very important sites of that period in North Africa, but also almost everywhere in the continent we are in.

First step

The very first Homininae – characterized by their adoption of erect posture and bipedalism – are, up to now, known from Chad, Ethiopia and Kenya. So the sites of Sahelianthropus tchadensis, Ardipithecus kadabba, Ardipithecus ramidus and Orrorin tugenensis should, of course, kept in mind for an urgent shortlist of localities, or regions, to be protected.

At this point, we can also think about listing some important paleontological sites, preceding the split - or chronologically close to it - and which have already provided primate fossils, for example the Ethiopian site of Chronopithecus, or the Kenyan site of Samburensis or Nakalapithecus and many others more ancient.

Second step

After a new climatic change, a new opening of the landscape, happening around 4 million years ago, a sort of new generation of Homininae flourished in central, eastern and southern Africa. It is the time of Kenyanthropus with its flat face, and the time of Australopithecus, more aggressive, a better biped but still climbing (or not). We can mention Kenyanthropus platyops, Australopithecus bahrelghazali, Australopithecus anamensis, Australopithecus aferiensis, Lucy, Selam, and Australopithecus africanus. I guess that the type of sites, by this time, have been discovered and the new taxa named, should be listed for special care. I know that the Turkana National Park, the Lower Awash Valley and the Sterkfontein, Kromdraai, Swartkrans area are already on the World Heritage List but Koro Toro in Chad is not either.

Third step

A third climatic change, almost a drought, the one that I called the The (H)Omo Event, happened around 2.7-2.8 million years ago.

I called it The (H)Omo Event because it was in the Lower Omo Valley in Ethiopia that this climatic change was first described, and because one of the adaptations occurring at that time, for this reason, has been called Homo, man. We are the product of an adaptation of a pre-human to a climatic change in Africa, in eastern Africa.

But other adaptations among the hominoids also appeared at that time, giving the demonstration of the existence of paleoecological niches, as well as the demonstration of a beautiful hominid biodiversity. Let us mention Australopithecus garhi, a robust adaptation specific to the Afar area, Zinjanthropus aethiopicus and Zinjanthropus boisei, robust East African hominids (different for me from South African ones), Australopithecus Prometheus (Little Foot), and Paranthropus robustus (on one side) and Australopithecus sediba (on the other), robust and slender South African adaptations to the climatic event we are talking about.

For this third sequence, the Turkana National Park, the Lower Awash Valley, the Sterkfontein, Swartkrans, Kromdraai area, already mentioned, as well as the Lower Omo Valley, the Lake Malawi National Park, and the Serengeti National Park are answering, in a way, a part of our request but not the totally.

This geological time, 2 to 3 million years ago, is also the beginning of culture. Very important archaeological sites have been identified and excavated in East Africa.

The Gona area in the Afar in Ethiopia, the Lower Omo Valley, West (Shungura) and East (Fefje), in Ethiopia again, and the East and West Turkana in Kenya, are among the earliest archaeological sites followed by the occupation and living sites succession of Melka Kunture in Ethiopia, Olduvai in Tanzania, and so on.

Fourth step

And then the genus Homo moved, enlarged his territory and reached North Africa, the Mediterranean shore and, for the first time, beyond Africa, to the Middle East, as soon as 2 million years ago, at least, probably more (2.5 million years ago). We will have to then consider many very important sites of that period in North Africa, but also almost everywhere in the continent we are in.

Fifth step

The time of the peopling of Eurasia has come, from the far west to the far east. And as the territory is very large and the demography of the hominids very small, the diversity of our family will flourish again. Remember Neanderthal Man, Denisova Man, Java Man, Flores Man, Modern Man and many others. I am sure, that we have not found yet. And during that period Africa, of course, is still very active.
Sixth and last step

Modern man finished the peopling of the earth and during that time Africa has been biologically and culturally very active and creative. Behind this statement I mean that many sites are hidden.

It is obvious that Africa is essential in the history of mankind, as the first 8 million years of this history (from 10 to 2 million years) are only African. It is then prestigious for Africa to be the unique origin of the hundred billion human beings who have existed since the very first one, and it is prestigious as well for every country where discoveries have been made - currently Chad, Ethiopia, Kenya, Tanzania, Malawi and South Africa - to be considered as a part of the cradle.

The idea of UNESCO to establish an official list of the most significant sites, natural and cultural, of the Earth, is a terrific idea. And its initiative to substantiate the African human evolution sites of the World Heritage List is a good opportunity for us to propose the places we are working on, to protect and promote them, their collections and our research.

After having listed outstanding monuments and sceneries, it is amazing to offer to UNESCO only landscapes, without anything on them, but sometimes with something below. It is a sort of classification of undergrounds, as an intrusion into the world of geology, the mineral world.

The sites are both symbolic, because they are places where important fossil or artefacts have been found, and sometimes symbolic and sustainable because they are still keeping a certain amount of sediments for more excavations, research on fossil and environments, collections, application of new techniques of reading the memory of the objects. Science is always sceptic, critical, ready to discuss, to debate, to control, to check and crosscheck and confirm or not what has been claimed before. Knowledge and thoughts are evolving according to the evolution of science, and science is evolving according to the evolution of research, techniques, mentalities and trends. So it is important to keep some matter for more investigations. But such places which are, of course, not spectacular, are much more difficult to protect than a temple or a castle.

So, as we said before, when the prestige of a site does exist and when this site is nominated for inscription on the famous World Heritage List, this prestige is considerably increased. And often, as for good wines, and I know what I am talking about, the year of inscription is mentioned after the label, ‘UNESCO World Heritage Site’, ‘Site du patrimoine mondial de l’UNESCO’.

Nomination of a site implies a lot of aspects to take into consideration: the site itself and its sediments, but also its collections, the place or places where they are stored, their conservation, availability - or availability of their pictures, casts and scans - for more studies or comparisons for the research itself, but also for popularisation for the public everywhere and anywhere, and for the ever-increasing number of visitors to these areas. And it implies as well, if necessary, the training of the scientists, curators and managers of the sites.

It is a big responsibility at the origin, including research on the legitimacy of the choice and on the credibility for the public, and for that scientific opinion is a necessity.

I wish you (us) a beautiful session, full of information, interest and passion. I am sure that more sites will reach, after this week, The List with a capital T and a capital L.

I would like to add one important point. Humanity is in good health, counting some thousands of hominids 2.5 million years ago, 10 million 10 thousand years ago, one billion 2 centuries ago, and 7 billion today.

It is clear that the surface of the earth, already very transformed by man, will become more and more transformed, more and more anthropised. A way, perhaps the only way, to keep some places as they are because they are important or just because we like them, is to protect them, establish more parks and nominate more sites for inscription on the World Heritage List... before the next climatic change.

Thank you again to Nuria and UNESCO, thank you Ethiopia, thank you to you all, for loving knowledge, science, paleontology, prehistory, our heritage and the heritage of our children.
**World Heritage and the Middle Stone Age: examples from East Africa and South Africa**

Nicholas J. Conard

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**What is the Middle Stone Age?**

The Middle Stone Age (MSA) was initially defined in the 1920s by A.J.H. Goodwyn and Clarence van Riet Lowe (1929) based on their research in South Africa. The authors wanted to create a new taxonomic system for prehistoric prey that was not based on observations and terms of European origin. Together, Goodwyn, who was based at the University of Cape Town and the South African Museum in Cape Town, and van Riet Lowe, who was by training a civil engineer and collaborated with several of the leading museums of South Africa, commanded the available knowledge about the Stone Age of southern Africa. At a time when the European tripartite system of the Lower, Middle and Upper Paleolithic had not yet gained currency, Goodwyn and van Riet Lowe divided the Stone Age of southern Africa into three main units, which they named the Earlier, the Middle and the Later Stone Age, which are often abbreviated ESA, MSA and LSA.

In the 1920s the temporal depth of the African Stone Age was unknown and largely a matter of speculation. Goodwyn and van Riet Lowe divided the Stone Age into an ESA characterized by assemblages containing handaxes and large, thick flake tools. They defined the LSA as having close affinities with the material culture of ethnographically documented hunters and gatherers or ‘bushmen’. The LSA assemblages often contained smaller lithic artefacts with abundant tools made on blades and bladelets. A wide range of organic artefacts and shell and ostrich eggshell beads. The MSA represented a collection of artefacts made by cultural groups that were thought to fall chronologically in between the ESA and LSA, and included the Howiesons Poort, Still Bay and other assemblages, most of which are characterized by triangular flakes and faceted butts. Goodwyn noted the affinities these assemblages had to the European and Mousterian industries and even suggested that cultural contacts took place between Africa and Eurasia (Klein, 1970). The transitions between the ESA and MSA and the MSA and the LSA, then as now, were difficult to pinpoint and characterize.

Based on the results of several generations of research, the chronostratigraphy of the MSA has begun to come into clearer focus. While researchers do not see a sharp break that identifies the start of the MSA, many colleagues today date the start of the MSA to roughly 300 Ka ago (Deacon and Deacon, 1999; McBrearty and Brooks, 2000; Klein, 2009). This age correlates roughly with the abundance of assemblages containing handaxes and a rise in the abundance of lithic assemblages using ‘parallel’ reduction techniques similar to the Levantinian knapping methods that characterize many of the Middle Paleolithic assemblages of western Eurasia (Conard et al., 2004).

The MSA ends roughly 30 Ka ago with the presence of assemblages based on the frequent use of platform cores and elongated debitage and often diminutive artefacts in the absence of parallel/Levallois lithic technology (Deacon and Deacon, 1999). The original suggestion that the MSA lacks diverse organic tools and ornaments has been refuted in recent years in connection with the abundance of new evidence for organic artefacts and symbolic artefacts such as personal ornaments that originate from MSA contexts (Conard, 2011, d’Errico and Stringer, 2011).

Although many of the specific observations from East Africa differ from those made in southern Africa (Clark, 1982, 1988), the basic aspects of the development from the ESA through the MSA to the LSA show analogous trends across Africa (McBrearty and Brooks, 2000; Klein, 2009). Until recently these trends tended to be used exclusively in sub-Saharan Africa. In recent years, however, the terms ESA, MSA and LSA are increasingly being used in all of Africa, and are beginning to displace the Eurasian terminology that has historically been used in North Africa. One impetus for having a uniform terminology for the major divisions of the African Stone Age is the emphasis that has increasingly been placed on viewing African Stone Age archaeology and human biological evolution as distinctive from that documented in Eurasia.

**Why is the MSA important?**

For many years the MSA was viewed as an intermediate period and as the least interesting phase of the Stone Age. The ESA provided us with insights into the origin of our species, and the LSA was important for its diverse and rich archaeological record and abundant rock art. The MSA, however, was largely ignored and often just viewed as a vast period in which little happened, and what did happen was viewed as being scarcely noteworthy.

This all changed over the course of the 1980s during which researchers including Bräuer and Stringer compiled enough evidence to demonstrate that modern humans evolved in Africa in contrast to previous models that argued that evolution occurred in parallel in many regions in what was often called the candelabra or multi-regional model (Bräuer, 1984, 1992; Stringer and Andrews, 1988). As more and more fossil evidence was mobilized for what became known as the ‘Out of Africa’ model, genetic studies of living people increasingly pointed to Africa as the homeland of all living people (Cann et al., 1987; Singer and Andrews, 1988).

Suddenly the MSA was no longer ‘the middle in the middle’ but rather the key period in which anatomically modern humans evolved. The question quickly arose as to whether or not cultural modernity and biological modernity evolved simultaneously and in parallel to one another. If, Africa would not be the single continent where our biological form first evolved, but also the continent in which people first began to live in a social-economic universe characterized by the manipulation of language and symbols, as is the case among all living people.

To test and refine these models, the last two decades have seen a remarkable revitalization of studies of the MSA. This research has taken place in northern, eastern, western, and especially southern Africa in the hope of gaining a better understanding of where biologically and culturally modern humans evolved.

**Examples of key regions and sites**

In this short paper, I will only comment on the work in regions I know best and on topics close to my research. This approach leads me to focus on East and South Africa in highlighting potential World Heritage sites. The working groups that participated in the UNESCO meeting in Addis Ababa in February 2011 presented a number of potential sites and groups of sites that would be appropriate for nominations on the basis of their Outstanding Universal Value (OUV), a prerequisite for achieving the status of World Heritage. As has been discussed in the papers of the World Heritage Papers series ‘Human Evolution: Adaptations, Dispersals and Social Developments (HEADS’ (UNESCO, 2011), prehistoric sites and sites related to human evolution are greatly underrepresented on the World Heritage List. Without policies and programmes to help remedy this situation, and given the impressiveness of the fossil record and the impression that the great built monuments of Europe are somehow more central and representative of the history of our species than the important sites that document how humankind evolved and dispersed across the planet. Here I highlight some of the arguments for nominating the site of Mumba Cave and the sites around Lake Eyasi in northern Tanzania and for the coastal and near-coastal MSA sites of southern Africa as World Heritage sites.

**Mumba and Lake Eyasi**

Research in and around Lake Eyasi in the Republic of Tanzania has a long and flamboyant history with a unique position in study of human biological and cultural evolution in East Africa. Work in this region is closely associated with Ludwig and Margit Kohl-Larsen who led a multi-year, multidisciplinary research programme, the Deutsch Ostafrika Expedition (DOE), between 1933 and 1939 (Kohl-Larsen, 1943; Kohl-Larsen et al., 1985; Rafalski et al., 1978). This ambitious and well-funded expedition simultaneously addressed research questions in human biological evolution, prehistoric archaeology and cultural anthropology within the framework of what, even by today’s standards, could be considered a modern research agenda. Today this region is characterized by its inaccessibility, bad roads and a poor infrastructure, making it all the more impressive to consider the achievements of this early team. In addition to the many results in Stone Age archaeology and human evolution, the expedition compiled important records and collections related to the Hadza hunters and gatherers of the region around Lake Eyasi (Pon and Müller-Beck, 1997).

The prospecton and test excavations of the DOE led to the discovery of multiple open-air sites on the plains near the shore of Lake Eyasi (Figure 1) (Kohl-Larsen, 1943; Kohl-Larsen et al., 1985; Rafalski et al., 1978). Many of these localities documented lithic and faunal material in stratified contexts. Perhaps the best-known specimen yielded from the open-air sites near Lake Eyasi is a heavily fossilized and well-preserved cranium of a late archaic human, usually referred to as Eyasi 1 or the Eyasi cranium (Kohl-Larsen, 1943; Brauer, 1984, 1992). Estimates of the age of the skull fall in the vicinity of 250 Ka ago, and the fossil is a key specimen for documenting the evolution of modern humans in Africa. Subsequent work in the Pleistocene sediments of Lake Eyasi has led to the discovery of additional lithic artefacts, hominin fossils and paleontological remains that belong to the same general contexts of the finds documented by the DOE in the 1930s (Meindl et al., 1987; Domínguez-Rodrigo et al., 2008). Although it is not of primary importance in this context, the members of the Kohl-Larsen expedition are also credited with finding the one of the first examples of Austricnthropus africanus in the form of the maxillary fragment from Garusi in 1939.
Perhaps still more remarkable were a series of excavations conducted mainly by Margit Kohl-Larsen in a number of rock shelters and shallow caves near the base of a major inselberg, referred to as the Laghang-Ishimijega Hills on the plain east of Lake Eyasi at an elevation of about 1050 m asl. The most notable of these excavations was at Mumba Shelter (Figure 2). Research at Mumba began with a test excavation in 1934. This sizeable test excavation had dimensions of 9m x 4m with a depth of 5.5m. The results convinced the Kohl-Larsens to have a full-scale field season dedicated to excavating the site (Kohl-Larsen, 1943). Margit Kohl-Larsen succeeded with this goal in 1938 and conducted excavations from 20 January to 28 August. Together with her crew she excavated a surface of 12.5 m x 9.0 m to a depth of 10.5 m, corresponding to a volume nearly 1000 m$^3$ when one considers that the excavation became somewhat narrower at its base. The expedition carried and shipped the vast amount of all classes of artefacts and ecofacts from Mumba along with the ethnographic materials, fossils and finds from other sites to Germany for study, where they are still housed in a number of museums and research institutes. The logistical effort that the team mobilized was nothing short of remarkable. Excavations at Mumba Shelter also yielded a series of LSA skeletal finds that have contributed to our understanding of human biological evolution in East Africa (Bräuer, 1983).

The team of the DOE also conducted excavations in other important rock shelters of the region and defined the cultural stratigraphy of the region (Kohl-Larsen, 1943). Subsequently, researchers including Mehlman, Domingez-Rodrigez, and Pendergast among others have returned to Mumba Rock Shelter, to other rock shelters from the same inselberg to conduct excavations (Mehlman, 1979, 1991; Pendergast et al., 2007). This work, combined with studies on the rich and many faceted collections from the Kohl-Larsen expedition (Bretzke et al., 2006; Marks and Conard, 2008; Díez-Martín et al., 2009), makes Mumba Shelter and the other sites in this area northeast of Lake Eyasi one of the key groups of sites in East Africa for documenting both human biological evolution and the evolution of cultural innovations over the course of the MSA. Work is currently underway on a broad range of lithic and organic finds from Mumba and the other neighboring rock shelters, and a wide range of grinding equipment, modified ochre and artefacts made from shell and ostrich eggshell are present in existing collections (Figures 3–5) (Weiss, 2000). As research continues, the central importance of these sites for our understanding of the Stone Age prehistory of East Africa is coming more strongly into focus.
Based on the historical and current importance of the sites around Lake Eyasi and Mumba and the surrounding rock shelters, these sites represent strong candidates for the status of World Heritage. Despite new research in recent years, vast amounts of material from the collections made by the Kohl-Larsens and Mehman remain to be studied. The region also offers considerable potential for new fieldwork.

Coastal and near-coastal MSA sites in southern Africa

Although one can trace the history of Stone Age research in coastal regions of South Africa back a century, the last two decades have seen a flurry of ambitious research in the region. Perhaps, in part, fostered by the fall of apartheid in South Africa in the middle of the 1990s and as a result of the increased awareness of the importance of the MSA for our understanding of human evolution, researchers from around the world have joined South African colleagues to create an unusually rich and productive research environment. These developments have led to numerous high-profile international publications on the MSA and has made the southern African subcontinent the most dynamic research environment for questions related to the evolution of modern behavior, as indicated by advanced technological innovations and a wide range of symbolic artefacts. The discoveries at Blombos over the past decade have done much to focus attention on the evolution of modern behavior (Henshilwood et al., 2001, 2002, 2004). Here examples of shell ornaments, engraved ochre and bone artefacts attracted attention and have led to the identification of similar artefacts from earlier excavations at Klasies River Mouth, Blombos, Die Kelders, and the sites at Pinnacle Point (Figure 6). All of these sites contribute to our understanding of MSA and the spatial-temporal innovations of that led to the development of what could loosely be referred to as modern patterns of human behavior, as indicated by advanced technological innovations and a wide range of symbolic artefacts.

When one considers the key sites, Klasies River Mouth, Blombos, Sibudu, Diepkloof immediately come to mind, as do Elands Bay Cave, Hoedspruit, Die Kelders and the sites at Pinnacle Point (Figure 6). All of these sites contribute to our understanding of MSA and the spatial-temporal innovations of that led to the development of what could loosely be referred to as modern patterns of human behavior, as indicated by advanced technological innovations and a wide range of symbolic artefacts. The discoveries at Blombos over the past decade have done much to focus attention on the evolution of modern behavior (Henshilwood et al., 2001, 2002, 2004). Here examples of shell ornaments, engraved ochre and bone artefacts attracted attention and have led to the identification of similar artefacts from earlier excavations at Klasies River Mouth, Blombos, Die Kelders, and the sites at Pinnacle Point (Figure 6). All of these sites contribute to our understanding of MSA and the spatial-temporal innovations of that led to the development of what could loosely be referred to as modern patterns of human behavior, as indicated by advanced technological innovations and a wide range of symbolic artefacts.

Other work has addressed patterns of innovation and technological change in lithic assemblages from the MSA (Wurz, 2002; Soniano et al., 2007; Porraz et al., 2008; Villa et al., 2010). In this context the stratigraphic and chronological relationships between Still Bay and Howiesons Poort assemblages have often been the focus of research, and the importance of bifacial points and segments as strict cultural markers is often accepted uncritically. Today work is addressing whether these cultural groups form relatively homogeneous and narrowly defined chronological units. Researchers are also debating whether or not these periods can be viewed as the zenith of symbolic complexity that waned in latter periods due to a range of environmental or demographic changes (Jacobs et al., 2008; Lombard and Parsons, 2011). My feeling is that scenarios that postulate a radical decline in cultural development after the Howiesons Poort are problematic on theoretical grounds and not adequately documented in the archaeological record (Conard, 2012; Conard et al., In press). Lyn Wadley and my excavations at Sibudu (Figure 6) document highly-developed lithic traditions preceding and following the Still Bay and Howiesons Poort, and I am skeptical of the near mythical status as periods of great innovation that both the Still Bay and Howiesons Poort enjoy in some quarters.

Certainly the lithic assemblages of the younger phases of the MSA at Sibudu are characterized by distinctive Tongati and Ndokwee tools and other artefacts that document advanced lithic technology at the site, and question the notions that Still Bay and Howiesons Poort assemblage types are uniquely developed (Conard, 2012) (Figures 9–11). Researchers from the University of Tübingen, Paris West University Nanterre La Défense, and many other institutions are currently studying assemblages from across the subcontinent to better characterize the patterns of technological change over the course of the MSA. In the coming years we should gain a greatly improved understanding of the variability during the MSA that will allow us to contextualize and critically assess the patterns of lithic innovation and the coming and going of new assemblage types (Porraz et al., 2008; Soniano et al., 2007; Villa et al., 2010; Lombard and Parsons, 2011).
Other lines of research on the southern African MSA have also produced remarkable results in recent years. When we consider our understanding of the evolution of new patterns of subsistence during the Middle and Late Pleistocene, few regions have contributed as much to ongoing debate as southern Africa. For years Klein has argued that key shifts in subsistence strategies has been linked to the evolution of modern behaviour. Klein argues that the evolution of symbolic culture arose in the context of a genetic mutation for language (Klein, 2009; Klein and Edgar, 2002). In this context he sees that a major shift in population densities and subsistence practices associated with the later phases of the MSA around 50 Ka. He argues his position on the basis of details studies of shellfish, tortoises and mammalian fauna (Klein, 2009; Klein and Cruz-Uribe, 2000).

This work has generated much debate and has not always been supported by independent studies (Fith, 2008). Many other teams are studying faunal and floral assemblages to examine changing patterns of subsistence and to consider whether or not environmental change triggered cultural responses during the MSA (Figures 12) (Marean et al., 2000; Marean, 2005; Clark and Plug, 2008; Clark, 2009).

Many other scholars envision a much earlier rise in modern patterns of behaviour characterized by symbolic communication and advanced technology. Parkington (2001) has argued that a shift toward the use of marine resources in the diet of the MSA inhabitants of southern Africa may have helped to trigger cultural development. This view is based on the important nutritional qualities of marine foods such as shellfish, and most notably omega 3 fatty acids, that according to Parkington may have fostered enccephalization. This controversial hypothesis is currently under study using results from the excavations at Pinnacle Point, Hoedsjiespunt and other sites (Marean et al., 2007). While the importance of marine resources is debatable, by the late Middle Pleistocene shellfish contributed to the diet of the coastal residents of southern Africa.

Other research in southern Africa has led to claims that bow and arrow technology was in wide use in the region. Arguments have been made using both lithic artefacts and the contents of usewear and traces of hafting the fear (Lombard, 2005; Lombard and Phillipson, 2010), as well as based on the presence of occasional indications of bone projectiles (Blackwell et al., 2008).

Wadley (2010) has also suggested that the faunal remains recovered from Sibudu may well reflect trapping small animals. These and other observations are examples of how faunal studies in southern Africa are leading to the development of new hypotheses that are helping to improve our understanding of the MSA of the subcontinent.

Research on the use of ground ochre has received much attention in recent years. Some researchers such as Watts (2002) have stressed the importance of ochre in the contexts of ritual and symbolic communication, while Wadley (Wadley, 2005; Wadley et al., 2009) has proposed that ochre has a significant role in social organisation among southern Africa. This research has been important in understanding the ways in which the symbolic communication of ochre has been used to create a shared social identity, and it strikes me as unlikely that archaeologists can rigorously separate these two spheres. One essential characteristic of modern cultural behaviour is that many areas of life and experience are permeated by a seamless fabric of symbolic functions, and it strikes me as unlikely that archaeologists can rigorously separate these two spheres. One essential characteristic of modern cultural behaviour is that many areas of life and experience are permeated by a seamless fabric of symbolic and practical realms.

Advances in the study of floral remains and in geoarchaeology are also making important contributions to research on the MSA. Recently Wadley, Goldberg and colleagues have used preserved floral remains and micromorphological studies of sediments at Sibudu to document what they interpret as examples of bedding (Goldberg et al., 2009; Wadley et al., 2011). They view the construction, use and eventual burning of this bedding as an innovation of the MSA that reflects an important behavioural advance. Additional geoarchaeological analyses and the study of burnt plant remains and bones have been used to document the evolution of the use of fire at sites including Sibudu and Diepkloof (Schleg and Conard, 2006; Siemons and Wadley, 2008).

These and many other examples of innovation research illustrate the importance of the coastal and near coastal MSA sites of southern Africa. This dynamic research environment shows no signs of slowing down and at numerous international meetings the southern African MSA is at the centre of the debate on the location and timing of the cultural innovations that are often equated with the key steps toward culturally modern behaviour. The irreplaceable contributions the sites including Klasies River Mouth, Blombos, Sibudu, Diepkloof, Elands Bay, Cave, Hoedsjiespunt, Die Kelders, the sites at Pinnacle Point and others have made to Stone Age research justify their potential that could be further researched as a seminal nomination for World Heritage status. At present heritage officers, archaeologists and paleoanthropologists are working to prepare such a nomination and to determine which sites should be included. Policies are also being developed to determine how to best preserve the sites for future research while making them available to a broader public.

Conclusion

In this paper I have briefly summarized some of the arguments that could be made to recommend two groups of sites for further research towards potential World Heritage status. These are two of several potential Middle Stone Age sites or groups of sites that deserve consideration in this context, as indicated in the recommendations of the working groups at the UNESCO meeting in Addis Ababa in February 2011 (UNESCO, 2011). As I see the situation, the challenges in both cases relate not to the scientific importance of the potential nominations, but to preserving and managing the sites, while at the same time fostering an environment for productive research.

In the case of Mumba Rock Shelter and the sites around Lake Eyasi, it is the inaccessibility of the sites and the low level of economic development in this region that helps to protect the sites. At present the sites are only rarely visited by researchers, and relatively few people even know where the sites are located. Based on the scientific merit of the sites, one could make a strong case for their candidacy. The relatively undisturbed natural setting around Lake Eyasi, although not of primary importance, also adds to the appeal of a potential nomination. As far as I am aware, no steps have been taken at present to start the nomination process. Research on the collections from different sites and different phases of excavation continues, and the value of the sites will become better recognized in connection with the ongoing research. Finally, the region of Lake Eyasi is also the area where the remnant populations of Hadza hunters and gatherers live, and while they are, of course, not the remains of a kind of fossilized society, the Hadza have often been the focus of study into the social and economic behavior of hunters and gatherers. In this regard they have often contributed to our understanding of the past (O’Connell, 2006; O’Connell et al., 1988a, 1988b).

These coastal and near-coastal MSA sites in South Africa are all in areas that are in the midst of economic growth, building development and population increase, often at the expense of the natural environment. Again the challenges related to nominating these sites in a serial nomination do not relate to the quality of the scientific arguments, but rather to issues of preserving the sites, site management and maintaining an environment in which research can prosper and contribute to the local communities. In the case of some of these sites, there exists a perception that preserving heritage will retard economic development, such as in the case of the planned developments near Sibudu, and analogous issues in less extreme form apply to several of the other sites in question. Another issue for these MSA sites is how heritage officers could implement a coherent management plan for sites spread hundreds of kilometres apart and in multiple provinces. These questions, however, do not pose fundamental problems, and heritage officers and scientists in South Africa have started to work toward the goal of nominating these important sites in a serial nomination for World Heritage status. At the same time research continues at most of the key sites, and ensures that the importance of the sites – and the likelihood of a successful nomination – will increase in the coming years.

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Ethnographic parallels for human evolution sites on the World Heritage List

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Introduction

One of the assessment criteria for World Heritage nominations requires evaluation of the authenticity of the information supplied to the World Heritage Committee in the nomination dossier. Because there is no oral history from the people who originally lived at sites significant for human evolution, interpretation depends on the scientific analysis of evidence for human evolution, adaptation, dispersal and social developments (HEADS). This is sometimes drawn from ethnological and anthropological research on hunter-gatherers of the past few centuries. It is therefore useful to examine how analogues and parallels have been used and how they might affect both authenticity and credibility.

In this brief review, ethnographic examples are drawn from the San (Bushmen) of Namibia, Botswana and South Africa from the mid-1800s to the present, to demonstrate ways in which they have been applied in the analysis of archaeological material from human evolution sites in sub-Saharan Africa. Ethnological studies of other hunter-gatherers and sites on other continents have also been appropriate but, for the sake of brevity, only a small sample is selected here. Ethnological and taphonomic parallels (for example, Brain, 1981), while important for interpretation of australopithecine sites, are not included.

Ethnographic parallels in the African Stone Age

Parallels between human behaviour in the past few hundred years and the behaviour of people hundreds of thousands of years ago is usually based on inference using the ‘if … then’ line of reasoning. If a pattern of behaviour identified in the archaeological record appears to be analogous to an ethnographic example, then the range of credible explanations will be tested against that ethnography. Assessment criteria will include the time difference between the two examples, their biological and economic similarities and their geographic and environmental setting. The main categories of behaviour used in such analogues have been:

- Landscape adaptations;
- Economy and diet;
- Artefact manufacture and use;
- Social structure;
- Beliefs and cosmology.

Table 1 summarizes the degree of credibility that might be considered in these categories and examples of parallels that have been applied are summarized below under general headings that refer to the approximate stage of evolution of the tool-makers.

<table>
<thead>
<tr>
<th>Biological Evolution</th>
<th>Adaptations and Dispersals</th>
<th>Economy and Diet</th>
<th>Artefact Manufacture and Use</th>
<th>Social Structure</th>
<th>Beliefs and Cosmology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holocene</td>
<td>XXX</td>
<td>XXX</td>
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<td>XXX</td>
<td>XXX</td>
</tr>
<tr>
<td>Homo sapiens</td>
<td>XX</td>
<td>XX</td>
<td>XXX</td>
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<tr>
<td>Early Homo spp.</td>
<td>X</td>
<td>X</td>
<td>?</td>
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</table>

Table 1: Ethnographic parallels relevant to HEADS

A general guideline to the degree of applicability of ethnographic parallels for the main behavioural categories relevant to human evolution, adaptations, dispersal and social developments (HEADS), it makes the assumption (not necessarily true) that successive species of Homo might have had different behavioural characteristics. High credibility is indicated by XXX, and lower credibility by XX and X. Possible application is indicated by ? and the space is blank where credibility is unlikely or absent.

Early Homo spp.

The concept of the ‘home base’ was an important milestone in the analysis of Earlier Stone Age sites such as Olduvai in Tanzania and Olorgesailie in Kenya. Based initially on the observation that only humans, not apes, accumulate artefacts and food debris at places that they return to repeatedly, mainly for food sharing (Isaac, 1978), the hypothesis changed over the years to ‘central place’ and ‘cache’ models (Isaac, 1984; Potts, 1994) that were drawn from biological as well as generalized ethnographic observations. From the evidence of tool marks on bone, it seems that the earliest tool-makers in the Oldowan were gatherers and scavengers rather than active hunters of large game animals. Acheulean sites, with more direct evidence for hunting from cut marks on bones and a wider variety of prey (Klein, 2009), are therefore more likely to demonstrate behavioural similarities with recent hunter-gatherers.

Despite claims for a hut circle at Olduvai (Leakey, 1971) excavations such as that at Melka Kunture (Chavaillon and Piperno, 2004) demonstrate the difficulty of isolating anthropogenic activity from natural erosion patterns, and detailed behavioural parallels between the Acheuleans and recent hunter-gatherers are rare. Unlike recent hunter-gatherers, the Acheulean handaxe-makers commonly lived close to water, often on river banks, in stream channels and alongside lakes and springs, but very seldom in caves (Deacon, H.J., 1998; Klein, 2009). There is repeated use of the same raw material sources and very little change in artefact design over 1 million years and throughout the geographic distribution range.

The biological concept of species distribution suggests the Earlier Stone Age (Lower Palaeolithic) Acheuleans occupied a narrow ‘stenotopic’ niche as terrain specialists using resources from productive nineine habitats (Figures 1a and b). This suggests that Acheuleans lacked the social mechanisms and imagination that is ethnographically evident amongst African populations to occupy all niches in the landscape and to step out of their routine. In comparison with hunter-gatherers in the recent past, the Acheuleans were ‘primitive’ people (non-modern) who were very set in their ways (Deacon, H.J., 1998).

Pieces of red ochre – used as pigment for body decoration during ritual ceremonies, paint for rock art and as a preservative for tanning hides in hunter-gatherer societies – have been found associated with Acheulean artefacts at several sites in southern Africa, including Kathu Pan, Wonderwerk and Duxforetfontein, and at Kaptzhun in Kenya (Klein, 2009). It is uncertain why it was collected during the Acheulean, but it might have been used in similar ways to those documented ethnographically. This could imply that ritual behaviour and/or technology for clothing was already practised.

While ethnographic models are often not appropriate for this early stage in human evolution, the distribution of Acheulean sites beyond the shores of Africa, and the later migrations of modern humans, clearly indicate that people were more than capable of moving from one place to another. Anthropological theory might be appropriately applied to behaviour in terms of availability of resources, group dynamics and issues of identity, but the challenge is to find ways of testing these hypotheses in the archaeological record. After all, many other mammals moved out of Africa too, although not in the same timeframe. And none made it to Australia and the Americas.

Archaic and near-modern Homo sapiens

Evidence from sites in East and South Africa shows that the disjunction between the handaxe-makers and the Middle Stone Age was complete by about 200 Ka ago. Efficient hunting and gathering is assumed from faunal remains in this time range. In the Middle and Later Stone Age, the distribution of hominid bases indicates that a wider range of habitats was used.
Post-Acheulean artefacts are found in all landscape situations indicating eurytopic behaviour of terrain generalists (Figures 1a and b) willing to try anything (Deacon, H.J., 1998). This suggests the development of social mechanisms to adapt, disperse and aggregate. Their lifestyle and economy became more like that of known hunter-gatherers and ethnographic parallels are thus more appropriate. Was the change primarily the result of human physical, cognitive or technological evolution, or a combination of all three?

The Klases River fossils represent one of the African populations of modern people, isolated at the southern end of the Continent. The human bones are fragmentary and there is morphological variability between individuals. Some are gracile and one mandible fragment is as small as that of a San female. The remains are mostly skull parts, some with cut and tear marks, percussion impacts and burning. They occur in a particular horizon c. 115 Ka old. Is this the result of some form of ritualized secondary burial practice, evidence for interpersonal violence, or dietary cannibalism? There are ethnographic parallels for all three of these practices and other examples of possible cannibalism in archaeological deposits in Europe, for example at Atapuerca CD in Spain dating to c. 800 Ka (Klein, 2009).

Structured hearths, the focal point of family life in the ethnographic present, are recognizable in long sequence deposits and are unequivocal evidence for regular home bases. There is an impressive number of hearths with carbonized surrounds to be seen in exposures at Klases River. They are small domestic fire places and are often associated with burnt shell and bone. The preparation of food, including plant foods, around small hearths suggests that family units used them as they do in the ethnographic present. Rules of cleanliness are evident in the discard of the bulk of the food waste in middens which are separate refuse areas. The use of marine foods shows expansion of the territorial range as well as a more varied diet.

The Middle Stone Age industries at Klases River and related sites are based on flake and blade technology with good evidence for hafting, as in ethnographic examples. There are marked changes in stone tool design over time indicating several periods of innovation. Stone segments from the Howieson’s Poort industry of the Middle Stone Age, c. 60–70 Ka ago, are similar in shape to smaller ethnographic specimens. Ethnoarchaeological studies of hafting and use-wear experiments based on ethnographic parallels, as well as micro-residue analysis conducted on 53 segments from Sibudu Cave in South Africa, argue for the design and use of segments as arrowheads at least 40 Ka earlier than previously thought (Lombard, 2007, 2008; Lombard and Phillipson, 2010).

Decorative items known ethnographically for both daily use and for rituals have been found in deposits of similar age (c. 60–75 Ka ago) in both North Africa and South Africa. They presage items found frequently in Holocene deposits and amongst present-day San communities. At Grotte des Pigeons in Morocco and Blombos Cave in South Africa, perforated Nassarius shells were strung together, presumably as necklaces. Diepkoold Cape Cave and Klein Kliphuis shelter, also in South Africa, have numerous ostrich eggshell fragments with incised lines similar to those on decorated ostrich eggshells used as water containers by the San in recent times (Klein, 2009). Ostrich eggshell beads have been found in small numbers in several Middle Stone Age deposits. Ochre from Blombos Cave with engraved designs comes from deposits below a wind-blow sand horizon dated to 70 Ka ago (Henshilwood et al., 2009). There are no exact ethnographic parallels for the decorated ochre, but similar designs are found on bone, ostrich eggshell and arrow shafts made by 19th and 20th century San. Painted slabs from Apollo 11 in Namibia are associated with terminal Middle Stone Age artefacts about 27,500 BP (Wendt, 1976). The images are similar to rock paintings on the walls of caves and rock shelters in that region that date within the past 10 Ka and have strong connections with the belief system of the San in southern Africa.

The gradual increase in the number of decorative items through time is indicative of a growing awareness of symbolism and the value of non-utilitarian artefacts.

Holocene

From about 12 Ka ago in southern Africa, artefact assemblages have clear parallels with toolkits documented ethnographically amongst the San and Khoe people who were living there at the time of European contact from 1,500 AD onwards (Deacon and Deacon, 1999). For the first time, ancestors of the San began burying their dead in formal graves, often decorating the body with beads and covering the grave shaft with powdered ochre (Deacon and Deacon, 1999).

It is tempting to assume that beliefs and customs about artefacts that were recorded in the last few hundred years apply also to similar artefacts made within the past 12 Ka. Poisoned arrows, for example, made and used by the 19th and 20th century San, were part of an intricate system of beliefs and rituals. They were regarded as having special potency and played a role in healing ceremonies as well as hunting (Deacon, J., 1992). Rock paintings of arrows seem to confirm the oral history statements about their potency. Similarly, animals such as the eland that are widely represented in rock paintings and engravings, feature prominently in the cosmology of the San, and there is good reason to conclude that ethnographic parallels can provide insight into the beliefs of Later Stone Age people throughout the region (Lewis-Williams and Chalvis, 2011).

Oral histories from the /Xam San people interviewed in the 1870s (Bleek and Lloyd, 1911; Hollmann, 2004) and from the Ju‘hoan in Namibia (Biesele, 1993), and the Ikung (Yellen, 1977; Lee, 1979; Katz, 1982; Wiessner, 1982), Guvi (Silberbauer, 1981) and Nharo (Guenther, 1986) in Botswana have been particularly influential. They have contributed to research in fields as diverse as the identification of gender-specific activities and gift exchange in Later Stone Age rock shelter deposits (Wadley, 1989, 1996); explanation of regional differences in stone artefact frequencies (Deacon and Deacon, 1980); reconstruction of social relations (Mazel, 1989), interpretation of rock paintings and engravings (Lewis-Williams, 2000; Lewis-Williams and Chalvis, 2011), comparisons between 20th century hunting patterns and those reflected in faunal remains at Later Stone Age sites (Deacon, J., 1984) and understanding the gathering part of the Later Stone Age economy (Deacon, H.J., 1993). By building up a database of successes with the recognition of credible ethnographic analogues, it should be possible to test for similar parallels further back in time and in different geographic and environmental situations.

Lessons learnt and advice for HEADS

While ethnographic studies tend to be time-specific, group-specific and area-specific, there are high-level similarities amongst hunter-gatherer societies that can be used with caution to recognize and interpret past behavioural patterns at archaeological sites. Modest success has been achieved in southern Africa, particularly at sites dating to within the past 12 Ka, but further back in time as well. More insights are possible both in this region and beyond, especially where ethnographic sources are available. This would apply both to archival records that have not been opened or read closely for decades or even centuries, and to people and communities who retain important memories but have not been consulted.

The HEADS programme can play an influential role in encouraging States Parties who are preparing to add sites to the Tentative List or who are gathering information for nomination dossier to make a concerted effort to identify ethnographic materials that could have relevance for interpretation of human evolution sites. Indigenous communities with links to the site should be consulted both for any information or memories they might have, and to obtain permission to share knowledge about sensitive issues.

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Scientific Perspectives: Africa and HEADS


The astonishing paleontological, archaeological and paleoecological richness of Africa is reflected in the common understanding that it was the cradle of humankind. It is the continent where, among others:

- The highest number of hominins remains has been discovered (by far);
- There is evidence of the earliest bipedal walking;
- An unprecedented number of 2 million-year-old sites have been found;
- One million-year-old sites, being numerous and rich, do not cause the excitement they ignite in other contexts;
- Anatomically-modern humans appeared 200,000 years ago;
- There is early evidence of graphic activity and symbolic behaviour;
- Past and present biodiversity is better evidenced and preserved than anywhere else;
- There are huge numbers of rock art sites, dating up to recent times.
- It is probably also the continent most frequently quoted in the major international journals, which has established the reputation of scientists working in Quaternary Sciences. This is reflected in the World Heritage List, which includes major sites related to human evolution in Africa, such as the Lower Valley of the Omo, and the Lower Valley of the Awash (Ethiopia), Ngurongoro Conservation Area (United Republic of Tanzania), and Fossil Hominid Sites of Sterkfontein, Swartkran, Kromdraai, and Environ (South Africa).

More are to be found on the Tentative List, such as The African Great Rift Valley – Olorgesai Prehistoric Site (Kenya), Kalambo falls archaeological site (prehistoric settlement site) (Zambia), Pleistocene occupation sites of Klases River, Border Cave, Wonderwerk Cave (South Africa) and comparable sites relating to the emergence of modern humans – even if more often than not they have remained there for years. Rock art is also represented all over the continent, both on the World Heritage List and the Tentative List.

This ‘African superpower’ in human evolution is more than a scientific issue, however, and will be briefly evaluated below in two different perspectives:

- Narrative/narratives which stem out of discoveries, as perceived both in Africa and outside Africa;
- Capacity-building and management of sites.

Narratives

Both the ‘Africa as the Cradle’ and ‘Out of Africa’ narratives are found everywhere in the media and in popular books – the second narrative being the most preeminent. The scientific community recognizes a minimum of three Out of Africa events, related possibly to Homo habilis, and positively to Homo erectus and Homo sapiens, while several more are suggested by recent research (Lepre et al., 2011). This is barely perceived outside the scientific circles: the common understanding is that there was an early hominin dispersal, and then a later one, of humans ‘like ourselves’, often related to the ‘African Eve’. The later one actually sometimes gets superposed and mixed with the much earlier ‘Lucy’ icon. Whatever the accuracy – or not – of this narrative, it is severely biased towards the ‘Out’: Africa is indeed the Cradle, but does not interest much as such; its later one actually sometimes gets superposed and mixed with the much earlier ‘Lucy’ icon. Whatever the accuracy – or not – of this narrative, it is severely biased towards the ‘Out’: Africa is indeed the Cradle, but does not interest much as such; its importance is rather seen as the provider of actors for mighty events which happened outside the continent. Developments in paleoenetics, coupled with a biased perception of the past – which admittedly is rather a paradox – will possibly help in addressing the issue.

The outcome of accurate mapping of the human genome (Green et al., 2010; Yotova et al., 2011) points to a major difference between contemporary African and non-African populations: in the genome of the former ones there is no evidence of admixture with Neanderthals, while the opposite is true with present-day humans from everywhere else in Eurasia, Oceania and the Americas. In the popular understanding, Neanderthals are the archetype of primitive and rough humanity. Accordingly, a Neanderthal signature within genes can easily – even if wrongly – be perceived as questioning the status of most, but not
all modern humans. This, in turn, might lead to reconsidering the role of Africa as more than just a kind of container and provider, with real things happening elsewhere.

As mentioned, the implications of the tropical and African origin of all past and present humans are neither properly understood, nor elaborated into any detail. Human expansion and adaptation within Africa itself, ending in the colonization of extremely diverse environments, is not addressed in detail, as if not really interesting.

There is a fresh start of a more detailed narrative, however, in African countries, such as in Ethiopia: museum panels in Addis Ababa, just as leaflets for tourists, underline that this is the place ‘where it all began’, leaving it open for further elaboration. More importantly, not just foreign tourists, but also African schoolchildren visit museums and sites where this message is conveyed.

Capacity-building and site management

If the ‘Africa as the Cradle’ narrative has to be better recognized and substantiated, in order to attract attention and balance the ‘Out of Africa’ narrative, capacity-building and site management are a central issue.

On the other hand, a country will invest in capacity-building, conservation and site management in the archaeological and palaeontological field only if research on the prehistoric past is perceived as important. The two sides of the problem are interlocked.

This is well understood by site managers all over the continent, as was evidenced at the meeting, ‘Preparation of a Road Map to promote the inscription of African human origin sites on the UNESCO World Heritage List’, in the framework of the UNESCO World Heritage Thematic Programme ‘Human Evolution: Adaptations, Dispersals and Social Developments (HEADS)’, held in Addis Ababa, Ethiopia, in February 2011. At a working group which met on topics related to site management and conservation, managers expressed very clearly, and even dramatically, their need and request for further training, and for sharing best practices adapted to the challenges often faced in the continent. Paleo-tourism is perceived as a resource in itself, and also as a way to promote interest for the past, which in turn can lead national and local authorities to invest more in education, site preservation and valorization. This positive perception is further enhanced when the Outstanding Universal Value (OUV) of paleoecological/paleoanthropological sites in Africa is underlined by a nomination to the World Heritage List, which in turn also promotes a specific kind of highly motivated paleo-tourism. ‘Africa as the Cradle’ will develop together with research, and preserved and well-managed paleoanthropological sites.

Bibliography


African human evolution-related sites: towards a sustainable conservation plan

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A multi-faceted challenge

The African continent widely documents the various steps of the human lineage from its earliest roots. It was therefore natural that the UNESCO World Heritage Centre, having launched the HEADS Thematic Programme ‘Human Evolution: Adaptations, Dispersals and Social Developments (HEADS)’ by means of several international meetings, decided to carry out the first regional meeting in Africa.

Promoting such inscriptions is an important concern, cognizant of the quite limited number of African prehistoric sites presently inscribed on the World Heritage List, that include only a minority of hominin fossil-bearing ones. Preparing a ‘Roadmap to promote the inscription of African human origins sites’ therefore represents an actual, multi-faceted challenge from various points of view addressing both scientific research and conservation/dissemination, a challenge that needs to consider the significance of human evolution-related sites as a whole (inscribed and non-inscribed sites as well).

On the scientific side, that challenge is to build an adaptable international instrument that remains on the cutting edge of a fast evolving situation in terms of palaeontology and evolutionary studies, of discovery, perception a conceptualization of behavioural/cultural remains, and of hypothesis/global interpretation of hominid dispersals patterns.

This adaptability is critical in terms of interpretive facilities. Beyond the simple illustration of a fantastic geographical and chronological diversity of fossils, the network of African sites must reflect, on scientifically-validated grounds, the documented milestones of our lineage by means of an ever-updated comprehensive story. One of the expected results is to help to clearly identify the main questions faced by the scientific community in order to understand our history, while being able to highlight them in a quite meaningful historical perspective.

Such a story cannot rely only on fossil-bearing properties, but has to consider – for conservation purposes – archaeological and palaeoenvironmental records as well. A variety of site types are brought together within that category, ranging from landscapes and significant geological outcrops to caves yielding ancient living floors, and open-air occupation sites.

From a long-term perspective, promoting the inscription of African human origin sites requires the HEADS Programme to be backed by a significant, interdisciplinary and inter-sectoral, multi-level training policy. Obviously, the latter is intended to address various aspects of the development of the concerned properties, to maintain and improve their Outstanding Universal Value (OUV), and to establish and share good practices as well. From the scientific point of view, this training effort has a threefold objective:

- Take part in the development of the sites authenticity (scientific validation) and integrity (conservation skills) by means of academic and practical networking, teaching and sharing of knowledge, as most of the properties are still far from having yielded their complete heritage content;

- Support the identification of a professional learning community able to define and share good conservation practices, and pay balanced attention to both the sites and the discovered material heritage (a specificity of prehistoric sites in general);

- Contribute to the UNESCO goal of knowledge sharing by promoting the dissemination of natural evolution patterns that, at the human evolution scale –and Africa is certainly the best area in this respect- are linked to a major humanistic value.

In light of the outcomes of the HEADS meeting in Addis Ababa, restricting ourselves here to the most ancient part of the history of humankind as related by the African continent (i.e. until the late Lower Pleistocene / early Middle Pleistocene, between some 800 000 – 600 000 Ka ago) we shall briefly consider below several issues that are directly related to that attempt to build sustainable and internationally relevant conservation plans.
Evolution

As a shortcut to dealing with evolution, we might say that the efforts have to bear on the well-known old cliché of the progressively standing ape-like creature, which is still present on many of our shirts – if not still in our minds. Though, we are definitely aware that a derived character, which is by essence chronologically more modern, is not necessarily a ‘better’ one.

As, for instance, humans still possess five fingers – a character inherited from vertebrates living during Devonian times, hundreds of million years ago, hence making our ‘multi-purpose’ hands use a quite ancestral anatomy. On the contrary, we know that the Equidae developed the horse’s specialized unique finger much later, during the Neogene times.

A similar comparison can be made regarding the use of anatomical features for subsistence and technical purposes. It is amazing to notice that evolution of higher primates led humans to progressively lose half of five clear anatomical tools, interfaces or sockets. Ape’s use make up of their four hands and feet. As a matter of fact, the number and size of their teeth, to the shape and robustness of their mandible and maxilla, their manducatory apparatus represents a very useful instrument when attempting to cope with uneasy situations. Humans lost their opposable toes on the feet. They lost as well – partly – the robustness and dental characteristics of the manducatory apparatus. Though, they still use it as we may observe on severe wear of fossil and even extant individuals, often linked to technical activities.

Roots

One of the critical questions reflected by current research in Africa is to understand the history of the Hominidea phylum since early Neogene times. In summary, it is to know to which extent the earliest hominids are descended from a quite long African ape evolution or have (cf. the ‘rolling cradle’) an Eurasiatic ape ancestor which dispersed back to Africa. Under this perspective, the African finds have to be situated in the framework of a palaeo-primatology that considers Far as well as Middle Eastern fields of research (see for instance Jaeger et al., 2005), and which have become particularly productive during the past decades (e.g. in Thailand, China and Libya).

The concern doesn’t have to cover the whole of the primate’s history, which might even predate the beginning of the Cenozoic Era. But it will help to consider current and forthcoming discoveries regarding great apes phylum – such as that of the recently described skull of Ugandapithecus major in Uganda (Senut et al., 2000) – in an ancient world-wide perspective.

Origins of the phylum

Such an approach will also help to maintain the overall conservation and interpretative process, enabling the conservation plan to consider any future hypothesis or theory (supported with relevant arguments) regarding the most ancient history of the hominids. As, for instance, it appears normal nowadays to include in ‘African human origins sites’ late Miocene and early Pliocene properties that yielded the remains of Sahelanthropus tchadensis (Chad, Brunet et al., 2002), Omoanthropus (Kenya, Pickford et al., 2001) or even Ardipithecus kaddi (Ethiopia, Haile-Selassie et al., 2004), and the subsequent Ardipithecus ramidus (Ethiopia, White et al., 2009). Today, these are subject to current debates regarding their actual status as candidates to pinpoint the differentiation of our lineage, and are much older than the (3–5 million years old) Australopithecus afarensis that was widely publicized in the media some 35 years ago (see also for instance Coppen, 1983; Johnson & Edey, 1981).

These debates deal with numerous anatomical aspects (e.g. skull, pelvis, femur, foot etc.) that determine the overall aspect and abilities of the body, including the most often highlighted bipedalism (e.g. Senut, 2006; White et al., op. cit.; Cerling et al., 2010). As mentioned above, they must be regarded as an ever updated analysis of a corpus mixing inherited and acquired characters, and not the simple witnessing of a linear phylogeny and chronology, as was the case some decades ago, a way of thinking that was much facilitated by the scarcity of discoveries at the time, compared to the present development of their spatio-temporal distribution.

Natural and anthropic records

Since the discovery of East African Australopithecus and early Homo representatives, research has paid specific attention to not only build an as-accurate-as-possible chronological framework of the discoveries – that highly depends on the nature of the surrounding volcanic and sedimentary deposits – but also to reconstruct their palaeoenvironmental context.

Such endeavours are quite important in order to set up the climatic and environmental constraints and their possible influence on hominid evolution in Africa (e.g. the current debates about the possible development of bipedalism in a woodland environment, and not necessarily owing to a severe opening of the landscape). It is also obviously meaningful in order to reconstruct the hominid group’s way of life.

Hence, beyond geological outcrops and related meaningful stratigraphical sections, conservation should address whole landscapes that reflect, to various degrees depending on the places (that have to be carefully recorded), the extension of hominid occupation of the area during ancient times. Here, a large variety of properties and records are concerned, both open-air sites and caves, and the related varied conservation practices.

From Australopithecus to Homo

The quite diversified and specialized groups that are presently gathered in the Australopithecus genus, the co-existence of some Australopithecus with the early representatives of the Homo genus (e.g. H. habilis) do not only document a rather normal ‘bushy’ evolution of the hominids. They also help us to realize an important fact, i.e. before – and partly during – the Upper Pleistocene dispersals of Homo sapiens throughout the Old then the New World, several forms of humankind have coexisted and to a certain extent interbred; a fact that is documented more and more through recent discoveries, e.g. the numerous studies regarding the extinction of Neandertal, the evidences recently documented of Flores (Morwood et al., 2004; Brown et al., 2004) and of Denisova (Krause et al., 2010).

Beyond several anatomical characters (even including the supposed neurological ability for articulated language, see Tobias, 1987; Grimaud-Hervé, 1998), early Homo genus characterization was – at least – partly grounded on the concomitant discovery of organized toolkit-making procedures. Though supported by field evidence, such a ‘cultural’ argument might seem somewhat subjective, and is presently debated, e.g. the discovery of Dikika (Ethiopia), of traces of butchery on animal bones suggesting that Australopithecus afarensis might have used stone tools (McPherron et al., 2010 vs. Domínguez-Rodrigo et al., 2010).

Early dispersals

Early representatives of the Homo genus might have quickly dispersed throughout Africa (though debated, the ‘Ain Anneh site in Algeria might date back to the early Lower Pleistocene, Sahouni, 2006). Archaeological records (and especially lithic industry assemblages) are quite useful and promising under that point of view. Acheulean assemblages (mostly handaxes and cleavers) developed c. 1.7 Ma ago in East Africa (e.g. Konso, Ethiopia, Asfaw et al., 1992; and Kokiselei, Kenya, Leptre et al., 2011) and rapidly reached the Levantine area (Ubeidiya, Israel, Horovitz et al., 1973; Repenning & Fejfar, 1982).

Much has still to be done to reconstruct the patterns of these early dispersals in Africa and neighbouring areas, that will deeply affect our knowledge of the earliest colonization of Eurasia, where the discoveries of sites predating 1 Ma ago have become more numerous: in Georgia (Dmanissi, c. 1.8 Ma ago, Gabouina et al., 2002; Lumley M.-A. & Lordkipanidze, 2006), in the Far East (e.g. Java, c. 1.5 Ma ago, see for instance Sénart et al., 2000) but also in Africa (southern Spain, see for instance Toro Moyano et al., 2011) or Perro Nord (Italy, Arzarello et al., 2007).
A promising future

Beyond that brief review of most ancient issues, the African continent still has numerous mysteries to disclose, especially regarding the period between 2 Ma ago (the extinction of the last Australopithecines) and c. 600 Ka ago. Hominid fossils are quite rare (e.g. Olorgesailie in Kenya, c. 900 Ka ago, Potts et al., 2004). Anatomical characters documented on several fossils, such as the skulls discovered at Bodo (Ethiopia), dated c. 600 Ka ago, or at El Dantasfontein in South Africa (which might be somewhat older), show a trend towards an increase of the cranial capacity but an overall archaic morphology, and are often compared to the Aisan Homo erectus.

This later period also witnessed the coexistence of the last pebble tools (c. 1 Ma ago) with the Acheulean assemblages. The continent has therefore much to tell about the diversities it is likely to reflect at the time, regarding exploitation of territories, subsistence and technical behaviours, and about the emergence of the very first anatomical characters that announce the origin of Homo sapiens, likely to appear on the Buea fossil (Ketyere, c. 1 Ma ago, see for instance Macchiarelli et al., 2004).

One of the specific interests of the HEADS meeting organized in Addis Ababa was to bring together a number of professionals dealing with surveying, geographic record, excavation and site management, hence matching the critical need for deep and fruitful exchanges, notably regarding conservation and research practices, and to also mitigate practices and lessons learnt during a sometimes long experience acquired within and outside the limited number of properties inscribed on the World Heritage List, e.g. the in situ conservation of remains at Laetoli (Rongoro Conservation Area, United Republic of Tanzania) and Olorgesailie (The African Great Rift Valley - Olorgesailie Prehistoric Site, Kenya) or Melka Kunture in Ethiopia. No doubt that an action carried out on such an enlarged scope, thanks to the UNESCO World Heritage initiative, will help the community concerned through the conservation of our origins to be ready to face and assimilate the progress of research.

Bibliography


Regional overview

The history of research in human evolution in Africa and what lessons have been learned

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Introduction

Although Charles Darwin is widely quoted as having predicted that mankind’s evolutionary forbears would be found in Africa, it was actually James Burnett, Lord Monboddo of Scotland, who predicted it nearly a century before Darwin’s work. In his 1774 publication, ‘Origin and Progress of Language’, Monboddo wrote: ‘From the South Sea, I will come back again to Africa, a country of very great extent; in which, if it were well searched, I am persuaded that all the several varieties of the species were discovered.’ It was another Scotsman, Dr Robert Broom, who in 1925, whilst writing about the newly-discovered Taung child (Australopithecus africanus, a link between ape and man), gave credence to Monboddo for his predictions. In that publication, Broom (1925) made a further prediction: ‘It seems to me not at all improbable that an adult Australopithecus will yet be obtained and possibly a perfect skeleton. Should such a discovery be made, it would be difficult to over-estimate its importance.’

It was indeed to be Broom himself who would discover that first adult Australopithecus (Broom, 1936) and thereafter to uncover other fossil clues to ‘human progression’ in Africa (in the form of early Homo—Broom and Robinson, 1949) as well as one of ‘the varieties of the species’ in the form of a human side branch, the flat faced, large toothed ape man which he named Paranthropus robustus (Broom, 1938; Broom and Robinson, 1952). The hoped for (though still not perfect) skeleton of Australopithecus was to be discovered by the present writer, 72 years after Broom’s statement and, in the years between, a great number of fossils tracing the stages of human progression as well as others representing varieties of the species were discovered in many parts of Africa by several different researchers. Thus Monboddo’s statement provides a fitting framework in which to place the topics that will be dealt with in this summary, i.e. a) ‘The several types of human progression’; and b) ‘The varieties of the species’ all set in the context of ‘Africa, a country of very great extent’ and of the people who have searched and those still endeavouring to ensure that Africa is ‘well searched.’

For the early researchers, who accepted that humans had evolved from a fossil form of ape, the expected stages of human progression would be from ape to ape-man – to early Homo – to early Homo sapiens then to modern Homo sapiens. All of these stages have now been discovered in Africa but the timing of such stages of progression as well as the correct identification of fossil representatives for each of these groupings is still a subject of debate and research.

The following pages provide an outline of these stages of progression and varieties in Africa with brief examples of some of the fossils that represent them.

The Miocene ape ancestors of mankind and the great apes

It was in 1856 that the first fossil of a great ape was discovered in the form of a mandible and a humerus at St Gaudens in France and was named Dryopsopithecus fontani (Lartet, 1856). Since then a great many fossils of a large variety of apes have been identified: more than 100 species have been found in Miocene sites in Europe, Asia and Africa. Surprisingly not one of these has yet been convincingly shown to be a direct ancestor of mankind or of the African great apes. However, in Asia, the orangutan of Asia clearly has close cranial affinity with the Miocene ape Sauropithecus (Stringer and Andrews, 2005).

For those who considered that mankind originated in Africa it was the Miocene apes of East Africa that held most promise of providing clues to human ancestry. The 18–20 million-year-old Miocene deposits of the Lake Victoria region in Kenya yielded many ape fossils beginning in the 1920s at the site of Koru. A maxilla was named Proconsul by Hopwood (1933) and it was thought that a Proconsul skull found on Rusinga Island by Mary Leakey in 1948 could be close to the ancestry of chimpanzees. Now, however, with the discovery of many more ape fossils from that region including a partial skeleton, it is apparent that the Proconsul fossils – which include small, medium and large species – do not demonstrate any particular links to the modern African apes but have a mixture of monkey and ape features (Stringer and Andrews, 2005).
Regional overview

Sahelanthropus

In July 2001, a team led by Michel Brunet discovered a crushed cranium which they identified as a 7 million year-old hominid in the very remote Djourab Desert of Chad, more than 2500 km west of the Rift Valley sites in East Africa. The site is located three days drive from the capital N’djamena, and the abundance and variety of well-preserved fossil animals in the desert are testimony to the former extent of what was the mega-Lake Chad. The impact of this find is not only its great age but also the realization of the logistic challenges that Brunet and his colleagues have had in looking for such ancient fossils. The find is a small cranio-facial fossil with a massive brow ridge. Human-like features are the lack of anterior facial projection, the small canine ( worn on the tip), the thick enamel on the teeth, and indications from the anterior position of foramen magnum and short basiocciput that the head was being supported on an upright-walking individual (Brunet et al., 2002; 2005).

The cranio-dentary does not resemble a chimpanzee and for the small cranio-facial size, the brow ridge is relatively more massive than that of a male gorilla, but unlike the gorilla, there is no supratrochlear sulcus. Of course, those who consider that chimps are the closest relative to humans were expecting the earliest hominid to resemble a chimpanzee (see Klein, 2009). The fact remains that it is the fossils and not genetic hypotheses that show us the relationships or lack thereof and, so far, there are no early hominid fossils that show any particular relationship of humans to chimps. This point was made by Clarke (2002) with reference to an Sahelanthropus skeleton from Sterkfontein which will be discussed later and which shows that the australopithecine arm and hand did not evolve from a chimp-like or gorilla-like knuckle-walking anatomy.

There are also four partial mandibles and some isolated teeth which all add support to the contention that Sahelanthropus is an early hominid.

Orrorin Tugenensis

In 2000, Martin Pickford and Brigitte Senut found a hominid in the Lukemo Formation of the Baringo district of Kenya represented by some partial limb bones, partial jaws and some teeth dating to about 6 Ma ago (Senut et al., 2001). The upper section of a femur together with half of a pelvis has several human-like features that indicate bipedalism and the five molars have thick enamel and resemblances to hominids rather than to apes (Senut et al., 2001).

Ardipithecus ramidus

In 11 articles within a special section of the journal Science, Tim White and his colleagues (White et al., 2009) provided detailed analysis of the anatomy and environment of a 4.4 million year-old hominid named Ardipithecus ramidus. A fragmented and fragile partial skeleton had been excavated by Aramis in the Middle Awash area of Ethiopia and represents the most complete fossil out of at least 36 individuals recovered there since 1992 (White et al., 1994). The skeleton, of a c. 120 cm tall female, includes a considerable amount of the skull, a partial pelvis, the right lower arm with much of the wrist and hand, the right lower leg and ankle with much of the foot, and also much of the left hand and foot. Whilst the skull and dentition display some human-like features (short cranial base, short face with small canines, and broad mandibular corpus), the brain is small (300–350 cc), and the foot has a very divergent big toe. This mix of characters is what might be expected for an early ancestral hominid, and the human-like features of the cranium are found also in Sahelanthropus.

A yet earlier form of A. ramidus was published by Yohannes Haile-Selassie (2001). Some teeth, a partial mandible, partial ulna and humerus, and a foot phalanx and a hand phalanx were found in deposits dating to 5.2 to 5.8 Ma ago in the Middle Awash of Ethiopia. They were named Ardipithecus ramidus kadabba.

The Lothagam mandible

In 1967, a portion of the right side of a hominid mandible containing one heavily worn first molar was found by Bryan Patterson’s Harvard team at Lothagam, west of Lake Turkana, Kenya (Patterson et al., 1970). It was dated to 5.5 Ma ago. It had unclear affinities, but Pilbeam (1972) noted its similarity to A. africanus and illustrated it together with an A. africanus mandible from Makapansp. It was also later discussed in more detail by Kramer (1986) and Hill et al. (1992). Now, with the discoveries of older Australopithecus in the form of A. anamensis and of the earlier hominid Ardipithecus, it seems possible that the Lothagam mandible belongs to one of these taxa. It is worth noting the events leading up to its discovery (personal observation). A University of California at Berkeley student, Larry Robbins, had decided to explore the western shore of Lake Turkana for a Late Stone Age site to use for his PhD research. Despite bureaucratic obstacles and frustrating delays, he persevered and eventually prevailed in obtaining the necessary research permit. Together with another student, John Yellen, and a small team of assistants, they set off to the remote Turkana country. He found what he was looking for—a magnificent Late Stone Age site with bone harpoons. When Robert Soper, Laurel Lofgren (now Phillips) and I drove up to visit him there, he showed me a fossil site he had observed near by. I realized that the fossils were either Plioene or Mioocene and when I returned to Nairobi I told Bryan Patterson of Harvard University, who had been working at Kanapoi, that he might find the Lothagam site of interest. He did indeed investigate and recovered a wonderful collection of Miocene fauna, including the very ancient Lothagam hominid.

Australopithecus

In 1924 at Taung in South Africa, the fossilized skull of a child was blasted out of a limestone cliff during quarrying. It fortunately came into the hands of Professor of Anatomy, Raymond Dart, of the University of the Witwatersrand in South Africa and, after cleaning it out of the encasing rock, he identified it as a link between ape and man (Figure 1) and named it Australopithecus africanus (Dart, 1925). Also as a result of a quarrying, in 1936, the first adult cranium of an Australopithecus (Figure 2a and b) was recovered by palaeontologist, Dr Robert Broom, at the Sterkfontein caves (Broom, 1936). Subsequent research at the caves has uncovered hundreds of fossils of this ape-man genus (Broom and Schepers, 1946; Broom et al., 1950; Figure 3) which from 1947 onward was also found to be present at the Makapansgat Limestone Cave (Dart 1948a,b; Dart and Bone, 1955). The large, though human-like, cheek teeth, relatively small canines and proof of upright posture in the form of the pelvis confirmed Australopithecus as a member of the family of man, a hominid. By the 1960s it was generally considered that all of these South African ape-men belonged to the one species Australopithecus africanus, and that differences within the samples were...
Male-female variation. It has now been demonstrated by this author (Clarke, 1989) that some of the variation was because a second larger-toothed and flat-faced Australopithecus species was represented and this will be discussed later. It is possible to differentiate males and females of each of these species.

It was also generally concluded that Australopithecus africanus was probably ancestral to Homo and Robinson (1972) took the step of classifying it as Homo africanus, a move that was not adopted by other researchers. Indeed, although Australopithecus represents the expected stage of evolutionary development between ape and human, it now seems unlikely that the species A. africanus was ancestral to Homo as the dating of both Homo and A. africanus from both South and East Africa shows that they overlapped in time during the period between 2.3 and 1.6 Ma ago. In South Africa, A. africanus was present from just over 3 Ma ago until about 2.2 Ma ago and in East Africa three cranial fossils generally (but controversially) classed as H. habilis are actually very close morphologically to A. africanus. These are OH 13 and OH 24 from Olduvai, and KNM ER 1813 from Lake Turkana. All three lived at the same time and in the same area as early Homo at less than 2 Ma ago (Clarke, 2012, in press).

**Earlier forms of Australopithecus**

It was actually in 1935, one year before Broom’s discovery of the adult Australopithecus that a geologically older fossil of adult Australopithecus was recovered from Laetoli in Tanzania. It was a canine tooth, ape-like enough for Louis Leakey to assume it was a monkey. Only with hindsight, after many more such discoveries from Laetoli, did Tim White recognize its true identity in the collections of the British Museum (White, 1981). In 1939 at Laetoli – then called Garusi – Kahl-Larsen (1943) found a maxilla fragment that was variously classified as Megaentroopsis africanaus (Weinert, 1950) and Praeanthropus africanus (Semyuren, 1955). Both the canine and the maxilla are now recognized as being the first specimens of early Australopithecus found at Laetoli. The collection was later significantly increased through the work of Mary Leakey’s team at Laetoli in the 1970s (M.D. Leakey et al., 1976; M.D. Leakey and Harris, 1987). These were eventually classified as Australopithecus afarensis, with Laetoli Homoid 4 (a mandible) being the type specimen dating to 3.6 Ma ago (Figure 4). There has been some debate around this procedure because, whilst the type specimen comes from Tanzania, the specific name derives from the very distant Afar region in Ethiopia where, from 1975 onwards, a large and informative assemblage of Australopithecus fossils was recovered and eventually grouped with the Laetoli sample in A. afarensis (Johanson et al., 1978). It is possible, however, that, in view of the geographic and temporal separation of these two collections of fossils, two species may be represented. Kimbel et al. (2004) have commented on the temporal and morphological intermediary of the Laetoli sample falling between the younger Hadar (Ethiopia) A. afarensis and the older Kenyan A. anamensis.

The most famous of the Ethiopian fossils is the partial skeleton known as ‘Lucy’. There is also a fragmentary but reconstructed male skull, AL 444-2. Another very informative fossil is that of an infant skeleton with skull (Alemseged et al., 2006). The significance of A. afarensis is that whilst it is clearly bipedal and the dentition is clearly hominid, it has features such as the lower third premolar which are more ape-like than those of A. africanus. The Laetoli hominids appear to be even more primitive and resemble the earlier A. anamensis mentioned later in this section.

A major discovery at Laetoli occurred in 1978 when biochemist Paul Abell spotted what he considered to be the heel impression of a hominid footprint in a volcanic tuff outcrop that geologist Dick Hay was sampling. Subsequent excavation in 1978 by Tim White and in 1979 by Mary Leakey, Mwongela Muoka and the present author uncovered a 41 m long trail of footprints made by one large and one small individual (M.D. Leakey and Harris, 1987; Figure 5). The hominids were walking side by side and the prints, though obviously of a biped, have some ape-like and some unusual features. These are: a slightly divergent big toe, a strongly developed abductor muscle for the big toe, a straight and deeply impressed lateral edge to the prints, and an absence of individual small toe impressions (DePalma, 1991).

An older (4.2 Ma) and even more ape-like hominid was recovered from Kanapoi, Kenya and named Australopithecus anamensis (M.G. Leakey et al., 1995). The first fossil was a distal humerus discovered by Bryan Patterson’s Harvard expedition in 1965 (Patterson and Howell, 1967), but intensive survey by Maeve Leakey’s team three decades later resulted in the recovery of some mandibles, upper jaws and tibia portions.

The front part of a mandible published by Michel Brunet et al. (1995) from Chad and named Australopithecus bahrelghazali (Brunet, 1996) dates to c. 3.5 Ma and is possibly a representative of A. afarensis.

**The earliest artefacts**

In the 19th century the stages of cultural progression that were seen in the archaeological record led to the logical conclusion that the earliest cultural manifestation should consist of simple stone tools. Consequently prehistorians identified in several Miocene and Pliocene localities in Europe what they considered to be simple chipped flints. These became known as ‘dawn stones’ and a 17-page chapter entitled ‘The Eolithic Period’ was devoted to them by George Grant McCurdy (1924). All of these stones, as well as similar chipped stones found in Uganda by Wayland (1923; 1927; 1934) which he named Kafuan (O’Brien, 1939) were later demonstrated to be naturally produced (e.g. Bishop, 1959).

By 1934 Louis Leakey was able to write in his book, ‘Adam’s Ancestors’, about some genuine simple artefacts (flakes and rough cores) found by him at Olduvai Gorge in Tanzania and at Kanam in Kenya. This culture, he said, had been given the name ‘Oldowan’ and subsequent work at Olduvai Gorge has recovered large quantities of these artefacts in situ from many sites within the gorge (M.D. Leakey, 1971). Such simple artefacts of the Oldowan industry are now known from a number of sites in East Africa from 2.6 to 1.7 Ma ago: in Ethiopia, at Gona (2.6 Ma ago), Hadar (2.33 Ma ago) and Omo (2.4 Ma ago); in Kenya at Kanjera (c. 2 Ma ago) and Koobi Fora (from 1.9 Ma ago); and in Tanzania at Olduvai (from 1.9 to 1.7 Ma ago) (for syntheses see Plummer, 2004; Klein, 2009). Also in South Africa, two Oldowan-bearing deposits are dated c. 2 Ma at Sterkfontein (Figure 6) and >1.7 Ma at Swartkrans (Kuman and Field, 2009; Kuman, 2010; Sutton, in prep.).
Although these earliest tools date to periods when some Australopithecus and Paranthropus were in existence, it is not considered by most researchers that they were makers of those artefacts. Both genera had the manual ability to make tools but not a single artefact has been found at Australopithecus sites dating to the period between 4.2 Ma ago, when A. anamensis existed, to 2.9 Ma ago, when the youngest A. afarensis could be found. Also no stone tools occur with Australopithecus in South Africa between, c. 3 and 2 Ma, in the Member 2 and 4 deposits of Sterkfontein, the Member 3 and 4 deposits of Makapansgat, or the Australopithecus deposits of Taung.

Raymond Dart devoted many publications to his contention that Australopithecus had a bone tool culture (see particularly Dart, 1957), but Dart's osteodontokeratic (bone, tooth and horn) 'culture' has been shown to be not a hominid culture but the result of damaged inflicted on bones by hyaena and porcupine (Hughes, 1954, 1961; Brain, 1981). Also the supposed stone tools from the Makapansgat Australopithecus site (Brain et al., 1955; Maguire, 1968, 1980) have been demonstrated to be naturally-fractured stones (Mason, 1965).

It is perhaps no coincidence that the earliest Homo fossil known so far is a maxilla (AL 666) from Hadar, Ethiopia dating to 2.35 Ma ago and directly associated with Oldowahan artefacts (Kimbel et al., 1996; Hovers, 2009).

Thus, based on currently available data, it seems that Homo rather than Australopithecus or Paranthropus was responsible for the production of the earliest stone tools.

**Homo habilis**

As Louis Leakey, like most anthropologists in the early 1930s, believed the Piltdown skull to be a genuine, large-brained fossil hominid of the lower Pleistocene, it was not surprising that he would hope to find Homo sapens-like fossils in lower Pleistocene deposits of East Africa. When in 1932 he did find such a fossil at Kanam in western Kenya (Leakey, 1934, 1935), subsequent geological investigation by Boswell (1935) indicated that the mandible fragment had been displaced from a much younger deposit and did not therefore belong to the lower Pleistocene (see also Tobias, 1962). Unconvinced, Louis Leakey continued his searches, concentrating on Olduvai Gorge in Tanzania where primitive stone tools that he named Oldowan were being found in Lower Pleistocene strata. In 1959 when Mary Leakey found a massive-toothed skull (OH 5) eroding out of an early deposit, Bed 1 (L.S.B. Leakey, 1959), Louis was convinced that this was the maker of the stone tools and stated that it was 'almost certainly on the direct line of our ancestry' (Leakey, 1966). As if to emphasise this point, the artist Nave Parker produced a drawing of this hominid as it might have appeared in life and gave it features (nose and hair) like those of Louis Leakey! The skull was named *Zinjanthropus boisei*.

All this was to change when on 2 November 1960 during the Olduvai excavation of a stone tool layer older than that of *Zinjanthropus* (OH 5), Jonathan Leakey uncovered two parietals and a mandible of a mandible of a *Homo* hominid (OH 7). As the brain would clearly have continued his searches, concentrating on Olduvai Gorge in Tanzania where primitive stone tools that he named Oldowan were being found in Lower Pleistocene strata. In 1959 when Mary Leakey found a massive-toothed skull (OH 5) eroding out of an early deposit, Bed 1 (L.S.B. Leakey, 1959), Louis was convinced that this was the maker of the stone tools and stated that it was 'almost certainly on the direct line of our ancestry' (Leakey, 1966). As if to emphasise this point, the artist Nave Parker produced a drawing of this hominid as it might have appeared in life and gave it features (nose and hair) like those of Louis Leakey! The skull was named *Zinjanthropus boisei*.

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The choice of the specific name *habilis* was because the large brain, the associated Oldowahan artefacts and several hand bones indicating manual dexterity all pointed to *Homo habilis* being the early tool maker that Louis Leakey had long sought. Although it is undoubtedly correct that *Homo habilis* was the maker of Oldowahan tools it should be noted that hand bones of *Australopithecus* also demonstrate an opposable thumb in a hand capable of tool-making. It does however seem that it was the larger brained *Homo* rather than small-brained *Australopithecus* that regularly made stone tools. A welcome addition to the catalogue of *Homo habilis* fossils was made at Olduvai in 1995 by Rob Blumenschine's team (Blumenschine et al., 2003). In an excavation of an Oldowan site at Naisiusu (Figure 9) they unearthed a magnificent maxilla of an adult with full dentition (OH65; Figure 10).

The maxilla has strong similarity to that of the 1470 cranium and the cheek teeth roots are large and flaring relative to the smaller crowns. Thus OH 65 and 1470 and OH 7 together provide a good impression of the overall appearance of a *Homo habilis* skull. Although many researchers have seen that there is a big difference between 1470 and the smaller brained OH13, KNM ER 1813 and OH 24, they accepted the latter three as *Homo habilis* and the placing of 1470 into a new species *Homo rudolfensis* (Wood, 1999). They thereby ignored the fact that it is 1470 that compares with the type specimen of *Homo habilis* (OH 7) and the other three do not. Thus it is the small-brained fossils that should be removed from *Homo habilis* (Clarke, 2012).

The OH7 Homo habilis mandible (type specimen). © Ronald Clarke

8. Homo habilis KNM ER 1470 (above) and with the OH65 maxilla (below). © Ronald Clarke

9. The site of the OH65 find at Olduvai, seen on the distant slope. © Ronald Clarke

10. The OH65 Homo habilis maxilla. © Ronald Clarke
Eleven years before the discovery of the Olduvai Homo habilis child another fossil child skull of early Homo (SK27) was uncovered by Broom and Robinson at Swartkrans cave, South Africa (Broom, 1949; Broom and Robinson, 1952), but they considered it to be a large-brained Paranthropus with an aberrant large canine (Figure 11). The author, Clarke (1977a) recognized its true identity as an early Homo child with canine and brain size normal for that genus. Although similarities were found between OH7 and KNM ER 1470, a species was not attributed. However after now comparing it with the OH 65 Homo habilis dentition, the author is convinced that SK27 is a child of Homo habilis, contemporary with the Oldowan artefacts from Swartkrans. The irony is that whereas Louis Leakey in 1960 thought a Paranthropus cranium (OH5) was on the direct line to modern humans, Broom and Robinson in 1949 went to the other extreme and classed a real Homo cranium as a Paranthropus. In truth Broom and Robinson were the first people to discover Homo habilis but they did not know it. The earliest probable representative of Homo habilis is a maxilla A. L. 666 from Hadar, Ethiopia dated to older than 2.35 Ma (Kimbel et al., 1996, 1997). It has strong similarities to the Olduvai OH 65 maxilla.

A 3.5 million year-old deformed cranium from Lothagam, West Turkana, Kenya has a face resembling that of the 1470 cranial but a much smaller cranial capacity and it has been placed in a new genus as Kenyanthropus platyops (M.G. Leakey et al., 2001). It is possible that this cranial is of the kind of hominid that was ancestral to Homo habilis.

A 2.4 million year-old mandible from Atapuerca in Malawi bears strong resemblance to the OH 7 type mandible and thus apparently represents Homo habilis (Brophy et al., 1995).

**Homo ergaster**

Among the earliest historically recognized indications of the existence of ancient humans were flint handaxes found in river gravels, in England in 1797, and in France in 1838. These were eventually named as Acheulean after St Acheul in France where many of them were recovered. The earliest known handaxes in northern Europe date to c. 500 Ka ago (Roberts et al., 1995; Roberts and Parfitt, 1999), and in southern Europe in Spain to c. 900 Ka ago (Scott and Gibert, 2009). Yet older Acheulean implements of similar form were recovered from sites in Africa. The origins of the Acheulean date to about 1.76 Ma ago at Kokapet in Kenya (Linge et al., 2017). Such simple handaxes and cleavers known as Early Acheulean are well known from sites such as EF HR at Olduvai and Peninj in Tanzania, at Konso in Ethiopia, and the Vaal River gravels, Sterkfontein and Swartkrans in South Africa (Figure 12) (for East Africa see, for example, M.D. Leakey, 1971; Isaac and Curtis, 1974; Asher et al., 1992; de la Torre, 2009; for South Africa see, for example, Kuman, 2007; Gibbon et al., 2009).

The authorship of the Acheulean handaxes and cleavers has been a matter of conjecture. When a pharmacist, Mr Conyers, found the first handaxe with a fossil elephant tooth at Grey’s Inn Road, London in 1690, an antiquary, John Bagford, thought it was a spear point of an ancient Briton who had used it as a weapon to kill an elephant of the invading Roman Emperor Claudius (Oakley, 1972). Although, with hindsight, we may find such a fanciful scenario amusing, it is surely no more fanciful than the amusing, it is surely no more fanciful than the scenario of Emperor Claudius (Oakley, 1972) using a handaxe with a fossil elephant tooth at Greys Inn Road, London in 1690 to kill an elephant. Mr Conyers was actually an apothecary who had used the fossil tooth as a medicine for toothache.

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The cranium discovered by Lorenzo Rook in 1995 at Buia, Eritrea (Abbate et al., 1998; Rook et al., 1999) seems to represent either a late Homo ergaster or a very archaic Homo sapiens (Figure 15). It derives from a stratum dated by paleomagnetism to about 1 Ma ago. It has prominent brow ridges combined with a high vertical-sided braincase and a brain size of about 775 cc. From nearby contemporary sediments there are concentrations of Acheulean artefacts (Clarke, personal observation; Abbate et al., 2004).

A partial braincase with prominent brow ridge and similar small size (727 cc compared to Buia’s 775 cc) was collected at Olduvai site V.E.K. in Bed IV in 1963 (Leakey and Leakey, 1964; Rightmire, 1980; Anton, 2004). It is contemporary with Acheulean artefacts found in Bed IV.

A small frontal bone with prominent brow ridge was recovered at the prolific Acheulean site of Olorgesailie, Kenya in 2003 and is dated to between 970–900 Ka (Potts et al., 2004). Its estimated cranial capacity is 800 cc. This fossil is either a late Homo ergaster or perhaps a very early representative of archaic Homo sapiens, the species to next be discussed.

A nearly complete skeleton with skull of an 8-12 year old Homo ergaster male was discovered in 1984 at Nariokotome, West Lake Turkana, Kenya, by Richard Leakey’s team (Walker and Leakey, 1993). It is dated to 1.5 Ma ago. The individual is about 1.6 metres tall and could have reached 1.85 metres in adulthood. The height and proportions of the skeleton with its very long legs are similar to those of modern humans who live in that hot, arid region today.

### Archaic Homo sapiens

Following on morphologically and temporally from Homo ergaster, there are several finds from a variety of countries in Africa that fill places in the time frame between 1.0 and 0.3 Ma ago. The crania and braincases can be assigned to archaic Homo sapiens based on their relatively large brain size and high braincases with vertical sides. One of the earliest discoveries of a fossil hominid in Africa was the Broken Hill cranium or Rhodesian Man cranium blasted out of a cave being mined for zinc at Kabwe/Broken Hill, in what was then Northern Rhodesia (now Zambia) on 17 June 1921 (Woodward, 1921). Although the cranium is dated to between 970–900 Ka, it has no artefact association. Also from North Africa is the site of Ternifine in Algeria, where in 1954 three mandibles and a partial estimated to be about 780 Ka old were found in lacustrine sands (Arambourg, 1963). The fossils were associated with Acheulean artefacts and classified as a new genus and species Atlantanthropus maatunicans. However, there seems no reason to exclude them from archaic Homo sapiens.

Another fossil that can be classified as archaic Homo sapiens was recovered at Elandsfontein near Hopefield, Saldanha, on the southwest coast of South Africa in 1953 (Singer, 1954). It consists of a calotte with massive projecting brow ridges, but it has the high vertical sided braincase characteristic of other archaic Homo sapiens (Figure 18). It is associated with later Acheulean handaxes and may be possibly as much as 600 Ka old (Singer and Wymer, 1960). A similar but very fragmentary calotte was found by Kohl Larsen on the shore of lake Eyasi, Tanzania in 1935. Its age could be between 400–200 Ka old, based on associated fauna and artefacts (Reck and Kohl-Larsen, 1936).

Although all of these fossils seem to represent archaic direct ancestors to Homo sapiens, they are clearly very different to modern humans and thus require some nomenclatural differentiation. That they are members of the genus Homo is not in question, and thus the original generic names of Cyphanthropus for the Kabwe/Broken Hill cranium or Palaeoanthropus for Eysai are not an option. Even the various species names applied to these fossils, such as rhodesiensis (Kabwe), maatunicans (Ternifine), saldansensis (Elandsfontein), and njarasensis (Eyasi) are debatable. However, to distinguish these archaic African Homo sapiens fossils from more modern looking later Homo sapiens, it would be preferable to group them under at least one sub-specific name. The priority would go to rhodesiensis (the first one to be named in 1921).

### Nearly modern humans

More modern looking forms of Homo sapiens developed during the last quarter of a million years. Among the oldest of these is the Florisbad partial cranium (Figure 19), recovered from a spring deposit near Bloemfontein, South Africa by T.E. Dreyer in 1932. It consists of the front portion of a braincase with a partial face (Dreyer, 1935; Clarke, 1985). It has been dated to about 260 Ka ago (Grun et al., 1996). The associated faunal rich spring deposits also contain artefacts of early Middle Stone Age type (Kuman and Clarke, 1986; Kuman et al., 1999).

A calavara with similar morphology to that of Florisbad, i.e. with a large cranial capacity but a sloping frontal bone and lacking prominent brow ridges, was found in 1968 at Kibish, Omo, Ethiopia (R.E.F. Leakey et al., 1969). This Omo 2 cranium has high vertical sides to the braincase, a strongly-angled occipital with occipital torus, and is dated to 195 Ka (McDougall et al., 2005). A second cranium, Omo 1, found at Kibish about 3 km away from Omo 2 and associated with a partial skeleton, is rather different. It has a more vertical forehead and more rounded occipit. The significance of this great variation is not clear, but there is a possibility that they are from different aged deposits (see Klein, 2009).

Also from Ethiopia from the site of Herto, there is a robustly structured cranium that is clearly Homo sapiens but which has a thick brow ridges and a sharply angled occipit like that of Omo 2. It was found in 2003 and is dated to about 160 Ka ago (White et al., 2003). It is associated with an industry said to have both Acheulean and Middle Stone Age characteristics.
Two other crania with similar morphology to that of Florisbad are Laetoli Hominid 18 from Ngaloba, Laetoli, Tanzania (Magoni and Day, 1993), dating to about 120 Ka ago, and KHM ER 3884 from Guomde, Lake Turkana, Kenya, dated to 270 Ka (Brauer, 2001).

Other similar early Homo sapiens from this time period are the Elieye Springs cranium from Lake Turkana (Brauer and Leakey, 1986) between 200–300 Ka old, and the Jobel Irhoud crania from Morocco dating to perhaps 190 Ka old (Grund and Stringer, 1991).

There are a great number of other sites yielding near modern Homo sapiens from 100 Ka ago onwards. Two of the best known are Border Cave and Klasies River Mouth in South Africa. All of these crania cannot be covered here but a detailed overview of these near modern H. sapiens discoveries can be found in Klein (2009).

Varieties of the species

In addition to the generally agreed basic stages of human progression between Miocene ape and modern Homo sapiens, there were other varieties of early hominid in Africa that were apparently not on that main evolutionary route to Homo sapiens. These are notably the megadont forms of the genus Paranthropus and similar megadont forms Australopithecus prometheus and Australopithecus garhi.

Paranthropus

It was in 1938 at Kromdraai, near Sterkfontein Caves that a schoolboy, Gert Terblanche discovered the first fossils of what Dr Robert Broom named Paranthropus robustus (Broom, 1938). The name signified its evolutionary position, i.e. parallel to man and robustly structured. It had a flat face and very large cheek teeth.

10 years later Broom and John Robinson discovered more complete examples of Paranthropus at nearby Swartkrans (Broom and Robinson, 1952) and were able to see the full cranial anatomy of this bizarre hominid. It had massive molars and premolars with low bulbous cusps that, in older individuals, were worn down to a flat occlusal surface with side to side scratches and pitting. By contrast, the canines and incisors were relatively small. The mandible was massively structured (Figure 20) and, in order to accommodate the large temporal muscles needed to operate the crushing, grinding dentition, the zygomatic arch curved outward and the cheek bone moved forward creating a central facial depression. In the males a sagittal crest formed on top of the brain case. In both males and females, the postorbital constriction of the temporal muscles combined with the low concave frontal squame formed a characteristic triangular area or frontal trigone (Figure 21). A good female skull of this species as well as several other examples were found by André Keyser at Drimolen, South Africa. A massive species of Paranthropus was found at sites in East Africa beginning with Mary Leakey’s discovery of ‘Zinjanthropus’ at Olduvai Gorge in 1959 (Tobias, 1967). This is now classified as Paranthropus boisei and the species has been found at Peninj (Tanzania), East Lake Turkana (Kenya), Chesowanja (Kenya) and Omor and Konso (Ethiopia). Both of these species with their brain capacities of 500 to 530cc lived in the same areas as early Homo between 2 and 1 Ma ago.

Australopithecus prometheus

A yet more archaic species of Paranthropus, very massive but with an unflexed cranial base, alveolar prognathism and smaller cranial capacity (c. 410cc), occurs at Omor and West Lake Turkana at c. 2.5 Ma ago. It is named Paranthropus aethiopicus and was formally named Paraaustralopithecus aethiopicus (Arambourg and Coppens, 1967; Walker et al., 1986).

Raymond Dart (1948a,b) considered that the first fossil hominid from Makapansgat in South Africa, a parieto-occipital portion was morphologically distinct from the Australopithecus of Taung and Sterkfontein and so named it as a new species. The second specimen from Makapansgat was a child mandible with large bulbous-cusped molars similar to those of Paranthropus (Figure 22), but some other fossils from that site were clearly like A. africanus. From Sterkfontein also, there is now abundant proof of a second species (Figure 23) in addition to A. africanus (Clarke 1989, 2008) and this should also be classed as A. prometheus. A nearly complete skeleton with skull (STW 573) from the Silberberg Grotto of Sterkfontein belongs to this second species (Clarke 1998, 2008). I am currently cleaning this fossil from the encasing breccia and can reveal that it has anteriorly-positioned cheek bones with flat, broad nasal skeleton, an elongated face, a gutter forming the lower nasal margin, a low forehead, and a sagittal crest. In all of these features it resembles Paranthropus but differs from that genus in its large canines and incisors (Figure 24).

Australopithecus garhi

A partial cranium recovered at Bou, Middle Awash, Ethiopia and dating to 2.5 Ma ago has enormous cheek teeth but also large prognathic anterior dentition (Asfaw et al., 1999). It is clearly not a Paranthropus and although it has some resemblances to other Australopithecus species there are also enough significant differences to place it into a distinct species. There are also cutmarked bones in the same horizon at a nearby site, which suggests that a tool-making hominid, but not necessarily A. garhi, was present at that time.

Australopithecus sediba

Two well preserved partial skeletons discovered at Malapa in South Africa’s Cradle of Humankind world heritage site have been placed by Berger et al. (2010) into a new species which they consider to have some Homo-like characters. It has strong similarities to East African specimens OH 13 and
Regional overview

KNM ER 1813 which have been classed by some authors as Homo habilis. However as noted in the earlier section on Homo habilis, not all researchers agree with that classification as these specimens closely resemble A. africanus and differ greatly from the type specimen of Homo habilis, OH 7.

Homo erectus

This name has been widely misused in the palaeoanthropological literature through being indiscriminately applied to numerous fossils from a variety of time periods and countries, mainly because they have prominent brow ridges. It has also been applied to isolated mandibles believed to come from the time period when ‘Homo erectus’ filled the perceived evolutionary gap between Homo habilis and Homo sapiens.

Homo erectus or Pithecanthropus erectus, as it was originally called, was first found in Java, Indonesia and characterised not just by prominent brow ridges but mainly by the shape of the braincase, which is low and wider across the base than across the parietals. Hominid fossils from Zhoukoudian, China known as Sinanthropus pekinensis were later grouped with Homo erectus, as were several other fossils from China. However, this lumping is debatable, and it is probable that several fossils in China have been wrongly classed as Homo erectus when they really represent archaic Homo sapiens or Homo habilis. In Africa, many fossils that have been labelled by some researchers as Homo erectus from earlier deposits are classified by other researchers as Homo ergaster.

One rare African fossil of Homo erectus (OH 9) that does conform to the Asian Homo erectus morphology was found on 2 December 1960 by Louis Leakey on the surface of site LLK, Bed II, Olduvai Gorge, Tanzania (L.S.B. Leakey, 1961). It is estimated to date to 1.2 Ma ago and is not associated with any artefacts (Figure 25). It seems most probable that some Homo erectus spread from Asia into Africa, rather than the other way around (Clarke, 2000).

Lessons learned

1) It is now abundantly clear that Lord Monboddo’s prediction of 1774 has come true. Africa has indeed yielded all the several types of human progression, as well as several varieties of the species.

2) Despite all the discoveries, there are still many questions to be answered and gaps to be filled. The discoveries made in the past 90 years or so have been increasingly more prolific, more widespread, and more revealing about the antiquity and evolution of humankind. Africa is still, however, only partly searched, and there are still vast areas to explore and many more surprises to be uncovered.

The searchers who have made big discoveries have not always been palaeoanthropologists. Some have been searching for minerals, diamonds, sand or gravel, stalagmite, archaeological remains, or geological samples, and in so doing, have opened up treasure chests of information about our evolutionary heritage. For example, the first discovery of an archaic Homo sapiens was by zinc miner Zwigelaar at Broken Hill in Zambia. The first Australopithecus was blasted out by lime miner De Bruyn at Taung, South Africa. The first adult Australopithecus was revealed by lime miner Barlov at Sterkfontein. Unknown diamond diggers uncovered ancient Acheulean tools and fossil animals in the Vaal River gravels. A schoolboy, Gert Terblanche, led Dr Broom to the first known Paranthropus, which he had found at Kromdraai, and a PhD student in archaeology, Larry Robbins, found what was, at the time, the oldest hominid site at Lothagam, Kenya. Geologist Dick Hay’s quest for samples to understand the Laetoli geology led to biochemist Paul Abell noticing the first heel impression of the 3.6 million year-old Laetoli Australopithecus footprint trail. Mary Leakey’s renewed work at Laetoli in the 1970s, leading to the discovery of several ancient Australopithecus fossils, as well as the footprints, was prompted by Ndutu wildlife lodge owner, George Dave, looking for building sand and telling Mary that he found fossils.

Thus people from all walks of life have been instrumental in the discovery of our ancestry and need to be considered in its appreciation and explanation in the form of heritage sites and museums. Palaeoanthropology, i.e. the study of human ancestry, should be thought of as a study of the people, by the people, for the people (with acknowledgment to Abraham Lincoln’s Gettysburg Address). In order to do this, the story of human evolution needs to be presented to the public in a manner that is accurate, comprehensive, and stimulating. Too many museum displays around the world are deficient in all three of these requirements.

Heritage sites

Although different nations and peoples around the world have their own regional heritage, the very origins of culture and of the early humans that developed that culture can be traced back to Africa. Indeed all humans around the globe owe their existence to those first humans and their ancestors. Hence it is important not only to conserve such early heritage but to find ways of making it accessible to all mankind. Conservation concerns not only the tangible aspects of early heritage i.e. fossils and artefacts but also the sites from whence they derive and the history of the discovery process.

Unfortunately, making the heritage accessible to the population at large can conflict with efforts at conservation. Thus for reasons of preservation and research original fossils, especially of hominids, usually cannot be displayed. Opening sites to the public can present problems of erosion and damage from vehicle and foot traffic. Then there is always the problem of a minority who can cause damage by carelessness or through random collecting of souvenirs in the form of stones or bones. In East Africa, the Leakeys managed to strike a balance between conservation and public access by the construction of site museums at Olduvai, Olorgesailie and Kariandusi and the provision of guides. Through the construction of wooden catwalks and minimal wooden barriers alongside the sites and with the building of thatched roofs over selected sites, important concentrations of fossils and artefacts were both protected and made accessible to the public. The design and materials used in the structures ensured that they did not detract from the natural ambience of the areas concerned. A similar site museum inspired by the Olorgesailie site has been constructed by Marcello Piperno at Melka Kunture.

The provision of trained guides who also worked on the excavations allowed the public to have accurate information about the sites and ensured that they did not stray from the designated roads and paths and did not touch or pick up any stones or bones. Regrettably at Olduvai since the end of Mary Leakey’s involvement there, the site museums have fallen into disrepair and many artefacts and fossils have either been washed away or removed (Figure 26).

Many important sites do not however lend themselves to construction of site museums or even to public access either through remoteness (such as the Djourab Desert of Sahelanthropus) or through being on private land or in concrete-like cave deposits such as Sterkfontein, Swartkrans and...
Regional overview

Makapansgat. In the latter sites it is not possible to expose fossils and leave them visible to the viewing public. Instead, at Sterkfontein, the public are taken by guides through the underground cave system and then the surface excavation site is pointed out to them through a wire-mesh fence.

If, due to conservation or other factors, a site is not readily accessible to the public then its significance can be made available through carefully planned site museums that present lucid displays of the discoveries that make it a World Heritage site. In the case of the Cradle of Humankind World Heritage Site displays should cover not only the cave formation, influx and ancient environment but also the major discoveries. These are: the first adult ape-man, the first Paranthropus, the richest Paranthropus site, the first discovery of early Homo, the first discovery of Homo ergaster, the first discovery of an almost complete ape-man skeleton, the oldest stone tools in southern Africa and the association between Homo ergaster and Early Acheulean artefacts (Clarke and Partridge, 2010). Currently these important discoveries are either not mentioned at all or do not feature prominently in the Sterkfontein museum.

Some sites such as Olduvai or Olorgesailie, being situated in national parks, have additional attractions for the public such as environment and wildlife (Figure 27). Other sites are not so endowed but people like to visit them because of their specific association with a particular person, event or discovery. In other words they are iconic sites. People go to feel the ambience associated with those historic events. The site of Laetoli in Tanzania is just such an iconic site where the magnificent trail footprint was uncovered. In order to protect these prints, they had to be buried again, and because of their easily erodible nature, it is doubtful that, if any of them were uncovered, they could survive for any length of time. In such a case, it would be best to create an accurate cast reproduction of the footprint trail to be set into the landscape near the discovery point. Such a cast would not only be durable but also replaceable and would provide visitors with the information in the original setting. For added interest, some blocks with original footprints of animals that were contemporary with the hominid could be put on display, together with casts and illustrated reconstructions of relevant hominids and animals from the sites. It should also be a requirement for world heritage sites that any museums associated with them should have a primary focus on their specific subject matter and that local experts familiar with the site should be engaged to advise on such subject matter.

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Hadar Region, northern Ethiopia. Screening the hillside for small bone material and teeth which were eroding from above. This excavation produced from 12-15 individuals and became known as the ‘First Family’ - A. afarensis, 3.2 Ma ago. © David L. Brill
ICOMOS vision of how to fill the gaps on the African World Heritage List related to human evolution

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Introduction

This document suggests how a set of criteria might be employed in the case of Outstanding Universal Value (OUV) of sites related to human evolution. Attention is paid to how human evolution sites might be rigorously evaluated, their significance assessed within a simple but effective chronological framework and a narrative structure that is consistent with UNESCO. A draft set of criteria that are suitable for human evolution sites is presented, and its potential for Africa briefly outlined.1

ICOMOS and the World Heritage Convention criteria

ICOMOS’s primary role is advisory. It is responsible for the evaluation of all nominations of cultural properties made to the World Heritage List by States Parties to the World Heritage Convention (i.e. those countries that have ratified the Convention) against the criteria laid down by the World Heritage Committee. In addition to the basic criterion of “Outstanding Universal Value”, as specified in the Convention, these relate to aspects of authenticity, management, and conservation (ICOMOS, 2007).

As acknowledged in the Operational Guidelines for the Implementation of the World Heritage Convention,2 ICOMOS “is closely associated with all aspects of the intellectual development of the Convention” (UNESCO, 2011): the Convention is not static, but dynamic, and responds to both internal and external developments. Advice offered by ICOMOS will similarly be developmental and dynamic.

As an Advisory Body, the guidance offered by ICOMOS has to be compatible with the terms and criteria of the Convention, in particular, regarding the criteria for inscription as a World Heritage site (Paragraphs 77 and 78 of the Operational Guidelines), and the criteria of authenticity (79–86) and integrity (87–95).

ICOMOS, human evolution sites and the World Heritage Convention

For largely historical reasons, human evolution sites present several challenges in relation to both ICOMOS and the criteria of the Convention. The origins of ICOMOS lie in the fields of architectural conservation and protection, and the centrality of the Convention to the architectural and archaeological heritage (ICOMOS, 1964). When the Convention was drawn up in 1972, its principal concerns were also with sites from the past 5–6 Ka, i.e. historic or late prehistoric periods. Neither body was established to consider the type of highly ephemeral sites that document 99 per cent of humanity’s existence.

Paragraph 77 of the Operational Guidelines

The criteria of Paragraph 77 in relation to human evolution sites are problematic with respect to the following:

Criterion (i): with the exception of some Upper Palaeolithic sites in Europe (particularly painted ones) and a few contemporaneous ones in Africa and Australia from the past 20,000–30,000 years, human evolution sites are not likely to represent a masterpiece of human creative genius.

Criterion (ii): they will not exhibit “developments in architecture … monumental arts, town-planning or landscape design”. However, they might exhibit developments in technology, which is mentioned in this criterion: one example would be the wooden spears, 350,000–400,000 years old that were discovered at Schöningen (Germany).

Criterion (iii): they will not bear testimony to a “civilization”, unless the term is extended (as some French Palaeolithic prehistorians have done) to incorporate any learned set of traditions.

Criterion (iv): they will not provide (as with criterion (ii)) an outstanding example of building or architecture … which illustrates (a) significant stage(s) in human history, although they might provide an outstanding example of a technological ensemble. An example might be the earliest-known stone tool assemblages, 2.6 Ma old, from Kadar Gona (Ethiopia).

Criterion (v): they will not be likely to be an “outstanding example of a traditional human settlement, land-use, or sea-use”.

Criterion (vi): by definition, they will not “be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance”.

Paragraph 78 of the Operational Guidelines

As cited above, this paragraph states: “To be deemed of Outstanding Universal Value, a property … must have an adequate protection and management system to ensure its safeguarding”.

There are three reasons why this is particularly problematic when dealing with human evolution sites.

(a) The first is that most sites relating to human evolution are highly ephemeral. This is particularly true of the oldest sites, i.e. those over 1 Ma old. A discovery might be rated as significant and even spectacular, but the evidence is unlikely to comprise more than an assemblage of fossil bones and teeth, and/or fragments of flaked stone in a cave, or in a deposit that has been once part of an ancient floodplain or stream system. Once excavated (or collected, if it found on the surface), there is often nothing left to protect that demonstrates the nature and significance of the find. A few examples illustrate this point:

- WT15000, West Turkana (Kenya): this discovery is one of the most spectacular ever made in palaeoanthropology, and comprises an almost complete skeleton of a young male Homo erectus who died in a stream bed 1.5 Ma ago and was rapidly buried by stream sediment. It is the most complete hominin skeleton of its age in Africa and Asia, and has shown much previously unclear about human development, pathology and anatomy at that time. The first fossils were collected on the surface, and were lost by excavation, and by sifting c. 100 tons of sediment. The site is thus a dump of sieved sediment and a slight depression where material was excavated.

- Lucy (a.k.a. Australopithecus afarensis), Afar Triangle (Ethiopia): Lucy is a partial skeleton that is probably 2.9 Ma old, and although not as complete as WT15000, is a major source of information on the physiology and anatomy of our lineage before the genus Homo. Her remains were found on the surface, and the remainder excavated from near the surface. No archaeological record remains at the site.

- Kadar Gona (Ethiopia): this locality has the oldest artefacts in the world, c. 2.6 Ma old. Their Outstanding Universal Value is that they show what could be seen as the ‘birth of technology’ that leads directly to the present. The evidence comprises flaked lumps of rock, most of which are now in museums and research institutes. A few small and eroding trenches are all that is left to show the site where they were collected and excavated.

3 Homoids, hominins and hominoids. It was recognized by the mid-nineteenth century by scientists such as Thomas Huxley that human skeletons were more like those of apes (gorillas, chimpanzees and orangutans) than any other group of animals. At the same time, humans were clearly different from apes in that we habitually walk upright and have larger brains relative to body mass. In formal, zoological terms, apes were classified as pongids, and humans (and later their ancestors) as hominids. This easy to understand and intuitively sensible classification was undermined in the 1980s by studies of genetic similarities and differences between humans and apes. These show that humans, gorillas and chimpanzees (and also bonobos) are far more like each other than any other species. The implication is that the orangutan lineage diverged long before that of gorillas, chimps and humans, and there is some fossil evidence in support of that hypothesis. The basic distinction is thus between one family of African apes – which now includes humans and the family of Asian apes like the orangutan. Family names of animals end in ‘–id’ – e.g. felid, suid, bovid, equid. The basic distinction is thus between one family of African apes – which now includes humans and the family of Asian apes like the orangutan. Family names of animals end in ‘–id’ – e.g. felid, suid, bovid, equid. The basic distinction is thus between one family of African apes – which now includes humans and the family of Asian apes like the orangutan. Family names of animals end in ‘–id’ – e.g. felid, suid, bovid, equid.
There are of course some exceptions to the general statement that most human evolution sites are too ephemeral to protect. Cave sites are one major exception, especially if they are sufficiently large that some deposits are still left in situ. These can be protected and managed. Examples are caves in Sierra de Atapuerca (Spain), those at and around Zhoukoudian (China), and those in Sterkfontein Valley (South Africa). Other well-known ones of major significance are the Mount Carmel caves (Israel), Tabun, Israel, the Haia Fleah (Libya) (Figure 1); Nah Caves (Borneo); and those in south-west France, south Germany, and along the coast of South Africa. The second are open-air sites where sufficiently large amounts of material were found in a small area that the site can be provided with some protection. Well-known examples are some of the 1.8 Ma old ‘living floors’ at Olduvai Gorge (Tanzania), the c. 1 Ma old Acheulean site of Olorgesailie (Kenya), and those at Melka Kunture (Ethiopia) (Figure 2).

(b) The second reason why it would be difficult to arrange ‘an adequate protection and management system’ is that a large number – indeed, probably the greater majority – of open-air sites relating to human evolution are discovered in landscapes with high rates of erosion. In open-air situations, fossil bones are best preserved in fine-grained, water-lain sediments in which skeletal parts are rapidly buried shortly after an animal’s/human’s death but without being transported and damaged by strong stream currents. These sediments are usually soft, and easily eroded. The main erosive agent is usually rain. In semi-arid and arid environments, this can be very heavy, even if the annual total is low. Trampling by animals (especially herd animals) can also be a significant cause of erosion and damage to fossils. In these types of environment, sites have very short lifespans – once eroded, they and their contents are likely to be destroyed within a few years. Sites with fossilized hominin footprints – as examples, Laetoli (Tanzania), and Ileret (Kenya) – are especially ephemeral, and almost impossible to protect for public viewing without enormous investment. Here, it is better to make a 3-D cast that can be displayed locally and/or in the national museum. High rates of erosion can be excellent for scientific expeditions, because new sites are continually being exposed; it is however a nightmare for conservationists, or those who might wish to protect them.

(c) The third reason why ‘an adequate protection and management system’ is often challenging to arrange is that the host nation could lack the personnel and resources to implement such schemes. Human evolution sites are often in remote areas; local literacy and participatory rates in higher education are low, GDP and per capita income are also low, and the infrastructure is poor. Although there are small numbers of dedicated and enthusiastic individuals with a genuine interest in managing and protecting their country’s heritage, they often have neither the infrastructural and government support.

ICOMOS and the concept of ‘authenticity’ of the Operational Guidelines

Paragraph 80 of the guidelines states: ‘The ability to understand the value attributed to the heritage depends on the degree to which information sources about this value may be understood as credible or truthful.’ In Paragraph 84, ‘information sources’ are defined as all physical, written, oral, and figurative sources, which make it possible to know the nature, specificities, meaning, and history of the cultural heritage.

At the very least, ICOMOS can and should be able to advise the World Heritage Committee regarding the credibility of the information sources relating to a human evolution site. However, given the problems raised by the existing criteria in Paragraph 77 for human evolution sites (see above), ICOMOS can also play an active role in advising on the types of information that are needed to evaluate the reliability and significance of information on particular human evolution sites. An attempt to do so is provided in Section IV (Criteria for evaluating African human evolution sites).

ICOMOS and the concept of ‘integrity’ of the Operational Guidelines

Paragraphs 80–89: ICOMOS is comfortable with the notion of integrity as expressed by the guidelines (Paragraph 88: ‘Integrity is a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes’), although palaeolithic archaeologists tend to define the term somewhat differently, by respect to the time-resolution and degree of post-depositional disturbance of a site. The two definitions of integrity are not incompatible, however. A site with high integrity, in the sense of being derived from a short, well-defined period of time and with minimal post-depositional disturbance, is more likely to contain identifiable elements of Outstanding Universal Value (‘wholeness and intactness’) than one that covers a long period of time, and has a complex history of deposition, reworking and re-deposition.

A human evolution site of Outstanding Universal Value should include all elements needed to express it (or at least, an important part of it).

Criterion (b) of Paragraph 88 – that the site is ‘of adequate size to ensure the complete representation of the features and processes which convey the property’s significance’ – is somewhat problematic in respect to human evolution sites. ‘Lucy’ (see above) is, for example, of ‘adequate size’ to show the earliest indications of bipedalism, even though the remains would fit into a shoe box. The earliest evidence for symbolism (some lumps of

1. Caves are one type of human evolution site that can be afforded some degree of protection. One example is the cave of Haia Fleah, Libya, which contains a long sequence of archaeological deposits from the past 100 Ka. © Graeme Barker.

2. Some African open-air early palaeolithic sites can be provided with reasonable, inexpensive protection by using local materials and labour. This example shows one of the 1-million-year-old Acheulean sites at Melka Kunture, Ethiopia. © Robin Dennell.
The World Heritage List in Africa

Moving beyond current World Heritage criteria with respect to human evolution sites

As shown above, the criteria Operational Guidelines for inscription of a World Heritage site should be adapted to human evolution sites because (i) these sites are ephemeral, (ii) they lack monuments or evidence of architecture, and (iii) they are difficult to protect given that most found in open-air contexts were exposed by natural processes of erosion. Additionally, (iv) the protection and management systems in countries such as Ethiopia and Kenya, where many key discoveries have been made, are unlikely to be as robust as in more developed countries.

Paragraphs 77 and 78 therefore need to be adaptive to take account of the special nature of human evolution sites. At the same time, any attempts to extend World Heritage status to human evolution sites need to take account of the ethos and underlying principles of the Convention, particularly in respect of the need to demonstrate the Outstanding Universal Value of a site or discovery.

As part of an ongoing process, the recent meetings at Burgos (2009) and Addis Ababa (2011), organized by the UNESCO World Heritage Centre, have made useful contributions to the intellectual development of the guidelines with regard to human evolution sites. The following points summarize some of the key outcomes of this process.

Narratives of human evolution

The presentation of human evolution sites needs to convey a narrative that is consistent with the underlying principles of UNESCO and suitable for the mass, global audience of the twenty-first century. At the Burgos meeting, the ICOMOS representative proposed three major narrative themes: the unity, diversity and adaptability of humankind. That is to say, evidence that is earlier than that of our own species is evidence of the ancestors of all of us, irrespective of race, colour, creed, etc; that the evidence from the past 160,000 years (in Africa), the past 100,000 years in Asia, the past 50,000–60,000 years in Europe, North Africa and much of Asia. Societies using stone but not pottery or metals persisted up to recent times in parts of sub-Saharan Africa, the Americas and Australasia, but are not relevant here.

Time-frames of human evolution

At the Addis Ababa meeting, considerable attention was paid to how best to define and divide the fossil and palaeolithic evidence for human evolution. The first concern was to define the scope of human evolutionary studies and its time-depth. The second, covered in the next section, was to consider how this time-depth might be subdivided or periodized.

(a) Time-depth of human evolution studies.

At the Burgos 2009 meeting, the study of human evolution was split into a ‘pre-archaeological’ component (i.e. over 2.6 Ma), and an archaeological one. However, the point at which the ‘pre-archaeological’ component began was not defined. This was clarified at the Addis Ababa meeting, along with an agreed definition of ‘human evolution’.

At issue here is the definition of the term ‘human’. For a purist (and several social anthropologists), the term should be applied only to our species, Homo sapiens, in which case, ‘human evolution’ refers only to the past 200,000 years. A more relaxed definition is that the term ‘human’ should refer to the genus Homo, in which case, extinct types of Homo (H. habilis, H. heidelbergensis, H. erectus, H. neanderthalsis, etc.) should be included. This would extend the study of ‘human evolution’ back to 2.5 Ma. The definition of ‘human evolution’ that most physical anthropologists would use is that its baseline is the point at which our ancestors diverged from the ancestors of our nearest cousins, the gorilla, chimpanzee and bonobo, i.e. the extinct African apes, and this definition was accepted by the meeting at Addis Ababa. At present, the earliest fossil evidence for our lineage (from Chad, Ethiopia and Kenya) extends back to c. 6–8 Ma, which is in broad agreement of when modern genetic differences between us and African apes first diverged. This definition would incorporate the earliest archaeological evidence, which now dates back to at least 2.6 Ma (i.e. before the first appearance of our genus) and perhaps to c. 3 Ma.

There is no logical end-point to ‘human evolution’ as evolution is a dynamic, ongoing process, but the end-point of human evolution studies is usually set somewhat arbitrarily at the end of the most recent ice age, c. 10 Ka, which also marks the end of the Palaeolithic in Europe, North Africa and much of Asia. Societies using stone but not pottery or metals persisted up to recent times in parts of sub-Saharan Africa, the Americas and Australasia, but are not relevant here.

Periodization of the evidence for human evolution

A framework for studying and presenting human evolution has to be simple enough to be easily understood by a lay audience, yet sufficiently robust to be acceptable to experts. At the Addis Ababa meeting, it was proposed that a simple threefold periodization would fulfill both requirements.4

(b) Pre-Homo: evidence preceding the emergence of our genus.

At present, the earliest evidence for our genus dates back to c. 2.3–2.4 Ma (and is thus younger than the earliest evidence for stone tool-making). Evidence for hominins that are distinct from the ancestors of chimpanzees and gorillas and earlier than our own genus is currently exclusively African, and mainly from Chad, Ethiopia, Kenya and South Africa. It includes the oldest-documented, 6–7 Ma, genera Sahelanthropus (Chad) and Orrorin tugenensis (Kenya), and younger ones of Kenyanthropus platyops (Kenya), Prothero robustus and Paranthropus (South Africa), and numerous species within the best-known genus, Australopithecus. These species are (in no particular order) Australopithecus ramidus, A. kadabba, A. aferensis, A. anamensis, A. dinkika, A. anthicus, A. garhi, A. bareghazali (all East African), and A. africanus, and A. robustus (in South Africa). (The fact that specialists disagree about the validity of some of these taxa is irrelevant in this context; the main point is that they are the main groupings in the scientific literature).

As noted above, the earliest archaeological evidence, c. 2.6 Ma from Ethiopia, predates the earliest current evidence for our genus, and was likely made by a late type of australopithecine. This need not be surprising as tool-making is not a uniquely human trait: chimpanzees have a complex material culture including several simple tool-types (largely organic, of twigs and leaves), and simple stone tools were probably used by several types of early hominins. Little is known about subsistence, but some cut-marked bones from Ethiopia c. 2.5 Ma, (and some that may be even older) indicate that hominins were using stone tools to deflesh large mammals by this time. These were possibly killed by large carnivores, and then scavenged by hominins.

4 In Africa, these three periods are sequential. In Europe and Asia, there are substantial overlaps between ‘early Homo’ and its contemporaries and H. sapiens. Neanderthals, for example, co-existed with H. sapiens until the former became extinct c. 30–35 Ka, and on Flores (Indonesia), Homo floresiensis (a.k.a. ‘the hobbit’) survived until c. 12 Ka. This point does not invalidate the proposed three periods, but does indicate that outside Africa its application is less straightforward.
Early Homo and contemporaries. As noted above, the earliest evidence for our genus dates back to c. 2.3–2.4 Ma. The skeletal evidence is very fragmentary, but the fossil hominin record between 2.0 Ma and 2.5 Ma is very sparse. It is also ambiguous in that the teeth of early Homo are very similar to those of gracile (i.e. lightly-built) australopithecines. Consequently, earlier, and better, evidence for our genus may be found that is older than 2.4 Ma. For this reason, the meeting felt that it was wise to reserve a date for when our genus first arose.

The earliest African representatives of our genus co-existed with other types of hominin for a considerable period of least 500,000, and possibly 1 Ma. The earliest types of Homo are known only from Africa (mainly Kenya, Tanzania and South Africa), and by a variety of species names: H. habilis, H. rudolfensis, and H. ergaster (a.k.a. H. erectus sensu lato, i.e. in a general sense). These co-existed with Paranthropus (a.k.a. AustraLopithecus robustus) in South Africa, and Paranthropus and/or Zinjanthropus (‘Nutcracker Man’) in East Africa, until perhaps as late as 1.2 Ma. The precise time-ranges of each of these species are uncertain, partly because of problems of dating, partly because the evidence for each is often meagre, and partly because it is always difficult to establish time-ranges for rare taxa.

After 1.6 Ma, H. ergaster is the main type of African hominin until at least 1 Ma. Thereafter, the African fossil hominin record is poor until c. 200,000 years ago. Experts disagree over whether the main fossil hominin specimens between 1.0 Ma and 0.2 Ma from Daka, Buza, Bionji (Ethiopia), Kabwe (Zambia) and Ndutu (Tanzania) should be classified as H. erectus s.s., H. heidelbergensis and (thus similar to other fossils in Europe and perhaps parts of Asia), H. rhodesiensis, or as something else.

Archaeologically, the earliest forms of Homo used initially simple technology known as Oldowayen, from the German name of Olduvaigorge (Tanzania), and after 1.6 Ma, large cutting tools and bifacial handaxes and cleavers known as Acheulean, named after St Acheul (France), where these were first recognized in the nineteenth century. After 300,000–400,000 years ago, stone tool technology in Africa (but also in Europe and Western Asia) became more complex and began to involve greater attention to core preparation before flaking. The manifestations of these developments was the African Middle Stone Age, which became increasingly diversified into several regionally distinct variants, often recognized by different types of stone points that were probably used as the tips of projectiles.

In terms of behaviour, early, pre-modern Homo, developed slowly but considerably over the immense time-span of the African early palaeolithic. A major trend in our evolution as a primate was a shift towards a carnivorous lifestyle, whereby a greater intake of meat protein helped to sustain our brains. Human brains are energetically very expensive, as they are disproportionately large for their body mass. The main evidence for subsistence and diet comes from analyses of bones of animals found associated with stone tools and other signs of human activity. There are major problems deriving an image of paleoanthropological subsistence from the archaeological record, and it is generally recognized that the diet of Homo was very diverse and complex.

The earliest African representatives of our genus were sort of scavengers, but are very similar to those of gracile (i.e. lightly-built) australopithecines. Hominins for the first time began to involve greater attention to core preparation before flaking. At some point, bone became part of the hominin repertoire. Its earliest use may date back 1.5 Ma (South Africa, and Choswara, Kenya) but indicate only the ability to utilize natural fires (e.g. from lightning strikes); the earliest evidence for what appears to indicate the ability to make fire repeatedly comes from Gesher Benot Tamir (Israel) and is c. 800 Ka old.

Homo sapiens. Most, but not all experts, would agree that Africa has the earliest evidence of our own species, H. sapiens. Quite how and when the species first appeared is still unclear. Some experts use the term ‘archaic Homo sapiens’ to classify various fossils between 100 Ka and 260 Ka, whereas others dislike the use of value-laden terms such as ‘archaic’ or ‘primitive’, and prefer instead to classify them as H. sapiens (s. str), which was the term used to describe fossils from early in the African Pleistocene. This is c. 260 Ka old.

These disagreements partly reflect the problems of dealing with a small, fragmentary and often poorly dated fossil record, and partly arise from more fundamental issues of which traits are sufficiently unique and discernible to demarcate one species from another in another lineage from the European lineage.

There is substantially less disagreement over African hominin fossils that are less than 190,000 years old. Crania from Herod (Ethiopia), that are c. 160,000 years old have been classified as H. sapiens idaltu, and may be the first unambiguous evidence of our species. Younger finds, such as a mandible from Klases River Mouth (South Africa) and c. 125 Ka old, and some from Jebel Irhoud (Morocco), 130–190 Ka old, probably indicate that our species was cosmopolitan across the African landscape by the last interglacial, 125 Ka ago.

Archaeologically, the appearance of our species in Africa is accompanied by many innovations and changes from previous behavioural patterns. These have been studied under blanket headings such as ‘the rise of modernity’ or ‘modern human behaviour’. Without being drawn into a complex and ongoing debate over the meaning and scope of these terms, or their applicability to the archaeological records outside Africa, a number of features can be identified. Two are the first appearance of symbolism (geometric patterns of incisions on bones), and personal ornamentation (red ochre for body decoration, beads and pendants). Many link this to the development of a human-type of language, i.e. with syntax and grammar. Rock art also appears by at least 26,000 years, in South Africa, although earlier in Western Europe. A wider variety of raw materials were used, especially bone, ivory and shell. Marine resources (shellfish, inshore fish, sea mammals) were used, perhaps for the first time on a systematic basis. There is greater evidence for cooking and using fire; stone was obtained and used over greater distances; the range of food resources widened to include smaller mammals; hunting techniques probably also improved. After 80 Ka ago, blades and micro-blades became common end-products of flaking, and many were probably used in composite tools. In other words, by the end of the Pleistocene 10,000 years ago, a recognizably ‘modern’ lifestyle of hunting, gathering and fishing was in place.

A checklist of criteria for evaluating African human evolution sites

The significance – or Outstanding Universal Value – of particular human evolution sites in Africa (or Africa or Europe) could be evaluated within this framework of three over-arching narratives (unity, diversity and adaptability), and three simple but effective time lines (pre-Homo, early Homo, modern Homo).

When evaluating human evolution sites, it is essential that the same methodological rigour is brought to bear as on recent historic monuments, even if the criteria for evaluating them will inevitably differ from those of the past six millennia. Site evaluations of human evolution sites should be consistent with the overall global themes of human unity, diversity and adaptability, and based on clear, explicit criteria that can be substantiated. As Paragraph 80 of the Operational Guidelines states in its discussion of authenticity: ‘The ability to understand the value attributed to the heritage depends on the degree to which information sources about this value may be understood as credible or truthful. Knowledge and understanding of these sources of information, in relation to original and subsequent characteristics of the cultural heritage, and their meaning, are the requisite bases for assessing all aspects of authenticity. Paragraph 84 further states that “Information sources” are defined as all physical, written … sources, which make it possible to know the nature, specificities, meaning, and history of the cultural heritage’. A site evaluation should also demonstrate how and why a particular site has an Outstanding Universal Value within its particular time-frame, i.e. in demonstrating its wider significance as an outstanding set of evidence regarding human evolution before the appearance of our own genus, or early, pre-modern Homo, or the early history of our own species. Table 1 shows a specimen checklist that could be applied to human evolution sites from Africa or elsewhere in order to evaluate the type, quality and significance of evidence. Most of the fields cover the type of basic information that document the site/ discovery, and are self-explanatory. It is essential to stress that the suggested checklist is not a grading, points-driven, system; an evaluation of the significance of the site or its evidence is an overall judgement based on the assessors’ view of the quality of evidence on offer. Some of the most important aspects that arose at the Addis Ababa meeting are highlighted below, as a result of a collective perspective.

Type of site: cave or open-air

This is a basic distinction in palaeoanthropology, as each has its own set of potentials and problems, and its own investigative procedures. Cave deposits usually cover a longer time-span than open-air sites because of the depth of deposits, and often yield a wider range of palaeoenvironmental evidence; open-air sites often contain much more extensive evidence of subsistence and social activities over short periods. In short, each carries its own set of expectations as to what should be present, and what is likely to be absent.

Age estimates: dating methods

Dating is absolutely fundamental to investigations of human evolution sites as well as to assessments of their significance. Ideally, the date of a site should be both precise and accurate. However, some dates are precise but not accurate, and others are accurate but not precise. For example, a site might be dated to 1.6 ± 0.02 Ma, which is a precise date, but the date could be wholly wrong (e.g. the site could be only 500,000 years old), in which case it is not accurate. Alternatively, a site could be dated to a period between 1.8 Ma and 0.9 Ma, which is certainly not precise, but might be correct, in which case it is
accurate. There is a regrettable tendency by both the public and some specialists who should know better to attach undue importance to absolute dates, simply because they appear precise. When they are single determinations, they can usually be an estimate of age, but no more than that.

There have been enormous advances in the past 20 years in our ability to date objects and strata from the past 5 Ma. These include a wide range of isotopic techniques based on radioactive decay systems (e.g. C¹⁴ for the past 40 Ka, and for older material, uranium-thorium (U³⁸⁷–Th²³⁴), potassium-argon (K-Ar), argon-argon (Ar³⁸⁷–Ar⁴⁰), and more recently, cosmogenic aluminium-beryllium (Al⁶⁰–Be³⁷) dating. Other important absolute techniques (i.e. those that provide an age estimate and an indication of likely error) are thermoluminescence (TL) and optically stimulated thermoluminescence (OSL). One technique of fundamental importance in palaeoanthropology is palaeomagnetism, which exploits the way that the Earth’s magnetic field switches periodically. As these reversals are recorded in volcanic rocks (which can be dated isotopically) as well as marine and fine-grained terrestrial sediments (e.g. water-lain deposits and loess), this technique has worldwide applications. Age estimates are accurate but not precise (see above). A typical one might be for example 2.58-1.95 Ma, i.e. in a period between two periods of normal polarity, known as the Gauss Chron and Olduvai Subchron. Biostatigraphy is one of the oldest dating techniques, and is still indispensable: in East Africa, for example, the use of various pig species as markers (i.e. time-specific) played a major role in clarifying the age of various sites; various types of rodents fulfil the same role in Europe.

Four points about dating worth making:

(a) Almost every major site and discovery in human evolution studies has or has had its dating controversy. This includes ‘Lucy’ (see above), several major hominin specimens from Lake Turkana, Olduvai Gorge, and the South African australopithecine sites. The same applies to their counterparts in Europe and Asia. From this it follows that the more dating techniques that can be applied to a site, the more robust its dating is likely to be: ‘triangulation’ and cross-checking are essential for establishing the age of most human evolution sites.

(b) As with shares and house prices, dates of sites can go up or down – dating is a dynamic process. The age of sites can change through the application of more refined techniques, or through re-examination of its original stratigraphic context. A well-known example from outside Africa was the re-dating of the earliest sites in the Sangiran Dome (Java) from over 1 Ma to c. 1.7 Ma; others are the progressively older (and probably more reliable) age estimates for cave sequences in the Levant (especially Tabun), and at Zhoukoudian (China).

(c) Because dating is dynamic, the significance of a site can also change if its estimated age changes. For example, the cave of Chauvet (France), is often cited as containing evidence of the oldest pictorial art in the world, c. 35,000 years old: clear evidence, for some, of the first arrival of modern humans into Western Europe. However, a strong argument is now being advanced that the art is late glacial in age, and probably only 12,000–15,000 years old. The paintings are still magnificent, but if the younger age estimate is accepted, their ‘universal value’ has been fundamentally altered.

(d) Because dating is so crucial in palaeoanthropology, a human evolution site may be regarded of immense importance – or having a universal value – if it preserves unambiguously a major chronological marker horizon that can be linked to fossil and archaeological evidence. As examples, the sites of Olduvai (Tanzania), and Dmanisi (Georgia), are of immense significance because fossil hominin and archaeological evidence can be tied to the Olduvai Subchron, which is a short period of palaeomagnetic normality (i.e. the Earth’s magnetic field pointed north, as today) between 1.77 Ma and 1.95 Ma ago.

Site contents

These can vary from a single find to large, complex and multi-faceted assemblages of hominin and other mammalian remains, stone tools, plants remains and a variety of palaeoenvironmental evidence (pollen, phytooliths, insects, sediment types, etc.). These can be divided into two broad categories of primary and secondary evidence. The main types of primary evidence are hominin remains, artefacts (primarily stone, but sometimes bones, ivory, shell or organic materials; sometimes with later sites, evidence of pannetal or mobility art), butchered animal bones and (rarely) evidence of plant foods. Secondary evidence usually relates to past environmental conditions, and can include small mammals (especially rodents), pollen, phytooliths, etc. Ideally, an outstanding human evolution site should have superlative primary and secondary evidence, but preservation is very rarely so favourable. However, in order for a site to be an outstanding example of a particular aspect of human evolution, it requires a superlative type of primary evidence: it is hard to see how a human evolution site could be regarded as outstanding if its primary evidence was poor, but the secondary evidence was superb.

How crucial are human remains to the definition of an ‘outstanding’ human evolution site?

At the Addis Ababa meeting, there was extensive discussion of whether fossil hominin evidence was an essential pre-requisite for a human evolution site to be worthy of World Heritage status.

The justification of this view is that it is the fossil skeletal material that provides the evidence for our origins, and it is also the class of evidence that commands world-wide attention from the media and interest by the public. To quote the ICOMOS document ‘Potential fossil hominid sites for inscription on the World Heritage List’ (1997) by Professors Stringer and Gamble, it is the skeletal evidence that shows ‘how, when and where we evolved’. All these questions require fossil evidence to be answered. Accordingly, their recommendations over which sites should be considered were entirely fossil-led, perhaps unsurprisingly, as Stringer is the UK’s foremost expert on fossil hominin remains.

The danger of this viewpoint is that archaeological evidence is seen as irrelevant or inconsequential unless associated with hominin remains, and even then, is of lesser importance. Those at the Addis Ababa meeting (including this author) felt strongly that a palaeolithic site could have outstanding value without human remains on the grounds that it is the archaeological evidence that shows how our ancestors interacted with the environment and each other. Thus the wooden spears from Schöningen, or evidence for early symbolism, sea-faring, stone tool-making, subsistence or the colonization of a new type of environment could be seen as having outstanding value, even if hominin remains were absent. This author’s advice from ICOMOS is thus whilst hominin skeletal evidence is of course the primary source of evidence of our physical development, it is the archaeological evidence that best illustrates our social development and means of adapting to differing environmental conditions: the fossil evidence shows us the actors, but it is the archaeological evidence that shows us their actions. In short, a human evolution site can have outstanding value without human fossils remains.

International scientific status: in what language?

Paragraph 80 of the Operational Guidelines describes the scientific status of a site as ‘the degree to which information sources about this value may be understood as credible or truthful’. As palaeoanthropology is now a global discipline, one can reasonably expect that a world-class human evolution site – or the most significant aspects of it – should be published in English (as the global scientific language) in the top scientific journals – Nature, Science, PNAS (Proc. National Academy of Sciences USA), J. Human Evolution, J. Archaeological Science, American Journal of Physical Anthropology (AJPA), Quaternary International, Quaternary Science Reviews, etc.

Two caveats are appropriate here. First, journals are not always bias-free, and many of the above give greater primacy to human skeletal evidence over archaeological material. The second is whether material has to be published in English in order to have evident international scientific status. In some countries, this position was adopted long ago: examples are the Netherlands, Israel and India. However, many French researchers (and politicians), for example, would disagree strongly, and indeed, much exceptional material has been published in French but not English. However, there seems to be an increasing recognition among French scientists that their work is often overlooked if not published in English, and many are now publishing in both languages; some French journals (e.g. Paléorient) now have bilingual texts. The same trend is being followed by researchers in Spain, Germany, Italy, the Czech Republic, and more recently China. There is however a danger that some outstanding human sites remain unrecognized because they are not published in English, in major international journals. There is still a mountain of material published in Chinese that is imperceptible to non-Mandarin readers, although their most important material is now appearing in Western outlets. The most impenetrable material is Japanese: Japan has some superlative sites from the past 30 Ka that are virtually unknown outside the country because Japanese material is rarely published in Western journals (i.e. in English or French).

To summarize, a human evolution site cannot be recognized as having international scientific recognition unless it is accessible to an international audience; and that in turn leads to the expectation that it is published in a language that most international scholars can read. If researchers in a particular country feel that their evidence is undervalued because it is published in a local language, they need to find ways of presenting it to a wider international audience.
Protection

As shown above, the issue of protection is problematic for many human evolution sites, particularly in open-air contexts where erosion rates are high, and where sites are exposed as well as destroyed by ongoing (and usually long-running) processes of erosion. As also explained above, such evidence as may be found is often very ephemeral – a few bones or flaked stones.

What can be suggested is that steps can sometimes be taken to safeguard the geological contexts in which discoveries are made. These might include restricting building or agricultural developments (as at Ain Hanech, for example), limiting/controlling mining, restricting livestock and thereby reducing trampling and vegetational degradation, or conserving a stretch of coastline that contains an important series of caves (as in South Africa). Protection also implies that staff are locally available to monitor sites or an area of sites, and able to restrict illegal collecting or excavation; and it also implies a reliable management structure so that those tasked with protection have demonstrable and effective back-up at government level. This is obviously difficult in many African situations, but aspirations of the possibility of acquiring World Heritage status might provide the necessary stimulus for national and international cooperation.

Curation

Effective curation requires proper dedicated storage facilities (i.e. with suitable shelving, containers, lighting, etc.), an effective cataloguing system that can record what is being curated, and also locate it in storage, and trained personnel who can and will check that material is not deteriorating or missing. A small but often crucial requirement is that labels do not fade, rot or get eaten by insects/rats, or become detached from their objects. All these require money, but also personal motivation, and a recognition by management that curation is a long-term and important responsibility. As with issues of protection, aspirations of the possibility of acquiring World Heritage status might provide the necessary stimulus to ensuring that curation is effective.

Table 1. Checklist for evaluating human evolution sites

The aim of the checklist is to allow an accurate profile of a site and its contents to be established. As a guideline it lists the type of information that could be included in a nomination file. A formal submission would of course require documentation on each relevant aspect, as with any research proposal.

<table>
<thead>
<tr>
<th>Site name:</th>
<th>Site type (cave, open-air):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relevant to:</td>
<td>pre-Homo, early Homo; Homo sapiens (indicate which)</td>
</tr>
<tr>
<td>Time-span/Age:</td>
<td>Present/absent</td>
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<tr>
<td>Attributes</td>
<td></td>
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<tr>
<td>Dating:</td>
<td>PalaeoMagnet-K, Ar-Ar, Th-U, C14, biostratigraphy, other (when dated, and how many dating methods)</td>
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<td>Primary evidence:</td>
<td>hominin remains</td>
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<tr>
<td>Primary evidence:</td>
<td>material culture (stone/bone/other)</td>
</tr>
<tr>
<td>Primary evidence:</td>
<td>evidence of diet (butchered animal remains, plant foods, shell-fish, fish, etc.)</td>
</tr>
<tr>
<td>Other types of primary evidence (symbolism, art, organic etc.; fossil footprints)</td>
<td></td>
</tr>
<tr>
<td>Secondary evidence:</td>
<td>environmental data (e.g. small mammals, pollen, palaeoecos, sediments, volcanic ash, etc.)</td>
</tr>
<tr>
<td>International scientific status; high quality publications (e.g. top international journals or monographs)</td>
<td>‘Added global value’: in relation to comprehensive comparative analysis</td>
</tr>
<tr>
<td>Protection measures for the site(s): applied research for the protection of the site</td>
<td>Applied research for conservation or curation of materials; standards for curation and/or preservation of mobiles</td>
</tr>
</tbody>
</table>

Suggested amendments to the criteria for inscription of human evolution sites

In this section, an attempt is made to provide an alternative set of criteria for evaluating human evolution sites for inscription on the World Heritage List. These could be appended as an annex, or as subsets of Paragraphs 77–78 and the relevant paragraphs on authenticity and integrity. The proposed criteria also allow for serial and cluster nominations. It is important to emphasize that few sites would satisfy each of the proposed criteria; however, a nominated site should satisfy at least one of them to merit inscription. Potential examples are indicated.

For human evolution sites and discoveries:

(i) the geological formation should contain evidence of a major point, episode or aspect of human evolution since the divergence of our lineage from those of gorillas, chimpanzees and bonobos (potential examples: Koro Toro, Chad (Figure 4); Tugen Hills; Lucy + local area, WT15000; Laetoli, etc. – the point here is to shift the emphasis from the ‘site’ (i.e. a few bones or stones, or some fossil footprints, to their geological context);

(ii) the site or sites in its/her associated geological context should represent a major example of the technology of our ancestors before the end of the most recent ice-age (potential examples: Kada Gona, Ologeasalile (Figure 5), Schöningen);

(iii) the local sequence of geological deposits should contain outstanding and well-dated evidence of how our ancestors developed over time (potential examples: the Casablanca sequence; Olduvai Beds I–IV; Ain Bouchentain/Hanech (Oldowan to Acheulean); ‘Ubeidiya, Israel; long cave sequences e.g. Haua Fteah, Libya, Tabun, Israel, Mumbai);

(iv) the site should represent a major development in our understanding of the antiquity and complexity of human evolution (potential example: Taung).

4. Koro Toro, Chad: this area of now-featureless desert has produced some outstanding examples of our earliest ancestors. The global significance of this type of evidence lies in the geological formation containing these fossils, rather than any single place where fossils were found. Similar examples of fossil-rich ancient landscapes are known in Algeria and East Africa. Source: ‘Missions de terrain’, Mission Paléoanthropologique Franco-Italienne (MPFI), 2010.

5. Ologeasalile, Kenya. This site contains vital evidence of the type of Acheulean technology that is found throughout Africa, Europe and western Asia, and thus illustrates a major technological phase in our evolution. It is also an example of the type of open-air site that is relatively easy to protect and display to the public. © Ronald Clarke.
(v) the site and its associated geological context should represent a major example of the lifestyle of our ancestors in a particular environmental setting and under a particular set of climatic conditions (potential examples: Ain Hanech, Koobi Fora, Melka Kunture, Olduvai, Olorgesailie; Gesher Benot Ya‘aqov, Israel);

(vi) the site, or group of sites in a well-defined area, should represent a major example of how our ancestors developed and demonstrated their ability to engage in symbolic behaviour (potential example: the coastal caves in South Africa (Figure 6); areas of rock art and associated habitation sites).

Potential for Africa

Africa is the only continent with a record of the whole of humanity’s existence over the past 6–8 Ma; it also contains the earliest evidence of our ancestors’ ability to make stone tools, the earliest evidence of our genus, and of our own species. It contains the only fossil record of our evolution before 2 Ma, and a substantial part of our evolution thereafter. It has many outstanding palaeolithic sites of all periods, and these include some of the earliest examples of hunting, using marine resources, and symbolism. There is in short an immense amount in the African record to celebrate, and to highlight as worthy of World Heritage status as outstanding examples of humanity’s existence over the past 6–8 Ma. It is hoped that these can be recognized under criteria of the Operational Guidelines for the Implementation of the World Heritage Convention.

6. Pinnacle Point, South Africa, is one of several coastal caves in South Africa that have produced some of the earliest examples in the world of personal ornaments, evidence of symbolic thought and the use of marine resources by early Homo sapiens between 60–125 ka ago. Although each cave site is important, their global significance lies in the collective evidence from all the cave sites that have been investigated along this coastline. © IACPN

Bibliography


Ethiopia’s paleoanthropological World Heritage sites: research and conservation

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Background – the geographical distribution of paleoanthropological sites in Ethiopia

Ethiopia’s paleoanthropological importance is linked to its location in the Great East African Rift System. This Rift System has provided favourable conditions for the geological processes that allowed the creation of sediments that preserved archaeological materials, fossil remains of ancestral humans and ancient animals. In Ethiopia, the Rift begins in the Afar Triangle in the north, where the three arms of the Rift System, including the Gulf of Aden and the Red Sea come together forming a triple junction. The Rift extends to the south slicing through Ethiopia, Kenya, Tanzania and Malawi.

The geological history of the ‘Afar Rift’ has had dynamic features of geological transformations, with continuous and undisrupted evolution witnessed with multiple fault-blocks, layers of volcanic ash and sedimentary rocks preserved with interbedded units of soil formations. Imbedded in these sedimentary formations are abundant Miocene and Pleistocene-age hominid and faunal remains, and the material evidence of early human activities across the ancient landscapes. Currently, these fossil-bearing sedimentary beds are being exposed because of continuous geological activities and erosion. The present day landscape located within the Ethiopian section of the East African Rift (stretching from the Afar Triangle in the north to the Main Ethiopian Rift in the centre, and extending to the Omo Rift in the south) has produced numerous research areas and sites of paleoanthropological importance.

The most prominent of these sites with direct bearing on human evolution include, from north to south: Hinki Megeita, Ledi, Mille Chiffra, Hadar, Gona, Dikika, the Middle Awash, Kessem Kebena, Galli, Chorora, Melka Kunture, Gadamota, Konso Gardula, Fejej and the Lower Omo. Each of these research areas and sites has multiple localities, such as the Middle Awash, which often provided chronologically sequenced dates covering the last 6 Ma. Thousands of fauna (including human remains) and archaeological materials have been collected from these sites. Thus, the major discoveries made in the last 50 years have placed Ethiopia at the forefront of paleoanthropological research in the world.

Ethiopia has two major paleoanthropological sites already inscribed on the World Heritage List: the ‘Lower Awash’ and the ‘Lower Omo’ sites.

At the time of its inscription in 1980 the Lower Valley of the Awash covered 250 km² which included the area properly known as Hadar (where Australopithecus afarensis or the fossil hominid commonly known as Lucy, or AL 288-1 was discovered), the southern Hadar, or present day Dikika area, located to the south of the Awash River, and part of the Gona research area. Thus, most of the Gona research area, the recently named Busidima Formation, and all of the Middle Awash research area were not included in the 1980 nomination. Nonetheless, discoveries made since the 1980s along the Awash River have demonstrated the presence of sites of great antiquity and of paramount importance further south of the already inscribed area.

The Lower Valley of the Omo was the second major paleoanthropological site to be inscribed on the World Heritage List in 1980, based on the data available at the time of its inscription. Since its inscription, new sites have been discovered on the Eastern side of the Omo River, in the Fejej area (WoldeGabriel et al., 1992).

The Konso Gardula paleoanthropological site is located in southern Ethiopia, 580 km from Addis Ababa (Figure 2). The site was discovered in 1991 and soon became famous for the abundant fossil remains, including the discovery of well-preserved fossil hominids including Homo erectus and Australopithecus Boisie, and the oldest Acheulean artefacts dated to 1.7 Ma BP. The Konso site is composed of small and patchy localities (Asfaw et al., 1992; Suwa et al., 1997) (Figures 3, 4, 5 and 6). As agricultural land is very scarce in Konso, farmers were encroaching into the site and...
some of the most important localities had been impacted. Efforts were exerted by the researchers working at the site, and the local and federal culture office representatives. A conservation area was delineated and maps prepared, together with community leaders and the concerned officials. Efforts continue to teach and sensitize the community about the need for site conservation. Among the solutions deemed reasonable by the researchers was to salvage the archaeological and paleontological sites by applying a 100% collection strategy of all identifiable fossils, and controlled surface archaeological collections. Still this leaves all unexposed fossils to be impacted by farming. The wealth of information amassed in the last 30 years or so, i.e. since the inscription of the Lower Awash and Lower Omo sites, warrants revisiting of their status, either to retain their status, or include new sites as serial nominations or as recommendations of new nomination files. It would be equally important to revisit the old nomination files and update them in line with new developments within the nomination system, such as the creation of appropriate maps for the sites, preparation of management plans, review of the nomination criteria and revision of their Outstanding Universal Value (OUV).

Research conducted in the Ethiopian Rift over the past 40–50 years

As noted above, in 1980 the Lower Awash site was inscribed on the World Heritage List based on the major discoveries made in the area during the 1970s. The discovery of Lucy and numerous other similar hominid fossils that lived between 3.0 and 3.6 Ma ago at Hadar has resulted in the naming of Australopithecus afarensis, a new hominid species (Johanson et al., 1982; Kimbel et al., 1994, and references therein). The discovery and publication of this new species by a team of international scientists (French and American) at that time, pushed back the antiquity of humans and the advent of bipedalism by at least one million years. In addition, the discovery of stone tools, evidence of the earliest material culture dated at 2.5 Ma had significantly changed the perception of the antiquity of culture and humanness. It was thus based on the data available at that time that the Lower Valley of the Awash was inscribed on the World Heritage List in 1980 under criteria C (ii) (iii) (iv). The description used in the nomination states that ‘...a reference point in the study of the origins of mankind, the Awash Valley contains one of the most important groupings of paleontological site on the African continent.’ That description is true and still stands firmly today.

4. 1.4 million-year-old artefacts scattered on the surface, Konso Paleoenthropological site. © Yonas Beyene

Mille-Chiffra

The Mille-Chiffra is an important new research area surveyed since 2002. Although some reports exist about earlier brief visits to the site, no discoveries were reported until recently. Among the major discoveries from this area include a partial skeleton of a hominid that lived 3.8 Ma ago. Furthermore, the latest major discoveries at this site have shown definite presence of more than one hominid species in the 4.0–3.0 Ma time interval (Haille-Selassie et al., 2012). Thus far the Lucy species has been the only well-defined hominid from this time interval in the Afar (See Leakey et al., 1995 for Kenyanthropus platyops).

5. Artefacts at Konso Paleoenthropological site. © Yonas Beyene

Gona

The Current Gona Project study area includes sites that lie outside of the 1980 Lower Awash inscription. The area to the east and west of the Gona River has been surveyed since the beginning of the 1990s yielding the earliest stone artefacts dated to 2.6 Ma ago, and several new discoveries that enabled the area to be recognized for its new important localities (Semaw, 2000) (Figure 8). A number of new archaeological localities investigated at Gona since 2000 have yielded stone artefacts and associated fossilized fauna bearing evidence of cutmarks dated to 2.6 Ma ago, the earliest such evidence documented in the archaeological record (Semaw et al., 2002; Dominguez-Rodrigo et al., 2005) (Figure 9). Fossil hominids...
attributed to *Ardipithecus ramidus* (first recognized and named from the western margin of the Middle Awash research area) were also discovered at Gona (Semaw et al., 2005). In addition, the Gona study area is known for yielding the first Homo erectus female pelvis dated ~1.2 Ma (Simpson et al., 2008). What is now part of the Gona study area has been included in the Lower Valley of the Awash nomination of 1980.

**Dikika**

Dikika is well known for yielding a skeleton of a baby *Australopithecus afaarensis* nicknamed ‘Salam’ (Alemseged et al., 2006). Although the site is situated south of Gona, much of the study area is located to the south of the Awash River opposite the well-known site of Hadar. The site was not investigated in greater detail at the time, but part of this research area was included in the Lower Valley of the Awash nomination of 1980. Recently, the Dikika team has reported the presence of fossil bones dated to 3.4 Ma ago with evidence of cutmarks attributable to the activity of *Australopithecus afaarensis* (McPheron et al., 2010). If further proven, this claim pushes the evidence of the use of stones much further back in time, and further investigations are needed to corroborate early hominid use of tools at such an early date.

**The Middle Awash research area**

**Western side of the Awash River**

The area south of the Lower Awash is commonly known as the Middle Awash. This area was surveyed from the mid-1970s up to 1981. Further survey and research in the area since 1991 has led to the discovery of more than 300 localities that have produced more than 50,000 fossils and stone artefacts. This research area contains a 1 km-thick sequence of sedimentary units spanning the time between the Holocene and Upper Miocene (10 Ka and 5.8 Ma BP) (WoldeGabriel et al., 1999) (Figure 11).

The oldest sediments are located on the western edge of the rift floor along the area commonly known as the ‘western margin’. Here, pockets of sediments are exposed between fault blocks which have opened small windows through which animals and hominid fossils are exposed. A number of localities were designated here. These localities are very small in size but the wealth of materials recovered in the western margin has enabled scientists to understand the paleoenvironmental settings in which our ancestors had evolved between 5.2 and 5.8 Ma ago (Figure 12). The presence of volcanic ash has enabled the localities to be dated using radiometric methods (Figure 13). As a result these sites are among the most securely dated for this time period. The fossil human ancestors discovered from this time period from the western margin are named *Ardipithecus kadababa* and are dated between 5.2 and 5.8 Ma ago (Haile-Selassie, 2001; Haile-Selassie et al., 2004).

The younger sediments from the area known as the ‘central Afar complex’ are dated between 4.0 and 4.4 Ma ago, a very critical time period in the study of human evolution and its environmental context. The series of sites located near a small Afar village called Aramis and its surroundings have produced, through 20 years of field research work involving a team of 48 international scientists from 12 countries, the remains of a new hominid species named *Ardipithecus ramidus* (White et al., 1995; 2009). Various localities that yielded the remains of *Ardipithecus ramidus* were studied and securely dated using key tephra horizons. It is worth noting that a skeleton of *Ardipithecus ramidus* (dubbed as ARDI), representing 60% of a female individual was recovered from Aramis and has been made public. Fossil remains of various animals that coexisted with *Ardipithecus ramidus* have allowed greater understanding of the environmental context in which the hominids existed and evolved. The importance of these localities goes beyond the evolutionary history of human ancestors to include the bio-communities and environmental settings that were instrumental, perhaps to changes, which may have directed our evolutionary path. The details of the research work undertaken in the central Afar complex have been published in detail (e.g., White et al., 2009. See also the 10 accompanying articles in the same issue of Science).

The integrity of the above-mentioned sites is well maintained, and these sites are very critical for understanding the evolution of hominids and their environments between 4.4 and 5.8 Ma ago. Also, it should be noted that, to date, these are the only large number of securely dated and in situ occurrences known from this significant time interval in human evolution.

11. Chorora paleoanthropological site. © Yonas Beyene

12. Dr. Giday Woldegabriel is sampling volcanic ash for dating in the Middle Awash. © Tim D. White

13. The Herto site. *Australopithecus garhi* and stone tools discovered in the area. © David L. Brill

10. Major Paleoanthropological localities of the Middle Awash research area. © Yonas Beyene
To the south of Aramis and still within the ‘central complex’, localities at Assa-Issie have produced remains of *Australopithecus anamensis*, known originally from Kenya (Leakey et al., 1995). The *A. anamensis* fossils from the Middle Awash are securely dated at 4.2 Ma ago. (White et al. 2000).

Further to the south of the central complex, series of sites dated between 3 and 0.85 Ma ago have delivered important hominin fossils, notably, *Australopithecus garhi*, *Homo erectus*, archaic *Homo sapiens* and *Homo sapiens* remains (Asfaw et al., 1999, 2002; de Heinzelin et al., 1999; White et al., 2003; Clark et al., 2003; Beyene, 2010). Among these, the earliest indication for tool use is evidenced from a locality known as Bouri where *Australopithecus garhi* was found in close proximity with cut marked and broken bones (de Heinzelin et al., 1999). The cut marks and chop marks on these bones resulted from the use of sharp edged stone tools, suggesting meat and marrow consumption by hominids leading to consequent brain expansion in early *Homo*. It is to be noted here that the oldest evidence for stone tool-making comes from the Gona sites dated at 2.6 Ma ago (Semaw, 2000; Semaw et al., 1997; 2003).

### East side of the Awash River

The Middle Awash includes the area that lies to the west side of the Awash River between Sibabi located southwest of Gewane and Meselu in the north. This area lies on the opposite side of the central Afar complex which is located west of the Awash River.

Localities from the eastern side, among the best known, include Bodo, Maka, Belohdelie, Hargufia, Matabeitu and Meadura. Bodo and Maka are well known for yielding important fossil hominids. In 1978 an almost complete *Homo erectus/rhodesensis* skull (commonly known as the Bodo Man) and dated to about 600 Ka ago was discovered at the Bodo site. Stone artefacts of Acheulean technology (handaxes) were found in association with Bodo. The Bodo skull exhibits cut marks made by sharp stone tools, which is believed to be indicative of cannibalism (White, 1986).

The Maka site has delivered the remains of *Australopithecus afarensis* and associated fauna (White et al., 1993). The Belohdelie site has also delivered important skull fragments assigned to *Australopithecus afarensis*. Hargufia, Matabeitu, Meadura and Bodo are significant sites for the middle Pleistocene archaeological records that they contain (see de Heinzelin et al., 2000). However, none of the above-mentioned sites have been considered for nomination so far.

### The Upper Awash

The Awash River has a series of Paleanthropological sites along its catchments in the Upper Awash area. These sites include the Kessem-Kebena Paleanthropological research area and the Melka-Kunture research area (Figure 17). Further south of Kessem Kebena, an important Miocene age site called Chorora has been documented on the east side of the Awash (Figure 18).

The Kessem Kebena research area was discovered in 1988 by the inventory team of the Ministry of Culture of Ethiopia. Paleontological evidence which are as old as 4 Ma ago and archaeological sites dated to 1 Ma ago were recorded. The fossiliferous and archaeology bearing sediments are very patchy and sparsely placed, but the Kessem-Kebena research area is among the most important paleoanthropological sites in Ethiopia (WoldeGabriel et al., 1992).

Further south of the road between Borderde and the town called the ‘Awash’ is the Chorora Paleontological site which contains a series of patchy pockets of Miocene sediments located to the east of the Awash River. Chorora has been known since the 1970s and earlier research in the area has yielded non-primate fossil fauna. Recent field investigation of the site has led to the discovery of a new species of ancestral gorilla, *Chororapithecus aethiopicus*, dated to 10 Ma ago (Suwa et al. 2007).
Conservation of sites in the Afar Rift

The above-mentioned sites are located in the Afar which is inhabited by Afar nomadic pastoralists. The area is sparsely populated and no major conservation problem of sites has been encountered as there was no major development undertaking in the area. However, times have now changed and the situation is different since the Lower Valley of the Awash was inscribed. Ethiopia is now taking major initiatives to develop its natural resources to alleviate poverty: dams are under construction; mechanized farms are underway; roads are being built connecting the various regions; and new towns are being founded. These activities no doubt will affect the integrity of the once pristine landscapes and environments. In order to mitigate the impacts of development programmes, the boundary of the various sites should be clearly delineated and mapped. Once this is accomplished, management systems that involve all stakeholders including local communities should be put in place. Development and conservation of sites should complement each other.

New nominations in the Afar Rift?

As noted above, Hadar, part of Gona and Dikika areas were included in the inscription of the Lower Valley of the Awash in 1980. Several new sites further to the south, north and east of the above-mentioned sites were discovered since then and numerous very important discoveries were made over the past two decades. In addition to *Australopithecus afarensis* (Lucy’s species), other additional genus and species with major bearings on human evolution such as *Ardipithecus kadaba* (5.8 Ma), *Ardipithecus ramidus* (4.4 Ma), *Australopithecus garhi* (2.6 Ma), and *Homo sapiens idaltu* (0.165 Ma) were discovered in the Afar Rift and introduced to the world. The southern Afar has also produced the oldest primate, *Chororapithecus aethiopicus* (10 Ma).

It would be difficult and perhaps unwise to nominate all of the above-mentioned sites individually. It may be commendable to prepare a serial nomination based on precise maps of the individual sites and a workable management plan.

The southern Ethiopian sites

The Lower Valley of the Omo

The Lower Valley of the Omo, inscribed on the World Heritage List in 1980 under criteria (iii) and (iv), is the second Ethiopian paleoanthropological site inscribed on the World Heritage List. At the time, the site was inscribed based on the discoveries made in the late 1960s and 1970s.

[Image of Lower Valley of the Omo]
The Omo paleoanthropological site is located about 1,000 km south of Addis Ababa. As the nomination dossier indicates the site was ‘...investigated in the 1930s by Professor Camille Arambourg, and again from 1968 onwards by a large team of specialists as these sites have been the subject of a great number of what are perhaps the best documented monographs and publications. This site is consequently of exceptional universal value from the historical and scientific point of view’ (UNESCO, 1980). Currently a French research team is undertaking active field research in the Omo (Boisserie et al., 2010; Delagnes et al., 2011). Careful investigation of the site using up-to-date technologies has enabled better documentation of the various localities discovered in the 1960s and 70s (e.g., Howell et al., 1987).

Discoveries made within the 1–4 Ma sediments of the Lower Omo have enabled scientists to document and investigate major human and faunal evolutionary stages during the Plio-Pleistocene. The multiple volcanic ash layers interbedded at the site have proven to be amenable for dating the Omo discoveries. As a result, Omo has been used as a reference point for dating many other sites in Africa. Thus, the ‘Lower Omo’ is referred to as the benchmark for biochronological dating of Plio-Pleistocene sites elsewhere in the African continent (White and Harris, 1977).

At the time of its inscription, very few sites were known and recognized south of Lower Omo. Further surveys to the east of the Omo River in 1989 resulted in the discovery of yet another important site known as Fejej (Figure 22). Ongoing field research undertaken at Fejej has led to the discovery of important Plio-Pleistocene hominids and archaeological sites. Remains of human ancestors dating between 2 and 4 Ma ago were discovered together with animal fossil bones. The Fejej archaeology is dated to 1.9 Ma and the materials are typical of Oldowan (Mode I), similar to other coreflake assemblages known around 2 Ma ago. Further, the Fejej ancient landscape has yielded a spectacularly petrified fossil forest dated to around 28 Ma ago. This important site has become a reference point since it fills a time gap missing in many other sites (de Lumley and Beyene, 2004) (Figure 23).

A new nomination in the area?
As noted above for the ‘Afar Rift’ along the Awash River, nominating a series of sites around Omo may not be appropriate at this stage. It would rather be reasonable to carefully map the sites in the region and prepare a management plan for their proper conservation, taking into account the current ongoing development plans in Ethiopia. Tentatively, the Fejej site could be included with the ‘Lower Omo’ as a serial nomination.

Conservation in the Lower Valley of the Omo
The Omo has been one of the best preserved sites, mainly because of its inaccessibility due to its location in the remotest part of Ethiopia. However, its remoteness is coming to an end as roads connecting the various regions of the country are approaching the Omo. Based on the rapid development plans launched by the Ethiopian Government and current public need for modernization, numerous changes are underway all across the country. Yet, the Government is conscious of the need to protect the sites and the Authority for Research and Conservation of Cultural Heritage (ARCh) is commissioned to undertake detailed mapping and documentation of national heritage. In addition, the research group actively working in the Omo, under the direction of Jean-Renaud Boisserie of the CNRS, France, is collaborating with the ARCCh with the mapping and management-related technicalities. Such joint work between the antiquities administration and researchers is among the best practices that need to be pursued further.

Management bodies and regulations
The Constitution of the Federal Democratic Republic of Ethiopia, Proclamation No. 1/1995; Article 91 declares that ‘Government and all Ethiopian citizens shall have the duty to protect the country’s natural endowment, historical sites and objects.’ Based on the Constitution, the Ethiopian Cultural Policy (1997) also underlines that ‘...Creating awareness that the conservation and preservation of cultural, historical and natural heritage are the duties and responsibilities of governmental and nongovernmental organizations, religious institutions and all Ethiopian nationals.

The national institution entrusted for the protection of sites and monuments, as well as sites that are already on World Heritage List, is the Authority for Research and Conservation of Cultural Heritage (ARCh), Ministry of Culture and Tourism of Ethiopia. Sites are administered and protected based on decrees issued both by the Federal House of Representatives and Parliaments of the Regional Governments. Sites of national importance are directly candidates for nomination. Sites that are proposed by regional governments are candidates for the National List and could eventually be proposed for nomination. All the sites are administered jointly by the Federal and Regional Institutions. Thus, management of the Lower Awash and the Omo sites are under the responsibility of the Federal Government (ARCCh), like that of Axum, Lalibela, Gondar, Haraz, Tiya megalithic site, the Konso Cultural Landscape and the Semien Natural Park.

The ARCCh is organized under a General Director with the following divisions: Research Directorate; Collection and Laboratory Directorate; Inventory, Inspection and Standard Directorate; Conservation Directorate; the National Museum and World Heritage Sites Directorate.

Plans and projects related to key needs and future growth
It has been frequently discussed that management plans are critical for the conservation of sites. It is true that in the absence of such an instrument, it would be difficult to
maintain the OUV of sites. The contribution of researchers in the preparation of management plans for sites that they are working on has to be considered. Input from researchers is critically important in providing the necessary data for designing plans that could be effectively implemented. Whereas management plans involves all stakeholders and owners, it is imperative that the State Party takes the responsibility for properties that are already on the List. As management plans involve inventories, documentation, mapping, identification of values of the sites, legal issues, ownership, use, etc., a concerted effort has to be employed.

The Ethiopian Government has included tourism in its poverty alleviation programme. Therefore, it is timely to use this opportunity for conservation, capacity-building and for developing responsible tourism in the areas of paleo-tourism and eco-tourism. The construction and functioning of interpretive centres close to sites serve, in addition to its services to tourism and benefits from it, to increase the interest and awareness of local communities.

In order to accomplish the above-mentioned objectives, a new tourism policy is now in place. This policy should pave the way for a tourism plan based on management plans for paleoanthropological sites as well. Based on this policy the local people can learn about the significance of the sites and their cultural heritage, and international tourists can be attracted to visit these areas. As such, the wealth of paleoanthropological discoveries made in the Ethiopian Rift could be used to promote tourism. In order to effectively exploit this wealth, training should periodically be given to tour guides, and local authorities and community members need to be aware of the significance of cultural heritage and be sensitized for their protection and conservation.

Synergy between the various above-mentioned players could support the conservation efforts of sites on the World Heritage List and the recognition and nomination of new ones.

Bibliography


**The earliest Stone Age of Ethiopia in the East African context**

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**Introduction**

The earliest ancestors of human lineage as well as the earliest prehistoric record are still today concentrated in East Africa. In this context, Ethiopia has a leading position, which can be seen in the multiplicity of interdisciplinary international research projects in the field, the significant proportion of Ethiopian scientists involved in all human evolution-related fields, and the outstanding number of site complexes related to the early stages of humankind. This potential has long been recognized by UNESCO which is reflected in its inscription of the Lower Valley of the Omo and the Lower Valley of the Awash in Ethiopia on the World Heritage List in 1980. Today these properties remain the only two Early Stone Age site complexes in East Africa on the World Heritage List.

But Ethiopia is also part of a broader set of East African countries that share a common heritage and common physical features. Because of the great antiquity of the earliest East African prehistoric sites, and in addition to their specificities and low visibility compared with built heritage, they require adapted conservation and awareness-raising methodologies. This paper does not attempt to make an exhaustive overview of past and current research on the Early Stone Age. Rather, it focuses on the specific aspects that need to be considered for assessing the Outstanding Universal Value (OUV) of the earliest archaeological sites, with a special concern for the prehistoric record ranging from 2.6 to 1.8 million years (Ma) ago, which corresponds to the initial stage of the Early Stone Age in East Africa.

**Physical settings**

The physical settings that characterize the Early Stone Age record from East Africa play a determining role in the preservation, study and management of this cultural heritage. During the Neogene and Quaternary periods, the combination of intense volcanic and tectonic activities with rapid sediment deposition in the East African Rift System has enabled the preservation of fossils and artefacts within rift graben or half-graben basins (Chronowicz, 2005; WoldeGabriel et al., 2000). The concentration of early hominin habitats in these tectonically altered landscapes would not only relate to exceptional conditions of preservation. It would also reflect a hominin choice that targeted these basins because of their high biodiversity (Reynolds et al., 2011).

In this context, Ethiopia has a leading position, which can be seen in the multiplicity of interdisciplinary international research projects in the field, the significant proportion of Ethiopian scientists involved in all human evolution-related fields, and the outstanding number of site complexes related to the early stages of humankind. This potential has long been recognized by UNESCO which is reflected in its inscription of the Lower Valley of the Omo and the Lower Valley of the Awash in Ethiopia on the World Heritage List in 1980.
The archaeological sites are stratified in geological formations that are overwhelmingly rich in fossiliferous localities which yield a variety of animal and hominin species. The paleontological record is so far more prolific in quantity and more widely present, both in time and space, compared with the archaeological record. This unique paleontological and paleoanthropological record allows for an accurate reconstruction of the bio-environmental settings and their impact on hominin settlement dynamics. A demonstrative example is given by the Shungura formation in the Omo Basin, where more than 53,000 vertebrate fossils have been recovered, encompassing more than 150 animal species and at least 4 hominin taxa in a temporal interval ranging from 3.6 Ma to 1.0 Ma ago (Coppen and Howell, 1976; Howell and Coppen, 1976), while less than 3,000 archaeological remains have been recorded that are mostly concentrated in a limited chronological range between 2.3 Ma and 2.1 Ma ago (Howell et al., 1987).

Archaeology in East Africa: brief historical background

Archaeology in East Africa initially developed in the wake of paleontological research. The remarkable development of paleoanthropological and prehistoric research from the 1930s was first initiated by paleontologists. Among the pioneers who gave a decisive impetus to the investigations, Camille Arambourg (who worked in the Omo region in the early 1930s) and Louis Leakey (who started his investigations at Olduvai Gorge, Tanzania, during the same period) appear as major figures. They gave rise to generations of ‘fossil hunters’ and initiated the first interdisciplinary studies, from which emerged the first research into prehistory. Since the 1930s, paleontology has maintained a leading position in the study of hominin-bearing formations in East Africa, and many more efforts have been made in support of paleontological investigations compared to that of archaeology.

Field methods developed by archaeologists have kept their specificities compared with paleontological investigations, due to the specific nature of both kinds of records. The paleoanthropological record forms a taphocenosis which is by nature widespread, as a result of primary dispersed habitats combined with secondary dispersion and fragmentation processes after animal (or hominin) death, due to water transport in particular. The field investigations developed by the paleontologists are therefore based on large-scale surveys and surface samplings complemented by scarce and limited test excavations. This large-scale approach contrasts with the methods developed by the archaeologists who have to deal with scarce and circumscribed localities, where hominins produced, used and discarded stone tools. As a consequence, archaeological investigations focus mainly on the extensive excavation of a limited number of sites, sometimes to the detriment of a broad-based field approach.

In this context archaeology has also greatly benefited from some methodological inputs from paleontology and, in particular, by taphonomic studies (Behrensmeyer, 1975, 1983). Since the 1980s, the study of site formation processes has been one of the major focuses of archaeologists working in East Africa. Based on the statement that all sites have suffered post-depositional disturbances (Isaac, 1997), these studies provide basic clues for discriminating the anthropic versus non-anthropic induced processes that lead to site formation. With field approaches that remain largely distinct, archaeology and paleontology are still closely linked. They explore the same fields and share a number of basic issues related particularly to early hominin subsistence behaviours and adaptability to varying biotic environments.

The first tool-makers

We do not yet precisely know who the first tool-makers were, as almost all hominin fossils have been uncovered in large paleontological surface localities outside any archaeological context. Direct associations between both categories of remains are extremely rare. Such occurrences are limited to the sites of Hadar A.L. 666 (Kibbel et al., 1996), Fejej-1 (Lumley de and Marchal, 2004), both associated with hominin remains assigned to early Homo, and Olduvai FLK Zinj and Olduvai FLK NN Level 3 (Leakey, 1959; Leakey et al., 1964; Tobias, 1967) where the fossils of Australopithecus boisei and Homo habilis were found in direct association with archaeological material. At a number of localities, the association between hominin fossils and stone tools is indirect, either because the use of stone tools is only documented by the presence of cutmarked bones, or because hominin fossils have been found in geological deposits that are contemporaneous with archaeological material in the same micro-regional context.

Indirect evidence of stone tool use has been reported at a number of sites where cutmarks and hammerstone fractures on herbivore bone fragments have been identified, but with no associated artefacts and sometimes with no available rocks suitable for knapping in the environment of the sites. Examples of such indirect associations are documented for instance at Bouri in the Middle Awash Valley at 2.5 Ma (cut-marked and broken mammalian bones associated with Australopithecus garhi) (Ardrey et al., 1999; de Heinzelin et al., 1999), and at Dikika in the Lower Awash Valley at 3.39 Ma ago (cut-marked and broken mammalian bones in a context with fossils of Australopithecus aferiensis are present) (McPherron et al., 2010). However, in these contexts of open-air localities where bones might have been subject to a number of modifications by mammals (e.g. trampling, breakage or gnawing) or by water transport within coarse fluvial sands, the reliability of the modifications assigned to hominins is to be validated by solid experimental or actualistic database (Domínguez-Rodrigo et al., 2010, 2012).

Furthermore, the absence of associated stone tools – and, in the case of Dikika, the absence of unmodified faunal fragments and in situ material – considerably undermine the relevance of these finds. More convincing taphonomic and archaeological arguments are still required to support the hypothesis of regular meat consumption using stone tools prior to 2.6 Ma ago, which corresponds to the earliest evidence of cutmarked bones documented at Gona, in indisputable archaeological contexts (Domínguez-Rodrigo et al., 2005).

Indirect associations between hominin fossils and stone tools found in close proximity are documented in West Turkana (early Homo) (Prat et al., 2005) and in the Omo-Shungura Formation (early Homo and Australopithecus boisei) (Howell et al., 1987). Whether the hominin fossils are found in direct association with stone tools or not, it can never be firmly established that they belong to the tool-makers. They could well be as part of the background paleontological record that lived in the surroundings of the sites and formed potential preys for large carnivores. As a consequence, the earliest tool-makers may be any of the hominin taxa who were present in East Africa between 2.6 and 1.8 Ma ago, including the diverse forms of robust australopithecines, and the early Homo who first appeared in East Africa by 2.6 – 2.5 Ma ago. This debate has long been biased by the tautological reasoning that linked the emergence of the genus Homo with the capacity for making tools, resulting in a hominin taxonomic classification largely grounded in cultural arguments (de la Torre, 2011). It cannot be excluded that several taxa might be involved in the development of stone technology during this time range. This crucial issue is still open and its clarification remains one of the most important challenges for the current and future investigations.

From tool recognition...

Based on the current archaeological record, the recognition and identification of the earliest known prehistoric sites rest on a single category of remains: lithic artefacts. They are neither very complex nor of great esthetic value, but they nevertheless constitute a unique cultural and scientific heritage. Although very simple, the homin-in-made artefacts are easily distinguishable from geofacts, i.e. naturally broken stones, and from non-human-primate stone artefacts. The latter include pounding implements used for cracking nuts or other hard organic materials, and occasional sharp-edged flakes issued from non-controlled stone flaking processes (Haslam et al., 2009). The capacity to systematically produce sharp-edged flakes with a controlled hand-held percussion technique is a human specificity. It gives end- and by-products that are easily identifiable by specialists.

The first stone tools resulting from an intentional manufacturing process and issued from indisputable geo-chronological contexts are dated to 2.6–2.5 Ma ago. They have been uncovered at the Gona EG10 and EG12 localities in the Afar region (Ethiopia) (Semaw, 2000; Semaw et al., 1997). They form part of a set of site complexes, ranging between 2.6 and 1.8 Ma ago, which constitute the earliest prehistoric record yet documented in the world. No more than 8 site complexes are documented for this time range: (1) 4 are located in Ethiopia (Gona, Hadar, Omo-Shungura and Fejej site complexes), 3 in Kenya (Lokahale, Koobi Fora and Kanja Sera South site complexes) and one in Tanzania (Olduvai site complex). All these site complexes include a number of archaeological localities that varies between 2–3 and several tens of localities. They are all investigated as part of long-term interdisciplinary and international projects, with a significant involvement of East African scholars.

The earliest prehistoric sites are most commonly assigned to the Oldowan culture, initially introduced by Louis Leakey (1936) and later on more precisely defined and classified by Mary Leakey (1971) at Olduvai. She divided the industries from Bed I to Upper Bed IV (1.9 to 1.1 Ma ago) into several stages: Oldowan (Bed I) and II, Developed Oldowan A (Middle Bed II), Developed Oldowan B (Middle and Upper Bed II) and Developed Oldowan C (Beginning of Upper Bed IV), based on the relative frequencies of distinct typological categories (e.g. light duty tools, spheroids and subspheroids). Since Mary Leakey’s pioneer work, a number of alternative classification systems of the Oldowan artefacts have been proposed, in particular by Gynn Isaac and Isaac (1967), Isaac and Toth (Isaac et al., 1997; Toth, 1985), resulting in a great diversity of systems and a non-existing consensus potential (Schick and Toth, 2006). Currently almost as many classification systems as Oldowan site complexes exist, which is not so surprising given the high inter-assemblage diversity. Therefore, a more and more detailed picture of the Oldowan is emerging.
The term ‘Mode 1’ is preferred by some researchers, most probably because of its more universal value. It was initially proposed by Graham Clark and designates all the simple technologies based on ‘chopper-tools and flakes’ (Clark, 1961). In East Africa, the terms Oldowan and Mode 1 equally apply to the simple stone technologies prior to 1 Ma ago. Grouping together all the lithic artefacts that were produced in a single techno-complex called Oldowan, or Mode 1, implies the existence of a long-lasting initial stage of stone technology with no major behavioral or cognitive shift, as suggested by a number of archaeologists (Semaw, 2000; Semaw et al., 1997; Stout et al., 2010). Other archaeologists prefer to distinguish a pre-Oldowan (or archaic Oldowan) stage that encompasses all the assemblages prior to 1.9–2 Ma ago (Lumley de, 2006; Lumley de and Beyene, 2004; Roche, 2006), given a number of shared technological features. It is also true that a drastic lack of sites between 2.3 and 2 Ma ago limits our understanding of the evolutionary technological processes that could link the earliest assemblages with the ‘classical’ Oldowan ones, after 2 Ma ago.

The specificities of the earliest assemblages are documented by a number of sound technological markers which can be listed as follows:

- advanced knowledge and control of stone fracture mechanics;
- prevalence of a simple flake-core technology, with no core volume management;
- debitage method consisting basically in unidirectional and unidirectional removals;
- intended for the obtention of modified and unmodified flakes with cutting edges;
- exclusive use of locally available raw materials;
- marked preference for homogeneous fine-grained source materials;
- selective procurement of angular morphologies with angles that were suitable for a direct flake extraction.

Although the functional properties of the artefacts look perfectly adapted for cutting soft tissues, in particular meat, there are very few indications of carcass processing for meat and marrow consumption prior to 2 Ma ago. No microwear analysis of stone tooledges has yet been carried out. Furthermore, evidences of bone modifications resulting from butcherly activities are extremely rare. The oldest and best documented examples of cuts marks on herbivore bone fragments are found at Gona (DG6, G613, W69 at 2.6–2.5 Ma ago (Domínguez-Rodrigo et al., 2005), but yet concern a very small portion of the bone specimen and are few at these localities. There is however no doubt that the earliest stone tools were prominently, if not exclusively, cutting implements used for butchery.

Do the earliest lithic assemblages differ from the classical Oldowan ones? In a way, it is clear that a continuity exists, based on the persistence, in the post-2 Ma Oldowan assemblages, of a simple flake technology which is also often described as the least-effort technology (Isaac et al., 1997). This technology has in fact persisted over a much longer time period and it is also present during the Acheulean and in many more recent assemblages up to the Holocene. In these contexts, simple flake technologies correspond to expedient tool productions that complement more elaborated systems of production, either by shaping or flaking. The main specificity of the earliest stone tool industries in comparison with younger industrial complexes, including the post-2 Ma Oldowan, is that the unique target of the tool-makers was to produce flakes from a simple core reduction technology.

Conversely, the post-2 Ma Oldowan assemblages appear to be more diversified, with the development of the first shaped implements on pebbles, e.g. choppers and proto-bifaces, the presence of pounding implements, e.g. spheroids and anvils, that are particularly abundant in the Olduvai Beds I and II assemblages (Leakey, 1971; Mora and de la Torre, 2004), together with more frequent retouched tools on flakes. The first appearance of flaked bone tools and bone hammers, documented at Olduva in several assemblages (Backwell and d’Errico, 2004, also coincides with this time range. These innovations likely responded to the emergence of new technological needs after 2 Ma ago. It makes no doubt that stone tool categories as exclusively, cutting implements used for butchery.

Shifting in raw material procurement equally occurred between the earliest assemblages and the post-2 Ma Oldowan series, as pointed by Goldman-Neuman and Hovers (2012). In the earliest assemblages, the raw materials that were used for knapping correspond exclusively to locally available materials. However, a selective procurement among the local resources was performed by the earliest tool-makers, as early as 2.6–2.5 Ma ago at Gona (Stout et al., 2005), and around 2.3 Ma ago at Lokalalei (Delagnes and Roche, 2005; Harmand, 2009; Hadar A.L. 666 (Goldman-Neuman and Hovers, 2012; Harmand, 2009; Stout et al., 2005) and at the Omo-Shungura sites (Delagnes et al., 2011). The selectivity focused on specific petrographic groups: fine-grained lavas at Gona, Lokalalei, and Hadar A.L. 666, quartz at the Omo-Shungura sites. At Lokalalei 2c, the earliest tool-makers also targeted angular blocks or cobbles that provided to the tool-makers natural angles directly workable for producing flakes (Delagnes and Roche, 2005; Harmand, 2009). The major difference after 2 Ma ago consists in the first evidence of raw material transport over relatively long distances (> 10 km), in particular at Kanjera South (Braun et al., 2008), associated with a broader spectrum of occupied habitats (Pummer et al., 2009). Together with the recent data concerning FwJi20 site at Koobi Fora that point out an increased diversity of early hominin dietary adaptations (Braun et al., 2010), these data suggest more advanced strategies of resource acquisition after 2 Ma ago. It seems very likely that the tool technofunctional diversity after 2 Ma ago originated from a very diversified substratum of diversity patterns. It certainly marks an important step in hominin adaptation to varying environments.

Does the shift related to raw material transport and tool functional diversity after 2 Ma ago reflect a major evolutionary shift for the human lineage? The answer depends upon the behavioral patterns that are considered as significant for defining thresholds in hominins cultural evolution. Whatever the criteria which are adopted, differences do exist between the earliest and the ‘classical’ Oldowan assemblages, that deserve to be highlighted considering their significance for assessing the behavioral adaptation of the early hominins to their environment. Neither the notion of a pre-Oldowan stage which would have been drastically distinct from the Oldowan, nor the notion of a large Oldowan entity encompassing the pre- and post–2 Ma assemblages are fully satisfying, given these behavioral shifts. This taxonomic issue, which is currently one of the most debated issues with regard to the earlier hominin cultures, has to be considered as a means rather than an end, all the more as ‘if the system is effectively a least-effort one then the recurrence of the defining features across time and space does not necessarily imply cultural continuity or affinity (i.e. participation in a particular network of cultural connections that was transmitting distinctive, idiosyncratic traditions).’ (Isaac et al., 1997).

Variability also exists with regard to the elaboration of the earliest stone tool assemblages compared with the post-2 Ma Oldowan assemblages, but its interpretation appears more debatable. The first reason is that elaboration is a very subjective and hazy notion, which can be assessed according to a number of criteria that differ according to the researchers and that can interfere with external factors, such as variations in raw material quality and availability or variations in the hominin groups involved in stone tool making. The criteria that are most commonly used, whether alone or combined, are mainly based on productivity or strategy of stone tool making (Delagnes and Roche, 2005), control of core reduction (Semaw, 2000) and gesture control (Delagnes and Roche, 2005), anticipation of needs via raw material or tool transport (Potts, 1991), atypicality to flaking accidents (Hovers, 2009). The available data are heterogeneous and only few case studies provide a set of relevant information regarding these criteria that can be directly compared.

The second reason which makes the interpretation of inter-assemblage variations quite tricky to assess in terms of elaboration is that the observable variations do not fit with a linear process of changes. For example, grip and gesture control, productivity, control of flake detachment look more advanced at Lokalalei 2c (Delagnes and Roche, 2005; Roche, 2000), that likely reflect distinct technical and cognitive capacities. Similar variations are observable between Lokalalei 2c and the Omo-Shungura archaeological series (Chavaillon, 1976; de la Torre, 2004; Delagnes et al., 2011; Merrick and Merrick, 1976), but in this case they rather relate, at least in part, to dissimilar environmental constraints. In the Omo-Shungura Formation, raw materials were indeed scarce and hazy notion, which can be assessed according to a number of criteria that differ according to the researchers and that can interfere with external factors, such as variations in raw material quality and availability or variations in the hominin groups involved in stone tool making. The criteria that are most commonly used, whether alone or combined, are mainly based on productivity or strategy of stone tool making (Delagnes and Roche, 2005), control of core reduction (Semaw, 2000) and gesture control (Delagnes and Roche, 2005), anticipation of needs via raw material or tool transport (Potts, 1991), atypicality to flaking accidents (Hovers, 2009). The available data are heterogeneous and only few case studies provide a set of relevant information regarding these criteria that can be directly compared.

Whatever their elaboration, all the earliest stone tool assemblages evidence technical skills that are well beyond the basic understanding of stone conchoidal fracture mechanisms. It implies that they do not reflect an initial stage of tool-making apprenticeship. An earlier stage certainly occurred, which still has to be identified (Panger et al., 2002). If the emergence of stone tool making corresponds to an abrupt event, as proposed by some (Rogers and Semaw, 2009), then the temporal resolution of this elaborable geochronological data would drastically limit our chances to clearly identify it. If we consider that the invention of tool-making rather fits with a long process of emergence, it is very likely that the low degree of technological elaboration of the first artefacts and/or the low-density of the lithic clusters would result in a weak archaeological visibility. Whatever the alternative, the recovery of the first stone tools assemblages remains one of the most exciting challenges in prehistory. It makes no doubt that the East African Rift System forms potentially the best context in the world for taking up this challenge.

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The combination of these basic sedimentological, geo-chronological and archaeological criteria has recently been used in the Omo-Shungura Formation in order to test the reliability of several archaeological sites (Delage et al., 2011). These sites, recovered and excavated by Chavaillon's team in the late 1960s and early 1970s (Chavaillon, 1970, 1975, 1976), were supposed to represent the earliest known artefacts. Site categorization as in situ (Member E) or displaced (Member F) as the undebatable archaeological occurrences recorded in Member E (2.32 to 2.23 Ma ago) by Chavaillon and Merrick (Chavaillon, 1976; Merrick et al., 1973; Merrick and Merrick, 1976). Furthermore, their anthropogenic origin has recently been questioned (de la Torre, 2004). The site of Omo 71 had an historical value because it was the first archaeological site recovered by Chavaillon in the Lower Omo Valley in 1969, which significantly pushed back the age of the earliest stone tool production documented at that period, some hundred thousand years prior to the Olduvai and Koobi Fora prehistoric record. The stratigraphic position of the site, in member E, is firmly established thanks to the presence of two major tuffs (E and F) directly below and above the site. But the sedimentary context: a high-energy flow deposit rich in large mammal bone fragments and river pebbles, is not a favorable one. Archaeologically, the absence of in situ deposition, the small number of the lithics, the compositional alteration of the bone, the absence of a major chert flake which resembles the typical Holocone flakes from the overlying Kibish Formation, confirm, as stated by de la Torre (2004), the unreliability of this site which has to be eliminated from the Omo archaeological record.

The site of Omo 84 displays very distinct features. Its sedimentary context appears very favorable for site preservation, as it consists of a silt clay deposit totally devoid of gravels and pebbles, and typical of a floodplain environment. The archaeological setting consists in a circumscribed and quite dense accumulation of artefacts which have been found in situ. The assemblage includes a significant proportion of intentionally knapped flakes and its petrographic composition, clearly distinct from that of the local pebble sources, is indicative of a selective raw material procurement focused on quartz. All these features point to an anthropic assemblage preserved in an archaeological site which has likely been not drastically disturbed by post-depositional processes. Nevertheless, the complexity of the stratigraphy around the site, with multiple faults crosscutting (Chavaillon and Bouabent, 1979; Howell et al., 1987), makes impossible a reliable chrono-stratigraphic positioning of this site. Omo 84 forms thus an undated archaeological locality, with a low scientific and heritage value.

This site reevaluation in the Omo-Shungura Formation has been combined with 2008 with extensive surveys performed in the geological members (E to F) that range below Member E, where most archaeological sites are concentrated (Delage et al., 2011). In 2011visit, the same strict sedimentological, geo-chronological and archaeological criteria have been used to identify in a total absence of sites in Members B to E, which have however yielded abundant fauna and hominin fossils. It implies either that the invention of stone tool-making has been locally abrupt (circa 2.3 Ma ago) and asynchronous with regard to the earliest known lithic assemblages, or that it results from the arrival of new hominin groups who introduced this invention in the region. The example of the Omo-Shungura Formation illustrates the far-reaching implications of an accurate and multi-criteria site diagnostic.

Site categorization

The site complexes reported to the Earliest Stone Age record from East Africa include a number of archaeological localities which have yielded hominin-made artefacts associated with large mammal bone fragments. They are most often preserved within a single archaeological horizon. They vary significantly in terms of spatial configuration or preservation and artefact/bone density, ranging from high density accumulations concentrated in small circumscribed areas to isolated scattered pieces. The question most often raised as to whether bones and lithics are the result of natural processes (bioclasts are functionally similar to in situ deposits, 2009), as insofar as the sites correspond to open-air settlements in environments that were rich in biotic resources and that attracted hominins as well as a variety of small mammals. In these contexts, site recovery depends on several natural processes, mainly tectonics and erosion. While tectonics has enabled entire blocks of sediment to get unearthed and accessible as a result of block uplifts and overturnings, erosion continuously brings out archaeological remains from the natural slopes or sections thus created. As a consequence, what is visible to the archaeologists when surveying a small eroded portion of sites which are either still buried to a large extent within the sediments or largely, even sometimes completely, eroded (Figure 2). The only way to test these two alternatives is to carry out test excavations that may lead to extensive excavations in the best cases. Site preservation and integrity cannot be assessed without excavating, at least partially, the sites, and this evaluation is essential for defining their scientific potential and heritage relevance.

The most classic and easily identifiable archaeological sites are formed by dense accumulations of remains in well-dated and in situ geological deposits. Most parts of past and current investigations focus on these sites which are the remnants of indubitable anthropic settlements. This category of site is present in the archaeological record from the earliest stages of stone tool production, in particular at Gona (EG10 and EG12 (Semaw, 2000; Semaw et al., 1997), at Lokalalei 1 and Lokalalei Jr (Biluwa et al., 1992; Rock et al., 1999), and Hadar A, B, and C (Glassman-Neuman and Hovers, 2005; Hovers, 2003), as well as in a number of post–2 Ma localities, e. g. Olduvai FJK-Z1 (Leakey, 1971), Koobi Fora Fkj, 50 (Bun et al., 1988), Fiege
Fi-1 (Lumley de and Beyene, 2004), and Kanjera Excavations 1 and 2 (Plummer et al., 1999). Some of these sites could result from several successive hominin short-term settlements mixed together within a palimpsest, with the pending question of the relationship between the artefacts and the faunal remains in most occurrences. Several sites seem to result from a single occupational phase, as suggested by their spatial patterning (e.g. Lokalalei 2c, FxJi50, Fejej Fi–1: op. cit.). They constitute the most relevant contexts for accurate restitutions of hominin activities at the site scale. The potential of these high density sites is also due to the abundance of the lithics, which include the products and by-products of a significant number of knapped blocks or pebbles, allowing in-depth analyses of core reduction strategies and hominin technical skills. Refits that conjoin cores and flakes have been performed in most assemblages, following the pioneer refitting work performed at Koobi Fora since the early 1980s (Kroll, 1981; Kroll and Isaac, 1984). The refits have been initially used to assess what stages of lithic reduction have been performed in the sites. It has been convincingly shown that some high density sites correspond to places where hominins passed in and out, transporting flakes and cores at different stages of reduction from one place to another, which implies complex organizational strategies (Delagney and Roche, 2005, Toth, 1987). More recently, the significant refits achieved for the Lokalalei 2c assemblage have led to a blow-by-blow reconstruction of core reduction sequences, giving new insights on the advanced technological behaviors of some of the earliest tool-makers (Delagney and Roche, 2005). The earliest archaeological sites from East Africa form high-resolution contexts which can thus compare with many younger prehistoric sites in terms of preservation and scientific potential.

A part of the archaeological record consists in lower density sites, also mentioned as ‘off-site’ scatters or mini-sites (Isaac et al., 1981). They yield several to few hundreds of artefacts, in connection or not with faunal remains. Their relevance depends largely on their preservation and it is important to distinguish the low-density sites that proceed from discrete occupations from the ones that correspond more likely to the margins of high-density sites that have been largely eroded (Figure 2). The latter have a limited archaeological potential while the former are true archaeological sites. They may also be the remnant of a single occupational event by contrast with high-density sites formed by successive overlapped occupation episodes mixed within palimpsest. The relevance of such low-density occurrences for accurately defining hominin activities at the site scale is optimal. Their scientific relevance has long been recognized, in particular by Isaac who has stressed their potential for intersite analyses, due to their functional complementary with regard to the high-density occurrences (Isaac et al., 1981). This approach was particularly well adapted to Koobi Fora were both types of sites coexist.

In other contexts, the low-density sites constitute the unique category of archaeological site that is documented. Such is the case in particular in the Omo Shungura Formation where all the sites correspond to circumscribed concentrations of small series of artefacts, rarely associated with faunal remains. The excavations carried out by Chavaillon and Merrick in the 1970s focused on a small number of sites that correspond to the richest localities (e.g. Omo 123, Omo 57, FxJi1, FxJi2: (Chavaillon, 1976; Merrick et al., 1973), whose collections nevertheless do not exceed 400–500 artefacts. The surveys conducted since 2008 in Member F (Boisserie et al., 2010; Boisserie et al., 2008; Delagnes et al., 2011) have brought to light an unexpected large number of low-density occurrences. More than 100 localities, consisting from less than ten to several tens of artefacts, are yet recorded in an area of circa 4 km² situated in the middle part of the Shungura formation. Isolated non-in-situ pieces as well as groups of artefacts scattered on modern erosive floors, e.g. guily beds, cannot be considered as relevant site indicators and are not considered in this record. The archaeological sites are plotted via a GIS inventory together with the paleontological localities and raw material sources in order to assess hominin settlement patterns with regard to the biotic and minerialogical resource distribution. Our current working hypothesis is that the fluviatile system, either braded or meandering, in which the Omo tool-makers settled, has involved a patchy distribution of resources that might have favored short-time settlements by small and highly mobile groups of hominins, resulting in a great number of small archaeological sites (Delagnes et al., 2011). Whatever the final interpretation, no doubt that this patchy distribution responds to distinct hominin land-use patterns than what prevails in sites complexes characterized by a small number of high-density occurrences. Low-density sites are highly meaningful for assessing some aspects of early hominin behaviors that are still poorly documented, regarding site function, hominin settlement dynamics and resource management at micro-regional scales. They form a discrete and thus particularly fragile record that deserves as much attention as high-density sites.

Conclusion

The Earliest Stone Age record from Ethiopia, and from East-Africa as a whole, suffers from intense erosion processes due to precipitations of high-intensity and short duration which are characteristic of the arid and tropical regions. But in reality, people are today a far greater menace to this vulnerable heritage. The rapid agricultural and demographic development of some remote areas from East Africa is most often performed without prior coordination and conciliation between the relevant stakeholders. The local heritage authorities have little influence when faced with the powerful political and economicallobbies that promote far-reaching development strategies based on the sale of large areas for agricultural purpose, without concern for their heritage content. A genuine threat weighs in particular on the cultural and natural heritage of the Lower Omo Valley in southern Ethiopia. Conciliations that aim to balance the cultural and economical interests are in progress with the support of UNESCO. One important challenge that the heritage authorities will have to face in the coming years rests on their ability to promote alternative development strategies that preserve the unique cultural and ecological heritage formed by the East African rift basins, in agreement with the interests and the development of the local communities.

These issues transcend the actual political borders and concern all the African countries that form the native land of humankind. Furthermore, the heritage value of the East African fossil bearing formations is not restricted to the documentation already acquired. It also reposes on an outstanding potential which still has to tell us a lot regarding our origins, as suggested by the multiplicity of major paleoanthropological and archaeological discoveries that have been done in these contexts during the last two decades. These discoveries have considerably refined our understanding of early hominin biological diversity, behavioral complexity and biogeographic adaptability. Interdisciplinarity is the essential prerequisite to all these discoveries and the central pivot of all related studies. Since the beginning of field investigations in the early 1930s, it has played a major role in the conduct of research. More collaborative endeavors between the specialists could still be performed and no doubt that paleontologists and geologists would gain much by developing finer-grained field methods in some contexts, while archaeologists would also benefit a lot from the development of broader-scale field approaches. A more systematic use of methodological tools such as satellite imagery and geographic information systems could also greatly enhance the interactions between the disciplines. The development of geographically-referenced database would help for compiling multidisciplinary data in common interactive research tools, for integrating a wider array of occurrences in the archaeological record, including the low-density sites that are very rarely excavated and most often neglected, and for providing site inventories and large-scale mappings. Such mappings are part of a feedback process that researchers should more systemically prioritize in order to better assist the relevant authorities in their decision-making capacity with regard to the protection and valorization of the Earliest Stone Age heritage.

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Tanzania and the Outstanding Universal Value of its paleoanthropology: approaches at Laetoli and lessons learned

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Introduction

The first trail of the Laetoli hominin footprints consisting of four prints were initially discovered in 1976 by Mary Leakey and her co-workers, followed by a full excavation in 1977 that revealed a sequence of well-preserved footprints in volcanic ash dated to 3.66 Ma (Leakey and Hay, 1979; Leakey, 1981). The prints were preserved in volcanic ash (tuffaceous tuff that was numbered as Tuff 7) that hardened into a soft stone. The prints were molded and extensively studied by Robinson (1987), White and Suwa (1987), before they were reburied to preserve them until a better solution could be found. Tuttle (1987; 1990; 1992) produced perhaps the most systematic and thorough study of positional behaviors of the Laetoli printmakers based on the first generation of the hominin footprints trail cast. The interpretation of the Laetoli printmakers continues to generate heated debates in the scientific corridors, where interpretations range from an Australopithecus afarensis-like printmakers to a much more human-like australopithecine (Meldrum et al., 2011; Reicheln et al., 2010, 2008; Tuttle, 2008; Berge et al., 2006; Harcourt-Smith 2005; Deloison, 1991; Day and Wickens, 1980; and White, 1980).

Conservation efforts of the footprints trackway

In 1996 the prints were re-excavated and re-studied under the supervision of the conservation expertise of the Getty Conservation Institute and the Department of Antiquities in Tanzania. The prints were carefully treated and reburied again with several layers of herbicide-treated industrial construction fabrics and various types of sediments as a permanent solution for conservation and preservation in what was considered to be an appropriate and a pristine method (Figure 1). In their brief
Laetoli sediments, which were deposited on top of the basement rock of basalt origin, also provide important information relevant to the discussion of the preservation of the hominin footprints at Site G. The Upper and Lower Laetolil Beds were entirely deposited on land, on the crest and flanks of a broadly uplifted dome overlying the Precambrian bedrock in the Eyasi Plateau. The Laetoli Beds occur in a series of shallow outcrops with many discontinuous exposures spreading about 1,600 km² to the south and west of Lemoruguri, and to the northwest of Lakes Massai and Nduatu (Hay, 1987; Manega, 1993; Deino, 2011). The Laetolil Beds, especially the Upper Beds, preserve a unique type of fossil record of hominin footprints and animal trackways that have been dated to 3.5 Ma and they also provide a snapshot of past environments at Laetoli. A generalized description of the columnar section of Plio-Neogene Laetoli sediments by Hay (1987) indicates that, lithologically, the Laetolil Beds consist of deposits characterized by lava flow, tuffs and clay stone. The deposits are mainly of nephelite-phosphorite, melilitte-carbonatite composition and/or aeolian tuff origin.

Additionally, P2 strategy does not provide access to the original ichnofossil record (footprints). Although the original reburial by Mary Leakey ensured a short-term preservation of the tracks it could not protect the prints from the unexpected threat of root growth from trees on the trackways, which continues to be a serious threat as was observed by our team in February 2011. The P2 strategy, however, provides minimal protection in that it does not allow for systematic real-time monitoring, and does not necessarily imitate the original burial conditions of the prints as in the case of Laetolii hominin footprint trackways.

The present re-excavation of a limited section of the southern end of the footprints trail at Laetoli provided us with an opportunity to re-evaluate the methodology of the Antiquities-Getty Conservation Institute (AGCI) project (which was purely a P2 strategy) after 15 years. Based on the archaeological and geological evaluation of a 4 m² area re-excavated at the southern end of the trackways, the P2 conservation strategy at Laetoli seems to have not entirely served its intended purpose, which was to preserve the footprints from weathering, root penetration and chemical dissolution. Ironically the conservation strategy that was used, based on carefully designed laboratory-controlled experiments, did not suffice in the Ngorongoro ecosystem because the environment is so dynamic and randomly patterned that it defeated the whole conservation process. In this report we provide first hand archaeological and geological evaluation of the current conservation status of the Laetoli hominin footprints.

Geological description of the Laetolil Beds

Laetoli sediments, which were deposited on top of the basement rock of basalt origin, also provide important information relevant to the discussion of the preservation of the hominin footprints at Site G. The Upper and Lower Laetolil Beds were entirely deposited on land, on the crest and flanks of a broadly uplifted dome overlying the Precambrian bedrock in the Eyasi Plateau. The Laetoli Beds occur in a series of shallow outcrops with many discontinuous exposures spreading about 1,600 km² to the south and west of Lemuruguri, and to the northwest of Lakes Massai and Nduatu (Hay, 1987; Manega, 1993; Deino, 2011). The Laetolil Beds, especially the Upper Beds, preserve a unique type of fossil record of hominin footprints and animal trackways that have been dated to 3.5 Ma and they also provide a snapshot of past environments at Laetoli. A generalized description of the columnar section of Plio-Neogene Laetoli sediments by Hay (1987) indicates that, lithologically, the Laetolil Beds consist of deposits characterized by lava flow, tuffs and clay stone. The deposits are mainly of nephelite-phosphorite, melilitte-carbonatite composition and/or aeolian tuff origin.

The Lower unit of the Laetolil Beds consists of graded water-worked tuffs, lapilli tuffs and conglomerates (in the upper 30 m) that are chemically easily identifiable. The unit consists of mudflow deposits, aeolian and water-worked tuffs with channel fillings from the eroded Oligo-Lavas and few layers of conglomerates and breccia (Hay, 1987; Manega, 1993). The topmost part of this unit, however, is about 75% reworked tuff of aeolian origin with numerous thin water-worked tuff layers that are 45–60 cm thick, indicating the existence of a substantial amount of water in the area during and after their deposition. The remainder of the Upper Laetolil Beds is composed of approximately 20% air-fall volcanic ash. One to two percent of the upper unit consists of easily distinguishable stream-reworked tuffs (Hay, 1987). The water-worked tuffs within the unit are generally composed of fine to coarse-grained, moderate to well-rounded and highly-indurated tuffs. They are well sorted with thin laminae that vary in thickness. The water-worked tuffs are also dominated by clay-like deposits, which comprise about 90% or less of the entire unit. This sedimentary evidence points toward a set of complex depositional environments.

At Locality 8, which includes Site G for example, the exposed Upper Laetolil Unit exhibits a 120°SW – 210°SW strike and a 5° to 10°SW dip with a two-joint system (vertically and horizontally) filled with calcite material of varying size and width ranging from 1–60 cm in thickness. The calcite-filled joints can easily be distinguished within the exposed Upper Laetolil Beds below the footprint tuffs. The thickness of the two joints at Locality 8 tends to increase as one moves northward towards and beyond the footprint site G. An open joint of about 40 cm thick characterized by a 210° SW and 195° SW striking system occurs, and most sediments at Locality 8 are dominated by air- and water-fall tuffs that are distinctly laminated. The laminae are closely interbeded and vary in thickness (12 – 15 cm) thus indicating the possible existence of a substantial amount of water that may well have supported a variety of flora and fauna.

Exposures of about 3 m thick located northeast of the footprint site G are composed of sediments that reveal evidence of intensive bioturbation. The sediments in this area consist of deposits that are downgraded, heavily worn, reworked and loosely packed. These deposits consist of laminated layers with medium to fine grain sands. About 150 m southeast of site G, the Upper Laetolil exposures bear a 30°SW strike with a 6°SW magnitude dip. The exposures here consist of a sorted fine to medium topmost sand layer about 60 cm thick, subdivided into sub-layers of 15 to 45 cm-thick loosely packed tuffs.
The re-excavation of the prints in 2011

As directed by the Ministry of Natural Resources and Tourism (Division of Antiquities), the partial re-excavation of the Laetoli hominin trackway took place from 8 to 16 February 2011 with the stated objective of re-evaluating the current conditions of the footprint trackway. Ideally, to obtain a maximum evaluation and a better picture of the trackway condition, a complete and full-fledged excavation would have been proper, but the timing and the enormity of the project would have logistically been impossible in such a short time. Therefore, a 4 m² area was excavated at the southern end of the footprints trail (Figure 1). Accordingly, the southern end of the footprints trail happens to be the area that contains the better preserved hominin footprints, therefore it was the best place to perform the re-evaluation. We can also say that it was scientifically the most appropriate area to re-excavate and use the obtained qualitative and quantitative data as a baseline to draw scientifically informed conclusions about the current status of the trackway. Our observations and conclusions were based on what was observed in the field and supported by quantitative data from the photogrammetry work conducted by Nefta Matthews and her co-workers from the U.S. Bureau of Land Management (BLM) during the excavation process. We would have liked to include quantitative data from Heinrich Rüther and Julian Smit’s work (1996) from the University of Wits, South Africa, who so far have the best data from the original conservation project, but due to the fact that the two arrived late to the field (due to travel logistics and fieldwork timing issues) and the fact that their data could not be available until later this year, we decided to go ahead and provide what we believe to be a sound preliminary report that is purely rooted in scientific observations.

Methods

The re-excavation efforts from 8 to 16 February 2011 included a site documentation that was carried out by the BLM photogrammetry team before the excavation started. To better understand the partial re-exca-vation of the Laetoli footprints at the southern end of Site G, the following schema modified from the GCI-Antiquities 1995 conservation work (Figure 2) was adopted and written to describe the layers and the order in which they were removed to expose the footprint tuff:

a. Volcanic (Lava) Boulders: This is a layer that consists of large, medium and small lava boulders. The volcanic rocks and soil creates the topmost protective bural layer at site G. The layer was created to protect the prints from animal trampling and gully erosional process, which occurs during the rainy season.

b. Layer 5: This layer is a layer of black cotton soils that can be seen everywhere in the Laetoli area. The layer is characterized by heavy volcaniclastic matrix of clayey-soil that is expansive when wet and will contract when it is dry. It was laid down to protect Layer 4 from erosion, reduce water infiltration into the lower levels when the wet clay expands. The layer is also high in carbonate content and provides a chemical buffer against calcite dissolution by infiltrating rainwater.

c. Layer 4: This is a sand layer consisting of Gurus sand, which was uniformly placed (about 20 cm thick). A small part of Layer 4 is the remainder of the 1979 Leakey’s fill, which had been sieved to obtain the fine sand used in Layers 2 and 3. The rest of Layer 4 is newly quarried Gurus sand, which has a wider particle size distribution.

d. Enkamat: This is a 10 mm-thick and 1 m wide geoinustrial piece that was used to reduce the slippage of Layer 4 from the underlying surface of the biobarrier and to reduce soil erosion. The strips was tied together with plastic ties and pinned to the biobarrier with wire to prevent it from shifting during the work.

e. Biobarrier 2: This is a layer which has been impregnated with Roundup™ herbicide designed to inhibit vegetation growth. The 1.45 m-wide strip is laid directly over Layer 3 (Figure 2).

f. Layer 3: This layer is identical in composition to Layer 2. It is moulded in the centre over the first layer of the biobarrier (elevated to a height of 25 to 35cm) in a north-south direction. With Layer 3 the centre of the mound shifts to the west, extending from the 1995 trench wall on the east to the 1995 wall on the west.

g. Layer 2: It is sand placed in a north-south mound tapering off to the east and west sides. It is 25cm to 35cm deep at the centre of the mound. It is placed directly over the geotextile layer.

h. Geotextile: A layer of geotextile is placed over Layer 1. It is placed over the region of excavated tuff and covers a small, unexcavated surface just southwest of the tuff. The geotextile is a horizontal separator and a small defense against plant growth.

i. Biobarrier 1: 1.45 m-wide strips are laid directly over Layer 2 extending further to the east 1995 trench wall and to the west 1979 trench wall. Biobarrier strips cover the vertical walls of the entire 1979 trench walls, including the drainage trench.

j. Layer 1: This layer is characterized by 5 cm thick of fine (0.9mm) sieved sand placed directly on the footprints. It covers only the excavated section of the tuff and acts as a direct protective layer to the footprint tuff.

The excavation work started after the systematic photographing of the entire site G was done, where a 4m² grid system was mapped out. Once the grid was established the excavation proceeded with the removal of the volcanic boulders that make up the topmost layer on the footprint burial site. The removal of the top layer was done in one day where large and small boulders were placed in separate piles. Then photogrammetry data was taken immediately after the boulders were removed. All plants growing on top of the layer were also cleared out as well (Figure 3a); some of the plants were taken to the NCA headquarters for species identification. The plants were identified as Gynura pseudochinna, Seneccis schure, Berthiya spekana, Hibiscus apollosus, and asparagus africanus.

The team continued with a meticulous work of removing Layer 5, which consists of black cotton soil. Some plant roots were encountered in this layer (Figure 1) and samples were taken for identification. Stephan Simon from ICCROM took some samples for geochemical analysis from the black cotton layer as well. The layer provides protection to the other underlying layers (4 and 3) that are separated by an Enkamat and biobarrier 2 layers (Figure 2). When the black cotton soil was removed, the Enkamat and biobarrier 2 were carefully placed in a pile and covered with a plastic sheet to protect them from rain and direct sun.

Lessons learned

Perhaps one of the biggest surprises during the re-excavation occurred when Layer 4 and the subsequent Layers 3, 2, and 1 were exposed. Although all these layers were protected and treated with herbicide and insecticides, they all revealed some intensive bioturbation and root growth from various plant species native to the Laetoli area (Figure 3a). The excavation of Layer 4, which is 20 cm thick and characterized by a gravel/sand mixture (pale in color and well sorted) has an undulated surface indicating the uneven distributed weight of its overlaying layer of volcanic boulders and the black cotton soil. Roots, compaction, and insect tunneling were observed on this layer. The photogrammetry team took some photos before the layer was removed. The gravel/sand mix from Layer 4 was carefully placed on a tarp and covered to be used later during the reburial process. Furthermore, the excavation work continued with careful removal of Layer 3, a sand layer that varies in thickness from 25 – 35 cm thick. During the removal of this layer, we noticed that the edges were damp whereas the middle part of the excavated area was very dry, particularly the western part. Two herbicide-treated plant stumps were removed from this layer; they were identified by Martha Demas from the Getty Conservation Institute (GCI) as S3 and S4 plant remains from

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1 The intervention was undertaken as a national decision. Ed.
the 1996 GCI-Antiquities conservation work. The exposed layer also revealed the drainage system that was put in place as well as the sedimentary sections from Mary Leakey’s work in 1977.

Another set of photogrammetry data documentation of the BioBarrier 1 was conducted, and the material was then carefully removed. Removal of Layer 2 commenced after Layer 3 was completely removed. Layer 2 is composed of unevenly distributed sand in a north-south direction with an east-west tapering. The layer varies in thickness from 25–35 cm thick and was placed directly over the geotextile barrier that separates it from Layer 1 (the fine sand layer). The sand layer was carefully removed and placed on plastic sheets and covered to be used later during the reburial process. Despite the herbicide impregnated in the BioBarrier 1, which was intended to protect the underlying layers, roots and traces of bioturbation have thrived on this layer (Figure 3b). Some of the roots penetrated through the biobarrier separating Layer 2 and Layer 1. On the surface below the biobarrier, a combination of clay-siltic termite tracks were also observed (samples were taken for chemical analysis at the Geology Department of the University of Dar es Salaam). After the roots were photographed, they were then measured and removed. Some root samples were taken for further identification in the botanical laboratory at the Ngorongoro Conservation Area Authority (NCAA). The roots were identified to be: *Hypoestes triflora*, *Desmodium sp.*, *Sporobolus ludwigii*, *Eriochloa smensi* and *Setania sp.* The roots and tunneling tracks were measured, where the tunneling averaged between 5–10 mm deep.

Exposure of the footprints trackway was carried out by removing Layer 1, which is characterized by 10 cm-thick fine-grained sand. Only three excavations could work in tandem at a time. This was perhaps one of the most difficult task that required proper care and attention. A cast was brought to the site to guide us with the removal of Layer 1. For this work only fine brush, soft wood spatula and wooden picks were used. The team noticed that as we got closer to the footprint tuff the fine sand layer had crystallized (carbonate precipitates) and was adhering to the tuff making it difficult to remove it just by brushing it off. The volcanic tuff preserving the footprints was extremely moist, and the rim impression of two of the prints G2/3–28 had dissolved into a clay-like matrix, thus losing its original state (Figure 3d).

On the fifth day of work, it rained and the surface around the site was so wet that buckets of water had to be used to remove the standing water before we could remove the protective plastic tarps. Some water seeped through the tarp into the footprint tuff; paper towels were used to sponge out the water from the tuff. As the footprint tuff was exposed, a decision was made not to completely clean off the sand since that would have scoured the tuff surface thus obscuring the surface topography. G2/3–30 print had some mechanical damage, which resulted from sediment movement during the re-excavation (Figure 3d). Such damage has great implications in future monitoring plans, suggesting that every time the prints are re-excavated for monitoring purposes, chances for mechanical damages will also increase. Despite the adhering of sand to the footprint tuff, the team noticed that complete cleaning of the tuff surface could only achieved under a climate controlled structure in the future. Layer 1 was meticulously documented by the BLM photogrammetry team.

Public outreach and presidential visit to the site

For many years, it has been argued that people in developing countries have immediate priorities which do not include the appreciation and/or conservation of their cultural heritage. That notion continues to echo with many in the conservation and tourism industry. Having recognized the importance and voices of local people in the area, the Ministry of Natural Resources and Tourism reserved the sixth day as a day where the general public could view the exposed footprints. This day was also part of an outreach effort officially planned to enable the President and other Government dignitaries to visit to the site. The day started with a briefing by Donatius Kamamba, Director of Antiquities, on the details of the presidential visit to the site and what was expected to be presented to Jakaya Mrisho Kikwete, President of the United Republic of Tanzania, by the various expert teams that participated in the re-excavation work. All teams (conservation, photogrammetry and documentation, geology and archaeology) produced a summary report that was discussed and merged into a single, concise document. One of us, Charles Musiba, was tasked to produce the document which was presented to President Kikwete and Ezekiel Majege, Minister of Natural Resources and Tourism. As the document was being prepared another photogrammetry and 3-D scanning team lead by Heinz Rüther and Julian Smits scanned the entire site using their 3D laser scanner for documentation purposes and they further undertook a photogrammetry documentation that was planned to be used in a qualitative and quantitative comparative analysis of the GCI-Antiquities 1995 work and the 2011 work. As the two finished with their work, Martha Demas from the GCI and Jesut Temba from the Antiquities Division continued with the fine cleaning of the footprints tuff, which included removing some roots that had penetrated the tuffaceous layer (Figure 3d).

By mid-morning various dignitaries arrived at the site and at noon the President Kikwete arrived at the site accompanied by Minister Ezekiel Majege, the Permanent Secretary of the Ministry of Natural Resources and Tourism, Dr Ladislaus Komba, several NC4A Board Members, the Chief Conservator of the NC4A and the British-High Commissioner was also in attendance. Two of us (Audax Mabulla and Charles Musiba) respectively briefed the President at the newly-constructed Laetoli Visitors Centre and at the site as part of the official visit to the site. After the President and dignitaries left the site, the photogrammetry team (BLM team) continued with the documentation, and covering the re-excavated area commenced. The reburial work was conducted under the supervision of Martha Demas and Jesuit Temba where Layer 1 was first sieved for plant seeds and other debris before it was finely distributed on the footprint tuff. Unfortunately by early afternoon it started to rain again and work has to be stopped.

The reburial work of the excavated area

On the eighth day of re-excavation, work started with sieving and drying sand from Layer 2 before it could be put back on the exposed footprint area. All 2011 re-excavation participants helped with the reburial work. All layers were carefully and meticulously laid back on the excavated area in a reverse sequence (starting with Layer 1 all the way through Layer 5, finishing with the volcanic (lava) boulder layer). Before Layer 4 and 5 could be laid down it started to rain again, so work was postponed until the next day. The excavation team and many other excavation participants finished the covering of the prints on the 9th day of the field work.

Technical observations

Although the GCI-Antiquities conservation effort was well crafted and meticulously applied at Laetoli, some conservation conditions such as nature’s dynamics could and cannot necessarily be created in a controlled laboratory environment. As a result, the team was surprised to see how some flora and micro fauna managed to survive and thrive under the buried prints. One could argue that observed results from the re-excavation yielded some lessons learned that will help with the future conservation efforts of the Laetoli hominin footprints. Below is a summary of technical observations that were individually drawn up by the geology and archaeology team and jointly discussed and agreed upon. The two teams independently observed that:

Geologically the overlaying prints of fine sand created morphologic interactions (by obscuring micro-details of the footprint topography) and by bonding with the tuffs. The sand contains calcium carbonates which precipitates this process;
sites. Such a process can accelerate sediment (tuffs) cracking, flaking and embedding of the overlaying sand into the tuffaceous clay;

4. Bioturbation was observed to have penetrated the geotextile and the tuffaceous surface. It is caused by the spreading of roots coming from both sides of the protected site, and is one of the most conspicuous damages that escapes control by reburying;

5. As a result of the above-mentioned bioturbation process, the second alteration type was detected in the form of insect tunneling, adding more impact to the potential integrity of the tuffaceous surface;

6. All these unexpected modifications position doubts to the scientific basis of the control protocols that were adopted in protecting the site, especially in light of taphonomic research, which clearly demonstrate the variability of conditions of similar lithological contexts when subjected to different chemical and physical processes irrespective of their spatial proximity;

7. Sediment compaction, the impact of the weight added to the footprints bearing tuffs by the addition of multiple layers and boulders, is hard to evaluate. Nobody knows what effect that has on the tuffs. Furthermore, chemical conditions that are locally generated by creating artificial sedimentation are also more difficult to assess;

8. Thin fractures which were also observed in some parts of the exposed tuff do pose some serious questions on the integrity of weight bearing on – and overburdening – the footprints tuff.

Conclusion and further recommendations

Consequently we may ask ourselves whether the conservation strategy of the Laetoli hominin footprints have indeed served Tanzania’s best interests in education and science for the general public. It has been argued that replicas of the hominin footprints together with documentation of the conservation project are showcased at the Olduvai Gorge Visitors Centre and in the National Museum in Dar es Salaam (Agnew and Demas, 1996). Pan intended, when one takes a critical look at those two exhibits, then we realize that the displays have been showcased not to promote science education in Tanzania but to popularize the conservation effort that was undertaken from 1996 to 1998. Here we argue, however, that the exhibit itself takes on a turn from a popular – and largely western – manifestation of Laetoli with a representation that heavily projects an abstract, harsh, remotely disembodied landscape. This particular and yet abstracted static Laetoli landscape, which has been vividly reproduced in the displays, remain largely unchallenged, appearing innocent and perhaps irrelevant to the contemporary northern Tanzania landscape and its people.

All the above-mentioned observations has led the geology and archaeology teams to conclude that a tight control of the soil chemistry, temperature, and water content is needed on a regular basis, not sporadically as it has been observed. Burial of the footprint trackway site exposes the tuffs to so many chemical, mechanical, and biological variables whose parameters are hard to control. Therefore, it is our conclusion that burying the footprints – even though well intended as a conservation strategy – does not guarantee the long-range survival of the footprints and the integrity of the site due to the following challenges:

a. Exposing the footprints (partial or complete) trail every 5 to 10 years for evaluation would require a large amount of resources;

b. Every time the footprints would be exposed to further unavoidable damage, and weathering will be imprinted on the tuff surface.

Based on the teams’ observations and the above-listed shortcomings, we believe that rebural is not only an expensive short-term solution, but does not guarantee the integrity of the footprints, because nature is stochastic and therefore hard to control when real-time monitoring is lacking. Two critical questions have to be asked: (a) can the hominin footprints be sustainably and scientifically conserved and monitored in real time at Laetoli?; and (b) what has to be done in order for such a project to not only take off but also be sustainable? These two questions are essential in that they require an assessment of both the current conservation status, management of the site, capital funds, and human resources needed for the project. Having weighed on the observations gathered in the field, the team recognized the enormity of this task and carefully recommended the following:

1. Construction of a climate-controlled museum seems to be the best solution contra to reburying the footprints because it guarantees a real-time monitoring of the site. It also opens the window to sustainable use of this site to improve the human living condition;

2. That, in order to do this, the exposure of the footprints can only be carried out after proper geological and conservation studies are conducted. So far no detailed geological survey showing the geochemical and geomorphological properties of the sedimentary sequences documented at the site exists;

3. That climatic-controlled data has to be collected on the physical and chemical properties of the sediments;

4. That all conservation measures successfully applied to other open footprints sites in other countries be taken into account to provide guidance for decision-making process;

5. That a proposed museum at Site G will be in harmony with the natural surroundings and the environments by offering a closed space where climatic and physical conditions can be monitored and modified as needed;

6. That available technologies (particularly infra-red geothermal sensors) used to monitor humidity and temperature using solar energy, in conjunction with well-trained museum personnel, will guarantee the proper monitoring of the footprints on a daily basis. This will leave faith out of the monitoring process, where sound data and appropriate observations will lead to best predictive models that will allow for re-evaluation of the process.

7. For these reasons we urge for the formation of a panel of experts in collaboration with museum curators, technicians and other properly-trained personnel appointed to oversee and monitor the exposure and exhibition of the footprints trail.

8. Education programmes should not only focus on the footprints conservation and human origins but also empower the communities surrounding the site in order to guarantee sustainability of the museum.

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Bibliography


Northern Africa

Fayum Depression, Egypt. © David L. Brill
Lower Palaeolithic settlements in the Maghreb: current state of knowledge and perspectives in the framework of the World Heritage Convention

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Introduction

The Maghreb refers to the area of North Africa that lies between 22°N on the Atlantic coast of Morocco to 22°E in the Libyan littoral. It was named by the Arab geographers Moghrab (‘westernmost island’). The present dominant physiographic feature in this part of the African continent is the Sahara. In this, the world’s largest desert, the landscape has been shaped over time by wind, creating one of the harshest environments on Earth, characterized by sheer slopes, shifting sand dunes, sand seas called ergs, barren stone plateaus, lifeless gravel valleys, seasonally inundated basins known as chotts and dayas, and sparse large-depression cases fed by springs. Hence, the Sahara with its current inhospitable habitat constitutes a sort of natural barrier impeding terrestrial movements of plants, animals and humans between sub-Saharan Africa and the northern part of the continent. Yet, palaeoenvironmental evidence indicates that the Sahara desert has undergone various climatic and environmental shifts since the Plio-Pleistocene with periods of substantially wetter conditions when the Sahara formed a corridor allowing free movements of early humans and fauna in both directions.

Such periods of favourable environmental conditions must have allowed early hominids to disperse from the tropical savannahs of Africa into the southern Mediterranean temperate regions. Indeed, recent studies have shown that there are a number of Lower Palaeolithic sites in the Maghreb that are sealed in a primary context, bearing witness to an earlier hominid settlement in this part of the African continent than was commonly assumed. For example, the site of Ain Hanech on the Algerian High Plateau preserves Oldowan occurrences that date back c. 1.78 Ma with Oldowan industry, truly similar to that documented in eastern Africa. Furthermore, the sites document a continuous archaeological record followed by discoveries of more ‘pebble tools’ at Mansourah near Constantine by Laplace-Jauretche (1956) and Sidi Zin (Boussofara, 1985). The sites reinvestigated include Ain Hanech, Tighennif and the Casablanca sequence. The main focus of the investigations at Ain Hanech was to resolve the questions relating to the dating of the site and the nature of the association of the fossil bones with the Oldowan stone tools (Sahnouni, 1998; Sahnouni and de Heinzelin, 1998; Sahnouni et al., 1996; 2002; 2004). The research at Tighennif focused primarily on sediments analyses, dating the site, and taphonomy of the faunal assemblages (Demy et al., 1987; Geraads et al., 1986). The revised work at Casablanca put more emphasis on the chronostratigraphic framework and its weaknesses

The chronostratigraphic framework and its weaknesses

The Maghrebian Lower and Middle Pleistocene deposits suffer from the absence of a precise chronological framework due to a lack of datable volcanic materials. Uranium-series, electron spin resonance (ESR) and optically stimulated luminescence (OSL) dates are most applicable only for late Middle and Upper Pleistocene deposits. As a result, the dating of the Lower Palaeolithic sites relies primarily on biochronology and inferred correlations of sea-level sequences between the Atlantic coastal sites and the Mediterranean deposits. Indeed, the Casablanca coastal area offers the most extensive Pleistocene stratigraphic sequence, which exposes a series of fluctuating high and low sea levels interbedded with terrestrial sediments reflecting changes in climate. The sequence is used by geologists (Néouille and Rhioum, 1941; Choubert et al., 1956; Bibeiro, 1961a; 1971) as a chronostratigraphic framework for dating the prehistoric industries known from the region. It consists of a series of seven marine cycles, interbedded with six terrestrial episodes named after stratigraphic description of type-localities. The marine cycles include, from the oldest to the youngest, Maghrebien, Messouadien, Maanfien, Affarabet, Harounian, Oualdian and Mellihan. The terrestrial cycles are Moulouyan, Sefiane, Amairian, Tensifian, Pescoutian and Soltanian. The ‘pebble-culture’ or pre-Acheulean industries are dated to Moulouyan and Sefiane continental episodes, while the Acheulean spanned from the Amairian to Pescoutian (Bibeiro, 1971, p. 74). Although this chronostratigraphic system was defined for Atlantic Morocco, it became increasingly a classic scheme and a widespread Quaternary chronological framework for the entire Maghreb.

However, the validity of the Casablanca chronostratigraphic system was questioned by a number of researchers (Beaude, 1965; Texier et al., 1986; 1994). They argue that the system presents a number of weaknesses such as the ambiguity of the pluvial-ardiate alternate principle, the complexity of correlating the Moroccan climatic episodes with the European glaciations, and negligence of the role of the local Quaternary uplift and isostatic movements controlling the deposition of the successive episodes. Based on a lithostratigraphic approach, Texier et al. (1994) suggested an alternative chronological key for the Pleistocene sequence, incorporating four main formations. These formations include, from the oldest to the youngest, Ouald Hamida Formation, Anfa Formation, Kel el Haroun Formation and Dar Bouaza Formation (Lefèvre and Raynal, 2002; Texier et al., 2002). The Lower Palaeolithic sites, which consist basically of Acheulean occurrences, spanned from Ouald Hamida Formation to Kel el Haroun Formation, from c. 1 Ma to 163 Ka (Rhodes et al., 2006).

In the Sahara, the alternating erosion-sedimentation cycles, in the absence of any other chronological criteria such as preserved fauna and datable volcanic material, served as a guide to build up a chronological framework for the succession of the prehistoric industries of the Souara region in the north-western Sahara (Alimen, 1978; Chavalion, 1964). Six erosional and depositional cycles have been identified. The ‘pebble culture’ is correlated with the Mazzerian episode (Early Pleistocene), and the Acheulean with the Taouritian and Ougartian episodes (Middle Pleistocene).
The Oldowan tradition

The earliest lithic artefacts attributed to Mode I that are presently known are in Eastern Africa and are dated roughly between 2.6 Ma and 1.5 Ma. Major sites include EG10, EG12 and OGG7, Gona, Ethiopia (Semaw et al., 1997, 2003); Lokalalei, West Turkana, Kenya (Roche et al., 2003); Kobb Fara, East Turkana (Isaac, 1997); Olduvai Gorge, United Republic of Tanzania (Leakey, 1971, 1975); Melka Kunture, Ethiopia (Chavaillon and Piperno, 2004). South African sites that yielded Mode I artefacts include Sterkfontein (Kuman et al., 2005) and Swartkrans (Clark, 1993). These artefacts are generally assigned to the Oldowan Industrial Complex, named for Olduvai Gorge in northern Tanzania. The Oldowan technology is simple but required mastering by early hominins of some fundamental stone-flaking techniques. The Oldowan assemblages incorporate cores and core-tools (choppers, polyhedrons, subpolyhedrons, spheroids),debitage, and less-frequent retouched pieces as well. Similar assemblages are known from the earliest archaeological sites in the Maghreb, including Ain Hanech. These assemblages were generally referred to as ‘pebble culture’ and sometimes as pre-Acheulean.

Figure 1 shows the sites yielding ‘pre-Acheulean’ assemblages, most of which are located in Morocco and Algeria. Outwith these countries, only a single bifacially-flaked core-chopper, encountered within a sandy-clay deposit, has been reported in Tunisia (Grogueb and Ouedlati, 1990). In Atlantic Morocco, Mode I assemblages recovered from investigated sites in the vicinities of Casablanca allowed Biberson (1961b) to construct a typological chronological sequence showing the evolution of the pre-Acheulean industry over time. He divided the pre-Acheulean (previously labelled ‘pebble-culture’) into four successive stages. Stage I includes the oldest artefacts from simple technological gestures (unidirectional). Stage II incorporates ‘pebble tools’ characterized by bidirectional flaking. In Stage III the multidirectional technique appears where the artefacts are considered to be more evolved. The last stage (IV) is characterized by the emergence of the first Acheulean tools. Stages I and II constitute the ‘Ancient Pre-Acheulean’ while Stages III and IV depict ‘Evolved Pre-Acheulean’ forms (Biberson, 1976). However, Raynal and Texier (1989) and Raynal et al. (1990, 2004) revised Biberson’s stratigraphic sequence casting doubts on the antiquity of his ‘pre-Acheulean’. They claim that the ‘pebble culture’ assemblages are either surface finds, reworked materials, from polycyclic colluviums, or even pseudo-artefacts generated by high-energy deposits. The authors concluded that the earliest human occupation in Morocco is Acheulean estimated to a maximum of 1 Ma (Raynal et al., 1989; 2002).

Located on the edge of the eastern Algerian High Plateau, the site of Ain Hanech contains the oldest North African archaeological occurrences. Ain Hanech was discovered by Arambourg (1970; 1979) and yielded a Plio-Pleistocene fauna associated with Oldowan artefacts. Since 1992–93 this major site is subject to systematic investigations (Sahnouni, 1998; Sahnouni and de Heinzelin, 1998; Sahnouni et al., 2002, 2004). Ain Hanech is not a single site but rather a Plio-Pleistocene site complex with several palaeontological and archaeological localities, including Ain Bouchent, Ain Hanech and El-Kherba. Ain Bouchent is a palaeontological locality and the oldest in the region, and it is situated stratigraphically 13 m below Ain Hanech. It has yielded a Late Pliocene fauna (Sahnouni et al., 1998, 2003). Ain Hanech is located near a small local cemetery. El-Kherba is a newly discovered Oldowan locality in the immediate vicinity south of Ain Hanech. Preliminary palaeomagnetic and biochronological evidence indicates that both localities are estimated to date c. 1.77 Ma.

Major excavations were undertaken mainly at Ain Hanech and El-Kherba yielding rich archaeological assemblages. The remains are contained in three distinct levels (A, B and C) sealed in a fine sedimentary matrix, indicating burial in a floodplain deposit, with a low-velocity regime, and that minimal site reworking might have occurred. Fossil bones are well preserved overall, except for a few that underwent some minor post-depositional alteration. They show neither a strongly preferred orientation nor high inclination. The stone artefacts are fresh with an overwhelming amount of debitage present.

The archaeological assemblages consist of Oldowan artefacts associated with fossil animal bones. The fossil fauna is savannah-like and comprises proboscideans (Anancus, Elephas magrebensis); equids (Hipparion libycum, Equus), rhino (Ceratotherium mauritanicum); hippo (Hippopotamus), said (Kolpochoerus heseloni); giraffids (Sivatherium mauserum, Giraffa camelopardalis); bovid (Pelorus hovelli), Gazella perrinii, Oryx edouali), ‘Alcelaphus’, ‘Hippotragus’, ‘Hippotragus’, ‘Hippotragus’, ‘Hippotragus’), carnivores (cf. Vulpes, Lycaon, Crocuta crocuta); Mauremys, Crocodylia and Lagomorpha. Some of the taxa, which were unknown previously from the site, point to its great antiquity, particularly Anancus, ‘Dicerorhinus-like’ rhino, Kolpochoerus, Equus numidicus and Pelorovis (Sahnouni and van der Made, 2006; Hadijous and Sahnouni, 2006). Made primarily from limestone and flint, the lithic assemblages incorporate a full range of Oldowan artefact categories, including cores, unifacial and bifacial choppers, polyhedrons, subpolyhedrons, spheroids, whole flakes and retouched pieces (chipped scrapers and denticulates) (Figure 2). Several simple flakes and retouched pieces were used to cut meat as evidenced by the presence of meat polishes on their edges. The lithic artefacts from Ain Hanech and El-Kherba are very similar to those known from Olduvai upper Bed I and lower Bed II, especially in terms of flaking patterns and resultant artefact forms (Sahnouni, 2006b).

The Oldowan site of Ain Hanech may be viewed as a spot for short-term occupations by early hominids. The site was near a shallow river embankment, where raw materials were accessible from nearby river beds, and with plenty of game for acquiring meat. The technology used by Ain Hanech hominids is simple (Mode I technology), expedient and characterized by a low degree of standardization. There is no evidence for long-distance raw material transport. The industry is primarily composed of core-tools(choppers, flakes, fragments and occasional retouched pieces that are the main characteristics of early stone artefact assemblages assigned to the Oldowan. Bones belonging to different animal taxa such as equids, large and small bovids, hippo and elephant were recovered in association with the lithic artefacts. One taxon, equids, appears to dominate the faunal assemblages. Whole flakes and retouched pieces were used to process soft animal tissue, suggesting that meat was a major component of early hominid diet in North Africa. An in-depth study is under way for documenting subsistence patterns, the strategy employed for meat acquisition and breaking bones for marrow.
Monts Tessala

Another potentially important Oldowan site is Monts Tessala in north-western Algeria where the localities of Douar Kailia near Ouend’Tilat and Douar El Ouennene near Sig have yielded in situ Oldowan artefacts (Thomas, 1973). These localities are situated at the limits of the sub-valleys and the southern Tell (Tessala and Ouad Ali Mounts) of the Oran region. Stratigraphically, the artefacts were contained in a detrital deposit sometimes comprising heterometric gravels wrapped in a clear sandy or silt matrix. The deposit, sealed by a palaeosol, was correlated with the Salebriean pluvial cycle dated to the Lower Pleistocene. The lithic assemblages totalling 237 pieces included 48 artefacts recovered from Kailia and 187 from El Ouennene. The artefacts were fresh and made primarily from limestone (97 per cent) and Jurassic or Cretaceous sandstone. The assemblages comprised unifacial and bifacial choppers (8.51 per cent); polyhedrons and/or cores (14.04 per cent); whole flakes (69.78 per cent); retouched flakes (2.55 per cent); and split cobbles (5.1 per cent) (Figure 3a). Based on Biberon’s classification system, the industry is assigned to the ‘pebble culture’ Stages III or IV.

Oldowan-like artefacts from the Sahara

Oldowan-like artefacts have also been found in at least four localities in the vast Algerian Saharan landmass. These include Aoulef (Hugot, 1955), Reggan (Ramendo, 1963), Saoura region (Alimen and Chavaillon, 1962) and Bordj Tan Kena (Heddouche, 1980). While the specimens from Aoulef and Reggan are surface collections, those from the Saoura region and Bordj Tan Kena were excavated in situ. At this latter site (8°20’ E, 26°32’ N), Heddouche (1981–82, 1982–83) has excavated 154 ‘pebble tools’ (Figure 3b) from a Glacis type deposit. However, not a single flake was reported associated with the flaked cobbles, which raises the issue of site integrity. The assemblage incorporates unifacial and bifacial choppers, discoids, a partial biface and a trihedral pick made from quartzite. Because of the abundance of bifacial choppers, Heddouche (1982–83) assigned the industry to the later stages of the Evolved Pre-Acheulean of Biberon’s classification system.

The Aoulef and Reggan collections comprise 90 and 321 specimens respectively. The artefacts include a range of types: unifacial, bifacial, multifacially flaked pebbles, discoids, and whole flakes made from variable raw materials (quartz, quartzite, sandstone, flint, fossil wood and other eruptive rocks) (Figure 4). Interestingly, the surface collection from Reggan includes a flake that refits nicely with a bifacially-flaked chopper made from quartzite (Figure 4a) (Ramendo, 1964). If the flake was not removed as a result of post-depositional processes, these conjoined pieces suggest that the assemblage may not have been heavily disturbed by natural agencies.

In the Saoura region, Alimen and Chavaillon (1962) collected 110 ‘pebble tools’ in situ from several localities contained in alluvial and lacustrine deposits dated to the Mazarian pluvial cycle (= Lower Pleistocene). Made primarily from quartzite and quartz; the ‘pebble tools’ include split pebbles, and unifacial and bifacial choppers with an alternate flaking reduction (Figure 4c–f). Sediments and pollen analyses indicate that the climate was fairly humid during the Mazarian episode (Alimen, 1981).

The Acheulean

The Acheulean is much better represented than the Oldowan. There are numerous sites distributed all across the Maghreb and the Sahara showing remarkable technological development over time. The major sites are in Atlantic Morocco, on the High Plateaus and in the Sahara.

The Acheulean of Atlantic Morocco

A very informative Acheulean sequence is remarkably represented in the Casablanca area. The sequence was first explored by Neuville and Ruhlman (1941), extensively studied by Biberon (1961b), and recently revisited by French researchers (Raynal and Texier, 1989; Raynal et al., 2002). These studies showed the long development of the Acheulean tradition over time in the Atlantic Morocco. While the broader lines of the sequence from previous studies remain unchanged, the recent revised work especially enhanced the chronological framework using a range of dating means and techniques, such as magneto-stratigraphy, biochronology, OSL and ESR.

Beginning with the Lower Acheulean at the Thomas Quarry 1 Level 1, the sequence spans c. 1.0 Ma to 163 Ka. According to Raynal et al. (2002), Thomas Quarry 1L represents the oldest human occupation in the Atlantic Morocco. Composed of two stratigraphic units (U1 and LS), this cave site yielded typical Acheulean artefacts associated with a small faunal assemblage. The faunal assemblage included a few diagnostic elements: Loxodonta atlantica, Equus mauritanicus, Gazella atlantica and Lelwel’s antelope. Oldowan artefacts (Thomas, 1973) and Acheulean artefacts (Thomas, 1973) were obtained from boulder cores. Other artefacts include unifacial and bifacial choppers, polyhedrons and spheroids, as well as a few denticulates.

Oldowan artefacts from: (A) Monts Tessala sites, Algeria (redrawn after Biberson, 1967); (B) Bordj Tan Kena (redrawn after Heddouche, 1981–82). Note that both sites include proto-bifaces.

Oldowan artefacts from Saharan sites in Algeria (redrawn after Biberson, 1967), including a–d: choppers from Reggan; e: from Aoulef; f: from Mazzer.

Early Acheulean artefacts from: (A) Thomas Quarry 1 Level 1, Morocco, (1–2: picks, 3–4: bifaces) (redrawn after Raynal et al., 2002); and (B) Tighennif (formerly Ternifine, Algeria (5–6: picks, 7–8: bifaces) (redrawn after Balout et al., 1967).
The Middle Acheulean is illustrated at Rhinoceros Cave and Thomas Quarry Hornind Cave. ESR dating at Rhinoceros Cave made on rhino tooth enamel shows a wide range of dates. For example, first calculated ages gave 279±49 Ka for early uptake and 476±75 Ka for linear uptake (Rhodes et al., 1994). The recalculated ages are considerably older than those just published due to the revised sediment gamma dose rate value at the site. The new dates are 435±65 Ka for early uptake and 735±129 Ka for linear uptake (Rhodes et al., 2006). The excavations at Rhinoceros Cave have yielded a faunal assemblage in which white rhino remains are abundant suggesting ‘specialized hunting’ by hominids (Raynal et al., 2002, p. 69). The associated lithic assemblage is characterized by an increase of discoid cores, flakes, rare cleavers and large ‘bi-facial’ pieces. Thomas Quarry Hornind Cave has yielded hornind remains, fauna, and artefacts deposited in secondary context with materials from outside washed into the cave (Raynal et al., 2004). The bifaces are rare, and carnivores are responsible for collecting much of the faunal remains. With similar composition of artefacts to Rhinoceros Cave and Thomas Quarry Hornind Cave, the Sidi Al Khadi-Heluai Quary, ST1C quarry, Bears Cave, Uttornes Cave and Cap Chatelier sites are also assigned to the Middle Acheulean.

The Middle Acheulean in the Casablanca area is the main site representing the Upper Acheulean. The OSL estimated age is 376±34 Ka (Raynal et al., 2002, p. 71). The assemblage is characterized particularly by predetermined flake productions, thin small bifaces made on large flakes, and rare cleavers.

The Acheulean on the High Plateaux

The Acheulean is known from a number of localities across the High Plateaux in Algeria, including Tighennif, Kef Sefiane, Errayeh, Lac Karar and Sidi Zin in Tunisia.

Tighennif

Situated in north-western Algeria, Tighennif (formerly Tellmine or Paikae) is among the most significant Acheulean sites not only for North Africa but also for the entire Old World. The site was discovered in the nineteenth century in the course of sand quarry exploitation, where vertebrate fossil bones and lithic artefacts were collected. Subsequent sporadic investigations by Pomel and Pallary showed the importance of the site. Between 1954 and 1956 Arambourg carried out large-scale excavations that led to the discovery of the oldest North African hominid remains associated with a rich fauna and very informative Acheulean lithic assemblage (Arambourg and Hoffstetter, 1963). The fauna by and large belongs to the base of the Middle Pleistocene. A revised list includes particularly Loxodonta atlantica, Ceratotherium simum, Equus mauretanicus, Metridiochoerus compactus, Giraffa cf. pomelii, Oryx cf. gazella, Chacmaebates, Crocuta crocuta, Theropithecus cf. oswaldi, Homo erectus and three forms of gazelle (Geraads et al., 1986).

The lithic assemblage comprises Oldowan and Acheulean artefacts, including choppers, polyhedrons, trihedrons, bifaces (Figure 5b 5–8), cleavers, cores, retouched pieces, large and small flakes, and fragments. The artefacts are made from quartzite, sandstone, limestone and flint. The industry is assigned to the Lower Acheulean based on the use of hard hammer percussion and proportions of ‘pebble-tools’ (c.50 per cent), bifaces and bifaces with cortex base (c.29 per cent), and ‘proto-cleavers’ (c.65 per cent) (Balout et al., 1967). Djermali (1985) considered the small flint flakes (10 per cent of which are retouched) as a chronologically separate lithic assemblage but there is no stratigraphic proof of this. The technology employed is particularly sophisticated, suggesting a higher level of hominid skill and intelligence. In addition to a fairly materialized symmetry on this bifaces and the successful production of large cutting tools, the hominids used a novel flaking technique called Kombewa. The Kombewa technique involves manufacturing flakes with dual ventral faces, providing the hominids with the advantage of shaping cleavers with a convex edge and large scrapers (Balout, 1967, pp. 728–29; Dauvois, 1981).

In spite of the additional research carried out at Tighennif, its age still remains uncertain. For example, palaeomagnetic studies made on the lower deposits indicated ‘probably’ a normal polarity, which is correlated with the Brunhes Chron (c. 0.8 Ma) (Geraads et al., 1986), yet the Jar-ramilho Subchron could not be ruled out. Biochronologically, the fauna contrasts sharply with that of Ain Hanech. The similarities between the two sites are limited to a few taxa that persisted throughout the Pleistocene, i.e. rhino, hippo and hyena. In contrast, the taxa that are biochronologically older are found only at Ain Hanech and not at Tighennif (e.g. elephant, equids, suids, giraffids and gazelles). Given the great faunal turnover between the two sites, a late Lower Pleistocene age for Tighennif is plausible. In fact, both the macro-mammals and the lithic assemblage are very similar to that of Thomas Quarry 1 level L whose age is estimated as c. 989 Ka (Rhodes et al., 2000), see above. Nonetheless, re-dating the site of Tighennif is totally warranted.

Based on taphonomic evidence, it can be inferred that Tighennif hominids carried out their activities near a lake. The site has been minimally disturbed as judged from the very low density of archaeological materials recovered at the site (0.8 items/m3) (Geraads et al., 1986), as well as by hominid involvement in the accumulation of the faunal remains (Dennys et al., 1984). Evidence of cutmarks left on hippo and antelope bones suggests that the hominids hunted or scavenged animal carcasses falling on the lake banks (Dennys et al., 1984, p. 486) and processed them with their tools. However, the most notable activity at Tighennif is the hominid manufacture of bone tools. A small equal metrical bone, found during the latest excavations, exhibits an intentional retouch on its distal part forming an abrupt point (Dennys et al., 1984, plate 1). A similar retouched metacarpal from the Middle and Upper Bed II at Olduvai Gorge also attests to an early use of bone tools (Leakey, 1971, plates 36, 40).

Kef Sefiane and Errayeh

Kef Sefiane and Errayeh are two newly discovered Acheulean sites in Algeria. Kef Sefiane is situated in the north-eastern High Plateau, and consists of three main Acheulean horizons noticeably separated by travertine deposits. Limited test trenches have yielded a total of fifty-one artefacts made from limestone, most of which are bifaces. Other artefacts include choppers, cleavers and spheroids. Using Bordes’ typology, Amara (1981) concluded that the horizons represent three stages of a local development of the Acheulean tradition: Lower Acheulean, Middle Acheulean and Upper Acheulean. Yet, no fauna or debris elements were recovered due to their presumed chemical dissolution which would have been active in the travertine formations (Amara, 1981, p. 147).

Errayeh is located 45 km west of Tighennif on the western High Plateaux. It is situated on both sides of the Boughaara ravine, cut by different phases of the guility active in the region. There are two archaeological levels separated by a sterile consolidated reddish sand deposit (Derradji, 2003; 2006). The lower level yielded a typical Acheulean industry contained in a gravel and sandy matrix. The assemblage incorporated choppers, polyhedrons, simple cores, cleavers, bifaces, as well as large and small flakes made from quartzite, sandstone and flint. The industry is very similar to that of Tighennif in terms of both raw material use and techno-typological characteristics. Regrettably, unlike Tighennif, there is no fauna associated with the lithic assemblage.

Lac Karar and Sidi Zin

Lac Karar was discovered by Gentil in 1894 north of Tlemcen city in north-western Algeria. This site presents some similarity with Tighennif at least with regard to its location on an artesian spring. Boule (1900) studied the fauna and associated artefacts. The fauna includes Loxodonta atlantica, Equus mauretanicus, Ceratotherium simum, Hippopotamus amphibius, Sus scrofa, Cervus, Alcelaphus, Connochaetes gnou, Ovis sp. and Hemiaucasus antiquus. The artefacts, assigned to the Upper Acheulean, comprise lanclaceolate and coniform bifaces, cleavers, as well as large and small flakes. Balout (1955) argued that the Lac Karar occurrences are heterogeneous and they may incorporate a mixture of different prehistoric cultures. Thomas (1977) considered the site to be slightly older (>200 Ka) than Tchadiane.

The site of Sidi Zin near Kef in north-western Tunisia has been studied by Gobert (1950). It consists of a sequence of three archaeological levels sealed by a tuff deposit. The lower and middle levels yielded Acheulean assemblages dominated by lanceolate and coniform bifaces (Figure 6 1–2). The upper level is rich in unfacial points and cleavers. In the tuff stratum the Acheulean disappears entirely and it was replaced by a Middle...
The Sahara is rich in Palaeolithic resources and an enormous amount of material was collected during the nineteenth-century colonial explorations by the French military. Subsequent scientific expeditions have also shown the overwhelming presence of the Acheulean in much of the Sahara. The major sites include Tihodaine in the Central Sahara, in Algeria (Arambourg, 1948; Arambourg and Balout, 1955; Reygasse, 1935), Saoura in the north-western Sahara, in Algeria (Chavaillon, 1964; Alimen, 1978) and Draa Valley in southern Morocco (Biberson, 1954, 1985; Nocain, 2000). Tihodaine is among the most important sites in the Sahara, yielding an abundant Acheulean industry associated with mammalian fauna. The site is situated north-east of the Ahaggar area bordering the Tassil n’Ajer plateau in Algeria. It consists of four localities (Tihodaine I, II, III and IV) spanning from the Lower Palaeolithic to the Neolithic. The Acheulean site (Tihodaine I) was discovered in 1861 and had been investigated primarily by Arambourg (1948), Arambourg and Balout (1955) and Thomas (1977). The Acheulean deposits consist of residual buttes partially covered by dune sands of the current erg. The Acheulean artefacts and associated fauna were contained in lacustrine sediments with diatomite and a high proportion of kaolinite deposited during the first lacustrine episode of the formation of the lake. Thomas (1977) correlated the site with the middle level of Sidi Zin, and estimated its age to at least 250 Ka. The fauna of Ethiopian type is a mixture of relic taxa such as Elephas, Equus, Mesochoerus, Ceratherium, Connochaetes, Taurotragus and Atelopus; and Sahel-Sudanese taxa such as Gazella and Oryx. There is no precise account of the bifaces and cleavers (Figure 7) collected from surface from the earlier expeditions. However, Oussedik (1972) analysed 300 complete bifaces, which are primarily ovate and cordiform, as well as numerous bifaces that are finer and thinner compared with those known from Tighenfin.

The north-western Sahara has a long Acheulean sequence, especially at the two sites of Saoura and Tabibabala-Tarchenhit. Chavaillon (1964) and Alimen (1978) undertook a comprehensive study of the Pleistocene deposits of the region and showed a developmental sequence of the local Acheulean tradition. The lithic assemblages, made up of local metamorphic rocks, occur in gravel terraces and in fine- and coarse-grained sediments. The sequence consists of seven stages grouped into three major periods. The earliest period (Stages I and II) is correlated to the sedimentary Taouritian cycle, and is characterized by over 50 per cent ‘pebble tools’, crude trihedrons, rare bifaces, nucleus and flakes. The second period (Stages III, IV and V), rich in Acheulean assemblages, is dated to the Ougartian depositional period. In this period, the ‘pebble tools’ form only 16 per cent and the bifaces were produced using the soft hammer-stone. Cleavers are numerous, and Levantian flakes are already present making up to 24 per cent of the total flakes. There are also assorted types of nucleus (Kombewa, West Victoria, Levantos). The third period (Stage VI and onwards) is correlated with the Final Ougartian cycle. In this period, finely made bifaces and cleavers predominate the assemblages followed by retouched flakes which were mainly scrapers. ‘Pebble tools’ become rare at this stage.

In southern Morocco, Antoine and Biberson (1954) and Biberson (1965) explored the Tarfaya basin and Wadi Draa, respectively. Biberson (1965) outlined the development of the Acheulean in the region based on surface materials collected primarily from dismantled terraces. Based on an in-depth technological and typological analysis, Nocain (2000) concluded that the Acheulean in Tarfaya is characterized by the preponderance of the Levantos technique and tools on flakes with few bifaces and cleavers.

**Development of the Acheulean**

The oldest Acheulean occurrences are recorded in East Africa and are dated to around 1.65-1.60 Ma at Konso Gardula (Ethiopia) and West Turkana (Kenya) (Beyene, 2004, Roche et al., 2003). By this time new technological innovations appear in the archaological record, such as bifaces, picks and cleavers often made from boulder cores. The major Acheulean sites in East Africa are Kökilesale 4 (KSI) in Western Turkana (Roche et al., 2003), Kosmo Gardula (Afawa et al., 1992; Beyene, 2004), Olduvai (Bed II and IV, Leakey and Roe, 1994), Peninj (Isaac, 1975; Isaac and Curtis, 1974), Melka Kunture (Chavaillon and Piperno, 2004), East Turkana (Isaac and Harris, 1978), and Sterkfontein (Kuman et al., 2005). Technologically, the Acheulean bifaces are the result of the conceptual development from bifacial choppers (Biberson, 1967; Sahnouni, 1987, p. 178), and it is not surprising that at Olduvai the developed Oldowdan with bifaces and the Acheulean overlapped (Leakey and Roe, 1994). Even though it lasted for approximately 1.5 Ma, trends are weak in the Acheulean to the extent that it is hard to date Acheulean assemblages on typological and technological grounds (Klein, 1999). Nevertheless, late Acheulean assemblages, particularly bifaces and cleavers (c. 250 Ka) can straightforwardly be discerned from earlier ones. In contrast to the early Acheulean, the late Acheulean assemblages incorporate remarkably symmetrical and thinner bifaces, well-made cleavers, as well as predetermined techniques for standardized flake productions.

Unlike East Africa, there is no record of chronological transition from the Oldowdan to the Acheulean in the Maghreb. Here, whereas the Oldowdan is dated to c. 1.78 Ma (e.g. Ain Hanech and El-Kherba), the oldest securely dated Acheulean is only dated to around 1.0 Ma, for example Thomas Quarry Unit 1 Land possibly Tighenfin. Thus, there is a huge chronological hiatus between the Oldowdan and Acheulean in this part of the African continent probably due to either the lack of systematic fieldwork or the preseriation of transitional sites. There are three sites with potentially early Acheulean occurrences, including the Ain Hanech upper level deposits, Monts Tessa la and Bordj Tan Kena. At Ain Hanech, crude bifaces and large flakes are found in coarse sediments located 6 m above the Oldowdan horizons (Sahnouni, 1998). The pre-Acheulean assemblages from Monts Tessa la (Thomas, 1973) and Bordj Tan Kena (Heddouche, 1981–82) have a very small frequency of proto-bifaces and crude bifaces. On typological grounds, these assemblages can be characterized as early Acheulean. Regrettably, although they are stratigraphically in situ, none of these assemblages can be securely dated.

The North African Acheulean tradition has been divided into several phases reflecting stages of development over time in order to date the Acheulean assemblages. The proposed stages include:

- four stages (II, III, IV and IV) for the Maghreb (Balout, 1955);
- three stages for the Atlantic Morocco (lower, middle and upper) (Raynal et al., 2002);

These subdivisions are often based upon frequencies of ‘pebble tools’ versus bifaces/cleavers, higher frequency of cores and Levantos index (Alimen, 1978); presence of bifaces with cortical base (made from cobbles and pebbles) (Biberson, 1961b), size and morphological changes of bifaces (e.g. from triangular to cordiform to ovate) and use of soft hammer-stone (Balout et al., 1967; Tixier, 1958–59); and technological sophistication of manufacturing cleavers (Tixier, 1957). However, as stressed by several Palaeolithic archaeologists, time trends in the Acheulean are not strong, and thus not appropriate for dating the Acheulean assemblages (e.g. Klein, 1999). With regard to the Acheulean of the Maghreb, the Middle Acheulean stage is not clearly defined. For example, Sidi Al Khadir-Helasou Quarry and Bears Cave sites are considered Middle Acheulean in spite of the absence of bifaces in the former and the heavy marine disturbance of the remains in the latter (Raynal et al., 2002, p. 71).

The frequency of artefacts such as ‘pebble tools’ versus bifaces and flake industry are often based on assemblages lacking integrity due to their secondary geological context. Moreover, shape of bifaces may have been impacted by the quality of raw materials used.

In my opinion, only the early and late Acheulean stages can be obviously characterized in the Maghreb. The early Acheulean is remarkably well represented at the sites of Thomas Quarry 1 Level L, Tighenfin and Enayat, and in north-western Sahara. In addition to typical Oldowdan tools including core/choppers, the early Acheulean assemblages contain a large number of bifaces, trihedrons, cleavers, discoid cores and flakes produced using hard hammer stone. Sometimes, the Oldowdan
Hominid association

All the hominids discovered so far in the Maghreb are associated with the Acheulean activities (Table 1). They are known from Tighennif (Algeria) and from several Moroccan sites. The Tighennif hominids include three mandibles (Figure 9), a fragment of a parietal and isolated teeth (two incisors, a canine, two premolars and four molars) (Arambourg, 1955; 1956; Arambourg and Hofstetter, 1963). The age of Tighennif is estimated at c. 0.8 Ma (Geraads et al., 1986). The only post-cranial remains known in the region comes from Ain Maarouf near El Hodjeb, Morocco. It is a left femoral shaft displaying both H. erectus and archaic H. sapiens features (Hublin, 1992). Based on fauna, Ain Maarouf is believed to be older than Thomas Quarry 1 and slightly younger than Tighennif (Geraads et al., 1992; Geraads, 2002). At the adjacent cave sites of Hominid level of Thomas Quarry 1 and Oulad Hamida 1 (formerly Thomas Quarry 3) fragmentary remains have been collected. These include an incomplete mandible (Errouchi, 1969) and three teeth (Raynal et al., 2002) at Thomas Quarry 1; and a cranial piece with part of the face, a right frontal, temporal and isolated teeth (two canines, four premolars and two molars) (Errouchi, 1972). The Sidi Abderrahman Litorines cave yielded two mandibular fragments consisting of a posterior part of the right mandibular corpus with three molars, and a left post-symphalveal part with P3. The two mandibular parts do not articulate but apparently belong to the same individual (Arambourg and Bibrion, 1956). The Litorines cave sequence is believed to be contemporaneous with Isotope Stage 11 (c. 400 Ka) (Raynal et al., 2002). At Salé, workers exploiting quarries on the Atlantic coast recovered a quasi-complete calvarium (Figure 9) associated with a fragment of the upper left maxilla (O2-N2), and a natural endocranial cast (Jaeger, 1975). The calvarium was found isolated but appears to come from an ilionite deposit corresponding to the late Dugarian climatic cycle from the North-western Sahara, especially Tabaebala-Tachenghit. The density of the Oldowan-type artefacts is less, and the typical Acheulean specimens are generally thin and finely made. The bifaces display particularly a well-designed symmetry, and are usually ovate, lanceolate and coordiform. Likewise, the cleavers show a high degree of refinement and generally outnumber the hand-axes. Of particular interest are the cleavers from Tabaebala-Tachenghit (Figure 6) manufactured using a novel technique of core preparation and flake detachment. As described by Tiéssier (1957), the method entailed predetermining the shape of the cleaver before knocking it off the boulder core. © CNRPAH, Algeria.


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<td>Tighennif (ex. Temfireine, Algeria)</td>
<td>0.8 Ma?(1)</td>
<td>Arambourg (1955, 1956) Arambourg and Hofstetter (1963)</td>
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<td>Ain Maarouf (Morocco)</td>
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<td>A cranial remain with part of the face, frontal and temporal bone, and several upper teeth</td>
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<td>A quasi-complete calvarium and fragment of upper left maxilla (O2-N2), natural endocranial</td>
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As a whole, the hominids of the Maghreb appear to form two groups that are chronologically and morphologically distinct. The first group is older, encompassing hominids from Tighennif, Ain Maarouf, Hominid level of Thomas Quarry 1 (Th1-G), and Oulad Hamida 1-Homo erectus cave (OH1-HEC) (formerly Thomas Quarry 3). The second group is slightly younger and comprises hominids from Sidi Abderrahman, Salé and Kebitat. Taxonomically, the Tighennif and the Sidi Abderrahman hominids are closely related to Asian Homo erectus, but they cannot be identified precisely to this group. Because of this variation, Arambourg considered them as a local geographic subspecies *Atlanthropus mauretanicus* (= H. erectus mauretanicus) (Arambourg, 1954; 1955; 1956; 1957; Arambourg and Bibrion, 1956; Arambourg and Hostetter, 1963). The Thomas Quarry (Errouchi, 1969; 1972) and Kebitat (Saban, 1977) hominid specimens are assigned to H. erectus. The like the Ain Maarouf femoral shaft (Hublin, 1982), the Salé specimen, with small cranial capacity, displays a mosaic of archaic and progressive features. Thus, it is regarded by Jaeger (1975) more as H. erectus and by Hublin (1985) as H. sapiens retaining H. erectus characteristics.

Recently, palaeoanthropologists have attempted to make a taxonomic separation between early African H. erectus (= H. ergaster) dated to 1.9–1.1 Ma and their Asian counterparts, arguing that the latter possess several autapomorphic features that are not found in the former. Klein (1999) considers even later African H. erectus (until 0.6 Ma), such as Tighennif hominids, as H. ergaster. He argues that H. erectus developed exclusively in Asia whereas H. ergaster persisted in Africa until the emergence of *H. sapiens*. Whatever the adopted...
taxonomy of the Maghreb hominid fossils, the consensus of most authorities is that they probably represent an endemic stock from which the local H. sapiens developed, for example human fossils from Djebel Irhoud, Temara, Dar Esiiltan and Tangier.

Subsistence patterns

Only limited information on early hominid subsistence in the Lower Palaeolithic of the Maghreb is available, which is based on study of microwear on lithic artefacts and fossil bone modification patterns. The evidence from both studies indicates that early hominids processed primarily meat with their lithic tools. For example, microwear analyses carried out on a selection of Ain Hanech artefacts made from flint show that both simple flakes and retouched pieces were utilized for meat cutting (Figure 10) (Sahnouni and de Heinzelin, 1998; Verges Bosch, 2002). An ongoing study of Ain Hanech faunal remains points to the presence of bones with hominid-inflicted butchery marks and carnivore-inflicted tooth marks, suggesting possible competition with carnivores for early access to animal carcasses.

Evidence of Acheulean hominid butchering marks is present on antelope and hippo pelvic bone fragments from the Acheulean site of Tighennif. The antelope remains were probably broken as a result of marrow extraction. The hippo bone fragment bears a clear-cutmark made for cutting the oblique internal muscle of the abdomen (Denys et al., 1984). Wood-working and bone-scraping polishes are evident on several Acheulean artefact edges (quartzite and sandstone) from Thomas Quarry I and II sites (Beucher and Roche, 1982). These include two choppers, a polyhedron, a flake and a denticulate (from Thomas Quarry 1); and two bifacial choppers and two flakes (from Thomas Quarry 3 [currently Ouled Hamida]).

Palaeoecological settings

Only a few palaeoenvironmental and palaeoclimatic reconstructions are known to be associated with Lower Palaeolithic sites in the Maghreb. The available information is mainly derived from research recently undertaken on some sites, and the reconstruction attempts were inferred from stratigraphy, fauna, carbon isotope ratios and pollen. At the Oldowan sites of Ain Hanech and El-Kherba, sedimentological evidence indicates an alluvial floodplain setting possibly traversed by a meandering channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel. The fauna suggests an open and arid landscape, inferred from the presence of more hypsodont bovines, an increase in the abundance of equids, and the disappearance of the gazelle channel.
Perspectives in the framework of the World Heritage Convention

As is clearly shown throughout this chapter, the Maghreb has a wealth of Lower Palaeolithic sites that are significant not only for the fields of palaeoanthropology and prehistory but also for the world archaeological heritage. Of these sites, the Ain Hanech/Ain Bouzherif sequence and Tighennif (formerly Ternifine) in Algeria, and the Casablanca sites in Morocco, are particularly relevant for documenting the history of humanity in North Africa. For example, the site of Ain Hanech preserves the oldest archaeological occurrences in North Africa (c. 1.8 Ma) that consist of Oldowan stone artefact assemblages associated with a Plio-Pleistocene fauna of biochronological and palaeoecological interest. Many of the fossil bones bear evidence of hominid-inflicted butchery marks reflecting patterns of subsistence acquisition by early humans and their interaction with the animal biomass. Further, Ain Hanech records an environmental and climatic change, which seemingly impacted on hominid foraging activities. The site of Tighennif is important for yielding the oldest human remains in North Africa pertaining to Homo ergaster/erectus dated to 0.8 Ma. The hominid remains are associated with a well-defined technological and morphological tradition of a sauvage-like fauna with direct implications on the palaeoecology of the region, as well as on hominid adaptation and behavioural patterns. The Casablanca sites are equally pertinent and consist of a long Acheulean sequence displaying nearly a million years of lithic technological development and changing patterns of hominid ways of life. In addition, the Casablanca sites have yielded a series of hominids of different ages and morphologies, including cranial and post-cranial remains showing early human physical traits changing over time. In sum, like other sites in eastern and southern Africa, the Casablanca sites display the technological and morphological evolution of the early Acheulean, an industry that is even more perceptible, such as the use of soft hammerstone for more precision on thinning and shaping bifaces with a well-defined symmetry, and predefined flaking techniques for manufacturing standardized artefacts. A good example of the latter is the Tabarka-Tachenghit technique that entails pre-shaping the cleaver prior to detaching it from the core. These technological novelties probably concurred with the emergence of the Middle Acheulean in the Maghreb.

Considering that the three sites are subject to an increasing threat of destruction by development, and that they have potential for World Heritage candidature, it is strongly recommended that these sites be submitted to the Tentative List for the future recognition, conservation and research of sites relating to the process of human evolution in Africa within the framework of the Action Plan of the World Heritage Thematic Programme, Human Evolution: Adaptations, Dispersals and Social Developments (HEADS). The sites are suitable candidates for inscription on such a list, given that they fulfill the criteria being set by the international experts for the selection of African human origin sites, including the presence of hominids (in Tighennif and some Casablanca sites), artefacts and fauna; appropriate dating; availability of palaeoenvironmental data; and publication in international peer-reviewed journals. The recognition and inclusion in the World Heritage List of African human origin sites will better ensure their long-term conservation and the management of their specific vulnerability, as well as their promotion for multidisciplinary international research and diffusion of knowledge.

Conclusions

This chapter summarizes the current evidence on the Lower Palaeolithic record in the Maghreb (Figure 12). The Maghreb documents major Lower Palaeolithic sites found in sealed and primary context, and a large number of these sites have yielded pertinent information on the time, nature and palaeoecology of ancestral hominid settlements in this region of Africa. The Ain Hanech archaeological evidence shows that the human presence in North Africa dates back to c. 1.8 Ma, and the earliest artefact tradition was the Oldowan (Sahnouni, 2006a; Sahnouni and de Heinzelin, 1998; Sahnouni et al., 2002; 2004), semi-stricto East African Oldowan (e.g. Leakey, 1971; Semaw et al., 1997; Semaw, 2000). This contrasts with the short chronology model proposed by archaeologists working in Morocco (Raynal et al., 2001; 2002; 2004). According to this short chronological model, the earliest human occupation in the Maghreb is dated to 1 Ma, and the earliest stone tool tradition was the Acheulean. While this model may be appropriate for Atlantic Morocco, it cannot be extrapolated to the entire Maghreb. In contrast, the long chronology model for an early human occupation in the Maghreb fits relatively well in the generally accepted scenario regarding hominid expansion into the Northern Hemisphere. The current evidence indicates that early hominids colonized the Eurasian landmass shortly before 2 Ma. Indeed, the oldest presence of hominids out of Africa is documented in the Caucasus at the site of Dmanisi in Georgia. Dmanisi is dated to 1.8 Ma, and has yielded several hominid fossils associated with an early Pleistocene fauna and Oldowan-like artefacts (Gabunia and Vekua, 1995; Gabunia et al., 2000; 2002; de Lumley et al., 2005). Mode I artefacts from China are dated to 1.6 Ma at Majouzankai (Nihewan basin) (Zhu et al., 2004), and possibly older at Longgupo estimated to 1.8 Ma (Boeda et al., 2011). There is now evidence that hominids and Oldowan-like artefacts dated to more than 1 Ma have been found in southern Europe, including Atapuerca in Spain, with hominids dated to 1.2 Ma (Carbonell et al., 2008); Barranco León and Fuente Nueva 3 (Guadix-Baza basin, southern Spain) dated to 1.3 Ma and 1.2 Ma respectively (Duval, 2008; Oms et al., 2000; Toro-Moyano et al., 2003); and Pirro Nord (southern Italy) dated to 1.3 Ma (Azzarollo et al., 2009).

The Oldowan tradition is followed by a fairly complete Acheulean record. Spanning roughly 1.0 Ma to 100 ka, the Acheulean in the Maghreb embodies discernibly two stages: early Acheulean and later Acheulean. The evidence for the Middle Acheulean in the Maghreb is scanty. In both stages, the Acheulean exhibits technological innovations and a continuous development of the morphology of the artefacts. An excellent illustration is the manufacture of Kombeva flake, which is characterized by dual ventral faces offering the hominids the advantage of shaping sharp cleavers. In the late-Acheulean the technological progress is even more perceptible, such as the use of soft hammerstone for more precision on thinning and shaping bifaces with a well-defined symmetry, and predetermined flaking techniques for manufacturing standardized artefacts. A good example of the latter is the Tabarka-Tachenghit technique that entails pre-shaping the cleaver prior to detaching it from the core. These technological novelties probably concurred with the emergence of the North African modern humans around 300 ka.

Palaeoecologically, the Maghrebian Lower Palaeolithic hominids lived in both riverine and lacustrine environments. The faunas indicate open and savannah habitats as inferred from the presence of equids and gazelles, yet hippopotamus entails the presence of a permanent body of water. Stable carbon isotopic studies provide more precise palaeoecological and climatic conditions. For example, at El-Kherba Oldowan site a climatic temporal change is recorded showing grassland expansion and increased aridity over time. It is likely that this and environment had impacted on early hominid foraging activities, limiting...
their acquisition of food resources and water supplies. In spite of the changing ecology, meat probably constituted a major part of early hominid diet, as indicated by the presence of cutting meat traces on stone tools and hominid-inflicted butchery marks on fossil animal bones. No Oldowan hominids have been discovered so far, but those responsible for the Acheulean activities may form two groups: H. ergaster (= early H. erectus) and late H. erectus from which the modern humans of the Maghreb might have emerged.

To summarize, the Lower Palaeolithic evidence from the Maghreb shows that this part of the African continent has the potential for contributing significantly to a better understanding of early human adaptation to the Mediterranean ecology, and for providing possible clues on the time and route of their subsequent dispersal into Europe. For this reason, sites yielding pertinent knowledge of the history of humanity – particularly Ain Hanech, the Casablanca sequence and Tighennif – need to be further considered for their potential inclusion in the World Heritage List of human origin sites in Africa for future conservation.

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**Bibliography**


Desert environment: background and consequences for conservation of early archaeological sites in North Africa

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The Egypto-Libyan desert is vulnerable to man’s activities in another, very different sense. Having been subjected to wind erosion for a great period of time; evidence of its past successive human occupations are all concentrated together on the present surface. Hence if appreciable progress is ever to be made in the interpretation of the human past in this desert it seems probable that special methods involving comparative statistics concerning the surface density and distribution of the various types of artifacts will be necessary. ... But, alas, human nature is such that the temptation to pick up and remove ancient artifacts seen lying on the ground is almost irresistible. Even now the original statistical pattern of artifact distribution must in some places have already spooked (Bagnold, 1962).

Introduction

The above quote from Ralph Bagnold, one of the best-known early explorers of the Libyan desert, clearly presents the dilemma that we face when trying to implement arrangements to protect the cultural and environmental heritage in desert areas. In this chapter, I do not deal with desert parks in general but try to focus – mainly from the viewpoint of an archaeologist, for whom the desert is an open book of history – on some problems of the management of protected areas arising mainly from their remoteness and the impracticability of organizing any kind of control. Most of the pertinent problems, however, are not specific to protected areas but concern the conservation of desert heritage in general. Protected areas do, however, provide a chance to focus on certain threats and to develop means and methods that can then be implemented on a larger scale for the general protection of the environment and archaeology.

UNESCO has repeatedly stressed the need for a more balanced and credible list of cultural and natural World Heritage sites and mentioned the less-represented sites, especially the desert landscape of the Sahara and the cultures that have developed within it. This part of the world, which for so long has been regarded as an expanse without history, has played a crucial role in the particularly important phase between 10,000 BC and 5000 BC, when favourable climatic conditions allowed the development of the first African pastoralist societies. At the end of this humid phase, around 5000 BC, the progressive aridity of the Sahara and the consequent movements of people towards the Nile Valley and the sub-Saharan areas set in motion the processes which led to the development of the Egyptian civilization and the great African migrations. It is this special historical role that puts this region at the centre of African history and instigates measures for the protection of its heritage.

The cradle of African pastoralism

Looking at the stunning assemblage of hundreds of cattle skulls around the second-millennium BC tombs at the city of Kerma in Nubia (Chap. 2, Bonnet, 2004) or the early dynastic burzah of Saqqara in Egypt (Emery, 1954), and recognizing the pride and intimate relations between humans and cattle expressed by countless much older rock paintings from all over the Sahara (Figure 1), it becomes evident that cattle pastoralism with its related ideological background must have played an important role in and north-east Africa for thousands of years. Pastoralism based on cattle, often combined with sheep and goats, is still the prevailing subsistence strategy in the arid and semi-arid zones of Africa which today make up more than one-third of the continent. The origins and development of this cultural phenomenon are far beyond the chronological reach of cultural anthropology, and it is one of archaeology’s strengths to be able to record cultural behaviour over long periods of time and to differentiate between changes of various time depths. On the other hand, prehistoric evidence is scarce due to the frequently poorly-developed...
Collaborative Research Centre ACACIA (Kuper and Knöpelin, 2006). Although far from complete and inclined to reveal the gaps in knowledge – especially regarding environmental and economic data – it can nevertheless serve as the background to a scenario of Holocene human occupation in the desert areas of north-east Africa (Figure 4).

4. Climate-controlled occupation in the eastern Sahara during the main phases of the Holocene (Kuper and Knöpelin, 2006). Red dots indicate major occupation areas; white dots indicate isolated settlements in ecological refuges and episodic transhumance. Rainfall zones are delimited by best estimate isohyets on the basis of geological, archaeozoological, and archaeobotanical data: A – During the last Glacial Maximum and terminal Pleistocene (20,000–8500 BC) the Saharan desert was void of any settlement outside of the Nile Valley. B – With the abrupt arrival of monsoon rains at 8500 BC, the hyper-arid desert was replaced by savannah-like environments and was swiftly inhabited by hunter-gatherer groups. C – After 7000 BC human settlement became well-established all over the Egyptian Sahara, fostering the earliest adoption of domesticated animals by c. 6000 BC by hunter-gatherer groups. D – Retreating monsoonal rains caused the onset of desiccation of the Egyptian Sahara at 5300 BC. Pastoralists were forced to emigrate to the Nile Valley, to ecological refuges, or to the Sudanese Sahara where they developed fully-fledged pastoralism. © Heinrich-Barth-Institut e.V.

The Sahara savannah

The chronological framework for the eastern Sahara now available, covering an area from Siwa in the north to Wadi Hower more than 1,500 km farther south, is mainly the result of large-scale interdisciplinary research into the landscape archaeology of the Eastern Sahara. This was started in 1980 by the Besiedlungsgeschichte der Ost-Sahara (BOS) project at the University of Cologne and was continued between 1995 and 2007 by its state of archaeological research in Africa and the mostly poor preservation of faunal remains at open-air settlement sites in and regions, especially because of the effect of wind erosion. Moreover, today this scarce evidence is endangered by the impact of growing desert tourism.

Radiocarbon dates for the earliest domesticated animals in Africa clearly prove that the north-eastern part of the continent is where animal husbandry took off (MacDonald and MacDonald, 2000; Cloke, 2002), reaching West Africa in 2300 BC (Meinig and Van Neer, 1996; Linseele, 2007), East Africa in 3000 BC (Marchal, 2000), and the southern end of the continent about 2000 years ago (Smith, 2000; 2005; Sadı, 1998). As a review of the radiocarbon-dated sites in north-east Africa shows (Riemer, 2007), unequivocal evidence for cattle-keeping in this area starts at around 6000 BC. From then onwards it was present throughout the Neolithic/pre-dynastic period of Egypt until it found, during the third millennium BC, marvellous expression in the fascinating illustrations – such as those furnishing the Old Kingdom tombs of Ti, Mereruka and other nobles in Saqqara – vividly reflecting the daily life of the farmers and testifying to close human-animal relations. Outside the Nile Valley the same intimacy is mirrored in numerous Saharan rock paintings that, despite their only approximate dating, unequivocally demonstrate the extent to which cattle dominated the life of the artists (Figure 2).

Looking for the origins of this way of life, the Holocene human occupation of the Eastern Sahara and its dependence on changing environmental conditions needs to be followed up with regard to different geographical settings and latitude in the various sub-areas. The following general outline of the Holocene development is reflected in more than 700 radiocarbon dates from the Eastern Sahara and the Nile Valley. This framework, comprising four stages of Holocene human occupation from ‘Early’ through ‘Middle’ and ‘Late’ to ‘Final’ (Figure 3), may serve as a background for a more comprehensive understanding of the importance of this region for the history of Africa as a whole.

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Northern Africa

For a period of at least 20,000 years during the terminal phase of the Pleistocene and before the onset, after 9000 BC, of monsoonal rains that opened the Holocene in northern Africa, the Sahara Desert extended about 400 km farther south than it does today (Krippner, 1999, p. 491). This is clearly reflected by the lack of late Pleistocene sites in desert regions (Figure 4a). In contrast, in the Nile Valley a cluster of Late Palaeolithic sites can be observed, especially in the area now covered by the Assuan Lake where significant archaeological research and rescue work took place in the early 1960s. However, at the end of the Pleistocene, the Nile Valley experienced major changes of the river’s course triggered by increased rainfall in the African highlands. Obviously due to a ‘Wild Nile’ (Butzer, 1980), living conditions along the river became harsh and may have caused competition for space and food resources. This is suggested, for example, by drastic evidence of violence within the cemetery of Jebel Sahaba at the eastern bank of Assuan Lake, dated to between approximately 16,000 BC and 13,000 BC (Wendorf, 1968). At this Sudanese site near Wadi Halfa close to the Egyptian border, many of the sixty-one exhumed individuals (including nine children) were found with flint projectile points in their decayed bodies or embedded in their skeletons.

At the beginning of the Holocene, with the arrival of monsoonal rains in the ninth millennium BC, a savannah-like environment made the Eastern Sahara habitable. When the first people reoccupied the area it is still a matter of speculation. Nile dwellers might have left the then inhospitable river valley, while groups from the south, already adapted to savannah ecology, would just have continued on their way of life. Their Epipaleolithic finds reveal them as hunter-gatherers, who – following Wendorf’s arguments (Gautier, 2001; 2007; Wendorf et al., 2001) – possibly already practised some cattle husbandry in the Nabiya/Kesiba region (Figure 4b). While the evidence for such an early ‘pastro-foraging’ economy is inconclusive, the presence of well-made pottery bearing wavy-line decorations is a general achievement of the ninth millennium BC, and is also found in other parts of the southern Sahara between the Niger and the Nile (Jesse, 2003). This reoccupation of the Eastern Sahara must have proceeded rather quickly up to the far north-west of Egypt, where Epipaleolithic settlement in the Regenfeld area in the central Great Sand Sea proves that suitable living conditions were already present before 8000 BC in what is today the Libyan desert’s most barren part (Riemeier, 2003; Kupper, 2002).

Most striking in the overall distribution of sites from this period is an almost complete lack of evidence of occupation of the Egyptian Nile Valley, where only the site of El Kab testifies to human presence during that time (Vermeersch, 1978). This corresponds to the scattered settlement area in northern Sudan, which also lacks dates prior to 7000 BC. This possibility cannot be excluded that this pattern may be related to insufficient research or to sites being irretrievably buried under metre-thick river sediments, most probably conditions in Wadi Hawar were too marshy and hazardous for human settlement due, among other factors, to frequent inundations, mosquitoes and crocodiles. Therefore hunters and gatherers obviously preferred the less wooded grasslands in the northern zones of the Eastern Sahara to the regularly flooded and densely wooded environments farther south.

While 7000 BC human settlement became well-established all over the Libyan desert, due to economic and technological adaptation to the different regional ecological requirements (Figure 4c). In the north, within the reach of the Egyptian limestone plateau, bifacial lithic technology, obviously rooted in the Levant, caused a complete change in the stone tool kit which can later be followed up in the pre-cultural dynamics of the Nile Valley (Kindermann, 2004). Rocker-stamped pottery of Sudanese tradition was well represented as far north as the Egyptian oases region and the Great Sand Sea (Kuper, 1988; Hope, 2002; Riemeier and Jesse, 2006). However, the most important achievement of this formative phase was the adoption and rapid spread of livestock-breeding after the introduction of domesticated sheep and goats from the Near East (Figure 3). On the other hand, cattle might have been domesticated locally and are well documented at places such as Naba Playa (Wendorf et al., 2001; Gautier, 2007) where they mark the beginning of herding – the ultimate origin of African pastoralism. However, due to the small geographic base different areas such as Naba Playa and the Abu Ballas region where rich faunal material from several sites at Mudpans – dated to between 6500 BC and 5500 BC – revealed no evidence of domestic livestock (Van Neer and Uerpmann, 1989; Kupper, 1993).

While neither the dates themselves nor the radiocarbon curves indicate any rupture in the development during this phase, at least neither the dates themselves nor the radiocarbon curves indicate any rupture in the development during this phase, at least nine children) were found with flint projectile points in their decayed bodies or embedded in their skeletons.

As the desert began to retreat and environmental conditions improved, the human population grew, and more people settled in the region. By 6500 BC, the human population had grown to about 500,000 people, and by 6000 BC, it had grown to about 1 million people. The increase in population led to changes in the way people lived and worked. For example, more people means more food needed, and so agriculture became more important. People began to cultivate crops and raise livestock. This led to a more settled lifestyle, as people no longer had to constantly move to find food and water. This also led to the development of towns and cities, which were able to support larger populations. The increase in population also led to more conflict, as people competed for resources. This led to the development of new technologies, such as weapons and tools, to help people defend themselves.

At Eastprent near the eastern end of the Abu Ballas region where cattle are well-documented in the archaeological record around 5000 BC (Gehlen, 2002). Generally, it was not until the end of the Formation phase at 5300 BC that herding appears to have become a vital human subsistence strategy in the Egyptian Sahara, while at the same time the first farming communities developed in the Fayum area.

Return of the desert

The retreat, after 5300 BC, from regions that were becoming arid into areas with permanent water, into extra-zonal ecological niches such as the Gilf Kebir plateau or, further south, to the Sudanese plains where rainfall and surface water were still sufficient (Figure 4d), fostered more regionally diverse socio-cultural adaptations. A small number of radiocarbon dates from the western fringes of the Great Sand Sea and the Abu Mulahar plateau reflect sporadic occupation, whereas the eastern Abu Minqar and Abu Ballas areas lie within the range of transhumance from the Farafra and Dakhla oases. In the valleys which dissected Gilf Kebir, ceramic traditions developed that can be detected later in the Lajja area of northern Sudan. In general, the process of ‘pastro-foraging’ (as well as ‘Late-style Complex’) was replaced by new regional ‘agricultural’ modes in pottery and other cultural components. This includes, in particular, the rise of cattle pastoralism as reflected in the rock art of Jebel Ouenat and Gilf Kebir and in the later settlement remains of the Lajja Area and Wadi Hawar (Keding, 1997).

Compacting this Saharan pathway into food-producing economies with the traditional Near-Eastern model of ‘Neolithisation’, it turns out to be a specific North African variant of this basic change in cultural evolution: instead of the western Asian transition from mobile hunter-gatherers to sedentary, yet pre-ceramic farmers and stock-keepers, we see pottery-producing hunter-gatherers, pastro-foragers, as well as hunter-fishers replaced by nomadic cattle-herders in desert or the dry savannah environments of the Sahara. With the exception of the Nile Valley and the oases, cereal-farming does not seem to have been a constituent of this Saharan mode, given that even the best environmental settings were insufficient for agriculture and the mid-Holocene savannah still provided ample wild-growing grains, fruits and tubers.

Paradoxically, in certain landscapes the decreasing trend in annual precipitation may have been associated with an increase in the vegetation cover because of a change in seasonality. Geo-archaeological evidence from Gilf Kebir suggests that the intense daytime summer monsoon rains of the early Holocene pluvial resulted in less grass growth than the quantitatively lesser winter rains of the terminal humic phase, which presumably fell at night (Linstadt and Krippner, 2004). These favourable circumstances may have maintained the rich culture of cattle-keepers who left their art in Jebel Ouenat and Gilf Kebir during the second half of the fifth and the fourth millennium BC.

A comparison between the distribution of settlement around human settlement of 6000 BC with that of around 4000 BC (Figures 4c and 4d) suggests that the exodus from the Sahara coincides with the rise of the first settled communities in the Nile Valley (Kuper, 2002). With regard to their economic base, the Old World cereals wheat and barley, these first mixed-farming groups which started with fully developed agriculture in the Fayum and at Merime around 5000 BC are clearly rooted in the Near Eastern Neolithic. However, on the other hand, not only the above-mentioned elements of their stone technology, but also essential aspects of their social and cognitive world might be traced back to western origins. This especially concerns the role of Saharan cattle-herders and their spiritual heritage in the Neolithic of the Nile Valley. Recently it has been stressed that the Badari culture on the middle Nile is mainly represented by cemeteries (Wengrow, 2003). Most, occupation sites consist only of ash layers, cultural debris and animal droppings, and they recall African stock pans. Together with poor evidence for permanent dwellings and domestic architecture, this suggests a rather mobile or semi-sedentary existence during the early pre-dynastic of the second half of the fifth millennium BC. In the recent past the excavation of the seasonal hunting and fishing site of Mahgar Dendera 2 confirmed the temporary character of Badarian settlements (Hendrickx and Vermeersch, 2000; Hendrickx et al., 2001), but also illustrated that hunting and fishing still continued; the first in elite and religious behaviour, the second to complement the diet (Linselle and Van Neer, 2009).

This may accompany the practice of cattle burials as also known from the Badari culture (Brunton and Caton-Thompson, 1928), which was previously represented by the Western Desert. In the Nabiya area ‘Late neolithic’, complete animal bodies were exhumed, including one interred in a carefully built burial chamber with a wooden superstructure and dated to 5400 BC (Wendorf and Schild, 1994). Thus Saharan cattle traditions might well have become an essential part of Neolithic life on the fringes of the Nile Valley and may have contributed practically and spiritually to the long-lasting and complex process of integration of the Pharaonic civilization in the Nile. In particular, however, upset the diverse socio-cultural and religious traditions cultivated in the Eastern Sahara, made their way from here through the continent whose southern tip was reached only 2,000 years ago. In many parts of the continent today African herders – whether Fulani in West Africa, Dinka in Sudan, Maas in Kenya or Himba in Namibia – with their proud traditions still maintain a vivid picture of what might be called ‘living archaeology’.

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Desert parks in the eastern Sahara

This new estimation of the Holocene development in north-east Africa is mainly based on the results of archaeological and environmental research carried out in the Eastern Sahara during the last thirty years. As a consequence of their experiences during extended fieldwork in the desert, scholars of the University of Cologne who were involved in these studies over the years tried to support the endeavours of concerned states to protect important sites of their cultural and natural history, including some unique archives of rock art. So ten years ago Sudan had already designated Wadi Hourar as a National Park; in 2007 Egypt established Gilf Kebir National Park; Chad is currently promoting the concept of Ennedi-Ounianga National Park; and in 2004 UNESCO launched an initiative to make the Jebel Ouenat natural and cultural heritage site a Transboundary Cultural Landscape of Egypt, Libya and Sudan (Krippel, 1996; 2007; Krippel and Gehrm, 2007; Kuper, 2007; 2009). The realization of the original aims of all these projects (Figure 5), however, has been substantially hampered by a number of political, financial, bureaucratic and also personal issues that question the feasibility of projects under such circumstances and how their effectiveness can be developed.

Raising awareness of 'hidden monuments'

The main difficulties are rooted in the environmental conditions that make the desert an open book of history where – as Bagnold has pointed out (1982) – due to wind erosion all remains from the past are exposed on the surface (Figure 6). This fascinating situation now often turns into a problem as, in the boundlessness of the desert, visitors, who would normally never steal an artefact from an open-air museum, can be driven by their pursuit of discovery and souvenirs and thoughtlessly, even if not deliberately, impact the contextual information hidden in prehistoric sites – a loss of cultural heritage that can never be reclaimed. Because most desert parks are located in remote areas, no regular control is possible, and as they cannot be fenced in, ‘fences’ have to be erected in the minds of the visitors and their guides. So from the outset, all efforts of conservation should be accompanied by programmes of information, education and training and be completed by measures of preventive archaeology.

The following considerations address mainly two groups of desert travellers: (a) those with little or no interest in landscape and history who regard the desert merely as a scenario for an adventurous trip, and (b) others who, fascinated by the scenery and the omnipresent traces of man’s past in it, are consumed by the temptations of amateur archaeology. Between these two groups are (c) those who are simply hunting for souvenirs. All of them, however, are the intended targets of information and education programmes which aim to raise awareness of the vulnerability of the desert and the understanding that archaeology is not simply the quest for historical objects, but fundamentally the search for their context.

Consequently information programmes, aimed at raising awareness for the desert’s values in the first instance, will address the open-minded members within a tourist group, but should at the same time activate and enable its guides and accompanying official personnel to control the remainder. With regard to the high environmental motivation of many desert travellers, there seems to be a realistic chance of finding active support among them when trying to convince them to refrain from moving and collecting artefacts. It does not seem easy, when talking about the importance of preserving context, to recognize and define what constitutes an archaeological site. Some criteria are self-evident, others have to be deduced, for example from the presence of artefacts. Situations where caution should be advised because archaeological evidence can be expected are, for instance, obvious in:

- rock shelters and caves that are a priori possible habitation sites of prehistoric man and preferred places for rock paintings and engravings;
- stone circles, cairns and other structures that might be remains of dwellings, graves or hunting devices;
- geological profiles, such as stratified sediments of fossil lakes, that might enclose prehistoric objects like potsherds, stone artefacts, bones, etc.

The major part of archaeological surface sites, however, is difficult to distinguish in the desert landscape. Even though they are the main features representing human habitation sites in this environment, they essentially consist only of a scatter of stone artefacts that to the untrained eye are hard to differentiate from natural stones. Only where larger objects like milling stones and grinders, or bones and even hearth stones catch the eye do such structures more easily reveal their settlement character. Nevertheless these ‘hidden monuments’ are the main source of information about the daily life of past societies, about their economic base, the state of technology, the social structure of the community and the environmental conditions that determined its life. To answer such questions, however, is only possible if the original statistical pattern of artifact distribution is undisturbed, as stated by Ralph Bagnold (1982). A medieval document missing an unknown number of pages or a Pharaonic inscription missing pecked-out hieroglyphs are virtually as worthless as the stolen pieces themselves when they are taken out of context. The reason for destruction might be simply vandalism (Figure 7), the play instinct (Figure 8), collection zeal (Figure 9), or perhaps even the intention to help the archaeologists (Figure 10). The ‘just one tool’ taken out of the context of thousands of others could be – as the example in Figure 11 shows – a crucial link in a chain of information decoding a message from the past.

Consequently the main challenge to prevent further destruction of prehistoric desert sites is twofold. First, visitors have to be informed...
and their visits monitored. Second, and most essential, their guides, drivers and official escorts have to be sufficiently trained to be able to identify prehistoric artefacts and sites. Only then will they be able to act as rangers and not only observe the visitors, but also their own team members when, for example, setting up camp, or where a car has accidentally hit an archaeological site. It is evident that such a necessary training programme will be quite difficult to realize, not only with regard to the heterogeneous participants but particularly because of the local infrastructure and administrative obstruction.

Of the desert parks mentioned above, only Gilf Kebir National Park, Egypt’s largest protected area at 47,000 km², has been subject to some administrative efforts since 2007. In Sudan the further development of Wadi Howar National Park was obstructed by the Darfur conflict, while Ennedi-Ounianga National Park in Chad is still in preparation. Also the project of Jebel Ouenat as a Transboundary Cultural Landscape of Egypt, Libya and Sudan is still at a preliminary stage. So the following remarks mainly rely on some observations and experiences during the four years since Gilf Kebir National Park was established.

Conclusion

It is certainly a difficult challenge to manage a park area that is situated farther than 1,000 km from its headquarters, unconnected to any traffic route and void of any human population. Because of these conditions, Gilf Kebir Park clearly differs from other, comparable desert parks such as Acacus or Tassili n’Ajjer. Nevertheless this situation provides the chance to develop new protection strategies that might serve as pilot projects for similar problems.

Indeed – bearing in mind that it is not possible to establish regular ranger posts and that instead of fencing in the park area, ‘fences’ need to be set up in the minds of the visitors – a training programme has already been launched in the first year of Gilf Kebir National Park in Bahariya oasis for desert drivers and guides, in order to acquaint them with different aspects of their job, from geography and archaeology to medical care and the protection of the environment (Figure 12). Although a proper curriculum was still lacking, the reception among the thirty participants was very positive, not least because these efforts met with the growing understanding among tour operators that the desert only can continue to attract tourists as long as it can maintain its natural pristine state.
There is a need for a proper management plan, adequate visitor information, education programmes, systematic training of rangers, and increased control and monitoring of tourist groups and their visits. External experts who could provide specific field studies necessary for a comprehensive management plan should be, in turn, supported by the administrative bodies regulating access to the park. Monitoring of foreign funding in favor of conservation measures and ensuring its proper implementation is also required. The effective management of such a challenging area calls for a body of skilled people with an efficient, flexible infrastructure. Only under such management will it be possible to achieve a proper degree of protection and implement some of the following recommendations:

- Regularly repeated training courses for desert drivers and guides.
- Framing comprehensive curricula for these courses.
- Printing leaflets with basic information on the different topics of the courses.
- Including military and police escorts in this programme.
- Distributing information leaflets among tourist groups and in hotels.
- Desert code of conduct signed by each registered tourist.
- Obligation to keep to fixed routes in major sites of interest.
- Control by remote route-tracking devices.
- Random ranger patrols.
- Arrangement of camping areas with sanitary facilities at main sites of interest.
- Setting up information plates at main sites of interest.
- Actions of ‘preventive archaeology’.

The last point essentially concerns the preservation of archaeological sites. As the example of Djara shows, where the dripstone cave now attracts thousands of tourists every year, it is possible to implement protection if the relevant information reaches concerned institutions at the right time. At Djara – thanks to the immediate notification by the discoverer and well before the first tourist reached the site – in 1993 an archaeological survey and test excavations were able to be carried out that later resulted in a major archaeological research programme in the entire area (Kindermann, 2010). In contrast, near the Cave of Beasts at Wadi Sura in the Gif Kebr region, the archaeological context in its surroundings was damaged right after its discovery in 2004 (Figure 9). However, as many tourists who perhaps discover an archaeological site will be ready to cooperate with the respective institutions, it is mainly a matter of organizing the information and acting on it. This certainly requires mobile units of an Archaeological Desert Survey that could well be integrated into the park management. It does not seem too utopian to think about combined patrols of environmental and archaeological rangers who could also regularly monitor the main tourism routes and survey hitherto untrodden areas.

“One of the most exciting things about African history is that much of it still awaits beneath the earth”, an optimistic statement from the Cambridge historian John Biffle (1995), may hold true for the major part of the continent but not for the pure desert regions, where Bagnold’s warning (1982) makes us aware of the vulnerability of historical heritage. ‘Preventive archaeology’ might show a way to cope with this challenge.

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Southern Africa

Fossil Hominid Sites of Sterkfontein, Swartkrans, Kromdraai, and Environs, South Africa.
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Conservation and management of human evolution-related sites in South Africa: present and future perspectives

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Introduction

In general, recognition of human evolution as a continuing process enabling understanding of the development of early humans, the associated adaptations, dispersals and social development mechanisms that led to modern-day humanity and habitat have become fundamental to the UNESCO World Heritage Committee, as in the Action Plan of the World Heritage Thematic Programme on Prehistory (UNESCO World Heritage Centre, 2010a). The investigation of human evolution through understanding how early humans lived and interacted with their environment, but encompasses the development of human language and its exploitation of the environment as long as 2.6 Ma ago, and the way in which social development processes have continued to shape the environment until today (McBrearty and Brooks, 2000; Singer, 2002). Until recently, the emphasis has been on studying the emergence of humanity with no strong interest in the preservation of the places that host such evidence. This precipitated the UNESCO World Heritage Centre to push for the secure conservation and management of sites bearing evidence of human evolution which it sees as a way of facilitating the preservation of the conditions of authenticity and integrity relating to human evolution sites. It should be noted however that, to achieve this, States Parties must have the relevant legislative frameworks to support the formulation of conservation and management strategies that allow for synergy between science and management of sites or the environment that preserves this invaluable record. The Committee fosters public access to these sites and engages local communities in their management. This chapter discusses the conservation and management of sites in South Africa (both listed and in the Tentative List) related to Human Evolution: Adaptations, Dispersals and Social Developments (HEADS), and the various lessons that can be incorporated in developing a road map for the conservation and management of human evolution and prehistoric sites in Africa. It reviews the legislative framework protecting HEADS related sites in the country, existing conservation and management strategies and partnerships, as well as public access to such sites. It also highlights the complexities of conservation and management of heritage resources, with the issues of multiple pieces of legislation and decision-making bodies at times complicating, rather than simplifying, the process. In addition to this challenge is the lack of synergy between scientific research, management of the environment or sites, traditional management systems of such landscapes, and issues of making science in general relevant and accessible to the public. Although these challenges exist, South Africa has made some quantifiable progress in the management and protection of these sites.

Background

The UNESCO World Heritage Committee defines human evolution sites as properties that are related to natural and cultural processes regarding human lineages. These are believed to include biological and cultural changes testifying to the remarkable success of our predecessors who continuously adapted to ever-changing environments and whose worldwide dispersals record their survival even in the most extreme conditions (UNESCO World Heritage Centre, 2010a). Scientific research has shown that the heritage of human evolution spans millions of years and offers insight to the emergence of the anatomical, biological and behavioral characteristics of humans, allowing for a better understanding of the diverse biological and socio-cultural features that characterize humanity (Phillipson, 2005). Research has further shown that equally important in understanding the evolution of human species is the record of life in general and the Earth’s history (investigated through geological and palaeontological studies), which allows understanding of an interchange between humanity and the environment. Interdisciplinary research is therefore considered key to an evaluation of the authenticity and integrity of sites, as started at previous international meeting of the HEADS Programme.

While recognizing the representation of human evolution sites in the World Heritage List, the World Heritage Committee notes the general under-representation of prehistoric sites in general (hominid sites, rock art and settlement sites, etc.). Therefore from 2008, the Committee started discussions on the issue and made recommendations, from a global perspective, for human evolution and the World Heritage Convention. Redefining concepts and approaches became critical to the Committee, even though this was a testing task. Discussions related to the Action Plan resulted in the development of a revised title ‘Human Evolution: Adaptations, Dispersals and Social Developments (HEADS)’. Refer to Annex III, Decision 34/C.105/5F for detailed discussion (UNESCO World Heritage Centre, 2010a). Integral to this theme is the biological, behavioural and technological changes – the adaptations, dispersals and social development processes – which shaped humanity into what it is today (Jacobs et al., 2008; Brown et al., 2009). These processes also offer a window to appreciate humanity’s transformation from reliance on the natural habitat, to the largely built environment of today, making it imperative to consider cultural developments of contemporary populations and how they relate to early times (UNESCO World Heritage Centre, 2010a).

Through the HEADS theme, the World Heritage Committee intends to strategically evaluate Africa’s human evolution issues, and identify the priorities for conservation and management of already listed sites, and guide the formulation of strategies for sites in the Tentative List. The Committee therefore considers the conservation and management of human evolution sites integral to its upholding of humanistic values associated with such sites, ensuring that they are enjoyed by all.

HEADS related sites in South Africa

In contextualizing the objectives of the HEADS Programme to Africa in general, and to South Africa in particular, the idea of Africa as the cradle of humankind need not be emphasized. Scientific research has affirmed this, and the World Heritage List as well as the Tentative Lists, bear witness to the significance of Africa in the investigation and understanding of humanity. The World Heritage Committee inscribed the human evolution-related property, Fossil Hominid Sites of Sterkfontein, Swartkrans, Kromdraai, and Environs (South Africa); on the World Heritage List in 1999 which was later extended in 2005. This single listing includes the Cradle of Humankind World Heritage Site (COH WHS) in Gauteng province, the Taung Skull World Heritage Site in North-west province, and Makapan Valley World Heritage Site in Limpopo province. The significance of these sites to the understanding of the emergence of early and modern humans – anatomically and biologically – and their relationship with the environment as it may be evidenced by the social development and cultural processes, will not be discussed here as it is addressed elsewhere in this volume.

However, it is worth highlighting a few critical issues regarding their contribution to:

- the understanding of origins and the diversity of the genus Homo, and how its genetic, biological and anatomical characteristics as well as the associated social and cultural development and organization, which are apparent at Sterkfontein, Swartkrans, Kromdraai and Taung sites (Tobias and Clarke, 1996; Suominen et al., 2001; D’Errico, 1993; Thackeray et al., 2001; Thackeray, 2002); These sites hosted abundant hominin remains, an example of the hominin Australopithecus africenus, for example, Mrs Ples skull and ‘Little Foot’, ape-man Paranthropus robustus, extinct mammals and evidence for probable tool-makers, and first evidence for coexistence between early humans and robust australopithecines (Berger and Tobias, 1996; Kuman and Clarke, 2000; Thackeray, 2000; Thackeray and Gommery, 2002);
- the understanding of the Earth’s history, record of life and human/environment relationships as may be presented through in situ palaeontological deposits which are evident at Gondikini, Gladysvale and Drimolen (Keyser, 2000; Keyser et al., 2000; Minter et al., 2003); These sites also have evidence of extinct mammals, extremely robust Paranthropus robustus, and materials dating between 2.6 Ma and 1 Ma, fossiliferous deposits dating from 2.5 Ma to 1.6 Ma, with a rare occurrence of juvenile Homo, for example at Drimolen.

As a contribution to understanding humanity’s colonization of new environments, and how technological innovations and social developments facilitated adaptations and dispersals, South Africa has three human evolution-related areas included on its Tentative List. These are included in the same property, Plio-Pleistocene occupation sites of Klases River, Border Cave, Wonderwerk Cave and comparable sites relating to the emergence of modern humans, which allows for the addition of other comparable human evolution-related sites. These sites record some of the oldest materials relating to modern humans, with archaeological materials spanning thousands of years, and evidence of exploitation and interaction with coastal, riverine and cave environments. Located in KwaZulu-Natal province, Border Cave has evidence of occupation dating between 75 Ka and 35 Ka ago, and recorded evidence of anatomically modern humans (Wladwy, 2005, 2007; Clark and Plug, 2008; Lombard and Phillipson, 2010). Klases River is another site with evidence of anatomically modern humans, and how they exploited both the riverine and sea environment between 115 Ka and 35 Ka ago (Vogt, 1973; Deacon and Geletine, 1988; Wurz, 2002). It is one of the few sites in South Africa with evidence of colonization and the use of fire at those earliest stages in human social development. In the Northern Cape, Wonderwerk Cave presents a record of human evolution and environmental exploitation spanning 2 Ma (Chazan et al., 2006) and is one of the very few sites in South Africa and Africa with evidence of continuous occupation or exploitation of the habitat. This is a clear indication of the site’s potential contribution to the investigation and understanding of human adaptation strategies, dispersal and social development mechanisms. Other human evolution-related sites worthy of serial nomination are Sebulo Cave in KwaZulu-Natal province, and Boomplaas, Blombos and Die Kelders caves...
in Western Cape Province. Bearing in mind this and the issues discussed above, it is critical that conservation and management strategies, with legislative backing, are in place to safeguard these sites and ensure continuing research on human evolution.

**Legislative framework**

The 1972 World Heritage Convention, now ratified by 189 of the 195 Member States of UNESCO, facilitated efforts towards formulating policies and legislative frameworks to safeguard heritage resources. The Convention ensures that States Parties take effective measures to conserve and present the natural and cultural heritage. Any relevant international legislative framework which protects biodiversity, such as the 1992 Convention on Biological Diversity (CBD), also emphasizes appreciation and responsible exploitation of the environment which has sustained humanity, and continues to do so, thereby providing an opportunity for studying palaeo and present human/environmental relationships. The conventions, charters and international bodies have played a critical role in safeguarding heritage by creating a platform for the formulation of legal frameworks to protect heritage by States Parties. South Africa’s World Heritage sites are protected through several pieces of legislation. In fact, South Africa is one of the first member States of UNESCO that have developed a legal framework, resulting in the World Heritage Convention Act (WHCA), Act No. 49 of 1999 which is one of the main legal instruments protecting World Heritage sites in the country. Other pieces of legislation that directly or indirectly protect human evolution-related sites in South Africa include the National Heritage Resources Act, Environment Conservation Act, National Environmental Management Act, National Environmental Management: Protected Areas Act and the National Environmental Management: Biodiversity Act.

The World Heritage Convention Act (WHCA), Act No. 49 of 1999 ensures protection, conservation and preservation of World Heritage sites, establishes management authorities for such sites, and mandates formulation of integrated management plans. The main advantage of this Act is that it explicitly protects the natural and the cultural heritage, both on the World Heritage List and the Tentative List. It offers environmental protection and promotes sustainable development and tourism at World Heritage sites in line with the UNESCO World Heritage Convention and the Operational Guidelines for the Implementation of the World Heritage Convention. Setting up management authorities provided for in this Act is critical for the day-to-day management of sites, and negotiating issues of access where these sites are in private property.

Equally important in the protection, conservation and management of human evolution sites is the National Heritage Resources Act (NHRA), Act No. 25 of 1999, which recognizes geological, palaeontological and archaeological resources. Through its Sections 35 and 38, this Act protects geological formations and materials, palaeontological and palaeonthropological sites and materials, as well as archaeological deposits. These resources may not be researched, exported, tampered with, etc., unless permitted by a heritage authority. Section 38 safeguards these resources for posterity by assessing the impact of all developments with a potential threat on such resources. The advantage of this Act is that it protects – issues of effectiveness aside – these resources irrespective of their status in the world, thereby potentially protecting those in the Tentative List and those yet to be discovered. Under the administration of the South African Heritage Resources Agency (SAHRA) and Provincial Heritage Resources Authorities (PHRAs), the Act mandates identification, assessment, conservation and management of heritage resources, including human evolution-related sites. SAHRA coordinates such activities for National Heritage Sites, while PHRAs are responsible for resources at provincial and local level. It should be mentioned however that with the slow process of identification and evaluation of sites to determine whether they are of national or provincial level, human evolution-related sites are under threat – with conservation and management becoming the sole responsibility of researchers.

As indicated earlier, there are other legislative tools protecting human evolution-related sites, even though they may have not been originally set for that purpose. Human evolution-related sites in South Africa also get protection from the National Environmental Management: Protected Areas Act (NEMAPA), No. 57 of 2003, and the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).

Considering the above, South Africa seems to have done well in terms of providing the legislative framework necessary for conserving and managing its natural and cultural heritage. This clearly demonstrates that one would want to obtain from Member States not only ratification of the 1972 World Heritage Convention, but measures put in place to facilitate that, particularly legislation. However, there must be synergy between the various pieces of legislation and a coordinated implementation process that allows for the achievement of the intended aims of the legislation within the context of current societal needs.

The South African World Heritage Convention Act recognizes the role of the NHRA and the National Environmental Management Act (NEMA) in the protection, conservation and management of World Heritage sites. The only snags is the challenge of implementing these many pieces of legislation that are overseen by different authorities – too many pieces of legislation and implementing bodies often create lethargy. Although this can be averted by having management authorities representing all critical stakeholders, regulations, standards and procedures for these pieces of legislation need to be streamlined to ensure effectiveness and synergy. Other related challenges are discussed below.

Although the South African World Heritage Convention Act promotes that ‘the participation of all interested and affected parties in the governance of cultural and natural heritage must be promoted’ and that ‘decisions must take into account the interests, needs and values of all interested and affected parties’, there is still a challenge with synergizing decision-making processes. Though South African sites have not been put under the ‘World Heritage in Danger’ list yet, there is a need to consider how this can easily happen if heritage concerns are not streamlined into socio-economic planning, and vice versa. Who has an upper hand in ensuring that human evolution-related sites are protected from destruction? Do decision-making processes for socio-economic amenities take into consideration commitments that South Africa has made to the World Heritage Convention through the WHCA – which apparently protects both listed sites and those in the Tentative List? Addressing these challenges would improve the outlook for human evolution sites and ensure sustainability.

Most of the South African heritage (HEADS related sites and general archaeological and palaeontological sites) is on privately-owned land, and although both the WHCA and the NHRA are very clear on the management of heritage resources in private property – that there must be management plans and heritage agreements – there are still issues of free access to sites. Of the sites already listed as examples, very few are accessible to the public – most landowners only allow restricted access by researchers. While rights of property owners are appreciated, restricted access implies that local communities and the general public continue to be alienated from human evolution sites – making them ‘elite’ sites that can only be accessed by scientists. Property owners also often want to know who has an upper hand in issues of access – property owners or the law protecting heritage? Where access is granted, who pays for the conservation and management of resources in their properties, and who pays for the maintenance of access roads in their properties (which are utilized for research and management purposes)?

**Conservation and management strategies**

**Human evolution-related sites and management planning**

The UNESCO World Heritage Convention considers conservation and management critical, and regards them mandatory to any inscription, and essential when defining the Tentative List. Conservation and management tools must consider, among other issues, materials and their on-site and off-site conservation needs – scientific management, threats to sites, general environmental management structures, and public access to sites and information. This makes conservation and management planning not only a technical process for conservation and preservation of heritage resources (Cleem, 1989; Smith, 2004), but also the ‘protection and administration of archaeological heritage in its original environment and in its relationship to history and contemporary society’ (Blinn, 1989, pp. 72). It is worth noting that management planning must be preceded by the proper inventory and documentation of sites. Sites must be surveyed and documented to create a baseline of their physical characteristics which can in turn be used to monitor their deterioration. While scientific research is the main contributor to this process, the authorities and managers must also ensure that research and conservation concerns are addressed through action plans. The World Heritage Committee considers sound conservation and management of human evolution-related sites as a vehicle to uphold humanistic values that must be enjoyed by all. In response to this, the South African World Heritage Convention Act mandates setting up management authorities, which should facilitate the formulation of conservation and management plans, and ensure coordination and monitoring of resources in WHS by all stakeholders. The management authorities ensure that sites are accessible for research, and where possible, accessible for educational and tourism purposes. The management of proclaimed palaeontological, palaeonthropological and archaeological sites within the WHS is the co-function of the management authorities in line with the WHCA, and SAHRA through the NHRA. SAHRA is responsible for the coordination and monitoring of research on such sites through Section 35 of NHRA.

**Management strategies**

Integrated management plans and specific management plans have been formulated for the 15 human evolution-related sites included in World Heritage listed properties in South Africa. The advantage of integrated management planning is in relating heritage resources to the broader landscape in which they exist, thereby creating a platform for investigating how humanity evolved, the adaptation, dispersal and social development processes, and the associated enabling environmental conditions. Specific plans for these sites have provided detailed assessments of conservation and management issues at site level, and the development of action plans. These plans discuss the legislative and administrative issues, site descriptions – which include the physical features, values and significance of sites – and site analysis that looks at the status quo and assesses the risk at
such sites. Such assessment considers the challenges for the surface and cave deposits, research and research-related issues, and management and public access issues at such sites. The action plans set out the management and monitoring tasks for critical stakeholders as mandated by legislation – WHCA and NHRA – and to ensure adherence to this legislative requirement. Heritage Agreements are drawn up between landowners and the management authorities (on behalf of other stakeholders). Research on human evolution-related sites and heritage resources in general, is permitted by SAHRA and PHRAs. With the majority of inscribed sites also having National Heritage Site status through the NHRA, SAHRA is the main permitting body for research activities (Section 35) and coordination of development activities (Section 38) that might threaten such sites. A biannual inspection and monitoring programme is currently in place and undertaken by all critical stakeholders (Figure 1). It is meant to monitor research activities as well as to evaluate the implementation of conservation and management plans.

Both the NHRA and the NEMA mandate an impact assessment for projects with potential impact on heritage resources and the environment. All critical stakeholders have a say, and the Department of Environmental Affairs issues, development authorization based on the stakeholders’ concerns. Unlike most African countries, South Africa has legislation, regulations, guidelines and standards for carrying out impact assessments. This integrated approach to environmental management is advantageous for HEADS related sites. The only challenge arises where the socio-economic needs are prioritized over heritage resources and government overrides the decisions of heritage and environmental authorities, or heritage management is not planned in the context of contemporary societal needs.

**Challenges to the implementation of management strategies**

It should be highlighted that implementation of these plans remains a challenge due to a lack of human and financial capacity, and the other issues that face South Africa and Africa in general. This means that the effectiveness of plans cannot be adequately evaluated and the appropriate corrective action taken. Also, where attempts are made to integrate or streamline decision-making procedures, the process may get even more cumbersome due to a lack of adequate resources. For example, where an arrangement is made for integrated permits, it means all stakeholders must be adequately equipped and staffed, otherwise research activities will be hampered. SAHRA and the Cradle of Humankind World Heritage Site Management Authority (COH WHS MA) are currently piloting the integration of permitting processes under Section 35 of the NHRA with Environmental Authorisations that NHRA (as CONWHS MA) has to implement. This could be one of the tools for integrated conservation and management of human evolution-related sites, thereby ensuring sustainable management of World Heritage landscapes. Extending this approach to implementing other sections of the Acts would even ensure protection of sites in the Tentative List. Incorporation of the World Heritage Convention Act in the permitting and environmental decision-making processes would offer effective protection even for sites in the Tentative List, which are often under more threat from development than the already listed sites.

The nature of deposits and the state in which the materials present themselves must be accommodated in permitting processes, conservation and management strategies. As research has shown, the understanding of human evolution is not solely on the completeness of what is being studied, as even pieces of bones or fragments of artefacts can yield invaluable information. Equally important therefore is the amount of time often required for excavating human evolution-related sites, and permitting bodies, landowners and management authorities must be mindful of this.

The relationship between immovable and movable heritage is of the utmost importance to the UNESCO HEADS World Heritage Programme. The conservation management plans must ensure synergy between the protection, conservation and management of the movable and immovable resources related to HEADS sites; institutional networking is thus critical. Management authorities, heritage authorities, researchers and repositories (museums and universities) must work together to formulate and implement conservation strategies for sites and collections. There could, for example, be issues of storage and security, movement of collections among researchers and institutions, and uncontrolled collecting by members of the public, all of which must be considered by heritage authorities, management authorities and researchers. Standards applicable to sites (immovable) must be extended to collections (movable). In South Africa, the main repository for inscribed human evolution-related sites is the Witwatersrand University in Johannesburg, with the Transvaal Museum housing a lesser percentage. This chapter purports that collections relating to HEADS sites must get as much attention as the sites, in terms of research, protection (legislation and policy), conservation, management, funding and enjoyment by the public. Funding of World Heritage sites must be extended to conservation of collections and provision of proper facilities for storage and analysis. However, there are other challenges that should perhaps be addressed at UNESCO level; for example, there is generally a lack of funding for research in Africa, as evidenced by the large amount of research activities initiated by external researchers, as opposed to being initiated locally. This means that, although Africa has world class heritage resources, the expertise does not reside in the continent. The fact that there is also a lack of funding to build world class research facilities will affect capacity building for younger generations.

Limited funding for heritage resources affects the implementation of the various good pieces of legislation that countries have, and South Africa is not an exception. As is the case elsewhere, heritage resources have to compete for funding with other socio-economic amenities, and since they are often considered to have no immediate impact on people’s lives, they tend to get less financial attention. Where management authorities are set up and management plans are in place, there is not enough human and capital funding to implement conservation measures. It should be noted that the lifespan and future of sites not only rely on being listed with UNESCO, but also on the implementation and the effectiveness of the legislation and conservation and management plans – something that South Africa, and African Member States, need to engage in as a matter of urgency.

The other issue affecting largely African countries is the battle faced by environmental and heritage authorities to protect heritage resources against development – and this equally affects inscribed sites and those in the Tentative List. Basic socio-economic amenities such as access to clean water, housing, energy and employment often attract major projects like mining, power stations, dams and infrastructural developments which threaten heritage resources. HEADS related sites, which at times appear less appealing to non-scientists, and less meaningful when compared to the need for basic amenities, are often in the firing line. Besides these large scale issues, there is the problem of developments encroaching into the core and buffer zones of sites. This becomes an even more serious threat where World Heritage sites, such as the Cradle of Humankind, are on privately-owned land. Although the properties are at the moment largely used for residential, farming and nature conservation, there may be future challenges if land use drastically changes. At the Taung Skull World Heritage site, neighbouring villages are encroaching into the buffer zone.

Another issue that concerns conservation and management planning for HEADS related sites in Africa is the history of heritage management in the continent. Ndlovu (2001) highlighted that within the African perspective, the landscape on which heritage sites exist should be seen as part of the cosmology of a people. He argued that there is very little or no distinction between nature and culture, and no sharp separation between humanity and nature. The landscapes we study allow interplay between humanity and nature, and this need not be compromised by conservation and management tools. These critical issues, which support the objective of the HEADS theme, must form the basis for action planning for sites, as a way of ensuring sustainability.
Public access to sites and partnerships

Why public access and community engagement?

‘Access’ in this chapter relates to physical interaction of the public with sites, and access to information, both printed and electronic, through whatever media. The World Heritage Committee requires proper site interpretation and basic visitor management facilities, such as walkways and viewing platforms which do not affect the OUV of sites. While this is a major concern for other countries, South Africa seems to be doing well regarding access and visibility of HEADS related sites to the public – something that has been noted and appreciated in the Action Plan. However, public access to heritage resources is not only a concern for UNESCO as there is global concern that scientific research must be made meaningful to local populations by allowing access to research results and sites. The Action Plan fosters consideration of local communities and their views and ownership rights are carefully documented and embraced in the conservation and management of related sites. There is also global concern for a more relevant scientific research that incorporates communities’ values and their relations to landscapes under study. Researchers on HEADS related sites should seek contemporary relevance of their work (Incoll, 2007; Buggery and Mitchell, 2002), and provide information which contemporary communities can use as a reference point to address their societal problems. This can either be through public meetings and notices, or focused group discussions with any particular sector of the community that may be affected by the World Heritage site. Considering the issue of social development and that human evolution is an enduring process, the safeguarding of heritage landscapes for the future must include the values associated with such resources and their relevance to communities (Chinhakure and Punvit, 2008; Ndobochani, 2009). As noted by Given (2004), people continually create their interpretations and identities by making reference to the past, and this chapter argues that this should be considered in the conservation and management of HEADS related sites. There should be consideration of communities’ pursuit of understanding and protecting the past, which revolves around issues of identity, land rights, tradition and nation-building. For example, Preucel and Meskell (2004, pp. 16) highlighted that, over and above being a source of knowledge about human evolutionary processes, archaeology is also used ‘in a developing counter-hegemonic discourse by indigenous peoples throughout the world as they seek to control the presentation of their pasts as a means of reclaiming their presents’. Scientific research is therefore often expected to contribute to addressing contemporary political and socio-economic challenges (Rowlands, 2007). Meskell’s (2007) argument for community involvement is premised on the fact that ‘it is the very materiality of our field -- the historical depth of monuments and objects, their iconic value – that immediately has residual potency in the contemporary imaginary’. Recognition of this relationship, which is apparently not new according to Marshall (2002), is believed to benefit both the contemporary community, the archaeology discipline and scientific research in general (Layton, 1994; Marshall, 2002; Meskell, 2007; Atlay, 2007). Actually, consideration of the above issues can often become handy when battling for protection of heritage resources which currently compete for funding and appreciation with more meaningful issues like social amenities. Ndoro (2001) argued that local communities must be proud of themselves and of their heritage in order to participate in any economic and democratic development in the present world (see also Buggery and Mitchell, 2002). It must be pointed out however that where the concept of engaging communities has been embraced, there are still challenges of how and when to engage them, and with what tools.

Strategies for engaging communities and the general public

Communities can be involved by assisting during research thereby developing income generation and skills, over and above the fact that their involvement may facilitate awareness and a sense of belonging through heritage. When skills development has been successful, it has proven very useful in dealing with fossil sites where fossil-bearing brecias often take long hours of careful work to extract the fossils. The involvement of communities in such activities promotes appreciation of the complexity of dealing with HEADS related sites. Communities can also provide guides, either as employees of management authorities or as independent guides. Some members of the community can also be appointed as Heritage Inspectors, in line with Section 50 of the NHRA, as a way of ensuring the monitoring of sites, given the limited resources governments allocate to heritage protection.

Where an integrated management approach is employed, communities can offer valuable knowledge regarding the management of landscapes, and their involvement in formulating conservation and management strategies can actually enhance the effectiveness of such plans. For example, the effectiveness of conservation management plans at the Cradle of Humankind is dependent on the cooperation of landowners and the local communities. It is therefore critical that there is a two-way process that allows for implementation of legislation and the incorporation of the local population’s aspirations in the decision-making process. However, it may not be an easy task to incorporate effectively the communities’ views in decision-making as it often requires more time and the adoption of qualitative research methodologies to document what to incorporate. Challenging as it may be, it would be an effective approach to ensure that communities’ views are gathered, analysed and presented as corroborative and parallel opinions to the scientific knowledge.

Communities can also be engaged in scientific research by allowing them physical access to sites and the information. Although physical access to sites must be done responsibly – in the context of safety and the fragility or carrying capacity of sites – it must be seen in light of making science more visible and relevant to the public. Besides the physical access, sites can also be made visible and meaningful to communities through formal publications and any other relevant media. However, for many parts of Africa, for example, the formal publications and web-based communication may not be the most effective media as the bulk of the populations where sites are located are less developed. Such aspects must therefore be considered when developing information dissemination strategies. Also, where management authorities are set up and visitor management facilities such as interpretation centres are in place, interactive devices can be introduced thereby reducing the pressure on the carrying capacity of sensitive sites. The main visitor centre for the Cradle of Humankind sites in South Africa is an example of how the public can be engaged through research and physical access to sites (Figure 2) and the use of interactive devices. The Tsodilo Hills World Heritage site in Botswana offers an example of how communities can be engaged as employed and independent guides, and how they can be involved in community income-generating heritage tourism projects. Heritage tourism should probably be considered as one of the most effective ways of facilitating community and public access to sites. According to Pedersen (2002), where the logical and holistic process of tourism and visitor management is synthesized in conservation and management planning, it can facilitate sustainability of heritage resources while meaningfully contributing to the lives of local people.

The challenge for implementing the issues above and the general aspirations of the World Heritage Committee would be defining and identifying who to involve, and the extent of their involvement – who is the local community? Where community is regarded as ‘people living on or close to archaeological sites, or people who trace their descent to archaeological sites’ (Marshall, 2002), or heritage resources in general, then this would include landowners, general community membership and categories of the community that trace their descent to sites. Community involvement activities elsewhere have shown that communities can be engaged in three ways:

- by relinquishing partial control of projects to communities, or community archaeology (Marshall, 2002);
- by engaging communities at all stages of research projects, or community-based archaeology (Groen et al., 2002);
- by consultation where researchers, recognizing issues of land rights, negotiate with communities for their consent to already identified research projects (Groen et al., 2002).

Conclusion

The discussions above have shown that research on human evolution-related sites in South Africa is largely coordinated at national level. SAHRA issues permits, ensures conditions are adhered to, even though that may not be possible at all times. Inspection and monitoring is done with participation by all stakeholders and this is meant to monitor the implementation of plans, identify risks and plan corrective action. To create a more conducive environment for research, permitting processes must be streamlined to facilitate a concerted effort towards integrated conservation. HEADS related sites and collections associated with such sites must be given equal appreciation and funding. There must be institutional networking to minimize illicit movement of collections, and conducive storage facilities and relevant expertise made available for related sites and
collections. This would promote capacity-building, which is currently a concern for UNESCO and its Member States, not only within states but among them for networking at regional and international levels.

The South African World Heritage Convention Act, the National Heritage Resources Act and the National Environmental Management Act are the main legislative instruments protecting HEADS related sites and these facilitated setting up management authorities, and the coordinated research and management of sites. Inscribed HEADS related sites in South Africa have conservation and management plans in place that outline their significance and the conservation challenges they face, and generate mitigatory measures. There is however need for more research and baseline documentation of all the resources that make up World Heritage landscapes. Documentation must even include resources which were not considered at the time of listing, as exploitation of these resources often affects conservation and management of the listed sites. Properties and their buffer zones must be clearly identified, and heritage resources defined at site-specific and landscape levels so that prehistoric land uses are managed in the context of the contemporary requirements.

There are a number of concerns regarding conservation and management planning at World Heritage sites, in South Africa and Africa at large. The main challenge facing South Africa is lack of implementation, due to lack of adequate funding for personnel and development of actual conservation recommendations of conservation management plans. Being at an advantage of already having conservation management plans, South Africa needs to align these to the Action Plan. Conservation and management plans for sites in the Tentative List must be developed and, unlike the existing plans for already listed sites, these should take into consideration government and local authorities’ socio-economic and development plans in those areas.

Besides inherent conservation challenges to sites, there are issues of managing the impact of development both on inscribed sites and those on the Tentative List. Heritage needs are often prioritized over provision for socio-economic amenities. While appreciating that due to the need for states to develop, and that not all heritage can be preserved in situ, preservation by record or rescue of material from highly significant sites should only be allowed if development projects are location-specific and cannot be redesigned or relocated. Member States must ensure that the conservation and management of natural and cultural heritage is not indiscriminately prioritized over other resources. In most cases, destruction of sites is due to lack of integration of heritage issues at the planning stages of development – disregarding the fact that heritage concerns should be integrated in socio-economic planning. Equally important in this matter is that heritage and environmental decision-makers should consider heritage conservation and environmental management within the context of evolving landscapes. Where heritage and developments can coexist they must be allowed to do so, on condition that management programmes are developed and approved by the affected parties. Besides risk assessment from developments there should be general assessment of risk at sites which may be brought by research and natural processes. Risk assessment must be integral to conservation and management planning at sites, both open-air and cave sites, and this must be done at the time of listing and during the lifespan of sites to safeguard their integrity and authenticity. Equally important is a periodic review of plans, and ensuring that they are aligned to accommodate community and public participation in the management of World Heritage sites.

Bibliography


Approaches to the archaeological record

Volcanics of the pressurized earth that form the southern margin of Lake Turkana, East African Rift System, northern Kenya. © David L. Brill
Les marqueurs biologiques, rôle et standardisation minimale pour le prélèvement de terrain à des fins d'études en laboratoire

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Introduction

Marqueurs biologiques des conditions environnementales des sites à hominidés

L'Afrique compte de nombreux sites à hominidés. À la lumière des recherches actuelles, il existe un consensus scientifique considérant que l'émergence de la lignée humaine a eu lieu sur ce continent. Dans les périodes géologiques anciennes, les différentes étapes de l'évolution humaine se sont effectuées sous des formes variées (genres et espèces) représentant différentes adaptations morphologiques liées au changement de mode de locomotion, à l'habitat, au mode de stratégie alimentaire, à la fabrication d'outils, à la sociabilité etc. De l'Afrique, sont parties plusieurs vagues de migrations des premiers hommes, venant successivement peupler les autres continents, l'Asie, puis l'Europe et enfin l'Amérique du Nord. Les conditions environnementales dans lesquelles cette évolution s'est produite et les multiples changements qui l'accompagnent sont primordiaux pour comprendre les phénomènes d'adaptation liés aux modifications d'habitats, de disponibilité de ressources, et du climat. Leur étude revêt aujourd'hui un intérêt tout particulier dans la perspective de modélisation et de prédiction de changements futurs, notamment du climat, changements auxquels nos sociétés modernes devront s'adapter.

Toute reconstitution des conditions environnementales des sites à hominidés, dans le passé, nécessite un effort pluri disciplinaire de la part des scientifiques engagés dans ces recherches. Aux études géologiques qui permettent de dater les couches géologiques, et de placer les événements dans une succession chronologique, s'ajoutent les études paléontologiques qui précisent l'ensemble des animaux (la faune) associés à la présence des premiers hommes, aux sites qu'ils occupaient, ainsi que ceux qui furent ultérieurement chassés ou domestiqués. Des techniques plus sophistiquées d'analyses d'éléments biologiques sont également utilisées pour reconstituer les paysages végétaux, les conditions environnementales, notamment climatiques. Parmi ces techniques, nous discuterons les marqueurs biologiques qui renseignent sur la composition des paysages végétatifs (écosystèmes) comme les restes fossiles macroscopiques de bois, fruits, graines ou feuilles, les restes microscopiques tels que pollen ou phytolithes, les éléments biochimiques associés au cycle de l'oxygène et du carbone dans les échanges entre l'atmosphère et les plantes. Bien que conduites à l'endroit des sites qui font l'objet de conservation du patrimoine international, de telles études concernent une région s'étendant bien au-delà du seul site concerné. En particulier les conditions climatiques seront appréhendées en tenant compte des mécanismes qui déterminent le climat global et ses variations. De telles études doivent être effectuées avec un standard scientifique de très haute qualité, tenant compte des progrès de la discipline scientifique utilisée et garantissant un état de connaissances le plus avancé, en progression constante et en collaboration internationale.

Associés aux sites à hominidés de l'Afrique orientale, les exemples que nous présentons dans cet article correspondent à ces critères d'excellence garantissant leur valeur universelle exceptionnelle. À l'exception de quelques sites archéologiques où les objets lithiques sont conservés dans des grottes (Porc Épic, Moshe en Éthiopie), la plupart des sites à hominidés correspondent à des sites de plein air, parfois de grandes dimensions. Un certain nombre de critères doivent être nécessairement remplis pour prêlerre sur les sites considérés au patrimoine de l'humanité les marqueurs biologiques dont l'étude en laboratoire fournira une information et une référence au caractère unique et universel. Outre la qualité scientifique qui doit être unanimement reconnue dans des publications obéissant aux standards des revues internationales appropriées, les autres critères varient selon la nature de l'information fournie soit par des objets individuels ou des informations successives obtenues sous forme de séries temporelles.

Plantes fossiles

Objets individuels associés aux sites archéologiques

Les sédiments contenant les restes fossiles d'hominidés montrent parfois la préservation de fragments de plantes. Ceux-ci peuvent être trouvés dans les niveaux géologiques qui contiennent les fragments osseux des hominidés eux-mêmes. C'est le cas de noyaux attribués aux fruits fossiles d'un Micocoulier d'Ethiopie (Celtis), arbre encore fréquent dans la forêt rivireana, et qui furent trouvés en association avec Ardipithecus ramidus (White et al., 2009; WoldeGabriel et al., 2009) et des restes de bois fossiles identifiés appartenant à un figuier Ficarcao (Jolly-Saad et al., 2010). D'autres restes de plantes fossiles proviennent des sites à hominidés, mais ne sont pas conservés précisément dans les strates qui contiennent les fragments osseux des hominidés. C'est le cas de noyaux de fruits d'un arbre (Antrocaryon) de la famille des marquiers (Bonnellie et Letouzeau, 1976) ou de bois fossiliés trouvés dans le gisement de la Basse Vallée de l'Orô (Dechamps et Maes, 1985), dans les dépôts du Lac Turkana ou le gisement de Laetoli en Tanzanie (Bamford, 2011). Dans le cas des premiers exemples, l'association des restes de plantes et des fossiles d'hominidés apporte une information directe sur la composition de la végétation, du paysage, voir de l'habitat à l'époque même où ces hominidés vivaient dans la région. Dans les autres exemples, la mise en association de l'information nécessaire que soit effectuée un travail préalable de coordination interdisciplinaire. Il est indispensable d'établir la position géologique des objets par rapport aux niveaux contenant les restes à hominidés. Ce travail repose sur l'expertise du géologue et sur la datation des couches successives par les éléments volcaniques en laboratoire. L'intérêt pour le site à hominidés peut être tout aussi important, mais il est indirect. C'est ainsi que la présence des fruits comestibles d'Antrocaryon, établie dans la vallée de l'Orô entre 3.4 et 3.3 millions d'années, se révéla contemporaine de la présence dans plusieurs sites d'Afrique orientale d'un autre genre d'hominidés (Australopithecus afarensis, alias Lucy), trouvée ultérieurement dans le bassin de Turkana et la vallée de l'Awash.

Plantes fossiles non associées aux sites lithiques, mais ayant une valeur archéologique

Un troisième cas de préservation des restes de plantes mérite considération. C'est celui de riches gisements où des conditions particulières ont permis la conservation exceptionnelle de feuilles, graines, bois etc. Ces gisements sont soit proches des sites à hominidés comme dans l'île de Rusinga sur le lac Victoria, au Kenya, soit très loin et dans un autre contexte comme pour le site de Chilga en Ethiopie au nord du lac Tana, sur le plateau éthiopien, à des centaines de kilomètres des sites à hominidés de la vallée de l'Awash dans le Rift (Yerem et al., 1987). Ce site est remarquable par la possibilité de obtenir des datations chronologiques dites “absolues” effectuées par la méthode d’analyse en laboratoire des éléments radioactifs des cendres volcaniques qu’il contient. Un âge de 27 millions d’années a été attribué aux flores fossiles de Chilga. Très diversifiée, la flore fossile du gisement de Chilga contient plus d’une centaine de plantes taxonomiquement identifiées (Jacob et al., 2005). Elle témoigne de l’existence de forêts humides diversifiées, caractérisées par l’abondance des palmiers (Pan et al., 2006) et des fougères, forêts dans lesquelles se vécu de formes animales aujourd’hui disparues. L’analyse des assemblages de pollen et des plantes fossiles préservées à Chilga, atteste de l’installation d’un climat saisonnier de type mousson, sur le plateau nord éthiopien, à une époque qui précède de beaucoup l’émergence des hominidés en Afrique orientale. On en déduit donc que précédemment à l’apparition des ancêtres de l’Homme, il n’existait pas en Ethiopie de forêt humide primaire semblable à la forêt équatoriale. Si la première étape de l’évolution humaine a eu lieu consécutivement à un changement d’habitat de la forêt humide à la savane, ainsi que présumé par Darwin, cette étape se serait effectuée ailleurs que sur les hauts plateaux d’Ethiopie, et postérieurement à 27 millions d’années, ce qui indique également les études comparatives du génome humain et de celui des grands singes. Cette information a un intérêt relatif aux théories concernant l’évolution humaine. Elle a un caractère universel unique. Les flores fossiles de Chilga offrent par ailleurs un intérêt tout aussi important, relatif à la mise en place de la remarquable biodiversité des forêts actuelles d’Ethiopie. La datation de ces flores confirme le caractère ancien de la biodiversité actuelle. Cet exemple illustre les liaisons possibles entre sites distincts, susceptibles d’être intégrées dans des programmes différents de conservation du patrimoine mondial.
Pollen et séries polliniques

La Palynologie est l’étude des grains de pollen des fleurs, une discipline scientifique développée dans le milieu du XXe siècle. Elle est résolument des grains de pollen est constituée de molécules organiques très résistantes pouvant être conservées sur des périodes géologiques de plusieurs millions d’années, à condition d’avoir été préservées de l’oxydation par l’oxygène de l’air. Produits en grande quantité et dispersés dans l’atmosphère, on les trouve en abondance, enfouis dans les sédiments de lacs ou de rivières, mieux préservés dans les régions tempérées que tropicales. Des études palynologiques ont été initiées sur la plupart des sites à hominidés d’Afrique, notamment de l’Afrique orientale.

Les pollens fossiles sont des objets microscopiques. Leur étude nécessite un transfert au laboratoire des échantillons prélevés sur le terrain. Le prélèvement s’effectue dans des conditions établies selon des standards précis. Au laboratoire, les sédiments subissent une préparation par des traitements chimiques qui détruisent les matières minérales de façon à ne conserver que la matière organique. Ce résidu contient les pollens présents pour l’observation au microscope, sous lequel, ils sont comptés manuellement. Identifiés comme appartenant aux plantes qui ont produis par comparaison à des références modernes, les pollens fossiles fournissent des informations à la fois qualitatives et quantitatives sur la composition de la végétation environnant le site considéré.

Critères ou standards de prélèvement des échantillons pour étude en laboratoire

i. Positionnement des données pollen: indication géographique la plus précise possible compréhendre les coordonnées géographiques, latitude, longitude et altitude fournies par positionnement GPS.

ii. Datation des sédiments dans lesquels sera faite la collecte des échantillons sur le terrain. Une bonne coordination entre spécialistes des biomarqueurs et (les) géologues garantir la position exacte des échantillons ramenés en laboratoire par rapport aux strates géologiques datées (de préférence par les méthodes les plus précises possible de radio chronologie) et par rapport aux strates contenant les fossiles d’hominiens. Le prélèvement des échantillons doit être ainsi effectué lors des missions communes de terrain, en collaboration avec le paléontologue et les géologues, de façon à préciser la provenance des échantillons et l’échange d’idées et la qualité des discussions lors de l’interprétation des résultats.

ii. Expertise scientifique requise pour chacun des biomarqueurs envisagés, garantissant l’identification la plus précise possible grâce à la consultation d’une collection appropriée de référence (par ex pollens des plantes actuelles de l’Afrique tropicale), et d’ouvrages descriptifs de référence, disponibles dans la communauté internationale.

Durant les dernières décennies, l’expertise sur les pollens africains, développée en parallèle avec les études sur les hominidés, a abouti à la mise en commun des connaissances par la création d’une association composée de nombreux chercheurs africains, se réunissant toujours les deux ans. Trois laboratoires africains développant l’expertise palynologique ont été créés en Afrique: Addis-Ababa, en Ethiopie, Nairobi, au Kenya, au Gabon et des experts maintenant bien formés sont présents dans d’autres universités au Togo, en Tanzanie et en Ouganda. Une mise à disposition de nombreuses photographies de pollens sur un site Webb (African Pollen Data Base) contient aussi des données comparatives d’assemblages de pollen correspondant à différents écosystèmes tropicaux modernes pouvant servir à l’interprétation des assemblages polliniques fossiles utilisés pour les sites à hominidés. Un réseau scientifique de ces experts fonctionne au niveau international.

Informations fournies par les pollens

L’étude des pollens fossiles fournit sur l’environnement végétal des sites à hominidés des informations à la fois qualitatives et quantitatives.

Les informations qualitatives indiquent les plantes entrant dans la composition de la végétation, ainsi que les espèces d’arbres présents. Leurs caractéristiques physiologiques telles que feuillages persistants ou caduques renseignant sur la saisonnalité du climat. La comparaison avec les espèces actuelles indique la possibilité d’obtention de fruits comestibles sur une période de l’année, toute information utile à la compréhension des modes de fonctionnement de nos ancêtres à différentes époques de leur développement, y compris aux périodes récentes d’apparition des cultures, céréales, millet, oliviers etc.

Les informations quantitatives reflètent l’abondance des diverses plantes avec certain biais qu’il est important de connaître par comparaison à des études menées sur des assemblages polliniques modernes d’écosystèmes de surface de sols prélevés dans les différents types de végétation connus en Afrique tropicale. La base de données polliniques de référence ainsi constituée
correspond à plus de 1000 points localisés par leurs coordonnées géographiques et distribués dans les différents écosystèmes tropicaux cartographiés par les botanistes et encore préservés sur le terrain. Les différents types de forêts, humides, sèches, sempervirentes, décidues, à caractère montagnard ou fluvial, les savanes à arbres ou arbustes, la végétation intermédiaire entre forêts et savanes, enfin les prairies de haute altitude, les différents types de déserts etc., sont représentés dans une base de référence de données polliniques modernes. L’ensemble des données acquises au cours des 40 dernières années par les spécialistes est maintenant disponible pour une communauté scientifique plus large et de futures interprétations des données de pollen fossile qui peuvent être obtenues ultérieurement sur les sites archéologiques classés au patrimoine de l’humanité.

Pollen et séries polliniques en environnements des sites à hominidés

Les données polliniques se présentent sous la forme de comptages d’individus attribués à des plantes et sont résumées en graphiques sous la forme de pourcentages soumis à des traitements statistiques. On parle d’informations quantitatives. Les variations de pourcentages des pollens appartenant à divers types de plantes sont interprétées en distinguant l’environnement immédiat de l’environnement régional. Un exemple est fourni par les résultats palynologiques obtenus au site d’Hadar qui montrent une abondance des Cyperacées et des Rosaceae massetées (figyes) dans les sédiments lacustres à la base de la série (Bonnefille et al., 1987) qui contiennent de très nombreux restes d’Australopithecus afarensis (Kimbel et Johanson, 1994). L’abondance des plantes sub-aquatiques inféodées aux bordures lacustres traduit la présence d’un grand lac d’eau douce, peu profond dans lequel furent enfouis les restes osseux des hominidés trouvés parmi les articolations anatomiques (Alemseged et al, 2000). Les arbres indiquent la végétation environnante parfois distante de quelques kilomètres. Par référence aux nombreuses données modernes, une interprétation basée sur des méthodes de statistique des assemblages fossiles a permis de reconstruire la présence de plusieurs biomes dans l’environnement régional d’Australopithecus afarensis. La succession temporelle de ces biomes au site d’Hadar montre clairement d’importants changements d’environnement et
Les phytolithes

Les phytolithes sont des concrétions siliceuses formées à l’intérieur des cellules ou entre les cellules des plantes. Elles se retrouvent préservées dans le sol après la destruction des plantes qui les ont produites. Particulièrement abondantes dans les époxydes des feuilles de graminées, les phytolithes ont des formes distinctives démontrant l’appartenance des plantes à grandes familles de graminées, en apportant une indication supplémentaire et unique sur la caractérisation des processus par lesquels les deux grands groupes de graminées fabriquent des molécules organiques à 3 ou à 4 atomes de carbone durant la photosynthèse. On les désigne sous le terme de plantes en C3 et plantes en C4. Ces caractéristiques sont par ailleurs liées à des conditions climatiques. Les plantes en C3 sont adaptées à un climat saisonnier plus aride.

Les isotopes

Définition et standard d’évaluation

On désigne par isotopes les atomes d’un élément ayant dans leur noyau le même nombre de protons, mais qui est différent par le nombre de neutrons. Par exemple tous les atomes de carbone ont 6 protons dans le noyau, mais ils peuvent avoir 6, 7 ou 8 neutrons. Les isotopes concernés sont appelés 12C, 13C, 14C. Ils sont produits naturellement. Les plantes puisent leur carbone dans l’atmosphère au moyen de la photosynthèse en effectuant un fractionnement qui leur est propre. Ce fractionnement tend à enrichir les plantes en 13C, le moins abondant des isotopes, et donc à diminuer la proportion de 13C, qui est le plus abondant (98%) et qui on mesure donc plus facilement. La valeur du fractionnement est mesurée par rapport à un standard et exprimée sous la forme d’une différence de la proportion du carbone lourd 13C réduit par rapport à la composition du standard international. C’est ainsi que les arbres sont caractérisés par des valeurs de 13C diminuées de -20 à 23‰ tandis que certaines graminées des milieux arides auront des valeurs de 13C diminuées de l’ordre de -12‰. Par application de ce fractionnement, on caractérise l’abondance de certaines plantes d’une manière remarquable, universellement applicable à tout sédiment contenant de la matière organique, quel que soit l’âge du sédiment et la provenance géographique. Développée il y a quelques décennies, la technique requiert des équipements modernes, sophistiqués de mesure des radiocarbone. Une grande maîtrise des méthodes analytiques est donc la condition indispensable pour permettre le prélèvement d’une série d’échantillons adaptée à la problématique de recherche envisagée aux sites archéologiques classés. Seuls des chercheurs spécialisés seront habilités à prélève sur le terrain les échantillons de référence destinés aux mesures de laboratoire.

Application aux sites à hominidés


Avant 8 millions d’années, l’Afrique était essentiellement couverte par une végétation dont l’activité due à la photosynthèse fabriquant des molécules à 3 atomes de carbone (plantes en C3, valeurs de -30 à -20‰). Globalement dans les régions tropicales, en lε de végétation a régressé au profit des plantes en C4 qui sont devenues plus abondantes. Cela s’accompagne de plus en plus d’espaces entre 8 et 3 millions d’années, consécutivement à l’établissement de conditions de plus en plus arides. Parmi les plus anciens hominidés trouvés en Éthiopie, Ardiapithecus ramidus occupe une place particulière avec des caractéristiques anatomiques adaptées conjointement à la bipédie et à la suspension arboricole. La présence Ardiapithecus ramidus est actuellement restreinte aux seuls niveaux datés de 4,4 millions d’années. En l’absence de préservation des phytolithes, les reconstitutions sur l’environnement d’Ardiapithecus basées sur l’interprétation des faunes associées ont été complétées par l’examen des phytolithes et des isotopes. Comparées à un ensemble de données de références modernes, les valeurs des isotopes 13C mesurées dans les échantillons fossiles de Middle Awash contemporains des hominidés indiquent une végétation dont le couvert arborescent ne représenterait plus de 10% de la surface totale (Cerling et al., 2010). L’analyse des phytolithes a été effectuée sur les mêmes échantillons que les isotopes. Elle montre une abondance de plus de 50% de phytolithes de graminées, ce qui indique aussi une végétation ouverte avec une faible proportion d’arbres. L’habitat ainsi établi par les marqueurs biogéochimiques est en contradiction avec l’évidence de milieu boisé, information fournie par les macrofaunes et les adaptations morphologiques à la vie arboricole de cet hominidé. Une controverse scientifique fait daté parmi la communauté. Ce débat concerne l’influence des conditions de milieu sur l’émergence d’un mode de bipédie apparu.

En tant que marqueurs biogéochimiques, les isotopes du carbone peuvent être aussi mesurés dans les concrétions calcaires qui se forment dans le sol, quand l’évapotranspiration excède l’infiltration induisant un stress de déficit hydrique. Un travail considéré a été réalisé dans le bassin du Lac Turkana (Wynn, 2004). Des mesures isotopiques ont été effectuées par plusieurs auteurs sur de nombreux échantillons datés de 4 millions d’années à la période actuelle, dans les sédiments où ont été trouvés de très nombreux fossiles d’hominidés appartenant à plusieurs genres et espèces. Illustré par la Figure 3, les résultats montrent...
une évolution des valeurs de δ¹³C de moins en moins négatives, ce qui indique un accroissement d’aridité dans les conditions climatiques de la région du Lac Turkana, depuis 3 millions d’années. La mise en place de ces conditions plus arides a été mise en parallèle et discutée par rapport à l’émergence de deux lignées évolutives distinctes, celle du genre Homo et celle du genre Australopithecus, qui représentent des adaptations évolutives distinctes. Par leur contribution aux discussions relatives aux processus éволutifs, on apprécie le rôle important que les marqueurs biologiques apportent à la valeur universelle du site reconnu depuis quelques années au patrimoine de l’humanité.

Comment un site nonolithique peut avoir une valeur archéologique?

Dans les chapitres précédents, nous avons discuté comment les marqueurs biologiques analysés dans les sédiments des sites archéologiques contribuent à l’établissement de la valeur remarquable universelle d’un site. Dans ce chapitre, nous envisageons la contribution apportée par l’étude de marqueurs biologiques analysés sur des sédiments qui ne correspondent pas aux sites archéologiques eux-mêmes, mais qui, cependant, peuvent contribuer à leur interprétation, et de ce fait avoir un intérêt tout particulier, notamment relatif à l’archéologie ou à la problématique environnementale de l’origine des hominidés. Une inter-comparaison de résultats obtenus à partir de marqueurs distincts et indépendants est la garantie que les résultats obtenus auront une valeur universelle. L’exemple discuté résulte d’études scientifiques interdisciplinaires. Il concerne deux longues séries temporelles des pollens pour lesquelles plusieurs types de marqueurs biologiques : pollen, matière organique et isotopes ont été analysés dans des laboratoires distincts, à partir des mêmes échantillons prélevés selon les standards décrits précédemment et analysés dans les laboratoires par des spécialistes selon les normes internationales les plus adaptées et les plus modernes.


Le graphique de la Figure 4 indique la chronologie (Time scale) c’est-à-dire la mesure du temps en milliards d’années sur l’échelle verticale des ordonnées. À gauche, sont représentés les résultats des analyses polliniques obtenus sur deux séries marines. Celle de l’Afrique de l’Ouest correspond à une synthèse des données obtenues sur plusieurs sondages pétroliers réalisés dans le golfe du Niger (Morley, 2000). Celle de l’Afrique de l’Est correspond aux analyses polliniques d’un sondage effectué dans le cadre des Programmes des Forages Oceaniques Profonds (Deep Sea Drilling Programme, DSDP) de la recherche scientifique internationale, répertoriés sous le numéro DSDP 231 (Bonnefille, 2010). L’échelle des absisses correspond aux valeurs de pourcentages des pollens d’arbres cumulés tels qu’ils ont été calculés dans les différents niveaux étudiés des sondages. Sur la partie droite de la figure, nous avons indiqué les ordres d’apparition des différents genres d’hominidés trouvés en Afrique orientale et centrale, selon l’ordre chronologique d’apparition et de disparition (extension temporelle), sans tenir compte des différentes hypothèses de filiation de l’un à l’autre. Au centre, nous avons indiqué les épisodes géologiques avec les événements majeurs qui les caractérisent la crise de salinité méditerranéenne (Messinian Salinity Crisis, MSC), la fermeture du golfe de glacioïde du plateau du golfe du nord (Northern Hemisphere Glaciation, NHG), à l’extrême droite du graphique, les informations résument les extensions des glaciers polaires ainsi que les cyclones orbitales dominantes des variations du climat global.


C’est certainement la période entre 5 et 3 millions d’années qui fut la plus favorable au développement des végétations boisées sur tout l’ensemble de la zone intertropicale avec un maximum entre 4 et 3 millions d’années. Les hominidés répertoriés pendant cette période correspondent aux genres Ardipithecus trouvés seulement dans la vallée de l’Awash et à deux espèces d’Australopithecus trouvées dans la vallée de l’Awash et dans la région de Turkana (Leakey, M.G. et al., 1998). Ces deux espèces présentent des adaptations différentes à la bipédie.

Approaches to the archaeological record

L’évolution de la végétation et l’histoire climatique globale reconstruites d’après l’étude des pollens sont complétées dans le sondage du golfe d’Aldén par l’étude des isotopes analysés sur des molécules organiques provenant des cuticules des plantes conservées dans les mêmes sédiments (Peakeins et al., 2005). La figure 5 montre les variations des pourcentages de pollen de graminées par comparaison avec les valeurs des isotopes de δ13C dans les sédiments marins et dans les carbonates des sols du bassin de Turkana. Tandis que les graminées fluctuent entre 5 et 1.5 millions d’années, les isotopes indiquent une progression de la proportion des plantes en C3, laquelle est interprétée comme une indication d’une plus grande proportion des graminées adaptées à des conditions climatiques plus anciennes dans le tapis herbacé de savane qui n’a pas progressivement occupé plus d’espace au cours de cette période géologique.

L’information originale obtenue sur les sérı̂es marines et fournie par plusieurs biomarques associés montre de façon particulièrement démonstrative la contribution qu’une série non lithique apporte à l’interprétation universelle des sites à hominidés de l’Afrique orientale. Notons que l’obtention de sondages dans un ou plusieurs lacs profonds localisés soit à Turkana, soit dans le bassin de l’Awash serait du plus grand intérêt. Leur étude permettrait de préciser la compréhension de l’histoire des végétations, en la complétant par des résultats détaillés concernant les ensembles régionaux que constituent ces deux bassins aux sites classés remarquables. Ces projets envisagés par une large communauté internationale sont aussi soutenus par les archéologues. Les résultats attendus des études qui porteraient sur les biomarqueurs de ces séries non lithiques, provenant par sondages dans les sédiments lacustres, susciteraient de nouveaux résultats à la compréhension de l’histoire de l’humanité. Ils apporteraient une contribution exceptionnelle à la valeur de ces deux sites dont l’abondance et la qualité exceptionnelle des éléments lithiques et osseux font déjà l’objet de préservation.

Interdisciplinarité, critères d’excellence et protection des sites à hominidés

Les études conduites par les préhistoriens et les archéologues sur les sites à hominidés en Afrique ont été depuis le début effectuées dans le cadre de relations interdisciplinaires tant au cours des missions de terrain que pour les études au laboratoire. Les expéditions, le travail de terrain, les séminaires, les conférences impliquent anthropologistes, paléontologistes, préhistoriens, géologues, géochimistes, paléobotanistes, géographes, ethnologues depuis 1965, date des premières grandes expéditions dans ce domaine. Ces études à caractère international ont été effectuées en commun, avec une volonté de coopération. Conscients de la valeur universelle exceptionnelle des sites à hominidés de plein air soumis aux aléas des phénomènes naturels de destruction par érosion ou modifications environnementales liées à l’action humaine, les chercheurs impliqués ont eu à cœur d’associer les meilleures expertises possibles. Conscients du caractère unique et précieux des études et des objets récoltés, les acteurs de ces travaux ont agi pour la conservation de ce patrimoine mondial sur l’origine de l’espèce humaine et les différentes étapes de l’évolution des sociétés primitives. Ils ont participé à la protection de ces archives uniques en suscitant dans les communautés impliquées aux différents niveaux, régional ou national, la création de lieu de stockage des archives fossiles, de musées, sur les lieux de fouilles ou au niveau national. Ils ont inventorié, catalogué les objets recueillis, créé des bases de données regroupant les fausses fossiles disponibles pour des études futures et des comparaisons avec les faunes susceptibles d’êtres mises à jour ultérieurement et dans d’autres régions du monde. Ils ont ainsi largement préparé les bases d’une protection plus large au niveau international.

Si la géologie tient une place de choix dans l’établissement de la chronologie, la sédimentologie, et l’étude de microorganismes renseigne sur le mode de dépôt, la proximité de source d’eau douce, rivière ou lac, de volcans, cendres dans lesquelles nos ancêtres ont parfois laissé des empreintes exceptionnelles comme à Laetoli. La paléontologie a pour objet l’étude des animaux associés aux hominidés, soit directement sur les endroits où ceux-ci ont été extrait, soit dans les couches géologiques avoisinantes. Parmi ces animaux dont les plus anciens ont aujourd’hui disparu, un certain nombre ont été chassés, servant de nourriture, ou ensuite domestiqués. Tous renseignent sur le comportement et le mode de vie de nos ancêtres. Les fossiles ont été non seulement inventoriés, catalogués dès leur collecte sur le terrain, mais préservés dans les collections appropriées des différents musées, notamment d’Addis-Abeba et de Nairobi où la conservation de ces collections nécessite une formation particulière pour les conservateurs et gestionnaires. L’interdisciplinarité est la règle. La faune est si riche et si variée que les paléontologues doivent être spécialistes de chaque groupe de mammifères, éléphants, singes, cochons afin de se voir confier les études pour des comparaisons garantissant un niveau d’excellence internationale.

Beaucoup d’indicateurs, notamment biologiques, ont été utilisés afin de préciser les conditions et le contexte environnemental dans lequel se sont effectuées les différentes étapes de l’évolution humaine. Parce qu’elles traitent d’objets microscopiques qui ne peuvent avoir été déchirées qu’après des traitements chimiques en laboratoire, les études de paléobotanistes portant sur les bums fossiles, les grains, les pollens, les phytolithes associées aux marqueurs isotopiques sont moins visibles. Cependant, elles permettent de reconstituer la végétation environnante (forêt, savane, forêt claire etc.) dans laquelle on a pu voir les premiers hommes, la végétation dans laquelle ils ont trouvé ou cultivé les ressources nécessaires à la survie de leurs groupes et sociétés. Les adaptations alimentaires des premiers hominidés sont des étapes cruciales de l’évolution humaine, étudiées à partir des morphologies dentaires. Conscients de la qualité unique des informations fournies par les indicateurs biologiques, les scientifiques impliqués dans ces spécialités ont élaboré des bases de données internationales regroupant leurs données, permettant une mise à disposition pour échange d’information entre chercheurs. En ce qui concerne les pollens, « l’African Pollen Database» contient non seulement des données fossiles mais aussi d’abondantes données modernes pour un millier de sites géographiques distincts, distribuées en Afrique tropicale, dont la protection pourrait être envisageable dans le cadre de la préservation de la biodiversité dans le monde tropical. Collectées depuis un demi-siècle, quelques-uns des objets de représentent un patrimoine unique, à valeur universelle exceptionnelle informant sur une biodiversité réduite ou parfaitement disparue. Il est probablement nécessaire d’envisager aussi une protection de la collection des données de référence des pollens à partir d’échantillons de plantes africaines conservés dans les herbes nationaux et internationaux. Ce sont là des caractéristiques et aspects de recherche, non visibles associés aux sites préhistoriques à hominidés.
Approaches to the archaeological record

L'Afrique orientale a produit le plus long enregistrement de l'histoire de l'évolution de nos ancêtres depuis 6 millions d'années, un inventaire tout à fait exceptionnel. Certains sites n'ont que des restes sporadiques mais de qualité extraordinaire car ils ont produit l'ensemble des pièces d'un squelette presque complet. Les squelettes d'Ardipithecus ramidus (Ardi) à Middle Awash, d'Australopithecus aferensis (Lucy) à Hadar, et d'Homo erectus (Big Boy) à Turkana sont remarquables. Cependant, il existe des gisements, moins spectaculaires car ayant fourni moins de restes d'hominides, mais qui sont tout aussi importants et dignes de figurer au patrimoine de l'humanité. C'est le cas du gisement de la basse vallée de l'Omo qui contient un enregistrement temporel exceptionnel par l'épaisseur de couches fossilifères, la richesse des successions fauniques répertoriées. La présence de dépôts successifs de cendres volcaniques a permis d'établir des repères indispensables pour les autres sites où les datations sont moins faciles à obtenir et moins fiables. L'extension des cendres volcaniques datées que l'on retrouve dans les sédiments marins confère à la série de l'Omo une valeur de référence universelle.

Bibliographie


Introduction

Determining which African sites related to human origins have Outstanding Universal Value (OUV) is a complex process involving multiple variables. The geological record provides the basic framework for understanding much of the relevant evidence. In particular, the sediments from which artefacts and fossils are recovered provide the context for interpreting these remains, both in terms of the changing environments in which human evolution in Africa occurred as well as the antiquity and tempo of biological and behavioural change. Geology also dictates much of what is recovered from the archaeological and palaeontological record, and serves as a practical starting point for delineating the boundaries of sites with OUV.

But the geological record itself will, in most cases, be insufficient to provide OUV status to a site. Of critical importance here are the early human (hominin) fossil remains and archaeological material sometimes found with them. The fossils provide an important index of the various evolutionary forces that have shaped the evolution of our own species, Homo sapiens. My emphasis here is on the diversity of these early populations, as multiple lines of evidence indicate that in the past, unlike the present, multiple species and genera of hominins overlapped in time in Africa. Even within our species there is remarkable morphological variation, and the nature and causes of this variation are still poorly understood. As such, each hominin fossil makes an important contribution to our understanding of human diversity.

Hominin fossils are relatively rare things, and as important as each one is, the archaeological record provides the best evidence for human diversity, particularly behavioural differences over time and across space. The archaeological record preserves the material traces of the actions of early hominins, including the tools they used, the by-products from making the tools, food debris, habitation structures and rare evidence for ways in which social and symbolic parts of their lives were organized. My emphasis here is on the stone tools, as these provide the largest record of past human behavioural evolution and diversity.

Geology and human evolution

The geological record provides the context for understanding the fossils and artefacts that comprise the majority of our evidence for human evolution. 

- Fossils and artefacts are generally recovered from outcrops. The extent of outcrops provides concrete boundaries for defining the extent of archaeological and palaeontological sites.
- The preservation of most fossils and artefacts depends on their rapid burial by sediment in the past as well as their recovery by removal of these sediments due to later erosion or controlled excavation. The nature of the sediments characterises (a) the type of environment in which the fossils or artefacts were deposited, and (b) the extent to which a variety of formation processes, such as winnowing or chemical weathering from water, have affected the recovered material (Schiffer, 1987; Waters, 1992).
- Understanding the tempo of human evolution requires a precise chronology. A variety of radiometric methods of age estimation are now available for multiple components of the geological record, including sediments, organic remains within sediments, lava flows and volcanic ash deposits.

Each of these is dealt with in more detail below.

Geology as a boundary

A practical concern in the study of early fossil and archaeological sites is the definition of site boundaries, and geological units of outcrops, formations, members and beds can be useful in this regard (Figure 1). Indeed, the very notion of ‘site’ is complex, as it often denotes one specific location where fossils or artefacts have been recovered, and this area of recovery is often only

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1. Panoramic view of Locality 1 of the Kapedo Tuffs in Kenya’s Rift Valley during excavation as described in Tryon et al., 2008. Artfactual-bearing sediment outcrops capped by resistant volcanic ash deposits (tuff) stand in sharp relief from the surrounding landscape. Outcrop boundaries define the limits of the site. © C.A. Tryon
a small portion of the total fossil- or artefact-bearing deposit. For example, an archaeologist observes artefacts eroding from a hillside, conducts a controlled excavation of a 20 m² area, recovers a dense concentration of in situ stone artefacts, and notes that their spatial distribution suggests that the patch of archaeological material extends further into the hillside. In this case, although the excavated area may be informally referred to as a site, in reality the extent of the spatially contiguous, but unobserved and unexcavated material remains unknown. How then to define the limits of the site?

The outcrop is one of the fundamental units of analysis for a field geologist. An outcrop is simply any exposure of rock visible at the Earth’s surface, whether it is composed of sediment, lava, or other material. Outcrops may consist of resistant material exposed as adjacent softer material is eroded away, or may be visible in steep exposures found in streams, along fault lines, or other places where erosion has made formerly buried rocks visible. The study of the sediments in which fossils or artefacts occur typically requires the analysis of multiple outcrops. The sedimentary record is the complex history of multiple periods of deposition and (in most cases) eustatic sea level changes, each of which can represent a unique moment in Earth’s history for tens of millennia. Sedimentary environments also vary spatially. Streamside, lakeside and cave settings are particularly complex. Depositional environments (each with their own distinctive sediments) at streams include the channel, the channel margin and the floodplain. For lakes these include the lake centre, margin and often streams that empty into it. Depositional environments in caves can include areas of roof collapse, water percolation from underground sources, as well as layers of windblown dust. Recognizing this spatial variation requires the analysis of multiple outcrops.

However, comparing multiple outcrops is only a useful way to observe spatial variation if it can be demonstrated that the sediments or other materials among the outcrops compare actually derive from the same time interval. To do this, geologists recognize a hierarchy of mappable lithostratigraphic units, that is, layers or strata of sediment grouped according to shared characteristics whose presence can be mapped across large areas. The formation is the basic geological unit; multiple formations can be combined into groups, or subdivided into members and further into beds. More complex ways of linking outcrops using volcanic ash deposits are discussed below.

Geological formations and members are frequently used as the basic unit of analysis at African sites related to human evolution. This is illustrated by two examples. The sediments of the South African cave Sterkfontein are attributed to the Sterkfontein Formations, which are divided into a series of members (Brain, 1981). Most comparisons of Sterkfontein formation members are made among members. The member is the appropriate unit of comparison, even in the absence of radiometric age estimates, because inter-member differences record major changes in sedimentation, either due to changes in depositional environment or intervening periods of erosion or non-deposition. In the Okote Member of the Koobi Fora Formation (Kenya), multiple sites occur across an area <50 km². Because sediments of the same member represent the same approximate block of time (in this case constrained by multiple methods to approximately 1.4–1.6 Ma ago), variation in ancient environments, floral and faunal communities, and the archaeological record of early hominins can be examined (Rogers et al., 1994; Stern et al., 2002; Brown et al., 2006). Such an approach is essential, as hominin foragers ranged across ancient landscapes that included a variety of habitats, and no one ‘site’, however defined, will preserve the full range of this environmental or behavioural diversity. Recognizing this diversity necessitates a perspective on early sites that moves beyond the ‘findspots’, where particularly striking fossils may be found or dense collections of artefacts, to a view that considers the long-term potential of ancient landscapes to inform us about the context of ancient hominin behaviours. Using outcrop boundaries of geologically defined formations and members is one way to achieve this goal.

Depositional context, formation processes and palaeoenvironment

The environmental context of palaeoanthropological sites is important for understanding the nature of many of the anatomical and behavioural adaptations seen in the fossil/archaeological record. For example, the expansion from forested to more open savanna habitats is a key, if controversial, feature of many explanations for the origins of bipedalism, the defining hominin trait (Harcourt-Smith, 2010). Therefore, the environmental context plays its part in determining the OUV of some sites, such as the controversial forested conditions inferred for the 4.4-million-year-old site of Aramis (Ethiopia) (cf. Cerling et al., 2010; White et al., 2010). Understanding the palaeoenvironment requires a careful reading of evidence such as fossils, pollen grains, phyoliths and other deposits that indicate certain habitats. However, it also requires an understanding of how fossil sites formed, where the evidence comes from, and how representative the collected data may be.

The sample of fossils and artefacts used to study human evolution in Africa represents only a fraction of the past. For a fossil to be studied, the animal first has to die, or its body has to be deposited, in a place conducive to rapid burial by sediments. Bones exposed to the surface rapidly degrade and lose much of their information in temperature and moisture. Various scavengers from microorganisms to hyenas may feed on and destroy all or part of a bone. Similarly, migratory game animals or tumbling boulders in a stream might crush and fragment bones. Of those bones rapidly buried, few are fossilized, which is the process of the transformation of organic material to inorganic material; essentially bones become stones (e.g. Behrensmeyer, 1978; Gifford-Gonzalez, 1991).

Only those bones deposited in specific kinds of environments such as those conducive to calcium carbonate-rich groundwaters will have the potential to become fossils. Not those that do fossilize have to be recovered by archaeologists or palaeontologists, either through excavation or careful inspection of areas for fossils naturally eroded from outcrops. Furthermore, fossils that remain on the surface can be subject to some of the same destructive processes that affected non-fossilized bones, such as fragmentation with fluctuations in temperature and moisture (Conard et al., 2008). Stone tools are naturally more durable and tend to survive much better than bones, but the types, numbers and arrangements of stone tools can also be affected by a variety of events that occur between the time they are deposited and the time they are recovered for analysis (Schick, 1986). Understanding depositional context gives us some of these formation processes that contribute to the fossil and archaeological record.

Depositional context refers to the nature of the final sedimentation that buried fossils or artefacts before their recovery. For example, do the fossils in mud deposits adjacent to a lake or among cobbles and boulders in the middle of a stream channel? Each of these settings tells us something different. Mud is dominated by fine-grained material <0.05 mm, and it falls out of suspension only in very still waters. Therefore, we would expect a fossil buried by mud not to have travelled far from where the much larger and heavier animal originally died. Muddy deposits often favour the preservation of complete skeletons. In contrast, fossils from a cobble- and boulder-dominated stream deposit have likely travelled some distance from where they were originally deposited. As the stream has sufficient power to move large rocks along its base, it would also have sufficient power to transport a fossil, and unlike the muddy lake deposit, the location of fossil recovery may be quite far from where the animal originally died. Similarly, complete skeletons are rare as the different elements get separated, transported and deposited at different places along the stream system.

Depositional context therefore affects what is recovered, but it also tempers our interpretation of what past environments were like. To continue the above discussion, the cobbles and boulders of the stream could tell us that there was a competent river (i.e. one with a strong flow) in the area of that outcrop. Even if the fossil within that stream deposit was of a type of animal indicative of a particular kind of environment (e.g. a gnu), it would only tell us that the savanna environments that gnu favour occurred somewhere upstream (Behrensmeyer, 1982). Similar problems affect archaeological assemblages. For example, making even a simple stone tool can create dozens of discarded sharp splinters of stone, called flakes. If deposited in a muddy environment, it may be possible to recover them all and refit them, that is, put them back together in the reverse order from which they were removed from a stone core. Doing this is a powerful tool for studying ancient methods of stone tool production, discussed below. The same artefacts deposited in a stream would not have the same degree of preservation, with smaller elements being transported progressively downstream (Schick, 1986).

Age estimates and (tephro-) stratigraphic control

Determining the age of fossils, artefacts and environmental data is key to understanding the tempo and pattern of human evolution. Chronology provides the means to estimate first and last appearance dates for various species or behaviours, and can document the dispersal of early human populations or the spread of new ideas such as those involved in tool production. As such, for a palaeoanthropological site to have OUV, it must be well dated. For example, it is both the long stratigraphic sequence and the number of radiometric age estimates that make Olduvai Gorge (United Republic of Tanzania) such an important site (Haya, 1976; White et al., 2000). It is the temporal framework that makes the numerous different types of archaeological sites and hominin fossils of multiple genera and species such an essential part of the palaeoanthropological record. Because of the excellent chronological control at Olduvai Gorge, we can document archaeological change through time (e.g. the Oldowan, Acheulean, Middle Stone Age and Later Stone Age sequence) as well as lateral differences in hominin archaeological signatures that show behavioural variation in response to environmental variation (e.g. Jones, 1994; DeCaspem et al., 2002). The dated stratigraphic evidence from Olduvai Gorge is also critical in our discussions of the evolution of the diversity of the hominin lineage, as both Paranthropus boisei and Homo habilis are found from the same stratigraphic strata there (White et al., 2000).

The stratigraphic record provides the fundamental chronological tool. The stratigraphic sequence provides relative ages. This can include the chronological ordering of strata at a single site, or a comparison of like-aged deposits across multiple sites. The latter is typically done using tephrostratigraphy, identifying the same distinctive stratigraphic layer at multiple outcrops. Tephrostratigraphy is a specialized branch of lithostratigraphy, one that focuses on tracing volcanic ash deposits (tephra) across a landscape (Lovell, 2011). Tephrostratigraphy is widely used in eastern Africa, where rifting and related geological activity results in widespread volcanic activity. Tephrostratigraphy works on the basis of identifying the characteristic geochemical
signature, or ‘fingerprint’, of a given eruption. Most volcanic ash deposits are composed of minute glass shards that are bits of magma rapidly quenched at the time of eruption, cooled after leaving the source volcano. Most tephrostratigraphic efforts focus on analysis of the chemical composition of the glass shards as this represents the magma composition. Each volcano, and often each eruption, has a unique geochemical signature because of the many complex processes active in magma chambers that affect composition, including melting the host rock on which the volcano is formed, the depth of the magma chamber, duration since a previous eruption and other factors.

Many eruptions are very explosive and disperse ash rapidly over large areas, often measured in hundreds of km². Identifying the same ash layer in multiple outcrops provides a time line for comparing among different areas, and thus for studying lateral variation. This approach has been particularly useful in the Turkana Basin of northern Kenya and southern Ethiopia (Brown et al., 2006), where some of the same ash layers have been found in deposits to the north, east and west of Lake Turkana and perhaps even farther afield, including the Gulf of Aden to the east and Uganda to the west (Pickford et al., 1991; Brown et al., 1992).

As noted above, identifying the same ash layer around Lake Turkana led to the development of a ‘landscape archaeology’, whereby archaeological variation at multiple sites of the same approximate age was compared. This sort of comparison is essential for the study of foragers, particularly those living in seasonal and tropical settings such as much of Africa. Foragers in these settings are highly mobile, and as such, no single archaeological site will preserve evidence for the full range of behaviours of an early hominin group. Comparison of multiple sites of the same age in different environments may begin to accurately capture this variation. Studies of site-to-source distances of stone raw material, discussed in greater detail below, suggest that even the earliest hominins were moving about (and transporting stone tools) over distances >10 km (Braun et al., 2008). This emphasizes that when considering the OUV of a ‘site’ we must consider a ‘site’ as but one part of past behavioural systems. Widely dispersed tephra provide one means to establish the physical boundaries of some of these past landscapes of use.

As important methods such as tephrostratigraphy are, other methods are required to determine the actual age of sediments, fossils and artefacts. The most relevant for the palaeoanthropological record are a battery of radiometric methods, so called because they rely on the rate of radioactive decay of isotopes that provide a ‘clock’ that provides an age estimate. As stressed by Colman (1987), radiometric methods are not ‘absolute’ methods nor do they provide ‘dates’, but rather provide an age estimate with attendant uncertainties that derive from a number of possible sources of error, including sample contamination, analytical uncertainty regarding instrumental precision and the effects of sample size on counting statistics. Thus, for example, a typical radiocarbon age estimate might be 24,342±450 years ago. This result represents the mean estimated age (24,342 years ago) and the range at one standard deviation (±450 years), indicating a 67 per cent chance that the age of the sample occurs within the range of 24,792–23,892 years ago. Combine this uncertainty with the fact that most radiometric methods do not directly date the objects of interest, such as artefacts or fossils, but rather associated material from the same or bounding strata. Thus, for example, although the K–Ar and 40Ar/39Ar methods can very precisely date lava flows, the age of a lava flow rarely has any direct interest to palaeoanthropologists. However, if this lava flow overlies an archaeological site, then it provides a minimum age for the underlying material, which must have been deposited before the lava flowed over the site and capped it.

There are a number of radiometric methods of age estimation that are used by palaeoanthropologists working in Africa. Radiometric methods work on the principle of more-or-less steady rates of measured isotopic decay, and more detailed treatment of these methods can be found in Ludwig and Renne (2000). Each method is applicable to different materials and different time intervals, and some are considered more reliable than others. Radiocarbon, 40Ar/39Ar and uranium series are considered among the most reliable. The radiocarbon method dates organic material such as wood or shell, and thus the age of a lava flow rarely has any direct interest to palaeoanthropologists. However, if this lava flow overlies an archaeological site, then it provides a minimum age for the underlying material, which must have been deposited before the lava flowed over the site and capped it.

Stone tool technology

Geological approaches form a natural component of the study of the African archaeological record. Stone artefacts represent the transformation of the geological record (rock) into the archaeological record, the latter preserving the physical traces of past human or hominin behaviours. Two elements are particularly important.

- The physical properties of the rocks selected for use as tools. Few of the rocks exposed on the Earth’s surface are suitable for making stone tools, and those that are have various physical properties that reflect things such as the ease with which they fracture for making stone tools, to how long they will retain a sharp edge for cutting or other tasks. Even the earliest tool-makers were aware of these properties, and their study along with how tools were made are important clues for understanding the evolution of human cognition and our increasing reliance on tools for survival.
- The distances over which stone was transported, either among mobile foragers or even by trade, provides the empirical data needed to study the emergence of the sorts of complex social networks characteristic of modern humans. These and other characteristics of a stone tool assemblage contribute to the OUV of African archaeological sites.

How do we know?

Archaeologists have learned about stone tool production from a variety of sources. These include the study of populations in Africa that make and use stone tools, or did so until quite recently (e.g. Clark, 1984; Weismann, 2006). There have also been a number of laboratory-based investigations of the physics behind tool production, as well as a number of experimental approaches used, including modern replications of ancient artefacts to understand their methods of manufacture (see Whittaker, 1994). These experimental approaches have helped shift the study of stone tools from one of finished products to an emphasis on the process of manufacture (Irwin et al., 1999). This process begins with the raw material: unmodified, naturally occurring stone. This typically occurs as primary deposits (e.g. outcrops) or as secondary deposits (e.g. rounded cobbles in a river bed derived from upstream sources), where material has been eroded from outcrops and redeposited elsewhere. After careful selection of pieces of the appropriate material, size, shape and quality, stone tool manufacture is a reductive process using a number of different means, broadly divisible into percussion, pressure and grinding.

The terms ‘tool’ and ‘stone tool’ are used rather loosely as our ability to infer which pieces of stone were used and what they were used for is often rather limited. While some pieces such as bifacial points (including arrowheads) are often carefully shaped with function inferred by analogy, many sharp edged flakes were probably used for cutting without further modification. Although microwear or usewear analyses can sometimes determine the function of these flakes, these methods are not universally effective or applied to all materials. Thus, ‘tool’ refers to those pieces of stone that were used or could have been used to accomplish a given task.

Stone raw material

Rocks typically used to make stone tools are fine-grained, homogeneous in composition, hard and fracture in a predictable manner. Even the earliest (>2 Ma ago) archaeological sites show that hominins could select high quality raw material from a range of options. At Gona (Ethiopia) and Lokalalel (Kenya), for example, hominins preferentially selected relatively fine-grained lavas that exhibit good conchoidal fracture. This selection is notable because these high quality rocks are rare in the cobble bars in the adjacent streams that were used as raw material sources (Stout et al., 2005; Harmand, 2007). At the approximately 2-million-year-old site of Kanara (Kenya), rocks that maintained a sharp edge even after repeated use as cutting devices were selected over those that flaked more readily (Braun et al., 2009). There are thus clear trade-offs among different rock types in their usefulness as tools (e.g. ‘durability’ vs ‘flexability’). At sites dating to approximately 164 Ka ago, some hominins in South Africa were even applying complex methods of heat treatment to rocks to modify and improve their knapping qualities (Brown et al., 2009).

In addition to determining the selection of materials for various physical properties, the study of stone raw material sources also allows us to determine how far stone tools were transported about the landscape. These data are important as
they provide empirical evidence for hominin ranging areas. Such a measure can be effective because stone tools were often discarded at areas far from where they were made, either because they were made in anticipation of future use (e.g. the rock quarry and the butchery site were at different locations) or because stone was a valuable resource in some parts of the landscape (e.g. there is only one raw material source for an area of 100 km²). Attributes of an artefact to its geological source requires methods similar to that employed in tephrostratigraphy: identifying unique physical or geochemical signatures of particular raw material sources that can be matched with artefacts from that source (Church, 1994; Shackley, 2008). These sorts of analyses compare artefacts to specimens from geological sources. They can include visual inspection using the naked eye, low power (10×) magnification or petrographic thin sections. A variety of geochemical analytical techniques is also used, such as X-ray fluorescence (Church, 1994; Shackley, 2008).

These data, mostly available from eastern Africa, show that by about 2 Ma ago some hominins were transporting stone artefacts >10 km away from the landscape (Brown et al., 2008). By 130 ka ago some artefacts of obsidian (a type of volcanic glass) were transported at least 300 km from their source (Merrick et al., 1994). This type of long-distance movement of stone probably exceeds the foraging range of past hominins, and instead signals the development of some sort of trade or exchange networks (Marwick, 2003; Ambrose, 2010). Among recent African foragers, these sorts of exchange networks are the material signals of important social ties among groups that often function to buffer various types of risk associated with drought years common to marginal environments (e.g. Ambrose and Lorenz, 1990). The Middle Stone Age archaeological site at Prolonged Drift (Kenya) shows that most of the obsidian at that site was obtained from distant sources, despite the availability of closer obsidian outcrops (Ambrose, 2006), and may emphasize that it was the social action of exchange, rather than the functional qualities of the stone, that was the most important. Stone raw material sources can represent an uncomplicated and potentially important aspect of the OUV of a site, and can provide a direct measure of the extended networks and landscapes inhabited by early hominin populations.

Techniques, methods, innovations

The study of stone tools reveals an increasingly diverse number of methods of modifying stone for the production of tools. Stone-working techniques are the means by which force is applied in order to remove pieces of stone (Tiesler, 1967). Making stone tools by removing smaller pieces of stone (‘flakes’) is referred to as knapping. Different knapping techniques vary according to the type of percussor used and the manner in which force is applied. Some percussors, such as hammerstones, are preserved in the archaeological record. The use of hammer-mades from bone or wood is inferred from traces left on stone flakes or tools. Experimental and archaeological evidence strongly suggests that multiple techniques were often involved in the manufacture of even a single stone tool (e.g. Toth, 1997; Tryon et al., 2005; Soriano et al., 2009).

Hard hammer (stone on stone) percussion is one of the most widespread and oldest knapping techniques known. Such hammerstones are identified in the archaeological record by the presence of cobble or other stones with localized pitting or battering resulting from repeated striking, and have been found among sites greater than 2 Ma old in eastern Africa (e.g. Roche et al., 1999). Useful stone flakes can also be produced by throwing one stone against another, striking a stone core against a larger stone (the ‘anvil’) to initiate fracture, or resting a core on an anvil and striking it from above, the so-called ‘bipolar’ technique (Schick and Toth, 1993; Toth, 1997).

Soft hammer percussion, in contrast, involves flake removal using a hammer or percussor that is softer than the piece being struck, typically to produce relatively thin flakes. Soft hammers include organic materials like bone or hard wood, as well as certain types of relatively soft stone (e.g. limestone or haematite). There is little direct archaeological evidence for organic hammers in Africa because they are unlikely to preserve in the archaeological record. Tiesler’s (1996) experiments suggest their use in flake manufacture at Isinya (Kenya) 700 Ka ago. Remarkably, the soft stone hammerstones are documented at Sibuku (South Africa) by traces of ostre or haematite (the rock from which the hammer was made) that rubbed off onto, and are preserved on, the flakes removed to shape ~70,000-year-old Still Bay (Middle Stone Age) spear points (Soriano et al., 2009). In addition to percussion, stone may also be fractured by the pressure technique by applying pressure to the edge of the stone while held in the hand using a piece of bone or other material. This technique was used for applying the final shaping to Still Bay points (Moure et al., 2010).

Some stone tools are also produced by cyclocizing. Ground stone tools often formed incidentally as a result of grinding or processing vegetal matter or pigments. Although often visually unimpressive, such tools can signal major shifts in human behavior, such as in the extensive use of pigments, perhaps as a colorant for decorating the body or structures, dates to at least 200 Ka ago (Barham, 2000). Other more recent examples of grindstones, such as those from Wadi Kubbaniya (Egypt) dating to the Late Glacial Maximum, record early evidence for the intensification of resource use to include labour-intensive foodstuffs needing extensive preparation, such as seeds and tubers (Wendorf et al., 1989a, 1988b). These are part of the general broadening of the dietary niche of early humans that represents a fundamental shift in our relationship with the environment, and in many ways was an important precursor to the origins of plant and animal domestication (Stiner, 2001).

Methods of stone tool manufacture

The method refers to the patterned sequence of gestures involved in sequentially removing pieces of stone in the manufacture of flakes or tools (Tiesler, 1967). Methods vary in the length of time it takes to make the objects and how much they contributed to the patterned variation in the archaeological record. Implementing these methods requires specific hand-eye coordination and a complex visual and spatial understanding of core morphology, which changes as the core is reduced (Stout et al., 2008). A number of different flake production methods were used at early African archaeological sites, including the discoidal, Levallois and blade production methods. Each of these represents a different approach to reducing a block of stone and often produces a distinctive type of flake or shape of core. Discoidal cores are the outcome of the flaking around the perimeter of a core, alternating flaking from one of two opposed surfaces. The resulting discoidal core is circular in plan view, biconical in profile, and distinguished by an irregular surface from which flakes were removed about its perimeter. Discoidal cores generally belong to some of the oldest Levallois Uplands; until the present, the method has consisted of a series of flaking that produces relatively wide, thin flakes. Levallois cores are shaped somewhat like discoidal cores, but differ in that the ‘upper’ and ‘lower’ surfaces are not used interchangeably. Rather, only the upper surface is used for the production of the larger Levallois flakes (Inizan et al., 1999). This sort of technology is commonly found at the sites associated with the earliest fossil Homo sapiens in Africa, leading some to suggest that it is an archaeological marker of the presence of our species (Foley and Lahr, 1997). Methods of blade production result in the manufacture of elongated stone flakes, and blades typically show less shape variation than the flakes produced by other methods. As such, they are often used in technologies where the stone elements are replaceable parts of composite technologies, as is inferred for some of the bored pieces and microblasts found at Middle and Later Stone Age archaeological sites. Blades have historically been considered a hallmark of modern cognitive ability, although this view is disputed by many (e.g. Bar-Yosef and Kuhn, 1999).

Types of stone tool

A diverse range of stone tools has been found at Early, Middle, and Later Stone Age sites in Africa. This diversity attests to both the increasingly complex ways in which tools were used, as well as the increasingly large numbers of functions that these tools served. Some types of tools such as Acheulian handaxes were made and used with little appreciable temporal or geographic variation for more than a million years, and are found across Africa as well as Eurasia. Such slow rates of change and spatial uniformity are foreign to modern expectations of rapid change and geographic diversity. In this sense, later tool types that show distinctive variation in time and space may provide the material evidence for more familiar patterns of the use of technology. Prominent among these are the Howieson’s Poort (HP) and Still Bay (SB) industries of southern Africa. Both persist for archaeological short time-spans (3 Ka – 5 Ka) and the strikingly similar forms produced at HP sites (distinctive backed pieces) and SB sites (distinctive bifacial points) occur in sites across South Africa and parts of Namibia (Jacobs et al., 2008). The apparent stark contrast between the HP and SB and the Middle Stone Age industries that came before and after them have led some to suggest that the makers of HP and SB assemblages were among the first populations of modern humans who subsequently migrated northwards and then out of Africa (Mellars, 2000). More detailed work focusing on how these stone tools were made is now indicating a more gradual appearance and disappearance of the HP and SB industries (e.g. Ponsa et al., 2008).

Early populations of humans in Africa

Stones are only one proxy for the diversity of hominin populations in Africa. The other key sources include the hominin fossils as well as the more rare elements of the archaeological record, including early evidence for art or related symbolic behaviour. The latter is a particularly human characteristic and the OUV of such sites may be correspondingly greater.

The hominin fossil record

The taxonomy of human evolution is complex and varies among palaeoanthropologists, who debate the significance of a variety of anatomical features for sorting hominin fossils into various categories (Wood, 2005). The issue is complicated, as fundamental concepts such as genus and species were originally developed for the study of living organisms. Applying
these concepts to the fossil record has proven difficult, as it is less complete and samples longer time spans, rendering our understanding of variation incomplete. For example, given a taxon such as Homo erectus that persisted for at least a million years, how much variation should we expect within this species, and how much or what kind of variation needs to be present to distinguish it from another species, for example, Homo sapiens? These are complex questions and rather than attempting to provide an answer, I choose instead to focus on the diversity itself.

Homo erectus is a particularly interesting taxon to consider in discussions of diversity. It is both long-lived (conservatively 1.6 to 600,000 years old) and widespread, being found across most of Africa and large parts of Eurasia, including as far east as mainland China and the Island of Java. Not surprisingly, there is substantial variation across time and space. Some distinguish the African and Eurasian specimens at the species level, designating those from eastern Europe (as Homo erectus) and those from Africa as Homo ergaster (Wood and Collard, 1999). Others, such as Anton (2003), emphasize the high levels of diversity among the sample, and suggest that Homo erectus is a highly variable, polytypic species across time and space. The diversity within Homo erectus is underscored by the Buia cranium from Ethiopia (Abbate et al., 1998) that includes a combination of physical characteristics once considered diagnostic of both the Eurasian and African populations.

Although the available data suggest an African origin for Homo erectus, Dennell and Roebroeks (2006) speculate that more complex scenarios such as an Asian origin for Homo erectus from an earlier pre-erectus migrant may be possible with the back-migration of Homo erectus into Africa. Given some of the age estimates and the ever-increasing database of dated sites, such a hypothesis is plausible. Moreover, their analysis of hominin diversity includes the geography of dispersed hominin populations as well as the archaeological record. Dennell and Roebroeks (2006) suggest that the variation in hominin fossils and artefact-making traditions may well result from the geographic isolation of hominin communities. This model need not be specific to Homo erectus. Indeed, similar models have been used to explain the biological and behavioural diversity among chimpanzees (Whiten et al., 1999), and it can work equally well for other populations of homins as well.

Hominin diversity

The diversity of humans on the planet today is one of the marks of what makes us human. The fossil record clearly indicates that diversity is an ancient characteristic of the hominid lineage. Every hominid fossil discovered is therefore an important document of this diversity. Measures of diversity are directly linked to sample size, and thus the more fossils found, the more robust the measure of diversity. The variation within Homo erectus has already been discussed above. Our own species, Homo sapiens, also has a complex history of changing diversity.

Variation within Homo sapiens is seen in the genetic record with the appearance of a number of distinct genetic lineages within our species appearing in Africa over the past 200 Ka (Behar et al., 2008). It is also seen in the fossil record. For example, in their analysis of hominin fossil remains from Herto (Ethiopia), White et al. (2003) attribute the three well-preserved crania to Homo sapiens idaltu, that is, distinct from living humans at the level of sub-species. While sub-species can be difficult to recognize and define even among living populations (and therefore particularly difficult among fossil samples), this designation serves to underline that members of our species from approximately 160 Ka ago do differ from those living today (Grine et al. 2007) and Crevecoeur et al. (2009) compare well-dated –40,000-year-old Homo sapiens crania from Africa (as well as Eurasia) to those of recent populations, and demonstrate that higher levels of between-population anatomical variation existed in the past than in the present. Combined with the Middle and Later Stone Age evidence for behavioural diversity (Clark, 1988; McBrearty and Brooks, 2000; Barham and Mitchell, 2008), these data suggest that although different in scale, behavioural and biological diversity among Homo sapiens has a long pedigree.

The hominin fossil record is diverse well before the appearance of Homo erectus or Homo sapiens. Diversity in the fossil record can complicate our interpretations of the evolution of Homo in Africa, and multiple hominins genera and species in Ethiopia (and before) the formation of the earliest archaeological record 2.55 Ma ago. This diversity renders it difficult to impossible to identify the identity of the stone tool-makers with any confidence. Olduvai Gorge in Tanzania, probably the most famous paleoanthropological site in Africa or elsewhere, makes an important case in point. From a single level at the site of EK 3N, come a number of Oldowan artefacts, the type of specimen of the robust australopithecus Zinjanthropus (Paranthropus) boisei as well as the homolotype for Homo habilis, the earliest recognized species attributed to our genus. Which species made the tool is uncertain, and indeed the anatomical evidence suggests that either may have.

The archaeological record: symbolic behaviour

The origins of symbolic behaviour are for many a defining point in characterizing modern human origins. Identifying it, is difficult, in part because we are limited to material items that happen to preserve in the archaeological record. Identifying symbolic behaviour is also difficult because although we may find the objects (e.g. beads), we lack an understanding of the contexts that gave the objects meaning. Indeed, our recognition of symbolic behaviour is largely limited to those items or actions for which we can see no obvious ‘function,’ in the sense of somehow actively modifying the physical world. For some, the widespread use of symbolic behaviour, particularly the use of personal ornamentation, and its current distribution from beach to beach, heralds the appearance of language and thus fully modern cognition (Klein, 2009). There is undoubtedly a fundamental change in the archaeological record at or near the appearance of Later Stone Age sites approximately 40 Ka -30 Ka ago, in part associated with an increased use of shell beads. However, as more and more African archaeological sites are excavated, there is increasingly good evidence for the, at least sporadic, earlier appearance of similar shell beads at sites approximately 80 Ka –70 Ka ago in both northern and southern Africa (Henshildwood et al., 2004; Bouzouggar et al., 2007). To some this signals an earlier date for the appearance of modern symbolic behaviour in Africa (McBrearty and Brooks, 2000), whereas to others the very sporadic nature of the appearance of this behaviour suggests that the use of material expression of material behaviour may be tied to population density, which likely fluctuated throughout prehistory (Powell et al., 2009).

The extent to which there were regional traditions of symbolic behaviour remains difficult to assess. In part, what shell beads were made from depended on geography; marine species were used at the coast, whereas landnails or ostrich eggshells were used at sites in the interior. In some instances, as at Bir-El-Ater in Algeria, marine shells were traded up to 200 km inland, indicating the sorts of landscape connections also inferred from stone raw materials (Vanhaeren et al., 2006). Ochre and other pigment use is widespread, but painted caves or rock shelters are rare beyond the Holocene (>12 Ka ago), and detailed comparisons cannot be made. Where sites with early rock art exist, such as the 40,000 – 50,000-year-old painted slabs from Apollo 11 Cave, Namibia (Vogelsang et al., 2010), they should feature prominently in considerations of OUV.

Treatment of the dead is also complex symbolic behaviour, the meanings of which can be very difficult to interpret from the archaeological record. The early evidence for treatment of the dead among early African hominins is fragmented, controversial and poorly understood, but hints at diversity among this important activity. Some of the earliest evidence occurs on an approximately 600,000-year-old skull from Bodo in the Middle Awash region of Ethiopia, with a number of cutmarks on the face and brow consistent with defleshing are preserved. As the face is a region with little nutritional value, the marks are consistent with any treatment (White, 1986). This contrasts with the approximately 160,000-year-old skull from Klasies River, South Africa. There, remains of Homo sapiens are highly fragmentary, burned and show cutmarks that these individuals held substantial meaning to the broader social group long after death. Some of the earliest complete burials include an infant from Border Cave (South Africa) dating to over 33 Ka ago and probably to 76 Ka ago (Gün and Beaumont, 2001) and burials of adults and infants from sites greater than 40 Ka ago at Terra Nova Hill and Nadel Khatar (Egypt) (Verniers et al., 1998; Verniers, 2002). These few examples hint at some of the rare but remarkable instances of early human symbolic behaviour in Africa.

Conclusion

Determining the OUV of African sites related to human evolution requires assessing a range of variables. Evidence from the geological record, stone tools and hominin fossils is critical for making this assessment. Geological context is fundamentally important, as it provides the foundation for determining site age and palaeoenvironment, and outcrops delineate the physiographic boundaries of most artefact- or fossil-bearing sediments. Among recovered artefacts, stone tools and the by-products of their manufacture are the most numerous, in part because of their durability. The ways in which stone tools were made demonstrates substantial diversity in early human technical skills, including the ability to select appropriate types of raw material from a range of possible options and to employ complex combinations of techniques and methods to produce different kinds of utilitarian tool types. The hominins that made these early stone tools included early members of the genus Homo and a number of other taxa, including our own species, Homo sapiens. Ancient populations of Homo sapiens probably differed in a number of ways from those living today, but show familiar patterns of biological and behavioural diversity as well as tantalizing clues of complex social and symbolic lives of which we can only glimpse small portions, including difficult-to-interpret personal ornamentation and special treatment of the dead. As these behaviours underpin all modern societies, they may be especially important to consider when marshaling valuable resources to preserve elements of African heritage that truly represent universal values.
Bibliography


How can ethnoarchaeology and human behavioural ecology inform conservation efforts?

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Introduction

Methodological and theoretical studies derived from studies of modern hunter-gatherers have a long history of use in archaeology and give life to the stones and bones recovered from prehistoric sites. Here I discuss the use ethnoarchaeology and models derived from human behavioural ecology (hereafter referred to as HBE) as two different, but complementary, tools that have special explanatory value for early hominin sites. In comparison to Holocene-age archaeological sites, early hominin sites often contain a limited range of artefacts, are often poorly preserved and/or taphonomically complex, and lack recognizable features and internal organization (e.g. Dominguez-Rodrigo et al., 2005; Kibunja, 1994). These challenging conditions often make direct interpretation of material remains very difficult without reference to ethnoarchaeological studies or theoretical models. I discuss the value of ethnoarchaeological studies and models derived from HBE as explanatory and predictive tools for the archaeological record, especially as it pertains to early hominin sites. My focus is on how these tools are used to infer, explain and predict subsistence and economy patterns from early hominin sites. Human evolution is characterized by a number of significant changes in subsistence economy (see Table 1) and some of these, such as habitual meat-eating and cooking, are believed to play pivotal roles in physiological, anatomical and behavioural evolution.

I begin by discussing the history and relevance of contemporary hunter-gatherer populations as sources of information for ethnoarchaeological research and models derived from HBE. I then focus on the use of ethnoarchaeological studies as sources of analogy for the archaeological record. While these studies clearly have explanatory and predictive value for the archaeological record, I also highlight how these tools can have practical applications in conservation assessments and site management plans for early hominin archaeological remains.

Contemporary hunter-gatherers, ethnoarchaeology and human behavioural ecology

Contemporary hunter-gatherers are often used as case studies in ethnoarchaeological research and as sources for testing hypotheses derived from HBE models. Human populations involved in all types of economic pursuits (e.g. horticulturalists, pastoralists) can also inform these studies (see David and Kramer, 2001), but hunter-gatherer populations have special significance because they embody a social, political and economic system roughly analogous to one that purportedly characterized 95 per cent of human prehistory (i.e. before the advent of domesticated foods). Contemporary hunters and gatherers are defined here as populations that gain almost all or at least more than half of their subsistence income by hunting and gathering wild resources. Hunter-gatherers are found throughout the world, but comprise less than 1 per cent of the total population worldwide (see Kelly, 1995; Lee and Daly, 2000a; 2000b). Today hunting and gathering populations are found throughout sub-Saharan Africa, but number less than 500,000 people (see Table 2, Hitchcock, 2000a).

<table>
<thead>
<tr>
<th>Milestone*</th>
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<tbody>
<tr>
<td>Habital and long-term meat-eating and acquisition</td>
</tr>
<tr>
<td>Sexual division of labour and diversified foraging effort</td>
</tr>
<tr>
<td>Expansion of diet breadth</td>
</tr>
<tr>
<td>Cooking and the advent of composite foods</td>
</tr>
<tr>
<td>Intensification of resources</td>
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<tr>
<td>Food storage</td>
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<td>Food production (domestication)</td>
</tr>
</tbody>
</table>

*These milestones are not necessarily listed in chronological order.

Table 1. Milestones in subsistence evolution
Approaches to the archaeological record

Table 2. Contemporary or Ethnohistoric African Hunter-Gatherers (after Hitchcock 2000a).

<table>
<thead>
<tr>
<th>Group</th>
<th>Geographic Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushmen (San, !Kung)</td>
<td>Namibia</td>
<td>Howell 1979; Lee 1979; Marshall 1976</td>
</tr>
<tr>
<td>Ju'/hoansi (!Kung)</td>
<td>Northern Botswana</td>
<td>Cashdan 1980</td>
</tr>
<tr>
<td>Khomani</td>
<td>South Africa</td>
<td>Hitchcock 2000a</td>
</tr>
<tr>
<td>Bugakwe</td>
<td>Northern Botswana, Namibia, Southern Angola</td>
<td>Bock and Johnson 2004</td>
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<td>Xanekwe</td>
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<td>Kua</td>
<td>Botswana</td>
<td>Vallette-Nousailes 1993</td>
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<td>Dama</td>
<td>Botswana, South Africa</td>
<td>Cashdan 1980, Lebzelter 1934</td>
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<td>Kwadi</td>
<td>Southwestern Angola</td>
<td>Cashdan 1980</td>
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<td>Tsua</td>
<td>Botswana, Zimbabwe</td>
<td>Hitchcock 1995, 2000b</td>
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Hunter-gatherers and changing views of early hominins

Anthropological perceptions of hunter-gatherers strongly influence how scholars view the lifestyle and evolution of early hominins. Although these views have changed over time, anthropological perceptions of hunter-gatherers and the inferences of prehistoric and premodern foragers often developed in tandem. According to Barnard (2000), there was no well-developed concept of hunting and gathering as a lifestyle prior to the seventeenth century. With the colonization of remote lands during the seventeenth and eighteenth centuries, perceptions of hunters and gatherers were shaped, in part, in an attempt to justify domination over diverse indigenous populations. Hunters (e.g. Barnard, 2000) living close to or as part of nature, but having ‘nasty, brutish and short lives’ (Hobbes, 1662). Some of these views prevailed into the nineteenth century with unilinear and progressive evolutionary scenarios that placed the advent of domesticated plants and animals as a great step forward for humanity in comparison to hunting and gathering, which was viewed as backward (see Morgan, 1964).

By the early twentieth century, anthropology gained steam as an established discipline and several ethnographers developed different kinds of models defining the uniform attributes (such as territoriality, exogamy, warfare, etc.) that defined all hunter-gatherers (e.g. Radcliffe-Brown, 1948; Steward, 1938). Steward’s (1938) work was particularly important because it recognized the link between different economic and sociopolitical features and the local ecology. However, despite the anthropological interest in hunter-gatherers, very little systematic information on how these populations lived actually existed. At the same time, early discoveries in palaeoanthropology, such as the Taung child identified by Dart (1925), lead scholars to contemplate how early ancestors lived. Dart (1953) envisioned aggressive hominins, driven by bloodlust and possessing cannibalistic tendencies, that lived largely by hunting. The eventual discovery of ‘living floors’ at Olduvai Gorge (FLK 22 Zinjanthropus, Bed I) and the presence of kill-sites and home bases (Type B and C sites, respectively) at Koobi Fora seemed to support the hunting scenario (e.g. Leakey, 1964; 1971; Isaac, 1971). These findings reinvigorated the long-standing idea that hunting, as manifested by historic and contemporary hunter-gatherers, had ancient roots in human prehistory (see Ardey, 1961). But it was not until the late 1950s and early 1960s with the excavation of the Mesolithic age site, Starr Carr, by Grahame Clark (1954) that hunter-gatherer archaeology became an established field of inquiry.

In 1966, the pivotal ‘Man the Hunter’ conference (see Lee and DeVore, 1968) brought together some of the most detailed and systematic studies of contemporary hunter-gatherers ever assembled. This conference challenged prevailing typological models of hunter-gatherers and questioned long-standing behavioural stereotypes about subsistence, territoriality and sociopolitical organization. R. B. Lee’s (1979) work with the Ju’hoansi hunter-gatherers was probably the most influential of these new studies and his ethnographic study informed (and continues to inform) archaeological reconstructions for decades. Lee’s work:

- challenged the idea that meat was the dominant resource by highlighting the importance of gathered foodstuffs; and
- promoted the view that subsistence needs could be met with very little work effort (but see Hawkes and O’Connell, 1985).

These new studies gave rise to another set of misconceptions about hunters and gatherers who were often popularly portrayed as embodying a zen lifestyle having very few wants and needs and ‘living the original affluent lifestyle’ (e.g. Sahlin, 1972). Ethnographic studies of contemporary hunters and gatherers were viewed as appropriate ‘living analogues’ with direct application to inferences of hominin evolution (Washburn and Lancaster, 1968). One highly influential model was the ‘home-base model’ proposed by Glynn Isaac (1971; 1978), which emphasized the use of central locations, food transport, meat-sharing, a sexual division of labour and pair bonding as an integrated adaptive complex that separated hominins from apes. The model drew heavily on the ethnographic record of contemporary hunter-gatherers, and while it has since been challenged, remains a cornerstone in the history of thought on hominin evolution.

By the late 1980s and early 1990s, revisionist views replaced old perceptions with new stereotypes, often portraying contemporary hunter-gatherers as disenfranchised victims and/or professional primitives (e.g. Headland and Bailey, 1991; Schrire, 1980; Wilmsen, 1989). Revisionist paradigms were important because they drew attention to the fact that most known contemporary hunter-gatherers did not represent isolated populations and were actively engaged in larger economic, social and political networks. The fallout from these views cast doubt on the value of hunter-gatherer studies in general, and extended to reconstructions of early hominins’ lifestyles with the rejection of models drawn from ethnographic studies (see Binford, 1981; 1984; 1988; Blumenschine, 1987; Blumenschine and Pobiner, 2007). Many palaeoarchaeological researchers, for example, concluded that the earliest hominins were obligate or passive scavengers of the leftovers of prey killed by carnivores (fields) and that the behavioural patterns displayed by contemporary hunters and gatherers did not emerge until after the spread of anatomically modern humans (e.g. Binford, 1985; 1988). Both of these ideas continue to inform reconstructions of past hominin lifestyles (see Blumenschine and Pobiner, 2007; Dominguez-Rodrigo, 1997; 1999b; Dominguez-Rodrigo et al., 2007) and have led to a wider (and ongoing) argument about when behavioural modernity emerged (Klein, 2000; but see McBrearty and Brooks, 2000).
More recent views of contemporary hunter-gatherers are built on a wider range of theoretically driven ethnographic studies (e.g. Alvared and Gillespie, 2004; Bird and Bliege Bird, 1997; Hill and Hurtado, 1996, Lupo and Schmitt, 2004; Sosis, 2000).

Using theoretical models, these studies not only describe, but also attempt to explain, the adaptive variability in economic, social and political systems deployed by these populations. In archaeology, and especially in research on hominins, parallel attempts to explain behavioural variability displayed in the archaeological record through the use of theoretically driven models are still in nascent stages (but see Havkes et al., 1991; O’Connell et al., 1999; O’Connell et al., 2002).

**Problems with hunter-gatherer analogues**

The use of modern hunter-gatherers as analogues and referents for the archaeological record is often criticized as being limited by a biased and tautological ethnographic record (e.g. Wobst, 1978: 207). Nevertheless, there are some approaches that make contemporary hunter-gatherers poor reference points for prehistoric populations, and especially premodern hominins. For example, all known contemporary hunter-gatherers are (and have been) involved in larger interaction spheres and networks that include non-foraging populations. Forest foragers in Central Africa, supplement their diet by growing domesticated crops and/or by exchanging forest products for starches grown by settled horticulturalists (Lupo and Schmitt, 2004). Historically, the Okeik (or Dorcabo) in Tanzania exchanged wild honey with settled horticulturalists for grain (Blackburn, 1974). Other populations, such as the Hadza in Tanzania and the Jù’Hoansi of Namibia and Botswana, regularly interact with tourists and are employed in wage labour with local enterprises. Historically, a number of San groups were employed as soldiers in civil and national wars (see Wilmsen, 1989). Thus, none of these populations can be considered full-time hunter-gatherers representing a pristine condition or isolated people unaffected by larger local, national and global events. Most contemporary hunter-gatherers are living in so-called marginal or extreme environments, defined as locations marginal for agricultural and livestock production. Some Bushmen populations, for example, were historically or recently pushed into these non-traditional areas through marginalizing military and political processes. Most of the Ju’Hoansi, who once lived a very mobile lifestyle, are now living at permanent camps next to boreholes. Others, such as the Hadza, have found their homelands diminished by the encroachment of herding populations, and some segments of the population have been forcibly settled in government camps. There are no living examples of hunter-gatherers occupying highly productive ecological zones. Clearly, the range of variation in ecological and social structure displayed by contemporary populations is limited and other kinds of structures that are not recapitulated in the ethnographic or historic record likely existed in the past (Kusimba, 2005).

Probably the most often repeated critique against using models based on contemporary hunter-gatherers focuses on the anatomical, technological and inferred behavioural differences that separate modern humans from premodern hominins. Australopithecines lacked modern dental and masticatory architecture, gut morphology and digestive kinetics, and had a life history that was comparable to a modern chimpanzee (Pan troglodytes) (e.g. Aiello and Wheeler, 1995; Aiello and Key, 2002; Aiello, 2007; O’Connell et al., 2002). In comparison with modern homins, early Homo (H. habilis and H. rudolfensis) had a smaller cranial capacity with presumably different cognitive abilities, a smaller body size, and used very simple stone tool technology (i.e. Oldowan). More modern physiology and anatomy including increased body and brain size, shifts in body fat to muscle ratios and a trend towards a slower-paced life history does not emerge until some 1.3–1.8 Ma with Homo erectus. True anatomical modernity is not achieved until Homo sapiens appears and even then it is not clear if these populations were cognitively or behaviourally modern. Some specialists argue that anatomically modern homins underwent a neurological brain reorganization resulting in a cognitive revolution some 40,000 to 50,000 years ago (Klein, 2000; but see McBrearty and Brooks, 2000). To compensate for the differences between modern humans and early hominins, some researchers advocate using other sources of analogy such as non-human primates, especially chimpanzees. But the use of other non-human organisms as analogues for premodern hominins rests on the assumption that the behaviour of those organisms is static and has not undergone change over time. Modern chimpanzees separated from the last common ancestor leading to modern humans some 5 Ma, and recent phylogenetic reconstructions based on mitochondrial (mt) genomes demonstrate the emergence of two different lineages and at least four subspecies beginning some 2.1 Ma (e.g. Bjork et al., 2010). Whether or not the observations of modern chimpanzees are representative of ancestral populations that lived some 5 Ma remains open to question.

**Implications for conservation**

Despite all the caveats discussed here, contemporary hunter-gatherers still represent the best source of information researchers have for understanding and reconstructing the past. Contemporary humans represent the current end point of ongoing and continuous dynamical evolutionary processes. Researchers can only understand the complex trajectory of those processes by reference to the end point. These studies not only have relevance for understanding human evolution but also can directly inform conservation efforts.

As discussed further below, by using predictive models and testing hypotheses derived from HBE, studies of modern hunter-gatherers can provide insights into important and potentially universal behaviours and features that are not readily appreciable from the archaeological record. Predictions concerning different aspects of the past human behaviour and the archaeological record will be based on hunter-gatherer studies, such as age of foraging range, maximum resource transport distance and the location of central places or residential sites relative to resources can be directly applied to the management of site properties by defining site areas.

Hunter-gatherer populations, themselves, comprise a unique storehouse of information for many different disciplines that have a positive and appreciable value for industrialized and post-industrialized societies. For example, understanding how changes in subsistence influenced hominin evolution has practical applications beyond archaeology, and can inform recent discussions concerning the epidemics of cardiovascular disease and metabolic syndrome that plague contemporary industrial societies (Colagiuri and Miller, 2002; Cordain, 2005; Satin and Eaton, 2001). A recent study is particularly illustrative Cordain et al. (2002) conducted a comparative dietary study of thirteen hunting and gathering societies worldwide. They found that a high reliance on animal proteins characterized these populations, with meat representing a mean proportion 68 per cent of diet and in some cases much more. Curiously, they found no signs among these populations of cardiovascular disease that currently affects most post-industrial nations. These and other studies suggest that meat and fat consumption might lead to disease and challenges the current therapeutic treatments for these conditions (high carbohydrate and low-fat diet) offered in post-industrial nations. Because these hunters and gatherers do not live under the same conditions as people in commercialized and computerized nations, they offer a unique test case of many assumptions concerning the effects that a post-industrialized lifestyle has on health, diet, psychological well-being, etc.

Finally, because hunter-gatherers worldwide are rapidly diminishing and models derived from these populations have been, and continue to be, so influential in guiding reconstructions of early hominin behaviour, conservation efforts should be extended to protect the homelands of foraging peoples. Although, hunting and gathering populations will continue to change and respond to modern circumstances, their ethnographic histories represent pivotal referential sources that have guided perceptions of early ancestors for decades and, as such, have extraordinary value to everyone.

**Ethnoarchaeology: archaeological analogies from the real world**

Ethnoarchaeology is a methodology used to generate simple analogies to help interpret the archaeological record. By definition, it is the study of contemporary peoples from an archaeological perspective. It necessarily involves the direct observation of people to make connections between dynamic actions (or behaviours) and static patterns (material remains). Ethnoarchaeology found impetus as an outgrowth of so-called ‘action archaeology’ as practiced in the 1950s and 1960s (Kleinidest and Watson, 1956; Heider, 1967), and became a formal field of study in the late 1970s and 1980s. Most of these early applications focused on testing common assumptions used by archaeologists to interpret the material record against ethnoarchaeological observations (see Heider, 1967; Binford, 1988; O’Connell, 1987; O’Connell et al., 1991; Stiles, 1977). One of the most significant works came from Binford (1978, 1981) who used ethnoarchaeological observations of modern Nunamiut Eskimos as a backdrop for re-evaluating faunal remains from important early hominin sites, such as Olduvai (Binford, 1981; 1985; 1988). He concluded that the Olduvai faunal assemblages were dominated by animal heads and feet which ran counter to the part selection that typified modern hunters, and compared favourably to parts abandoned by predators at kill-sites. This analysis, in part, led Binford (1981) to challenge conventional views of early hominins as hunters by proposing that these populations were obligate, marginal scavengers who exploited the largely defleshed limb bones of carcasses abandoned by bone-crunching predators to obtain small amounts of marrow and tissue.

**Problems with ethnoarchaeology**

The central weaknesses and difficulties with ethnoarchaeological studies were recognized early by researchers. Ethnoarchaeological applications to the archaeological record largely constituted the use of analogies and were plagued by the same problems associated with the use of any analogue (Wyley, 1982, 1985). As stated by Wyley (1985) all analogies, regardless of what they are based on, are amorphial and, by their nature, imply the existence of more similarities between cases than can be established from the premises and are always liable to error. Furthermore, many early ethnoarchaeological studies only tested and (usually failed) different archaeological assumptions (so-called ‘cautionary tales’), but rarely proposed alternate models for the archaeological record concept (Simms, 1992). This put ethnoarchaeological studies in the site of debunking assumptions rather than refining and developing future research possibilities. But some of the most significant weaknesses to the approach were identified by O’Connell (1995). He observed that almost all ethnoarchaeological studies were descriptive and bound within a specific cultural and temporal context. While these studies can identify deviations in the archaeological record from their observations, they were unable to predict or explain variability in behavioural patterns, especially those from...
Approaches to the archaeological record

Case examples in ethnoarchaeology and conservation implications

Ethnoarchaeological studies are used as analogues to interpret and give life to archaeological remains on different scales of analysis. Here I describe just a few case examples of recent ethnoarchaeological studies and how their findings might be relevant to conservation efforts.

Toolmarks on large animal remains: A recurring theme in early hominin studies concerns when habitual meat consumption emerged. Toolmarks are used as a catalyst for the use of fire by prehuman species, and for activities such as the division of labour (Isaac, 1978; Kaplan et al., 2000) and is implicated in the evolution of anatomical and physiological features associated with early Homo (Avello and Wheeler, 1995; McHerrin, 1994; Millson, 2003; Wood and Collard, 1999). However, inferences concerning how, when and why early hominins obtained carcasses – and, by implication, the quantity, quality and predictability of animal protein in the diet – remain highly controversial (Binford, 1981; Blumenschine and Pobiner, 2007; Dominguez-Rodrigo, 1999a; 1999b; Dominguez-Rodrigo et al., 2007; O’Connell et al., 2002).

Current debates focus on when hominins first began acquiring fully fleshed big-game carcasses and are based largely on the identification and interpretation of toolmarks displayed by animal bones recovered from paleoarchaeological sites. Ethnoarchaeological studies, in concert with well-controlled experimental research, provide the basis for identification and functional interpretation for these toolmarks (Dominguez-Rodrigo et al., 1997; Egeland, 2003; Lupo and O’Connell, 2002; Pobiner and Braun, 2005). Given the importance of meat eating in hominin evolution, the presence of authenticated toolmarks on animal bones can potentially enhance the conservation value of a site or series of sites.

Thus far, some of the earliest known toolmarked bones are from the Hata Member of Boun Formation (Ethiopia) and date to approximately 2.5 Ma (see de Heinzelin et al., 1999). Bone specimens from this site include incisions displayed on a mandible of a medium-sized alcapli-tine; cuts, chips and hammerstone marks on the tibia midshaft of a large bovid; and dismemberment and fillet marks on a Hippotherium (three-toed horse) femur (de Heinzelin et al., 1999). At Gona, a site complex dating from 2.58 to 2.1 Ma, there is evidence of toolmarks on high flesh-bearing parts of medium and large-sized animals (Dominguez-Rodrigo et al., 2005; Semaw et al., 2003). More recently toolmarked bones from the Sid-hakama Member of the Hadar Formation in Dikika (Ethiopia), predates 3.9 Ma, could push the date for tool-use and meat-eating back over 800,000 years (McPherson et al., 2010). The cut, scrape and percussion marks on bovid remains purportedly represent the earliest toolmarked bones and are putatively associated with the remains of Australopithecus afarensis (but see Dominguez-Rodrigo et al., 2010).

Clearly, the debates over meat-eating are based upon multiple lines of evidence, but small-scale analogies, such as the interpretation of cutmarks, are often crucial to the overall inference. Conservation managers can further assess the importance of a site or site area by understanding and evaluating the scale and value of the analogies within the larger body of evidence. Importantly, some small-scale analogies are important to the overall history of thought on hominin evolution that transcends their direct interpretive value. For example, Binford’s (1981; 1984) interpretations regarding obligate scavenging hominins are also based on specific kinds of cutmarks that he believed reflected the butchering of stiff and desiccated carcasses. Even though these data were later shown to be ambiguous (e.g. Lupo, 1994), the evidence and associated sites remain important cornerstones in the history of evolutionary thought on early hominins.

Site and land-use patterns: Early ethnoarchaeological studies found that artefactual remains in human residential camps were often spatially organized into so-called activity areas (O’Connell et al., 1991). Several very prominent studies in ethnoarchaeology were devoted to evaluating whether or not standard archaeological field techniques (excavation and collection) adequately sampled sites given the size and organization of known contemporary hunter-gatherer camps. Yellen (1977) was one of the first to note that most archaeological field excavations were too limited in areal extent and exposure to capture the internal spatial structure of hunter-gatherer camps (Lyman, 1991; O’Connell, 1987). To improve recognition of different activity areas, more recent ethnoarchaeological studies are using microscopic and pedologic evidence to identify work areas, special-purpose camps or specific features in sites created by contemporary hunter-gatherers. Mallof et al. (2007), for example, use microscopic sedimentary features to characterize different kinds of hearths used by Hadza hunter-gatherers. Krudnov et al. (2004) found that short- and long-use Yupik fishing camps can be associated with unique and persistent special activity areas within those camps can be distinguished by different chemical compositions. These newer studies are important because they demonstrate the level of analyses that is required to identify finer-grained patterns of activities within sites.

On a larger landscape scale, inter-site comparisons of assemblages and sites can shed light on subsistence, economic and technological organization. In Binford’s (1978; 1981) seminal ethnoarchaeological study of the Nunamiat Eskimo, he focused on human settlement and subsistence patterns and the different ways in which people organized sites on the landscape to exploit different resources. His basic point was that in order to understand the relationship of different systems of prehistoric hunter-gatherers, anthropologists needed to gain a broad landscape scale perspective on the location of different kinds of archaeological sites. This perspective guides the rationale behind large-scale and systematic survey and landscape level analyses of sites and (site areas). Recent ethnoarchaeological research combined with GIS analyses and remote sensing identify fine-grained associations between different ecological features/landscape and specific sites or resources that might have been useful in the past (see Devineau et al., 2008). These data, in turn, are used to construct models to predict site location relative to resource distribution in the distant past. Additional ethnoarchaeological research, shows that within the larger organization of land use, sites or camps with a short period of use (such as camps and butchering sites) are most likely to reveal accurate information about resource use (Binford et al., 2001). Larger (and more archaeologically visible) sites were more likely to be palimpsests and less likely to yield clear pictures of human behaviour.

Conservation managers can make use of these studies in three different ways. First, these studies give managers a basis for evaluating the underlying methodology used to excavate a site. By understanding the limitations of standard archaeological practices (such as the limited areal extent), managers make decisions about how much area in and around a site should be protected for the future. They can also make decisions about whether or not additional research is warranted. By gaining an understanding of the limitations of the methodology used to make inferences, conservation managers are better informed to evaluate the value of a property. Second, conservation managers can also make use of the principle of landscape use when assessing the boundaries of properties or significant site areas for protection. Important sites generally do not exist in isolation, but are part of a larger system of organization involving more sites/locations. An adequate understanding of the organization of the system requires information for all adjacent sites. Different methods currently exist (see the discussion below on central place foraging models) which might help managers estimate maximum areas of protection for specific kinds of sites. Finally, using data derived from ethnoarchaeology, managers can discern which sites within a property are more likely to have behavioural value and yield accurate information about the past.

Human behaviour ecology: use of explanatory and predictive models in archaeology

Human behaviour ecology is a style of evolutionary thought that examines how environmental and ecological factors influence variability in human behaviour (Kelly, 1995; Smith et al., 2001; Winterhalder and Smith, 2000). HBE builds on concepts derived from evolutionary ecology, which examines the interaction between evolutionary forces and ecological variables, by focusing on behavior (Broughton and O’Connell, 1999). Anthropological and archaeological applications of models derived from human behavioural ecology to human populations began some thirty years ago (Bayham, 1979; Hawks and O’Connell, 1985; Jochim, 1988; O’Connell and Hawks, 1984; Simms, 1987; Winterhalder, 1981). The basic premise underlying HBE is that organisms are designed by natural selection to optimize reproductive success and are capable of rapid adaptive shifts in behaviour to adjust to environmental circumstances (Smith et al., 2001). While HBE can be used to address a variety of different kinds of behaviour, it is best known for models that address the foraging decisions of an organism. For example, the diet breadth (or prey choice) model predicts which resources an organism selectively exploits from a specific range of resources from the environment. Patch choice models examine why an animal selects specific resource patches over others and predicts when an animal should leave a patch to pursue other opportunities.

HBE models often take the form of optimization models. An optimization model is a quantitative tool used to assess the costs and benefits of different foraging strategies that defines: 1) the range of available choices, 2) the currency used to evaluate those choices, 3) the presumed goal of the organism and 4) the constraints that limit the payoffs of different choices (Trivers and Davies, 1997). Two important and interrelated concepts underlie optimization analysis: the idea of trade-offs and the principle of lost opportunities. The premise is that organisms unconsciously evaluate trade-offs among different strategies by comparing potential gains from exploiting a particular resource against the lost opportunity of pursuing an alternate resource (Stephan and Krebs, 1986). Currency refers to the units (currency) used to measure the costs and benefits of different decisions aimed at fulfilling a forager’s goal. An organism can have a variety of goals, usually in foraging models the goal is to maximize energetic return. Constraints include intrinsic and extrinsic factors, such as physiological limitations and encounter rates with prey, that may limit the pay-off derived from a strategy. These characteristics of optimization models are important because deviations between the predictions of any model and the observed pattern invite a reconsideration of the currency, goals and constraints.
Approaches to the archaeological record

Case examples in HBE and their implications for conservation

Although models derived from HBE are applied to any number of phenomena (Bird and O’Connell, 2006; Lupo, 2007; Winterhalder and Smith, 2000), the strongest applications are in questions about subsistence or economy.

Diet breadth models: Perhaps the model most often used in archaeology is rationale derived from the diet breadth model. The prey choice model assumes that foragers rank resources along a single scale of profitability, usually kilocalories obtained per unit of time (post-encounter rate). The basic assumption is that foragers attempt to maximize the long-term net rate of energy acquisition by adding resources into the diet in rank order from highest to lowest until the return rate per unit of time is maximized (Smith, 1983; 1991). Three important predictions follow from the prey choice model:

- foragers should always pursue high-ranked resources whenever they are encountered;
- the inclusion of lower-ranked resources in the diet depends on the chance of encountering higher-ranked resources; lower-ranked resources are added into the diet as a function of the abundance of higher-ranked resources and not as a function of their own abundance; and
- resources are added to and deleted from the diet in rank order.

Direct applications of the diet breadth to the archaeological record are hindered by the fact that most sites lack good preservation of organic materials (see Grayson and Cannon, 1999). Evidence for the consumption of certain resources is likely to be absent from most deposits, especially those dating to remote time periods. Another problem restricting application of the diet breadth model to the archaeological record concerns how return rates are estimated for different resources. Return rates are often based on observations of modern hunter-gatherers and/or replicative studies. But prey profitability varies as a function of the circumstances of capture (single or mass) and technology used to acquire and process the resource (Grayson and Cannon, 1999; Lupo, 2007). The problem is further compounded by the purported behaviour, physiological and technological differences that characterised premodern hominins. Early Homo, for example, lacked modern masticatory and digestive capacity and may have based resource selection on slightly different criteria than modern humans. Thus, most archaeological applications of the diet breadth model are indirect and generally make use of the underlying rationale that guides the model. When the encounter rate with high-rank resources increases, the expectation is that the diet breadth will become narrower and emphasize those resources. Conversely, when the encounter rates with high-ranked prey decrease, foragers will spend more time looking for additional and lower-ranked resources and the diet will expand.

This rationale can be applied to evaluate recent models that posit different selectional hypothetical changes in the diet of early hominins. Most researchers point to major anatomical and physiological features in later Homo (H. ergaster and H. erectus) that indicate an increased energetic demand and correspond to a higher quality diet some 1.8–1.7 Ma (Aiello and Wells, 2002; Aiello and Wheeler, 1995; Leonard and Robertson, 1997). If this model is correct it implies that high-ranked resources were becoming less abundant and that the diet was broadening and expanding.

By placing the significant milestones in human subsistence within the theoretical context described here, conservation policy can gain a greater understanding of the ecological factors that influenced hominin evolution. For example, a broadening of the diet at 1.8 Ma and the possible inclusion of fallback foods corresponds to well-documented changes in the environment (Kimbel et al., 1996; Segal et al., 2007) and the onset of intense global cooling and drying. If this scenario is correct, we expect foraging ranges to increase in size, as foragers must cover larger segments of territory to meet basic nutritional needs. Conservationists can fruitfully apply this information to estimates of the size of protected zones around sites dating to this time interval.

More recently some researchers have pointed out that the longitudinal pattern of human dietary change (including the milestones listed in Table 1) point to a general pattern of increasing the efficiency of food processing (Wrangham et al., 2009). However, it is important to recognize that increase in the efficiency of food processing as such may not lead to a reduction in the use of fallback resources if the use of fallback resources is an important strategy. This is particularly true if fallback resources are not limited in supply or if the fallback resources are able to maintain a high quality of diet even when the environment becomes more variable.

Costly signaling theory: Recent ethnographic evidence demonstrating that some men consistently pursue high-risk, costly or seemingly wasteful hunting opportunities even when less costly and more reliable alternatives are available challenges the conventional and long-standing view that men hunt to provision their families (Biege Bird et al., 2007; Lupo and Schmitt, 2004; Sosis, 2001). Furthermore, although meat is an energetically rich resource, prohibitions and customs governing its consumption and redistribution often limit the caloric rewards that hunters and their families can garner from these opportunities. These customs take several forms from prohibiting hunters from butchering and eating meat from their own kill to rules concerning who receives specific shares of meat, and societal norms that support the generous and widespread sharing of meat from certain prey with non-family members (Hawkes et al., 1991; Lupo and Schmitt, 2004; Wiessner, 2002). Hadza big-game hunters, for example, on average take home only 10 per cent (or less) of the meat they acquire and their shares are no larger and often smaller than those received by others (Hawkes, 2000).

Other researchers propose that high risk or costly hunting endeavours may work as a signal of the hunter’s qualities to others. Costly signalling theory (CST) promotes the view that certain kinds of activities are costly, but honest, signals to others about the signaler’s underlying qualities or intentions (see Table 3, Bird et al., 2001; Hawkes and Biege Bird, 2002; Biege Bird and Smith, 2005; Zahavi, 1975; 1977). CST refers to signals that are so costly that they impose a handicap on the possessor, are impossible or very difficult to fake, and work as honest indices of specific qualities. These signals ensure not so much that the message is received but that it is perceived as honest (Conk, 2005). While a signal can take many forms, useful signals relate to the skill, knowledge or quality being advertised and play to the characteristics of the receiver or audience (Biege Bird et al., 2001; Conk, 2005). According to this view successful hunters who engage in costly hunting activities reap direct benefits in the form of high quality, calorically dense, edible resources and also receive non-consumptive benefits such as access to younger and/or harder working wives, larger networks of allies and/or trading partners, increased popularity and political deference (e.g. Biege Bird and Smith, 2005; Hawkes, 2000; Smith, 2004; and Biege Bird, 2002; Wiessner, 2002).

The recognition of costly signalling in the archaeological record might help to explain the appearance of different forms of artistic expression, elaboration of ornamentation and ultimately shed light on the underlying processes that give rise to social inequalities (e.g. Hagan and Bryant, 2003; Pleurde, 2008). In the archaeological record of hunters and gatherers, CST could explain the appearance and persistence of seemingly inefficient or high-risk foraging activities. This approach has been recently applied to early hominin foraging strategies by O’Connell and colleagues (1999; 2002; Bird and O’Connell, 2006; Hawkes et al., 1991; 1998). They argue that female foraging and food sharing, not meat provisioning and acquisition, drive many of the physiological and anatomical changes associated with Homo species. According to this view, big-game acquisition by aggressive scavenging emerged as a kind of costly signal or competitive display by males, in tandem with shifts in female foraging and food-sharing patterns. Climate-driven reductions in foods that juveniles could handle on their own beginning approximately 2–2.5 Ma initiates a dietary shift involving a change in foraging range and broadening of the diet with an emphasis on difficult to acquire, but predictable and high return resources. The broadening of the diet increases the search costs for resources, and technological innovations that reduce the cost of processing emerge. In this model, adult females provision their offspring by collecting tubers (USOs – see Dominy et al., 2008). As provisioning by females and a heavy dietary reliance on tubers becomes established, older females assisted their junior kin favouring the survivalship of grandchildren and giving rise to a slow-paced life-history profile which underwrites increased life spans, decreased juvenile mortality, larger body sizes, and higher population densities (Hawkes et al., 1998; O’Connell et al., 2002).

Results of CST studies can enhance conservation efforts by redefining the appearance of specific artefacts or assemblage characteristics in the context of broader social evolution. In other words, CST recasts the emergence of specific behaviours within the overall evolutionary trajectory of the social and political complex that currently define our species. If, for example, the above scenario is correct, the appearance of large animal remains reflects a broader process of competition and the emergence of social processes within early Homo.

Table 3. Examples of costly signaling identified in the literature (see Lupo n.d.)

<table>
<thead>
<tr>
<th>Group</th>
<th>Activity</th>
<th>Purported signal</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faluk (Melanesia)</td>
<td>Torch fishing</td>
<td>Work ethics / skills</td>
<td>Sosis (2002)</td>
</tr>
<tr>
<td>Hadza (Tanzania)</td>
<td>Big game hunting</td>
<td>Social attention</td>
<td>Hawkes et al. (1991)</td>
</tr>
<tr>
<td>Ju’hoansi (Namibia)</td>
<td>Big game hunting</td>
<td>Social cohesion / social networks</td>
<td>Wiessner (2002)</td>
</tr>
<tr>
<td>Martu (Australia)</td>
<td>Kangaroo hunting</td>
<td>Generosity / political abilities</td>
<td>Biege Bird and Smith (2008)</td>
</tr>
<tr>
<td>Mer (Torres Strait)</td>
<td>Funeral feasts</td>
<td>Generosity / lineage solidarity</td>
<td>Smith et al. (2000)</td>
</tr>
<tr>
<td>Mer (Torres Strait)</td>
<td>Turtle hunts</td>
<td>Political abilities</td>
<td>Biege Bird et al. (2001)</td>
</tr>
<tr>
<td>Mer (Torres Strait)</td>
<td>Spear fishing</td>
<td>Abilities</td>
<td>Biege Bird et al. (2001)</td>
</tr>
</tbody>
</table>
Central place foraging models (CPF). CPF is an umbrella term that refers to several different foraging models that examine the behaviour of non-human foragers who transport resources to a central place to consume and/or provision offspring (Griars and Pearson, 1979). CPF models focus on how the costs of transporting a resource influence resource choice, load size, distances between foraging patches, the placement of central places and degree to which prey are processed (Kaspari, 1991).

Approaches to the archaeological record

In an anthropological context, CPF models have been applied to explaining the selective transport patterns of large animal remains by Hadza hunter-gatherers from the place of procurement to the place of consumption (O’Connell et al., 1988; 1990). Others have used CPF to model the distances different kinds of resources will be transported given different field processing costs (Bird and Bleie Bird, 1997; Metcalfe and Barlow, 1992). For example, Bird and Bleie Bird (1997) demonstrated the value of CPF by predicting the maximum terminal foraging distance (MTFD) for processed shellfish loads by Merian Islanders of the Torres Strait. They found that Merian processed different shellfish species in such a way as to maximize the rate of edible flesh delivered to a central place.

Several simplified versions of CPF are proposed for archaeological contexts to estimate distances between resource procurement points and central places (Jones and Madsen, 1989). Jones and Madsen (1989) propose a model that assumes that a resource load will not be transported beyond the maximum transport distance (MTD) or the point at which energy expenditure for carrying the load exceeds its caloric value. The model is most useful as a tool to rank the relative transport distances of resources rather than to calculate absolute MTD (see Madsen et al., 2000), because transport costs are hard to accurately estimate and vary as a function of terrain, body mass, shape and bulk of package and other factors (see Brannan, 1992; Lupo, 2006; Rhode, 1990).

Applications of CPF models to the early hominin record could be used to address a variety of questions about landscape use such as maximum size of foraging range and maximum distance of resource transport. These data might directly inform the conservation process by defining the hypotetical use area associated with specific properties and by extension the maximum zones of protection around designated sites.

Future and emerging questions

One additional value of HBE is its ability to help researchers and conservationists to identify new and emerging questions in human evolution. Some of these questions may be difficult to identify solely by reference to the archaeological record. For example, one emerging area of research has generated a number of archaeological applications of life history theory. Life history theory examines how energy is allocated throughout an organism’s life. Interestingly, modern humans have unique life history parameters in comparison to other primates that include: helpless young requiring prolonged parental investment, early weaning and short inter-birth intervals, a juvenile growth spurt, prolonged post-reproductive life-span and longevity.

One very influential model examining early hominin evolution through the lens of life history changes is proposed by Kaplan et al. (2000). They argue that a prolonged period of growth and learning was required in early Homo to develop the skills to be a hunter and gatherer. According to this view, hunting emerged among early Homo species as a strategy for provisioning helpless offspring with high quality, but technologically demanding, food resources during prolonged periods of juvenile dependency. Highly variable climate conditions favoured an environmental and dietary shift emphasizing cognitive solutions and intellectually demanding extractive technology (Kaplan et al., 2000). As juvenile periods became more prolonged, delayed or increased, periods of productivity into later life. Several consequences of this shift include delayed growth and maturation associated with longer periods of cognitive and intelligence development.

A more recent model that is built on the same rationale, stresses the role of cumulative social learning for the transfer of extramapric information and cooperation as central features of uniqueness in modern humans (Hill et al., 2009). In this model, early Homo species used large home ranges and focused on technologically demanding, but high quality food resources, including hunted prey, by 2 Ma. But provisioning dependent offspring and food sharing among adults was not sufficient to decrease adult mortality or increase juvenile dependency. The slow maturation pattern that typifies modern life-history profiles emerged well after the shift towards hunting, possibly by the Middle Pleistocene. Additional features, such as population growth, reliance on social transmission and cumulative cultural capacity, probably occurred later in time with the emergence of anatomically modern humans (Hill et al., 2009).

One might argue that life-history parameters are not readily discernable in the archaeological record and require large samples of skeletal remains. But general life-history parameters of extinct hominins may be inferred from body mass, brain growth and dental development (Dean, 2006; but see Robson and Wood, 2008). Nevertheless, the timing of the emergence of longevity and the prolonged post-reproductive lifespan in women, remain highly contentious (e.g. Hawkes et al., 1998; Kennedy, 2003; Martin, 2007). Recent findings by Casperi and Lee (2004), for example, suggest that longevity (as measured by the ratio of older to younger adult skeletal remains in archaeological contexts) did not significantly increase until the early Upper Palaeolithic.

Niche management and environmental interaction: Although, hunter-gatherers were once viewed as closely tied to the environment and often portrayed as conservationists, recent studies have underscored the ecological impacts of small-scale societies. For example, prey overhunting is documented in a number of ethnographic studies involving hunting societies (Alvard, 1993; 1994; Hames, 1987). But the role of prehistoric overhunting in species extirpation remains a controversial topic in archaeology (see Haynes, 2002; Grayson and Meltzer, 2002). Several very prominent archaeological studies have identified resource depression from overhunting in assemblages created by prehistoric hunter-gatherers (Broughton, 1994). Despite these findings, several other recent studies have identified instances of intentional resource management or niche construction among contemporary hunter-gatherers.

Niche construction was introduced by biologists in the 1980s and refers to a process whereby an organism modifies its niche and influences the course of evolution. Laland and Brown (2002) nominate niche construction (even if weakly expressed) as a primary cause of evolution along with selection, drift and mutation because it can change the frequency of variants and affect the direction of evolution.

Several prominent examples of niche construction are reported in the ethnographic literature involving the use of fire. Intentional burning of vegetation serves many different functions including increasing the encounter rate with certain prey, and encouraging the growth of specific plant foods. The Gitkan and Wet’suwet’en in British Columbia used fire to manage the availability and productivity of two kinds of wild berries (Gottfried, 1994). In Australia, the Kuku Yalanji hunter-gatherers, who occupy rainforest habitats in Queensland, manage wild yams by using fire to clear vegetation and maintain open forested areas where these plants grow (Hill and Baird, 2003). Recent ethnographic research among the Martu Aboriginals in Western Australia demonstrates that intentional burning of vegetation can increase women’s foraging efficiency and might attract large game (Bird et al., 2005). Intentional burning of wild grasses to drive prey is also widely reported throughout Africa and may serve additional functions that are as yet unrealized.

The prehistoric use of fire as a management tool is controversial, but some argue that long-term use of fire regimes/management significantly impacted some geographic areas for prolonged periods. In Australia, for example, the intentional anthropogenic use of fire is purportedly reflected by increases in charcoal and changes in the fossil pollen composition of sediment cores dating back to the Late Pleistocene (Miller et al., 2005; but see Mooney et al., 2011 for a different view). If, as some now argue, early hominins had the use of fire some 1–1.5 Ma (Brain and Silfen, 1988; also see Goren-Inbar et al., 2004) then intentional burning and management could plausibly date even earlier. Regardless of when intentional burning emerged, it is clear that hominin environmental modifications are part of our evolutionary history.

Conclusion

Ethnoarchaeological studies and models derived from HBE are eminently useful for explaining and predicting patterning in the archaeological record. Studies based on contemporary hunting and gathering populations provide especially useful tools for interpreting early hominin sites that generally contain very limited amounts of artefactual debris. But these same studies also have practical applications to conservation and site management plans. Case examples discussed here show how ethnoarchaeological studies might be used in conservation to

- evaluate site value and significance based on the scale of the analogy used to interpret the site and associated material evidence;
- assess the archaeological methodologies used to excavate the site with an eye towards future potential studies; and
- define and establish site boundaries or protected buffer zones around site areas.

Studies in HBE can inform conservation efforts by:

- providing models of the larger ecological circumstances surrounding specific sites and occupations;
- defining foraging ranges and potential zones of archaeological interest; and
- identifying future potential research questions that are often not directly associated with the appearance of a specific artefact or site.
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Approaches to the archaeological record


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Africa: the origins of humankind. Towards a better representation of human evolution in the framework of the World Heritage Convention

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In 1871 Darwin published ‘The Descent of Man’, in which he stated that we come from primate ancestry and that the original coordinates of this evolutionary process had to be placed in Africa (earning him the caricature of an ape in ‘The Hornet’, a satirical journal). Both of these assertions clashed completely with the Victorian spirit. Many decades were to pass before the necessary evidence about the processes of adaptation to the environment could be obtained and analysed, especially evidence concerning the relationship between organisms, the origin and extinction of species, and the domino effect of these fluctuations in terms of biodiversity. Since this time, the evidence discovered has become undisputed proof about evolution, although the charting of Neanderthal remains and Java Man was of some consolation to those who believed that Europe was the cradle of humanity. During the early decades of the twentieth century the Piltdown skull somewhat reassured a Europe that was unwilling to accept that the *Australopithecus africanus* discovered in 1920 could have anything to do with our evolutionary descent. Eurasia and Africa started gathering evidence from then on. Humankind’s ancestor, the *Zinjanthropus boisei*, was a discovery made in Olvudai, Tanzania, in 1959. We still do not know how to position it in our genealogical tree, but from that moment on Africa undoubtedly became the epicentre of every investigation. And since then, the African continent has remained a destination for international archaeologists and paleontologists to analyse the origin of our cultures, which has continued to evolve in its own way and to radiate from there in successive waves throughout the other continents. Africa is the ancestral home of the evolutionary history of hominids over the past 7 Ma, and of the history of its cultural evidence for 2.6 Ma. Africa incontrovertibly became the most prized seat of all the developments in biological and cultural change in our history.

Africa registers the longest sequence of human occupation of any continent, which confers it with a distinctive value. To compare it with the rest of the sequences throughout the world is also crucial. This exceptional sequence represents an unparalleled and unprecedented opportunity to understand our history as a species, first as members of the hominid line and later of the genus Homo, and to interpret in depth our appearance and behaviour as modern humans. Africa is home to our first ascription of meaning to things.

The contributions presented here allow an unequivocal coordination of evidence on a large scale and provide an explanation of some of the mechanisms of change. Ecological pressures and technological responses, anatomical changes and cognitive abilities are all explored through this study on morphology and on behaviour patterns, not to mention the analysis of the social transfer of learning.

Man and the chimpanzee share 98.8% of their genetic heritage; 8 Ma ago their genetic patterns began to diverge. New technologies and original myths attempt to respond to a universal curiosity that looks for an explanation of our earliest moments, whether from a biological or a cultural standpoint. Over the past 20 years, 6 new fossil descendants of the human family have been found, and palynological, ethnohistorical and genetic knowledge has continually grown with regards to the analysis of evolutionary events and the changing environments of natural selection. From the HEADS meeting in Burgos in March 2009, Professor Toshisada Nishida’s contributions to our analysis included the importance of factoring the 250 species of primates that live on Earth today into our sequence of study, and of reminding us that primates and humans have bigger brains than the rest of the mammals. This is fundamental for developing forms of social interaction and learning, manipulating raw materials, acquiring learnt behaviours and forethought, and cultivating community-family dependence. Our primate heritage explains a great deal about our place in the natural world (Potts, 2010). Bearing this in mind, it is vital to preserve their habitats in Africa today, just as Professor Nishida argued. We remember him in these pages as we reiterate our appreciation for his consistency in petitioning the international community to take a more integral approach in our analysis. We are deeply sorry for his loss.

The work of the researchers who participated in the Addis Ababa meeting in February 2011 has sought liaisons between specialties and between the technical and professional experience of their teams, resulting in an enormous amount of fossil evidence, and studies on formation, deformation, the way in which bones and teeth grew, and diets thanks to isotopic analysis, among others. Developments in genetic research and the very proliferation of archaeological material from around 2.6 Ma ago in East Africa mean that there is no lack of evidence for these disciplines to be able to develop as a whole and therefore to renew the spirit of enquiry in this research area. Studies presented here explore ways of studying behaviour patterns, the first evidence relating to symbolic behaviour 75 Ka ago, the rapprochement of disciplines to distance or discriminate between behavioural customs amongst chimpanzees and Homo, studies on bipedalism (a fundamental trait which separates us from our closest living relatives) and all other developments in biological evolution, group hunting, and production and use of lithic tools. With all of this, pools of knowledge can be gathered on how natural selection has operated at different moments of human evolution. This is why we need fossil records that provide evidence of adaptations and variations, but also the context in which they were discovered. Only with this synergy of content and structure can we understand how we became human, and both components are essential to be able to define a ‘site’ related to human evolution in the context of the implementation of the World Heritage Convention.

We do not know the nature of our last common ancestor with chimpanzees, nor do we know at what point they diverged. We do not know exactly where, how and when the first members of the *Homo* genus evolved, although undoubtedly it was in Africa more than 2 Ma ago. We possess scant and scattered evidence in Africa of apes between 12 and 8 Ma ago, and it is difficult to connect evidence found in East Africa over the past few years either with the first ape fossils or with the most recent hominids. Only after 4 Ma is there any evidence of bipedal locomotion. The first species of the genus *Homo* appear 2 Ma ago. The first hominids were able to inhabit extremely varied environments, although evidence is still very fragile, and they were able to cope with very different habitats within short distances, such as in the Afar Depression, Ethiopia, or in Lartoli, Tanzania. Although there are many questions left open, we can be reasonably sure that the answers are still to be found in Africa.

Africa has the biggest archaeological sequence on the planet, thereby constituting the whole continent with Outstanding Universal Value (OUV). For every human being, Africa signifies a journey back through our own history and a reconstruction of the itinerary. Our fossil heritage is the most common heritage of all humankind, and these pages invoke a spirit of reconnection. The earliest evidence of social behaviour of the origins of our coexistence habits, of language and symbolic thought are all found there.

Sibudu Rock Shelter, South Africa. © University of Tübingen
Conclusion and way forward

In Africa, science has been claiming for cultural autonomy since 1950, as well as for originality in the processes. Africa constitutes the basis for explaining modern societies. Genetics was able to reassess Brauer and Stringer’s convictions that the ancestral home of humanity is irrefutably Africa (Conrad, in this publication).

The most obvious message that can be gleaned throughout these pages is the conviction that physical, cognitive, technological and climatic matters need to be cross-referenced in order to establish a justification of the OUV of places linked to human evolution, as well as to define the conditions of authenticity and integrity. I would now like to draw attention to some of the neglected and neglected issues of the group of participants from the workshop, which are based on the latest arguments on how to plot interpretative gateways between the definition of the criteria for the Convention, and the best way to adapt them to the justification for the values of sites related to human evolution.

Professor Christian Tryon’s dissertation allows us to get to the bottom of the questions we need to address when using the criteria for cases of sites linked to human evolution. The geological record serves as the clue for the case. The study of sediments acts as an interpretative context for deposition and is what can really document the time of the changes. An understanding and a study of the geological framework is vital for understanding and interpreting biological or behavioural changes, which is why it has a special role in the identification of OUV. The importance given to the geological context does not in itself imply that it has the capacity to generate an independent value, although there is no reason to rule out the fact that criteria like (vi) or (ix) could pick up tectonic or volcanic activities that could be used to date and establish sequences and developments throughout the evolution of our descent. The geological context serves as a backdrop for different contemporaneities in genera and species of hominids, as well as in the loss of this diversity, which allows us to take stock of an enormous variety of morphology without always finding explanatory clues. The difference between genus and species is essential for the study of other living organisms; and the subject is even more relevant for designating the variables in what happened in our everyday lives. Their contributions establish that every variety has an essential role in putting together the jigsaw puzzle entitled: understanding human diversity.

After putting forward arguments about the value of geology as an interpretative key, it is clear to perceive its role in terms of designating the limits of a site, and the value of the role of geological contexts in defining conditions of authenticity and integrity when we try to agree upon the definition of geological unity. In the same way, it is also vital to analyze the sedimentary environments and depositional environments where sites are found, and at the same time the imposed conditioning related to the research plans both on a superficial and a stratigraphic level. Furthermore, as the geologist acknowledges the hierarchy of the litho-stratigraphic units, their observation is fundamental for all other disciplines that attempt to study the fossil record, human or otherwise. It is therefore obvious that evidence of behaviour models needs to be large scale, painted on a broad, general level. Therefore it is necessary that behavioural evidence be interpreted with the aid of geological parameters. Similarly, the site formation and variations in the deposits should be studied within a geological space and time frame. Geological studies also enable us to show how aspects connected to the integrity of the place need to cover distances of over 10 km from the finding in order to take into account sources of supply, positional forms, etc. Mineral heritage and its dynamics have been fundamental in demonstrating the significance of places like Omoh, Sterkfontein or Melka Kunture, where geological analysis has taken place, representing a full 30 years of active archaeological intervention. The geological map permits us to define limits and guarantee effective monitoring. Geological studies are essential for establishing primary geological positions and primary spatial positions, and the extent of alteration in the deposits.

In the case of chronology, we have proficiency in an enormous battery of radiometric methods, measures of isotopic decay, measuring through 40 Ar/39 Ar methods and the uranium series, luminescence methods, and of more detailed readings of radiocarbon chronological techniques. The participants recommended the need to use diverse methodologies in order to acquire different technical and disciplinary readings in the making of the site. The chronology of sediments, organic remains, lava and volcanic deposits are fundamental in the definition of OUV, as well as of the preservation of places referenced for dating of a whole continent, as in the case of Olдува, a place which has an incredible number of radiometric ages. Stratigraphy is understood as the great chronological tool for the reconstruction of our evolution. And where neither volcanism nor radiocarbon reach, scientists are aided by the uranium series and electron spin resonance dating, with computer tomography and SEM scanning.

Electron microscopy. Recent chronological dating methods and progress made in genetic interpretation are what have caused bibliographies on human evolution to grow over the last few years. With all of this the experts emphasized that chronology should not be understood as a value per se, and that the oldest fossil of some morphological variety may be as outstanding as the dating sequence, which allows for morphological or environmental variables linked to evolution to be established.

In Africa lithic industry appeared around 2.6 Ma ago, and that is where archaeology attempts to disclose the results of human activity and evidence of caring remains, food, fuel or hunting remains, habitation structures and evidence of a social or symbolic function. Forso it is not the absence of record and their relationship the record continues to leave, even today, unanswered questions. Together in this purpose are all the methodologies which now allow us to define the deliberate choice of rock according to its specific properties. The study of lithic technologies and the distance from the supply source are elements which assist in supporting the scaffolding of the OUV. Many of the contributions presented here make specific mention of the relationship networks built up after the MSA and of evidence of forms of use of materials and processes which go beyond functionality. Early stages of diverse patterns of canyons have been identified and fully connected to the same localities and some familiar remain in the scholarship project, and in the whole continental space, the analysis of an analysis framework which surpasses by far the map of exceptional findings in East Africa. South Africa presents a potential scenario for deciphering the interaction between culture and biology, through international archaeology campaigns which are beginning to find wider contexts to explain changes. The coast of the Indian Ocean benefits from dynamic intervention methods and a range of ways of verifying the fossil record. Since the findings in Blinkbos, South Africa, which seemed unique we are now making similar discoveries, such as ochre and ornaments. This area of study is invaluable for contributing to the debate on the diversity of adaptive responses, thanks to the evidence discovered from specialization in coastal adaptations, vital in broadening the array of cultural responses in modern humans.

It is clear that archaeological sites and palaeontological sites cannot be conceived as the place where a fossil or artefact is located. The artefact might be a fundamental part in the interpretation of the site, yet it cannot represent the entire basis of its value. If we wish to be in a position to study behaviour, we need to include wider conceptual and physical frameworks in our analysis, both in surface area and stratigraphic sequence.

In studies of evolutionary processes it is equally essential to examine the biological markers of the environmental conditions of hominid sites to explain adaptive models. Professor Raymond Bonneille’s contribution is a clear appeal for multidisciplinarity. The composition of plant landscapes (wood, fruits, grasses and seeds) or of micro-components such as pollen, phytoliths and bioelements associated with the oxygen and carbon cycle, are also essential for defining the conditions of authenticity and integrity of the record. Reference collections on Africa built up over the past 40 years enable us to work out sequences that began 8 Ma ago. The palynological record is neither lithic nor ossuous, but it has an unquestionable archaeological value. Translating the density variations of pollen’s vegetation cover, in a constant dynamic, has been fundamental for creating a background reading on continental value, like those of Turkana or Awash. Plant cover is accompanied by changes in variations detected in the fossil record in dietary adaptations and dental morphologies. Adaptive strategies also need to be understood in conjunction with environmental sequences.

We cannot forget the contributions that disciplines such as ethnography and cultural anthropology have developed, generating influences on the subject of hunter-gatherers and prehistoric humans.

In addition to the issues associated with analysing isolated erosion factors of depositional or post-depositional effects, challenges in establishing parallels of behaviour with non-producing societies, especially due to weaknesses of the oldest records, also need to be considered. The potential of the study of ethnographic models has been widely debated during the last 20 years. It has never been easy to identify how mobility records, stelite and diastole aggregation and the dispersion of hunter-gatherers groups ‘deposit themselves’. Furthermore, the types of habitats diversify since the end of MSA and, more so, in LSA. What is certain is that there were always bridges between archaeological and ethnographic disciplines that tried to find keys of inference. In this volume Prof. Deacon and Prof. Lupo talk about the possibilities and the results of the application of ethnoarchaeological methodologies, that is to say the process that contemporaries study from an archaeological perspective.

The developments in human behaviour ecology have been important in recent years when it comes to analysing how environmental factors influence human behavior. In reality the bridges between these disciplines create complex problems that cannot be answered by one sole discipline. What has been illustrated is that these disciplines can contribute to conservation work. The study of the identification of the scale of the investigations, the site’s limits, the methodologies of excavation and the area of influence. The contemporary study of occupation models and hunter gatherer methods open the way to questions which would not have been able to be made by themselves from an archaeological record and can be fundamental when interpreting sites such as Olorgesailie. Social and cultural anthropology also claim a role in this debate with a view of collaboration. The importance of the anthropological reading of human origins and have helped this cause with a key role in the reconstruction of human behaviors over one hundred years. The origins of human social life, Primatology, evolutionary psychology and genetics get caught up with the debates established by anthropology, giving clues on the use of resources, rituals, forms of relationships, reciprocity or political organization. Prof Deacon talks about the importance of oral records and the need for better conditions of preservation and recording the same time, recording and binding artistic expression of one of the most prolonged cultural sequences in Africa. The recommendation carries a sense of urgency. In the same way it is necessary to develop, as quickly as possible, protocols for anthropological research with original, contemporary communities.

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Why do we need an interdisciplinary approach?

With regards to the scientific methodologies previously analysed, the participants of the meeting in Addis Ababa identified a series of recommendations concerning interdisciplinarity, underlining scientific understanding and innovation as key in the transformation of perception of the built, archaeological and natural heritage environment (UNESCO, 2011).

The heritage environment has undergone repeated transformational pressures, the survivors of the past demonstrating resilience against many cycles of changing natural environments, cultural preference, economic conditions and conservation practice. The heritage environment will be subject to substantial transformational drivers over the coming decades - by economic, governance and sustainability pressures, linked to climate change impacts as well as mitigation and adaptation across a range of scales (UNESCO, 2011).

To meet future challenges there is a need to develop effective, adaptable management and decision-making policies and methodologies that utilize to best effect the latest scientific and technological developments. Heritage underpins and supports sustainable development. The proper conservation and utilization of our historic assets enhances our living and working environment. It also mediates cultural and historic identity at a range of spatial and temporal scales; important for our societies’ wellbeing. Its effective management also plays a significant role in the drive towards sustainability, including the need for increased conservation of resources. There is a complex interaction here between social aspects and material understanding, that involves a wide range of stakeholders, from individual citizens concerned about their cultural reference to government that makes decisions on management and conservation, academics, and industry supplying services working directly in conservation.

What is interdisciplinarity?

The interdisciplinary approach is of the utmost importance in the identification, study, management and evaluation of the sites. In Africa, any scientific and conservation project must be balanced in a way to involve many disciplines across the natural and social sciences (broadly defined) but whose list doesn’t need to be constrained. Beyond such multidisciplinary considerations, the discussion among the thematic group was more focused on the actual interdisciplinary dialogue and synergies (UNESCO, 2011).

In consideration of the conclusions of the Burgos meeting, and with special reference to African sites, the participants stressed that, prior to any study or nomination file, specific emphasis must be attributed to systematic analysis across the full range of existing and potential stakeholders. Legal and cultural dimensions in particular are integral to an interdisciplinary approach.

A consequence of ICOMOS having the responsibility for human-related sites is that, when dealing with human evolution-related sites, there is a possible neglect within IUCN of Quaternary geology, geomorphology, and Quaternary Science in the original meaning of the word.

Interdisciplinarity also needs to be integrated into monitoring and evaluating transformations. Dynamic natural phenomena may lead, for instance, to erosion, deflation, burial and flood. Human action may lead to physical changes, such as land use (e.g., pastoralism, agriculture and other intensive development aspects, which are often critical in Africa), and site management projects. Transformation processes may affect the narrative, conceptual and scientific value of the site, and understanding these impacts may require the application of emerging technologies. Owing to development initiatives and conceptual/ideological changes, the socio-cultural value of the site may also change.

Understanding patterns and processes of such transformations is a mandatory task in which interdisciplinarity plays a crucial part.

- Evaluation and periodic review of OUV and authenticity should be carried out within an interdisciplinary framework and used to assess change and development in these attributes.
- There is much scope for the inclusion of interdisciplinary evaluations of the boundaries for individual sites and the scope of serial sites, for example the use of stratigraphic boundaries to define archaeological sites. The underlying principle is that the boundaries should reflect the nature and scale of the phenomena under consideration, and be open to revision.
- Assessment of a site’s potential value, including less visible material proxies and its potential to yield future information, should be defined by multiple disciplines.

In identifying protocols responding to transformation processes, mechanisms could be put in place which overcome fragmentation in the research basis, and create new synergies, by bringing together researchers and research users in an expert multi-disciplinary and multi-institutional grouping. Such a group or groupings could apply itself to consideration of themes such as ‘Resilience and Adaptation’ and the ‘Nature of Transformation’, in relation to built, archaeological and natural heritage to encapsulate commonalities in material culture and environment. Included in this could be the development of responses to current and predicted climate change at a high spatial resolution.

Priorities could include:

- A programme to establish the foundations of heritage resources at sites. They can be used in the prioritization of resources and intervention strategies.
- Collaboration in the framework of the HEADS Programme with the Advisory Bodies and active networks which could stimulate a reappraisal of Neogene and Quaternary Studies in terms of World Heritage, especially towards the treatment of human evolution. Included in this might be a consideration of how criteria (ix) can be incorporated into expressing the role of landscape and landscape history in relation to human history.
Applying World Heritage criteria to human evolution sites

Table 1.

<table>
<thead>
<tr>
<th>Sites with hominin findings</th>
<th>Comparison of use of criteria for Sites Inscribed on the World Heritage List and on the Tentative List</th>
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The participants discussed at length how to interpret the criteria that justifies OUV in order to better express the meaning of paleoanthropological and/or archaeological sites associated to human evolution. According to Table 1, it is clear that there is a tendency to include natural values in the Tentative List to better reflect the integrated relationship between nature and culture. These pages justify a holistic approach to ensure the integrated conservation standards of fossil records, fundamental in allowing an interdisciplinary reading of the site and contributing to the justification of the relevant conditions of its integrity. The participants found it necessary to move forward reflecting more deeply on the use of criterion (viii).

The following points related to human evolution-related sites were identified in accordance with the existing criteria (ii)-(iv) outlined in the Operational Guidelines for the Implementation of the World Heritage Convention, and are open for future discussions:

(ii) The need to better conceptualize the expression ‘human values’.

(iii) The appreciation that this criterion has been widely used in inscribed sites. At the time of inscription, these sites did not, for the most part, include large archaeological deposits from cultural traditions or civilizations. It is interesting to note that the stages of evolution have been conceived as stages of civilization, placing all the value of the discovery of outstanding fossils in its research history.

(iv) This criterion, in fact, is the closest in representing technological and archaeological sites such as fossil records that have born witness to our ancestors’ morphological, biological and cognitive changes. ‘Human history’ is fundamental to the general statement of this criterion and includes all evolution of the genus Homo.

(v) Subsistence strategies, almost certainly specialized from an early date, can be linked to this criterion, e.g. coastal sites such as in the case of South Africa.

(vi) It is essential to characterize cognitive advances and forms of symbolism which are central in understanding our ways of learning, our beliefs, our faculty to use language and our capacity to transmit knowledge.

(vii) Some places are associated to sites of somatic beauty.

(viii) Some of the sites inscribed on the World Heritage List or submitted to the Tentative List incorporate outstanding stratigraphies which are key in understanding the history of the formation of continents, in addition to acting as a record of tectonic or volcanic activity which allows dating fossil records with relative or absolute chronology.

(ix) All species that accompany the genus Homo throughout evolution explain ecosystems and biological fossil diversity that are crucial in interpreting the first hominids’ paleo-economic and paleo-environmental behaviour.

Geographies of cooperation

I would like to emphasize key issues that have been raised in the contributions on sites in Ethiopia and in the Maghreb area. Ethiopia deals with sites where research history has evolved more and more rapidly since the inscription of sites on the World Heritage List and new evidence brings about the need to adjust forms of management and conservation, at the same time as adjusting protection limits to include research’s latest findings. North Africa, in turn, is to be included in the continental area so that processes that have taken place in its environment do not overturn the framework of interpretation of Mediterranean sequences. In addition to his contribution, Prof. Kuper points us to another critical step in the adapting history of the African continent: nomadic pastoralism in the Sahara.

The case of Ethiopia

For five decades, unequalled, consecutive archaeological results increased and transformed our knowledge about the evolution of genus and species, with sequences that start in the Middle Awash Valley around 6 Ma ago. Included in this is the recent discoveries of Dikika, Australopithecines, dated to 3.4 Ma ago in the Lower Awash Valley. Furthermore, a new site called Fejej, has been uncovered which dates to 1.9 Ma ago. Although it is not within the limits of the inscribed site, Lower Valley of the Awash, the boundaries of the site could be extended to include it to strengthen the site’s OUV. New evidence obliges us to adapt structures of protection and conservation.

The site of Middle Awash, which includes the whole complex of Afar and dates back to 4.4 Ma, has become a permanent area of research since its inscription on the World Heritage List and is now home to 300 archaeological sites; 50,000 fossils and a huge range of lithic industries were found. The World Heritage Retrospective Inventory exercise serves the purpose of updating, reviewing nomination files and defining and redefining limits, and/or updating regulations or management structures appropriate to the nature and scope of new evidence.

Omo is a point of reference for biochronological dating for the whole of Africa. Prof. Beyene’s work indicates a certain urgency in taking action on the development that will take place in the region. Prof. Delange’s contribution acts in tandem, confirming the area’s potential and challenges. His work shows us how difficult it is, despite having exceptional preservation conditions, to limit settings in Neogene and Quaternary environments which has been affected by major volcanic and tectonic activity. The area is allowing us to study early on for evidence the dynamics of paleoanthropological and archaeological records, and with it, the ability to analyze the intent of manipulation of the stone. Archaeologists’ micro digs have benefited from taphonomic methods developed by palaeoanthropologists. What is clear from Prof. Delange’s work is the struggle to distinguish, in the early phases of stone work, what is the product of human intention, anthropic activity and what is not. The application of new analytical methods is key in revisiting nomination dossiers and in broadening the spectrum of the site’s OUV. This is in accordance with the results of the most recent research into the Shungura formation which has already more than 100 sites of low archaeological density. This micro/macro reading is fundamental in understanding the position of deposits, in analysing what happens between archaeological sites and in order to be able to better design archaeological interventions before starting the excavation process.

In the case of North Africa

North Africa is where the sequence from the Lower Palaeolithic and the first continental migration dating back to 1.8 Ma ago is found, and shows evidence of some of the first adaptations of Homo ergaster/erectus. However, we still have very little research on the forms of subsistence of hominids in the Maghreb and it was only recently that we had the first palaeoecological and paleoenvironmental reconstructions. It is important that this geography be integrated into African studies, that North African terminology be incorporated into the rest of the continent’s and that the specificity of this geographical area be recognized from African industries. From a palaeoenvironmental point of view, this space protects the cultural and natural history of the desert and thus the subsequent forms of adaptation to aridity and to grazing.

Herders have not been studied in much detail archaeologically and this discipline is underdeveloped as a field of African studies. Their nomadic traditions and perishable material leave very transparent footprints, difficult to identify, and when they are visible they are difficult to preserve. Prof. Kuper’s contribution introduces us to the Holocene and evidence of domestication.

The North African contributions raise our awareness of the cultural richness through social archaeology of the territory. From latitude 37ºN to 35º, Africa gathers the world’s largest deserts, rivers and most plentiful lakes. These contributions encourage us to consider territories less remote but also in need of archaeological and anthropological attention and heritage protection. These areas play an important role in the social history of Africa today.
Conclusion and way forward

Human evolution narratives and African sites

In order to get balanced spatial and temporal coverage, the experts recommended further reflection on the potential of the following narratives/sites in order to contribute more effectively to the Global Strategy for World Heritage in terms of sites related to human evolution.

The following narratives identify different types of evidence of human evolution. They were drafted at the Addis Ababa meeting (UNESCO, 2011) to guide decisions by States Parties and to contribute to a credible, balanced and representative World Heritage List. The African sites suggested below could be considered for inclusion on the Tentative List and could ultimately start a candidature process to the World Heritage List. The list is, nevertheless, a useful guideline for the scientific community in Africa to help fill in the gaps in our knowledge about the long process of human evolution on the African continent.

1. Palaeontology, biology and physical anthropology: hominids among primates and genetic studies
   a. The oldest ancestors of human lineage, including great apes.
   c. Neurological evolution.
   d. Genetics and palaeogenetics of great apes and the human lineage.

2. Fossil traces of cognitive steps: cognitive changes and human biological and cultural evolution
   a. The manufacture of artefacts.
   b. Conceptual ability and transmission, including symbolic behaviour, the use of ochre, art, personal ornaments and burial.

3. Fossil traces of technological and subsistence innovation - economic and cultural adaptation to changing environments
   a. Fire control, behavioural changes from scavenging to animal domestication by means of hunting and collecting marine resources, and plantation preservation in the environment.
   b. The technological progress of artefacts from simple flakes to pottery by means of prepared cores and composite tools.
   c. Habitat patterns, e.g. shelter construction.

4. Colonization of new environments – records of expansion in new niches
   a. From tropical woodland to open woodland and grassland.
   b. From tropical to temperate areas.
   c. Specific or extreme environments.

5. Dispersals and migrations
   Within Africa, pan-African settlements including arid and elevated regions.
   Pulses of colonization, territorial and demographic expansions and contractions, noticeably in connection with climatic changes, environmental collapses and the availability or reduction of resources. Special attention must be paid to the major climatic events of the Quaternary including the Last Glacial Maximum and subsequent Holocene climatic change.
   Colonization from Southeast Asia to Australia and the Pacific Islands, the New World and high latitude areas.

Some of these narratives do not apply to Africa. Those that do apply have been identified at sites in the following countries. The numbers at the end of each site description refer to the narratives numbered above.

<table>
<thead>
<tr>
<th>NARRATIVE</th>
<th>STATE PARTY / SITE</th>
<th>REGION</th>
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<tbody>
<tr>
<td>1. Palaeontology, biology and physical anthropology: hominids among primates and genetic studies</td>
<td>Chad</td>
<td>Sahara</td>
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<tr>
<td></td>
<td>Djurub – primate and hominid fossils, fauna. Narratives 1, 2.</td>
<td>East Africa</td>
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<td></td>
<td>Ennedi/Ounanga – geological and environmental values. Narrative 1.</td>
<td>South Africa</td>
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<td></td>
<td>Ethiopia</td>
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<tr>
<td></td>
<td>Afar: boundary extension for a palaeoanthropological site that extends 250 km from Dubbi in the north of the main Afar rift to Kassam-Kabana in the south. Serial nomination: Omo WHS on the east side Fejej LSA to Mioene with hominids at 4 and 2 mya, continuous sequence of stone tools. Narratives 1, 2.</td>
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<td></td>
<td>Melka Kunture, Goda-Mota and Lake Zwa as a serial nomination: already fenced. A buffer zone needs to be identified. The two sites complement each other and would be managed by the same office and under the same budget. Narratives 1, 2, 3.</td>
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<td></td>
<td>Konso Gardula: Stands alone. More pertinent danger in terms of conservation and population encroachment. Narratives 1, 2, 3.</td>
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### Conclusion and way forward

#### NARRATIVE

<table>
<thead>
<tr>
<th>STATE PARTY / SITE</th>
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<tbody>
<tr>
<td>Mauretania</td>
<td>North Africa East Africa South Africa</td>
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<tr>
<td>Tunisia</td>
<td>North Africa East Africa South Africa</td>
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<tr>
<td>Sid 2m site: Late Acheulean - Mousterian open site less than 200,000 mya – fauna.</td>
<td>Narrative 3.</td>
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<tr>
<td>Algeria</td>
<td>North Africa East Africa South Africa</td>
</tr>
<tr>
<td>Ain Hanich – Oldowan to Acheulean and late Palaeolithic, including Ain Boucherin.</td>
<td>Narratives 2, 3.</td>
</tr>
<tr>
<td>Afalou-Taza Cave Complex over a distance of about 30 km. modern human burial. Sequence from Middle Palaeolithic to 10,000 – North African modern humans. Baked clay ﬁgurines 15-11,000.</td>
<td>Narratives 2, 3, 5.</td>
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<tr>
<td>Libya/Sudan/Egypt</td>
<td>North Africa</td>
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<tr>
<td>Nigeria</td>
<td>North Africa</td>
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<tr>
<td>Middle Stone Age with mobile art.</td>
<td>Narrative 3.</td>
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<tr>
<td>Nigeria</td>
<td>North Africa</td>
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<tr>
<td>River, Border Cave.</td>
<td>Narrative 3.</td>
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<td>South Africa</td>
<td>North Africa East Africa South Africa</td>
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<td>Various Middle Stone Age sites with a variety of examples of complex symbolism and coastal adaptations:</td>
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<tr>
<td>(a) With early modern human fossils and on the Tentative List: Klasies River, Border Cave.</td>
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<tr>
<td>(b) Without human fossils and not yet on the Tentative List: Blombos, Diepkloof, Sibudu.</td>
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<tr>
<td>Apollo 11 Cave – Middle Stone Age with mobile art.</td>
<td>Narrative 3.</td>
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<tr>
<td>Tanzania</td>
<td>North Africa East Africa South Africa</td>
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<td>Kenya</td>
<td>North Africa East Africa South Africa</td>
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<tr>
<td>Klasies – Middle Palaeolithic sequence and early domestication – cattle believed to be there at 9600 BC, presence conﬁrmed at 6000 BC. Narratives 3, 5.</td>
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<tr>
<td>Darfour: Lower Palaeolithic sequence and domestication with earliest sheep/goats with pottery at 6200 BC.</td>
<td>Narratives 3, 5.</td>
</tr>
<tr>
<td>Wadi Sura: cave site with unusual rock art – landscape with archaeological chronology from hunter-gatherers to pastoralism.</td>
<td>Narratives 3, 5.</td>
</tr>
<tr>
<td>Djbouti</td>
<td>North Africa East Africa South Africa</td>
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<td>Zimbabwe</td>
<td>North Africa East Africa South Africa</td>
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<tr>
<td>Libya</td>
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### Narratives that focus on Africa and its contribution to human evolution

1. Palaeoanthropology, biology and physical anthropology: hominids among primates and genetic studies.
2. Fossil traces of cognitive steps: cognitive changes – human biological and cultural evolution.
3. Fossil traces of technological and subsistence innovations – economic and cultural adaptation to changing environments.
5. Dispersals and migrations.

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*Note: The table and narratives provide a summary of key points discussed in the text regarding the evolution of humans in Africa.*
Conclusion and way forward

Possible gaps in World Heritage narratives of human evolution in Africa

- Gaps in hominin dispersal
- Colonization of new environments – records of expansion in new niches.
- Dispersals and migrations.
- General gap in sites in West and Equatorial Africa.

Possible gaps in World Heritage narratives of human evolution in Africa

- Ethiopia: Laga Oda, Temben
- Kenya: Dongodua
- Djibouti: Gobad

The way forward

It is particularly interesting to highlight the implementation of the World Heritage Convention in the States Parties that already have extensive experience in the conservation of sites linked to human evolution. We would now like to refer to the important contribution of Ms Nonolfo Matlholo in this publication, who presents us with the national perspective of South Africa, a country which holds 15 important registered archaeological sites which are all related to HEADS. From accumulated experience, her country has solid grounds to dictate protection systems and their regulation for research, conservation and management. This is fundamental for renewing the Tentative List, which includes a tendency to better represent OVU linked to modern humans and which include long sequences, as in the case of Wonderwerk Cave, or Klasies River mouth as a coastal site that, due to the finding of numerous skeletons there, demonstrates that modern humans evolved in Africa.

The participants followed the lead of the South African representative by collectively recognizing a series of priority conditions and actions that have been mentioned in the following paragraphs and which express the conviction of the specialists regarding the fact that:

- Conservation is not only the responsibility of the researchers. It is also essential to design research and conservation planning systems through action plans, in which science and management are not considered at different times or by unrelated teams.
- It is necessary to pay close attention, from the beginning of the nomination processes, to the problems that may arise from private property in the registered areas.
- It is fundamental to include in the research, conservation and management strategies a dialogue encompassing the values and environmental needs of contemporary society.
- It is necessary to be able to generate significant public access to the research results and, whenever possible, to facilitate educational initiatives and visitor interpretation at sites linked to human evolution.
- It is necessary to strictly clarify the role of the scientist and of the community in the decision-making processes regarding research and conservation.

As an educational and economic strategy it is necessary to develop good practices in paleoanthropological tourism, but always regarding the conservation of the site as the fundamental principle, from which all public uses of the site thereafter stem from.

All the processes linked to post-extraction require a collaborative investigation, as the Laetoli case proves. The different disciplinary and institutional visions should be taken into account favouring the preparation of the OVU. Significant access to a resource does not necessarily imply a physical visit. Sites such as Altamira or the Lascaux Caves cannot be visited. In the same way, it is fundamental that the communities are not limited or overshadowed by the distant past of their cultural capital. However, the communities also need to be clearly aware of the scientific criteria that contribute to finding the formulas for an efficacious balance between enjoyment and conservation and, with it, the effective regulation of visitor activity.

It is necessary to identify how, at a national level, it is possible to create decision-making strategies that do not work against the role of those in charge of heritage and instead favour other sectors related to the economy, environment and land management. The heritage protection laws, and the requirements of their studies on environmental and heritage site impact, cannot compete when a country is prevailed over by financial rather than conservation decisions. Energy, housing, water, mines or other types of infrastructure are invariably established so that the national laws cannot defend existing archaeological surface areas and subsoil.

Each of the narrative statements presented here builds a bridge between epistemological and disciplinary assertions, and tries to answer questions like: ‘When did our origins begin?’ and ‘From what moment can we begin to talk about mankind?’ All of these contributions explore the time and geography of the origin of our biological and cultural diversity from Africa. There is not a wish to create an encyclopaedia in these pages. In accordance with the experiences already developed in areas more thoroughly explored by African archaeology, questions can be agreed upon related to processes other than those already carefully studied in the Rift Valley, for other more comprehensive geographical areas not especially limited to Eastern Africa.

In these pages we have talked about hunting methods, scavenging, uses of fuel and the role of cognitive and symbolic advancements in the history of a species that is originally African, as the genesis of all our inventive boldness. Every contribution has given an overview of the extensive disciplinary investigation of the human condition, although it is evident that the sites registered to date in the World Heritage List do not include the whole episodic itinerary of our progress, making us the modern humans that we are today. This is what enables us to present the narratives that can put together a more complete sequence and one that is aligned with the current state of our knowledge. Let us hope that everything established so far becomes outdated, that its provisionality is put to the test by scientific advances and new registered sites. Hopefully we will be able to witness a better representation of paleoanthropology and of its processes in the African Tentative Lists.

Sites linked to the archaeology of human origins in Africa cannot be conceived exclusively as archaeological sites, neither because of their nature nor because the archaeological methodology may be the only or main discipline for establishing the OVU of the sites. The preceding chapters give a good account of the interplay between disciplinary dialogues and how they interconnect, which enables us to reconstruct the earliest attempts at our first cultural diversity.

In all of the places researched, the crossover between culture and nature is dealt with in an integrated way, in environments understood to be mutually represented. We are now able to see unprecedented results that fine-tune dating and allow for other constructions of models of the past. Nevertheless, these pages make it clear that we do not possess any evidence of lithic manifestations or of the technologies these entailed prior to 2.6 Ma ago:

- the meaningful stratigraphic contexts do not go back beyond over a million years ago, when we get further away from the Rift Valley, and that it is necessary to think of alternative research scenarios;
- there is a great shortage of information for ecologically extreme environments such as the desert or the tropical rainforests, for which they have not been able to chart evidence so far;
- the savannah was not only limited to eastern Africa and that even what today is desert could have been a herbaceous environment that facilitated migrations towards the Mediterranean, and that the exchanges of fauna across the Lib el Mandeb Strait testify to this;
- if the first colonist was Homo erector, able to reach Asia, it is not impossible to believe that his movements inside Africa also allowed him to reach other ‘nearer’ places than Georgia or Indonesia; and that the knowledge we have about the Plio-Pleistocene occupation in Africa is still very incipient.

Despite Africa being over 30 million square metres in size, its most outstanding archaeological sites in the history of research have been uncovered in the last 25 years. It is important to point out, that in the last few years, South African coastal sites have not ceased to amaze us with findings and have also produced a series of dynamics and research, especially modern humans’ strategies of subsistence.

The primary position of East Africa’s stratigraphies has always taken the lead over the terraces of the major river basins of the Nile, Congo and Zambezi, whose materials are found in secondary position. The Great Rift Valley allows us to analyse lake sediments from which we can establish chronologies throughout the rest of the continental terrain.

Much of the African continent has suffered bloodshed since 1970 which has slowed down research in Angola, Sudan and Libya, whilst research activities were still being carried out in Kenya and South Africa, contributing decisively to the formation of institutional architecture for investigation, led by national scientists. These pages also show us the need of establishing protocols for scientific cooperation with collegial research design, and in this sense, the aim of starting the nomination process can help.

It is not only about digging to find the most ancient or the biggest fossil, nor is it about just about excavating to find what could be considered a treasure or about dedicating research solely to find the missing link. It is about finding results that allow the preservation of sites where the establishment of interdisciplinary work makes them into a reservation area for future work through the preservation of integrity and good health of related movable heritage materials.
These pages would also like to acknowledge that the heritage of the first human cultures could quickly run out. The soil and subsoil is eroded by other continents. Many of the conclusions coming from this study reveal that there is urgent work to be done with our evolutionary heritage, with our resources being less renewable and which are, however, part of the irreplaceable wealth of what makes us humans.

We close this publication that the reader has in hand very soon after the UN Earth report of June 2012 was published in the wake of the Rio+20 Summit. The report gives a good account of how the situation has worsened compared to 2005 (Millennium Ecosystem Assessment). Perhaps now, more than ever, it will be useful to retrieve our repertoire of biological, conceptual and cultural tools; we now have the opportunity to choose a green future that respects our universal heritage. We must, therefore, put our ethic capacity and our ways of respecting creative diversity to the test.

If we are culturally prepared to adapt again, we must ask what opportunity are we going to give it, how we will activate a new awareness of survival, what is the degree of resilience that we have; that we are, and we were the most adaptable of mammals. These pages have made an attempt to teach us something about our far-distant past to help us understand what probably awaits us and, with that, to ask ourselves if we continue being the beginning or if our evolution is indicating that we are, in fact, at the end, the end of the chain.

We are grateful for the hospitality that Africa has shown towards the HEADS Programme, as generous as the African contribution to the knowledge of human origins has also been. We were all Africans in the past, and so through this work clues can be found to make us become more aware of our debt to Africa. We must make clear the responsibility that everyone holds to not deprecate its recent history; since in a distant past it was the cradle of humankind. Our strategies for research and conservation of our African evolutionary heritage must be carried out with an ethic of shared global responsibility.

We were finishing these lines when the sad news of Professor P. Tobias passing away reached us. Without a doubt with one of the most cohesive biographies in the history of research throughout the entire twentieth century, we remember him affectionately here, as his knowledge was as vast as the generosity with which he worked with UNESCO in the South African nomination procedures. These remain today as a benchmark for whatever ventures may be undertaken in the future.

In Africa every culture can recognize itself, in places where time stood still but where research today has been able to recreate our universal accumulated identity. In Africa we tried out our social brain for the first time and that is why there, more than in any other place, we must be prevailed on to exercise our memory for the origin of our genius.

The determination and perseverance of my colleagues in the World Heritage Centre has been another invaluable factor in allowing this publication to reach the hands of the reader. I am most grateful to my colleagues from the Africa Unit and the Arab States Unit for their advice and I would especially like to thank Penelope Keenan for her dedication and expertise, as well as Chantal Connaughton, Nina Ametller and Emmanuelle Lachaud for having rounded off the group that made this publication possible and which today enables us to achieve a greater awareness of the work involved and the challenges faced by international cooperation. I very much hope that these pages can show us once again how much we are collectively indebted to mother Africa.

Bibliography


Conclusion and way forward


Conclusion and way forward


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(English) November 2002; (Spanish) May 2005

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(English) December 2002

Periodic Report Africa
Rapport périodique pour l'Afrique
(English and French) April 2003

(May 2003

Identification and Documentation of Modern Heritage
(English with two papers in French) June 2003

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Partnerships for World Heritage Cities – Culture as a Vector for Sustainable Urban Development. Proceedings from the Urbino workshop, November 2002
(English and French) August 2004
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proceedings from the Vicenza workshop, November 2002 | In English September 2004 |
| 11    | Periodic Report and Regional Programme – Arab States 2000–2003  
Rapports périodiques et programme régional – États Arabes 2000–2003 | In English September 2004 |
| 12    | The State of World Heritage in the Asia-Pacific Region 2003  
L’état du patrimoine mondial dans la région Asie-Pacifique 2003 | In English October 2004; (In French) July 2005 |
| 13    | Linking Universal and Local Values: Managing a Sustainable Future for World Heritage  
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| 15    | Caribbean Wooden Treasures  
Proceedings of the Thematic Expert Meeting on Wooden Urban Heritage in the Caribbean Region  
4–7 February 2003, Georgetown – Guyana | In English October 2005 |
| 16    | World Heritage at the Vth IUCN World Parks Congress  
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Informe Periodico 2004 – América Latina y el Caribe | In French and English December 2005 |
| 19    | Fortificaciones Americanas y la Convención del Patrimonio Mundial  
American Fortifications and the World Heritage Convention | In Spanish with the foreword, editorial, programme, opening ceremony and seven papers in English December 2006 |
<table>
<thead>
<tr>
<th>World Heritage paper</th>
<th>Title</th>
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<td>29</td>
<td>Human Evolution: Adaptations, Dispersals and Social Developments (HEADS)</td>
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