The Archaeological Significance of Beads and Pendants

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Abstract

The archaeological significance of beads and pendants is discussed from the point of view of the cognitive evolution of humans. Evidence is discussed for the presence of beads from the Acheulian period onwards and experimental manufacture of ostrich eggshell beads was undertaken.

Introduction

The connection between the cognitive evolution of humans and the topic of the production and use of beads and pendants during the Pleistocene may not be readily apparent, and yet such portable palaeoart objects can be much more illuminating than most other archaeological finds, at least in this respect. To demonstrate this, let us consider the present consensus model of cognitive evolution as held by mainstream archaeology. According to it there was a massive, explosion-like development with the advent of the Upper Palaeolithic in southwestern Europe, and this is attributed to the appearance of anatomically modern humans in the region. Prior to this significant change, Europe, the model predicts, was populated by primitive humans who probably lacked language, complex social structures and culture, who had no form of art, hunted inefficiently if at all, and may have even been carrion eaters who lacked the use of fire. They may have had no habitation structures and wandered over the landscape rather aimlessly, eking out a most precarious existence for hundreds of millennia in Pleistocene Europe as well as elsewhere.

It is always useful to exercise a great deal of scepticism in considering the mythologies archaeology creates about the human past. The discipline has a tendency of 'getting it wrong' most of the time, but in the case considered here it may have excelled itself. I propose to look at this dominant model of cognitive development very briefly, in the context of a series of finds from the time interval in question, and then to focus on a specific issue.

To begin with, the claims relating to the late appearance of symbolism, art and language (e.g. Chase and Dibble 1987; Davidson and Noble 1989; Noble and Davidson 1996) are attributable to the ignorance of those advocating these models. Ocean navigation and the ability to colonize new lands by sea clearly postulate the use of complex communication systems, and while this does not necessarily indicate uttered language, that would seem to be the most likely explanation. We should have known for several decades that ocean crossings by colonizing parties seem to have been successful more than 700,000 years ago (Verhoeven 1958; Maringer and Verhoeven 1970, 1977; Bednarik 1995a, 1997a), which implies that they were by *Homo erectus*. In compiling a list of finds that may indicate the use of palaeoart or complex technology I listed literally hundreds some years ago (Bednarik 1992a, 1994a, 1995b). Hominids of the Lower Palaeolithic not only created markings on portable objects of various types, they also produced the oldest petroglyphs we have found so far (Bednarik 1993a) and made extensive use of ochre or haematite. There is good evidence that they recognized iconicity (the property of an object to resemble another, which it can then stand for). A rudimentary ability of this kind even seems to have existed in the Tertiary, as suggested by the Makapansgat cobble (Bednarik 1996a). Lower Palaeolithic humans certainly used strings and therefore probably knots, they created well-made wooden artefacts and they produced composite weapons (fastening stone to wood). Since there are several cases of stone walls by them that have been interpreted as parts of dwelling structures (Bednarik 1993b) it may be a little hasty to assume that they lacked habitation shelters. They certainly produced artefacts from such materials as bone and ivory, they were capable of drilling or boring, and we assume that we have evidence of their appreciation of exotic finds, such as crystals and fossil casts, which we know they collected on occasion. It is also wrong to say that their lithic industries were unchanging: prismatic blades, borers and burins occur in Acheulian deposits, and in the Amudian of North Africa and the Levant, which developed from the region's Acheulian, blade tools become a major component of the industry (Rust 1950; McBurney 1967).

More relevant to the present paper are the origins of beads and pendants, which I have considered for many years. My interest in this subject is based on the following reasoning. Beads and pendants are in most cases fairly easy to recognize, they are rarely confused with other artefacts. But whatever purpose they are used for, it seems to relate to culturally complex practices.

Beads tell us a great deal about both the technology and the culture of their makers and users. Technologically they illustrate not only the ability to drill through brittle or very hard materials, but also they imply the use of cordage (Warner and Bednarik 1996). The very essence of a bead or pendant is to be threaded onto a string, it would simply be pointless to perforate a small object for another purpose but to pass a string though it. However, the use of string also suggests the use of knots, because a string needs to be closed to form a loop to be effective. Although the ends of a string may be joined by means other than a knot, e.g. by the use of adhesive or by plaiting, these alternative means are either impracticable or they are technologically even more complex than the use of knotting.

Without doubt such technological deductions beads permit us are of great interest, but of more importance are perhaps the cultural and cognitive deductions they make possible. Beads can be used in a number of ways or for several purposes: they may be emblemic, for instance, and provide various forms of information about the wearer and his or her status in society. Availability for marriage, political status, state of mourning might be such possible symbolic meanings. At one level one might believe that beads indicate simply body adornment (White 1993a, 1993b), but this is almost certainly an oversimplification. Even if vanity were the motivation for wearing such items, stating this explains not why such items are perceived as 'decorative'. The concept itself is anthropocentric, we do not assume that other animals perceive the information imparted by the beads as meaningful. In human culture, however, various forms of meanings may be encoded in such objects, as well as in other kinds of body adornment (tattoos, body painting, cicatrices, infibulation, anklets, armbands, etc.). In ethnography, beads sewn onto apparel or worn on necklaces may signify complex social, economic, ethnic, ideological, religious or emblemic meanings, all of which are only accessible to a participant of the culture in question. To name just one example: beads or pendants may function as charms, they may be a means of protection against evil spells or spirits. None of this information is archaeologically recoverable.

Irrespective of their cultural purpose, beads convey complex information about the wearer which it would be impossible to create a context for without the use of a communication system such as language. This needs to be emphasized because it leads to the postulate that the use of beads assumes the availability of a complex communication system. We have many other indicators of possible language use during the Lower and Middle Palaeolithic (e.g. other forms of symbolism or successful ocean navigation), and the very early use of beads and pendants provides similarly crucial evidence which, collectively, renders the hitherto dominant model of cognitive evolution completely superseded. We can no longer afford to ignore this kind of evidence (Bednarik 1995b), and in the case of beads this includes the oldest known pendants in the world, and the oldest known beads in the world. I will briefly describe the evidence I refer to and will then focus on the latter, and the production processes they involved, to illuminate their role in exploring the perception of their makers.

Early Pendants and Beads

Small perforated objects of the Pleistocene may have been beads or pendants, or they could have been quangings, pulling handles or buckles as reported ethnographically (e.g. Boas 1888: Figs. 15, 17, 121d; Nelson 1899: Pl. 17; Kroeber 1900: Fig. 8). However, most of the utilitarian objects of this type are not only of a quite typical shape or design, they exhibit specific wear traces and material properties. To be more specific, small circular objects with central perforation are considered to be beads, especially where they occur repeatedly. Similarly, objects such as animal teeth, perforated near one end (near the root) are not thought to be pulling handles, nor are objects that are too fragile to function as such utilitarian equipment.

Middle and Lower Palaeolithic finds with both artificial and natural perforations are quite common, and have been found since last century. Hundreds of such objects are reported in the literature, although there is often no reliable evidence that the perforation is anthropic (cf. Klíma 1991). Some materials can be perforated by natural processes. For instance, bones can be chewed through by animal canines or partially digested by stomach acids, while gastropod shells are commonly perforated by parasite organisms. It is therefore preferable to rely only on specimens bearing clear evidence of human work, but it is to be emphasized that the perforation of a bead or pendant certainly does not need to be man-made. On the contrary, naturally perforated objects are commonly used in ethnographic specimens and it seems likely that the earliest beads ever used had natural perforations.

The earliest possible beads of the Lower Palaeolithic were mentioned almost one and a half centuries ago, occurring together with the first Palaeolithic tools ever reported, and from the very type site of the Acheulian. In the famous paper by Prestwich (1859), in which he recognized the authenticity of the St. Acheul stone tools Jacques Boucher de Perthes had been collecting for many years, the occurrence of possible beads is also mentioned. These were found to be fossilized remains of a sponge, *Coscinopora globularis*, but Prestwich was not quite convinced about their human modification. However, he does concede that "Some specimens do certainly appear as though the hole had been enlarged and completed" (Prestwich 1859: 52). Be that as it may, circular, disc-like fossil casts have since been found at other Acheulian sites, such as the crinoid columnar segments (*Millericrinus* sp.) from Gesher Benot Ya'aqov, Israel (Goren-Inbar *et al.* 1991), and disc beads made from ostrich eggshell occur in the Acheulian of Libya (see below). The subject of Lower Palaeolithic beads therefore needs to be considered carefully.

The perhaps earliest objects with indisputably human-made perforations we know of are the two perforated pendants from the Repolusthöhle in Styria, Austria. If their age estimate is correct, they are close to 300,000 years old. One is a wolf incisor very expertly drilled near its root (Fig. 1). The second is a flaked bone point, roughly triangular and perforated near one corner (Fig. 2). Both objects were first mentioned by Mottl (1951) but have received little attention since then. They were excavated with a lithic industry variously described as Levalloisian, Tayacian and Clactonian, which is in fact an undifferentiated Lower or Middle Palaeolithic assemblage, but clearly free of Mousterian elements. The occupation deposit was found well below an Aurignacian level, separated from it by substantial clastic deposits of stadial periods. There is no reliable dating evidence available, the age estimate is based on the faunal remains, especially the phylogeny of the bear remains. However, it is broadly supported by the typology of the accompanying lithics, which is easiest to reconcile with a late Lower Palaeolithic industry.

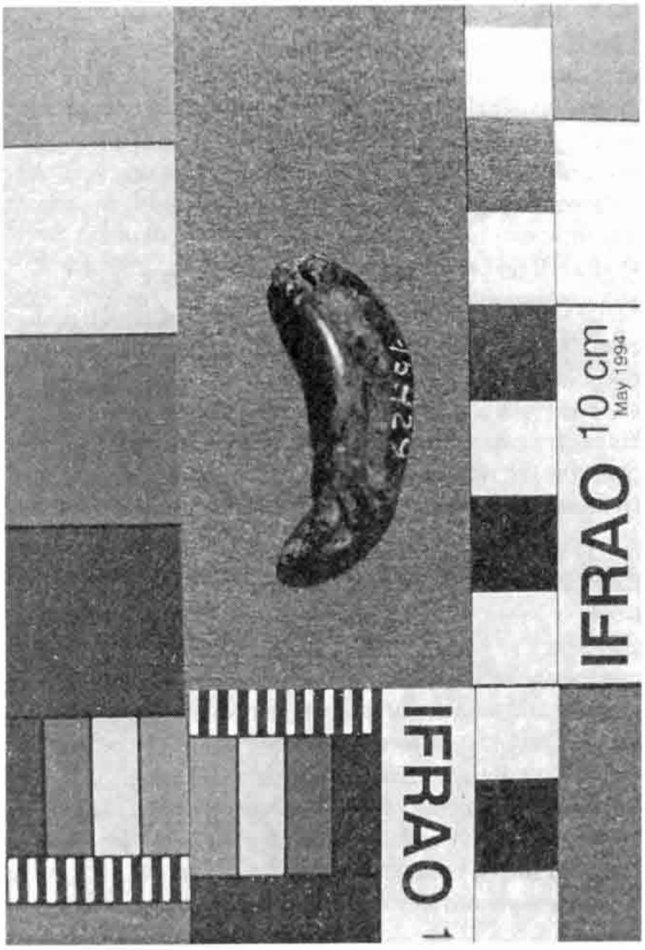

Fig. 1: Wolf incisor, perforated near its root. Undetermined late Lower Palaeolithic to early Middle Palaeolithic tradition, Repolusthöhle, Austria. Oldest known object of this type in the world

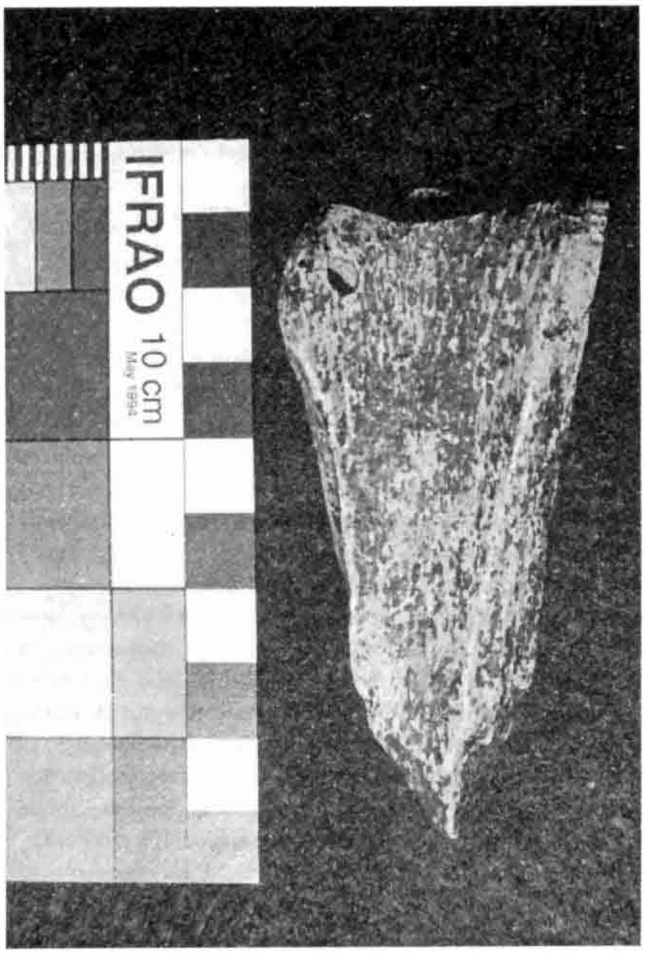

Fig. 2: Flaked bone point, perforated near one corner, excavated with the wolf incisor in Repolusthöhle depicted in Figure 1

Apart from the Acheulian ostrich eggshell beads reported below, there are no further reports of bead-like finds from the Lower Palaeolithic. It has long been known, however, that stone tools of that earliest period of human tool use were applied as borers or reamers, especially from micro-wear traces (Keeley 1977). The paucity of drilled objects is therefore probably attributable to a preference for softer materials to work with, especially wood. There can be no doubt that the Acheulian was a tool industry concerned primarily with wood working. Among the wooden implements or fragments of the Lower Palaeolithic are the seven objects from Schöningen, Germany (Bednarik 1996b), the spears and spear fragments from Bad Cannstatt (Wagner 1990), Bilzingsleben, Lehringen, Torralba (Howell 1966: 139) and Clacton-on-Sea, and the polished willow plank from Gesher Benot Ya'aqov, Israel (Belitzky *et al.* 1991).

There are numerous perforated objects also from the Lower/Middle Palaeolithic transition, and many of them may have served as beads or pendants. The Micoquian has yielded an artificially perforated wolf metapodium as well as a wolf vertebra from the Bocksteinschmiede, Germany (Marshack 1991). The Micoquian of Prolom 2, Crimea, produced no less than 111 perforated animal phalanges, besides four engraved palaeoart objects (Stepanchuk 1993). Although there is no proof that the phalanges were perforated by human hand, the fact that they are all of one species, *Saiga tatarica*, and that no perforated bones of other species were found in the cave, suggests that these may also be anthropic perforations.

The Mousterian of France has yielded a partly perforated fox canine and a perforated reindeer phalange from La Quina (Martin 1907-10), and another perforated bone fragment from Pech de l'Azé (Bordes 1969). In Spain, the same technological tradition has left us more perforated phalanges as well as a cranial fragment with a drilled hole at Lezetxiki (Baldeon 1993). The two perforated canines from Bacho Kiro, Bulgaria (Marshack 1991), too, are of the Middle Palaeolithic. As we approach the end of this technological phase, beads and pendants become increasingly common, and materials of stone are now drilled, first appearing in Russia and China. Thirteen such specimens from the lower occupation layer of Kostenki 17, found below a volcanic horizon thought to be about 38,000 years old, include not only polar fox canines and gastropod shells with perforations, but also stone and fossil cast objects (Bednarik 1995c: Fig. 4). From an intermediate Middle to Upper Palaeolithic site in China, Wenhua Shiyu, comes a broken stone pendant (Bednarik and You 1991), and the oldest beads found in Australia, from Mandu Mandu Creek rock-shelter, are about 32,000 years old (Morse 1993). That country's earliest known stone pendant is from the final Pleistocene of Devil's Lair, still belonging to a Middle Palaeolithic technology (Bednarik 1997b).

With the advent of the Upper Palaeolithic in Eurasia, beads become more numerous and are increasingly manufactured from unwieldy materials, especially ivory. Just three human inhumations at the Russian site Sungir', from a stone tool technology that is transitional between Middle and Upper Palaeolithic implement types, the Streletsian, contained more beads than have been found in the entire Pleistocene sites of the rest of the world. The three graves yielded 13,113 small ivory beads and over 250 perforated canine teeth of the polar fox. By this time, perhaps 28,000 years ago, the art of bead making had reached an extraordinary level, in which the results of thousands of hours of labour were lavished on three burials.

This synopsis of Pleistocene bead remains might convey the impression that beads were produced infrequently for 200,000 or 300,000 years, and then became much more numerous with the advent of the Upper Palaeolithic. While this is remotely possible it must be cautioned that this pattern of distribution in time provides a typical parabolic curve as demanded by taphonomic logic (Bednarik 1994b: Fig. 2). Accordingly the advent of the Upper Palaeolithic should *not* indicate the advent of frequent bead manufacture, but merely the *taphonomic threshold* of this phenomenon category. This is almost certainly the correct explanation of the evidence available to us, in which case that record must be tempered by taphonomic logic before it can be interpreted.

Ostrich Eggshell Beads of Pre-History

So far we have ignored one particular type of pre-Historic bead, the ostrich eggshell bead. To understand the significance of flat disc beads manufactured from this material, and their role in interpreting the cognitive evolution of humans, we need first to consider two factors: the distributions, in both time and space, of such finds, and the taphonomic explanation of both these distributions.

Disc beads such as those made from ostrich eggshell are a form of artefact that is not likely to have been made singly or in very small numbers. To provide such symbolic objects with a social meaning it would have been essential that they were made in quite large numbers, because it is repeated and 'structured' use which confers meaning on symbolic artefacts. The role of beads, as well as pendants, would have always been non-utilitarian, ideological, emblemic or symbolic. Moreover, very small beads such as those made from ivory or ostrich eggshell were probably not worn singly, because to achieve a decorative effect they are generally worn as sets in ethnographic specimens.

This renders it necessary to explain why — wherever ostrich eggshell beads have been found in Pleistocene contexts — only extremely small numbers were recovered. Moreover, why are the few known occurrences so extremely isolated in both time and space? Major intervening time spans have yielded no such artefacts, nor have vast geographic regions in which the ostrich is known to, or can be assumed to, have occurred. Taphonomic logic offers the most realistic explanation for this pattern (Bednarik 1986, 1992b, 1994b). Accordingly we are almost certainly dealing with a phenomenon of a very long *taphonomic lag time*. The extreme paucity of Pleistocene finds can readily be explained by postulating that they survived from beyond the *taphonomic threshold* of the phenomenon category in question (Bednarik 1994b: Fig. 2).

In India we have only a few specimens from the entire Palaeolithic (Bednarik 1993a, 1993c). Two are from Bhimbetka, south of Bhopal, and three from Patne, Maharashtra. Two of the latter are not perforated, although one is centrally scored. The Bhimbetka specimens were found in the neck region of an Upper Palaeolithic human burial (in shelter No. III A-28), so it has been suggested that they formed part of a necklace made up of beads of perishable materials. While the Patne specimens (Fig. 3c) range from 7 mm to about 10 mm diameter and are rather angular, those from Bhimbetka (Fig. 3a, b) measure about 6 and 7 mm respectively and are well rounded. In all, some forty-one Indian sites have yielded fragments of Pleistocene ostrich eggshell (Kumar *et al.* 1988). Radiocarbon dates ranging from about 39,000 to 25,000 years B.P. have been cited as relating to these finds. Of the 46 marked fragments I have examined, which are all those that have been found in India so far, 45 bear no anthropic decoration. They were marked by a natural process which I have described in detail, involving mycorrhyzal organisms, and which also affects other mineralized calcium carbonate-dominated substances of animal origin (ivory, limestone, bone; Bednarik 1992c, 1993c).

Other Asian regions producing ostrich eggshell beads are Siberia (Krasnyi Yar, Trans-Baykal), Inner Mongolia (Hutouliang) and the Gobi desert in northern China and

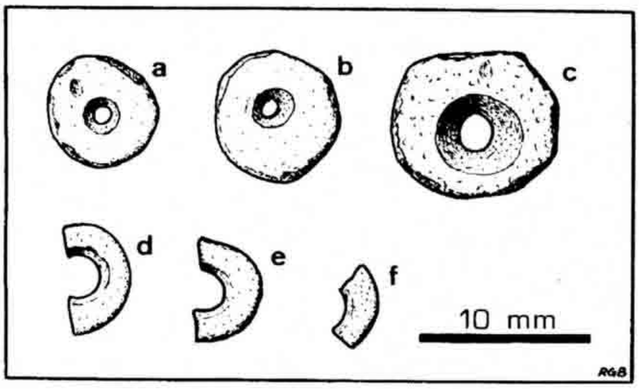

Fig. 3: Pleistocene beads made of ostrich eggshell, from India (a-c) and Libya (d-f): a, b - Bhimbetka III A-28, Upper Palaeolithic; c - Patne, Upper Palaeolithic; d, e, f - El Greifa site E, Late Acheulian

Mongolia. In particular, an Epipalaeolithic or perhaps Mesolithic stone tool industry of the Gobi, usually named after the site of Shabarak-usu, has produced many disc beads, made of freshwater shells as well as ostrich eggshell (Narr 1966, 366). This tradition, typically of non-geometric microliths, is not dated but seems to precede the local Neolithic (Bednarik and You 1991). The ostrich (*Struthio camelus* sp.), now extinct in Asia, seems to have been widely distributed to the end of the Pleistocene and even into the Holocene. Depictions of it have been reported from the rock art of Inner Mongolia but their identification has been questioned (Bednarik and Li 1991; Tang 1993).

Both southern and northern Africa have produced finds of worked ostrich eggshell. The southern African sites yielding such finds date from the Middle Stone Age right up to the proto-Historic period. Decorated specimens from the Howieson's Poort phase in Apollo 11 Cave, Namibia (Wendt 1974), may well be 70,000-80,000 years old, even older. This site has also produced beads made of eggshell from a layer thought to be 22,000 years old. Diepkloof Cave in the southwestern Cape, South Africa, has yielded about a dozen supposedly decorated ostrich eggshell fragments of the Middle Stone Age (Beaumont 1992; Bednarik 1993d). Ostrich eggshell beads from Bushman Shelter near Ohrigstad, Transvaal, have been suggested to date from somewhere between 12,000 and 47,000 years ago (Kumar *et al.* 1990). Such beads still occur in much more recent periods in southern Africa. For instance they are found in the Smithfield B, a tool complex of the African subcontinent's interior regions of the 14th to 17th centuries (Hirschberg 1966). The use of ostrich eggshell for a variety of purposes, including the production of disc beads and as water vessels, continued to be practised by the Bushmen of southern Africa until recent times, and has been described ethnographically (e.g. Forde 1934).

In the far north of Africa, where the ostrich has been extinct for millennia, two pre-Historic periods have provided evidence of the past use of ostrich eggshell: the Capsian and the Acheulian. The Capsian is an Epipalaeolithic blade and burin industry in northern Algeria and Tunisia, dating from the first half of the Holocene. It includes not only numerous figurative and non-figurative engravings on ostrich eggshell fragments (Camps-Fabrer 1966), but also beads of snail shells, teeth and small stones (Camps-Fabrer 1975: 280-2). Almost any excavation of major Capsian deposits produces ostrich eggshell beads, usually well rounded with central perforation. Containers of wholly preserved ostrich eggshells, too, have been recovered from the Capsian. The decoration they bear suggests that the engraved fragments found in the Capsian deposits may well be from such containers. Saharan rock art depictions convincingly resembling the ostrich are known and may well be of the mid-Holocene. Examples are from Wadi Tilizahren (Jelínek 1985a: Figs 4, 6, 31, 34, 55, 56; 1985b: Figs 5, 28) and Wadi Mathendous, Fezzan (Striedter 1984: Fig. 7); Tzeretegem, Niger (Striedter 1984: Fig. 187); Iheren, Tassili-n-Ajjer (Striedter 1984: Fig. 125); and North Thyout, Atlas (Muzzolini 1995: Fig. 200).

Of very considerably greater age than the Capsian are the three fragments of disc beads from a major Libyan occupation site of the Acheulian (Ziegert 1995). Also made from ostrich eggshell, they closely resemble those from other regions and later periods. These first Acheulian ostrich eggshell beads ever reported (Fig. 3d-f) come from the El Greifa site complex (Wadi el Adjal, near Ubari). The site is located on what was a peninsula of the huge Fezzan Lake of the Pleistocene, which then occupied a large part of southwestern Libya, measuring about 200,000 km^2. Its former extent is indicated by freshwater limestone expanses across the Murzuq Basin, overlying sandstone beds of up to 3000 m thickness (Thiedig 1995) that are still charged with freshwater of between 9000 and 24,000 years age, i.e. deposited during the wetter climate of the late Würm. El Greifa provides ample evidence of Early (Mindel), Middle and Late Acheulian (Riss) occupations, followed by Aterian (last Interglacial) deposits. Dating of sediments from 320,000 years to the end of the Pleistocene has been attempted by uranium/thorium analysis at the Niedersächsisches Landesamt für Bodenforschung, Hannover, but it is considered to be tentative and experimental. The significantly fluctuating lake levels also provide chronological data; for instance they were about 60 m higher in the Middle Acheulian than in the Lower.

The alkaline and calcareous sediments have provided excellent preservation conditions for insect remains, seeds, bone and ostrich eggshell fragments. The remains of what appears to be a round semi-permanent dwelling structure, about 180,000 years old, have been found on the former lake shore. There is ample evidence of quarrying of quartzite, and substantial ash beds indicate that the reed belt was annually burnt for a period of many millennia. The sites' lithic inventory includes generally 'handaxes', scrapers, borers and burins, but is dominated by large Acheulian types.

The favourable conditions also led to the preservation of three ostrich eggshell beads from the Late Acheulian of El Greifa site E. Dated by the U/Th isotopes of the calcareous sediments they are from, they appear to be in the order of 200,000 years old. The near-perfect rounded circumference and perforation (Fig. 3d-f) of the El Greifa ostrich eggshell beads demonstrate that even hominids of the Acheulian possessed a well-developed technology of working this fragile medium with the greatest possible confidence and skill. These perfectly made artefacts also imply the existence of the social structures necessary to provide an ideological context for the production and use of complex body decoration. The three beads are preserved as fragments only (c. 58%, 54% and 28% preserved respectively), but they share a similar perforation diameter of about 1.7 mm, and even their external diameter is very consistent (5.8-6.2 mm). This consistency in size and the near-perfect rounding of all preserved edges, internal and external, suggests the use of a standardized manufacturing process, a characteristic these beads seem to share with the much later beads of the Upper Palaeolithic as well as those of various cultural traditions of the Holocene.

Replicating Ostrich Eggshell Beads

The immediate purpose of my experimental replication work between 1990 and 1996 was to determine the technological processes involved in the production of beads of, and engravings on, ostrich eggshell. The results relating to engravings have been reported (e.g. Bednarik 1992c), here I will summarize my findings relating to beads, and their implications in terms of the cultural context of their production.

Kumar has conducted experimental replication work with heavily weathered ostrich eggshell fragments collected from Chandresal, which are in the order of 36,000-39,000 years old (Kumar *et al.* 1990: 36). He used Mesolithic stone tools to produce the perforations of two experimental beads, which each took him 10 to 12 minutes to drill through, working from both sides. In my own replication work I have always used fresh ostrich eggshell, because that is what was presumably used in the distant past, and I applied freshly made stone tools of different types and materials to establish relative suitability (Bednarik 1991, 1992c, 1993c). I found it difficult to economically drill through the unweathered shell using thin pointed tools of cryptocrystalline sedimentary silica. The most effective tools for this purpose were found to be rather coarse-grained quartzites and quartz. With them I initially reported drilling through the shell of a complete ostrich egg in times ranging from 70 to 90 seconds, i.e. working from just one side (Bednarik 1991).

I have subsequently found it easy to reconstruct the production processes for these beads. The raw material is of unusually consistent properties: the shell thickness is uniform, as is the three-layered morphology of the shell (described in admirable detail by Sahni *et al.* 1990). The only significant material variable is attributable to the shell's curvature, which is of a much smaller radius at the ends of the egg than it is along the sides. My replication work soon established that the manufacture procedure used followed a specific pattern, as demanded by the morphology and dimensions of the end product, work traces and the nature of the available stone implements. For instance I found that it was difficult and uneconomical to first shape the bead and then drill it, and that it was marginally easier to drill from the concave side than from the convex. Thus experimentation succeeded in reconstructing the work process quite convincingly, which it seems was as follows.

Once drained of its contents, an ostrich egg was dried and broken into fragments. These were then reduced further, into polygonal pieces of about 1-2 cm^2 area. This was done by carefully breaking the shell between fingers, probing for already existing fracture lines (Fig. 4). The small fragments were then drilled individually, which is a little more difficult than drilling into the complete egg. An experienced operator takes between 70 and 145 seconds (average 121 secs, n = 11) to perforate the dry shell from one side. (I consider that I became an 'experienced operator' after attempting to produce 25 or 30 beads, and quantitative production details reported here refer to subsequent work.) No significant differences in drilling time were noted according to direction (from outside or inside), but the outer veneer (< 0.1 mm; Sahni *et al.* 1990) is somewhat harder to start from, and is of course of convex surface, so I came to prefer the concave mammilary innermost layer (Sahni *et al.* 1990: Fig. 2) to start drilling from. Contrary to various opinions stated, I do not believe that ostrich eggshell beads were usually drilled from both directions, as it is very difficult to meet up with the centre of the first opposite indentation. It is much easier to ream out the opening once the boring tool breaks through, using the point of a thin prismatic sliver of chert. I propose that this is the way ostrich eggshell beads were customarily perforated.

I also drilled shell fragments soaked in water for 24 hours, taking from 80 to 140 seconds (average 118 secs, n = 11), which suggests that this does not affect workability of the shell. The principal variable in drilling time is clearly the quality of the stone tool point, and this can vary considerably. In my replicative work I used a variety of stone tool materials, including cryptocrystalline flint, microcrystalline cherts of various types, chalcedony, coarse and fine quartzites and quartz crystal. I also tried out a variety of tool morphologies, finding that thin points became blunt very quickly, as did finely-grained materials. Nevertheless, all materials I used necessitated the application of two or more points to produce a single perforation economically, so the time of making or resharpening borers has to be added to production time. Stout angular points on flakes or blades of 1-2 mm thickness at their end were found to be the most effective, and excessive pressure is counterproductive as it accelerates the wear of the tool point exponentially.

Once the perforation is complete it is reamed out from the other (convex or outer) side, using slender bladelets or prismatic points, which may be quite fragile. The duration of this process depends on the desired hole diameter, but in about one minute an even diameter of around 2 mm, eliminating much of the drilling cone, can be attained (Fig. 4). It is clear from my work that the three perforated beads

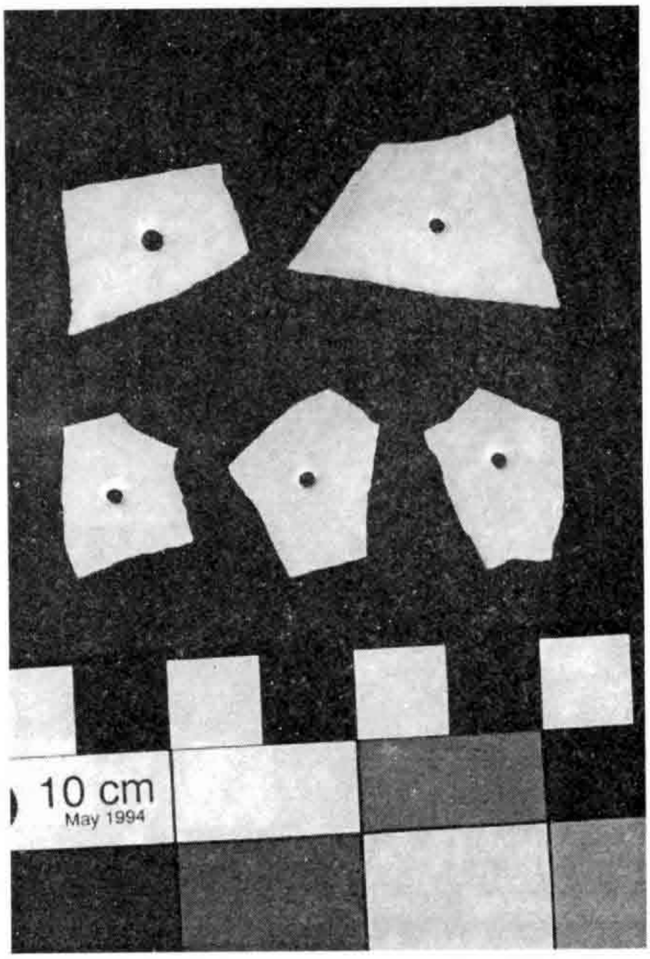

Fig. 4: Drilled replicative bead roughs before trimming, made from fragments of modern ostrich eggshell (of *Struthio camelus*)

of the Indian Upper Palaeolithic were reamed out by alternating rotation of the borer: this usually results in a slightly oblong perforation, as already noted by Semenov (1964: 78) in drilling through other materials with stone tools.

Before commencing the abrading of the still angular fragment, the excess area is trimmed off by gripping the piece firmly between two fingers in the area that is to form the final bead, and pressing its convex side against a stone surface. This process of snapping off small angular fragments until the actual bead blank is obtained (Fig. 5) requires skill and judgment: if the bead is incorrectly held or handled, it can easily crack through the perforation. The average time of the trimming process is 34 seconds.

Grinding the excess material from the fragment's edge is easy, although very demanding on the operator's finger tips. I found it convenient to divide this process into two steps, first grinding the bead blank into a roughly circular shape of under 10 mm, resembling the Patne specimen in Figure 3. This requires between 65 and 270

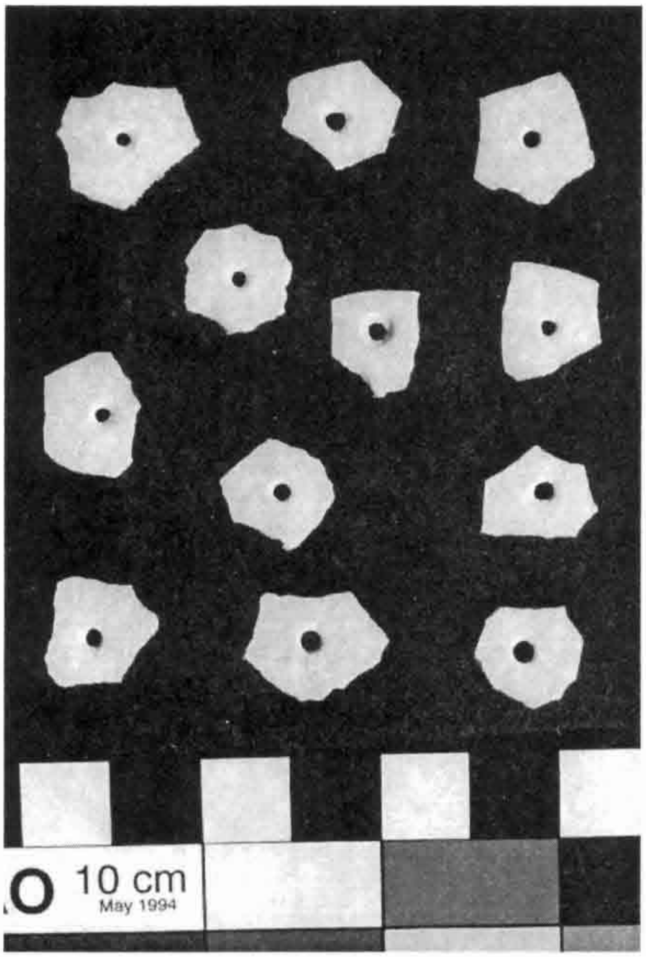

Fig. 5: Bead roughs after trimming

seconds (mean 217 secs, n = 12), the duration being related directly to the amount of excess material to be removed. Siliceous sandstone, silcrete or quartzite provide excellent grinding surfaces, and an experienced craftsman should not break any pieces in this process (Fig. 6).

In attempting to replicate the Acheulian specimens from El Greifa, I found that I had to further refine the product of the last step. It takes between 580 and 645 seconds to reduce the <10 mm beads to almost perfectly round specimens of about 6 mm diameter (mean 618 secs, n = 12). On this basis we can estimate that the time it took to produce one of the El Greifa ostrich eggshell beads, assuming that the maker was a skilled craftsman, was in the order of 17 minutes, or about 25 minutes if we include the time of preparing and resharpening stone points (Fig. 7).

Both the beads and the stone tools used in their manufacture were examined under a stereoscopic optical microscope at low to medium magnifications. The information so gained is not only useful in the microscopic study of pre-Historic bead specimens and stone borers, it also explained the surprisingly rapid blunting I experienced with the stone tools. Expecting to find significant microscopic spalling on working edges, I was surprised to see that the 'blunting' of borers was not so much due to wear, but due to clogging up of recesses with highly compacted calcium carbonate. Nevertheless, a characteristic type of wear sheen was also noted on the edges at the point of many tools.

The ground and powdered eggshell material was also examined carefully, and was found to contain surprisingly large chips of eggshell layer, commonly measuring 0.1-0.5 mm, but in rare cases of up to 1.8 mm length. However, over half the volume of the white powder is of much smaller grain size, most of it 2-20 m. Differences in its composition were noted according to the rock type used: a gritty siliceous sandstone and a silcrete produced slightly different cumulative grain size distribution curves than a dense central Indian quartzite.

Discussion

The replication of archaeological specimens is part of experimental archaeology, without which interpretation in this discipline is of very limited use. It is through the experimentation with technologies that we gain credible insights into how materials must have been utilized to produce the kind of record the archaeologist encounters. In this sense experimental archaeology is related to the study of the taphonomy of archaeological remains, and together these two areas of research can bring archaeological interpretation to life. I will try to illustrate this with the presently considered evidence.

The most important deductions we can draw from the present study concern the three Acheulian beads from Libya, and what we can learn about the circumstances of their manufacture, in terms of illuminating the conceptual world of their makers. The first observation we can make concerns the considerably finer workmanship of these Acheulian specimens in comparison to those we have of the Upper Palaeolithic (cf. Fig. 3). This may be unexpected, but it mirrors an experience we had recently with European rock art: the most sophisticated we have found so far, that of Chauvet Cave in France (Chauvet *et al.* 1995) turned out to be also the earliest we know of in the European Upper Palaeolithic (Clottes *et al.* 1995). Hence the idea of evolution towards increased sophistication is a Eurocentric myth in rock art development, and may well be so in other areas of archaeology.

The near-perfect roundness of the Acheulian beads can be obtained only by constant checking of the shape during the final abrading process, using not just a developed sense of symmetry, but possessing a very clear concept of a perfect geometric form. This roundness cannot be the result

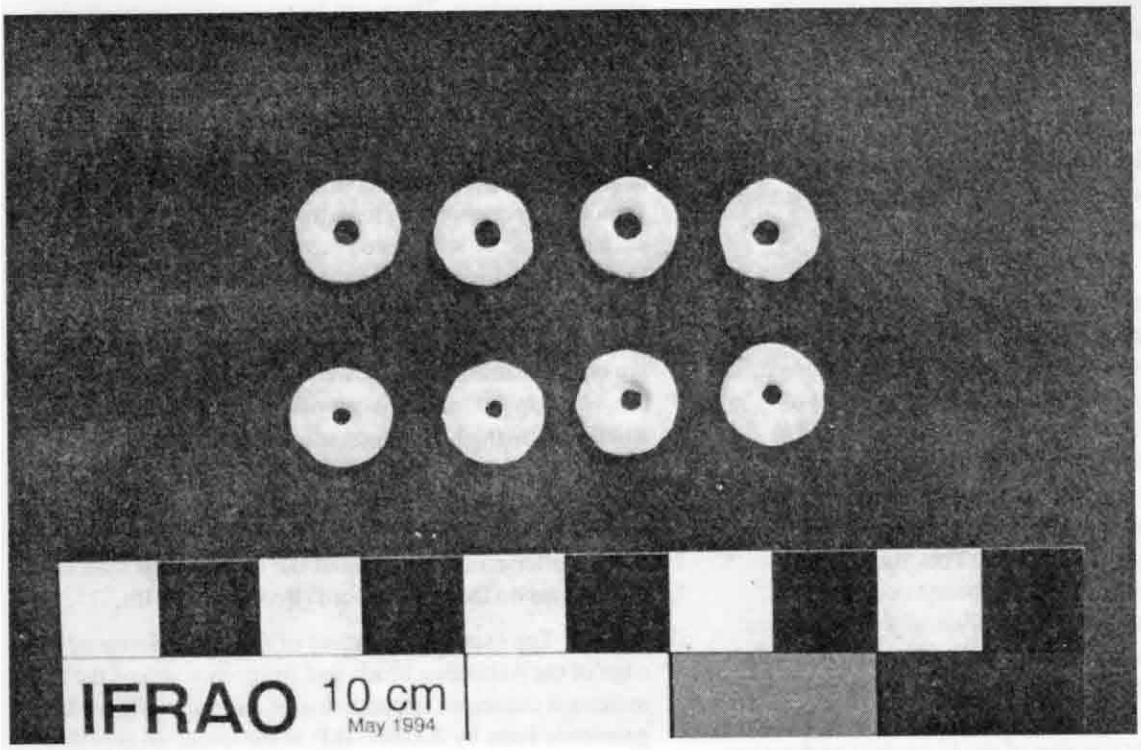

Fig. 6: Finished replicative ostrich eggshell beads of just under 10 mm diameter, matching those found archaeologically

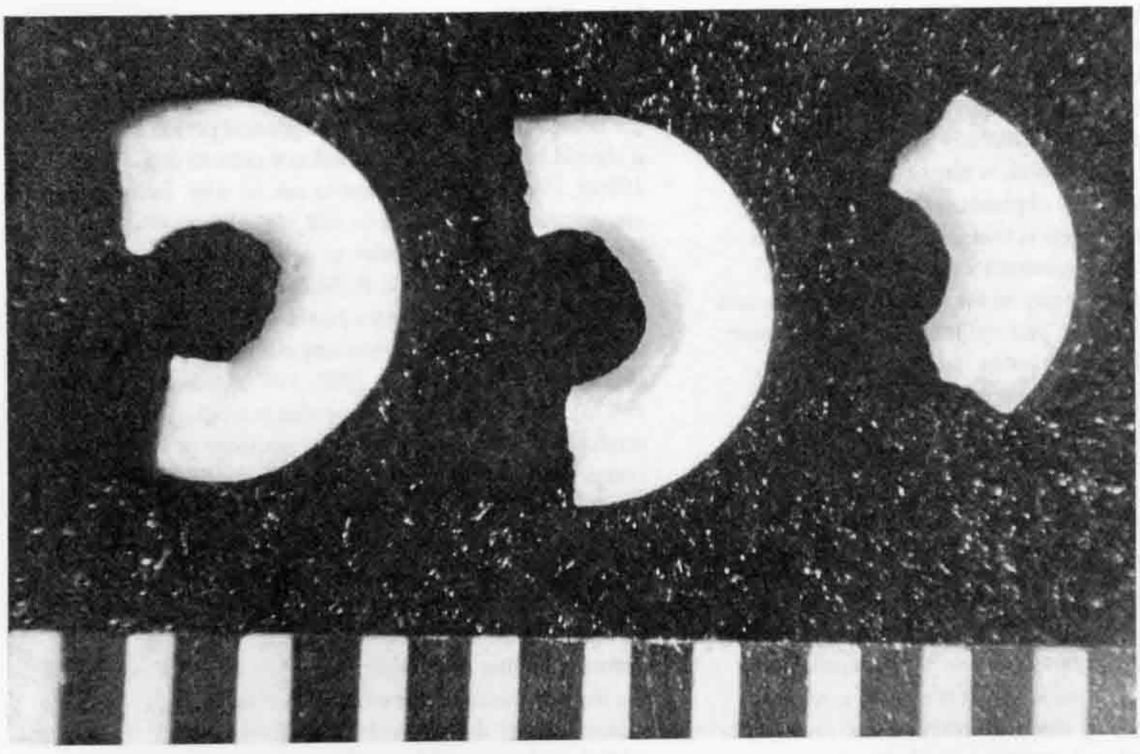

Fig. 7: Replicas of the Acheulian ostrich eggshell beads from El Greifa site E, Libya. Using Acheulian stone tool types, these beads take an experienced operator about 25 minutes each to produce

of chance or some 'instinct' driven by a mere desire to reduce the size of the beads. It is the outcome of a very clear abstract construct of form — a concept-mediated, geometrically perfect form. Moreover, it is the result of a determined effort to produce high-quality work. To extract the full potential information offered by these few beads, I find the following point particularly important, and it also demonstrates vividly the enormous benefits of replication studies.

During my experiments I found that as the beads are ground to a diameter of 8 or 7 mm it becomes increasingly difficult to hold them while grinding them, and after a time it becomes a rather painful task. The finger tips not only have to maintain a tight grip, they are also subjected to abrasion from the siliceous stone. About 6 mm is the diameter at which it becomes uneconomical to continue reduction further, and this is precisely the size of all three Acheulian bead fragments we have. This, too, is not a coincidence, but the result of a deliberate decision to reduce the beads to the smallest realistically possible size. It must be considered also that at sizes of under 6 mm, the beads become increasingly fragile: with a perforation of almost 2 mm, their rim width falls to under 2 mm. Moreover, because of what remains of the bi-conical perforation profile, the innermost part of the rim is never of full eggshell thickness. I found that if the beads were ground to a smaller size, they would become susceptible to fracture, either during manufacture or during subsequent use.

So we have two limits on minimum size imposed by practical considerations, and we need to ask: why did the makers of these beads push their technology to its practical limits? After all, a larger bead is much easier to see, yet a smaller bead represents a significantly greater effort. This observation coincides with the already mentioned geometric perfection of the form, which is most certainly deliberate. The most parsimonious explanation for both the size and the form of these objects is that these characteristics reflect a highly developed abstract value system and a considerable social complexity in the society that made and used these beads. Without a cultural impetus placing value and meaning on such perfect forms, and on an utmost standard of craftsmanship that pushes the technology available to it to the utmost limit, it seems simply impossible to account for the empirical characteristics of the evidence. There is certainly no utilitarian explanation to account for them, so the motivation of these artisans is to be found in ideology.

The strong hypothesis that humans of the Late Acheulian period, about 200,000 years ago, possessed such a cultural system is at massive odds with the currently dominant paradigm. Not only does it postulate a value system concerning purely abstract criteria, there must have been a socially shared and communicated meaning regarding the significance of the characteristics of these symbolic products. There can be no purpose in producing technological perfection if there is no comprehension and appreciation of its ideals.

Another insight provided by the replication of Acheulian ostrich eggshell beads (Fig. 7) concerns their technological perfection. It suggests that their makers drew from the experience of a long tradition of manufacturing such products of which we know almost nothing. We do know that perforation of hard objects (e.g. teeth) was probably already practised earlier, and very competently. Bearing in mind that most ethnographically known beads are of perishable materials, we may reasonably assume that this also applied in the distant past. Naturally perforated small objects may have been used as beads, such as crinoid columnar segments (Goren-Inbar *et al.* 1991) or the ear-bone of the cave bear (Marshack 1991: Fig. 6). Finally, but perhaps most importantly, taphonomic logic demands a much earlier commencement of the use of beads than can be detected on the fossil record (Bednarik 1994b).

The excellent rounding of the circumferential edge of the Acheulian beads and the even width of the ring indicate a conscious appreciation of an essentially abstract, geometric form by 200,000 B.P. at the latest, an appreciation which is amply evident from the later Middle Palaeolithic technological traditions. The latter period has provided such evidence from Hungary (the Tata nummulite; Bednarik 1992a: Fig. 4) to Australia (the extensive geometric rock art of that country's Pleistocene tradition, which is the world's most recent Middle Palaeolithic).

Mainstream archaeologists may find such evidence of early sophistication extraordinary, but seen in the context of other finds of the general period in question it should be neither unexpected nor controversial (Bednarik 1995b, 1996c). The question to ask is: why, for instance, are orthodox archaeologists still speculating whether language was possible prior to 35,000 B.P. (Davidson and Noble 1989) or 60,000 B.P. (Noble and Davidson 1996)? They are unaware that even *Homo erectus* must have had language to navigate the sea and colonize new islands (Maringer and Verhoeven 1970, 1977; Bednarik 1995a, 1997a). They may be unaware that petroglyphs, too, were produced in the Acheulian, that haematite or other iron compounds were used as pigment up to 900 millennia ago (Bednarik 1994a), that hafted tools with wooden handles, stone-walled dwellings and portable engravings date from the Lower Palaeolithic (Bednarik 1992a, 1995b, 1996d), and that the oldest beads or pendants we know about may be close to 300 millennia old (Bednarik 1992a). It is unfortunate that the dominant models in archaeology, since the time of the rejection of the Altamira art a century ago, remain largely determined by scholars who are unfamiliar with the relevant evidence. The most urgent task in archaeology is to introduce a systematic study of the limitations of knowledge of its practitioners '... concerning existing data... how language barriers and other biases limited the flow of information in this field, or how false constructs... flourished in archaeology' (Bednarik 1995d: 120). This should be done as one of the several strategies of introducing metamorphology (*op. cit.*), the scientific version of archaeology. The example illustrated in the present paper confirms this need for major reappraisal.

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