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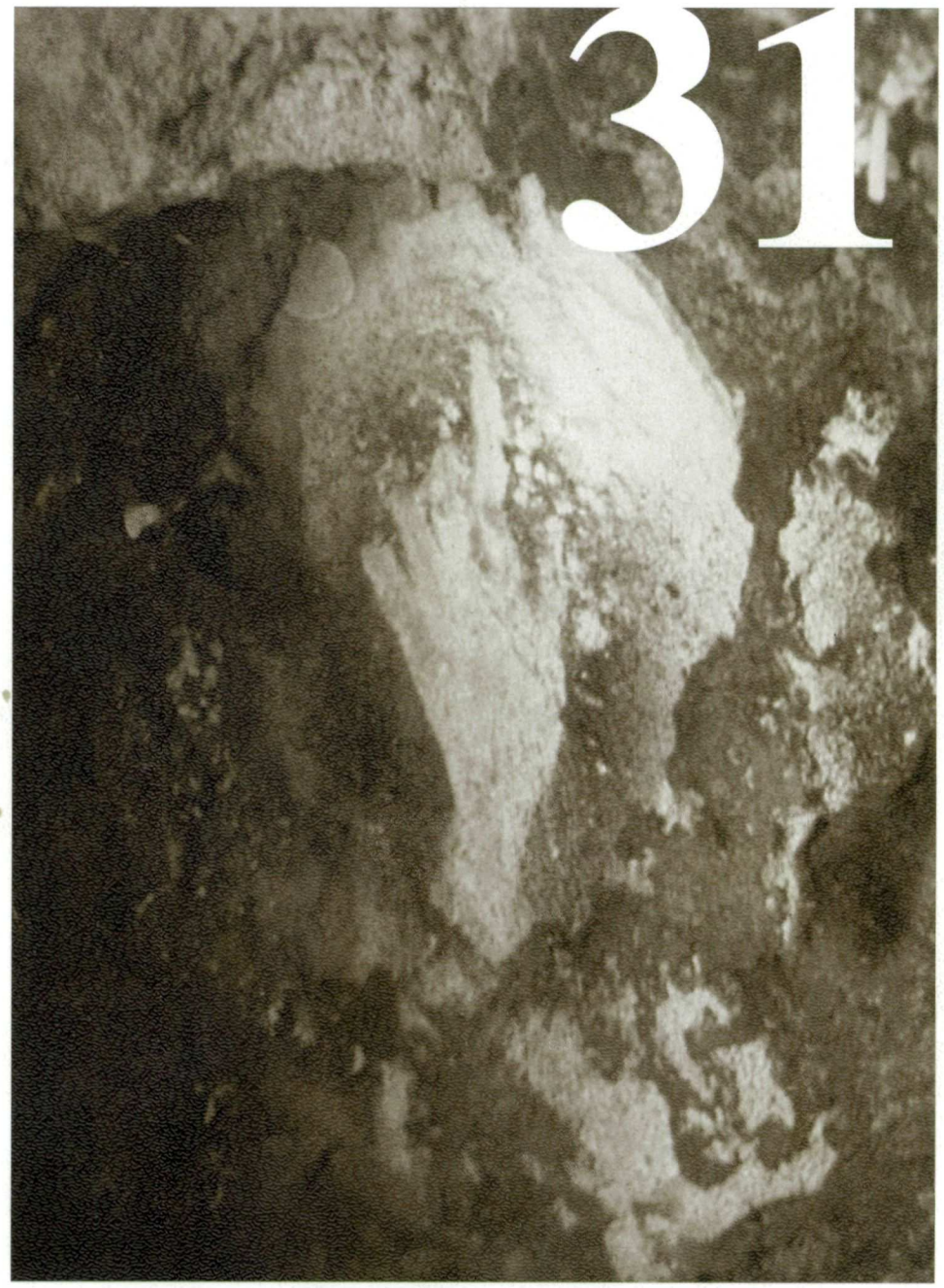

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HUNTERS OF THE GOLDEN AGE

THE MID UPPER PALAEOLITHIC OF EURASIA 30,000 – 20,000 BP

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Olga Soffer

5 Gravettian technologies in social contexts

After different lines of evidence, the gravettian sites of Moravia are held as aggregation locations where sizable groups of people gathered between early autumn and the spring months. An unprecedented variety of perishable and non-perishable items has been unearthed at such sites, reflecting the mastering of an array of different technologies used to make both utilitarian and non-utilitarian items. Amongst others, the use of plant fibres to manufacture basketry, textiles and netting is noteworthy. In this paper, it is argued that technological innovations signal the increased consumption demands of the co-residential groups, requiring a guaranteed food supply. Intensified ritual activity, as well as feasting, probably also characterised such gatherings of people. Seasonal aggregation was required to counteract the strain due to isolation of small, distant groups, living over vast depopulated territories during most of the year. Net hunting, which requires the co-operation of a whole co-resident unit, including women and children, would have allowed the production of the required surplus food, which otherwise would not have been made available by more restricted hunting parties, endowed with spears and lances only. The processing of plant food is also documented, further highlighting the importance of food procurement techniques usually associated with the feminine sphere of activity.

1. Introduction

Hunter-gatherers who occupied Central and Eastern Europe between some 30,000 and 20,000 years ago left behind a material record rich in technological diversity. These technologies have informed our reconstructions of gravettian lifeways, but have done so using insights only gained from the study of durable materials: stone, ivory, antler, and bone. Ethnographic and archaeological evidence, however, indicate that the overwhelming majority of material culture of all hunter-gatherer groups, both in the present and in the near and distant past, was made of perishable materials – with the documented ratios of durables to perishables hovering around 5%: 95% (e.g. Collins 1937; Taylor 1966; Helm 1981; Damas 1984; Croes 1997). Thus, given the wealth and diversity of perishables that were likely used in the Palaeolithic, our past failure to recover them not only strongly biases our understanding of those economies and technologies, but also makes invisible the inventories made and used by the majority of palaeolithic people – women and children (Kehoe 1990; Conkey 1991; Owen 1996). This occurs because technologies used by females, and by extension children, are far more perishable than those used by males – an observation confirmed by cross-cultural ethnographic data on the division of labour by sex and the concomitant implements associated with the different tasks (Mason 1910; Murdock 1937; Watanabe 1968; Murdock and Provost 1973).

In this chapter I begin redressing these past omissions by examining the technological repertoire of a subset of gravettian groups – those whose sites and inventories are assigned to the Pavlov culture and its immediate successors (Svoboda *et al.* 1996). I focus on data from the Moravian sites not only because they reveal a number of important technological innovations, but because the fortuitous preservation and recovery of perishable technologies here sheds light on the production and use of cordage and such cordage by-products as nets, baskets, and loomed textiles.

2. The sites

The data I examine come from the sites of Dolní Věstonice I and II, Pavlov I and II, Petřkovice, and Předmostí. Since these sites are treated in detail in the Svoboda *et al.* chapter in this volume, I will not dwell on them in detail. For the purposes of this discussion it is important to note first, that they were all occupied prior to the last glacial maximum dated to 20-18,000 bp, and thus fall into the Early Upper Palaeolithic period in those classificatory schemes which divide the Upper Palaeolithic into Early and Late (e.g. Lindly and Clark 1990). Second, as Svoboda and his colleagues note in this volume, the Moravian sites were occupied during a milder period of the last glaciation when the region was covered by a mix of park forest and grassland-steppe vegetation.

Although many of the sites are large and have yielded huge inventories (e.g. over 1,000,000 pieces at Pavlov I – Svoboda 1994, 1997), they do not represent single occupations, but rather resulted from repeated residential stays of groups along the slopes of the Pavlov hills (Klíma 1963, 1995; Svoboda 1991, 1994, 1996, 1997; Svoboda *et al.* 1996). The third important point about these sites is that

the overwhelming majority of their large lithic inventories are made on exotic raw materials originating from different cardinal directions at distances between some 60 and 300 km from the sites. This, together with the wealth and diversity of their features and utilitarian and non-utilitarian inventories, suggests that such sites as Dolní Věstonice I and Pavlov I served as aggregation locations where sizable numbers of people gathered. Finally, although incomplete, extant information obtained from faunal and botanical remains, as well as from edgewear studies, suggest that these aggregations took place between the early autumn and the spring months (Svoboda 1991, 1994, 1996, 1997; Opravil 1994; Svoboda *et al.* 1996).

3. The technologies

The inventories from these sites are very diverse and show masterful use of both hard and soft media in production. For the purposes of this discussion, I subdivide them into the durable and perishable categories.

3.1 Durables

As at all other palaeolithic sites, the vast majority of the Moravian implements are made of inorganic materials as well as of more durable organic ones such as ivory, antler, and bone. This category can be sub-divided as follows:

3.1.1 Inorganic

Inorganic materials used by gravettian groups include stone, coal, clay, mineral pigments, and fossil shells.

lithics. Stone – most specifically chert, flint, limestone, metamorphite, quartz, quartzite, radiolarite, rock crystal, sandstone, slate, and obsidian – was used for the production of a variety of tools, especially such diagnostic tool types as burins, backed implements, endscrapers, and microliths and backed microliths (Klíma 1963; Absolon and Klíma 1977; Svoboda 1996; Svoboda *et al.* 1996). Because these inventories have received a great deal of attention in the literature, as well as the fact that they are discussed in the Svoboda *et al.* chapter in this volume, I will not discuss them other than to underscore that these inventories contain sizable percentages of microliths, including geometric shapes. Although these inventories have not been studied in detail for signs of diagnostic wear damage, cursory examinations of some of these backed blades and microgravettes has led Kozlowski (personal communication, 1997) to suggest that some may have been used as points in projectile weapons. The high percentages of geometric or para-geometric microliths at these sites, representing one of the oldest microlithic inventories on record, points to the production of complex composite propulsion weaponry (Svoboda 1996; Škrdla 1997). Stone was also used to produce rare non-utilitarian pieces such as the female figurine made of haematite found at Petřkovice (Klíma 1955b, c).

In addition to these knapped inventories, the Moravian sites also contain small but ubiquitous inventories of stone implements shaped by grinding and polishing (Škrdla 1997). These inventories include slate pendants or wetstones, grinding stones or slabs and grinders, as well as ground and polished pebbles likely used as retouchers. Škrdla (1997) notes that while some of these implements became ground and polished through use, others were purposefully shaped in this manner to produce desired forms – thus constituting the oldest evidence to date for ground stone technology.

coal. Klíma's (1953, 1955b, c) excavations at Petřkovice document yet another gravettian innovation – the burning of coal in hearths. The use of coal for fuel at this point in time has, to date, been only documented at this one site, a fact which, together with the local abundance of this fossil fuel in the area, suggests opportunistic rather than habitual use. At the same time it also indicates a sophisticated control of pyrotechnology, which is also attested to in the production of ceramics discussed below.

boiling stones. A number of hearths at the sites, especially at Dolní Věstonice II, were covered by fire cracked limestone rocks. These were likely used in cooking, and the presence of small pits surrounding the hearths implies that cooking was likely done by stone boiling (Svoboda 1991, 1996; Svoboda *et al.* 1996).

ceramics. Large inventories of ceramic fragments recovered from Dolní Věstonice I and II, Pavlov I and II, and Předmostí, together with two kilns used to fire the ceramics, bear witness to the ubiquitous production of ceramics in gravettian Moravia (Vandiver *et al.* 1990 with references). Research on these fragments indicates that local loess was mixed with water to fashion both animal and human figurines which were then fired in temperatures ranging between 600-800 degrees.

In addition to making these figurines, the residents of the sites also used local loess to produce a number of other implements which we are currently studying (Soffer and Vandiver 1994, 1997). Preliminary findings suggest that this category of ceramic fragments, which we have identified as 'structural ceramics', may represent clay linings of baskets, daub used in the construction of dwellings and, possibly, of house furnishings and containers. Loess was also used to construct two kilns at Dolní Věstonice I, as well as to cement a construction of mammoth bones at Pavlov I (Klíma 1957).

pigments. Vandiver's (1997) study of pigments at Pavlov I documents the use of both pure red iron oxides, mixtures of

red iron oxides with local loess, and yellow clay-based pigments. Hard red iron oxides were ground into coloured powder which was then often mixed with local loess. These minerals were pulverised and mixed by grinding with pebbles on stone slabs. A similar range of pigments and of grinding slabs/palettes and grinding stones has been recovered from other Moravian sites as well (Klíma 1963; Absolon and Klíma 1977).

fossil shells. Numerous perforated fossil marine shells were also recovered from the sites (Klíma 1963, 1995; Absolon and Klíma 1977; Svoboda 1991, 1994, 1997; Svoboda *et al.* 1996). These, most likely, originated from local Tertiary deposits (Jarašová, personal communication, 1999).

3.1.2 Organic

The extensive ivory, antler, and bone artefacts recovered from the sites have been extensively published in the literature and, like the lithic inventories, will not be discussed in detail here. Klíma's (1963, 1987, 1994; Absolon and Klíma 1977) numerous publications on this topic document the fashioning of a wide range of utilitarian implements as well as of items of personal adornment and portable art. It is important to underscore that the utilitarian inventories contain both likely hunting weaponry (e.g. spears and lances) as well as a large suite of processing implements used as digging tools (hoes and mattocks), shovels, hammers, clubs, tent pegs, polishers, handles, piercers and awls. They were fashioned both by knapping and by grinding and polishing. Finally, the site of Předmostí has yielded the broken remains of a large antler needle, measuring 8.9 cm in length, with remnants of a cut-through eye (Klíma 1990a, fig. 28). Dating to some 26,000 bp, this item represents the oldest needle recovered to date and confirms the hypothesis expressed by a number of scholars on the basis of indirect evidence, that the use of needles dates well before the last glacial maximum (e.g. White 1992; de Beaune 1993). Their rarity in Eurasian sites prior to some 20,000 bp, together with the indirect evidence for tailored clothing at Sungir' (Bader 1978), dated to some 25,000 bp, as well as at Mal'ta and Buret' in Siberia at possibly 22,000 bp (Derevianko 1998), raise the question if other plastic materials, such as wood, were more commonly used to fashion them.

Finally, the inventories also contain numerous perforated animal teeth, usually arctic fox canines, used as items of personal adornment.

3.1.3 Range of items produced

The range of items produced from durable materials is very wide. The utilitarian inventory contains a diversity of hunting weaponry and processing equipment associated with a wide range of activities from the killing of prey to meat and hide processing, the making of tools and weapons from stone, ivory, antler and bone, and the digging of soil to daubing, the construction of kilns, the stone boiling of food, the grinding of pigments and the likely processing of tubers, fruit, and seeds for food (Mason *et al.* 1994), to sewing or looping.

The non-utilitarian inventories indicate the production of beads and pendants made of stone, shell, ivory, and animal teeth, ivory pectorals and rings, the engraving of curvilinear and geometric designs, and the production of realistic and stylised animal, anthropomorphic, and human figurines depicting both men and women.

3.1.4 Production techniques

The range of techniques used to produce these items is equally impressive. The reduction techniques include knapping, grinding, polishing, cutting, and drilling. While the use of all of these techniques to work ivory, antler and bone is documented from the Aurignacian onward (Knecht *et al.* 1993), Klíma (1994) and Škrdla (1997) note that it is the Gravettians who expand the use of abrasion, grinding, and polishing to working stone as well.

The additive techniques, seen in the production of ceramic inventories and in the fashioning of composite weaponry, include the conjoining of separate pre-fabricated pieces to form complete objects.

3.2 PERISHABLES

The recovery of diverse perishables from Moravian gravettian sites – including worked wood, cordage, textiles, baskets, nets, and plant foods – resulted from fortuitous Pleistocene behaviour, from recovery techniques and methods used as well as from expectations that evidence for these technologies should be there. The widespread use of fire by Pavlov groups to warm themselves, cook their food, and light their dwellings, as well as their use of pyrotechnology to produce their ceramic inventories, from time to time likely led to both intentional and unintentional conflagrations. These, in some cases, inadvertently preserved charred remains of structures, as in the case of a wood construction above the triple burial at Dolní Věstonice II (Klíma 1990b, 1995). In other cases, the fires destroyed the dwellings but in doing so preserved impressions of cordage, textiles, basketry and nets – as at Pavlov I, Dolní Věstonice I and II (Adovasio *et al.* 1999; Soffer and Vandiver 1997; Soffer *et al.* in press). In yet another case, as at Dolní Věstonice II, the preparation of tuber, fruit, and seed gruels is documented by charred macro-botanical remains recovered through flotation from a hearth (Mason *et al.* 1994).

3.2.1 Wood

Klíma's (1990b, 1995) excavations of the triple burial at Dolní Věstonice II recovered a charred inventory of worked

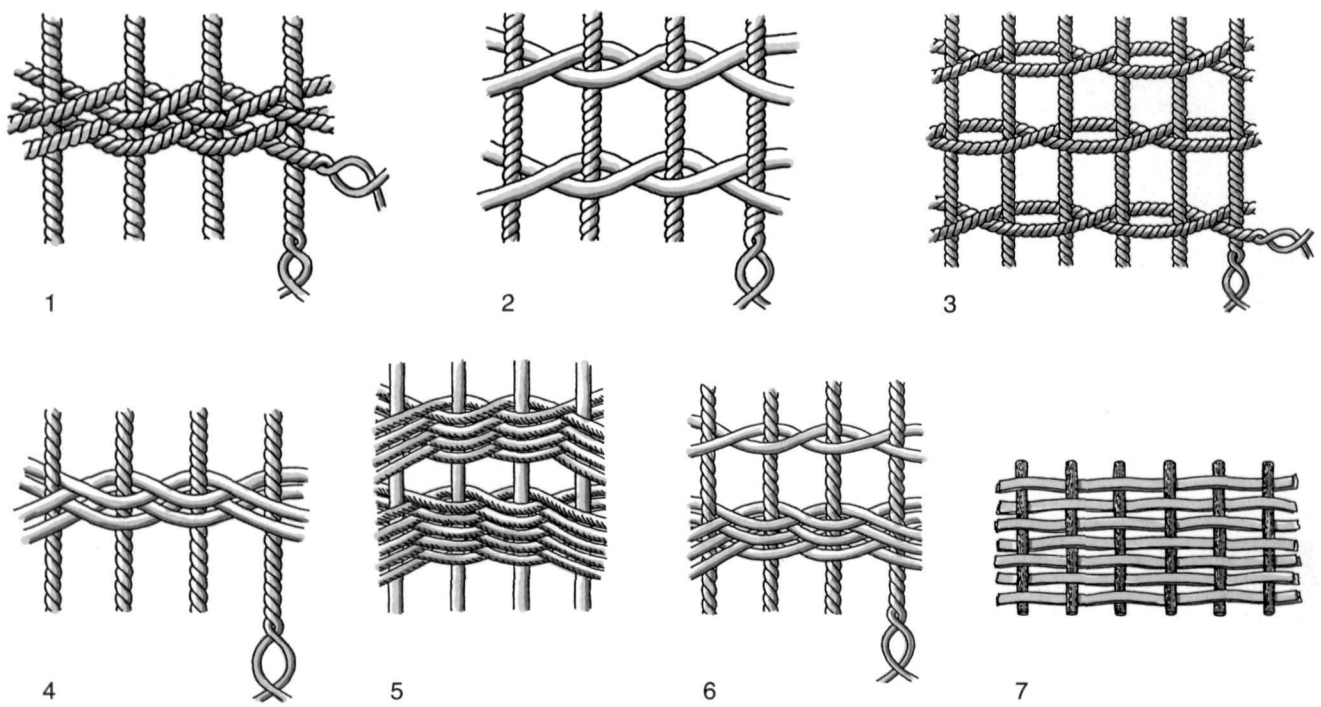

Fig. 1. Schematic diagram of twining and plaiting types represented in the Moravian textile and basketry impressions (after Adovasio *et al.* 1999, fig. 3. Soffer *et al.* in press, fig. 7)
1. Close simple twining, S twist weft, 2. Open simple twining, S twist weft, 3. Open diagonal twining, S twist weft, 4. Close simple twining, Z twist wefts, 5. Close simple twining, Z and S twist wefts, 6. Open and Close simple twining, Z and S twist wefts, 7. Wickerware-style plaiting, 1/1 interval

wood fragments made of coniferous taxa. He argues that these cut and shaped fragments once formed a super structure over the burial which was incinerated as the final part of the burial ritual. He has also documented the shaping of wood to make a number of other implements at Pavlov I, including likely anthropomorphic figurines (Klíma 1955a, 1990b). All of these objects are highly fragmentary and preclude exact identification to specific implements.

3.2.2 Plant fibers

Our research on the Pavlov I, and Dolní Věstonice I and II inventories has documented the use of plant fibers to manufacture cordage, basketry, textiles, and netting (Adovasio *et al.* 1999; Soffer *et al.* in press- both with references). The evidence for this technology comes from negative impressions of fiber-based constructions on fragments of fired clay and represent the oldest indications of fiber-based technology in the world to date.

textiles/basketry. The impressions show that textiles were produced by twining and exhibit seven of the eight commonly produced twining types, including open simple twining as well as open and closed diagonal twining. They also document simple plaiting to produce both loom-woven cloth as well as more rigid basketry and/or mats. Some specimens show conjoining of two pieces of fabric by whipping stitch to produce a seam (Adovasio *et al.* 1999 with references). This evidence for the conjoining of two pieces of textiles via a whipping stitch reflects sewing – a production technique indirectly attested to by rare needles and the use of tailored clothing hypothesized on the basis of funeral inventories and human depictions.

The impressed textiles were clearly made of plant rather than animal fibers. Pollen and macrobotanical data indicate a forest-steppe environment with the presence of both bast-bearing and other plants at the sites (Mason *et al.* 1994; Opravil 1994; Svoboda 1994; Svoboda *et al.* 1996). The impressions are sufficiently distinct to suggest that the textiles

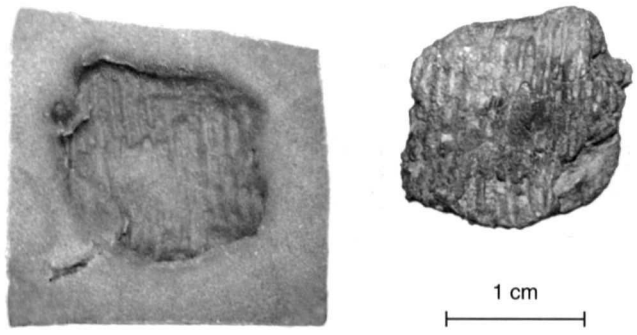

Fig. 2. Pavlov I- 54 no. 1 ceramic fragment (right) and its impression (left) – open simple twining, Z twist weft (photo O. Soffer)

were likely made of such bast-bearing fibers as milkweed (*Asclepias* sp.) and nettle (*Urtica* sp.). Fibrous bark of both alder (*Alnus* sp.) and yew (*Taxus* sp.) may have served for the production of basketry. All of these species have well-documented ethnographic and prehistoric uses as perishable production media (Barber 1991; Andrews and Adovasio 1996).

The impressions represent well-made items. The typological heterogeneity coupled with the general regularity and narrow gauge of the warp and weft elements used in the textile/basketry types identified to date, suggest a high level of standardisation and antecedent development. The same observations may be extended to the cordage specimens which are not portions of textiles.

cordage. Impressions of cordage in the assemblages document the production of a minimum of five different structural types including single, multiple, and braided specimens.

netting. The assemblage also contains several impressions of knotted cordage produced through the weaver's knot or one of its variants such as fishnet knot (Adovasio *et al.* 1999 with references). Depending on its precise configuration, ethnographically and archaeologically known knotted cordage often represents fragments of netting.

plant foods. Although the use of plant foods has been postulated for Eurasian hunter-gatherers by a number of scholars on both theoretical and associated empirical grounds (e.g. the presence of grinding stones and grinders), unequivocal evidence for them has been surprisingly sparse. Mason and her colleagues have identified in the macrobotanical remains from a hearth at Dolní Věstonice II as remains of cooked plant food residue used to make mush or gruel – possibly baby foods (Mason *et al.* 1994). It remains unclear if these remains represent refuse thrown into the hearth or resulted from spillage in cooking over open fires.

3.2.3 Range of items produced

The fragmentary nature of all perishable remains precludes clear identification of the range of items made from plant remains. We are most secure in identifying macrobotanical remains from hearths as food residue and on less firm ground postulating the uses that worked wood was put to. As noted previously, Klíma (1995) has suggested that some cut wood was used as structural elements in a funerary construction. Shaped wood may equally represent a range of items from fuel to burned discarded wood implements of unknown type, including figurines. Given the antiquity of shaping wood for hunting weaponry (e.g. at Swanscombe, Lehringen, and Schöningen), we can anticipate that Moravian groups fashioned a large suite of like implements as well. The hypothetical identification of some geometric microliths as arrow heads may hint at the existence of bows and arrow shafts as well.

Because the Moravian ceramic assemblage is highly fragmentary and the impressions very small in size, Adovasio and his colleagues note that it is also not possible to specify whether the identified textile structural types represent bags, mats, or cloth fabrics (Adovasio *et al.* 1999). If they are portions of bags or mats, they may have been used on floors or sitting/sleeping platforms in the case of mats, and as storage/transportation devices in the case of bags. They may also represent wall hangings and/or blankets. If they are portions of cloth fabrics, and the fineness of some suggest they were, they could represent a wide diversity of forms ranging from shawls to skirts, shirts, sashes or belts etc. Some scholars have, in fact, interpreted the decorations on some of the Upper Palaeolithic female figurines as depicting string skirts and textile belts (Barber 1991).

Ethnographic analogy suggests that some of the impressions could represent the intentional application of clay to the 'outside' of some flexible containers to provide a simple form of mould. They may also represent clay lining of baskets to make them watertight and suitable as containers for stone boiling. Another possibility are items that were simply impressed into moist floors as a consequence of use as well as the practice of transporting clay in bags. Intentional use of such items to pack or 'tamp' down prepared clay floors is possible, as is the use of wall hangings applied over and impressed into still wet clay which was subsequently accidentally fired after the structure was destroyed.

The presumed function of cordage is easier to stipulate – these items, likely, served the same function that cordage fills in all societies where it is produced – meeting a wide range of lashing, binding, and tying needs, as well as serving

as the production medium for other compound constructions such as items of clothing, bags, and nets (Adovasio *et al.* 1999). The identification of a sheet bend or weaver's knot on four of the impressions supports this hypothesis and suggests the production of knotted netting likely used for hunting.

3.2.4 Range of production techniques

The Moravian perishable inventories reflect the use of a wide range of production techniques. The preparation of plant foods pre-supposes the digging up of tubers and the gathering of fruits and pulses as well as the grinding of wild seeds. The presence of processed plant food residue in hearths hints that, in addition to stone boiling in cooking pits next to the hearths, cooking may also have been done in watertight containers directly over the hearths.

Remains of worked wood suggest the production of implements by reduction – through cutting and polishing.

The impressions of textiles, basketry and cordage reveal a slew of additional reduction techniques. The production of cordage resulted from plant harvesting, processing (retting and hacking), and twisting and/or spinning lengths of fibrous material. These items were then used in an additive fashion via twining and plaiting to produce artefacts created through repetitive conjoining of like segments. This involved both looping (in the case of nets) and weaving (textiles and basketry). The fineness of some of the weavings indicates, almost certainly, the use of non-heddle loom or weaving frame (Adovasio *et al.* 1999 with references). It is important to underscore that this inventory is characterised by a very high level of typological diversity. Adovasio and his colleagues note that younger Mesolithic/Archaic and Neolithic/Formative perishable assemblages usually exhibit a far more restricted array of types with a clear preference for certain warp and weft manipulations as well as preferred initial spin and especially final twist directions (Adovasio *et al.* 1998). It may well be that this later homogeneity reflects a stabilised technology practiced over millennia.

Finally, given the highly fragmentary nature of these remains and their association with dwelling structures (Soffer and Vandiver 1997; Adovasio *et al.* 1998), it is not possible to hypothesize whether they all represent utilitarian inventories. Depictions of possible woven belts and string skirts or aprons on some of the Upper Palaeolithic figurines (Barber 1991), as well as Klíma's (1990b) identification of one wood fragment as a remnant of an anthropomorphic figurine, suggest that perishable media, like their durable equivalents, were likely used to make both objects of utilitarian and non-utilitarian value.

4. Why these innovations at this point in time?

The gravettian record clearly documents a number of significant innovations some of which, like complex insert technology, show continuous development through Upper Palaeolithic times, while others, like polished stone technologies and, possibly, ceramic technologies, may not. This necessarily raises questions both about why these innovations arose as well as why some of them did not see widespread adoption and elaboration. To address these questions I next turn to some current theories of technology.

4.1 Understanding innovation

Technological change through time has been of prime interest to archaeologists and a focus of much research (e.g. Childe 1951; White 1959). This research, however, did not problematise change but assumed that the evolution of technology was a natural process not needing an explanation. This effectively separated technology from society and led to unsatisfactory explanations for change that focused on such prime movers as human 'genius' or invention, climatic change, diffusion, etc. (Dobres and Hoffman 1994). Today scholars see technological change as a historical process which takes place within particular economic, political, and cultural contexts (Parayil 1993). In considering these contexts, it is important to remember the following 'laws' formulated by Kranzberg (1989) for technology in general:

1. Technology is neither good, bad, nor neutral – meaning that technology interacts with society in ways that technological developments have impact beyond immediate purposes and can have quite different results when introduced into different contexts.
2. Invention is the mother of necessity – meaning that technology solves perceived problems.
3. Technology comes in packages, big and small – meaning that when one component of the social, political, economic, and cultural environment changes, others are affected.
4. Although technology might be the prime element in many public issues, non-technical factors take precedence in technological decisions – which highlights the social component of technological stability or change.
5. Technology is a very human activity and so is the history of technology.

Furthermore, it is necessary to view technological innovation as a process and to separate it into its constituent components: invention or discovery and its development. Spratt (1982, 1989) points out that in dealing with innovation process, it is necessary to understand what impels it to take place and then to delimit the course that the process takes: accepted and developed or not, if accepted is the development slow or rapid, etc.

These theoretical insights direct us to embed technology within human decision making from which it emanates (Lemonnier 1986, 1992, 1993; Nelson 1991; Van der Leeuw

1993; Dobres and Hoffman 1994). Since, as Torrence (1989), among others, points out, technology is developed in order to solve problems – it follows that seeing technology as a solution to problems – calls for specifying the types of problems which it addressed (Torrence 1989; Stiner and Kuhn 1996).

Our past studies of prehistoric technologies have followed adaptationist paradigms which favour seeing ecological/economic concerns as primary in human decision making (e.g. Torrence 1989; Nelson 1991). More recent research, however, points to the importance of economic, social and political, as well as ideological (something Lemonnier (1992) has termed "cultural logic") concerns of the decision makers.

Although a number of these important variables, such as ideology or strategic decision making by particular individuals may not be accessible in the study of palaeolithic innovations, because the record we have to work with is too coarse for such questions, nonetheless there are a number of insights that are applicable to Upper Palaeolithic Moravia. For the purposes of this discussion I wish to stress Basala's (1988: 11) point that technology is cultivated to meet perceived needs and that these needs are defined by individuals in a particular social matrix. The social matrix, in turn, is constrained by a number of variables which may be discernible in the archaeological record. Specifically, if we combine economic insights that it is consumption that stimulates production in pre-market societies (Gregory 1982; Minnegal 1997) with the understanding that technology is a seminal component of production – we see, first, that Moravian technological innovations likely signal changed – more specifically – increased consumption demands.

We can expand on this by making a few other predictions about the relationship between Moravian technological innovations and the social organisation of the groups who produced them. Since technology is associated with production, it follows that technological innovations represent an intensification of production. Second, since production needs are determined by consumption needs, we can anticipate that technological innovations were designed to meet some new socially determined needs. Furthermore, since, as Torrence and Van der Leeuw (1989: 10) have pointed out, innovations are more likely to be accepted in stress times when traditional ways of doing things are more likely to be seen as wanting, we need to look for possible causes of stress in Moravian times. Finally, in the absence of unique environmental conditions in Moravia 30,000-20,000 years ago which were unprecedented before or after this time slice, we clearly should seek such evidence for stress in the social rather than in the natural environment – more specifically – in changed group size of the co-residential units.

4.2 Studying technology – measuring innovation

A number of technological innovations at the Moravian sites relates to more efficient food procurement. To understand them I next turn to Oswalt (1976) who has systematised the study of ethnographic food production technologies by, first, identifying the technological units (technounits) employed to produce the implements and, second, by delimiting the methods of conjoining these units into the finished product. He sees the evolution of technology reflected in the increasing number of technounits used and in the more complex ways of conjoining them. Oswalt (1976: 199-208) identifies four specific principles universally used in artefact production, which appear sequentially through time:

1. reduction
2. conjunctions – the combining of different technounits to make composite artefacts (e.g. hafting)
3. replication – the combination of two or more like structural elements to function as parts of a complex form (e.g. complex insert weaponry, house construction)
4. linkage – the making and use of co-dependent artefacts (e.g. bow and arrow, spear thrower and spear).

In considering the facilities used in food procurement, Oswalt (1976: 129) points out, first, that it is technologically simpler to gain a hold on wild species than it is to kill them by other means, and second, that facilities designed to do so have fewer technounits than hunting weaponry. Using facilities in food procurement is not only technologically simpler, but also a practice which greatly increases the effectiveness of hunting weaponry. Furthermore, although tended facilities (those dependent on close monitoring by people – e.g. hunting nets, drive lines), are technologically simpler than untended ones, they require greater co-operation and collaboration than does the use of untended facilities. Untended facilities, on the other hand, consist of more technounits – which is the price paid for substituting technounits for people. Finally, Oswalt (1976) also demonstrates that facilities used to capture prey on land have fewer technounits than those used in water. This observation leads him to conclude that such harvesting techniques as net hunting likely originated on land for capturing terrestrial resources and that their use to harvest aquatic taxa developed later in time (Oswalt 1976: 129).

This perspective on food procurement technologies allows us, first, to see that all four principles of artefact production are in evidence in the Moravian inventories: reduction – stone and bone tools; conjunction – hafted implement; replication – composite insert technology, the making of nets and baskets; and linkage – grinding stones and slabs, possible bows and arrows. Second, it also sheds light on the possible use of nets as tended facilities for hunting terrestrial

game and the absence of evidence for their use for procuring either fish or birds. Furthermore, it also explains why, in spite of many suggestions that snares and traps were used by palaeolithic hunters (Pidoplichko 1976; Straus 1987; Pike-Tay 1993; Musil 1994, 1997), to date we have no firm evidence for these untended facilities, which may not have been in use before the Holocene.

5. Implications of theory and data for gravettian Moravia

In this concluding section I examine the Moravian technological innovations through the lens of theory and tentatively outline some proximate and ultimate causes – all social in nature – which may account for these inventories. I stress that in doing so I do not assume that all of them necessarily arose in Moravia some 27,000 years ago. Data on gravettian textiles and basketry, for example, clearly suggest antecedents. Regardless of when each was invented, my primary concern here is with their co-occurrence at this point in time. I begin with what we firmly know and progress to more hypothetical insights.

5.1 Types of sites

As noted previously, most of the sites assigned to the Pavlov culture are aggregation sites where sizable numbers of people co-resided together during the autumn to spring seasons. Given the recovery of food remains identified as likely weaning foods, we can assume that these co-residential groups included women and children. It is important to underscore that this is the earliest unequivocal evidence we have for aggregation sites in the Upper Palaeolithic. Preceding aurignacian sites in both Central and Western Europe are considerably smaller in size with smaller inventories and more limited numbers of less diverse faunal remains (Enloe 1993; Pike-Tay 1993; Pike-Tay and Bricker 1993; Svoboda *et al.* 1996) – suggesting that they were occupied by small groups. Furthermore, Hahn (1987) has noted that gravettian groups in Germany were either more mobile or had more attenuated exploitation territories than did their aurignacian predecessors, an observation which Svoboda *et al.* (1996) confirm for Moravia as well. I suggest that it is precisely this increase in seasonal mobility of small groups, and the concomitant attenuation of exploitation territories, which put a strain on mating, information exchange and risk sharing networks of gravettian hunters and gatherers, and that cold weather aggregations were their social solution for this strain.

Aggregations, however, while solving problems caused by group dispersal, create their own problems for both subsistence practices and for day to day social interactions (see Johnson 1982 on social consequences of aggregations). Large groups require more food and aggregations can only be viable if there is a guaranteed food supply. Large groups require more food than small ones – and this demand, in turn, calls for the intensification of food procurement efforts. These efforts can take a number of forms, some of which – such as more complex weaponry, communal net hunting (Adovasio *et al.* 1999), the broadening of the resource base to include medium and small sized prey (Musil 1994, 1997) – are evident in gravettian Moravia and constitute a form of intensification of subsistence pursuits.

5.2 Hunting implements

The presence of microliths and geometric microliths in the Moravian inventories in sizable numbers herald the presence of complex multi-component weaponry – most likely lethal barbed throwing and thrusting spears and lances. These short-range weapons, while likely improving hunting success, still limited prey choice to large-sized animals and the hunting methods to ambush. Churchill (1993), on the basis of cross-cultural ethnographic data, has recently demonstrated that long-distance hunting weaponry (i.e. spear throwers and bows and arrows) not only considerably increases the effective range of hunting implements but also makes possible effective hunting of medium and small sized animals. He has also demonstrated that the absence of long-distance hunting weaponry favours co-operative hunting (Churchill 1993). The gravettian record contains no spear throwers, and while some scholars have argued that some of the microliths may have served as arrows – and thus suggested that hunting with bows and arrows came into practice some 26,000 years ago – evidence for this is equivocal and in need of empirical demonstration. Finally, the abundant and varied faunal remains at the Moravian sites has led a number of scholars to argue for collaborative hunting (e.g. Klíma 1963; Musil 1994, 1997; Svoboda *et al.* 1996).

5.3 Hunting facilities

The inventories also contain evidence for the production of nets which were likely used for hunting. To date the mesh size of the hypothesized Pavlov nets is quite small, which would have made them suitable for the hunting of only small-sized prey. This observation is in good accord with the high numbers of such taxa as hares and foxes recovered from the sites (Musil 1994, 1997). It is also in good accord with cross-cultural ethnographic data which indicate the use of nets to capture small terrestrial fauna, including fur-bearers, throughout the world (Steward 1938; Satterthwait 1986, 1987; Roscoe 1990, 1993; Andrews and Adovasio 1996). While the ethnographic literature also documents the widespread use of nets for fowling and fishing, the lack of fish remains and the paucity of avian elements at Moravian sites (Musil 1994, 1997), suggests that fish and birds were not an important component of the Upper Palaeolithic diet at

these sites. This observation corroborates Oswalt's (1976) hypothesis that net hunting of terrestrial game likely preceded fishing and fowling with nets.

The fine gauge of virtually all of the gravettian weaving suggests that, perhaps, the larger gauge fraction of the perishable industry has not been preserved or recovered to date. Ethnographic data show that nets, in addition to capturing small-sized mammals in the 3-20 kg weight range, were successfully used to capture a wide range of larger-sized herbivores from kangaroos and even horses in post-contact times in Australia (Satterthwait 1986, 1987) to antelope, deer, and mountain sheep in North America (Frison *et al.* 1986; Andrews and Adovasio 1996). This implies that, if practiced, net hunting may have been used to procure larger-sized taxa in Upper Palaeolithic Moravia as well.

The possibility of net hunting carries important implications. Cross-cultural research indicates that net hunting is a communal effort, which, because of the relative lack of expertise necessary for success, as well as the minimal danger involved in such a non-confrontational harvesting technique, requires fewer skilled hunters and can and does utilise the labour of the entire co-residential social unit (Steward 1938; Anell 1969; Satterthwait 1986, 1987; Frison 1987; Wilkie and Curran 1991). It is, thus, the one hunting method strongly associated with the labour of women and children (Murdock 1937; Murdock and Provost 1973). It is likely that net hunting may have been more frequent in the past than documented in the ethnographic record, where it is rare but widespread (Manhire *et al.* 1985; Satterthwait 1986, 1987).

Finally, net hunting is also associated with large harvests in short periods of time and, thus, with the production of a surplus (Satterthwait 1986, 1987). Although such a surplus in some ethnographic cases is associated with participation in a market economy (e.g., the Ituri forest [Wilkie and Curran 1991]), in other cases, such as in Aboriginal Australia (Satterthwait 1986, 1987) or in New Guinea (Roscoe 1990, 1993), it is associated with large gatherings, feasting, and ceremonialism.

If, as I have argued above, the Moravian record does show the advent of group hunting and mass harvesting, then the use of particular tended facilities to do so – specifically nets – suggests increased demands on the labour of women, children, and of older individuals. Wilkie and Curran (1991) have argued that the Mbuti of the Ituri Forest took up hunting with nets to incorporate female labour into meat procurement pursuits. In the Ituri this was done to increase surpluses for trade. In Upper Palaeolithic Moravia it may have been done to support aggregations.

5.4 Food storage and preparation

The storage of food is clearly another method for insuring food surpluses – but it is a method for which we have no documented evidence until after the last glacial maximum (Soffer 1985, 1989). The Moravian sites contain no storage pits and the one potential candidate as such, uncovered at Pavlov I in 1951, Klíma (1977) interpreted as a pit house. The faunal remains at such sites as Dolní Věstonice I, however, do contain an abundance of filleting marks suggesting that meat was reduced to small strips (Soffer 1989). This, together with the presence of small boiling pits around many of the hearths at the sites, which suggests that meat was processed and cooked in small parcels, may possibly hint that meat strips may have also been preserved by drying. If this was the case, then Moravian groups may have practiced a form of portable storage – but this, while it can be hypothesized – remains to be empirically demonstrated.

The Moravian inventories also contain many implements, such as shovels, grinding equipment, and microlithic inserts possibly used in knives, which are associated with plant harvesting and thus with the labour of women (Klíma 1963; Zvelebil 1994). Direct evidence for plant foods, as noted, comes from the one hearth at Dolní Věstonice II whose contents were floated.

Little evidence exists for food preparation – but that on hand clearly reflects the labour of women who are universally responsible for food preparation and serving in the ethnographic record (Murdock 1937; Murdock and Provost 1973). The presence of grinders and grinding stones may indicate that some foods were ground before cooking. The fillet cut marks on animal bones suggest that meat was reduced into small packages. The boiling pits, in turn, suggest that the meat and plants were cooked in liquids producing something like gruels, soups, or stews.

Mason (*et al.* 1994) and her colleagues' recovery of foods at Dolní Věstonice II, if they represent food spilled in the process of cooking as opposed to food residue disposal, may indicate direct cooking over open fires. If this was the case, then some textiles/basketry impressed fragments of fired clay, some of which we have preliminarily termed 'structural ceramics', may represent fragments of cooking vessels such as clay lined baskets.

5.5 Maintenance implements

As noted before, the Moravian textiles and basketry are quite diverse. It is tempting to hypothesize that such diversity may reflect idiosyncratic production on the level of the household (Adovasio *et al.* 1999). It may also reflect the nature of Moravian occupations. Adovasio (*et al.* 1999) and his colleagues suggest that if sites such as Pavlov I and Dolní Věstonice I served as seasonal aggregation loci for a number of independent social units who spent the remainder of the year elsewhere, then these sites should present evidence of greater technological variability than locales where multiple social units co-resided with each other on a more permanent basis.

The presence of the textile/basketry impressions at these sites carries other social implications also. Cross-cultural research shows that in pre-market societies the production of textiles and basketry is associated with the labour of women (Murdock 1937; Murdock and Provost 1973; Schneider and Weiner 1989; King 1991). Given such patterns of production and use, the Moravian impressions thus directly reveal female labour. The fineness of the gauge of some of the textiles, in turn, suggests that this labour was quite intensive.

5.6 SURPLUS – SEDENTISM – TIME BUDGETS – INNOVATIONS

I next briefly examine some mechanisms which made the invention and/or extensive use of some new technologies possible. In this I follow Brown (1989) who has argued that in order to understand the adoption of technological inventions we need to consider not only consumer demand but also factors acting to constrain such demand.

5.6.1 Time budgets and technologies

The Moravian sites reflect both group aggregation and residential stability over a number of autumn through early spring months. This residential stability was made possible through food surpluses, in part likely obtained through communal net hunting. This, in turn, brought about the re-deployment of labour from direct procurement pursuits to the production of weaponry for future use as well as the production of a myriad of implements for maintenance activities (e.g. clothes, containers, jewelry, etc.). Such an intensification in the production of diverse inventories during periods of greater residential sedentism is amply documented for hunter-gatherer groups, especially those in northern latitudes who require greater amounts of tools and implements for survival (Kelly 1995 with references).

Different technologies require different time budgets, however. As Brown (1989) points out, some technologies widely used by hunter-gatherers, are congruent with "stop and go" production sequences. The making of spear heads, the carving of figurines, the looping of nets, or weaving with simple looms can be interrupted and resumed at a later time without detriment to the final product. These technologies are thus congruent with mobile lifeways. Other technologies, such as the harvesting and processing of bast-bearing plants to make plant fibers for weaving, require continuous work over a number of days and weeks and, thus, require greater residential stability. Ground stone technology to make large grinding slabs and grinders – items which are not easily carried from place to place – is another example of a energetically expensive technology associated with residential stability.

Furthermore, the seasonal availability or accessibility of the suitable raw materials for some technologies requires that residential stability occurs during those months when the suitable raw materials can be obtained. In Pleistocene Moravia, for example, loess for ceramic production was likely far more easily accessible from spring to autumn when the ground was not frozen. Ethnographic data on the harvesting of such bast-bearing plants as nettle and milkweed indicate that these plants are harvested and processed in the autumn months after the plants reach their maximal growth and dry out (Barber 1991). We can presume that they were harvested during the autumn in gravettian Moravia as well.

These brief observations indicate that for some technologies there is an association not only with residential stability but with such stability during specific seasons and the Moravian evidence shows that there was the congruence of the two at the sites.

5.6.2 Food sources and types of cooking

Brown (1989) also points out that some types of foods – specifically cereals – require long cooking at relatively high temperatures to make them digestible. We can add root crops to this as well. Such direct cooking stresses the cooking vessels much more than does indirect cooking by stone boiling. The Moravian data do indicate stone boiling in pits. At the same time, Mason's (Mason *et al.* 1994) data on plant foods at Dolní Věstonice II, although more tenuous, hint that other foods may have been cooked directly over hearths. If this was the case, we can anticipate the need for watertight containers – possibly met by tightly woven and/or clay-lined baskets. Furthermore, such direct cooking would have placed greater stress on containers, their more frequent replacement, and thus increased consumer need for more baskets. More frequent production, use, and discard would create more visible archaeological remains – which may account for their presence at the sites.

Finally, since hunter-gatherer aggregations are also associated with feasting requiring intensified preparation of food (Satterthwait 1986, 1987; Ames 1991; Hayden 1995), it is possible that if such feasting took place in Upper Palaeolithic Moravia, it too would have created increased need for the the use and production of containers.

6. Aggregations and rituals

Finally, I turn to a brief examination of the association of rituals, aggregation, and their material manifestations. Johnson (1982) has convincingly demonstrated that there is a strong structural connection between temporary aggregations of large numbers of people and ritual performances. Since ceremonies and rituals usually involve the manipulation of some non-utilitarian materials, we can anticipate finding larger numbers of such items at archaeological sites which served as aggregation locales.

Although it is nearly impossible to unequivocally demonstrate that specific archaeological artefacts were non-utilitarian ritual paraphernalia, some remains from the Moravian sites are likely candidates. Specifically, Vandiver's (*et al.* 1990 with references) study of the production and firing of the ceramic animal and anthropomorphic figurine fragments from the sites led her and her colleagues to conclude that these figurines were not produced to be durable objects – or "permanent art". They have argued, instead, that this inventory represents the residue of "performance art" – images that were important during the production and firing moments only, and that such production performances were likely ritual in nature. Finding such 'art' at Moravian aggregation sites is thus not unusual, but, rather, to be expected.

7. Final lessons

The above discussion reminds us, once again, of the fact which we all know well, but tend to forget in examining change in artefacts through time – namely, that technology has no evolutionary trajectory of its own but is embedded in the social context which both brings it into existence and brings about its abandonment. Some of the technologies we see in use in Moravia, such as the production of ceramics, is only faintly echoed at other Eurasian Upper Palaeolithic sites somewhat younger in time – e.g. Kostenki I-1 (Praslov 1991) or at Maina (Vasil'ev and Ermolova 1983)(for an extensive discussion of palaeolithic ceramic technology see Vandiver *et al.* 1990 with references). These faint echoes suggest either its abandonment for a time or its decrease in importance through time, until it resurfaces once again around 13,500 bp in the Russian Far East (Zhushchikhovskaya 1994; Derevianko and Medvedev 1995) and at the Jomon sites in Japan, where it includes the production of pottery. Complex insert technology, on the other hand, appears to undergo continuous use and elaboration through palaeolithic time.

Similar patterns in the use of technology are in evidence for hunter-gatherers who lived in more recent time periods as well. Manhire *et al.* (1985), for example, use rock art imagery to persuasively argue that net hunting was practiced in the past by the San – something not documented in the ethnographic record. Another example is the simplification of Tasmanian technology documented through time by Jones (1984).

Theoretical insights and these examples clearly show that technologies are adopted or abandoned in the social realms of solving problems. Because of this, to understand changes in technologies we must look not at the global but at the purely local social impetus and constraints. These, as Dobres and Hoffman (1994) note, are felt and reacted to by individual social actors for some of whom innovation is more advantageous while the *status quo* suits others better. In light of the near impossibility of identifying individual actors in the remote past, we need to identify the actions of as many different social groups as possible – including those of women, children, and the elderly, as well as any other groups we can detect. This chapter has shown that this means looking far beyond lithics and realising just how finite, biased, and woefully incomplete a picture of past lifeways these durables offer.

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