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Are land snails a signature for the Mesolithic-Neolithic transition?

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ABSTRACT – *Edible land snails, representing food remains, are frequently very abundant in late Pleistocene and early-middle Holocene archaeological sites throughout the circum-Mediterranean region. As such, they appear to represent a signature for a broad spectrum subsistence base as first conceived by Flannery in 1969, and therefore must be in some way related to the transition from foraging to food production. This paper investigates the implications that can be drawn from the presence of these snails through information on their ecology, biology, behaviour and nutritional value as well as the behaviour of the prehistoric human groups who collected and consumed them.*

IZVLEČEK – *Užitne kopenske polže pogosto v zelo velikih količinah najdemo kot ostanke hrane na pozno pleistocenskih in zgodnje-srednje holocenskih arheoloških najdiščih po vsem mediteranskem bazenu. Videti je, da so znamenje za bolj raznolik način preživljanja – kot je prvi zaključil Flannery leta 1969 – in morajo biti zaradi tega na nek način povezani s prehodom od lovstva-nabiralništva k pridelovanju hrane. V članku raziskujemo, na kaj lahko sklepamo iz navzočnosti polžev na najdišču glede na njihovo ekološko, biološko in hranilno vrednost ter raziščemo vedenjske vzorce prazgodovinskih skupin ljudi, ki so jih nabirale in jedle.*

KEY WORDS – *circum-Mediterranean; land snails; Mesolithic-Neolithic transition; diet*

> *If ever there was such a 'Golden Age' then surely it was in the early Holocene, when soils were still unweathered and uneroded, and when Mesolithic peoples lived off the fruits of the land without the physical toil of grinding labour. (Roberts 1998.125)*
>
> *At first hunting, fowling, fishing, the collection of fruits, snails, and grubs continued to be essential activities in the food-quest of any food-producing group. (Childe 1951.71)*
>
> *It is now clear that no recorded modern society has relied primarily on molluscan resources for subsistence. (Waselkov 1987.109)*
>
> *...one can conclude that while some snail layers of the Pyrenees are natural, others probably represent a casual resource taken from time to time, while a few seem to constitute actual snail-farms; in no case, however, can it be accepted that land molluscs were a staple food. (Bahn 1983.49–50)*

INTRODUCTION

Land snails are often abundant in Late Pleistocene and early to mid-Holocene archaeological deposits throughout the circum-Mediterranean region (Fig. 1). The most spectacular examples are the Capsian escargotières of eastern Algeria and southern Tunisia, but archaeological sites containing abundant land snail shells that represent food debris are known from elsewhere in the Maghreb, Cantabria, the Pyrenees, southern France, Italy, southeastern Europe, Cyprus, the Levant, the Zagros region, Ukraine and Cyrenaica (for a full review of these data, see *Lubell 2004*).

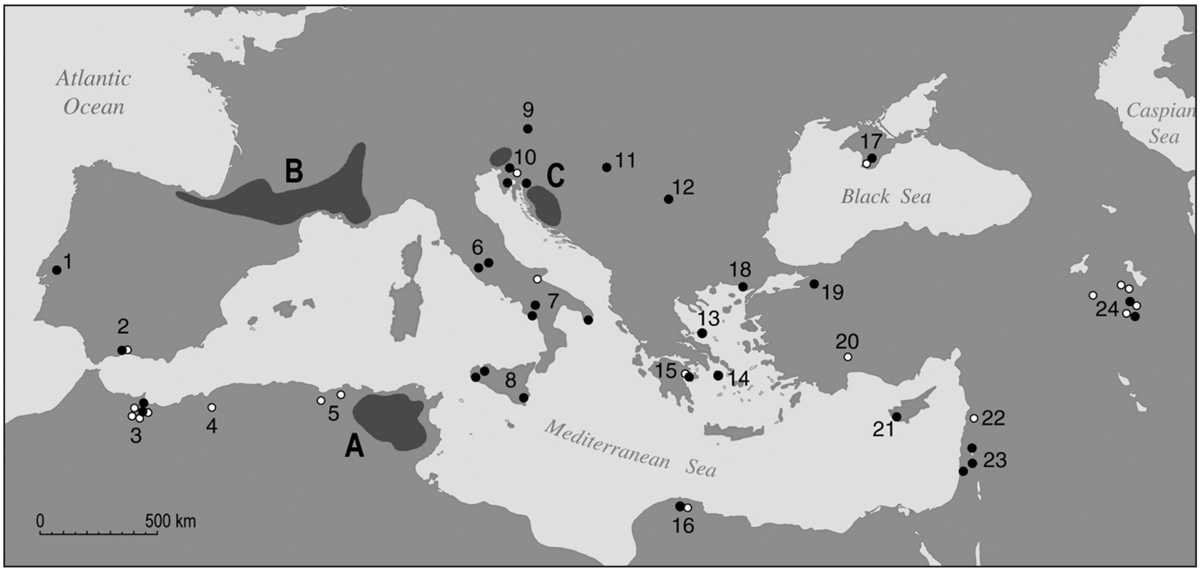

Fig. 1. Approximate location of some sites discussed in the text. Open circles represent sites or levels dated to the late Pleistocene (i.e. older than ~10 000 calBP); filled circles are sites or levels dated to the early and mid-Holocene. The hatched areas, the limits of which are estimated, mostly contain sites that would be represented by filled circles: (A) the main region for Capsian escargotières; (B) the Pyrenean region and southern France in which there are many sites containing abundant land snails; (C) the northeastern Adriatic region which also contains numerous such sites. Individually numbered sites are: (1) the Muge middens – Moita do Sebastião, Cabeço da Arruda, Cabeço da Amoreira – where land snails appear to be found only with human burials; (2) Nerja Cave; (3) Ifri n'Ammar, Ifri-el-Baroud, Taghit Haddouch, Hassi Ouenzga; (4) Taforalt; (5) Afalou bou Rhumel, Tamar Hat; (6) Grotta di Pozzo, Grotta Continenza; (7) Grotta della Madonna, Grotta Paglicci, Grotta di Latronico (8) Grotta dell'Uzzo, Grotta di Levanzo, Grotta Corruggi; (9) Rosenburg; (10) Pupićina Cave and other Istrian sites; (11) Donja Branjevina; (12) Foeni Salas; (13) Cyclope Cave; (14) Maroulas; (15) Franchthi Cave; (16) Haua Fteah; (17) Laspi VII; (18) Hoca Çeşme; (19) Ilıpınar; (20) Öküzini Cave; (21) Kissonerga Mylouthkia; (22) Ksar 'Akil; (23) Djebel Kafzeh, Hayonim Cave, Erq el-Ahmar, Mugharet ez-Zuitina, Ein Gev; (24) Asiab, Gerd Banahilk, Jarmo, Karim Shahir, Nemrik 9, Palegawra, Tepe Sarab, Shanidar Cave layer B, Warwasi, Zawi Chemi Shanidar.

Outside the Mediterranean region the occurrence of land snails as food debris in archaeological deposits is less common. Those instances I am aware of include Peru (*Chauchat 1988; Ossa 1974*), Texas (*Clark 1973; Hester, Hill 1975; Honea 1961; Malof on-line 2001*) and perhaps elsewhere in North America (*cf. Matteson 1959*), the Caribbean (*Keegan 2000; Veloz Maggiolo, Vega 1982*), East Africa (*Mehlman 1979*), the Sudan (*e.g. Fernández Martínez on-line*), Ghana (*Stahl 1985*), Nigeria (*Connah, McMillan 1995*) and the Phillipines (*Katherine Szabo pers. comm. 12.03*). There are no doubt others (*e.g. see Evans 1969; Waselkov 1987.Tab. 3.6*; website of the *ICAZ Archaeomalacological Working Group at http://triton.anu.edu.au/*). There is also evidence for past and modern use of amphibious fresh water snails (*Pachychilus* and *Pomacea*) as food amongst the Maya (*Emery 1989; Hammond 1980; Healy et al. 1990; Moholy-Nagy 1978*), prehistoric (ca. 4200 bp) middens of pond snails of the genus *Margarya* in Yunnan Province, China (*Kira 1999*) and apparently abundant acquatic snails at southern Chinese Mesolithic cave sites in the Nanling Mountains dating to perhaps 12 000 years and others in northern China dating to the same time range (*Zhang 1999*).

What is the significance of land snails as prehistoric food? Fernández-Armesto (*2002.56–7*) raises several points of interest.

[land snails] together with a few other similar mollusks, ... have – or ought to have – an honored place in the history of food. For they represent the key and perhaps the solution to one of the greatest mysteries of our story: why and how did the human animal begin to herd and breed other animals for food?

Snails are relatively easy to cultivate. ... They are an efficient food, self-packaged in a shell which serves at table as a receptacle. ... The waste is small, the nutrition excellent. Compared with the large and intractable quadrupeds who are usually claimed as the first domesticated animal food sour-

ces, snails are readily managed. ... [They] can be isolated in a designated breeding ground by enclosing a snail-rich spot with a ditch [and] by culling small or unfavored types by hand the primitive snail farmer would soon enjoy the benefits of selective breeding. [Snails] can be raised in abundance and herded without the use of fire, without any special equipment, without personal danger and without the need to select and train lead animals or dogs to help. They are close to being a complete food.

Paleolithic shell mounds ... are so common and in some cases so large that only scholarly inhibitions stop us from assuming that they are evidence of systematic food production. It is hard to break out of the confines of a developmental, progressive model of food history which makes it unthinkable that any kind of food was farmed so early; but snail farming is so simple, so technically undemanding, and so close conceptually to the habitual food-garnering methods of gatherers that it seems pigheadedly doctrinaire to exclude the possibility. ... In places where shell middens form part of a stratigraphic sequence, it is apparent that societies of snail eaters preceded settlers who relied on the more complex technologies of the hunt.

The importance of mollusks as probably the first creatures herded and bred by men has never been broached, much less investigated or acknowledged. So what little can be said about it has to be tentative, commended as much by reason as evidence.

Fernández-Armesto is only partly correct. Yes, archaeologists have tended to ignore the issue; the emphasis has been on the palaeoenvironmental information that can be obtained from study of archaeological land snail assemblages rather than on the role of land snails in human subsistence (*e.g. Abell 1985; Bobrowsky 1984; Drake 1960–1962; Eiseley 1937; Evans 1972; Goodfriend 1988; 1991; 1992; Margaritz, Kaufman 1983; Margaritz, Goodfriend 1987; Rousseau et al. 1992; Sparks 1969*). Even work dealing with molluscs as food in archaeological sites ignores any mention of land snails (*Meighan 1969*), while other papers have been more focussed on non-food uses (*Biggs 1969*). However, there have been a few studies with a different emphasis: Lubell *et al.* (*1976*) attempt to test the ideas first advanced by Pond *et al.* (*1938*) on the contribution of land snails to prehistoric diet in the Holocene Maghreb; Bahn (*1983.47–49*) constructs an interesting argument in favour of Mesolithic snail farming in the Pyrenees; Guilaine (*1979*), Chenorkian (*1989*) and Girod (*2003*) discuss various aspects of the dietary importance of land snails in prehistory.

In this paper I will take up Fernández-Armesto's theme and attempt to better understand whether the presence of abundant land snails represents part of a signature for the "broad spectrum revolution" (*Flannery 1969; Stiner 2001*). By doing so, I hope to be able to determine whether there is some hitherto unrealized correlation between the consumption of land snails and the transition to a diet based on herded animals and cultivated plants, perhaps analogous (but certainly not identical) to that proposed for marine and fresh-water aquatic foods and the appearance of anatomically modern *Homo sapiens* (*Broadhurst et al. 1998; 2002*).

ARCHAEOLOGICAL EVIDENCE

This paper complements my review of the archaeological evidence (*Lubell 2004*), and I will refer here to those data only as required. It is appropriate, however, to first set out the criteria that allow us to decide whether or not the land snail shells found in an archaeological deposit do, or do not, represent the remains of prehistoric meals.

There have been several arguments made against interpreting land snails as food remains, especially in Cantabrian cave deposits (*de Barandiaran 1947; Straus 1992.212; Aparicio, Escorza 1998; Arias 2002*). While these may, in certain instances, be correct, I find the counter arguments of Bahn (*1982; 1983*), Guilaine (*1979*) and Miracle (*1995*) more compelling. When considering open-air sites such as those in the Maghreb or the Zagros, the sheer quantities of shells found, and their consistent association with cultural materials, argues incontrovertibly for their anthropogenic origin and, in most cases, for their interpretation as food debris. There are certain species, such as *Rumina decollata*, which are known to be carnivorous and may thus have colonized the organic rich deposits themselves, but the majority of species are herbivorous and unlikely to colonize abandoned archaeological sites in such large numbers as are found (*Lubell et al. 1982–83*). Under some conditions today, land snails are known to be the prey of rodents which then accumulate the shells in substantial middens (*Yom-Tov 1970*), but these are devoid of any cultural associations. I suppose it might be possible that some prehistoric accumulations were formed in this way, given the apparent alternation of human and rodent activity in some open-air land snail shell middens (*Lubell et al. 1982–83*), but the frequency and size of the accumulations we find, argue strongly against this as an explanation for more than a very few.

The most convincing evidence for prehistoric land snail consumption is found in the Maghreb, beginning in the Iberomaurusian by 20 000 BP and continuing through the Capsian to at least 6000 BP (*Lubell et al. 1976; 1984; Morel 1974; 1980; Pond et al. 1938; Mikdad et al. 2000; 2002; Roche 1963*). In Iberomaurusian sites the land snails occur in dense deposits within caves and rockshelters. Capsian sites are more commonly open-air mounds, although numerous rockshelters are also recorded. Sites are often located near springs or passes, varying in size from a few to several hundred square meters in area, and in depth from less than one meter to well over three meters. The common components of almost all Capsian sites are the enormous numbers of whole and crushed land snail shells which led Francophone archaeologists to call them "escargotières". They are perhaps more accurately called "rammadiya", the name used by local Arabic speakers and derived from "ramad", the word for ash, because ash, charcoal and fire-cracked rock are the most common constituents of these dark grey deposits. In what I suspect was a tongue-in-cheek suggestion, both Gobert (*1937*) and Morel (*1974.299*) suggested they be called "cendrières". The composition of the deposits and the manner of their accumulation was well described by Pond *et al.* (*1938.109*): "*...a group of refuse heaps welded into a single mound ... composed of snail shells, camp fire ashes, hearth stones, animal bones and tools of bone and flint. It often contains human skeletons. Many present saucer-shaped depressions and hard-packed areas which seem to have been habitation floors. On many of these "floors" hearths or fire places, areas of burned stone, and deep beds of ashes are found*[1]." And echoed by Morel (*1974.300*): "*...un magma de lentilles de rejets qui ont été accumulées dans un désordre total et que les remaniements, la pluie et le vent, le tassement naturel ont, selon l'heureuse expression de L. Balout (1955.392), »moulé en un ensemble«. Les coupures stratigraphiques naturelles que constituent, par exemple, un lit de coquilles écrasées par le piétinement ou une mince couche de sable soufflé par le vent du Sud, y sont rares et toujours discontinues; la stratigraphie artificielle elle-même n'offre pas de garantie absolue.*"

Lubell *et al.* (*1976*) estimated the quantity of unbroken shell in a typical Capsian deposit (open-air, deflated, compacted) to be on the order of 25 000 shells/m^3, but despite this density we know that land snails were not the major source of animal protein in either the Iberomaurusian (*Morel 1978; Saxon et al. 1974*) or the Capsian diet (*Lubell et al. 1975; 1976*). That came from mammals such as aurochs (*Bos primigenius*), hartebeest (*Alcelaphus buselaphus*), zebra (*Equus mauritanicus*), mouflon (*Ammotragus lervia*), gazelle (*Gazella dorcas, G. cuvieri*), two lagomorphs (*Lepus capensis, Oryctolagus cuniculus*) and perhaps ostrich eggs (*Struthio camelus*) since the shells were used for both containers and ornaments. Other than the charred bulbs of *Allium* sp. found in the collections at the Logan Museum (*Lubell et al. 1976.919*), there is no direct evidence for the vegetal component in the diet. Analyses of charcoal from archaeological deposits (*Couvert 1972; 1975; 1976*) suggest that nuts (pine, pistachio, oak) and some fruits (carob, juniper) would have been available on a seasonal basis (see also *Roubet 2003*).

This subsistence reconstruction is similar to those from other parts of the Mediterranean region in which land snails are often found in abundance: for example, the Pyrenees (*Bahn 1982; Boone 1976; Guilaine 1979*), the Italian peninsula, (*Mussi et al. 1995*), the northern Adriatic (*Girod 2003; Miracle 2002*), the Aegean (*Sampson 1998; Sampson et al. 2002*) and the Zagros (*Braidwood 1983; Reed 1962; Solecki 1981*). It is consistent with the concept of a "broad spectrum" pattern as first proposed by Flannery (*1969*).

WHY LAND SNAILS?

Archeological evidence cannot tell us who was eating snails, how they were prepared, or whether or not they were part of an 'haute cuisine' or common fare... (*Hyman 1986.23*)

Hyman overstates the uncertainties involved, as the archaeological evidence makes clear (*Lubell 2004*). The more interesting questions to ask are: Why are land snails such a common item of food refuse in archaeological sites throughout the Mediterranean region that date just prior to the appearance of agricultural economies in the early post-Glacial period of rapid climatic and environmental change? Were

1 The only published plan of such a surface is in *Lubell et al. 1975; 1976.*

they a necessity, a luxury or merely an appetizer? Was their use as food restricted by age or gender? Might they have had ritual significance? An examination of data on late Pleistocene and early to middle Holocene palaeoenvironments in the circum-Mediterranean may assist in answering such questions.

PALAEOENVIRONMENTAL EVIDENCE

Several recent publications deal with late Pleistocene and Holocene environmental changes in the Mediterranean region. While there are identifiable long-term trends (*Marchal et al. 2002; van Andel 2000*), the situation is far from uniform and there is sometimes fundamental lack of agreement on how to interpret the available data (*Jalut et al. 1997* vs *Pons, Quezel 1998*). There has also been considerable debate as to whether or not identified changes should be ascribed to anthropogenic or natural causes (*Bintliff 2002*). Those studies I have found to be the most useful for my purposes here are Macklin *et al.* (*2002*) and Magny *et al.* (*2002*), several of the articles in a special issue of *The Holocene* (*vol. 11, no. 6, 2001*) and the summary treatment in Roberts (*1998*).

The general consensus seems to be that until at least the latter part of the mid-Holocene (i.e. long after the establishment of agricultural economies in most of the region), any changes observed can be ascribed to globally observed climatic events rather than anthropogenic causes.

Macklin *et al*. (*2002.1639–1640*) show that three alluviation events dated 21±0.8–26±2, 16±3–19±1 and 12.5±1.5–13±2 ka. can be correlated with abrupt decreases in sea surface temperature in the northeast Atlantic, thus providing evidence "that rapid and high frequency climate change in the North Atlantic during the Last Glacial period had a profound effect not only on the vegetation of the Mediterranean region, but also on catchment erosion and river alluviation" and for "a high degree of synchrony in major river aggradation events across the Mediterranean in catchments with very different tectonic regimes and histories".

Gvirtzman and Wieder (*2001*) studied sequences of palaeosols at seventeen localities along the coastal plain of Israel, and identify six episodes of pedogenesis (indicating wetter conditions) interspersed with seven episodes of sedimentation or accumulation (indicating drier conditions) during the past 53k years.

While these two sets of terrestrial sequences are not entirely congruent in terms of chronology – perhaps due in part to time lag as a result of distance from the ice sheets as well as meteorological and oceanic circulation patterns – the number and characteristics of arid episodes seem to me sufficiently similar to corroborate the scenario of Macklin and colleagues. I note the similarities of Holocene climatic variability as seen in marine records from the Mediterranean, the North Atlantic, the GISP2 ice record and elsewhere (*Casford et al. 2001.Tab. 4*).

Magny *et al*. (*2002*) use palaeohydrological and other data to show that the Holocene in the Mediterranean region can be divided into an earlier period of cooler and moister conditions and a later one which is warmer and drier (and see also *van Andel 2000*). The change occurred at ~5000 BP and is reflected in the pollen record, numbers of lakes and lake levels, distribution of radiocarbon dates as a reflection of settlement density, and Sapropel event 1 which indicates an increase in discharge of fresh water into the Mediterranean between 8000 and 6000 BP when lake levels were at their highest (*see Magny et al. 2002.Fig. 1*).

Reviewing the record from lake cores in Turkey and Iran as well as other data from the eastern Mediterranean, Roberts *et al*. (*2001b.734*) conclude: "All of these proxy-climate data sources are therefore in agreement that the hydroclimatic environment in the Eastern Mediterranean altered significantly during the mid-Holocene from relative water surplus to water deficit."

Roberts *et al*. (*2001a.633*) show that Holocene climates and environments across the Mediterranean region were neither uniform nor synchronous, and that the available palynological and palaeohydrological data: *...suggests that a complex rather than a simple patterning of Holocene climate change occurred across the circum-Mediterranean region, which is potentially explicable in terms of meridional or longitudinal shifts in atmospheric circulation. In any case, many records indicate rather marked climatic differences between the two halves of the Holocene [the main point of* Magny et al. 2002*], and this adds convincing weight to the argument that climates in the Mediterranean Basin have been modulated by precessional forcing during the Holocene*.

In another paper, Roberts *et al*. (*2001b.734*) stress the complexity of the overall picture and the likelihood that 'modern' climatic conditions were not established in the Mediterranean Basin until after 6000 cal. yr BP, presumably linked – directly or otherwise – to changes in the net receipt of solar radiation as a result of precessional forcing".

Despite all these uncertainties, which I expect will be resolved as further data are collected and analyzed, I think we can probably accept the generalized picture presented by Roberts *et al.* (*2001a.632; see also Roberts 1998.104*): *The herb-steppe which surrounded most of the Mediterranean Sea during the late Pleistocene was replaced during the early and mid-Holocene by sub-humid forest, sometimes dominated by conifers, more usually by broad-leaved deciduous trees. Typically mediterranean formations of xeric evergreen forests, shrub and heathland are only rarely represented in early to mid-Holocene pollen diagrams*.

It must, however, be acknowledged that there is no clear correlation between palaeovegetation patterns and the occurrence of sites with abundant land snails. Plotting the distribution of sites shown in Figure 1 against the vegetation patterns which can be reconstructed from the *Review and Atlas of Palaeovegetation: Preliminary land ecosystem maps of the world since the Last Glacial Maximum* (*Adams et al. on line*), indicates no consistent overall associations. Admittedly, this is only a very rough approximation of what would have been complex local patterns, but the lack of any clear correlation between major vegetation zones and site distributions is curious. Other variables (elevation? soil type? edaphic conditions? diurnal temperature ranges?) must no doubt be considered, but that is beyond the scope of this paper.

The Maghreb

Perhaps the only consistent association is the distribution of Maghreb sites within the zone of Mediterranean scrub, and so it may be useful to look briefly at conditions in the Maghreb, since that is where land snails are most abundant in the archaeological record.

During the end of the Iberomaursian and the beginning of the Capsian (i.e., the Younger Dryas), North Africa experienced a relatively arid phase, evidenced in part by lowered water levels in Lake Chad. After 10 000 BP, humidity increased again and vegetation zones of the Sahara appear to have had limits similar to modern ones. Moist conditions continued, reaching a maximum between ca. 9000 and 8000 BP when they were interrupted by a short but severe arid phase found worldwide and dated to 8200 BP (*Alley et al. 1997*). The effects of this event may have lasted until 7500 BP in North Africa. From ca. 6500 to 5500 BP, conditions became even more arid but were still more humid than today (*Adams et al. on-line; Vernet 1995*). Ballais (*1995*), interprets alluvial Holocene terraces in the eastern Maghreb as indicating greater humidity between about 8500 and 5000 BP, which is somewhat at odds with other (admittedly incomplete) evidence.

Analyses of charcoal (*Couvert 1972; 1975; 1976; Renault-Miskovsky 1985*), faunal remains (*Bouchud 1975; Lubell 1984; Lubell et al. 1975; 1976; 1982–1983; 1984; Morel 1974; Pond et al. 1938*) pollen and other data (*Lamb et al. 1989; 1995; Ritchie 1984*), provide a relatively good idea of the climatic and ecological conditions during the Capsian. Vegetation cover was open woodland savanna, probably not too different in many respects from modern East African environments, with Mediterranean forests and maquis at upper elevations and/or where humidity was higher. The 8200 BP event mentioned above is correlated with a change in Capsian technology that has been identified at several sites (*Lubell et al. 1984.182–184; Rahmani 2003; Sheppard 1987; Sheppard and Lubell 1990*).

The land snails found in such abundance at Maghreb archaeological sites provide less than satisfactory data about past climate and environment. The major species are *Helix aspersa, H. melanostoma, Leucochroa candissima, Helicella setifensis* and *Otala*. sp., and since all still occur in the region today, we have a reasonable idea about the local environmental/ecological conditions they represent. *H. aspersa, H. melanostoma* (the two largest) and *Otala* prefer shady, moister habitats, and are known to burrow. *L. candissima* and *H. setifensis* are much smaller, have greater tolerance for light and heat, and are often found clustered on the stalks of vegetation, far enough off the ground to avoid excessive heat build up within the shell. However, because all five species are adapted to semi-arid conditions and can aestivate for long periods of time, they are able to survive through periods of adverse conditions and are therefore less than perfect indicators of past climate. While their abundance in the sites might suggest that climate was more humid in the past than now, I suspect that modern conditions are more an artifact of environmental degradation brought on by monocropping and poor land conservation practices, a pattern well documented elsewhere in the circum-Mediterranean (*e.g. Labaune, Magnin 2002*).

In sum, from the late Pleistocene through to the mid-Holocene, the Maghreb was a very good place to be a hunter-gatherer. As I have suggested before (*Lubell 1984*), I view the abundance of easily available food resources as a key factor in the late arrival and adoption of Neolithic economic practices, late compared to the rest of the circum-Mediterranean region (but see *Roubet 2003*). However, this does not tell us why land snails were such a common component in sites elsewhere in the Mediterranean just prior to the appearance of food production and, in some areas, after it was well established.

SNAILS AS FOOD

Nutritional value

There are few comprehensive data available, but the best review I have seen is by Elmslie (*n. d.*) which confirms the generally held view that snail meat is high in protein and low in fat, with the majority of the fats in the form of polyunsaturates.

Despite the high consumption of snails in France (estimates cited by Elmslie are on the order of 30 000 tonnes per annum), the *New Larousse Gastronomique* is far from complimentary: *From a nutritional point of view, snails' flesh has little food value and is rather indigestible. However, it does contain a large quantity of both Vitamin C and mineral salts (calcium, magnesium, etc.)*. (*Montagné 1977.849–850*).

Snails can also be a fairly labour intensive food source, because in addition to collection, they must be purged before being consumed.

To avoid the risk of poisoning, snails must be deprived of food for some time before they are eaten, for they may have fed on plants harmless to themselves but poisonous to humans. Furthermore it is advisable only to eat snails which have sealed themselves into their shells to hibernate. (*ibid. 849*)

This is why it appears that aestivating/hibernating snails, with a sealed operculum, are preferred by modern producers and consumers (*Elmslie 1982*). Since they do not need to be "purged before eating, they are cooked with the epiphragm in place (i.e. they are not woken up first as the gut seems to be emptied before they go into diapause, and the rate of metabolism in that condition is extremely slow" (*Elmslie, pers comm 12/03/2004*).

Dr. M. Charrier (*pers comm. 06/03/2004*) contradicts this statement. She says that during dormancy hibernating snails accumulate excretory products in the kidney and the digestive gland and these have such a bad taste that the organs must be removed before cooking the flesh. Therefore, French farmers cook the snails at the end of the growth stage, and those kept during winter are intended to reproduce at the next season.

There is a long history of snail consumption in Europe, and especially in France as noted by Davidson (*1999*) and Hyman (*1986*), neither of whom mention nutritional value in any meaningful sense. Nor does Mayle (*2001*) although he provides some useful gastronomical data. Barrau (*1983.91*) makes only passing mention, while in Hagen (*1995.173*) we find the interesting anecdote that, "*Helix aspersa* ... was apparently eaten in Romano-British times, and was still sold in Bristol markets at the beginning of this [the 20th] century under the name 'wall fish'".

Bar (*1977*) provides archaeological, ethnohistorical and ethnographic examples of land snail consumption in the Levant (though not, of course, by either Muslims or Jews). This should be in no way surprising, for the abundance of land snails in semi-arid regions can be truly astonishing, and farmers consider them a crop pest. Even deep in the Sahara and other hot deserts, land snails can be remarkably abundant (e.g. *Schmidt-Neilsen et al. 1971*), so much so that experimental evidence has shown them to be useful as a survival food (*Billingham 1961*). The modern and much-touted "Mediterranean diet" especially as found in Crete (e.g. *Galanidou pers. comm. 2/2004; Simopoulos on-line*) often includes land snails, but there is as yet no reliable data on their contribution to the overall nutritional makeup[2].

Miracle (*1995*) interprets the land snails found in Istrian late Pleistocene and early Holocene sites as a low-ranked resource, compared to large ungulates such as giant deer, horse or elk, and argues that they would "enter the diet only in response to extreme shortage of other resources", although he al-

2 Dr. Nena Galanidou (Dept. of History and Archaeology, University of Crete) is beginning a research program on the ethnoarchaeology of modern land snail collection and consumption in Crete where "they form a vital part of modern rural diet and their collection has certain seasonal traits" (*pers. comm. 2/2004*).

lows that season may have an effect (*pp. 271–2*). He goes on to say that "the significant accumulations of land snails at sites like Badanj [in Levels 2a/2b, younger than 12 000 bp, *pp. 64, 493–4*] and Kopačina [ca. 9000 bp, *pp. 76–7*] indicate either extreme resource depletion and subsistence hardship for hunter-gatherers, or environmental shifts that forced snails to increasingly seek the shade and moisture of rockshelters...[but that] we lack the detailed taphonomic data needed to test these alternative hypotheses" (see also *pp. 487–88*).

Miracle's interpretation of the overall contribution of land snails to the animal protein component of the diet is congruent with the one we reached for Capsian escargotières in Algeria (*Lubell et al. 1976*), a view echoed by Morel (*1974; 1977; 1978; 1980*) for the Maghreb and by Girod (*2003*) for the northern Adriatic region [3]. However, none of us has as yet looked carefully into the nutritional value of land snails or their importance in the evolution of human diet as has been done for other molluscs (e.g. *Ackman 1989; Broadhurst et al. 1998; 2002; Chenorkian 1989; Crawford et al. 1999; Meehan 1982; Nestle 1999; Waselkov 1987*).

Appendix 1 provides data on the carcass composition of land snails which has been culled from a number of sources. Unfortunately, these data are rather uneven, only two of the analyses (G_1 and I) are based on populations that can be considered to have been "wild", and the units of measurement used are not always easy to compare [4].

Table 1 summarizes basic nutritional data values derived from Appendix 1 and adds data from two other studies. Land snails have a high water content (80% or more in all but one case), confirming the experimental observations of Billingham (*1961*). Protein value fluctuates widely, perhaps because of what the snails are eating (especially in those cases where commercial feeds are used), but the method of sample preparation and analysis may also have an effect on this. Total fat (i.e. lipid) content tends to be quite low and is apparently independent of size since the values given here are similar to those for the giant African land snail *Archachatina marginata* (*Ajayi et al. 1978; Imevbore, Ademosun 1988*) and for another giant snail (*Achatina fulica*) and the apple snail (*Ampullarius insularis*) in Korea (*Lee et al. 1994*). Land snails contain more crude protein and less fat than chicken (*Elmslie 1982.24, Elmslie n.d.*), and are therefore a lower source of energy (measured in cals/100 g) for humans than chicken (and presumably ruminant) flesh. Land snails contain all the essential amino acids required by humans, but in amounts so small that a diet based largely or entirely on land snails for animal protein would not provide sufficient amounts for adequate nutrition (*Grandi, Panella 1978; Imevbore, Ademosun 1988.81*). Land snails also contain the five essential unsaturated fatty acids (*Grandi, Panella 1978*), but again in rather small amounts and with much less of the ω-3 group (considered so important to development of brain and vision function *in utero* and during the first two years of life) than the ω-6 group [5] although unpublished data cited by Elmslie (*n.d.*) may, if confirmed, require revision of this interpretation.

Whether or not the nutritional value of land snails is affected by season of collection seems to be uncertain. In those regions where they are collected intensively (e.g. Greece and Bulgaria), there are government regulations that restrict the season of collection to ensure adequate population replacement (*Elmslie n.d.*). It is also uncertain whether or not the fatty acid composition of land snails changes seasonally: one study, conducted in the Netherlands (*van der Horst, Zandee 1973*) says they do not, whereas another conducted on Italian land snails suggests they do (*Cantoni et. al. 1978*).

I interpret these data as confirmation that land snails could not have been a primary food resource, and certainly not a major source of animal flesh for for-

3 Erlandson (*1988.106*), discussing the role of shellfish in prehistoric economies, suggests that "In mixed economies (both agricultural and hunter-gatherer), therefore, a protein perspective suggests that there may be nothing inconsistent with large shell middens reflecting relatively sedentary occupations where shellfish [and therefore I would argue, land snails] served as a long-term dietary protein staple".

4 In other molluscs, e.g. the Australian abalone *Haliotis rubra*, there may be marked differences in polyunsaturated fatty acid content of the flesh between wild and cultured specimens depending on the source and type of nutrients (*Su et al. 2004*).

5 For a review on the "essential" aspect of fatty acids, see Cunnane (*2003*). Imevbore and Ademosun (*1988.83*), writing about the giant African land snail *Archacatina marginata*, say that "since snail meat appears to be intermediate in essential and polyunsaturated fatty acids, it may not possess any outstanding nutritional and physiological characteristics much different from the other samples tested along with it". These were beef, chicken, goat, mutton, pork and two species of fish (*Tilapia macracephala* and *Clarias lazera*).

aging populations. They would not supply sufficient nutrition or energy, even in the enormous quantities apparently consumed by groups in the Maghreb, and they would have been a seasonal rather than a year-round resource. As with other molluscs, their visibility in the archaeological record is high, but the food value represented by the mass of empty shells is not always commensurate with appearances – a point made especially by Paul Bahn (*1982; 1983*).

Nonetheless, if we accept the characterization of the "paleolithic diet" of Eaton and Eaton (*2000.Tab. 2*), land snails, if consumed in sufficient quantities, could have provided a significant amount of low fat protein as well as the minerals, amino acids and fatty acids required for human nutrition (Appendix 1, Table 1, and the data in *Grandi, Panella 1978*). Because they were almost certainly eaten cooked (see *Wandsnider 1997* for a discussion of prehistoric cooking methods), water content is probably not a particularly important variable, and the low lipid content means that they would have had to be supplemented by other resources to achieve sufficient caloric input.

LAND SNAILS AND THE BROAD SPECTRUM REVOLUTION

How then, are we to interpret the consistent presence, and indeed abundance, of land snails in circum-Mediterranean archaeological sites dating just prior to the advent of agriculture? The generally held view is that when large numbers of land snails occur in late Pleistocene and early Holocene sites they are best seen as one component, normally a minor one, in a subsistence strategy that incorporated what had previously been "less preferred resources" (*Gebauer, Price 1992.3*; see also *Flannery 2000*)[6]. But this leaves unanswered questions as to whether or not land snails were a controlled and harvested resource (*Fernández-Armesto 2002*) or more an indicator of feasting events than of everyday diet (*Miracle 2002*).

	Appendix 1 $\bar{x} \pm 1\delta^a$	Grandi and Panella (*1978*)[b]	Lee *et al.* (*1994*)[c]
$H_2 0$	78.9 ± 9.2	79.46 – 80.50	81.20 – 82.36
Protein	38.6 ± 24.1	12.94 – 14.56	11.53 – 13.69
Carbohydrates (or ash)	3.0 ± 1.0	1.42 – 1.90	1.25 – 1.39
Lipids	4.3 ± 2.8	0.63 – 1.70	0.91 – 1.28
Minerals	2.1 ± 1.6	.006 – .008	
Essential amino acids	2.5 ± 2.4[d]	42.00 – 49.71	
Essential PUFAs	0.4 ± 0.1[e]	13.8 – 18.1	

a Data are g/100g raw.
b Data are percentage ranges for *Helix aspersa*, *H. lucorum* and *H. pomatia* except for minerals and PUFAs which are only for *H. aspersa* and *H. lucorum* and the latter is the percentage of all fatty acids.
c Data are g/100g edible portion for cultivated *Achatina fulica* and *Ampullarius insularus*.
d 41.9% of all amino acids
e 34.6% of all fatty acids

Tab. 1. Nutritional composition of land snails.

Biology and ecology of land snails

To investigate such questions we need to know something about the biology and ecology of land snails. In this section I have relied heavily on *The Biology of Terrestrial Molluscs* (*Barker 2001*) and several of the papers cited by the contributors to that volume.

There are thousands of species of land snails, each with its own characteristics, but there are a series of general traits that we can focus on here.

Because they have no physiological means of controlling intake or loss of moisture other than sealing themselves in their shell, and are relatively intolerant of extreme cold or heat (with certain significant exceptions – see, e.g. *Schmidt-Nielsen et al. 1972*), land snails have evolved physiological responses to deal with cold (hibernation) and heat or drought (aestivation) that allow them to survive extended periods without taking in nourishment. This, combined with the fact that they are also hermaphrodites and can on occasion self-fertilize, means that land snail evolution has been rather slow and polymorphism is quite common. Cooke (*1913.37–39*) cites a number of examples of land snails that survived up to five years of aestivation after which, in one 19^{th} century instance, a single *Helix lactea* placed in an herbarium, reproduced offspring. However, both Gomot de Vaufleury (*2001.343*) and Heller (*2001a*)

6 Flannery cites the evidence for land snails in the Mousterian levels at Devil's Tower, Gibraltar (in *Garrod et al. 1928*) as indicating even earlier broad spectrum patterns. As with the Pre-Aurignacian deposits at Haua Fteah (*Klein and Scott 1986; Hey 1967*), I believe the case for subsistence use at such an early date has yet to be demonstrated.

make it clear that the majority of pulmonate land snails breed by mating and outcrossing.

Most land snails are iteroparous (several reproductive periods, usually one each year for a number of years) although some are semelparous (only one reproductive period, after which the organism dies). They lay eggs in clutches, most often in holes excavated into the ground, and almost always during periods (seasons?) of increased moisture. Clutches vary widely in size – from as few as ten to as many as several hundred eggs – depending on the species and on soil and moisture conditions. Dessication has a marked effect on rates of egg mortality, and studies show that location with reference to prevailing climate can be critical. For example, in the Negev the rate of hatching was 100% for eggs laid on a northern slope, but less than half (46%) for those laid on a southern slope and thus more exposed to the sun (*Yom-Tov 1971*). In northern Greece, 25% to 38% mortality is attributed to dessication (studies cited in *Heller 2001a*). Even under the best of conditions, not all eggs will reproduce, not all will hatch at the same time, and some cannibalism by earlier hatching snails may occur.

Land snails are normally more active after dusk and when the ground is damp. They tend to be herbivorous, but there are some species better classed as omnivores and many can be carnivorous when the opportunity presents itself. They normally eat only small amounts of grasses, leaves are a minor dietary element, but stems, fruits and flowers are common dietary items. Senescent plant material is preferred, probably because of low toxin content (*Speiser 2001*). All land snails require some calcium in the diet for shell building, and this may come either from the soil or from shell and bone of dead animals. Dietary preferences are species-specific but also change seasonally. The tendency appears to be reduction of competition for resources so that "the dynamics of the populations [are] not influenced by the availability of specific resources" (*Hatziionannou et al. 1994.340*). Taking all of this into account, I conclude that intensive collection of land snails by humans would require not only a reasonably thorough knowledge of seasonal availability of the different plants preferred by different snail species, but also some understanding of land snail reproductive biology.

Gomot de Vaufleury (*2001*) reviews growth and reproduction in land snails. She points out that photoperiod length influences reproduction: the fewer hours of daylight, the lower the rate of egg laying, spermatogenesis and reproductive output. There are inter-specific differences, but the general principle obtains for all.

Temperature is also an influence. While reproduction can occur in a range from 5°–25°C, much higher rates occur in the range of 20°–25°C. Furthermore, maturation takes place far more rapidly in temperatures above 15°C with a long-day photoperiod.

Land snails living in temperate regions often hibernate during the winter, and during this time gametogenesis may cease completely and then resume prior to the end of the hibernation cycle: "the longer the hibernation period (up to 18 months evaluated), the sooner the mating behaviour occurred at the break of hibernation and the higher the reproductive output." (*ibid. 335*)

Tompa (*1984.124–125*) provides some data on the time from egg laying (oviposition) to hatching. There appears to be considerable variability, depending on size of snails, size of clutch, season and temperature. In temperate climates, eggs laid in autumn may overwinter and not hatch until the following spring. In other cases, eggs may hatch in autumn but the animals are not mature until the following summer. Chevallier (*1979.Fig. 14*) suggests that although adult size is attained within one year, it takes an average of two years for *Helix* to reach maturity, whether raised under controlled or "natural" conditions. These estimates are corroborated by papers on modern snail farming (*Elmslie et al.1986*) which provide additional data on controlled breeding and raising. I have been unable to find anything equivalent for "wild" land snails.

Many species live less than two years, but a number of the larger ones and especially the Helicidae which include the edible species most often found in archaeological deposits, can live between five and 15 years (*Heller 1990.Tab. 3*). To some extent, but especially amongst those species that inhabit unpredictable environments such as the semi-arid and desertic regions of North Africa and the Levant, the less favourable the environmental conditions the longer-lived the land snails (*ibid. 270*). Thus, reconstruction of palaeoenvironmental conditions (using species lists of land snails in addition to other proxy data), may be key to understanding how human populations relied on land snails as a food resource. A series of studies by Goodfriend (*1988; 1991; 1992; Margaritz, Goodfriend 1987*) have made a start in this direction, but more needs to be done.

Heller (*2001a*; see also *Heller 1988*), reviewing life history strategies, points out that predation affects survival, as does cannibalism of eggs by hatchlings. Predation by rodents, especially in arid and semi-arid regions, may lead to the accumulation of substantial middens of shell (*Yom-Tov 1970*), and at least one documented instance of massive predation by wild boar (*Sus scrofa*) reduced the adult snail population by 50% (*Heller and Ittiel 1990*). This allowed smaller individuals to grow to adult size whereas previously competition had kept them small. Heller and Ittiel suggest that the mucus left behind as a result of snail locomotion is a factor in reducing competition for resources by keeping down the number of adolescent individuals. This may have implications for human predation and control of land snails as a resource, especially if snails were kept in an enclosure prior to consumption – either bred there or collected and conserved there.

This leads to a whole range of possible considerations on the taphonomy of land snail shell middens such as those found in the Maghreb, where rodent burrows are ubiquitous. In almost all the instances I have observed, the presence of modern macrobotanical materials in the burrows argues against anything other than disturbance of the archaeological deposits by rodents. Nonetheless, some disturbance may be very ancient, if (as seems likely) sites were recolonized by snails and rodents during periods of non-occupation by humans (see *Lubell et al. 1982–1983*). We did, at one time, consider the possibility that abandoned escargotiéres would have been attractive habitats for land snails, thus leading to the large numbers of sites – occupation of one by a group who then collected snails at neighbouring sites. Unfortunately, the resolution of the archaeological record (or at least our data) is too coarse to test this hypothesis. The idea would, in any case, really only apply to the Maghreb where there are hundreds of contiguous, coeval open-air sites (*Grébénart 1975; Lubell et al. 1976.Fig. 1*) that could have functioned as "snail farms". It is not applicable in areas such as the Pyrenees or the northern Adriatic where sites are in rockshelters or caves, in neither of which would there be naturally occurring concentrations of land snails of the size and density found in archaeological deposits despite some suggestions to the contrary (*Bahn 1982; Girod 2003; Guilaine 1979* vs. *Aparicio 2001; de Barandiaran 1947*). Reviewing land snail ecology, Cook (*2001.453*) makes the point that: "*In population studies of terrestrial gastropods, many species have been found to exhibit a decline in abundance in both the summer and winter. In some cases, this probably represents a genuine decline in numbers, but in others it is best interpreted as substantial proportions of the population becoming inactive and therefore not being sampled.*"

The onset and termination of both hibernation and aestivation are controlled largely by prevailing weather conditions rather than endogenously (*ibid. 456*), however diurnal activities (i.e. circadian rhythm) are controlled by both endogenous factors and external ones such as length of day and amount of humidity (*ibid.*). Thus, "while the relationship between activity and weather is an important aspect of the control of behaviour, it is not a simple one" (*ibid. 457*).

Nor is the relationship between land snail populations and the environments in which they are found. LaBaune and Magnin (*2002*) studied land snail communities in overgrazed Mediterranean uplands and make some observations of interest here.

The number of xerophilic open-ground snails decreases when the grassland remains ungrazed, but a homogeneous grazed herb layer significantly reduces snail diversity and abundance.

A low richness and diversity of land snail communities is associated with large patches of grazed grassland, mainly with a continuous herb layer 5-cm high. On the other hand, the highest diversity is observed for communities living in scrublands or in smaller patches of grassland. Thus, heterogeneity seems to favour snail diversity both at the local and landscape scales. At the local level, the heterogeneity of vegetation (horizontal and vertical) and a complex cover of the soil surface enable more species to co-exist. At the landscape level, heterogeneity has an effect on land snail dispersal and on microclimate (*LaBaune, Magnin 2002.243*).

I take all these observations to mean that under prehistoric conditions, in which overgrazing is unlikely to have been a problem, both diversity and abundance of land snails would have been sufficient to enable extensive, and at times intensive, collection by humans without seriously impairing the survival of land snail populations as a predictable natural resource. However, a question remains.

How "productive" are land snails?

If we are going to consider seriously the proposition that prehistoric groups cultivated land snails as opposed to harvesting them as a wild resource, we need to look more carefully at questions of population control, breeding and productivity.

Fernández-Armesto (*2002.56*) proposes that: "*Land varieties can be isolated in a designated breeding ground by enclosing a snail-rich spot with a ditch. By culling small or unfavored types by hand the primitive snail farmer would soon enjoy the benefits of selective breeding. Snails are grazers and do not need to be fed with foods which would otherwise be wanted for human consumption. They can be raised in abundance and herded without the use of fire, without any special equipment, without personal danger and without the need to select and train lead animals or dogs to help*."

The literature on snail farming suggests to me that this is an oversimplification (*Elmslie n.d.*). As an example, Elmslie (*1982.23*) draws a distinction between "part life-cycle farming" and "complete life-cycle farming". In the former, wild snails are collected when abundant, kept in paddocks formed by simple wire fencing (in which the ground is carefully prepared), and fed on either natural vegetation or a mixture of salad vegetables and brassicas until market conditions are right for maximum profit. I suppose something similar to this scenario might, in a few instances, be a plausible approximation of what took place in the prehistoric past (and I admit the Capsian escargotières could be one such possibility), but in reality I believe it is far more likely that land snails were sometimes an intensively harvested, rather than a cultivated, resource. The key to resolving this may be modern data on population biology for both wild and captive modern populations.

Some data are available for wild populations in the Mediterranean region (e.g. *André 1982; Cameron et al. 2003; Heller 2001b; Iglesias, Castillejo 1999; Kiss, Magnin 2003; Staikou et al. 1988*) and elsewhere (*Greenwood 1974; 1976; Lange, Mwinzi 2003*). However, other than the papers by Greenwood and by Staikou *et al.*, they are not that helpful in this instance because most are concerned with species diversity rather than with actual population numbers and densities of single species or a limited number of edible species.

Greenwood (*1974; 1976*) studied populations of *Cepea nemoralis*, a species analogous to the edible snails found in archaeological sites, in the Derbyshire Dales of the north midlands of England. He estimates that for populations with densities of 0.1, 1.5 and 10/m^2, neighbourhood sizes (an expression of population) would be 190, 2850 and 12 000 respectively. Given his estimates for a generation interval of about four years, relatively constant annual production of juveniles, an average adult lifespan of approximately 2.4 years, mean lifetime production of young of 99.6 with a variance of 10 811 (!), and survivorship of at least 50%, it is clear that a population of 3000 adults (some of which would breed hermaphroditically) can produce an enormous number of offspring.

Staikou and colleagues (*1988*) spent four years studying a population of wild land snails in a 400 m^2 fenced off area in northern Greece. Four helicid species were present: *Helix lucorum, Monacha cartusiana, Bradybaena fruticum* and *Cepea vindobonensis*. Although only *H. lucorum* is considered an edible snail today, *B. fruticum* and *C. vindobonensis* are within the size range, and have some of the ecological characteristics, of the smaller species found in Capsian sites. Mean population densities (number of individuals/m^2 ± 1sd) over a three year period were: *H. lucorum* (4.95 ± 2.12) *M. cartusiana* (6.94 ± 2.77), *B. fruticum* (6.36 ± 1.25) and *C. vindobonensis* (1.42 ± 0.06). It is not clear from the publication how many of the individuals were mature (i.e. of edible size), nor were densities uniform across the entire sampling area. Nonetheless, if we use very conservative figures and say that only 50% could be considered mature at any one time, the total average numbers available to collect would be on the order of: 1000 *H. lucorum*, 1200 *B. fruticum* and 300 *C. vindobonensis* for a total of 2500 snails. For *H. lucorum* only, Staikou and colleagues estimate the mean annual crop (biomass) at 4.04gm^{-2} and an annual production of 5.02gm^{-2}. These hardly seem values high enough to provide anything like sufficient protein annually for a group of foragers.

In this light, I am dubious about the sort of figures one finds on websites devoted to snail farming. The following is only one of many possible examples.

Using a control group of 200 Helix aspersa *(Brown Garden) snails, under ideal conditions, we created a large number of market size snails in a three-year period. The following figures are based on this three-year study.*

Taking the 200 snails with a laying capacity of 150 eggs each during the spring and summer months we figured on having approx. 30 000 snails at the end of our first year of production. With a reali-

zation that we should expect a normal mortality of 40–50% from all causes we should then have something around 15 000 snails survive with half of these ready to produce 75 eggs each. This produces 562 500 snails if all survived. We again figured a 50% mortality rate, by the end of the third cycle something like 17 million snails would be produced if all lived. A more realistic figure of those growing to maturity would be something like 1/16th, or 1 000 000 plus. (www.frescargot.com/expect.htm)

Studies of species diversity and population biology for land snail populations on Crete (*Cameron et al. 2003*) and for *Helix aspersa* in north-western Spain (*Iglesias et al. 1996*) do not provide data equivalent to those found in Greenwood (*1974; 1976*), but they do suggest that his estimates are applicable to populations in semi-arid Mediterranean environments and even in arid ones (e.g. *Heller 2001b*) as do those of Staikou *et al*. (*1988*) discussed above.

Given these data, and the fact that most land snail species prefer dead plant material to fresh and herbs to grasses (e.g. *Williamson, Cameron 1976*), I am not convinced that raising land snails would have been all that more advantageous in most instances than relying simply on their natural fecundity to provide sufficient numbers to meet human dietary requirements.

I believe this is also borne out by the data available for captive, "domesticated" modern populations (e.g. *Elmslie 1982; n.d.; www.lumache-elici.com;* links found at *www.manandmollusc.net*) which show that raising snails is a far more complex activity than the procedures discussed by Fernández-Armesto, and far more prone to failure.

For example, this is from the U.S. Department of Agriculture website *www.nalusda.gov/afsic/AFSIC_pubs/srb96-05.htm#*.

Population density also affects successful snail production. Pens should contain no more than six to eight fair-sized snails per square foot, or about four large H. pomatia*; or figure one kilogram per square meter (about .2 pounds of snail per square foot), which automatically compensates for the size of the snails. If you want them to breed, best results will occur with not more than eight snails per square meter (.8 snails per square foot). Some sources say that, for* H. pomatia *to breed, .2 to .4 snails per square foot is the maximum.*

Snails tend not to breed when packed too densely or when the slime in the pen accumulates too much. The slime apparently works like a pheromone and suppresses reproduction. On the other hand, snails in groups of about 100 seem to breed better than when only a few snails are confined together. Perhaps they have more potential mates from which to choose. Snails in a densely populated area grow more slowly even when food is abundant, and they also have a higher mortality rate. These snails then become smaller adults who lay fewer clutches of eggs, have fewer eggs per clutch, and the eggs have a lower hatch rate.

Fig. 2. Did Mesolithic foragers dream of becoming Neolithic farmers and herders? Originally published in Guilaine (*1987.124*). Reprinted with permission.

CONCLUDING REMARKS

This enquiry is a work-in-progress. I cannot honestly say that I have so far been able to answer satisfactorily many of the questions initially asked although I am convinced that the answer to the question posed in the title – Are land snails a signature for the Mesolithic-Neolithic transition? – is an unequivocal "yes"; a point made in a humorous fashion by the late Pierre Laurent (Fig. 2). Here, and in a complementary paper (*Lubell 2004*), I have shown that there is a pattern and I have tried to offer some idea of how I think we might go about answering those questions. Land snails are often very abundant in late Pleistocene and early-mid Holocene sites throughout the Mediterranean region and elsewhere. In the vast majority of cases they represent evidence for prehistoric human diet. Given their geographic distribution and time frame, these sites, or levels within them, must have something to do with changes that were taking place as human groups underwent the transition from foraging to food production – sometimes known as the Mesolithic-Neolithic transition, sometimes as the Neolithic Revolution, sometimes as the Broad Spectrum Revolution. No matter what name we choose to give it, the pattern is there, it is intriguing, and it requires further interdisciplinary research to clarify just what the presence of all those land snail shells means.

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This paper began in 1966 when Ralph Solecki assigned me a seminar project to find out if the land snails occurring in the upper levels at Shanidar Cave could be used for palaeoenvironmental reconstruction. He could never have suspected where this would take us! I owe a debt I can now never repay to the late Alonzo Pond whose research in North Africa formed the basis from which my own began. Achiel Gautier (Rijksuniversiteit-Gent) started that quest with me and we have continued to share ideas ever since. As always, I thank Mary Jackes for her encouragement and help over almost that many years.

Finally, I thank the Inter-Library Loan Services of the University of Alberta Library for never failing me. Figure 1 is slightly modified from an original prepared by Michael Fisher, Department of Earth and Atmospheric Sciences, University of Alberta for Lubell (2004). Laurens Thissen pointed out errors which have been rectified in the version used here. Figure 2 is reproduced by permission of Professor Jean Guilaine (Collège de France).

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Appendix 1: Composition of land snail flesh[a]

	α	A	B	C	D	E	F	G1	G2	H	I	J
water	g	81.9	58.4	81.9		82.8		84.2	84.3	79.4		
ash	g		2.6	4.4				13.0	10.1	1.9		
calories	g		180.0									
nitrogen	g	2.0										
protein	g	12.8	32.2	70.6		12.9	16.1	60.6	65.0	12.3		
carbohydrate	g		4.0				2.0					
total fat	g	1.2	2.8	6.7		1.7		4.5	9.0	0.6		
saturated fatty acids	g		0.8		20.1	0.1						
monounsaturated fatty acids	g		0.8		16.8	0.1						
polyunsaturated fatty acids	g		0.6			0.1						
total ω-6					49.0							
total ω-3					7.8							
cholesterol	mg					65.0						
total minerals	g	0.8										
calcium	mg					57.0	170.0		1787.5	764.5		
copper	mg	3.0							12.1	2.5		
iron	mg					5.0	3.5		25.6	2.9		
magnesium	mg						250.0		503.1	77.3		
potassium	mg					347.0	100.0			161.7		
phosporus	mg					141.0	200.0		1213.6	130.3		
sodium	mg					206.0	259.0			59.1		
zinc	mg	1.6				1.6			93.3	1.2		
AMINO ACIDS (* = essential)												
alanine	mg	348.0		1.92						0.67		
arginine	mg	818.0		4.52						0.62		
aspartic acid	mg	1124.0		6.21						1.27		
cysteine	mg									0.21		
glutamic acid	mg	1765.0		9.75						1.90		
glycine	mg	333.0		1.84						1.02		
histidine	mg	394.0		2.18						0.18		
isoleucine*	mg	403.0		2.23						0.63		
leucine*	mg	887.0		4.90						0.92		
lysine*	mg	847.0		4.68						0.53		
methionine*	mg	1015.0		5.61						0.24		
phenylalanine*	mg	422.0		2.33						0.50		
proline	mg	425.0		2.35						1.05		
serine	mg	630.0		3.48						0.60		
threonine*	mg	226.0		1.25						0.55		
tryptophan*	mg									0.12		
tyrosine	mg	972.0		5.37						0.48		
valine*	mg	1111.0		6.14						0.56		
FATTY ACIDS (* = essential and unsaturated following Cunnane 2003: Table 1)												
12:0												0.21
13:0												0.04
Myristic 14:0	mg	890.0		1.48							0.28	0.38
15:0												0.26
Palmitic 16:0	mg	105.0		6.01	8.00					10.10	4.32	4.65
Palmitoleic 16:1	mg	29.0		1.70	1.80					1.08		0.66

	α	A	B	C	D	E	F	G1	G2	H	I	J
Heptadecanoic 17:0	mg	12.0								1.13	1.37	0.66
Stearic 18:0	mg	85.0		11.12	10.20					12.28	8.11	8.62
Oleic 18:1n-9	mg	178.0		14.38	12.60	30.00				16.64	10.70	8.91
Linoleate 18:2 ω-6*	mg	118.0		19.57		20.00				25.42	12.19	10.39
?-Linoleate 18:3 ω-3*	mg	18.0		0.97		1.00				2.00	2.28	2.46
Octadecatetraenoate 18:4 ω-3												1.79
Arachidic 20:0	mg	3.7									0.61	0.36
Gadoleic 20:1	mg	20.0								3.09	3.05	5.19
20:2 ω-6	mg									11.17	10.47	11.37
20:3 ω-6	mg									17.09	2.41	0.42
arachidonic 20:4 ω-6*	mg	65.0			14.10						15.61	18.69
eicosapentaenoic 20:5 ω-3*	mg	220.0									1.03	1.00
22:0												0.84
erucic 22:1	mg	2.6									2.53	0.94
22:2												2.61
22:3												3.34
22:4												6.59
clupanodonic 22:5 ω-3	mg	7.7									1.54	3.27
docosahexaenoic 22:6 ω-3*	mg	45.0										
24:0												1.72
other before 18:0												1.77
other after 18:0												2.00
unidentified												0.84

A Scherz *et al.* (*2000*). *Helix pomatia* L., 100g edible portion. Units of measure as per column α.

B Hui (*1996.Tab. 13.6*). Steamed or poached: contents/100g. Units of measure as per column α.

C Miletić *et al.* (*1991*). *H. pomatia*, freeze-dried and ground. With exception of water, estimated gravimetrically. Units of measure are % dry matter.

D Zhu, N *et al.* (*1994*). Average for *Helix* sp. + *Haplotrema sportella* + *Vespericola columbiana*. Units of measure are mean % of total fatty acids.

E Salvini *et al.* (*on-line*). *H. pomatia* per 100g edible. Units of measure as per column α.

F Fineli Food Composition Database (1999–2002) National Public Health Institute, Finland (http://www.ktl.fi/fineli/). Units of measure as per column α.

G_1 Gomot (*1998.Tab. 2*). Values are g/100g for "natural" (i.e. not fed on commercial meal) *H. pomatia* and *H. lucorum*,calculated on dry matter. Units of measure as per column α.

G_2 Gomot (*1998.Tabs. 2 and 4*). Values are averages of foot and viscera combined in g/100g for *H.a.aspersa*, *H. aspersa maxima*, *H. lucorum* and *H. pomatia* fed on E3–2 commercial meal, calculated on dry matter. Units of measure as per column α.

H Bonomi *et al.* (*1986*). Industrially raised *H. pomatia maior*. Units of measure as per column α.

I van der Horst and Zandee (*1973*). Wild *Cepea nemoralis*. Average of seven monthly values in mol per cent (the amount of each fatty acid present as a percentage of the total fatty acids recovered).

J Thiele and Kröber (*1963*) as given in Voogt (*1972.Tab. XI*). Values are free fatty acids expressed as %. For C17:0 this is 17:0 + 16:2.

[a] Data from Grandi and Panella (*1978*) are not included because they are expressed in a way that makes it difficult to compare with the values reported here. They are summarized in Table 1 and discussed in the text.

contents

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Documenta Praehistorica XXXI

Expected palaeoanthropological and archaeological signal from a Neolithic demographic transition on a worldwide scale

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ABSTRACT – *A signal of major demographic change was detected from a palaeoanthropological database of 68 Meso-Neolithic cemeteries in Europe (reduced to 36 due to a sampling bias). The signal is characterized by a relatively abrupt change in the proportion of immature skeletons (aged 5–19 years), relative to all buried skeletons (5 years +). From the Meso to the Neolithic, the proportion rose from approximately 20% to 30%. This change reflects a noticeable increase in the birth rate over a duration of about 500–700 years, and is referred to as the Neolithic Demographic Transition (NDT). Another category of independent archaeological data, on enclosures (N = 694), which are interpreted as a response to population growth within the social area, reveals a similar signal at the same tempo. If this is a true signal, we should expect it to be detected also in all the independent centres of agricultural invention worldwide. The NDT is at the historical root of the pre-industrial populations that would gradually spread across the Earth and which are now rapidly disappearing.*

IZVLEČEK – *Na osnovi paleoantropološke baze podatkov iz 68 evropskih mezo-neolitskih grobišč (zaradi pristranskih vzorcev zmanjšanih na 36) smo ugotovili večjo demografsko spremembo, za katero je značilna razmeroma nenadna sprememba deleža nerazvitih skeletov (starost 5 do 19 let) glede na vse pokopane skelete (5 let in več). Od mezolitika do neolitika to razmerje naraste od okoli 20% na 30%. Ta sprememba kaže na znaten porast deleža rojstev v obdobju 500 do 700 let in se nanaša na neolitski demografski prehod. Druga skupina neodvisnih, zaključenih arheoloških podatkov (N = 694) iz socialnega okolja, ki jih razlagamo kot odgovor na rast prebivalstva, kaže podobno spremembo v enakem tempu. Če je znak za spremembo pravilen, lahko pričakujemo, da ga bodo zaznali v vseh neodvisnih središčih začetka kmetovanja po svetu. Neolitski demografski prehod je zgodovinski začetek predindustrijske populacije, ki se je postopoma razširila po Zemlji in ki danes hitro izginja.*

KEY WORDS – *Neolithic; demographic transition; cemeteries distribution; enclosures distribution*

INTRODUCTION

The impact of the demographic change generated by the Meso-Neolithic transition on a European scale is mainly evident in the very significant increase in archaeological remains, but the pace of this change and its magnitude have not really been measured: was it, on average, slow or rapid? Did this major transformation in a way of life correspond to a relatively abrupt demographic change, with a significant increase in the number of humans, i.e. in the language of demographers, to a demographic transition? Or should we be considering rather slow growth, with no sign of any kind of demographic revolution?

A Neolithic demographic transition (NDT) can be detected through at least two types of data: palaeo-anthropological and archaeological. The first are represented by the distribution of skeletons by age in cemeteries. These distributions allow the generating demographic parameters to be directly inferred via the demographic theory of stable population (dating back to Lotka 1928; see *Bourgeois-Pichat 1994*, for a presentation). The archaeological data can also account for the change through variations in their density (quantity of information per geographical or temporal unit); assuming a roughly linear relationship between demographic density and archaeological density, we can indeed expect to see significant population growth producing a corresponding increase in archaeological information, and vice-versa: where remains are numerous, the population must also have been large; an archaeological desert means that there was nobody. The question thus arises as to which unit of archaeological information is relevant as a reflection of demographic change. The genetic data will be omitted here. Recent validations of contradictory genetic models that are taken into account for the distribution of markers in Europe – some of which indicate a Neolithic population movement originating in the Middle East (for a summary, see *Cavalli-Sforza 1997*), others a Palaeolithic movement originating in a Pyrenean refuge zone (*Torroni et al. 2001; Forster et al. 2001*) – leave the attentive observer in some doubt as to the chronological resolution of scenarios that can be tested against genetic data over periods of less than 50 000 years.

Palaeoanthropological data from cemeteries are still the best candidates for detecting demographic change. They make it possible to obtain a simple non-conventional demographic indicator on the distribution of skeletons by age, the information being represented by the proportion of immature individuals aged 5 to 19 years in cemeteries. In a growing population, the proportion of immature individuals (living or dead) is high; in a declining population, the proportion is low. Besides the palaeoanthropological data, we also looked for an independent archaeological marker. This is represented by enclosures. During a period when significant demographic growth occurred, a corresponding increase can be assumed in the number of constructions for collective use, such as places of worship, military establishments, cemeteries, markets, mills, etc. An NDT signal was detected from a palaeoanthropologic database of Mesolithic and Neolithic cemeteries, representing a space-time sample of this proportion on the scale of Europe (*Bocquet-Appel 2002; Bocquet-Appel and Paz de Miguel Ibanez 2002*). The questions that arise are: is the change detected from the palaeoanthropologic data echoed by the number of enclosures and enclosure systems? Do these two data categories, palaeoanthropological and archaeological, point in the same direction to represent the pace and range of a Meso-Neolithic demographic change, or do they show discordances, bringing the assumption of an NDT into doubt? If the NDT hypothesis is accepted, what was its pattern, i.e. in which direction was the variation in mortality and birth rates? What was its magnitude in terms of growth rate? What were its predictable epidemiological consequences and its long-term demographic implications on a worldwide scale?

PALAEOANTHROPOLOGICAL DATA FROM CEMETERIES AND THEIR DEMOGRAPHIC SIGNIFICANCE

After exhaustive research in the literature, these data have been represented by a non-conventional demographic indicator, which is the proportion *P* of immature skeletons aged 5 to 19 years, *d(5–19)*, relative to the total number of skeletons in a cemetery, *d(5+)*, minus children aged under 5 years, which are known to be under-represented:

$$ {}_{15}P_5 = d(5\text{–}19)/d(5+); $$

the demographic notation ${}_{15}P_5$ means the proportion of skeletons aged 5 years, to 5 years plus 15 years, i.e. 5 to 19 years. The criteria for the archaeological and anthropological selection of cemeteries and the corresponding enumerations and calculations are detailed in Bocquet-Appel (*2002*). The data represent 68 Meso-Neolithic cemeteries (Fig. 1). The dates (calibrated) of the cemeteries were either those given in the original publications, or the average dates of the cultures (or horizons) of these cemeteries. The demographic interpretation of ${}_{15}P_5$ is obtained from a reference sample of 45 preindustrial life-tables, from which demographic parameters were regressed on simulated stable populations, called palaeodemographic estimators (*Bocquet-Appel 2002; Bocquet-Appel and Masset 1996; Bocquet and Masset 1977*). As an example, Figure 2 represents the relationship of ${}_{15}P_5$, with the crude birth rate (*b*) and life expectancy at birth (e_0). The relationship holds good with the input variable in the population represented by *b*, but becomes null with the output variable represented by e_0.

ARCHAEOLOGICAL DATA

These are represented by approximately 700 enclosures in Central and Western Europe listed by Andersen (*1997*), to which a few units were added. Their significance as palaeodemographic markers is discussed in Bocquet-Appel and Dubouloz (*2003*). The Neolithic enclosures are interpreted as having a struc-

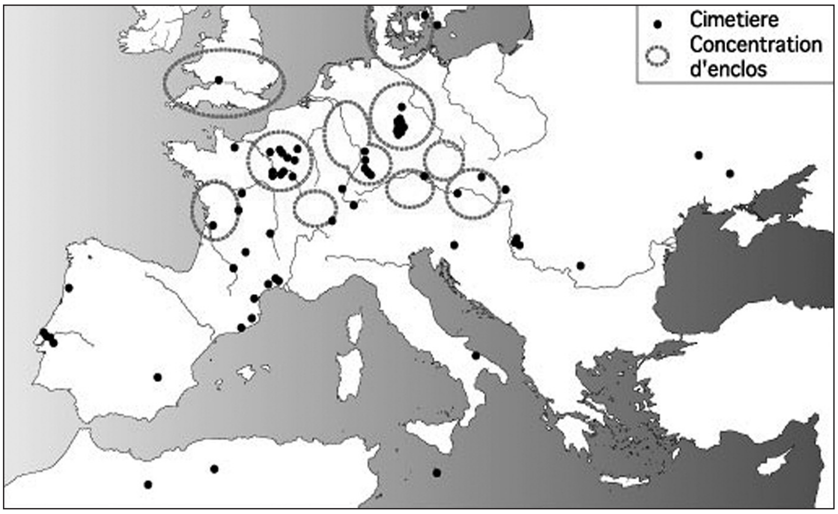

Fig. 1. Geographical distribution of 68 Meso-Neolithic cemeteries (black points) and of 694 enclosures (circles dotted lines) (from* Bocquet-Appel and Dubouloz 2003*).

tural link with the processes underlying the organization of social space in prehistoric communities. A common general significance, which seems to include particular cases, is that each one, at its own level (from local to regional) can be seen, as a territorial marker that polarizes the geographical and social space through a "monumental" signal of supra-domestic value. A connection is therefore likely between demography and sites of this type. This connection is taken as reflecting a form of demographic pressure. To minimize documentary risks stemming from differences in national archaeological practices, the geographical space analyzed is roughly copied from that of the "Danubian Neolithic colonization". The selected sites thus relate to the regions which, to the north of the Alpine arc, stretch from Transdanubia to the Atlantic and the Baltic (Fig. 1). An archaeological chronology, broadly dated by ^{14}C measurements, was used.

THE RELATIVE CHRONOLOGICAL REFERENCE FRAME OF THE CHANGE

The distribution of data in space and time accumulates processes in the Meso-Neolithic transition which occurred at different times from locality to locality on the map, and this makes it difficult to bring out the phenomenon of a single demographic transition that transcends absolute chronology and proceeds at its own pace. Instead of an absolute chronology, the reference frame was changed, and the data positioned within a relative chronology. The reason for this change of reference frame is to concentrate archaeological information that is relatively scarce and scattered over space and time into the same reference frame provided by a relative chronology, in order to bring out an overall pattern underlying the data. Assuming that the Neolithic demographic transition was a demographic process in itself, occurring independently of the geographical location and absolute date of the sampled sites (cemeteries), as did the contemporary demographic transition, then geography can be eliminated from the space-time distribution of data, to preserve only the time distribution with reference to the local date when the process began, which is called the 'neolithisation front'. A profile common to all the data was thus obtained, with no influence from geography or absolute chronology. The chronological distance of a cemetery to the neolithisation front, both localized in X, is thus the duration dt separating the dating of the front, $t_0(X)$, from that of the cemetery, $t(X)$, that is to say: $dt(X) = t_0(X) - t(X) = dt$. When dt is negative, the site is chronologically located before the neolithisation front, i.e. in the Mesolithic (see *Bocquet-Appel 2002*).

To help understand the nature of the change in the chronological reference frame, additional explana-

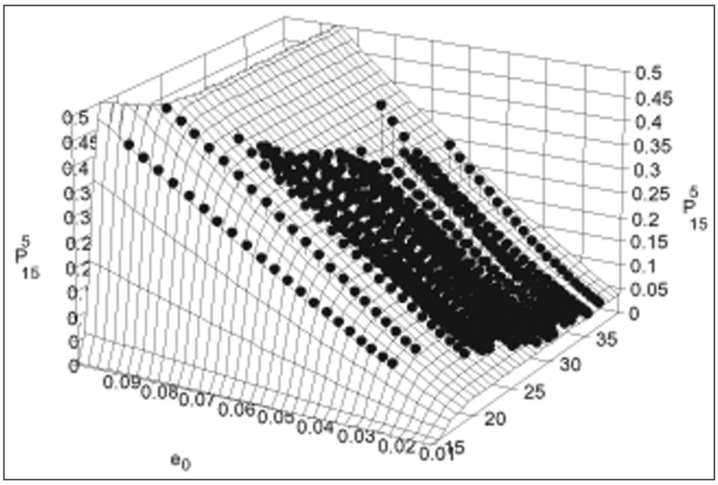

Fig. 2. Relationship of $_{15}P_5$, with the crude birth rate (b) and the life expectancy at birth (e_0). The relationship is good with the input variable in the population represented by b but nil with the output variable represented by e_0.

tions are given here, based on an historical example. It should be remembered that the contemporary demographic transition, featuring a historical drop in mortality and then in fertility, is a process taking place on a worldwide scale, but at different dates, in a chronological window extending from the 18th to the 21st centuries. For example, this transition started at around 1841 in Privas (France), 1901 in Carlow (Ireland) and 1961 in Coimbatore (India) (*Balabdaoui et al. 2001; Bocquet-Appel and Jakobi 1996; 1998*). In order to compare regional demographic changes regardless of the chronological time lag, for example to assess their pace or their amplitude relatively to each other, all the profiles representing the temporal change should be placed within the same neutral reference frame of a relative chronology. Within this framework, the natural reference point is the date when the transition process began in each region (respectively 1841, 1901 and 1961), which is taken as time t = 0. A relative chronology common to the three regions can thus be established by simply subtracting their respective starting dates from each of the three absolute chronologies. The resulting chronology is in units of deviation from the start of the process. It is actually a time span, but with no reference to an absolute chronology. This unit of deviation, may be called dt. Figure 3a shows the reduction in the average number of children, via the Total Fertility Rate (TFR) in the three regions of our example, through the relative chronology dt. The pace of the fertility transition is much faster in Coimbatore (India) than in Privas (France), although it occurred 120 years later. When the deviations, dt, are plotted on a graph, the range of chronological variation for the demographic transition, considered as a global phenomenon occurring independently of time or place, becomes apparent (see Fig. 3b). The representation of the demographic change is quite correct, whereas it is wrong if it is represented in terms of absolute chronology (Fig. 3c).

DATA ANALYSIS

A trend emerging from cemeteries and detection of the signal of a demographic transition

Figure 4 shows the $_{15}P_5$ profile obtained at a chronological distance from the neolithisation front dt, from the total database (U = 6, χ^2 = 20.450 with 1 df, P < 0.000). A transition signal is detected. This profile shows the trend underlying the $_{15}P_5$ in the relative chronology framework. It is estimated by a local fit in the $_{15}P_5$ cloud, which is comparable to a moving average (also called a Loess fit; *Bocquet-Appel 2002*). The test for rejecting the null hypothesis of a flat profile, i.e. not showing the broken line typical of an abrupt change occurring in a transition, was performed with Mann-Whitney's non-parametric U test. This test constitutes the detection of the signal of a demographic transition. Finally, to estimate the values of the demographic variables, palaeodemographic estimators were applied directly to the values of the profile of the $_{15}P_5$, not to the individual values for cemeteries. Although the profile (Fig. 4) is interesting, a bias from the over-representation of immature individuals in small cemeteries, probably of archaeological origin, was detected, forcing us to eliminate cemeteries where the sample

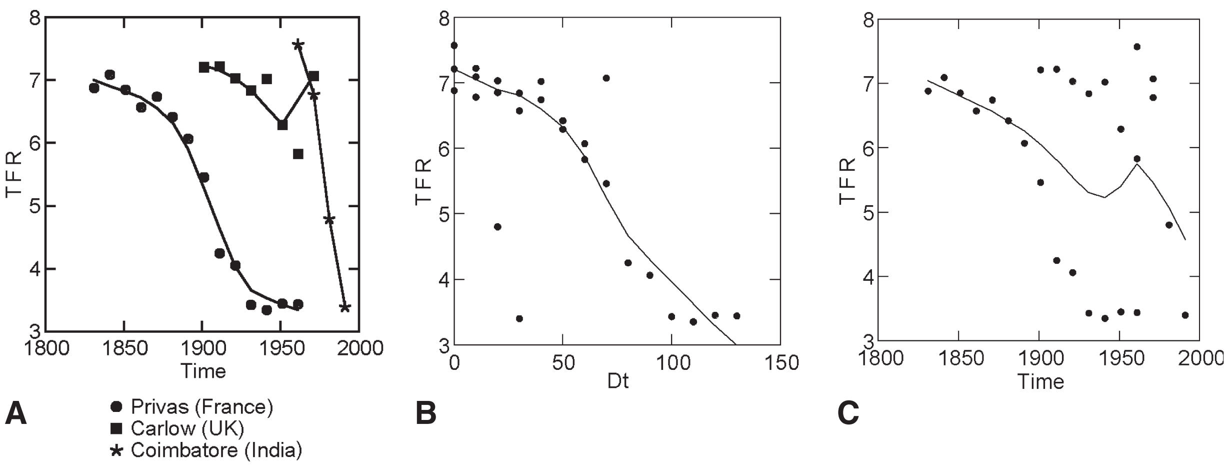

Fig. 3. Fertility transition (TFR) in three regions. The onsets are respectively in 1830 (Privas, France), 1911 (Carlow, Ireland) and 1961 (Coimbatore, India). A) Each transition in absolute chronology; B) The average (loess fit) of the three transitions in relative *chronology (dt); C) the average (loess fit) of the three transitions in* absolute *chronology. The pattern of the fertility transition is detected in relative (dt) but not in absolute chronology.*

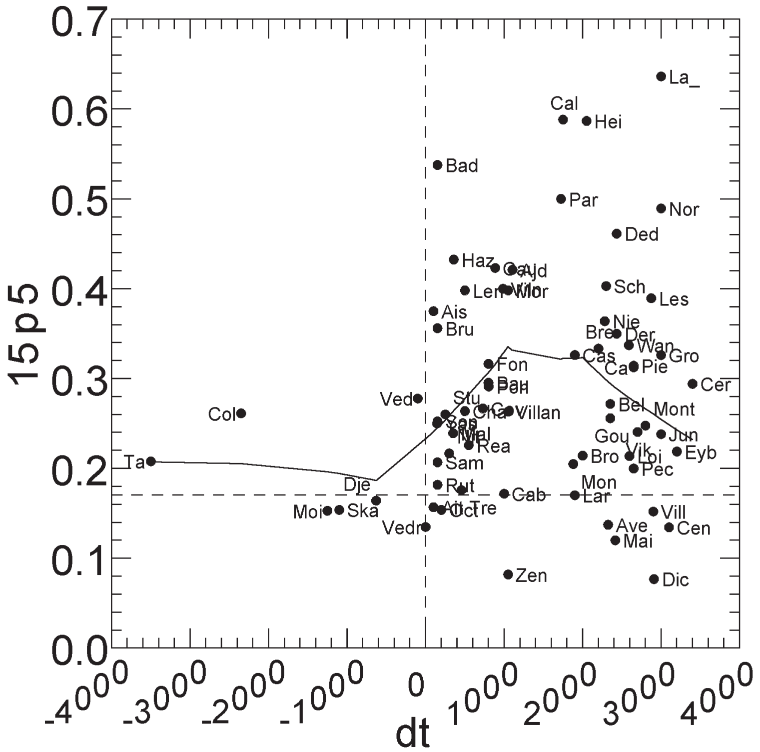

Fig. 4. Profile proportion of immature ${}_{15}P_5$ (P(5–19)) in the cemeteries (vertical axis) with the chronological distance to the neolithisation front (dt, horizontal axis). N = 68 Mesolithic and Neolithic sites. Note: dt = 0 is the starting chronological point of the neolithisation front, dt < 0 is in the Mesolithic, dt > 0 is in the Neolithic. Up to a constant, the profile represents the variation of the birth rate. It shows a continuous increase which begins around dt = –200 years until dt = 1000 years (from Bocquet-Appel 2002*).*

size of skeletons was below 50 (*Bocquet-Appel 2002*). The new, reduced sample thus includes only 36 cemeteries (3 Mesolithic, 33 Neolithic). This narrows the chronological frame from dt = –1.500 to dt = 3.000. Figure 5 shows the variation in estimated crude birth rate, with at profile of ${}_{15}P_5$ with dt, obtained from these 36 cemeteries. A signal of major demographic change, starting at the very beginning of the Neolithic (U = 26, χ^2 = 11.04 with 1df, P = 0.001), was thus detected. Our interest here is only in the zone on the neolithisation front. This is of particular interest as it provides information on the magnitude of the change at its onset. If we consider the maximum of the first bulge on the dt axis as representing the upper limit of the Neolithic demographic transition, at its onset, then the transition covers a relatively short time of approximately 500 years. On the profile, from dt = 0 to the maximum of the first bulge (dt ≅ 500), the smoothed value corresponding to the proportion of immature individuals relative to d(5+), ${}_{15}P_5$, rises from 16% to 27%, i.e. a 70%, increase, while the corresponding estimated value of the growth rate rises from –0.3% to 1.3% (±1.07%) (see *Bocquet-Appel 2002*). This very substantial change in the proportion of immature skeletons lasts almost throughout the entire Neolithic dt, relative to the Mesolithic. In short, the palaeoanthropological data from the cemeteries contain demographic information which, taken overall, reveal the pattern of a true Meso-Neolithic transition in Europe. With currently available data, a clear break from the previous stationary demographic regime of hunter-gatherers characterises this transition, over a relatively short time span of dt ≅500 years.

The trend in the enclosure data

Two approaches were used, the first based on absolute chronology, i.e. historical time, the second on relative, i.e. more local chronology, dt, in order to bring the results closer to those obtained with the palaeoanthropological data from cemeteries. Only the latter approach is described here (see *Bocquet-Appel and Dubouloz 2003*). The profile of enclosure frequencies (count) along the chronological distance dt is represented in Figure 6 (black line). This shows a rapid increase in the size of the enclosure sites, as from dt = 300–600 years, culminating at dt = 600–900 years, then a slow decrease until dt = 1200–1500 years, followed by a clear decline. The data were then sorted against the criterion of whether they were included in the distribution area of the Linear Ceramics Culture (LBK). The profile for LBK regions (dotted line) shows a rapid response at dt = 300–900 years; a recrudescence in the number of enclosures occurs at dt = 1800–2400 years after the beginnings of the Neolithic, measured locally, mainly from eastern Germany to Bavaria. The profile for the periphery shows two peaks close together, separated by a threshold located at a high level: the first of these peaks (where dt = 300–600 years) relates to the areas of the northern periphery (Denmark, Great Britain), the intermediate threshold (where dt = 600–1200 years) points to the north of France and the second peak (where dt = 1200–1500 years) represents the west of France. The extreme western periphery thus indicates a long time-lag, which can even be considered to broaden downstream (enclosures at the end of the 4^{th} and the beginning of the

3rd millennium in the west of France). This profile for peripheral enclosures (dotted line) thus suggests three different growth processes: a rapid response, as in the LBK regions in Denmark and England, a slow response in the west of France; and a moderate response in the north of France. The broad outline of the main profile (black line) and the fairly rapid "response" time after the "local" beginnings of the Neolithic that it suggests, correlate well with the demographic phenomenon deduced from the cemeteries (Figs. 4 and 5). This general distribution of territorial markers, in relative time, particularly in the LBK areas in Denmark and in England, suggests a rapid response from a strongly stimulated system, followed by its adaptation to the new situation.

DISCUSSION AND CONCLUDING REMARKS

In theory, what connects the variation of the two indicators (palaeoanthropological, representing the proportion of immature $_{15}P_5$, and archaeological, representing the number of enclosures), is the growth of population with the establishment of an agro-pastoral way of life. Their two profiles should, therefore, be similar. Figures 5 and 6 show that this is indeed the case. The two indicators also converge in the estimation of the pace at which this first demographic transition in Europe, considered overall, emerged. The pace was fastest for the palaeoanthropological data (dt ≅ 500) as for enclosure data (dt = 600–900). In other words, the demographic change that generated a noticeable growth in the population became established over a relatively short time span. This change is characterized by a clear break with the former stationary regime of Mesolithic hunter-gatherers (according to the palaeoanthropological data), over a time span of approximately 500–900 years, possibly less. The likely cause of the rising birth rate and underlying fertility rate is to be found in the shorter birth interval that ensued from the sedentarisation of farming communities (*Bocquet-Appel 2002*).

But, as we know, any growing population will eventually reach the limits of its carrying capacity, triggering off the mechanisms of the Malthusian model (for a summary, see *Wood 1998; Lee 1994*). The probable scenario is therefore as follows: after a rise in the crude birth rate, a corresponding increase in the crude death rate is to be expected, i.e. a return to homeostatic equilibrium. For the NDT, the rise in mortality must have been caused by the emergence of new pathogens, mainly infectious diseases resulting from the zoonoses of domesticated animals (cattle, sheep, goats and pigs), as well as from the anastomosis of village units that facilitated their spreads (*Bocquet-Appel 2002*). Mortality, which has a major impact on population, primarily affects children under 5 years old. A history of infectious diseases and their phyletic relationship with pathogenic animals is yet to be written (see also *Gubser and Smith 2002; McNeill 1993; McKeown 1988*). However, candidates would include viral diseases (smallpox, measles, mumps, rubella, chicken pox and poliomyelitis) and bacterial diseases (whooping-cough, diphteria, meningitis and typhoid). We now need to seek genetic markers of these candidate diseases, in the pulp cavities of the teeth of child skeletons, following the method that was successfully used for plague (*Drancourt et al. 1998*). We need to attempt a dating for the initial appearance of these infectious diseases, at the end of the Mesolithic era and the beginning of the Neolithic (for example with the PPNA vs. PPNB locally), in

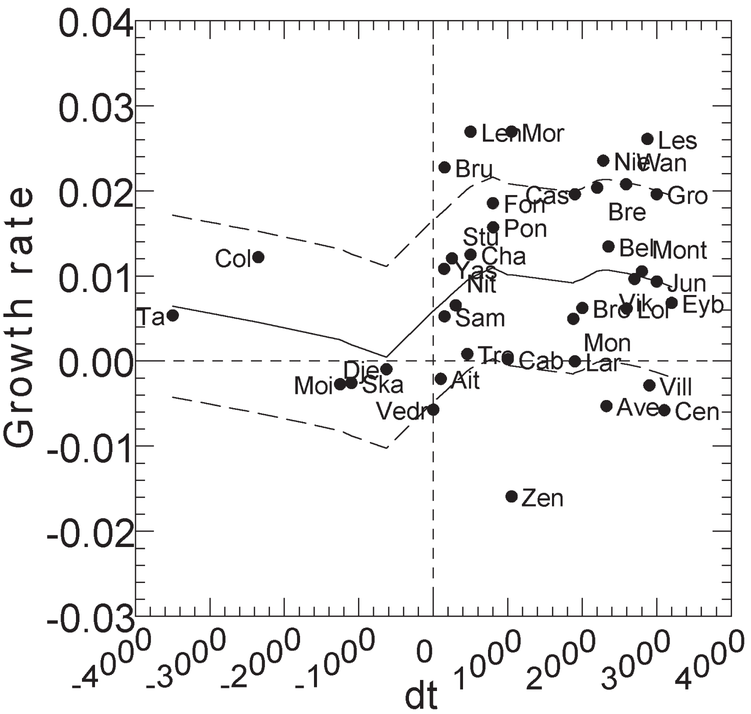

Fig. 5. Variation of estimated crude birth rate on the profile of $_{15}P_5$ with dt, obtained from the reduced sample of 36 cemeteries. The signal of an important demographic change is detected, which started at the onset of the Neolithic (U = 26.5, χ^2 = 11.04 with 1df, P = 0.001).

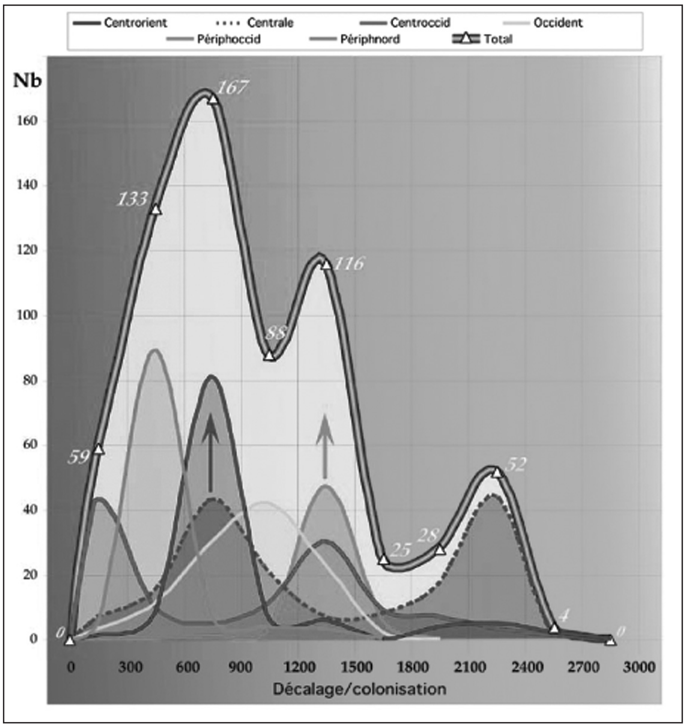

Fig. 6. Profile of the number of enclosure at the chronological distance dt (black line). It shows a fast growth of the number of enclosures as of dt = 300–600 years, to culminate with dt = 600–900 years, then a slow decrease until dt = 1200–1500 years before a marked depression (from* Bocquet-Appel and Dubouloz 2003*).

order to try to estimate the duration of the demographic expansion which preceded the return to homeostatic equilibrium.

The consequences of the NDT were perhaps comparable with that of the natural demographic transition in 19th century Europe, in terms of rapid demographic expansion. A consequence of the contemporary demographic transition has been an explosive growth rate of about 3% over a hundred years. What followed was the continent-wide destruction of the hunter-gatherers and horticulturists of North America and Australia, resulting from a major demographic invasion by surplus populations of European peasants. But the order of the causal demographic variables and their directions were reversed: rising fertility followed by rising mortality during the NDT, as against falling mortality followed by a drop in fertility during the contemporary Western demographic transition.

The detection of the NDT signal was conditioned by the space-time data available. The demographic pattern obtained is a kind of average of samples that centred in particular on the "Danubian" culture. The NDT we detected did not necessarily occur at the same pace everywhere on the map, especially around the periphery of Europe. A geographical differentiation of the process needs to be considered, depending on the local pace of neolithisation. More data, with a better distribution over time and space, should help to refine the regional picture of the NDT.

Finally, the assumption can now be made that the NDT occurred in all the independent centres of agriculture invention on Earth, during the chronological window from 10 000 to 4000 BP. Its signal should therefore be detectable in cemetery data from the regions corresponding to these centres. As the geographical expansion of the agro-pastoral economic system, the vehicle for the new demographic regime, extended from these centres, the areas eventually connected to form a single area of relative demographic homogeneity, giving rise to the worldwide pre-industrial population regime, featuring a low growth rate

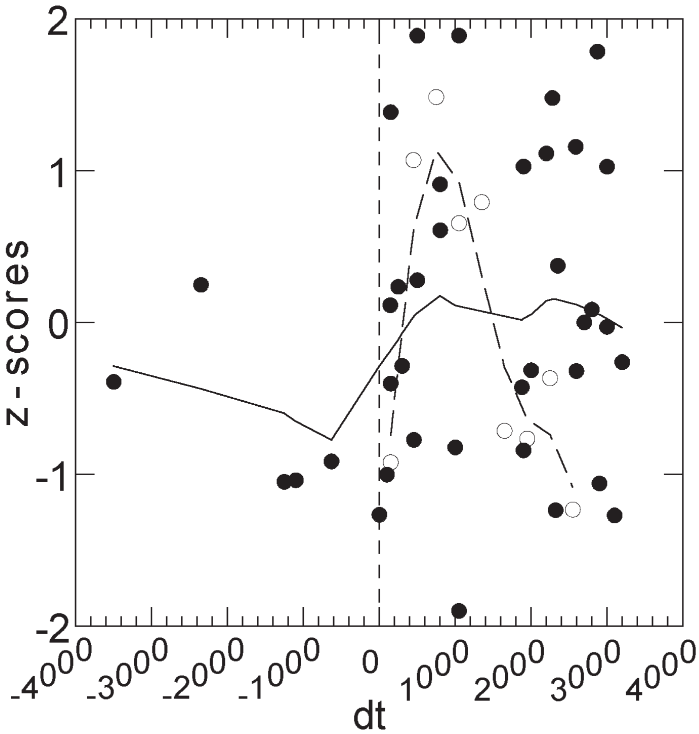

Fig. 7. Projection of the two standardized profiles (z-scores, vertical axis), palaeoanthropological (cemeteries) and archaeological (enclosures) with the chronological distance to the neolithisation front (dt, horizontal axis).

and high mortality and birth rates, also called the "high pressure system" (*McCaa 2002*). The relic demographic regime of the hunter-gatherers known to ethnography has remained at its margins. With the expansion of the contemporary demographic transition, this pre-industrial population regime, which dates back to the Neolithic, is now disappearing.

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Documenta Praehistorica XXXI

Modelling the Neolithic dispersal in northern Eurasia

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ABSTRACT – *Comprehensive lists of radiocarbon dates from key Early Neolithic sites in Central Europe belonging to the Linear Pottery Ceramic Culture (LBK) and early pottery-bearing cultures in the East European Plain were analysed with the use of the χ^2 test. The dates from the LBK sites form a statistically homogeneous set, with a probability distribution similar to a single-date Gaussian curve. This implies the rate of expansion of the LBK in Central Europe being in excess of 4 km/yr. Early pottery-bearing sites on the East European Plain exhibit a much broader probability distribution of dates, with a spatio-temporal trend directed from the south-east to the north-west. The rate of spread of pottery-making is in the order of 1 km/yr, i.e., comparable to the average expansion rate of the Neolithic in Western and Central Europe.*

IZVLEČEK – *S testom χ^2 smo analizirali obsežen seznam radiokarbonskih datacij iz ključnih zgodnjeneolitskih najdišč srednje Evrope, ki pripadajo kulturi linearnotrakaste keramike (LTK), in iz najdišč z zgodnjo keramiko iz vzhodnoevropskih nižin. Datacije z najdišč LTK so statistično homogene z verjetnostno distribucijo, ki je podobna Gaussovi krivulji. To kaže, da je bila stopnja ekspanzije LTK v srednji Evropi več kot 4 kilometre na leto. Najdišča z zgodnjo keramiko iz vzhodnoevropskih nižin kažejo veliko širšo verjetnostno distribucijo datacij, pri čemer je prostorsko-časovni trend usmerjen od jugovzhoda k severozahodu. Hitrost širjenja izdelovanja keramike je reda velikosti 1 kilometer na leto, se pravi da je primerljiv s povprečno stopnjo ekspanzije neolitika v zahodni in srednji Evropi.*

KEY WORDS – *Neolithic; LBK; pottery-making; expansion rate; radiocarbon; statistical analysis*

INTRODUCTION

Since Childe (*Childe 1925*) the concept of ‘agricultural revolution’ has been focused on the introduction of agriculture. Neolithisation was viewed as the spread of colonists bearing ceramic containers, domesticated plants and animals, new architecture, long-distance trade, burial rituals, and eventually overwhelming indigenous hunter-gatherers to the cultivation of domesticated cereals and rearing the animal stock (*Price 2000*). New criteria included sedentary settlements, social hierarchy and symbolic expressions (*Tringham 2000*). Yet to this day the shift to *agro-pastoral* farming is deemed to be the most important single signature of Neolithic (*Zvelebil 1996.323*).

However, recent archaeobotanic studies (*Hather and Mason 2002.4, 5*) show that it is often impossible to draw a clear distinction between agriculture and hunter-gathering, as hunter-gatherers may undertake agricultural practices and vice versa. This evidence shows that wild plant species were extensively gathered in most areas in Neolithic Britain (*Robinson 2000*). The appearance of ceramic vessels at shell-midden sites in the coastal areas of Europe (the Algarve in Portugal, Ertebølle in southern Scandinavia) apparently failed to modify subsistence based on marine shellfish resources and wild plants (*Stiner et al. 2003; Andersen and Johansen 1987; Robinson and Harild 2002*). On the other hand, pottery-making hunter-gatherers in the boreal forests of Eurasia display the attributes of complex societies, such as sedentism, high population density, intense food procurement, technological elaboration, development of exchange networks (that may include their agriculturalist neighbours), social differentiation, and territorial control (*Zvelebil 1996. 331*). It becomes increasingly clear that the distinction between agricultural and non-agricultural Neolithic is rather loose, and the dominant manifestations of the Neolithic are different in different parts of the world and even Europe (*Sériadès 1993; Trigham 2000*). Thomas (*Thomas 1996; 2003*) argues against the concept of a fixed and universal 'Neolithic package', and views the Neolithic as a range of various processes, generating considerable variability in subsidence practices. Similar views were popular amongst scholars in the former USSR, who identified 'Neolithic culture' with hunter-gathering communities manifesting a sedentary way of life, large-scale production, and the use of ceramic ware, polished stone and bone tools (*Oshibkina 1996a*).

The mechanism of spread of the Neolithic in Europe remains a subject of debate. A model of Neolithisation as a result of direct migration is omnipresent in the works of Childe (*1958*). More recently, this idea took the form of demic expansion or 'wave of advance' (*Ammerman and Cavalli-Sforza 1973*). This model was further substantiated by genetic markers (*Menozzi et al. 1978; Cavalli-Sforza et al. 1994*), which have been interpreted as an indication of the diffusion of a farming population from Anatolia into Europe. Renfrew (*Renfrew 1987; 1996*) linked the dispersal of farming with the proliferation of Indo-European languages.

There are several varieties of migrationist concept. These range from the direct colonisation of hitherto unpopulated areas or the annihilation of previous Mesolithic groups (*Childe 1958; Ammerman and Cavalli-Sforza 1973*), to a model of elite dominance (*Renfrew 1987*). Zilhão (*Zilhão 1993; 2001*) views Neolithisation as 'leap-frogging colonisation' by small sea-faring groups along the Mediterranean coast. An alternative approach views the process as an adoption of agriculture by indigenous hunter-gatherers through the diffusion of cultural and economic novelties by means of intermarriage, assimilation, and borrowing (*Whittle 1996; Tilley 1994; Thomas 1996*).

A unifying position advocated by Zvelebil (*Zvelebil 1986; 1996*) distinguishes three phases in the transition to agriculture: availability, substitution, and colonisation, each operating in the broader context of an 'agricultural frontier' (see also *Zvelebil and Lillie 2000*). The 'individual frontier mobility' concept relates Neolithisation to 'small-scale' contacts between hunter-gatherers and farmers at the level of individuals and small groups linked by kinship. Several writers (*Gronenborn 1999; Price et al. 2001*) argue that Neolithisation involved small groups of immigrant farmers who came into contact with 'local forager-herder/horticulturalists'.

The advent of radiocarbon dating has provided a new instrument for testing the various models of Neolithisation. The first series of radiocarbon measurements seemed to confirm the Childean concept of *Ex Oriente lux*, indicating that the 'Neolithic way of life penetrated Europe from the south-east spreading from Greece and the south Balkans...' (*Clark 1965.67*). Later publications based on comprehensive radiocarbon data for Neolithic sites suggested a more balanced view. Tringham (*Tringham 1971. 216–7*) discussed the spread of new techniques, and their adoption (or rejection) by local groups, resulting from an expansion of population. Dolukhanov and Timofeev (*Dolukhanov and Timofeev 1972. 29–30*) considered this process as a combination of diffusion and local inventions.

A recent analysis of a large dataset of Neolithic radiocarbon measurements (*Gkiasta et al. 2003*) has basically confirmed the earlier results (*Clark 1965; Ammerman and Cavalli-Sforza 1973*), showing a correlation of the earliest occurrence of the Neolithic with the distance from an assumed source in the Near East.

The earlier Russian writers (*Gorodtsov 1923*) attached a significant importance to human migrations. The Soviet archaeology in the 1930–50s totally rejected these views, stressing the 'autochthonous development' of archaeological entities. Migrationist concepts were revitalised in more recent Russian studies (*Klejn 2000*).

Over the past two decades, extensive series of radiocarbon dates were obtained for Mesolithic and Neolithic sites in broad areas of the former USSR (*Timofeev 2000*). This evidence has considerably changed the hitherto held views on the chronology of Late Prehistory in the area, with the new dates of pottery-bearing sites on the East European Plain being significantly older than previously thought (*Bryusov 1952*).

The present article addresses these and related issues from the viewpoint of the radiocarbon chronology with the use of the novel methods discussed below.

THE DATABASE

This work is based on two major databases of radiocarbon dates recently developed for Neolithic sites in Europe. All dates for the former USSR (the Russian Federation, the Baltic States, Byelorussia, Ukraine, and Moldova) have been included in the database developed at the Institute for the History of Material Culture in St. Petersburg (*Timofeev and Zaitseva 1996*). The date list for LBK sites in Central Europe was compiled mainly from the Radon (*Furholt et al. 2002*). We have also included radiocarbon dates from sites in Austria and Germany (*Lenneis et al. 1996; Stäuble 1995*). The latter dates appear to span relatively short time ranges and are relatively homogeneous archaeologically; we use them to estimate the typical empirical uncertainty of radiocarbon dates.

In all cases, data referred to as 'dubious' were omitted. Since our aim is to assess the early stages of Neolithisation, only dates from the lowest strata of multi-stratified sites were included. All the data were calibrated using OxCal 3.2.

STATISTICAL ANALYSIS

In order to quantify the spread of Neolithisation, we tested the hypothesis that the dates in each individual subset (namely, the LBK in the West and the Neolithic sites in the East European Plain) are coeval. In other words, we verified whether or not the radiocarbon dates in a subset can represent a single date contaminated by Gaussian random noise. If the data are compatible with this hypothesis, one can conclude that the Neolithisation proceeded rapidly (in the sense of radiocarbon dating); if this is not the case, the spread of Neolithisation was gradual.

Our analysis is based on the χ^2 test, and so requires a knowledge of the total errors of the date measurements, rather than just the instrumental ones that only characterize the accuracy of the radiocarbon age measurement in the laboratory (*Dolukhanov et al. 2001*). Therefore, we derive the lower limit of total uncertainty from statistically significant data sets belonging to archaeologically and culturally homogeneous sites. For several sites, we have been able to isolate a date subset that can be considered coeval in the statistical sense. It is important to ensure that the dates in this set are also archaeologically homogeneous.

The errors published together with radiocarbon dates, refer to the uncertainty of the laboratory measurement of the sample radioactivity alone, whereas the total uncertainty undoubtedly includes errors arising from archaeological context, from contamination by young and old radiocarbon, and from other effects (*Aitken 1990*). The relation of so-called instrumental errors to the total uncertainty of radiocarbon age estimates has been recently discussed (*Dolukhanov et al. 2001*). In order to estimate the total uncertainty of the radiocarbon dates in a sample we use a statistically representative set of dates belonging to a single archaeological object whose lifetime is negligible in comparison with the other time scales involved.

For the 20 calibrated dates from Brunn am Gebirge (*Lenneis et al. 1996*), the standard deviation is 99 years, which is useful to compare with the average published instrumental error of $\langle\sigma_i\rangle = 69$ years (after calibration, with individual errors σ_i ranging from 45 to 92 years).

Rosenburg is another site for which a statistically significant set of data has been published (*Lenneis et al. 1996*). There are seven dates plausibly belonging to the same Phase I of LBK. The standard deviation of these dates is 127 years, which is significantly larger than their average published error and rather close to the standard deviation of the Brunn am Gebirge dates.

The difference between the two error estimates, 100–130 years (the standard deviation in a coeval subsample) and 40–70 years (the mean instrumental error), is significant. Following our previous arguments (*Dolukhanov et al. 2001*), we accept 100 years as the lower limit for the total error of the LBK radiocarbon dates. This error is assumed to include several components, e.g., the instrumental uncertainty, the real life-span of an archaeological object, and various uncertainties arising from the archaeological context (inflow of old or young carbon, etc.). Of course, some archaeological objects can have smaller uncertainty (e.g., because of their shorter lifetime), but such cases have to be considered individually, and the corresponding uncertainty has to be estimated from independent evidence.

An estimate of the total uncertainty Σ_i for each date in each sample considered below was chosen as the maximum of the published instrumental error σ_i, as obtained after calibration and the corresponding lower limit discussed above. The lower limits are 100 and 127 years for the LBK and East European data, respectively, except for the Rosenburg LBK site, where 127 years was adopted.

The most probable common date T_0 of the coeval subsample is obtained using the weighted least squares method, and the quality of the fit is assessed using the χ^2 test,

$$\sum_{i=1}^{n} \frac{(t_i - T_0)^2}{\Sigma_i^2} \le \chi^2_{n-1}$$

where n is the number of measurements in the subsample, t_i , i = 1, ..., n are the dates belonging to the subsample, and Σ_i are their errors obtained as described above. If the χ^2 test is not satisfied, the dates deviating most strongly from the current value of T_0 are discarded one by one until the test is satisfied. This procedure results in a 'coeval subsample'.

The confidence interval Δ of T_0 has been calculated as (see *Dolukhanov et al. 2001* for details)

$$\Delta = \frac{\sigma}{n} \sqrt{\chi^2_{n-1} - X^2(T_0)}$$

where

$$\frac{1}{\sigma} = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{\Sigma_i^2}$$

and

$$X^2(T_0) = \sum_{i=1}^{n} \frac{(t_i - T_0)^2}{\Sigma_i^2}$$

The results of our calculations are presented in the form $T = T_0 \pm \Delta$; another important quantity is the standard deviation of the dates in the coeval subsample, σ_c. The quantity T_0 is the most probable age at which the cultural entity studied was at its peak. The confidence interval of T_0, denoted as Δ, characterizes the reliability of our knowledge (rather than the object itself). For example, small values of Δ can indicate that a slight improvement in the data can resolve a temporal heterogeneity in the subsample. The standard deviation in the coeval subsample, σ_c, is a measure of the duration of the cultural phenomenon considered. For example, it can be reasonably expected that the early signatures of the cultural entity under consideration appear by $(2–3)\sigma_c$ earlier than T_0, while the total lifetime of the entity is of the order $(4–6)\sigma_c$ (with a probability of 95–99.5%). In many cases, the significance of σ_c is similar to the total error of an individual radiocarbon date.

Our results are based on statistically significant samples; the number of individual dates in a sample cannot be smaller than, say, 5–10. Since a random element is present in any data, it is reasonable to expect that the spread of the data will grow with the size of the sample (even if the sample is drawn from statistically homogeneous data). The histogram of a coeval sample will fit a Gaussian shape. The Gaussian distribution admits data that deviate strongly from the mean value, and a pair of dates arbitrarily extracted from the widely separated wings of the Gaussian can be very different. The conclusion that they do belong to a coeval subsample can only be obtained from a simultaneous analysis of all the dates in the sample.

LINEAR POTTERY FROM CENTRAL EUROPE

The general LBK date list presented in Table 1 is taken from the *Radon* database, with the addition of dates obtained for several individual sites (Brunn am Gebirge, Rosenberg and others, for which numerous measurements were available). The final subset includes 47 measurements; 40 of them can be combined into a coeval subsample, with the most probable age of

$$T_0 = 5154 \pm 62 \text{ BC},$$

and the standard deviation

$$\sigma_c = 183 \text{ years}.$$

Both the general sample and its coeval part are further illustrated in Figure 1 in the form of date probability distributions.

THE NEOLITHIC OF THE EAST EUROPEAN PLAIN

This group consists of samples from the Neolithic sites of the East European Plain. These sites feature the large-scale production of pottery, but in most cases with limited or no evidence of either agriculture or stockbreeding. The sites are found in all parts of the East European Plain, and include the Lower Volga and the Lower Don areas, Ukraine, Moldova, Byelorussia, the Baltic States, Central and Northern Russia. They include several chronological stages and a considerable number of local 'archaeological cultures'.

Site	Index	Age bp	σ_i, yr	Age BC	Σ_i, yr
Les Longrais	Ly-150	5290	150	4100	167
Montbelliard	Gif-5165	5320	120	4125	142
Chichery	Gif-3354	5600	120	4450	150
Frankenau	VRI-207	5660	100	4525	125
Horné Lefantovce	**Bln-304**	**5775**	**140**	**4700**	**200**
Kaster	KN-2130	5840	55	4700	100
Schwanfeld 14				**4786**	**458**
Guttenbrunn	Bln-2227	5935	50	4830	100
Ulm-Eggingen				**4831**	**261**
Cuiry-les-Chaudardes				**4841**	**321**
Dresden-Nickern	**Bln-73/73A**	**5945**	**100**	**4850**	**133**
Hallertau	**HAM-197**	**5990**	**90**	**4875**	**125**
Menneville	**Ly-2322**	**6030**	**130**	**4900**	**225**
Mold	**Bln-58**	**5990**	**160**	**4900**	**300**
Chabarovice	**Bln-437**	**6070**	**200**	**4950**	**217**
Kirschnaumen-Evendorff	**Ly-1181**	**6050**	**200**	**4975**	**263**
Kecovo	**GrN-2435**	**6080**	**75**	**5000**	**100**
Dachstein	**Ly-1295**	**6280**	**320**	**5050**	**350**
Hienheim	**GrN-5870**	**6125**	**35**	**5065**	**100**
Friedberg	**Bln-56**	**6120**	**100**	**5075**	**125**
Niedermerz 3	**KN-2286**	**6180**	**120**	**5075**	**188**
Niedermerz 1	**KN-I.594**	**6180**	**50**	**5100**	**100**
Eilsleben	**OxA-1627**	**6190**	**90**	**5100**	**117**
Langweiler 2	**KN-I.885**	**6210**	**125**	**5100**	**133**
Lautereck	**GrN-4750**	**6140**	**45**	**5100**	**200**
Northeim-Imbshausen	**H-1573/1126**	**6192**	**140**	**5100**	**250**
Müddersheim	**KN-I.6**	**6210**	**50**	**5110**	**100**
Mohelnice	**MOC-70**	**6220**	**80**	**5125**	**163**
Niemcza	**Bln-1319**	**6210**	**80**	**5125**	**163**
Dnoboh-Hrada	**LJ-2040**	**6300**	**300**	**5150**	**317**
Bylany Stage II a-c	**GrN-4754**	**6270**	**65**	**5190**	**100**
Rosenburg				**5187**	**138**
Langweiler 9	**KN-2697**	**6370**	**210**	**5200**	**233**
Elsloo	**GrN-5733**	**6300**	**65**	**5215**	**100**
Köln-Mengenich	**KN-I.369**	**6320**	**70**	**5220**	**100**
Gerlingen	**KN-2295**	**6390**	**160**	**5225**	**158**
Langweiler 1	**KN-2301**	**6340**	**70**	**5245**	**100**
Brunn				**5252**	**99**
Geleen	**GrN-995**	**6370**	**60**	**5260**	**100**
Duderstadt	**H-919/889**	**6422**	**100**	**5300**	**100**
Blicquy				**5302**	**255**
Lamersdorf	**KN-I.367**	**6410**	**45**	**5340**	**100**
Langweiler 8	**KN-2989**	**6540**	**155**	**5375**	**158**
Eitzum	**Bln-51**	**6530**	**100**	**5400**	**100**
Göttingen	**H-1534/1027**	**6530**	**180**	**5400**	**200**
Schwanfeld 11				**5467**	**514**
Bylany Stage IV	BM-569	6754	96	5625	108
	$X^2(T_0) = 46.3$, $\chi_{39}^2(0.95) = 54.6$				

***Tab. 1.** Radiocarbon dates for the Linear Pottery (LBK) sites in Central Europe: the site name, laboratory index, the uncalibrated age and its instrumental error, the calibrated age and an estimate of its total error. Dates belonging to the coeval subsample are shown in bold face.*

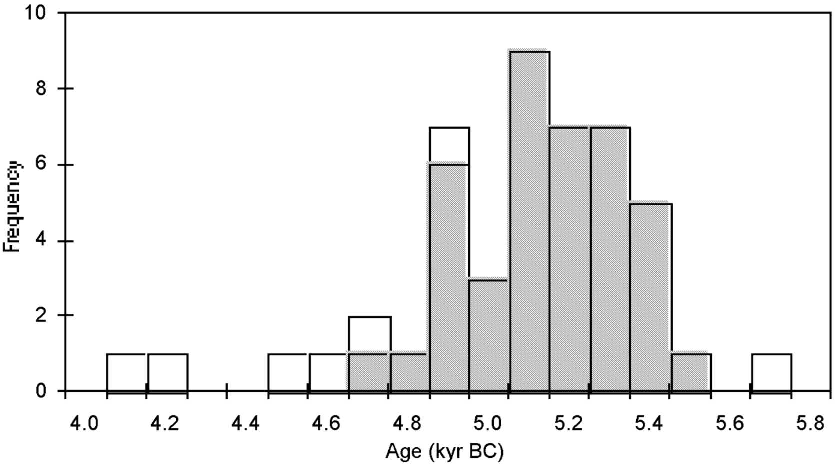

Fig. 1. The rate of occurrence of radiocarbon dated sites for LBK sites in Central Europe, according to Table 1. The coeval subsample is shown shaded, the remaining dates, unshaded.

In the case of the Serteya 2 Neolithic lake dwelling site in the Smolensk District (*Dolukhanov and Miklyaev 1986; Miklyaev 1995*) we have obtained a unique opportunity to assess the minimum statistical error of the radiocarbon age of Neolithic dwelling structures. The excavated area lies below the water level in the drainage canal and consists of rows of piles forming six distinct clusters. Each of these clusters allegedly formed a foundation for a platform on which a house was erected. The platform is well preserved in the case of Structure 1. Thus, the samples from each structure apparently belong to a single house constructed during a single season. Hence, the dates from each structure characterise a momentary event in the sense of radiocarbon dating. Botanical analysis shows that all the piles are made of spruce, which could not sustain prolonged stocking. Several samples were taken from different sets of annual rings in a single pile. We calculated the empirical error for four sets from Structures 1, 2, 3 and 6. In the case of Structure 1 all dates form a Gaussian-like distribution with one date obviously falling out. The mean age of the remaining dates is 2304 BC, with a standard deviation of 113 years. The corresponding values for the other structures are: 2372 ± 83 BC for Structure 2; 2295 ± 129 BC for Structure 3 (with one outlier), and 2219 ± 184 BC for Structure 6 (with one outlier). The average age of all four structures is 2298 ± 127 BC. The latter standard deviation, 127 years, is adopted as the minimum error in the statistical analysis of the dates for the entire East European Plain.

Yelshanian

The sites of the Yelshanian Culture (*Mamonov 2000*) have been identified in a vast area of the steppe stretching between the Lower Volga and the Ural Rivers. Small, presumably seasonal occupations are found close to water channels. Subsistence was based on hunting a wide range of animals (wild horse, aurochs, elk, brown bear, red deer, fallow deer, saiga antelope, marten, beaver), food collecting (tortoise, and edible molluscs, mostly *Unio*), and fishing. The remains of domestic animals (horse, cattle sheep and goat) were found at several sites, yet penetration from the later levels cannot be excluded. The stone inventory, which comes from mixed assemblages, includes single- and (rarely) double-platform cores, end scrapers (both from blades and flakes), burins, numerous axes, gouges and chisels (rarely polished), with the common occurrence of arrowheads made from blades, and tanged points. The archaic-looking pottery is made from silty clay tempered with organic matter, fish scales, and bone. The early vessels are small, with straight or S-shaped rims, flat or conic bottom. They are ornamented with imprints of pits, notches, incised and lines forming rows, rhombi, triangles, and zigzags. More complicated patterns appeared at later stages.

The sample contains eight dates, five of which can be assumed to be coeval, since they group within a narrow age interval, with a mean age and standard deviation of

$$T_0 = 6910 \pm 58 \text{ BC}.$$

The remaining dates are older (8025–7475 BC).

Rakushechnyi Yar

Rakushechnyi Yar is a clearly stratified Neolithic settlement located on a small island in the lower stretches of the River Don, ca 100 km upstream from the city of Rostov, which has 23 archaeological layers (*Belanovskaya 1995*). The deepest levels (23–6) belong to the Early Neolithic. The levels are 5–15 cm thick and separated by sterile sand or silt. The archaeological deposits, which are not identical in each layer, allegedly resulted from seasonal occupations. Fireplaces and the remains of surface dwelling structures occur in several levels. Animal remains consist of both wild (red deer, roe deer, fox, hare, numerous birds) and domesticated species (sheep, goat, cattle, dog and horse – either wild or domestic). Numerous shells of edible molluscs (mostly *Viviparus*) indicate the importance of food gathering. The flint industry includes end scrapers made from blades and flakes, retouched blades, and borers. Arrowheads and geometrics (symmetrical trapezes) occur only in the upper levels. The pottery is often tempered with organic matter and includes both flat- and pointed-bottom varieties. Their ornamentation is usually restricted to the upper part of the vessel and consists of triangular notches forming horizontal rows, small pits, and incised lines. The developed character of the material culture and the apparent absence of Mesolithic elements imply that Rakushechnyi Yar is not the oldest Neolithic site in the area; its preceding stage remains to be found.

Two Early Neolithic sites, Matveyev Kurgan 1 and 2, are located in the valley of the Miuss River, on the littoral of the Azov Sea (*Krizhevskaya 1992*). Site 1 includes the remains of a surface dwelling with hearths and post-holes, as well as an open, allegedly ritual fireplace. At Site 2, open fireplaces and large stone and clay inlays were found. The animal remains from both sites are dominated by wild species: aurochs, red deer, roe deer, beaver, wolf, wild boar, kulan, and wild ass (the latter two were more typical of the Mesolithic age). The domesticates, which formed 18–20% of the total assemblage, include horse, cattle, sheep/goat, pig, and dog.

Both sites contain rich lithic industries, with no less than 600 cores (both single- and double-platformed); elongated broad blades and less numerous flakes dominate the assemblage. End scrapers, made from large flakes, and retouched blades, were found, with various blade tools. There are about 90 geometric microliths, mostly trapezes, both symmetric and asymmetric. Several 'bifacial' flint axes were reported, yet the number of slate polished axes is much larger. The diverse bone-and-antler industry found at the both sites includes spear- and arrowheads, awls and their fragments. Both sites yielded slate sinkers for fishing nets. Only a handful of pottery items were found at each site: 6 fragments at Site 1, and 21, at Site 2. The pottery fragments were unornamented and manufactured from silty clay with no apparent artificial tempering.

The sample contains 10 dates from the lower layers (the Early Neolithic), of which six dates satisfy the criterion for contemporaneity, yielding

$$T_0 = 5863 \pm 130 \text{ BC}, \quad \sigma_c = 247 \text{ years}.$$

The remaining dates include one younger date (5000 BC) and three older (6550–6850 BC).

Bug-Dniestrian

The Early Neolithic in the western Ukraine and Moldova is usually associated with the sites of the Bug-Dniestrian Culture (*Danilenko 1969; Markevich 1974*). About 40 sites belonging to this culture are located on the lower terraces of the River Dniestr (Nistru) and its tributaries, and on the River Pyvdenyi Buh, in their middle courses. Thin archaeological deposits are found in the matrix of silty loam, often interbedded with alluvial sediments. The remains of an oval-shaped semi-subterranean dwelling and a rectangular surface dwelling were identified at the Soroki 1 site on the Dniestr. At early sites, about 80% of animal remains belong to wild species, mostly roe deer and red deer. Among the domestic animals, pig, cattle and (on later sites) sheep/goat have been identified. The archaeological deposits contain huge amounts of *Unio* molluscs and tortoise shells. Roach (the most common), wells and pike were found among numerous fish bones. Birds such as sparrow hawk, honey buzzard and wood pigeon have been recorded. Remarkably, impressions of three varieties of wheat were found on the pottery: emmer, einkorn, and spelt.

The flint industry was based on the prismatic core technique, with the common occurrence of retouched blades, backed blades, and small-size circular end scrapers. The numerous shapes include trapezes and triangles. Several blades at Soroki 1 show a sickle gloss. The Bug-Dniestrian sites include bone and antler implements: points, awls, mattocks, chisels, and 'hoe-like' tools. Polished stone axes, pestles, and querns were found at a number of sites.

The pottery corpus for the early Bug-Dniestrian sites includes deep bowls, with an S-like profile, and hemispherical flat-bottomed beakers made of clay tempered with organic matter and crushed shells. Ornamental patterns consist of rows of shell-rim impressions, finger impressions, and incised lines forming zigzags and volutes. Remarkably, several patterns find direct analogies in the 'monochrome' pottery of the Balkan Early Neolithic (Starčevo-Criş Culture). Imported potsherds of Linear Pottery (with 'music-note' patterns) were found at several sites on the Pyvdenyi Buh River belonging to later stages of Bug-Dniestrian Culture.

The sample contains a total of 7 date measurements from the sites on the Pyvdenyi Buh. All seven dates satisfy the statistical test for contemporaneity, with

$$T_0 = 6121 \pm 143 \text{ BC}, \sigma_c = 101 \text{ years.}$$

Early Neolithic Cultures in Forested Central and Northern Russia

The early Neolithic in the central part of the East European Plain exhibits several stylistic varieties of 'notch-and-comb decorated pottery', including the Upper Volga and Valdai cultures. The Upper Volga Culture consists of small-size sites usually found along the rivers of the Upper Volga basin, on lake shores, and in bogs and mires (*Krainov 1996*). The subsistence of Upper Volga groups was based on hunting (elk, red deer, roe deer aurochs, wild boar, and other wild forest animals), supplemented by fishing and food-collecting. The flint industry was based on blade blanks (rarely flakes); the occurrence of the 'Post-Sviderian' points indicates its genetic relationship to the Late Mesolithic (Butovian) tradition. The early types of pottery consist of small vessels (15–30 cm in diameter) that are either conical or flat bottomed, and made of chamotte-tempered clay. They are ornamented with impressions of notches, combs, cords and incised lines that form simple geometric motifs. Starting with the culture's middle stage, small round-bottomed cups appear, and mineral tempering becomes more frequent. Flat-bottomed vessels disappeared at a later stage.

The temporal division of the Upper Volga Culture is based on the sequences of stratified bog and mire sites (Ivanovskoe 3, Sakhtysh 1, Yazykovo, etc.). In these sequences, the Upper Volga deposits are found beneath the strata of the Lyalovo Culture that feature the pit-and-comb pottery. Previously, this culture was considered to be the oldest Neolithic entity in Central Russia.

The sites of the Valdai Culture are located along water channels and lakes in the upper stretches of the Volga, Lovat, Western Dvina and Dniepr rivers, within the Valdai Hills in Central Russia (*Gurina 1996*). This area is rich in outcrops of high-quality flint. The original flint industry includes circular end scrapers manufactured from elongated flakes, and large-size axes and chisels. It also includes Post-Swiderian points. The technology, forms, and ornamentation of the Valdai pottery are fairly similar to those of the early Upper Volga.

The sites of Sperrings Culture (or the Style I:1 according to Finnish writers) are located on ancient sea and lake shore-lines in a vast territory encompassing southern and central Finland and Ladoga and the Onega Lake basins in Russian Karelia (*Oshibkina 1996b*). The pottery corpus consists of large conical vessels, with straight rims decorated with impressions of cord, incised lines, and pits forming a simple zoned ornament. The lithic industry manufactured from quartz, schist, and rarely, flint, (presumably imported from the Upper Volga) retains a Mesolithic character. Earlier age assessments based on the gradients of the shore-line displacements (*Siiriäinen 1970*) have placed the I:1 Style in Finland into a time range of 4100–3000 BC.

Several Neolithic in the extreme north-east of European Russia, on the Pechora and Northern Dvina Rivers form the Chernoborskaya Culture (*Luzgin 1972; Vereshchagina 1989*). The stone inventory of these sites has a Mesolithic character, while the pottery reflects Upper Volga and Valdai influences.

The sample used here contains 55 radiocarbon date measurements. They include a series of dates from the stratified wetland sites of the Upper Volga Culture: Ivanovskoe 2, 2a, 3 and 7, Berendeevo 1 and 2a, and Yazykovo. The sample also includes dates

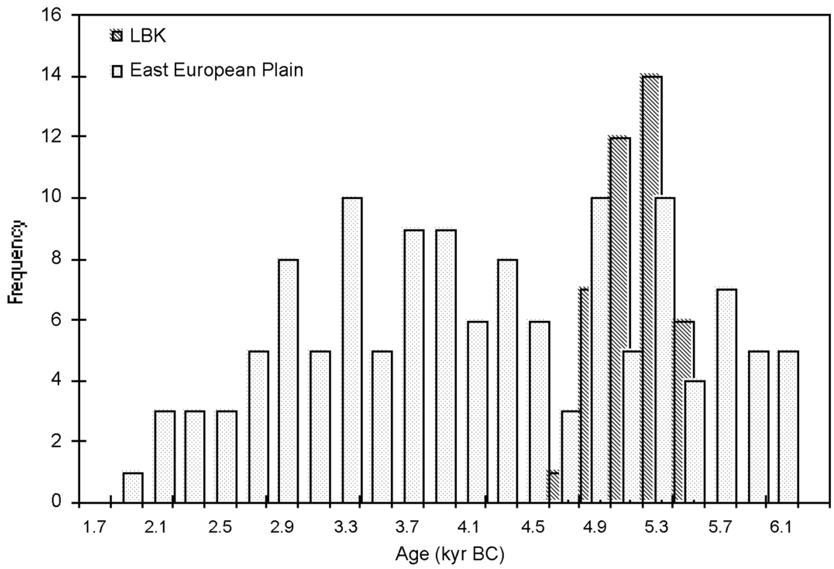

Fig. 2. The rate of occurrence of Neolithic radiocarbon dated sites on the East European Plain (light grey) and the coeval subsample of the LBK dates, as in Fig. 1 (dark grey).

for the Valdai Culture sites, which several writers consider to be related to the Upper Volga. We also include several dates from the Sperrings sites (located in Karelia), as well as two dates from Chernoborskaya-type sites in the Russian North-east.

Thirty-two dates satisfy the statistical test for contemporaneity and yield

$$T_0 = 5417 \pm 30 \text{ BC}, \sigma_c = 160 \text{ years.}$$

The remaining dates include those which are older (5800–6200 BC) and younger (4200–5200 BC) than the coeval sample.

The Neolithic of the East European Plain: the total sample

Our selection of Neolithic dates for the East European Plain as a whole contains 129 measurements presented in Table 1 and Figure 2. The data set exhibits a temporal structure with several broad maxima. One of them, at 5300–4900 BC, is remarkably close to the coeval LBK subsample discussed above, in both mean age and width.

DISCUSSION

According to Childe (*Childe 1958.110*), the LBK was 'made by ... farmers spreading from the southern cradle of cereals'. This view was corroborated with the use of the model of 'advance of advantageous gene', which asserted that early agriculture was brought to Europe by the descendants of Middle Eastern farmers who completely overran the indigenous Mesolithic population (*Ammerman and Cavalli-Sforza 1973*). An alternative hypothesis (well known to, but rejected by Childe) viewed Neolithization as the result of the adoption of farming by local hunter-gatherers (*Wittle 1996*). This has been substantiated by the finds of Late Mesolithic Danubian points found at LBK sites (*Street et al. 2002*). Another scenario has been suggested, where the spread of the LBK involved small groups of immigrant farmers who encountered 'local forager-herder-horticulturalists' (*Gronenborn 1999; Price et al. 2001*). The latter view is strengthened by the discovery of a distinct 'La Hoguette' pottery at several LBK sites in its north-western area. It is represented by pots of clay tempered with crushed shells and bone that have a conical, round-bottomed shape and are decorated with garlands of comb-like impressions (*Van Berg and Hauzeur 2001*). At the site of Place Saint Lambert in Belgium, La Hoguette pottery has been found in a Late Mesolithic context, yet with predominantly domesticated animal remains (*Van Berg and Hauzeur 2001.70*). Another cultural variety, the Limburg Group in the area of the Maas River, also supposedly belonged to a culturally distinct population. Being familiar with agriculture, this group coexisted, interacted and outlasted the LBK (*Modderman 1964*).

The emergence of numerous radiocarbon dates has sufficiently modified the earlier chronological schemes for the LBK. It is argued (*Price et al. 2001*) that the 'initial' LBK appeared in Hungary at around 5700 BC and spread further west. Using 'traditional' radiocarbon dates, it has been suggested (*Gronenborn 1999.156*) that the earliest LBK sites appeared in Transdanubia at around 5700–5660 BC, and reached Franconia around 5500 BC. However, our analysis does not reveal any temporal structure in the entire sample of LBK dates for Central Europe. Forty out of 47 LBK dates in our sample satisfy the criterion of contemporaneity, forming a Gaussian distribution spread from 5600–4800 BC (2σ range), with the most probable age of 5154 ± 62 BC. Our analysis indicates that the LBK propagated as a single-phase process that cannot be subdivided into distinct events (using radiocarbon dating alone); this is the reason most of the LBK sample can be characterized in terms of a single date (corresponding to the culture peak) with a relatively small error. In this sense, the spread of the LBK culture across the loessic plateaux of Central Europe had the character of a single event. Our results do not rule out the possibility that local Mesolithic groups participated in the process.

The resulting lower estimate of the rate of spread can be obtained from the width of the above probability distribution. With the largest dimension of the LBK region of about 1500 km (from Transdanubia to Franconia) and the time taken to spread over that area of about 360 years (twice the standard deviation of the dates in the coeval LBK sub-sample), the lower limit for the propagation rate of the LBK is obtained as about 4 km/yr. This value is consistent with the earlier estimates of about 6 km/yr (*Ammerman and Cavalli-Sforza 1973; Gikasta et al. 2003*) for a significantly larger region. The LBK propagation rate is in striking contrast to other European Neolithic spread rates of 1 km/s.

The probability distribution of radiocarbon dates for individual Neolithic entities on the East European Plain reveals a different spatio-temporal structure

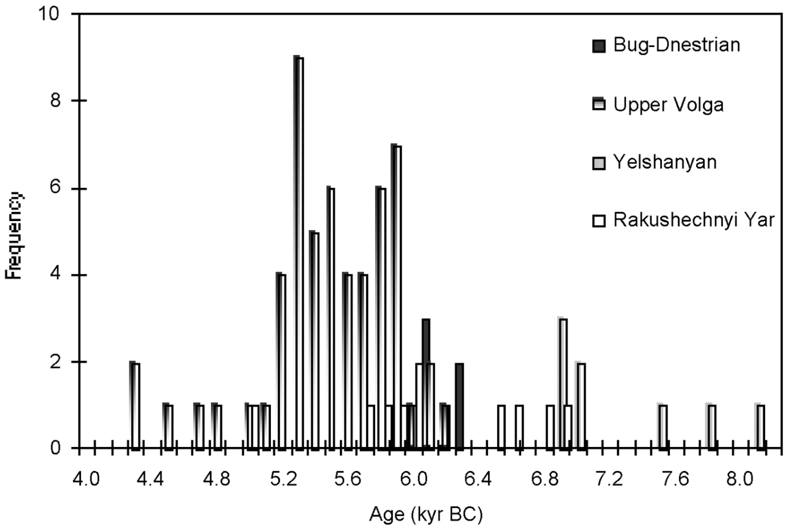

Fig. 3. The rate of occurrence of radiocarbon dates for distinct cultural entities on East European Plain.

emanating from the Eastern steppe area.

Recent evidence shows a very early appearance of pottery making in an area further east, stretching along the southern edge of the boreal forest in Eurasia (*Van Berg and Cauwe 2000*). This includes Jomon Culture in Japan, with the earliest 'incipient' stage at ca 11 000 BC (*Aitkens and Higuchi 1982*). An early centre of pottery making of an even earlier age (13 200–12 900 BP) has been identified in the lower stretches of the Amur River (*Derevyanko and Medvedev 1997; Kuzmin and Orlova 2000*). A group of early pottery sites in the Trans-Baikal province in southern Siberia (Ust-Karenga, Ust-Kyakhta and Studenoye) has yielded a similar age (*Kuzmin and Orlova 2000*). At these sites, subsistence was based on hunting-gathering and the intense procurement of aquatic resources. These pottery assemblages are stylistically unrelated and are believed to be local inventions (*Khlobystin 1996*). One may only speculate that pottery making developed independently in the context of broad-spectrum hunter-gathering economies with reliance on aquatic resources. This technical novelty initially emerged in the forest-steppe belt of northern Eurasia

extended over a long time interval. Our statistical age estimates for key cultural entities indicate that they form a clear temporal sequence from Yelshanian (6910 ± 58 BC), through Bug-Dniestrian (6121 ± 101 BC) and Rakushechnyi Yar (5846 ± 128 BC), to the Upper Volga and other 'Forest Neolithic' cultures (5317 ± 30 BC) (Fig. 4). The rate of spread of the pottery bearing cultures in East European Plain, estimated from the extent of the region involved (ca 2500 km for the distance from Yelshanian via Bug-Dniestrian to Upper Volga) and the time of spread (ca 1600 years, the time lag between the Yelshanian and Upper Volga cultures as estimated above), is about 1.6 km/yr. This is significantly smaller than the rate of spread of the LBK and yet comparable to other European Neolithic rates. This fact stresses again the unusual nature of the LBK. On the other hand, the comparable magnitudes of the rates of spread of farming in Western Europe and ceramics production in Eastern Europe are compatible with – although do not prove – their common Neolithic nature.

Our results reveal a clear spatio-temporal trend indicating that the Yelshanian–Rakushechnyi Yar temporal sequence (perhaps including the earlier Bug-Dniestrian) exhibits systematic propagation from the east, and so can be a manifestation of an impulse

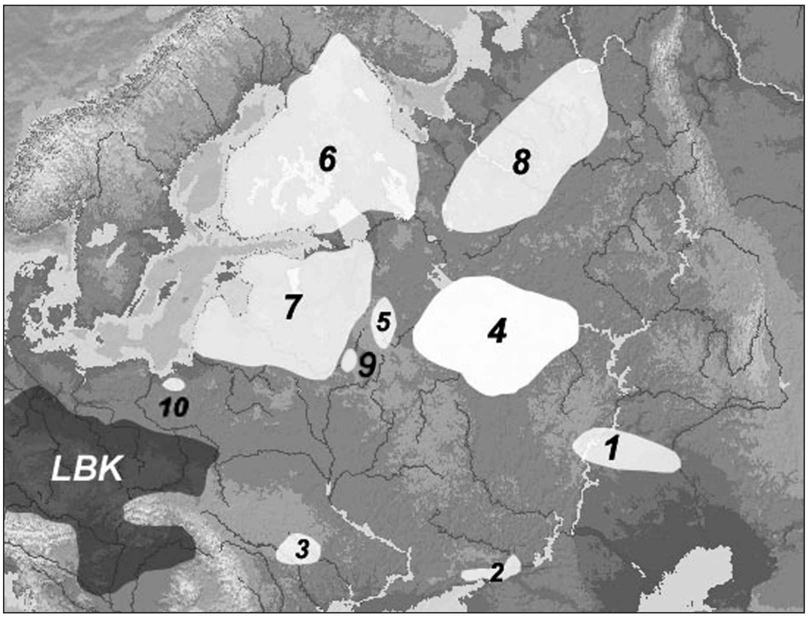

Fig. 4. Early Neolithic cultures in central and eastern Europe: Linear Pottery Culture (LBK); Yelshanian (1); Rakushechnyi Yar (2); Bug-Dniestrian (3); Upper Volga (4); Valdai (5); Sperrings (6); Narva (7); Chernoborskaya (8); Serteya (9); and Zedmar (10).

starting at 11 000–10 000 BC, and spread to the west to reach the south-eastern confines of the East European Plain by 7000–6000 BC.

The group of dates at 5300–4900 BC apparent in Figure 2, largely belongs to the Upper Volga and other early pottery-bearing cultures in boreal central and northern Russia. This is also the epoch of the LBK in Europe. Significantly, this period corresponds to the Holocene climatic optimum, characterized by a maximum rise in temperature and biological productivity in the landscapes of both Central and Eastern Europe (*Peterson 1993*).

A currently advanced model (*Aoki et al. 1996*) can be relevant in explaining these phenomena. These writers model the advance of expanding farmers accompanied by the partial conversion of the indigenous population into farming. The intruding farmers can spread either as a wave front or as an isolated, solitary wave. However, either intruding or converted farmers remain behind the propagating wave (front) in both cases. There are no definite signs of widespread farming in the East European Neolithic sites, even though there is clear evidence of the interaction of hunter-gathering and farming communities. This suggests a distinct scenario where an advancing wave of farming is not accepted by the local hunter-gatherers, but still results in demographic and cultural shifts. This approach can be further developed to incorporate the advantages of the wave of advance, adoption and other models in a single mathematical framework. A reliable assessment of these possibilities requires further analysis, including detailed numerical simulations.

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Documenta Praehistorica XXXI

The nature of early farming in Central and South-east Europe

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ABSTRACT – *This paper summarises models of crop and animal husbandry in Neolithic Europe and reviews the relevant evidence from three regions: the western loess belt and Alpine Foreland; the Great Hungarian Plain; and the southern Balkans and Greece. Intensive mixed farming (small-scale, labour-intensive cultivation integrated with small-scale herding) emerges as the most plausible model across these regions. Such continuity is in some ways counter-intuitive given climatic variability across Europe and archaeological diversity in settlement and house forms etc. It is argued that variability in the form of Neolithic settlements (nucleated versus dispersed, 'tell' versus 'flat' sites) should be understood not as a reflection of radically different farming practices but rather as different social permutations of the same basic farming and herding pattern.*

IZVLEČEK – *V članku povzemamo modele za poljedelstvo in živinorejo v neolitski Evropi in pregledamo ustrezne podatke s treh področij: zahodni aluvialni pas v alpskem predgorju; Panonska nižina; južni Balkan in Grčija. Intenzivno mešano kmetovanje (v malem obsegu, obdelovanje zemlje z intenzivnim ročnim delom, manjše črede) se kaže kot najverjetnejši model po vseh treh območjih. Takšna enotnost je na nek način nenavadna glede na različne klimatske razmere po Evropi, arheološko različnost naselbin in oblik hiš itd. Menimo, da raznolikost oblik neolitskih naselbin (jedrne proti razpršenim, 'tell' proti 'ravnim' najdiščem) ne kaže na zelo različne načine kmetovanja, ampak bi jo morali razumeti kot različne družbene permutacije istega temeljnega vzorca kmetovanja.*

KEY WORDS – *Central Europe; South-east Europe; crop husbandry; animal husbandry*

INTRODUCTION

"*Students of civilization have often credited the development of intensive agriculture to revolutionary inventions such as metal tools, the plow, and domesticated draft animals … or to particular environments which challenged the creative powers of the inhabitants … Comparative evidence now suggests that a great many peoples practice intensive cultivation with rudimentary tools, and that the necessary knowledge need not be diffused from a few centers of cultural innovation but may be developed to meet localized needs.*" (Netting 1971.21)

This statement illustrates several points that form a useful introduction to this paper. First, it shows that the central argument made here – early farming in central and south-east Europe was intensive – builds on a long-standing criticism of technology-driven evolutionary models of agricultural development. A more subtle evolutionary framework was proposed by Boserup (*1965*), who identified demographic pressure rather than technological innovation *per se* as the cause of intensification. According to this view, early forms of agriculture were extensive, involving long fallow periods and low energy inputs per unit area, and only became more intensive as a result of technological change fuelled by population pressure. Boserup (*1965*) ignored the beneficial effects of 'rudimentary' measures such as manuring, middening, careful hand tillage and weeding on crop yields (*Grigg 1979*). Following Kruk (*1973*), Sherratt

(*1980*) rejected the notion of a 'primeval' phase of shifting cultivation in Neolithic Europe but preserved the idea of low inputs per unit area by arguing that early 'horticulture' was confined to naturally fertile floodplain plots, recharged by spring flooding and requiring minimal soil preparation. This paper, however, will present evidence of labour-intensive cultivation, characterised by close integration of crop and livestock husbandry.

Second, Netting's statement raises the question of local (re-)invention of intensive farming methods. Given that the technology required is minimal, to argue that intensive agriculture represents the 'norm' across much of Neolithic Europe is not to deny the potentially diverse origins of Neolithic communities (*cf. Zvelebil 2000*), or to insist on a single 'centre of cultural innovation'. Rather, the intention here is, by demonstrating the intensive nature of early farming, to focus attention on the daily, seasonal and annual exigencies of farming in the Neolithic.

A third issue raised by Netting's comments is what constitutes 'intensification' of farming. This term is often used to refer to the application of farming technologies such as ard-tillage and ox-traction, but in fact these methods are associated with an extensification of agriculture: as the scale of cultivation expands due to the greater efficiency of the ox-drawn ard and metal harvesting tools, so inputs of labour per unit area are reduced (*Halstead 1992*).

MODELS OF NEOLITHIC FARMING IN EUROPE

A range of crop and animal husbandry models has emerged for various parts of Europe in the Neolithic. Table 1 presents a simplified summary of these models. Animal husbandry can broadly be characterised as intensive or extensive. Extensive animal husbandry refers to large-scale herding and consequently the need to move herds over considerable distances in order to find adequate grazing (*Halstead 1987; 1996a; 1996b; 2000; Russell 1988.15–16*). This form of animal husbandry is associated with a lack of manuring since animals are often herded well away from arable land. Crop husbandry regimes compatible with extensive herding, therefore, would involve little or no manure input per unit area. Such extensive crop husbandry regimes are: shifting cultivation, in which crops are grown over a few seasons on newly cleared forest soil fertilised by ash; extensive ard cultivation, in which crops are grown on a large-scale with the help of the ox-drawn ard; and floodplain cultivation, which exploits fertile crop growing conditions created by seasonal flooding of alluvium and the downward movement of water and nutrients from surrounding slopes. As indicated in Table 1, there are various ways in which these forms of low intensity cultivation may relate to animal husbandry. The closest integration is seen in the use and management of oxen maintained to pull the ard plough – such animals are kept close to the settlement, are stalled through the winter and supplied with fodder. The manure from stalled oxen may be spread on to arable fields, but the large scale of ard cultivation is such that manuring inputs and crop yields per unit area remain low. The chronic shortage of manure in this sort of system is evident from the scale of cultivation as it compares with the manure produced by traction animals. Ethnographic evidence suggests that a pair of oxen can cultivate c. 5–10 ha or more per year (*Halstead 1995; Forbes 2000*), while each animal produces about 12 tons of manure per year (*Rowley-Conwy 1981*). Given that intensive manuring may require something like c. 30–100 tons of manure per hectare (*cf. Alcock et al. 1994; P. Halstead field notes from Asturias, Spain*), it is evident that a pair of oxen cannot provide enough manure to treat the area cultivated intensively.

By contrast, intensive garden cultivation represents a form of farming that is closely tied to similarly small-scale and intensive livestock management (*Halstead 1987; 1996a; 1996b; 2000; cf. Russell 1988.15*) (Tab. 1). The nature of this interdependence between crops and livestock is summarised

Crop husbandry models	*Animal husbandry models*	*Integration of crops and animals*
Shifting cultivation	Extensive herding	Regenerating plots may be used as pasture
Extensive ard cultivation		Cattle traction to pull carts and the ard plough
Floodplain cultivation		The floodplain also offers seasonal pasture
Intensive garden cultivation	Intensive herding	Complex interdependence (see Table 2)

Tab. 1. Simplified summary of crop and animal husbandry models, showing relationships between crops and animals.

Animal contribution to crop husbandry	*Crop contribution to animal husbandry*
Manure to fertilise the soil, provided by animals grazing crops/stubble or by spreading of collected manure	Crop by-products and products (spoiled or surplus) used as fodder
Grazing of unripe crops to prevent lodging and promote tillering	Cultivation plots, which may be surrounded by hedges or fencing, provide grazing

Tab. 2. Interdependence between crop and animal husbandry in intensive mixed farming.

in Table 2. Movements of herds around settlements are relatively small-scale, resulting in a conservation of manure for use on arable plots. Particularly over the winter, animals kept close to the settlement require shelter and fodder, which may include surplus or spoiled crops and crop by-products as well as leafy hay/branch fodder. With careful management, a household herd consisting of a few cattle, sheep/goats and pigs (*cf. Suter and Schibler 1996*) would produce enough manure to maintain high fertility levels in small-scale cultivation (e.g. 1–2 ha per household). Animal manure may be applied directly, by spreading of collected manure from penned areas or stalls, or indirectly, by allowing animals to graze stubble. Historical and ethnographic evidence (*Tusser 1984.105; Forbes 1995; 1998; Burns 2003; P. Halstead, field notes from Asturias and Greece*) also attests to the use of sheep and goats to graze unripe cereals at a vegetative stage of growth in order to promote tillering (the production of multiple stems per plant), resulting in relatively short, dense crop plants that are less prone to lodging (falling over). Otherwise, high fertility encourages the growth of tall plants and hence may increase the danger of lodging, though other factors (weed infestation, weather, straw-length of cereal variety) also contribute.

In small-scale intensive management, animals are generally kept for their meat and perhaps also for milk and wool/hair, though the culling pattern is not geared towards intensive dairying or wool/hair production (*Halstead 1981; 1996a; 1996b; 2000*). This 'multi-purpose' exploitation of livestock may extend to include use of unspecialised traction animals, such as cows (e.g. those that do not produce much milk), which can be used to reduce human labour expended on tillage but do not greatly increase the scale of cultivation (*Halstead 1995; Bogaard 2004*).

Anthropologists and archaeologists have for some time recognised the adaptive advantages of intensive cultivation for farming families as well as the social significance of this form of husbandry, for example in the emergence of permanent social inequalities (*Netting 1971; 1990; Halstead 1989b*). Halstead's work on Neolithic Greece (*1981; 1996a; 1996b; 2000*) has focussed on archaeozoological and environmental evidence to build a case for intensive herding and cultivation. More recently, analyses of archaeobotanical assemblages from Neolithic sites in the western loess belt and Alpine Foreland (*Bogaard 2004*) and the Great Hungarian Plain (*Bogaard et al. in press a, b*) have made use of new ecological techniques (*e.g. Charles et al. 2002*) for the inference of crop growing conditions from arable weeds associated with crop remains. These studies suggest that intensive garden cultivation combined with intensive herding represent the 'norm' across central and south-east Europe during the Neolithic. Such general continuity in farming methods may appear surprising given the considerable differences in climate from the south-east to north-west, i.e. from the Mediterranean pattern of wet, frost-free winters and hot, dry summers, through the frosty winters and hot summers of central Europe to the cooler, wetter summers of the north-west. On the other hand, the 'buffered' and artificial character of intensive crop growing conditions would facilitate continuity in this form of husbandry (*Bogaard 2004*).

The following sections briefly review the evidence for intensive mixed farming in three adjacent regions of central and south-east Europe – the western loess belt and the Alpine Foreland; the Great Hungarian Plain; and the southern Balkans and Greece (Fig. 1). These regions will be dealt with in this order – the reverse of a chronological arrangement according to the timing of the agricultural transition – because the author's own research (*Bogaard 2004*) has mostly concentrated on the first region to be discussed.

Western loess belt and Alpine foreland

Bogaard (*2004*) carried out a series of ecological comparisons between modern weed floras from known crop husbandry regimes and archaeobotanical samples of arable weeds associated with charred crop material from Neolithic sites (c. 5500–2200 BC) in the western loess belt (mostly Germany) and the Alpine Foreland. The results indicate that cultivation plots tended to be permanent – that is, used for an extended period of time such as decades or even centuries, thus ruling out shifting cultivation (*see also Bogaard 2002*). Furthermore, the major cereal crops (mostly einkorn and emmer) were autumn-sown, with the implication that, even where it was topographically feasible, cultivation did not tend to take place within the spring flood zone of rivers and streams. Growing conditions of high soil disturbance and fertility appear to have been maintained with high inputs of labour, including manuring/middening, tillage and weeding.

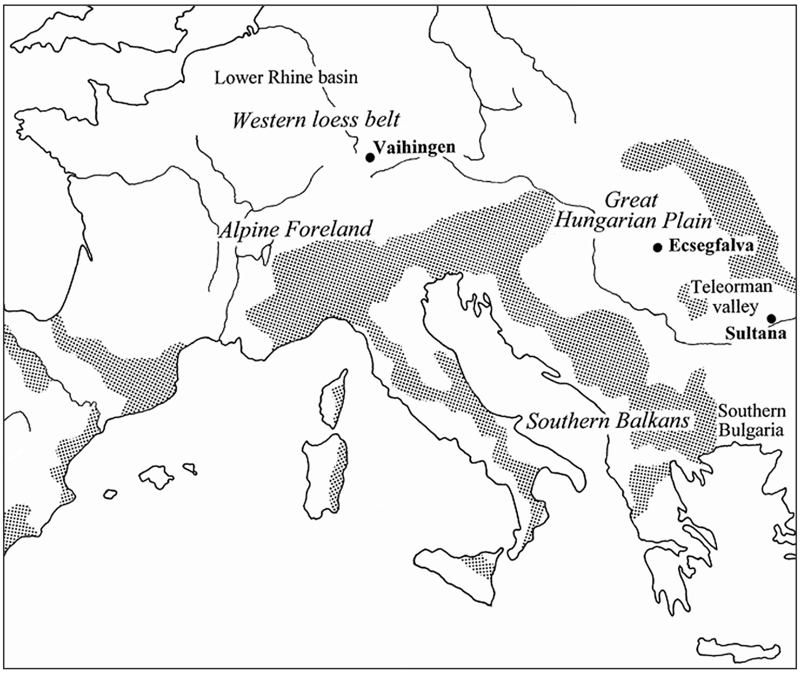

Fig. 1. Map showing the regions and sites mentioned in the text.

Cattle were the dominant livestock in these areas. There is as yet little published evidence for the mortality profiles of LBK cattle assemblages, though indications are that cattle were mostly killed as juveniles, and hence that meat production was emphasised (*Arbogast 1994.93; Benecke 1994a.95; 1994b.122–3*). Domesticated cattle and pigs appear to have been distinctly smaller than their wild counterparts throughout the earlier Neolithic (*Benecke 1994a.48–55; Döhle 1997; Lüning 2000.105*), implying a lack of regular cross-breeding between wild and domesticated populations and hence that herding was relatively small-scale and intensive. The only available demographic evidence for intensive dairying comes from the later Neolithic in the Alpine Foreland, where the scale of stock husbandry would be restricted by the lack of permanent pasture and the need to provide winter fodder (*Higham 1967; Becker 1981; Jacomet and Schibler 1985; Halstead 1989a; Gross et al. 1990; Hüster-Plogmann and Schibler 1997; Hüster-Plogmann et al. 1999*). Though livestock may have played a critical economic role as an 'insurance bank' against crop failure, particularly in regions of harsh climate, the evidence points to small-scale intensive mixed farming rather than to large-scale, extensive cattle pastoralism alongside shifting, extensive ard or floodplain cultivation.

Archaeobotanical analyses of waterlogged animal dung are available from several Neolithic lakeshore settlements of the Alpine Foreland, such as Egolzwil 3 (*Rasmussen 1993*), Horgen-Scheller (*Akeret and Jacomet 1997*), Arbon-Bleiche 3 (*Akeret et al. 1999*) and Weier (*Robinson and Rasmussen 1989*). These analyses have revealed a variety of feeding practices, including twig or branch foddering (prior to leaf emergence) and consumption of crop material. Mostly these analyses concern sheep/goat pellets, though cattle foddering, as well as the spreading of manure across an arable plot adjacent to the settlement, have been documented at Weier (*Robinson and Rasmussen 1989*). A link between dung and winter sheep/goat feeding at Arbon Bleiche 3 has been used to argue that herds were moved away from settlements in the summer as part of a transhumant cycle (*Akeret et al. 1999*), though an absence of dung containing summer vegetation could simply reflect the fact that animals were not kept in the settlement during this season of abundant grazing.

There is possible evidence for the use of cows as traction animals as early as the LBK (*Döhle 1997*), a practice that would not alter the scale of cultivation significantly (*above*). The best evidence for the use of oxen as traction animals dates to the end of the Neolithic sequence in the Alpine Foreland, in the Corded Ware phase (*Hüster-Plogmann and Schibler 1997; Schibler and Jacomet 1999*). Though there may have been a trend towards somewhat more extensive cultivation in some areas during the later Neolithic (*Schibler and Jacomet 1999*), the archaeobotanical samples available from later Neolithhic sites in the loess belt and Alpine Foreland appear to reflect intensively maintained growing conditions and hence a restricted scale of cultivation (*Bogaard 2004*).

Neolithic cultivation in the western loess belt and Alpine Foreland, therefore, can be characterised as small-scale, intensive and integrated with intensive livestock husbandry, but within these parameters there is emerging archaeobotanical evidence for variability between regions and sites and also within the archaeobotanical record of a single site. Regional cohesion in crop growing conditions is evident, for example, amongst LBK sites of the Lower Rhine-Meuse Basin and may reflect the existence of localised crop husbandry traditions (*Bogaard 2004*). The best example of intra-site variability in growing conditions is the LBK site of Vaihingen/Enz in the Neckar valley (*Bogaard 2004*), where a relatively large set of archaeobotanical samples rich in potential arable weeds suggests a continuum from relatively high to relatively low intensity cultivation. Nucleation and enclosure of longhouses at this settlement (*Krause 2000*) may have exaggerated the inevitable 'fall off' in cultivation intensity with increasing distance from home (*cf. Jones et al. 1999*).

Great Hungarian plain

There is increasing evidence that, contrary to earlier statements based on small samples (*e.g. Kosse 1979*), the faunal assemblages of early Neolithic sites of the Körös culture (c. 6000–5500 BC) in south-east Hungary are dominated by domesticated livestock, especially sheep/goat, with a relatively minor component of wild fauna (*Bartosiewicz in press*). Furthermore, demographic data on sheep/goat culling patterns from the Körös site of Endrőd 119 (*Bökönyi 1992*) and from the recently excavated Körös site of Ecsegfalva 23 (*Bartosiewicz pers comm.; in press; Pike-Tay in press*) point towards generalised/meat-oriented management rather than intensive dairying or wool production. The detection of dairy fat residues on potsherds from Ecsegfalva (*Craig et al. in press*) is consistent with a generalised herding strategy in which livestock were exploited for a range of products.

Archaeobotanical data from sites of this early Neolithic phase in the Hungarian Plain are scarce, but ecological analysis of the potential arable weed assemblage from Ecsegfalva 23 by Bogaard et al. (*in press a; b*) points towards intensive cultivation. Moreover, the topography of the area suggests that high dry ground in the vicinity was far more than sufficient to accommodate small-scale cultivation (*Bogaard et al. in press a; b*). Microwear analysis of sheep/goat mandibles from Ecsegfalva 23 by Mainland (*in press*) points towards high soil ingestion and over-grazing in penned areas, while MacPhail (*in press*) has detected soil micromorphological evidence for 'stalling refuse' at the site, again consistent with small-scale and intensive herd management integrated with arable farming.

Clearly, more interdisciplinary investigations such as those focussed on Ecsegfalva 23 are required in order to broaden this picture of early Neolithic crop and animal husbandry, but initial indications are that intensive mixed farming can be traced from the LBK back to the earlier Neolithic of the Hungarian plain.

Southern Balkans and Greece

Halstead (*1981; 1996a; 1996b; 2000*) has drawn together evidence for intensive mixed farming in Neolithic Greece (seventh-fourth millennium BC). Arguments include a lack of evidence for wide-scale woodland clearance in the pollen record or for ox-traction in faunal assemblages, the predominance of sheep (a species associated with open vegetation), mortality evidence that sheep were exploited for meat and a decrease in the size of domestic pig and cattle through the Neolithic (consistent with a lack of interbreeding with wild relatives). Moreover, Halstead (*1981; 1996a; 1996b; 2000*) estimates that Greek tell villages would require implausibly large herds to be supported primarily by livestock and concludes that cereals and pulses provided the bulk of the diet, though livestock offered a vital alternative source of food in times of crop failure.

Until recently there has been little archaeobotanical evidence for Neolithic arable weed floras in the southern Balkans or Greece, though Halstead (*1981; 1996a; 1996b; 2000*) has emphasised the diversity and prevalence of labour-intensive pulse crops. The work of Marinova (*2001*), therefore, on weeds associated with charred crop remains (including crop stores) at several Neolithic tell sites in southern Bulgaria is particularly critical. Floristically, these weed assemblages overlap considerably with those of central Europe and hence appear to be consistent with intensive cultivation (though this remains to be demonstrated by statistical and ecological analysis of the particular combinations of weed species occurring on a sample by sample basis). Recent studies of Late Neolithic-Early Bronze Age archaeobotanical assemblages in northern Greece (*Valamoti and Jones 2003; Valamoti 2004*) shed important new light on the use of livestock dung as fuel – implying that herds were kept near the settlement – as well as on animal feeding practices, including grazing of weeds in stubble/fallow fields and possible feeding of crop material to livestock.

Ongoing archaeobotanical work by the author further north, in the Teleorman valley of south-central Romania (*Bogaard 2001, unpublished*), has so far produced small assemblages of potential arable weeds from 'flat' sites of the Criş, Dudeştı and Boian cultures (sixth-early fifth millennium BC). The limited evidence recovered so far would again appear to reflect intensive, small-scale cultivation given the occurrence of annual weed species common on Neolithic sites in central Europe, such as Fat Hen (*Chenopodium album*), Black Night-shade (*Solanum nigrum*) and Black Bindweed (*Fallopia convolvulus*). A recently found cache of *Chenopodium album* seeds at Sultana-Malu Roşu (*Bogaard and Stavrescu-Bedivan unpublished*), a Gumelniţa culture (later 5th millennium BC) tell site in southern Romania, echoes occasional similar finds at LBK and later sites in central Europe (*Helbaek 1960; Knörzer 1967; Kroll 1990; Bakels 1991; Brombacher and Jacomet 1997; Lüning 2000.92*). Given the suitability of Fat Hen as a separately collected wild plant food (*Stokes and Rowley-Conwy 2002*), such finds urge caution in the uncritical use of this species as an indicator of intensive cultivation (*see also Bogaard 2004*). At the same time, it is possible that intensive cultivation in arable plots played a dual role for both successful cereal/pulse husbandry and the encouragement of alternative food sources such as Fat Hen.

DISCUSSION

Given the obvious relevance of routine practice for apprehending culture as lived experience (*e.g. Whittle 2003.22–49*), the nature of early farming practices in Neolithic Europe is of fundamental importance if we wish to understand the societies that emerged from the agricultural transition. The practice of small-scale, intensive farming in south-east and central Europe reflects a similar series of constraints and possibilities for the development of Neolithic communities in these areas. In addition to constraints on mobility for at least part of the community, for example, intensive mixed farming would encourage the development of household claims to fixed plots of land (*Bogaard 2004*).

Against this backdrop of similar constraints and potentialities, however, Neolithic communities in south-east and central Europe clearly took on a range of forms in terms of settlements and houses, distribution, longevity etc. Kotsakis (*1999*) has recently considered the different implications of Neolithic 'tell' settlements versus 'flat' sites in northern Greece, concluding that the more dispersed form of flat sites would allow more labour-intensive cultivation of plots interspersed between houses than would be feasible beyond the edges of nucleated tells. While new studies such as that of Valamoti (*2004*) will clarify this contrast in Greece, there is evidence that differential nucleation of longhouses among LBK settlements in central Europe was associated with different degrees of variability in cultivation intensity (above, *Bogaard 2004*). The implication is that different degrees of nucleation could amplify the potential for emerging differences in productivity between households, unless mechanisms were in place to ensure an even distribution of cultivation plots at varying distances from home (*cf. Forbes 1982.353; 2000*). Thus, the marked 'separation between household and productive space' (*Kotsakis 1999.73*) evident in nucleated settlements such as tells would have the effect of creating an extended continuum of cultivation intensity and hence more scope for differences in productivity between households than in more dispersed settlements. Moreover, a greater continuum of cultivation intensity surrounding nucleated settlements could accelerate inter-household competition, promoting tell formation in areas with a tradition of mud-brick architecture and superimposed rebuilding (*Halstead 1999*).

In this perspective, it is misleading to invoke radical differences in crop husbandry between tells and flat sites, such as a shift from manual horticulture to ard-based agriculture (*cf. Chapman 1990*). As *Kotsakis (1999*) suggests, the fundamental difference lies not in tillage method but in social attitudes to household versus productive space and continuity in the use of household space through time. It has been argued elsewhere (*Bogaard 2004; Bogaard et al. in press b*) that long-lived, intensively cultivated plots would themselves be the object of descent-based claims. Perhaps the contrast between tells and flat sites reflects a difference in emphasis between claims on household space, on the one hand, and productive space, on the other: in tells, the identity of the household is linked to household space and to its place in the community structure, whereas in flat sites with no superimposed rebuilding and greater household dispersal, proximal house replacement over time reflects a predominant concern with claims over 'sectors' of the residential area together with surrounding arable plots (*cf. Bogaard 2004; Bogaard et al. in press b*).

An issue raised at the start of this paper concerned the problem of identifying the 'origins' of intensive mixed farming, given its technological simplicity. Notwithstanding the possibility that intensive cultivation could have developed independently in different areas, the apparent continuity of intensive mixed farming across south-east and central Europe raises the possibility that the range of crops and livestock adopted in south-east Europe were already embedded and integrated in earlier patterns of intensive mixed farming in the Near East. This question lies beyond the remit of the present paper (*Bogaard in prep*) but may help to explain the 'packaged' nature of Neolithic life from its beginnings in the Fertile Crescent.

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contents

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Documenta Praehistorica XXXI

The transition to farming and the 'revolution' of symbols in the Balkans. From ornament to entoptic and external symbolic storage

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ABSTRACT – *In desimplifying the logic of colonisation and transition to farming we discuss hunter-gatherers' and farmer's symbolic structures in the Balkans and Carpathians. Particular attention is paid to the concepts of 'revolution of symbols', 'external symbolic storage' and 'signs of all time'. Our basic premises are (1) that ceramic technology and the principles of fragmentation and accumulation were not the exclusive domains of farmers and, (2) that the hunter-gatherers' symbolic structures and the process of transition to farming were not exclusive and competitive but rather correlative in maintaining control and power within society and over the frameworks of external interactions and exchange networks.*

IZVLEČEK – *V razpravi analiziramo 'kognitivne' pristope in koncepte, povezane s simbolnimi strukturami lovcev in nabiralcev ter poljedelcev. Opozarjamo na interpretativni pomen 'entoptov', 'revolucije simbolov' in 'eksternega hranjenja simbolov' v kontekstu procesa neolitizacije Balkana in Karpatov.*

KEY WORDS – *Palaeolithic; Neolithic; Eurasia; transition to farming; symbolism*

INTRODUCTION

The prejudices toward hunter-gatherers in general, and Mesolithic peoples in particular, are well embedded in the context of the humanistic evaluation of the genesis of European civilization ever since historian Herodotus of Halicarnassus (ca 485–425 BC) marked the agricultural frontier in his book The History as the boundary between the civilized and the barbarian worlds. The prejudices became broadly accepted in the typologically oriented perception of European prehistory as Gordon Childe put forward the concepts of 'an oriental view' and of the European Neolithic 'as a story of imitation' and 'at best, an adaptation of Middle Eastern achievements' (*Müller 1972.101–131; Trigger 1980.66–67; Budja 1996. 61–76*).

It was suggested that changes in collective psychology – 'the revolution of symbols'– must have preceded and engendered all the others in the process of transition to farming, and that the regions peripheral to the Levant did not become neolithicised until the new ideology reached them (*Cauvin 2000.23, 207–208*). Steven Mithen, thinks on contrary, that the rise of agriculture was a direct consequence of 'an integration of technical and natural history intelligence' evolved with the emergence of 'cognitive fluidity' (a term denoting how the modular human mind has learned to work) and the origins of art, religion, and science in the upper Palaeolithic. There were domestications of plants and animals that can only be related to the initial Neolithic (*Mithen 1996. 217–226*).

In southeastern Europe, the transition to farming has been related to intrusive agricultural communities that created the Neolithic diaspora in which farming communities dispersed across the regions. It was hypothesised that the migrating farmers brought in the new technologies, symbolic behaviours and symbols. The appearance of pottery has been understood for decades as the exclusive marker of cultural discontinuity between Late Mesolithic and Early Neolithic cultures. Pottery decoration was chosen as the marker of "indisputable typological similarities" with the cultural traditions of Asia Minor on the one hand, and the marker of the Early Neolithic ethnic groups on the other.

In the scenario of endemic movement, 'earplugs' 'pins' and 'stamp seals' are hypothesised to have been well embedded in the baggage of the immigrants. They have been understood as signifiers of a 'marine version of the wave of advance model' (*Renfrew 1987.169–170*), and also used as markers of the Near Eastern 'great exodus' and 'insular colonisation' of the Balkans (*Perles 2001.283–290; 2003. 99–113*).

It was hypothesised also that social and symbolic domestication preceded the transition to agriculture in the northern Balkans (*Hodder 1990.31–32, 41–43*).

In desimplifying the logic of colonization and transition to farming in southeastern Europe we pointed out elsewhere that elements of the Neolithic package are well embedded in hunter-gatherer social contexts and that Neolithic symbolic structures in the Balkans do not mirror the paradigmatic ornamental and symbolic principles of Asia Minor (*Budja 2003a; 2003b; 2004 in press*)

IN PURSUIT OF THE SYMBOLIC

The dichotomy between the material world and invisible ideas and feelings are topics under constant discussion. It may appear trivial, but while anthropologists can usually assess the functions and meanings of most artefacts and symbols by correlating them with selected, observable behaviours, pre-historians must construct hypothetical behaviours which can never be verified directly. Assigning functions to prehistoric artefacts therefore relies exclusively on inferential arguments and the axiomatic principle that artefacts are material containers that convey archaeologically accessible symbolism to the degree that we think they are material and cultural. Discussing 'Symbolic Archaeology' John Robb (*1998.331*) pointed out an interpretative paradox: "If we understand how a prehistoric rock carvings was made tech-

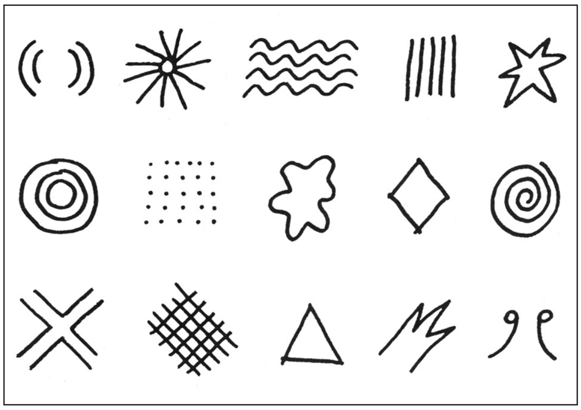

Fig. 1. Entoptic basic categories, each represented here by a typical form (after* Oster 1970.87*).

nologically without knowing why it was made culturally, the effort is considered a failure, and symbolic archaeology is pronounced impossible. But if we understand how prehistoric people produced their food technology without knowing the cultural reasons why they produced what and how much they did in the way they did, the effort is considered a successful demonstration of economic archaeology; never mind that we have reduced a complex, value-laden set of social relations to a simple faunal inference."

However, at the risk of oversimplification, he outlines three major traditions that archaeologists have followed in conceptualizing symbols: the structuralist, the processual, and the post-modern. Each has its own preferred objects of study, understandings of social relations and power, and epistemology. While the first tradition treats symbols as cultural structures, in the second they have been viewed as tokens that represent reality. In the last, symbols have been manipulated as tesserae, arbitrarily incorporated into phenomenological experience (*Robb 1998.329–346*). In the heuristics of identifying symbols, 'top-down' and 'bottom-up' approaches have been recognized. Ethnographic-cultural narratives have significant positions in both, whether embedded in a cultural matrix within which clusters of archaeological data can be integrated into meaningful virtual behaviours or in reconfigurations of the data within middle-range hypothetical interpretations (*Bouissac 2004. online*).

What we find to be creative approaches in the archaeology of symbols have been conceptualized as entoptics, 'the signs of all times' (*Lewis-Williams and Dowson 1988; 1993*), and as the cognitive model of 'external symbolic storage' (*Donald 1991; 1997; 1998a; 1998b*).

The syntagm 'external symbolic storage' relates to "...the most salient and indisputable property of material culture: it exists only in relation to interpretative codes stored inside the heads of the people who invented it, that is, inside their 'biological' memory systems. Written symbols, and even other less explicitly symbolic aspects of material culture, are external to biological memory, and serve as storage devices for the information needed to replicate entire cultures. This simple fact changes the nature of shared cognition. But it also makes the archaeologist's job very difficult, because the specific content of symbols can never exhaust their functions when in use. When in use, symbols engage biological memory, which is creative, constructive, dynamic, force. Symbols and cognitive artefacts are thus drawn into a maelstrom of shared cognitive activity in any culture. Artefacts are static things, and undoubtedly serve as static storage devices, but their functions in the larger cultural matrix go well beyond mere storage, because they are in dynamic interaction with the entire cognitive-cultural system in any living culture." (*Donald 1998b.184*). Donald recognized external symbols as very powerful transforming forces in human life that altered the cognitive landscape as they became more potent storage devices, capable of storing explicit and more detailed knowledge.

Donald's model proposes three stages/transitions in the evolution of culture and cognition. The first and the second cognitive transformations are still genetically based and linked to the development of mimetic skills and lexical inventions related to oral-mythic culture. The third, the transition from preliterate to symbolically literate societies, relates to the externalization of memory storage which rapidly involves new memory media and new types of symbolic artefacts. It began in the Upper Palaeolithic, and has been marked by a long and culturally cumulative history of 'visuo-symbolic' invention, which advanced through various well-documented stages, culminating in a variety of complex graphic and numerical conventions, and writing systems. External memory evolved to the point where records, mediated by a "literate" class, started to play a governing role and a variety of large, externally-nested cultural products, called theories, emerged.

Fig. 2. Petroglyph in Helan Mountains, China (after* Xu Cheng and Wei Zhong 1993.353*).

In the process of the externalization of memory, he conceptualized four structural arrangements. We point out two of these: cognitive reorganization and the changed role of biological memory (*Donald 1997.744–747*).

The first introduced new cognitive skill-clusters that are referred to as 'literacy' routines, including full symbolic literacy extends, which are well beyond the traditional Western perception of literacy, that is, alphabetic reading competence. The neuropsychology of various acquired dyslexias, dysgraphias and acalculias has revealed a cluster of functionally dissociable cognitive "modules" in the brain that are necessary to support these skills. It is hypothesized (see above) that 'literacy support networks' are anatomically and functionally distinct from those that support oral-linguistic skills. There are three dissociable, visual, interpretative paths involved in symbolic literacy: the pictorial, ideographic, and phonetic. They emerged at different historical phases of visuo-symbolic evolution, and remain functionally independent of one another. The most basic is pictorial, and is needed to interpret pictorial symbols such as pictograms and visual metaphors. The second, ideographic, maps visual symbols directly onto ideas, as in the case of Chinese ideographic writing, most systems of counting, and analogue graphic devices like maps and histograms. The third is phonetic, and serves to map graphemes onto phonemes, as in alphabetical print.

The second structural arrangement, the changed role of biological memory, relates to the way in which external mnemonic devices alter human working memory. Working memory is generally conceived of as a system centred on consciousness. Using a cognitive system model, Donald hypothesised that when we think, we either imagine, via the sketchpad (responsible for the manipulation and temporary storage of visual and spatial information), or verbalize, via an articulatory loop (responsible for storing speech-based information). In preliterate cultures, all individuals have had to work with this, and its limitations are well documented.

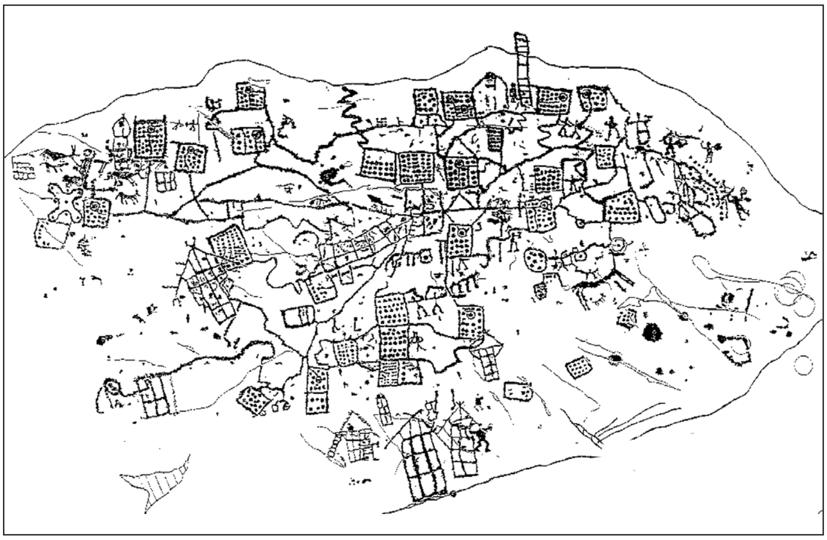

Fig. 3. Bedolina petroglyph topographic map (after Turconi 1998.Fig. 1*).*

This situation changed with the increased use of external symbolic storage and the breaking out of this limited working memory arrangement. The larger architecture within which the individual mind works has changed – the structure of internal memory is now reflected in an external mnemonic context that serves as the real 'working memory' for many mental operations, and as an external 'long-term' store. It allowed for important new developments, new meta-linguistic skills, the kinds of symbolic products and cognitive artefacts that humans could produce and maintain. It is believed that any single new entry in the external storage "system, from Palaeolithic cave-paintings to modern science, has never been a trivial occupation" (*Donald 1997.737–791; 1998a. 7–17*).

This model has been criticised because of its inconsistent correlation of the sequence of evolution of material culture and the sequence of cognitive transitions. Renfrew (*1998.3–4*) disagrees that the (third) transition to 'theoretic culture utilizing external symbolic storage' is marked as a palimpsest of a long and culturally cumulative history from upper Palaeolithic paintings to early writing systems in Mesopotamia. External symbolic storage employing symbolic material culture, he suggests, was not a characteristic of hunter-gatherer, but of agrarian societies, and the third transition can be equated only with the transition to farming. External symbolic storage in the form of writing, he adds, is a marker of a fourth transition and urban societies.

Parallel to 'external symbolic storage' Lewis-Williams and Dowson (*1988.201–244; 1991.149–162; 1993.55–65*) proposed the concept of 'the signs of all times'. The proposition is based on a neuropsychological bridge between modern experiences in altered states of consciousness and Palaeolithic and Neolithic imagery. They actualize the idea, originally proposed by Oster (*1970*) in America and Eichmeier, Höfer, Knoll and Meire-Knoll (*Eichmeier and Höfer 1974*) in Europe that the abstract ornaments and motifs on Neolithic pottery, clay stamps, megalithic art, rock paintings and engravings in Europe, Africa and Australia derived from the luminous, geometric entoptic phenomena, known also as form constants and phosphenes, seen in certain altered states of consciousness.

Neuropsychological laboratory experiments have shown that in an initial stage of trance, participants see luminous, pulsating, enlarging, fragmenting and changing geometric forms which include grids, sets of zigzags and parallel lines, dots, triangles, squares, circles, spirals, arcs, crosses, meanders, and nested centenary curves. (Fig. 1) These forms are defined as entoptic phenomena because they are 'within the optic system' and are independent of an external source of light. In the deeper, second stage of trance, participants try to make sense of these forms by elaborating them into iconic forms as objects familiar and/or important to them. In religious contexts they become important ritual objects. In the third and deepest stage of trance, mental imagery is more culturally controlled, and entoptics tend to be peripheral. The participant's attention is focused on iconic hallucinations of animals, people, monsters and highly emotional events in which they themselves participate. At this point of visual hallucination two intertwined principles overlap: geometric, entoptic images that derive from the universal human nervous system (neurologically controlled elements), and culturally controlled iconic hallucinatory visions of culturally controlled items such as animals and people, as well as somatic and aural experiences that derive from the subject's mind or culture (psychological elements). The complex iconic images appear to drive from memory, and are often associated with powerful emotional experiences. This shift to iconic imagery is also accompanied by an increase in vividness. Both kinds of image are processed or transformed according to neurologi-

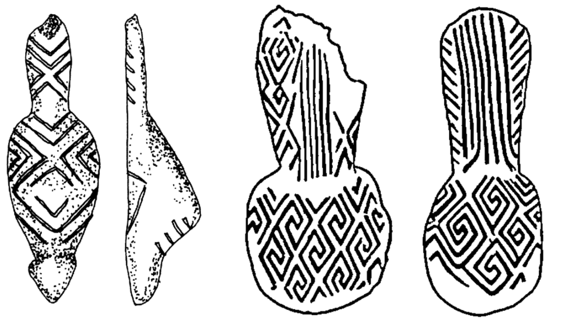

Fig. 4. Upper Palaeolithic ivory figurines. Mezin, Desna River basin, Ukraine (after* Abramova 1962. XXXI*).

cally based principles such as replication, fragmentation, combination, rotation, superpositioning, and juxtapositioning. The ways in which subjects perceive both entoptics and iconic hallucinations are many and varied. In such an experience a grid or dots may be integrated with animals and people, or an animal can be blended with the characteristics of another species and combined to produce composite animals and therianthropes. These three stages are not necessarily sequential, but cumulative.

Lewis-Williams and Dowson applied the three stage model of altered consciousness to two known and ethnographically well documented shamanistic arts from different continents and to Upper Palaeolithic paintings and engravings, both mobile and parietal, as well as to Neolithic megalithic art. The first is that of the southern African San (Bushman) rock paintings and engravings. The second is Shoshone Coso rock art of the California Great Basin. Both arts are known historically and ethnographically to be shamanistic. San rock art was favoured because shamanistic images can be studied simultaneously from two directions: neuropsychological approach explains the forms of depictions; the meanings of these depictions can be established from directly relevant ethnography.

In applying the neuropsychological, three stage model of altered consciousness and its utility to Palaeolithic and Neolithic imagery, they say that as many as 437 of the 488 (or 90%) societies that have been surveyed had some form of institutional altered states of consciousness. They ranged from foraging to more complex societies and, therefore "there are a priori grounds for suspecting some form of institutionalised altered states during the Neolithic" (*Lewis-Williams and Dowson 1993.55*; see also *Sherrat 1991.50–64*). However, as neuropsychological research has shown that hallucinations comprise geometric and realistic imagery, we have to be cautious in claiming that Upper Palaeolithic or Neolithic art derived "in part from the mental imagery of altered states if only signs had been present", and that "practically any geometric motif by itself" can not be recognized as entoptic in origin and therefore indicative of shamanism (*Lewis-Williams and Dowson 1990.407; Lewis-Williams 2004.107*).

It is hypothesised that at "least some Palaeolithic people experienced hallucinations induced by one or more of the many techniques that range from the ingestion of psychotropic drugs to sensory deprivation", and their mental imagery "would necessarily have included hallucinations very like the range of depictions in their art" (*Lewis-Williams 1991.158; 2002*). It has also been shown that altered states of consciousness can be experienced in a variety of circumstances other than shamanism, and that entopic phenomena can be seen in migraine attacks and schizophrenic conditions (*Asaad and Shapiro 1986.1088–1097; Richards 1971.88–96*). However, migraine-induced visions have certainly have played a role in religious experience in the European Christian tradition and, there is no need to exclude the variety of mental disorders, including schizophrenia, migraine and epilepsy, as well as the induction of altered states of consciousness by sensory deprivation, rhythmic dancing, hyperventilation, and pricking sensations etc. (*Eliade 1972; Pearson 2002*).

Sherratt (*1991.51–52, 54, 61–62*) indicates the importance of sensory-altering substances by saying that there would have been an extensive knowledge of the 'various mood-altering substances' which were available in the natural flora, and which survive today in the attenuated form of 'herbal reme-

Fig. 5. Ceramic 'Black Venus' of Dolní Věstonice (after* Soffer et al. 1993.Fig.1*)

dies'. The quantity of the stimulant need not be large, as it may be enhanced by fasting or breath control. Such experiences are likely to be deliberately sought in the course of ceremonies or rituals, at that time perhaps seen as a means of accessing other worlds. He sums up by saying that there was a considerable potential for the spread of even mild stimulants and of methods of preparation which enhanced their effectiveness and, that "any account of prehistoric Europe which omits a consideration of such substances is likely to be incomplete". Along the written records which give many accounts of drug use he notes some concrete evidence – ceramic pots for smoke inhalation in the Mihailovka, Tripolye, and Bodrogkeresztur cultures in eastern Europe, and in megalithic complexes in western Europe.

It is reasonable, therefore, to assume that some form of shamanism can be applied to early prehistoric art to objectify a religion centred on altered states of consciousness. Because the human nervous system is everywhere alike, we can assume that the effects of its functioning were the same from the Aurignacien to the present, and in all parts of the world. Neuropsychological research has shown that visual hallucinations experienced in altered states are cross-culturally uniform (*Eichmeier and Höfer 1974; Lewis-Williams 1991.159–160; 2002.189–227; Dowson 1998a. 73; 1998b.333–343; Dowson and Porr 2001.165–177*).

However, what needs to be mentioned is a criticism of the thesis that archaeological findings may be interpreted as shamanic and that there exists something like a 'general shamanic ability'. Anthropologists have made a coherent and strong front against, as they want to be "a refreshing antidote to a regrettable phenomenon...i.e. the uncritical and unfounded presentation of 'shamanism' as a key to understanding prehistoric rock art." (*Francfort and Hamayon, Bahn 2001.51*). The concept of 'the signs of all times' has been ideologised, such that rock engravings should be understood as homogenous religious phenomenon shared by the 'primitives' of all times and places, from Eurasian Palaeolithic hunters to the San of Africa and Shoshone of America, having one religion and one iconography, while 'high' civilizations have complex religious and religious iconographies. It is believed, paradoxically, that archaeologists marginalized shamanic processes to the level where rock art is interpreted as the creation of shamans, who, after a trance experience induced by obsessive dancing, fasting or hallucinogenic drugs, depict their visions on rocks and artefacts (*Layton 2000.169–186; Klein et al. 2002.383–420; Helventson and Bahn 2003.213–224*; se also *Hodgson 2000.866–873*).

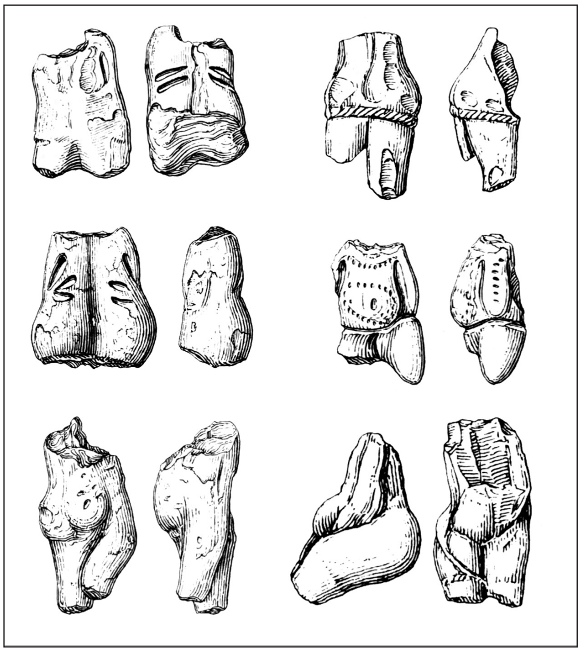

Fig. 6. 'Fragmented' anthropomorphic ceramic figurines from Dolní Věstonice and Pavlov (after **Verpoorte 2001.Figs. 3. 6, 7, 8, 9, 46 and 54*).***

We will not enter into a discussion of the diagnostic element of shamanism and the social status of shamans, but point out the concept of 'labelled landscape' that one may find neutral. That is to say, pre- and historically interactive symbolic palimpsests are available where replicated, fragmented, combined, rotated and superpositioned entoptics associated with animals and people have been recognized as evidence of an external symbolic storage of spatial knowledge, not necessarily related to a shamanistic interpretative network.

LABELLED LANDSCAPE

Along with temporal continuity, geographical continuity – the universal occurrence of rock art in Eurasia, Africa and Australia – has been demonstrated elsewhere. The rock art of China seems to be the earliest that has been recorded in historical documents, as early 6th century AD, when the geographer Li Daoyuan (472–527) mentioned the rock engraving in Shuijing Zhu (Commentary on the Classic of Rivers), he saw while surveying the land in many parts of China (*Chen Zhaofu 1991.26–36*).

The Chinese rock art concentrations, found along the northern frontier close to the remains of the

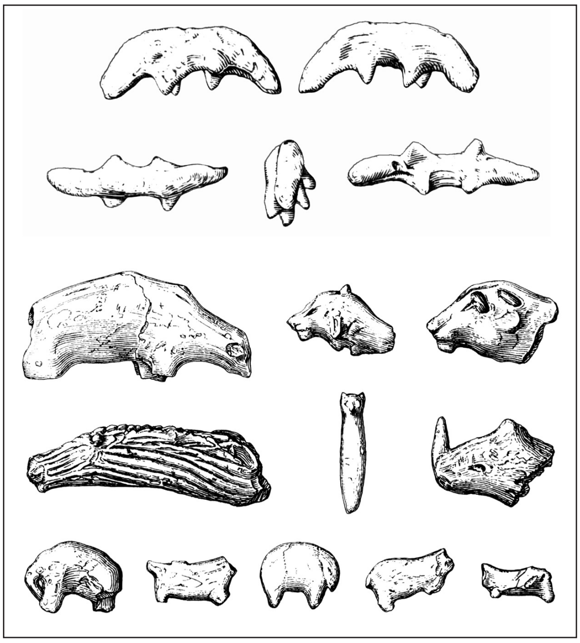

Fig. 7. Zoomorphic ceramic statuettes from Předmosti and Dolní Věstonice (after* Verpoorte 2001. Figs. 3.73 and 8.1*).

Great Wall, apparent symbols of the Chinese empire, have been studied recently (*Xu and Wei 1993; Demattè 2004.5–23*) (Fig. 2). Petroglyph sites are located on the two main mountain ranges: the Yinshan of Inner Mongolia, which runs for over thousand kilometres along the Yellow River, and the Helanshan of Ningxia Province. Archaeological and historical data indicate that for millennia – from the Neolithic to the later dynastic phases in the nineteenth century – these areas were (military) borders that separated different economic lifestyles, nomadic pastoralism in the north and arable farming in the south. It is believed that these mountains were chosen as petroglyph sites not only because they provided stone surfaces necessary for carving, but also because their canyons were on communication routes which connected the world of the steppe with China. Archaeological and textual evidence shows that the northern silk route passed through these areas, and that the local nomadic populations were engaged continually in exchange and trading activities. Paola Demattè suggests that the petroglyphs and paintings there were not only associated with religion, ritual and shamanistic activities, but also related to more prosaic activities such as dotting the landscape. It is that nomadic societies created their own signs to mark borders and to reiterate 'the symbolic attachment' to the land with which they identified. She points out a 'deeper and visual connection' between the single petroglyphs and written signs of the earliest (iconographic and symbolic) types (generally known as pictographs). It cannot be overlooked that these pictures also functioned in roles which in literate societies are taken up by writing. If the function of writing and that of petroglyphs may have something in common, there is also a deeper and visual connection between the two, particularly if the single petroglyphs are compared with the earliest pictographic forms of writing. In later periods, when writing became more widespread among the nomads, writing and engravings were combined and sometimes petroglyph production disappeared and writing took over the same surfaces. The inscriptions in Xixia script appended next to earlier petroglyphs describe them as 'the parents of writing' or 'the writing of the spirits of writing', thus making clear the close connection perceived by literate people between the two sign systems (*O.c. 20*). The systematic simplification and transformation of images into easily recognizable narrative symbols is an acceptable indication that petroglyphs were probably used to record and communicate information, perhaps to later generations, neighbouring groups, or even encroaching enemies. Similar spatial communication 'is also not unlike' that of literate cultures which were attached to their social territories by writings, edicts, historical inscriptions etc. (*Demattè 2004.17–21*). A similar 'borderland' concept has been applied recently in the interpretation of rock art distribution in Europe (*Bradley 2000*; see also *Coles 2000*).

There is no doubt that signs, labelling the landscape at significant locations, have been embedded in multiple functions and levels of symbolic behaviour, including spatial perspective. But more indicative are the alternative contexts where the topographic maps and complex landscape representations have been attached to rocks, house walls, and pots. There is a corpus of 43 prehistoric maps available, ranging from Almaden Upper Palaeolithic cave painting to Iron Age rock carving in Val Camonica, and a list of 67 hunting, fishing and gathering societies that created such maps (*Zubrow and Daly 1998.164–165, 170*). Palaeolithic and Neolithic petroglyphs, cave paintings, rock paintings, wall paintings, and

Fig. 8. Anthropomorphic ceramic figurine from Maina, Yenisei River basin in Siberia (from* Vasil'ev 1985.Fig.2*).

bone engravings are pictorial, including all the 'the signs of all times'. They are considered to be maps, as they display spatial relationships. They tend to have a focal point, in that emphasis and resolution decrease with distance from familiar points; and they show usage, ownership and horizon marking (*O.c. 167*). The well-known examples are the petroglyphic maps at Bedolina in Val Camonica in the Dolomites (*Turconi 1998.85–113*) (Fig. 3), a wall painting map in Çatalhüyük (*Mellaart 1967.Figs. 59, 60*) and the famous Tepe Gawra landscape jar (*cf. Zubrow and Daly 1998.Figs. 13.1–2*). All the items listed have been hypothesised as memory devices and, we may additionally say they are multifunctional and multidimensional in symbolic behaviour. The palimpsests of 'entoptics', 'pictorial' and 'ideographic' visual representation are still driven by mimetic organizational principles, although they operate as external symbolic storages at a different, more sophisticated level. However, they clearly reflect the external representation of spatial knowledge.

THE GREAT GODDESS OR DRESSED CERAMIC VENUS, SHAMANISM, EXTERNAL SYMBOLIC STORAGE, AND THE ORIGINS OF CERAMIC FRAGMENTATION

The small series of early Upper Palaeolithic sculptures in Europe consisting of female figurines, therianthropes, and several animal figurines is believed to have been followed in Gravettian by numerous zoomorphic and anthropomorphic figurines carved from mammoth ivory, bones and tusks, limestone and marble, or modelled in ceramics. There are corpuses of some 200 female figurines, and a much larger, but ill-defined number of animal figurines whose distribution in Eurasia from the Pyrenees to Lake Baikal in Siberia indicate a Gravettian cultural tradition. The main focus of attention has been on Palaeolithic depictions of women, commonly named Venuses. Less attention has been paid to stylized female figurines and the 'design motifs' attached to them. This selective focus on the emotionally charged primary and secondary sexual characteristics has led to 'gynecocentric' (see *Meskell 1995.74–86*) explanations of symbols of fertility, palaeo-erotica and self-portraiture on one hand, and conflicting conceptualizations of female divinity and the nature of mother goddesses (*Ucko 1968; Gamble 1982; Gimbutas 1982; 1989; 1991; Marshack 1991.17– 31; McDermott 1996.227–275; Goodison and Morris 1998; Soffer, Adovasio and Hyland 2000. 511– 537*).

It is worth remembering that Marija Gimbutas, although finding the model of the 'Great Mother' deity inconsistent with her conceptualization of the complex of nineteen female divinities embedded in the 'Great Goddess' (*1989*), applied to the Palaeolithic parthenon the 'bird goddess' only. She believes she has identified and decoded at least fifty ideograms, including many geometrical and other 'abstract signs' and 'animal symbols', but there is, again, a very limited number to which she applied to Palaeolithic imagery, and all of them supposedly relate to 'aquatic symbols', 'waters of life' and 'aquatic family' (*Gimbutas 1982; 1989*).

Three-dimensional imagery, animal statuettes, human figurines and therianthropes, (whether they bear geometric signs and entoptics or not), have been hypothesised in an alternative approach as shaman's helpers – it is believed they were reified spirit animals and dead ancestors, with all their prophylactic and other powers, as integral parts of shamanism (*Lewis-Williams 2002.169–293; Schlesier 2001.410*; see also *Layton 2000.169–186*). The suggested examples from Europe (Předmostí, Dolní Věs-

Site	Anthropomorphic	Figurative	'Ceramics'
Dolní Věstonice I	12 (note 1)	> 721	> 5,760
Dolní Věstonice II – north	–	⩾ 2 (10?)	431
Dolní Věstonice II – west	–	1	7
Dolní Věstonice III	–	–	1?
Pavlov I	8 (note 1)	> 100	~ 10,000
Pavlov II	–	?	~ 135
Předmostí I	–	⩾2	> 2
Jarošov II	–	–	1?
Krems-Wachtberg (note 2)	–	3	3

Fig. 9. Ceramic assemblages of Upper Palaeolithic Pavlovian sites in Central Europe (after* Verpoorte 2001.Tab. 5.1*).

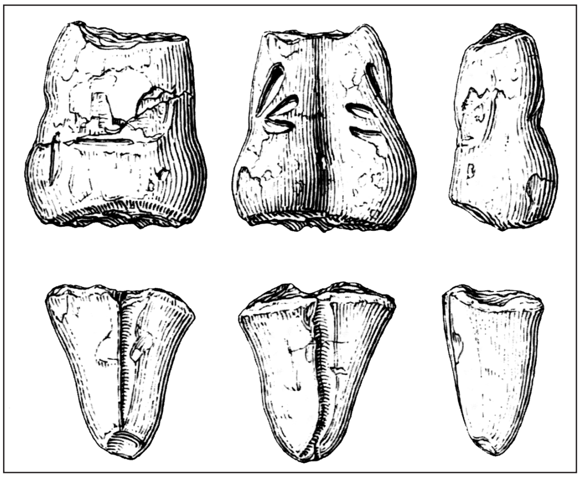

Fig. 10. Composed ceramic figurine, Dolní Věstonice in Moravia (after* Verpoorte 2001.Fig. 3.6*).

tonice) and Siberia (Mal'ta) are embedded in Gravettian and Solutrèan cultural contexts.

A much more simplistic approach focuses on the question of whether Gravettian Venuses in Eurasia depict an Upper Palaeolithic ideology of dressing or not. The results of very recent studies indicate 'dressed female bodies' and the occurrence of textile use and weaving technology. The focus has thus been moved from the sexual characteristics to 'symbols of achievements' of female weavers and related power, prestige, and value (*Soffer, Adovasio and Hyland 2000.511–537; Soffer and Adovasio 2004.270–282*). The 'geometrical design' on Mezin's figurines have been recognized as weaving patterns and design elements that can be linked to 'East European Slavs' (*2000.533*) (Fig. 4). We agree, they can be interpreted as aniconic geometrical designs for all times, but they might also have been acting as entoptic phenomena.

Despite the strong wind of interpretative change, there are still some intriguing points in interpreting Upper Palaeolithic imagery and technologies. Janusz K. Kozłowski has pointed out recently that "Gravettian Venus figurines exhibit more characteristics in common with the figurines of the initial Neolithic of the Near East than with the Late Magdalenian or Epigravettian". His comment was marginalized, as it revives Gimbutas interpretation, and conflates time and space (*Soffer, Adovasio and Hyland 2000.526, 533; Kozłowski 1992*).

However, it is broadly accepted that there are many thousands of ceramic artefacts – anthropomorphic and zoomorphic figurines and pellets – across Eurasia, from the Pyrenees to the Yenisei Basin in Siberia, well-embedded in Upper Palaeolithic contexts. We can not avoid the similarities of shape and ornamentation to much later Neolithic figurines in Anatolia and Europe, although thousands of years lie between them, and they appear indifferent social and economic contexts. It is a fact, however, that ceramics were used for figurines, instead of pots and polished stone, for decorative elements instead of axes.

The anthropomorphic figurines, zoomorphic statuettes and pellets of fired clay were produced at Upper Palaeolithic sites at Dolní Věstonice, Pavlov, Petřkovice and Předmostí in Moravia (*Klíma 1989. 81–90; Vandiver et al. 1989.1002–1008; Soffer et al. 1993.259–275; Gamble 1999.402–404*). The most easterly anthropomorphic ceramic figurine was found at an open air site at Mayininskaya near Maina, on the left bank of Yenisei River in Siberia (*Vasil'ev 1985.193–196; Maina online*). (Figs. 5, 6, 7, 8)

In Central Europe, ill-defined types of ceramic fragments were found at Krems-Wachtberg, Moravany-Lopata, Jarošov, and hypothetically at Kašov and Cejkov (*Verpoorte 2001.95–96*). On the Russian Plain at Kostenki, on the banks of the River Don, more than four hundred fragments of low-temperature-fired ceramic were found, contextually associated with hearth, marl and ivory Venus figures, and animal statuettes (*Abramova 1962; Soffer et al. 2000.814*).

At the Dolní Věstonice and Pavlov camps, located about three hundred meters from each other, more than 16 000 ceramic objects have been found. According to the available statistics, at Dolní Věstonice almost all the figurines and statuettes are fragmented

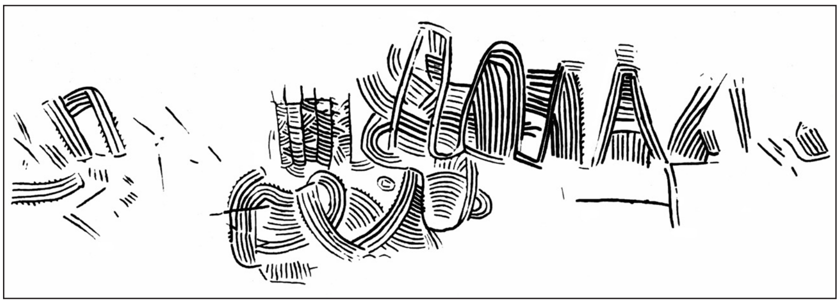

Fig. 11. Entoptic phenomena engraved on mammoth tusk, Pavlov in Moravia (*after Verpoorte 2001.Fig. 3.69*)

(Fig. 9). It is interesting to note that, with the exception of Předmostí, ceramic objects at the other sites were contextual associated with hearts or kilns, and that many fractures were not caused by mechanical means, but are high-energy fractures, caused by thermal shock. It should be noted that the pellets and balls which form a large part of the ceramic inventory remained mostly unbroken. This led Vandiver and Soffer to reconstruct the entire process of ceramic production by examining the technological skills which were involved. They found out that the local loess was suitable for shaping the female figurines, animal statuettes and pellets. Figurines and statuettes were made of several small pieces of clay stuck together (Fig. 10). Heads, legs, feet, ears and tails were shaped separately and attached to the bodies. They were fired at temperatures between 500° and 800°C. The most important finding was the evidence of thermal shock, an explosive reaction which shatters clay when it is being fired. It is believed the figurines, undried or fired at low temperature, had been purposefully rewetted to absorb some liquid, then put into a hot fire where they loudly exploded, sending pieces flying in all directions. It is believed the thermal shock was intentional, and the process of making and firing was therefore more important than achieving a lasting final product. All ivory objects and stone figurines, in contrast, survived in fairly complete states.

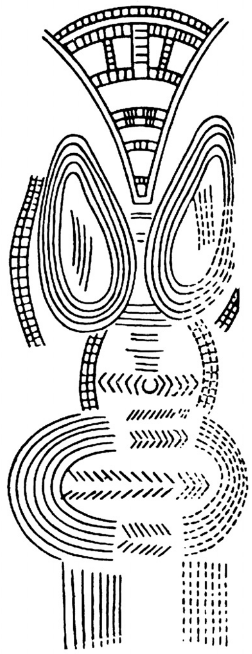

Fig. 12. 'Therianthrope' incised on mammoth tusk, Předmostí in Moravia (after* Marshack 1991.Fig.5*)

We have already mentioned that the majority of ceramics were found in the contexts of everyday activities, but at Dolní Věstonice, around and in the 'oven-like hearth' located in the middle of the hut, "two thousand pieces of 'ceramic', among which about one hundred and seventy-five with traces of modelling" were found (*Verpoorte 2002.56, 128*). The locus of production located in the settlement may reflect a utilitarian, but controlled behaviour related to making, firing and the noticeable fragmenting of the female figurines and animal statuettes. We should not overlook the fact that that thousands of clay pellets were not thermally shocked and were quite consistently fired in the higher temperature and equally distributed over the site (*Vandiver et al. 1989.1002–1008; Soffer et al. 1993.259–275*). A much smaller amount of ceramics was found at Dolní Věstonice II, where six modelled fragments had been deposited in the vicinity of a triple burial. Seven more were found in the 'first settlement unit', deposited in "two depressions in the vicinity of a large heart and a male burial" (*Verpoorte 2002.95*).

Venuses designed for fragmentation are not ornamented. There are a few at Dolní Věstonice and Pavlov bearing almost identical incised pattern on their backs (*Soffer et al. 2000.Fig.3; Verpoorte 2001.Figs. 3.6, 3.7, 3.11, 3.79*). (Figs. 6, 10) If we accept two basic premises: that the ceramics were not just kiln waste because the makers were 'awfully bad potters' and, that the female figurines and animal statuettes had been intentionally fragmented in well visible and audible explosions, then this was not merely 'playing with fire', but well-controlled pyrotechnic manipulation with newly adopted media – the ceramics. It is worth remembering Gordon Childe, besides the Neolithic revolution, put forward the idea that: "Pot making is perhaps the earliest conscious utilization by man of a chemical change ... this change in the quality of the material must have seemed a sort of magic transubstantiation – the conversion of mud or dust into stone. It may have prompted some philosophical questions as to the meaning of substance and sameness." (*Childe 1951. 76–77*).

Pot making obviously happened much earlier, and they were not vessels, but female figurines, animal statuettes, and small pellets that appeared in Eurasia first. The figurines from Dolní Věstonice and Pavlov are assigned to the Pavlovian, a local variant of the Eastern Gravettian techno-complex, and dated to

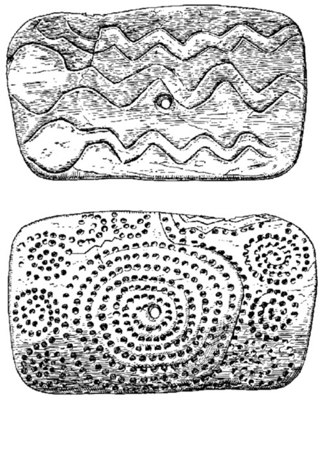

Fig. 13. Entoptics on ivory plate, Mal'ta in Angara River basin, north of Irkutsk in Siberia (*Abramova 1962.L. 2, LI. 2*). Plate (14.1 x 8.5 cm) with a drill-hole in its centre features three engraved snake figures on one side and impressed spirals on the other.

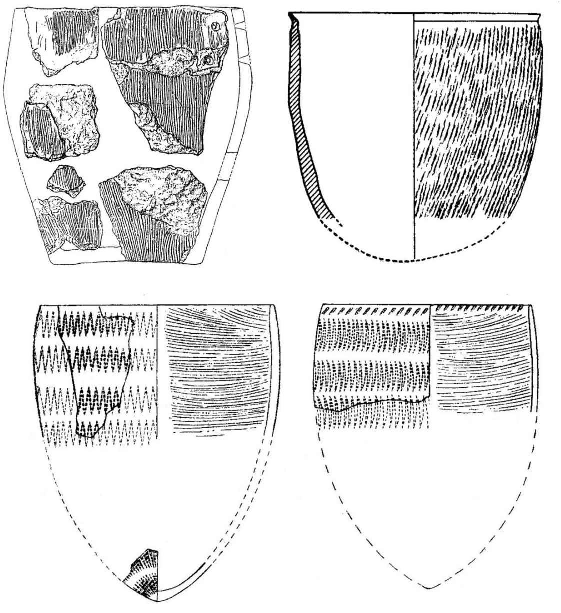

Fig. 14. Pottery in Osipovka and Ust-Karenga cultural complexes in Siberia and Xianrendong site in southern China (after* Kuzmin 2002.Figs. 2 and 7; Zhang Chi 2002.Fig. 9*).

about 26 000 BP (*Verpoorte 2001.86*). Ceramics at Kostenki are embedded in dates as early as 24 100 BP to as late as 18 000 BP (*Soffer et al. 2000.814*). A ceramic figurine at Mayininskaya was deposited in layer 5, which was dated to 16 540±170 BP and 16 176±180 BP (*Vasil'ev 1985.193–196; 1996; Vasil'ev et all 2002.526, Tab. 1*).

It may not be surprising that transubstantiation and fragmentation in the central European Upper Palaeolithic social context, whether formalized or not, were objectified with the help of Venuses, as they represent the principal component of the three-dimensional imagery of Gravettian parthenon. But it is surprising that the entoptics were not attached to new media, although being broadly applied to ivory and bone imagery, and also stone figurines. Did the audio-visual effects of transubstantiation and fragmentation simply replace them, and the visual and audible magic of newly adopted media, which was not conditioned by the shaman's altered states of consciousness, become accessible to the all members of community?

It is believed that ivory and stone Venuses had a much higher value than those modelled in ceramics, as there is no evidence that they were circulating within an alliance or exchange network and that "they were not made to be presented to Palaeolithic spectators" (*Verpoorte 2002.99, 108, 129*). But it is certainly not the case in Kostenki, where marble, stone and ivory female figurines were broken intentionally, as Abramova (*1962.9*) pointed out, adding that the number of fragments and traces of repeated pounding might suggest that the destruction of figurines had been ritually necessitated. And we should not overlook engraved entoptic phenomena at Pavlov and therianthrope, an engraved Venus at Předmostí that can be associated with iconic hallucinations. Marshack (*1991.24*) characterized the latter as 'horned geometric female' and 'mythologized creature'. Ivory plate at Mal'ta with engraved snakes on one side and impressed spirals on the other is believed to objectify a shaman's 'helper' (see above) attached to his costume (Figs. 11, 12, 13).

We mentioned above that we would not enter into a discussion of shamanism and their social status, it is reasonable to hypothesise that ceramic production – manipulation, with transubstantiation as the matter of technical knowledge and skills – may have affected their social position. Bearing in mind the dangers inherent in using ethno-historical evidence, it is worth remembering that in some social contexts and related cosmologies potters may be injurious to others because they cause diseases. The worst thing that could happen was that a rain chief should come into contact with a potter. Both would die. The potter would swell up with moisture, while the rain chief perished from a dry cough (*Barley 1994.64*).

Is it then possible that ceramic production in hunter-gatherer societies in central Europe was taboo from the end of the Pavlovian? And can we recognize the ceramic artefacts in the Pavlovian cultural context as external symbolic storage involving new technology, media and audio-visual symbolism? If so, we can assume that external symbolic storage employing technical and symbolic culture was therefore a characteristic of hunter-gatherer as much as of agrarian societies (contra Renfrew, see above). But it was not maintained continuously in Europe.

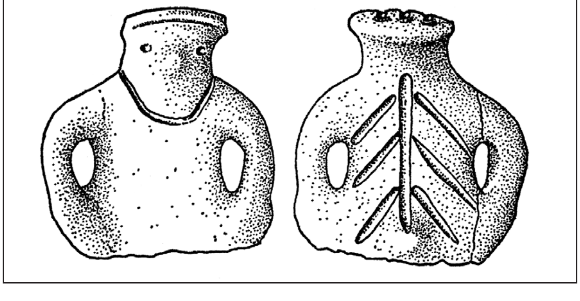

Fig. 15. 'Linearbandkeramik' figurine from Boskovštejn in Moravia (after* Höckmann 1967.Abb. 1.1*).

However, it was in Siberia. The chronological discontinuity there is negligible and we might speculate that the knowledge of ceramic technology was maintained continuously as the datating of a ceramic anthropomorphic figurine at Mayininskaya in the Yenisei River basin (see above) is close to that of the earliest pottery that appeared in the Amur River basin in the settlement contexts of the Osipovka and Gromatukha cultures. Pottery was dated to within the period of ca. 16 500–14 500/ 15 940–14 310 calBP (13 300–10 400 BP) (*Kuzmin and Orlova 2000.356–365; Kuzmin 2002.43; Kuzmin and Keally 2001.1125; Kuzmin and Shewkomud 2003.42; Kuzmin et. al. 2003.39–42; Vasil'ev 1985.193–196; 1996; Vasil'ev et al. 2002. 526.Tab. 1*).

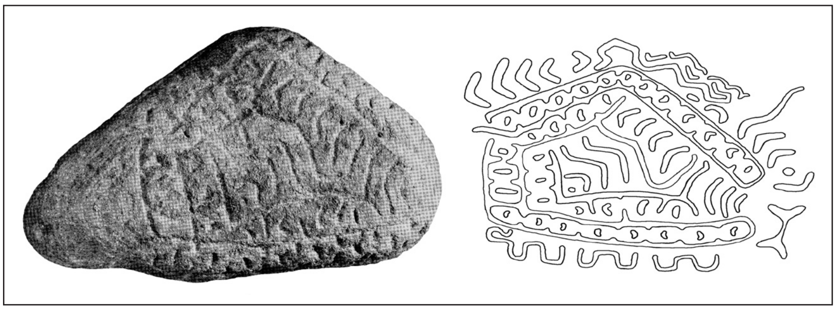

Fig. 16. Lepenski Vir petroglyph (after* Srejović and Babović 1983.Fig. 149*).

It has been suggested on the basis of the latest compilation of the earliest radiocarbon dates that pottery was adopted 'almost simultaneously, around 14 000–13 000 BP' in eastern Asia, which evidently predates the transition to farming. The ceramic vessels were thus recorded in cave sites at Miaoyan, Yuchanyan, Xiarendong and Diaotonghuan in southern China; the Odai Yamamoto, Kitahara and Tokumaru Nakata sites of the incipient Jomon (Chojakubo-Mikoshiba cultural complex) in eastern and northern Japan; the Gasya, Khummi, Goncharka and Gromatukha sites in Amur River basin in Siberia. The earliest vessels are described as deep bowls, with flat or pointed bases, with walls up to two centimetre thick. The estimated volume of the pot is approximately 5.5 to 6 litres. The secondary burning, carbonized adhesion, soot and water lines seen on many fragments, suggest that the basic functions of the pottery were boiling water and foods or other organic materials and extracting fish oils from salmonids. There are differences in ornamental motifs between the regions. While in Japan, plain vessels prevail, vertically grooved decoration is typical of Chinese pottery. In Siberia the ornamental principles are more complex, as they consist of vertical and horizontal grooves and zig-zag impressions. On some, the vertical zig-zag designs and horizontal lines were made with a comb, on others, sinuous lines were made by cords (*Zhao and Wu 2000.233–239; Zhang 2002.29–35; Kuzmin 2002.42; Keally, Taniguchi and Kuzmin 2003. 3–14*) (Fig. 14).

There have been few attempts to explain the principle of fragmentation as a social practice in hunter-gatherer contexts, especially for the ceramics. Departures and arrivals are hypothesised as an obvious motivation for such a rite in forager mobility (*Chapman 2000.40–41*), and the art (but not diffracted) could have been involved in establishing and maintaining the identity, the genius loci, of these places (*Verpoorte 2002.12*).

'Fragmented Goddesses' are more intensively discussed in Neolithic farming contexts. It is not because they were believed to posses the special creative magic necessary to coax fertility out of the earth and to be broken and discarded around the village, which brought new life to the soil (*Winn 1995*), but also because of a wide variety of available ethnographic practices. Figurines are used in initiation rites and then destroyed, buried or kept by an initiate; they are buried with the owners after use in fertility rites; they act as tokens in economic and social transactions (*Talaly 1993*). The principles of fragmentation and accumulation in the contexts

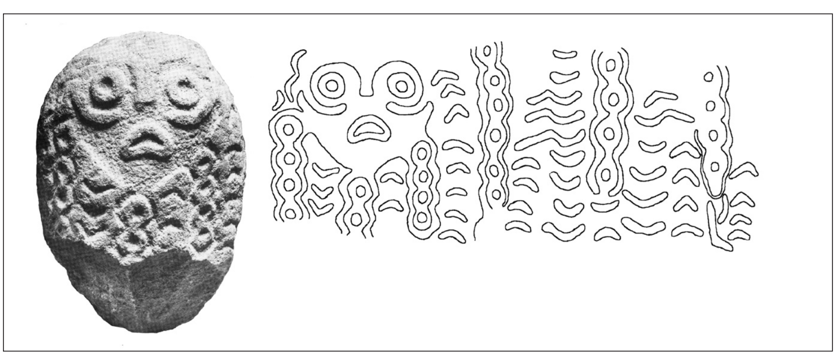

Fig. 17. Lepenski Vir 'therianthrope' (after* Srejović and Babović 1983. Fig. 118*).

of social interactions between persons, objects and places (*Chapman 2000*), and 'diffracted' approaches in studies of predominantly female figurines in 'early villages' (*Lesure 2002*) have been narrated recently.

For our approach, it is more important that in the Far East, in Jomon hunter-gatherer contexts, female figurines were incorporated into community rituals, where they were deliberately broken and scattered around the village (*cf. Chapman 2000.25–26*). Höckmann hypothesised a similar pattern in the central European Linearbandkeramik settlements, where the majority of figurines were intentionally broken and deposited as fragments, some still bearing an incised pattern on the backs similar to the Gravettian Venuses at Dolní Věstonice and Pavlov (*Höckmann 1967.2, Abb. 1.1, 5.1*) (Fig. 15).

Fig. 18. Lepenski Vir 'topographic map' petroglyph (after* Srejović and Babović 1983.Fig. 130*).

One can find of interest the ceramic 'earplug' embedded in a Gravettian assemblage at Pavlovi (*Klíma 1989.88, Abb. 4q*). It is well known that earplugs have been played an important role in the scenario of endemic movement and early Neolithic colonization of Europe. Their restricted geographical distribution, as well the distribution of "pins" and "stamp seals", is used as a key argument in modelling "insular colonisation" and rapid displacements over long distances, as they were hypothesised to be well embedded in the baggage of the immigrants. They have maintained this position since Milojčić conceptualized the pre-pottery Neolithic in Greece (*Renfrew 1987.169–170; Perles 2001; 2003.99–113; Milojčić 1959(1960).6; 1960.327–328*).

BOULDERS, POTS, ORNAMENTS AND/OR ENTOPTICS IN THE BALKAN MESOLITHIC AND NEOLITHIC

We mentioned at the beginning that the transition to farming in southeastern Europe was related to intrusive agricultural communities that created the Neolithic diaspora in which farming communities dispersed across the regions. It was hypothesised that the migrating farmers brought in the new technologies, symbolic behaviours and symbols. The appearance of ceramic technology and pottery production has been understood for decades as the exclusive marker of cultural discontinuity between Late Mesolithic and Early Neolithic cultures. The white and red painted pottery decorations were chosen as markers of 'indisputable typological similarities' with the cultural traditions of Asia Minor on the one hand and the marker of sequential demic expansions from the Konya plain in central Anatolia to floodplains in Thessaly first, and to the Danube and Carpathian Basins later on. It is worth remembering that in the broader Eurasian context, the earliest pottery in Thessaly predates by two centuries the appearance of pottery in western Anatolia, and that there is no significant chronological difference in pottery appearance, whether located on the southern tip of the Balkan Peninsula in Thessaly or in its most northerly margin in the Danube Region (*Budja 2003a; 2004*).

Iann Hodder (*1990.28–30*) believes that on the margin of the early Neolithic world in the hunter-gatherer settlement palimpsest at Lepenski Vir in the Danube basin he can read how economic domestication is associated with or is preceded by social and symbolic domestication. As there is no evidence of domesticates available, he puts forward the idea that the trapezoidal houses objectifying arena where indigenous hunter-gatherers neolithicise themselves socially and symbolically. The act of domestication is supposed to have been dramatic. The dead bodies and/or selected bones of ancestors and the antlers of wild stag were brought into the houses and buried within the domus. The same principle he applies to "cultural products", stone sculptures and statutes, which being wild because depict fish-like ancestors and retaining the form of natural boulders. They become domesticated when brought into houses and placed behind hearths. Pottery was not part of the scenario, although the excavator of the site, while interpreting the Mesolithic cultural phases at Lepenski Vir, pointed out that monochrome pottery fragments had been found lying on the floor of fifteen Mesolithic trapezoidal buildings. He described the pottery assemblage as comprising simple forms with limited ornamental techniques and motifs. The pots were mainly undecorated, and those that were ornamented comprised impressed ornamentation made by fingertip and fingernail or the edges of freshwater shells and awls (*Srejović 1971.8–9*). Pottery was contextually associated with burials, stone and other decorated sculptures, altars, and artefacts ornamented with various symbols and attached meanings deposited on the floors of the same buildings. A remarkable symbolic structure was well preserved in the centrally positioned trapezoidal building. A pot adorned with spiral ornaments was deliberately incorporated into a context associated with burials of newborns, and red and black coloured stone sculptures. Special attention should also be drawn at this point to a building where pottery was associated with a deer skull, a stone figurine and two juvenile burials (*Garašanin and Radovanović 2001.120, Fig. 4; Borić 1999.52; 2002a.Fig. 7; Budja 2003a. 347–359*).

The Lepenski Vir site in general, and trapezoidal buildings in particular, were recently dubbed a "deep time metaphor". Borić (*2002b.46–74; see also Chapman 1993.71–121*) hypothesises that they represent sacred heirlooms upon which repetitive mnemonic and apotropaic practices were performed. Houses with buried ancestors and animals and "boulders" placed on limestone floors he recognizes as sources of ancestral and apotropaic power and potency, evolving a consciousness of a collective deep time. From this perspective the disarticulated ancestral bones and skulls are attributed first-class apotropaic power and potency. Sculptured boulders are assigned as second-class agencies in anchoring and emitting ancestral powers and potencies.

It is well known, however, that almost all of them are carved, engraved and red and/or black painted with secondary (hydrothermal) pigment that can be distinguished from traces of burning (*Srejović and Babović 1983; Radovanović 1996.140*). But it is less known they bear petroglyphs, which we can interpret in accordance with a neuropsychological model of altered consciousness as 'signs of all time' – entoptic motifs and their construals (Fig. 16) and theriantropes (Fig. 17). Topographic markers and landscape representations are attached to some others (Fig. 18). They might have been maps and were perceived as mnemonic devices and as such can be incorporated into Zubrow's and Daly's corpus of prehistoric maps mentioned above. It is worth remembering that similar imagery was also attached to stone, bone and antler tools, and implements (*O.c.*) (Fig. 19).

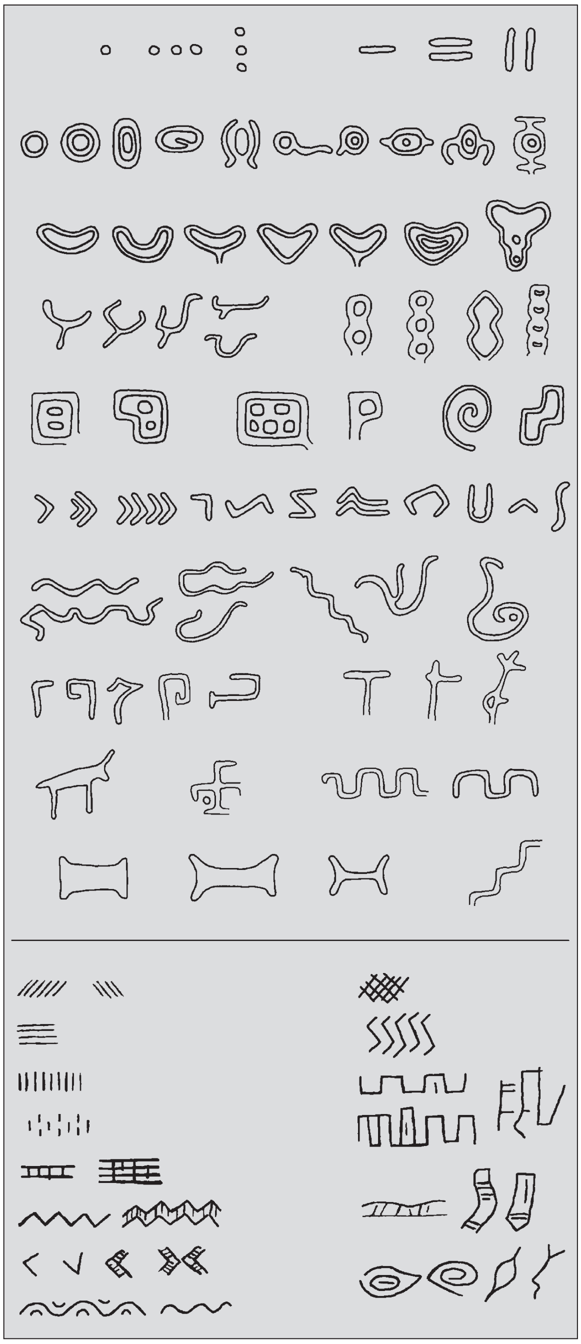

Fig. 19. Lepenski Vir. Engraved and incised imagery attached to stone monuments and stone, bone and antler tools and implements (**after Srejović and Babović 1983.Figs. 29 and 34*****).***

It is well known that they were embedded in hunter-gatherer settlement contexts at Lepenski Vir. But it is less known that they have also been found at

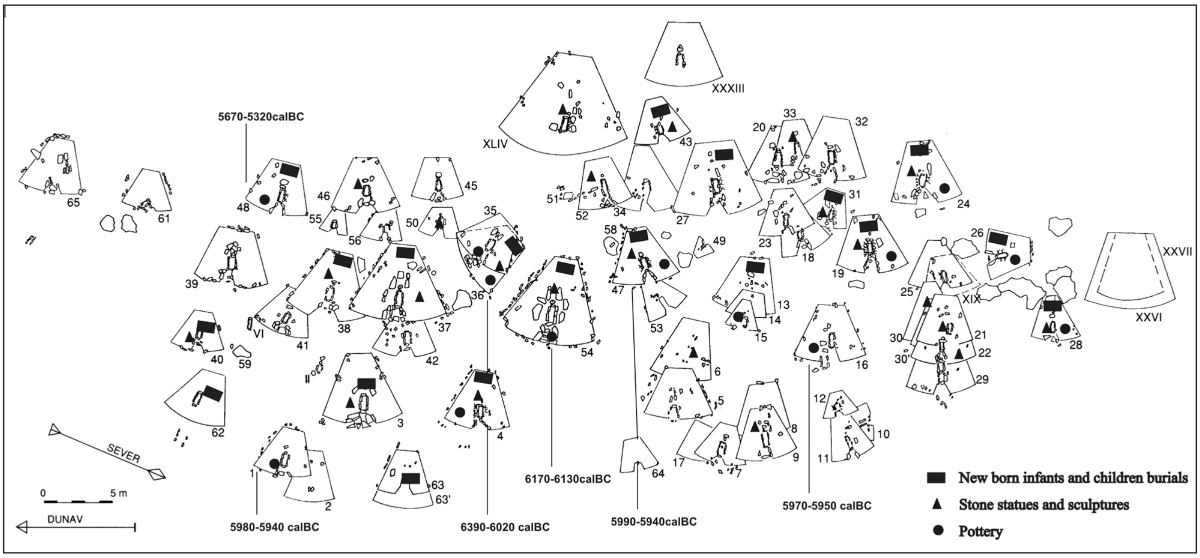

Fig. 20. Lepenski Vir site plan showing centrally positioned trapezoidal building 54, and children burials, stone boulders and pottery distributions (after* Babović 1997.Slika 1; Bonsall et al. 2000.Fig. 8; Borić 2002.Fig. 7*).

Vlasac, Padina, Hajdučka Vodenica, Cuina Tarcului and Schela Cladovei in the Danube Djerdap gorges (*Srejović and Babović 1983.56–57; Boroneaţ 1990. 479*). And it has been overlooked for decades that they were embedded in agricultural settlement contexts at Gura Baciului in Transylvania (*Vlassa 1972. 187–191; Lazarovici and Maxim 1995.379*).

We may hypothesise that hunter-gatherers and early farmers in the northern Balkans and Carpathians transformed the basic rock art principles in a way they made them portable and incorporated them into settlement and dwelling contexts. It is not that they brought and circulated the monuments within and between the settlements, but fixed them inside the trapezoidal buildings.

The sandstone boulders and blocks were brought from some 10 km from the upper stream of a tributary of the Danube. Contextual studies show a clear spatial patterning of monuments within the buildings, as a high percentage of monuments are found behind the hearths at the rear of the houses (*Srejović1969; Srejović and Babović 1983; cf. Chapman 1993.103*) and associated with burials, some of them of new born infants and children (*Budja 2003.352, Fig. 3*). They were not visible from the outside.

Were they institutionalised to mark the houses of ancestors and places of communal rituals, as is widely suggested? Perhaps, although it seems unlikely that the location of standing monuments in the dark confines of the rear of the buildings was conducive to communal, public and open rituals. It would be convenient to hypothesise closed, lineal or kinship shamanic rituals in household contexts, like the shamanistic role in Lepenski Vir already suggested. The male remains in grave 69 show he was buried in a seated position, and it is believed he was a shaman, as the trapezoidal disposal of his skeleton is clearly reminiscent of an architectonic canon which was adhered to for a millennium (*Srejović 1969.90; Srejović and Babović 1983.44–45*).

Freidman and Rowlands presented in seventies (*1977.201–276*) a model of social dynamics in 'tribal' societies whereby competitive feasting in the context of ritual activities may led to the emergence of dominant groups with special status involving control of rites and mediation between the community and the supernatural but also over the production and circulation of goods outside the local territory.

The question of the meaning of the geometric and iconic features attached to the boulders and tools remains. It would be convenient, again, to ascribe them to mental imagery that became part of a complex system of representation, and to prominent shamans who controlled by the agency of altered states of consciousness supernatural potency and manipulate with prestige and power. We must remember, however, that these symbolic storages were spatially embedded on the extremely strict geographical boundary in Danube Djerdap gorges that must have been respected in deep time as much by hunter-gatherers and nomadic pastoralist as farmers.

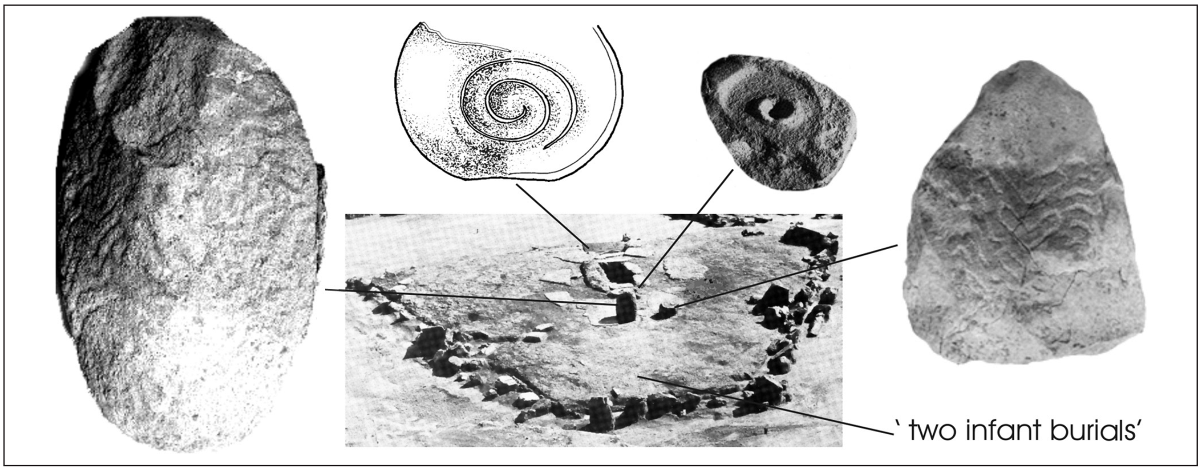

Fig. 21. Lepenski Vir. Symbolic inventory of the building 54 (after* Srejović and Babović 1983.18, 92–93,167; Garašanin and Radovanović 2001.Figs. 1–3*).

Ethnographic evidence of complex shamanic rituals and related depictions show that shamans and their power were clearly recognized in small societies and their internal social dynamics, as well as in external communications and even interactions between foragers and farmers. Thus !Kung (San) Bushman shamans struggle in the spirit world of trance experience against frightening spirits of the dead which during the ritual hover in the darkness beyond the light of the fire. The social relations between Bantu speaking farmers and San foragers are well known. Farmers recognized them as the original inhabitants and custodians of the land, but as the farmers were more dependent on rain, they requested San rain makers to perform rituals, giving them cattle in return. Thus shamans have ideological control over the farmers' economy on the one hand, and a new status as procurers of meat, with the power to distribute it, on the other. If !Kung woman marries into a farming community, in some cases the !Kung families acquire cattle as bridewealth (*Lewis-Williams 1991.150–153; Dowson 1994.337–341; 1998b.336–339*).

The interpretation of the Lepenski Vir iconography is based on the myth that all men were children of the river and descendants of mermen (*Srejović 1972.122; Radovanović 1996a.39–43; 1997.87–91; Whittle 1998.138–145*). Radovanović describes the river as being of critical and central importance as the direction for the passage upstream of the ancestors and the departure downstream of the dead, and as a metaphor for death and endings on the one hand, and life and return on the other.

The annual returns of anadromous fishes, sturgeon (*Acipenser sturio*) and Beluga (*Acipenser huso*) reaching up to 9 metres long and weighing up to 1500 kilograms and living up to 150 years, migrating from the Black Sea and the Mediterranean to the Danube must have been an impressive event, and it is not surprising that fish find their place in the symbolic imagery. But they were not the staple food there and survival did not depend greatly on fishing.

However fish-like forms and theriantropes have been well recorded in external symbolic storages on petroglyphs and stone monuments.

For our approach the important complex symbolic structure at Lepenski Vir is embedded in the centrally positioned trapezoidal buildings mentioned above. It consisted of a hearth positioned in the centre of the building, a ceramic pot placed in front of it, three stone monuments behind it: an altar and two erected boulders bearing petroglyphs, painted red and black, with the mandible of a mature woman deposited within it, and two burials of newborns in the rear of the building. The context is

Fig. 22. Lepenski Vir. Human hands modelled on globular ceramic pot (after* Srejović 1969.Fig. 90*).

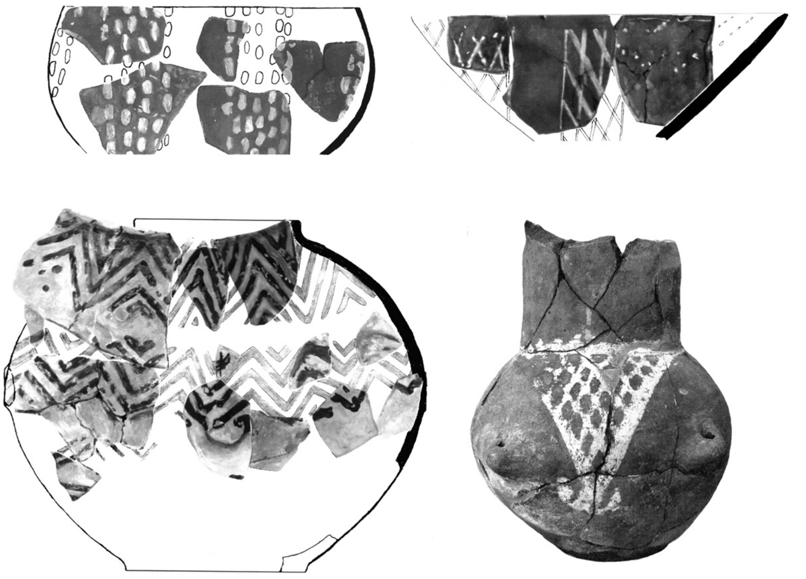

Fig. 23. Gura Baciului and Elešnica. The earliest coloured motifs attached to pottery (after **Lazarovici and Maxim 1995.PC I, III, VII; Nikolov and Maslarov 1978.Fig. 2***).*

radiocarbon dated to 6170–6130 cal BC at 2σ (*Srejović and Babović 1983; Garašanin and Radovanović 2001.118–120; Borić 2002.1032; Budja 2003a.352–355*) (Figs. 20, 21).

We argued recently that pottery was deliberately incorporated into hunter-gatherers’ symbolic structures in the Balkans, and we do not need to consider ceramics as exclusively related to farmers. The almost simultaneous interregional distribution of pottery in the Balkans, Ionia and the Adriatic reflects a network of integrative mechanisms that in some regions predate the farming economy and made possible the selective adoption of crops and/or animal husbandry in others (*Budja 2001.27–47; 2003a*).

It is our belief that pottery in the hunter-gather contexts in Lepenski Vir should not be marginalized to the level of containers and cooking pots, but understood in a complex symbolic scenario as a new medium bearing an old symbol. The vessel was certainly not incorporated into the symbolic structure of the central building by coincidence, and the spiral motif on it was certainly not attached by chance, as it represents one of the basic petroglyph motifs (Fig. 19), which was not applied to any other vessel found there. There must have been ideological reasons for ceramic vessels not having been coloured, although the technical manipulation of pigments and ornamental techniques was broadly applied to stone monuments. The pottery’s ornamentation was limited to finger, nail and awl impressions.

In discussing Lepenski Vir cosmology we should not overlook the particularly narrative symbolism, as shown in a human hands modelled on a large globe-like ceramic pot (Fig. 22). There is again an old symbol on the new medium, giving good reason to believe that the image itself and the act of inscribing it on ceramic vessel are simply parts of a longer chain of operations entailing hunter-gatherers’ rituals and beliefs.

When the ‘painted pottery’ appeared in the Balkans the first coloured motifs attached to the vessels had extremely standardized forms, patterns and colours. They were white and correlate perfectly with the basic list of ‘signs of all time’, which consists of dots, grids, zigzags and parallel lines (Fig. 23). Red and black correlate with more complex motifs and patterns: triangles, squares, circles, spirals, arcs, crosses and meanders which were adopted later (*Schubert 1999; Nikolov 2002*).

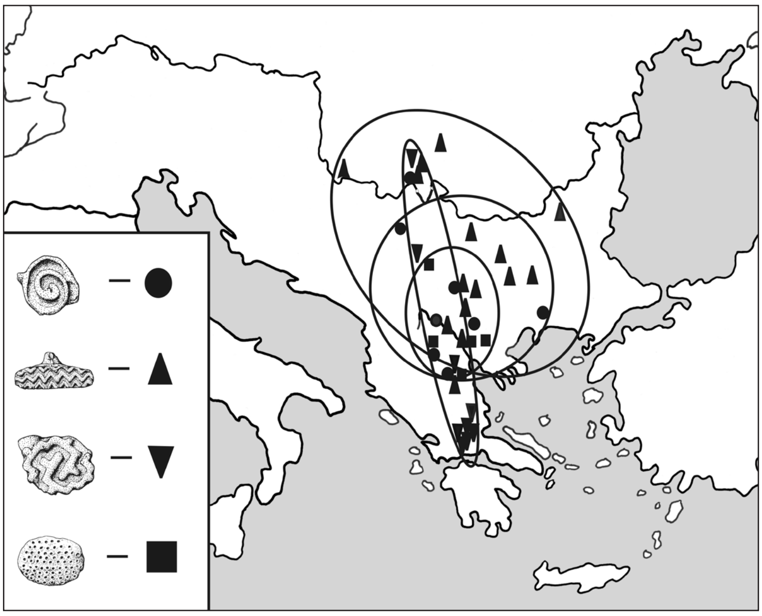

Fig. 24. Regional and interregional spatial distributions of stamp seals (after **Budja 2003.Map 2***).*

The ceramic and stone stamp seals (pintaderas) mentioned above are even better indicators, as they exhibit a chronological and typological sequence, but have more structured spatial distributions that might indicate local, regional and interregional cultural practices and social networks in the Balkans. While a labyrinthine design was decorated the first series of stamp seals in Thessaly, dots, zigzags and spiral designs were distributed in the other parts of the Balkans and Carpathians (*Budja 2003b.115–130*). (Fig. 24)

So, in summary we again point to the complex assemblage deposited in an agropastoralist settlement context at Gura Baciului in Transylvania that has been overlooked for decades (*Vlassa 1972.178–190; Lazarovici and Maxim 1995.379–384*). The similar principles we met in the hunter-gatherer context at Lepenski Vir are clearly recognizable: burials, fifteen sculpted monumental boulders, some placed on ceramic pedestals and stone plates with attached petroglyphs. While the impressed motifs on the pottery are identical to those from the Danube Djerdap Gorge, all the others are white and rarely red, and restricted to grids, zigzags and parallel lines. Stone and ceramic female figurines, and images and animal statuettes are reappeared finally (Fig. 22, 25). We might interpret bovine-like statuettes, supposedly representing Bos primigenius, as an indicator of economic change, as well as the broadening of the hunter-gather symbolic structure.

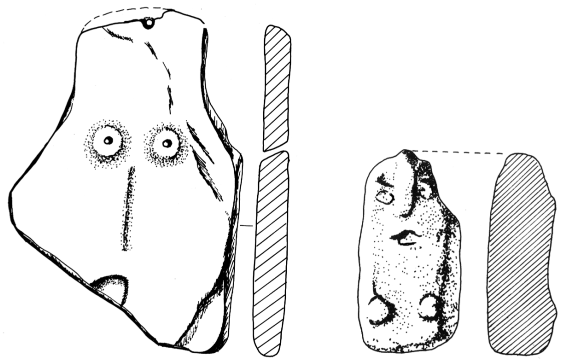

Fig. 25. Gura Baciului, stone plate with attached anthropomorphic image and ceramic female figurine (after* Lazarovici and Maxim 1995.Fig. 21, Fig. 22.1*)

CONCLUSIONS

It would be incorrect not to remind us of Boroneaţ's (*1990.479*) appreciation that the geometric motifs attached to hunter-gatherer tools and implements are identical to those painted on farmers' pottery, and that the "discovery of clay baking and processing towards the end of the Epi-Palaeolithic" in the Balkans and Carpathians resulted in the replacement of stone monuments with ceramic "idols".

We can assume that external symbolic storage employing technical and symbolic culture was therefore a characteristic of hunter-gatherer as much as of agrarian societies. From our arguments here we should expect that hunter-gather symbolic structures in the Balkans and Carpathians maintained long traditions and that the 'revolution of symbols' in the context of the transition to farming is not a paradigm we have to adopt.

Ceramic technology and the principles of fragmentation and accumulation were certainly not the exclusive domains of farmers. As the entoptics, on the other hand, were certainly not the principle exclusively driven in hunter's and foragers' societies that disappeared in the process of transition to farming. We agree with the critical appreciation that any geometric motif by itself can not be identified as entoptic in origin and therefore indicative of shamanism. Nevertheless, the first coloured motifs attached to vessels are extremely standardized in terms of form, pattern, and colour, correlating with the basic list of 'signs of all time'. The same concept was applied to stamp seals. Additionally, both were integrated in Early Neolithic settlements in the Balkans and the Carpathians where some were associated with collections of prestige objects (*Budja 2003.115–130*).

Our basic premise is that the hunter-gatherers' symbolic structures and the process of transition to farming were not exclusive and competitive, but rather correlative in maintaining control and power within society and over the frameworks of external interactions and exchange networks.

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Documenta Praehistorica XXXI

Archaeographic and conceptual advances in interpreting Iberian Neolithisation

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ABSTRACT – *Prehistoric research has evolved, in the last decade, from a mere collaboration of disciplines into a new, trans-disciplinary, approach to Prehistoric contexts. New stable research teams, involving researchers with various scientific backgrounds (geology, botanic, anthropology, history, mathematics, geography, etc.) working together, have learned their diversified "vocabularies" and methodologies. As a main result, a more holistic approach to Prehistory is to be considered. Previous models of the Neolithic on the Atlantic side of Iberia were focused on material culture and strict economics (this being an important improvement concerning previous typological series). Current research became open to discussing the meaning of concepts like "food production", "chiefdom" or "territory". It also dropped the "Portuguese/Spanish" frontier that pervaded previous models (to the limited exception of some interpretations for megaliths). Finally, new and important data is now confirming that the "Cardial Neolithic" coastal spread was only one, and a minor element in the Neolithisation of the western seaboard.*

IZVLEČEK – *Prazgodovinske raziskave so v zadnjem desetletju na osnovi sodelovanja različnih disciplin dosegle nov, transdisciplinarni pristop k prazgodovini. Strokovnjaki z različnih znanstvenih področij (geologija, botanika, antropologija, zgodovina, matematika, geografija itd.), zbrani v novih stalnih raziskovalnih ekipah, so se spoznali z različnimi strokovnimi besednjaki in metodologijami. Glavni rezultat tega je bolj celosten pristop k prazgodovini. Prejšnji modeli neolitika na atlantski strani Iberskega polotoka so se osredotočali na materialno kulturo in gospodarstvo v ozkem pomenu besede (kar je pomemben napredek v primerjavi zgolj s tipologijo). Današnje raziskave pa so odprte za razpravljanje o pomenu konceptov, kot so "proizvodnja hrane", "poglavarstvo" in "teritorij"... Ravno tako smo presegli omejevanje z mejo Portugalska/Španija, ki je vplivala na starejše modele (z delno izjemo nekaterih interpretacij megalitov). In končno, novi in pomembni podatki sedaj potrjujejo, da je bilo razširjanje impresso cardium neolitika ob obali le eno in da je bil to le manj pomemben element pri neolitizaciji zahodne obale.*

KEY WORDS – *Iberia; Neolithic; interpretative models*

Archaeology is a long term inquiry into the past, aimed at recognising major trends and paths. Even the increasingly detailed chronological methods do not enable us to achieve the level of identifying global synchrony. But we are able to characterise territories, to identify migration routes, raw materials exchange, and so forth. Archaeologists may look at adaptation mechanisms, both to environmental changes and social dynamics. They do so approaching resources management or technological improvements, but also inferring social change.

Behind the concepts of Neolithic or Neolithisation rests our notion that the shift towards food production and increasing social complexity was a major achievement from the point of human cultural evolution. This notion derives from a mere observation: in the framework of competition between hunter-gathering and agro-pastoralism, the latter prevailed, enabling demographic growth and wealth accumulation. Regardless of the interpretative models (population pressure or other), the fact remains that in the long term, agro-pastoral models have proved to have greater competitiveness. Agro-pastoralism was a step further towards globalisation, in rendering human behaviour more homogeneous (a process already acceleratiing within later Palaeolithic communities that engaged in specific symbiotic relations).

This Neolithisation is often perceived as progress from the later hunter-gatherer economies towards food production, assuming that animal and cereal domestication and increased social complexity were recognised as an improvement in these societies.

The Neolithic may hence be interpreted as a process of creating an artificial environment, an anthropic environment, filled in by selected species, burned prairies, and stone or wood constructions. Man acted in transforming more stable environments into quantitatively more productive, but less diverse and stable ones. As an example, deforestation enabled crop growth, but impoverished soils and accelerated erosion.

One must pay attention, though, to troubling evidence in this process, which suggests it was not so homogeneous: not all species were domesticated at the same time and in the same way. The earliest evidence varies greatly from site to site. There is a great diversity of strategies: hunting, gathering, animal breeding, and cultivation evolve side by side for over two millennia in Iberia. Behind demographic growth there are signs, in some cases, of seasonal hunger.

The earliest efforts to deal with the issue of the transition into a system once recognised as the origin of our own society were oriented towards the identification of its single, or main, origin. The focus could be on technological improvements (with Lubbock), major socio-economic changes (with Childe), adaptation economics (with Grahaeme Clarke and, later, Eric Higgs), population pressure, or other factors. But the goal was to identify the origin of the process, perceived as a single trend. To a large extent, the different theoretical approaches, from historic-culturalism onwards, "respected" this goal. Not surprisingly, Orientalism was the prevailing explanatory framework, since it provided a "one-sense" explanatory flow. The "wave of advance" model, established by Luca Cavalli-Sforza, is the most coherent expression of this approach: one centre, one process, one cause (even if the latter was subject to debate). We all know the arguments, taking the greater oriental antiquity of domestication, pottery (including cardial pottery) or population pressure, as well as the alleged absence, in the West, of the main domesticated species.

It is curious to notice that the dawn of archaeology was, to a large extent, much open to contradictory explanations, namely when dealing with quaternary stratigraphies. But this was not the case of Neolithic studies, and I believe that a major shift only occurred in the last quarter of the 20th century, when a new generation of models, focused on the process of transition rather than its ultimate result, were developed. The "availability model", by Marek Zvelebil and Peter Rowley-Conwy, and the "islands filter model", by James Lewthwaite, were among these, and the most influential in Iberian studies. More than before, they addressed the issues of local dynamics and continuity, and drew attention to the differences in rhythm of the process: Mesolithic sedentary sites, hunting farmers, pastoralists without agriculture, seasonalism, and so on (*Jorge 1998*).

This new generation of models was a response to the previous rather linear explanations, and provided more questions than answers. It was never a real alternative, but a questioning of earlier approaches. In Portugal, it dominated most of the prehistoric research developed in the last 30 years, but proved to be insufficient to break the previous linear approaches. There is a good reason for this: questioning rather than answering, these models became less popular in an expanding archaeology community, largely oriented to global heritage concerns, who felt the need to start their studies with a basic linear corpus of data associated with the old models. University demography, in this case, was the weapon used by "old timers". In fact, it is significant that three decades of research did not produce a single adjourned manual of Portuguese Prehistory, even if several very important books have been published, namely a "New History of Portugal", with an updated and interrogating Neolithic excellent section by Susana Jorge (*1990*). The manual, actually, would finally be offered by João Cardoso (*2003*), but following the old linear approaches.

In fact, the data accumulated in the last 30 years, largely gathered following the interrogations suggested by the second generation models, now require, at last, some answers (*Cruz 1997; Cruz and Oosterbeek 2000; 2001; 2002a; 2002b; Oosterbeek 1997; 1999*). It is my opinion that only two possible avenues may be followed at present: to resume diffusionism (which offers a coherent explanatory framework) or to build an alternative theoretical background. Let me make a short excursion into the evidence, taking the North Ribatejo region as a case study.

The North Ribatejo is an ecotonal region defined as the confluence towards the Tagus valley of three main geomorphological units. To the east, one finds ancient massif granitic, schist and gneiss formations. To the west are located Secondary limestone hills, and to the south, along the river banks, are recorded Tertiary and Quaternary detritic deposits. The middle Tagus basin, with its tributary main rivers (Ocreza, Eiras, Rio Frio, Moinhos, Zêzere, Nabão/Atalaia and Almonda – all on its north bank) unites these different units.

By the mid 7th to early 6th millennium BC, whereas in the lower, estuarine, part of the Tagus valley, Mesolithic groups were managing the landscape by building shell middens (as in the Muge area), other groups were still mainly mobile (sites of Amoreira, or Coalhos), leaving behind several sites dominated by macrolithic industries, mainly made on quartzite, associated with a flint bladelet industry. The latter is little more than residual evidence composed of broken tools, suggesting that these sites were temporary camps, and that once people left they would leave behind only the broken (flint) and coarse (quartzite) tools. A thorough geo-archaeological review of these sites enabled their clear allocation to the Holocene period (previously doubted by many authors). It is in these macrolithic contexts that pottery and polished stone axes first occur, in the transition to the 6th millennium (sites at Amoreira and, probably, Monte Pedregoso). One must consider that this chronology is equivalent to some Andalucian sites, and slightly older (but, in fact, partially overlapping) than the earliest dates for cardial contexts (Cabranosa and Caldeirão). The bulk of the lithic industry is coarse, dominated by direct abrupt percussion. The location of these settlements suggests an exploitation of riverside resources, including hunting and fishing (although no bone remains exist).

In the second half of the 6th millennium this scenario does not seem to have changed, although a few kilometres to the west, in the limestone area, cardial burials have been excavated (Caldeirão and Pena d'Água). Although we do not have absolute dates for the building phase of the earliest megaliths in the region, they are associated with industries similar to the settlement of Amoreira: coarse pottery, heavy duty tools, scarce flint objects, and polished stone axes. The fabrics of the pottery, and the lithic raw materials, coincide with those found in Neolithic non-cardial sites in the Tagus valley, and indicate a strong divergence from the cardial contexts, which are dominated by good quality decorated pottery and flint objects. One may trace the origins of megaliths in the other margin of the Tagus valley, in the Alentejo region, and one may also find another link between the two regions: rock art.

Thus, one observes that the earliest Neolithic is introduced in the region through two routes. One, occupying part of the limestone area, begins with burial cave contexts with cardial or epicardial pottery (the caves of Caldeirão, Nossa Senhora das Lapas, Almonda and, later, Cadaval, and even a cave as far North as the Alvaiázere mountains). Its probable origin is the Atlantic coast, where Neolithic sailors might have arrived from the Central Mediterranean, interacting with coastal Mesolithic population (*Araújo 1998; Soares 1997; Soares and Silva 2001*).

The other route, which occupies the Eastern and Southern territories, is dominated by macrolithic contexts associated with plain coarse pottery. These are dominant in settlements like Amoreira (Tagus valley), but also in the foundation layers of passage graves (e.g. Val da Laje). Their origin is to be found to the southeast, in the Alentejo, suggesting an inland spread of the Neolithic (*Calado 2001; Diniz 2001a; 2001b; Gonçalves 2001; 2002*).

This approach denies the dual vision of the Neolithic, opposing Neolithic incomers to epipalaeolithic indigenous people, a model long supported by Jean Guilaine (*1996*) and recently re-enacted by João Zilhão (*1992*). In the view of these authors, a more selective use of the available data, relying upon a minority of sites (e.g. the cave of Caldeirão in Portugal), suggests that the Neolithic package expanded to the West associated with cardial pottery, establishing, as J. Zilhão proposed for Iberia, "Neolithic enclaves". But such an exercise leads to difficulties: if the Neolithic is associated with a coastal "cardial spread", why do we find very old cardial ceramics inland? If shell-middens are the result of estuarine adaptation, why do we find them at great distances, like 800 metres a. s.l. and 40 km from the coast? If megaliths are part of a similar trend, why can't we identify a sound structural chronology for them? And if they are not, why can we find so many convergences, both in architecture and art? Why can we see similar bone arrangements in caves and megaliths? Aren't these signs of a web rather than of exclusive enclaves?

At this point we may resume our first arguments. I have mentioned that the questioning of established "truth" has been successfully raised in the past 30 years, but without leading to the construction of a global alternative interpretation model. This is, perhaps, because we are still operating in the "true/false" framework, which is efficient when considering archaeological evidence (objects, moments), but faces difficulties when dealing with temporal sequences (the main goal of our research). The latter are focused on objects' dynamics, and requires a non-Aristotelian framework, with three alternatives: possible (theoretically determined), true (instantly observed), and absurd (not possible).

Since all archaeological temporal distributions are aleatory (their comprehensive description is never shorter than their extension), one has to take this into consideration in the interpretation process. In fact, the available data (radiocarbon dates or other) is never a sample of the total universe of potential data, but a mere fragment of it. One must build a method to approach such aleatory distribution *Bogossian 1997; Chaitin 1975*).

The evidence mentioned above suggests that the Neolithic was a process without major material breaks, with several inter-group mechanisms, in which none of the material elements that integrate the "Neolithic package" needs to be present. A process where news is differentially and selectively accepted by some or imposed to others (see *Vicent-Garcia 1997*).

We are still far from being able to establish a global alternative theory to the current dominating framework that, ultimately, was generated with historical-culturalism. But I believe one head pursue in such a direction, using non-Aristotelian logics and mathematics as a guide.

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Documenta Praehistorica XXXI

Building a method for the study of the Mesolithic-Neolithic transition in Portugal

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ABSTRACT – *This paper focuses on the agricultural transition in Portugal and on demography across this transition, concentrating on two key skeletal samples, the Mesolithic shell midden of Cabeço da Arruda and the Neolithic burial cave of Casa da Moura. It extends our previous work on the demography of the transition and the methodology surrounding its determination. We explain our method for determination of the number of individuals in samples where whole skeletons cannot be used. We then concentrate on the estimation of fertility, placing it within limits of biological feasibility, sample inadequacies, and vagaries of age assessment. From our analysis, which includes an examination of historical issues with the sites, we argue for regional population continuity between 8000 and 6000 calBP, and suggest that Neolithic life-ways slowly intensified, founded on important elements deriving from the late Mesolithic, with changes that included increased fertility through shortening of the birth interval.*

IZVLEČEK – *V članku se osredotočamo na prehod v kmetovanje na Portugalskem in na demografijo pri tem prehodu, še posebej na dva ključna vzorca skeletov – mezolitsko najdišče školjčnih lupin Cabeço da Arruda in neolitska jama s pokopi Casa da Moura. To je nadaljevanje naših dosedanjih raziskav demografije prehoda in s tem povezano metodologijo. V članku razložimo našo metodo za določevanje števila posameznikov v vzorcih, kjer ni mogoče uporabiti celih skeletov. Nato se osredotočimo na oceno rodnosti glede na biološko zmožnost, neustreznost vzorcev in glede na omejitve pri ocenah starosti. Na osnovi naših analiz, ki vključujejo tudi zgodovinske vidike raziskav najdišč, zagovarjamo regionalno kontinuiteto prebivalstva med 8000 in 6000 calBP. Menimo, da se je neolitski način življenja počasi intenziviral na temelju pomembnih elementov iz poznega mezolitika, spremembe pa so vključevale naraščanje rodnosti in skrajševanje časovnega razmika med rojstvi.*

KEY WORDS – *Mesolithic; palaeodemography; human skeletons; Muge*

The dynamics of the agricultural transition constitutes one of the most debated areas of Holocene Old World archaeology (*see e.g. Ammermann and Biagi 2003; Price 2000*). In this paper we will focus on work in Europe and examine the use of human skeletal material, which is critical to any discussion on a demographic transition and population growth contemporaneous with the agricultural transition.

Bocquet-Appel (*2002*) argues that there was a Mesolithic/Neolithic transition in Europe entailing a major change in the nature of population growth. We will explore this concept using skeletal samples from Portugal that span the transition. In particular, we will investigate the large samples of apparently primary burials excavated at the Mesolithic midden sites of the Muge River valley, as compared with the equally large but quite differently interred Neolithic skeletal samples from sites such as the ossuary cave of Casa da Moura in the Estremadura. We will explore, in more depth than previously, the determination of numbers of individuals found within these sites, an issue which is crucial to their use in demographic analyses. As part of this discussion we will use published and unpublished data to examine the history of excavation of the Muge sites, focussing on Cabeço da Arruda, among the most complex of any Mesolithic site in Europe, with a history of multiple excavations going back to the 1860s.

SKELETAL SAMPLES OF THE PORTUGUESE MESOLITHIC/NEOLITHIC TRANSITION AND THEIR CONTEXT – INTRODUCTION

The sites that will be discussed in this paper in varying degrees of detail are in central and southern Portugal (Fig. 1). The two Mesolithic sites, Cabeço da Arruda (henceforth Arruda) and Moita do Sebastião (henceforth Moita), are near the exit of the River Muge into the Tagus, about 30 km northeast of the current Tagus estuary. These sites have had the most complex excavation histories of any European Mesolithic burial sites. First explored between 1863 and 1865 by A. F. Pereira da Costa and C. Ribeiro, they were excavated twice again in the 19th century, in 1880 by Ribeiro and again later in the 1880s by F. de Paula e Oliveira[1]. In the 20th century, excavations occurred in two phases. A. A. Mendes Corrêa excavated Arruda in 1937 with his collaborators, R. da Serpa Pinto, J. R. do Santos Junior and A. Ataíde, following several years of excavation in the early 1930s at Cabeço da Amoreira. In 1951 the bulldozing of the Moita site led to intervention by Mendes Corrêa and excavation from 1952 to 1954 by J. Roche and O. da Veiga Ferreira. Following upon this, excavations were undertaken at Cabeço da Amoreira between 1958 and 1967 under the direction of Roche and Veiga Ferreira, and extended to Arruda in 1964 and 1965. Finally, new excavations at Amoreira have begun under the direction of J. M. Rolão and M. Roksandić, with some section cleaning and stabilization at Arruda. Our primary discussion in this paper is of Arruda, while papers on Moita are in preparation (*Alvim, Jackes in prep.; Jackes, Meiklejohn in prep.*).

The major Neolithic site is Casa da Moura, a burial cave in the Estremadura, a karstic region north of Lisbon. It was first excavated in the 1860's by Delgado (1867) and re-examined by L. G. Straus in the

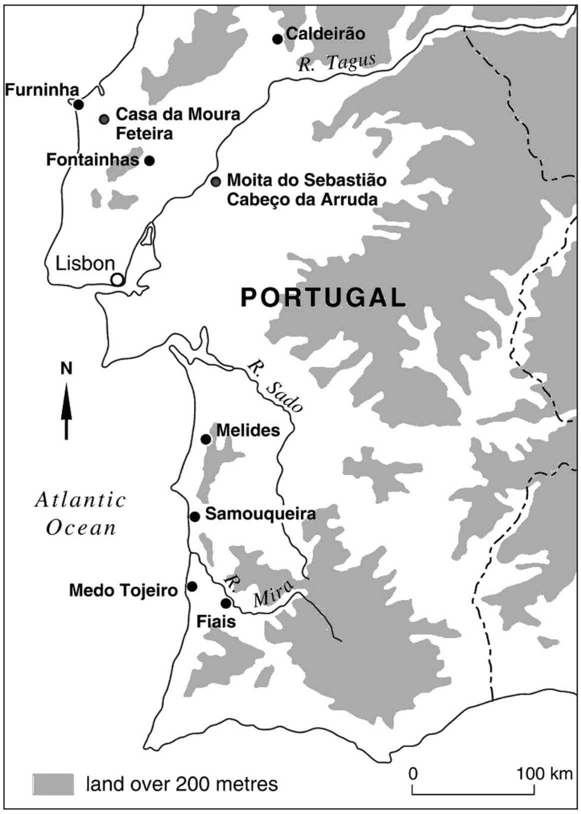

Fig. 1. Central and southern Portugal showing the location of a number of important Mesolithic and Neolithic sites.

1980's (*Straus et al. 1988*). Other sites noted in Figure 1 will be discussed where relevant.

The three surviving midden sites of the lower Muge valley lie on either side of a broad area of marsh through which a channel for the river has been dredged (Fig. 2). Moita and Amoreira lie just over 1 km apart on the south side of the valley, with Arruda just over 2 km to the northeast of Amoreira on the north side of the valley. Arruda lies on the edge of the valley flood plain and has been impacted by flooding, while Moita now lies under a rice processing installation[2].

Work in the 1950s and 1960s produced the first absolute dates for the Muge series, based on charcoal. These were from the Saclay laboratory, very early in the history of ^{14}C dating, with standard errors of 300 to 350 years. At Moita they provided a date for the base of the sequence (layer II) of 7080 bp[3] (*Roche 1957*). At Arruda they provided bracketing dates

1 See, e.g., Cardoso and Rolão 1999/2000, Newell et al. 1979 and Roche 1972. Roche was incorrect in stating that an 1892 excavation took place (*Roche 1972b.75*).

2 The lower Muge Valley is now structured as paddies for the intensive cultivation of rice. Other shell middens were destroyed in the 19th century for the planting of vines.

3 Uncalibrated dates are expressed as bp, while calibrated dates are expressed as calBP.

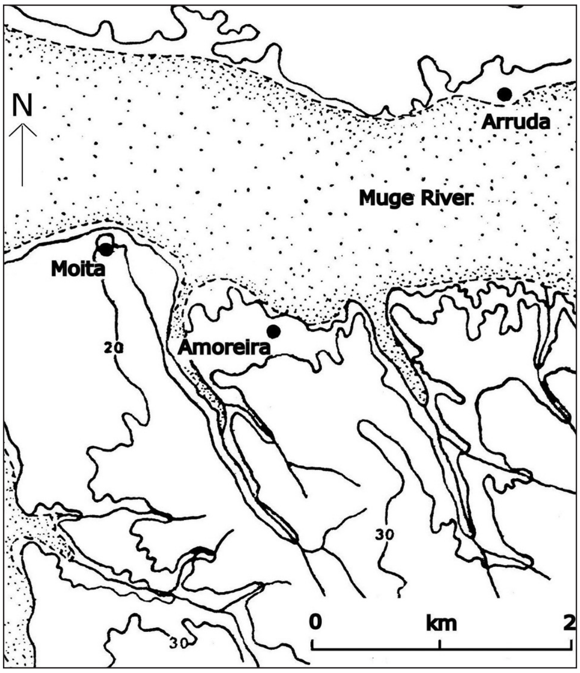

Fig. 2. The classic Muge Mesolithic sites (after **Roche 1972.20.Fig. 2*****). The Muge is an area of marsh (stippled) through which a drainage canal has been dredged.***

for the base and top of the site of 6430 to 5150 bp (*Roche 1965a; 1965b*). At Amoreira there were also bracketing dates of 7030 to 6050 bp (*ibid.*). Any overall chronology of the sites based on these dates was enigmatic at best and none of these dates could be firmly linked to any of the human skeletal material. The best date for Moita was 7080±130 bp for basal breccia charcoal (H2119/1546: *Roche, Veiga Ferreira 1972/73*) and for Amoreira, also on charcoal, 7135±65 bp (Hv–1349: *Soares, Cabral 1984; Kalb 1989*). No good dates were available for Arruda.

As part of our re-examination of the Muge skeletal series in the 1980s the authors, working with David Lubell, instituted a program of new AMS ^{14}C dates directly on the human skeletal material (*Lubell et al. 1994*) to which new dates have been added, deriving for example from the most recent excavations at Arruda by Rolão and Roksandić (*Roksandić in press*). The overall results (Fig. 3) suggest a sequential chronology, though the actual occupation of the sites may overlap. Moita seems to be the earliest with dates covering the period 7240 to 6810 bp. Amoreira with dates from 6630 to 6550 bp seems younger but needs further work. Arruda seems to fit in between, with dates of 7040 to 6360 bp. The more completely dated sites suggest an approximate 400 year time span for the occupation of Moita and a slightly longer 600 years for the occupation at Arruda. The possible sequential occupation of these sites is important in terms of other data that suggest differences between the sites, both in terms of the environment and human biology (for biological variability see *Jackes, Lubell 1999*).

There may be evidence of a change in patterns of environmental exploitation (Fig. 4, *Lentacker 1991*). The graphed data are for terrestrial herbivores on the three Muge sites, derived from the representation of the relevant taxa[4]. The frequency of lagomorphs apparently increases between Moita and the later sites. Suids, cervids and bovids all decrease, which could involve several variables including environment and access to animals within the effective catchment zone of the sites. Some specific non-food related faunal elements may provide other clues: red squirrel (*Sciurus vulgaris*) bones at Arruda indicates the presence of pine forest, as opposed to the current dominance of oak (*Antunes 1985*). Support for increased pine in the vicinity around 7500 calBP comes from the work of van der Schriek (*in prep.; van der Schriek et al. 2003*), which also documents this period as the time of maximum tidewater influence in the Muge. Thus, there were environmental changes over what appears to be a quite restricted time period of the Mesolithic occupation at Muge. Resource changes would have been mediated especially by the rise and fall of the Holocene sea level resulting in a rise and fall of the important molluscan dietary sources, especially *Scrobicularia plana*.

While faunal data may reflect a shift in diet within the period of occupation at the Muge midden complex, we have independently studied this through use of stable isotope determinations of ^{13}C and ^{15}N (*Lubell et al. 1994*). Results for Moita and Arruda, together with other Mesolithic individuals, and a Neolithic series, are seen in Figure 5. The results show a trend away from marine dietary elements towards terrestrial elements. As a series, Moita appears to be more marine than Arruda and both appear to be more marine based than the majority of the Neolithic individuals. There is no major divide in the sequence comparable to the marked shift documented for Danish material by Tauber (*1981; see also Meik-*

4 Material is from 1930s excavations at Arruda and Amoreira, but material for Moita may be from the 1960s (*Lentaker pers. comm. 8.iii.2004*), so there are certainly sampling problems related to the multiple excavations. A rereading of multiple reports on Moita excavations suggests the possibility that the layers containing mammalian bone were removed by bulldozers prior to excavation at Moita in the 1950s.

lejohn et al. 1998). However, the full situation is quite complicated when sample variation and outliers are examined.

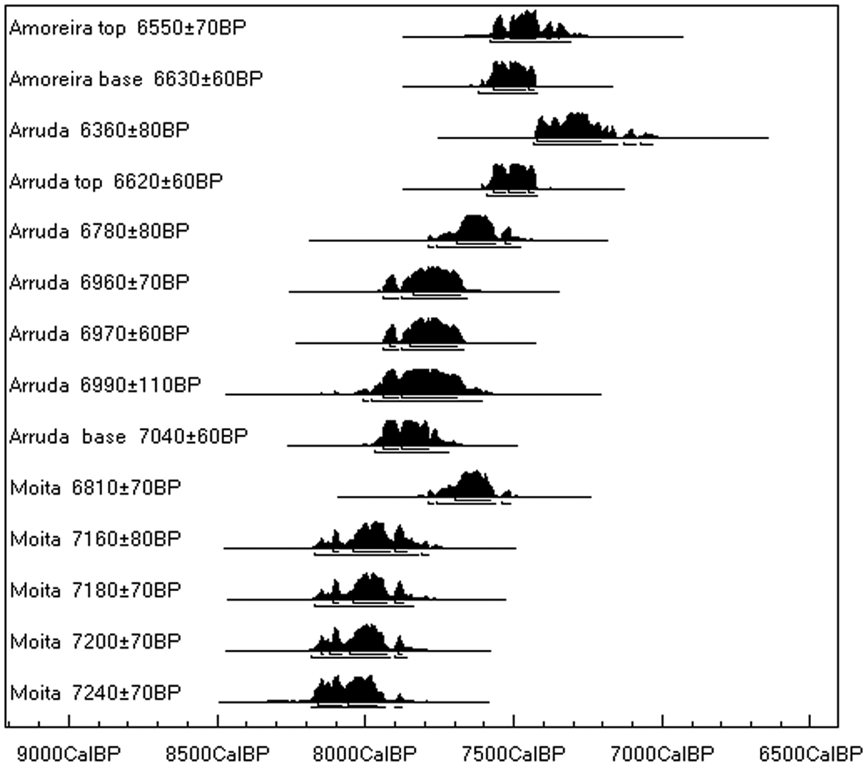

Fig. 3. Calibrated AMS ^{14}C dates directly on the human skeletal material (*Lubell et al. 1994*). New dates, identified as "top" and "base", from recent excavations at Amoreira and Arruda by Rolão and Roksandić (*Roksandić in press*). 1 and 2 standard deviations are shown beneath the probability curves (*Bronk Ramsay 2002*).

How do we explain outliers? Among the Mesolithic individuals we have one with an extremely high $\delta^{15}N$ value (>16), Samouquiera H2, who consisted only of arms when excavated (*Lubell, Jackes 1985*). The individual showed bilateral arthritis in wrists and hands, especially marked on the right side. The body was buried close to Samouquеira H1 who had sustained a major fracture of the right humerus leading to an open infected wound and also had an infected wound of the right foot. Both individuals therefore could be suggested to have disabling trauma, a consequence of which is likely to be a way of life and a diet different from their Mesolithic fellows. In addition, there may be a form of burial different from that for able-bodied people. In the case of Samouqueira, we seem to have people who, in the months before their deaths, were separated from the rest of the population. No other human remains were found among the 286 faunal bones[5] (mostly *Oryctolagus cunniculus*) scattered among the marine bivalves, gastropods and fish covering this cliff-top site.

In the Neolithic sample we have an individual who shows the most extreme marine shift in $\delta^{13}C$ values in our sample. The individual, who can be said to be maintaining a Mesolithic style diet, is our only analyzed individual from the Melides cave of Lagares, demonstrating how much more work needs to be done before we really understand the Mesolithic/Neolithic transition. This individual also has a high $\delta^{15}N$ content in the single stray rib analyzed[6]. One

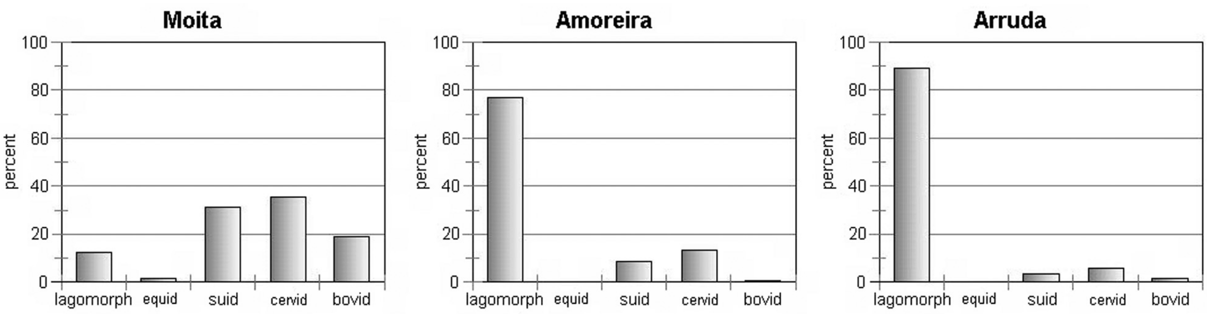

Fig. 4. Percentage representation among selected terrestrial mammals in the Muge collections of the Sala de Arqueologia e Pré-História Mendes Corrêa Museu de História Natural, Faculdade de Ciências Universidade do Porto (*Lentaker 1991.254–255*). The Moita material is, however, in the museum of the Serviços Geológicos de Portugal.

5 The exact number provided by Lentacker (*pers. comm. 19. IX. 1986*).

6 Since the site was an ossuary cave of disarticulated bone, we can say nothing more about this individual. Further analyses are now being undertaken on material from this cave.

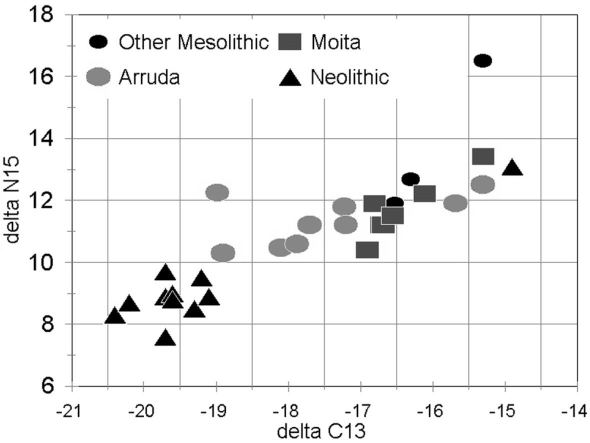

Fig. 5. Stable isotope values for Portugal. "Other Mesolithic" sites refers to Amoreira and to Samouqueira in the outlier position at the extreme marine pole of the diagram.

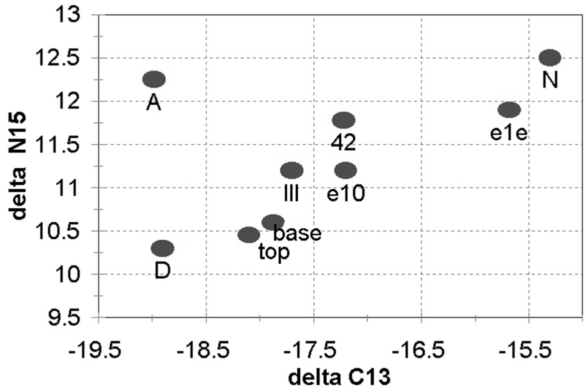

Fig. 6. Arruda stable isotopes. The two skeletons with "e" designations are undated individuals now being studied at the University of Coimbra. The skeletons labelled "top" and "base" are from recent work at Arruda by Rolão and Roksandić (*Roksandić in press*).

Arruda individual (N) is an outlier for the Arruda stable isotope distribution (Fig. 6), with a more marine based diet, and we know that he is exceptional for the Mesolithic population, with spinal changes that included osteoporotic collapse of T.10 and collapse and fusion of L.1 and L.2.

In the discussion above we proposed an initial interpretation from Figure 5 of a gradual shift from a marine to a terrestrial based diet. The conclusion is problematic when outliers are considered and especially when the dates for specific individuals are examined from the site of Arruda (Fig. 6). At the Neolithic "pole" to the left, marked by the most terrestrial shift, are Arruda A and D, individuals falling within the middle of the dated range for Arruda specimens (Fig. 7: individuals with probability ranges in grey)[7]. At the opposite Mesolithic "pole", the most marine-shifted, are Arruda N and an undated sample from 20th century excavations now being analyzed by Eugenia Cunha, University of Coimbra. Interestingly, Arruda N provided the youngest date in our Arruda time series at 6360 bp. As a result, there is evidence contrary to a clear temporal trend within Arruda, the site which may provide our longest occupation span. On the other hand, a possible interpretation of Arruda N stable isotopes would focus on the date as illustrating a trend towards the reduction of tidewater influence in the Muge, and thus a reduction of estuarine resources. There may have been pressures for seasonal travel far down the Tagus River.

This interpretation of Arruda N depends on a manipulation of the date of this individual. Critical to the entire question of Muge Mesolithic dating is whether the reservoir effect is skewing the dates. The date alteration for a 100 percent marine diet entails an age offset of 253±29 years for Portugal (*Monge Soares 1993*). The results of calibration with a reservoir effect correction estimated from the stable isotope values for each individual are seen in Figure 8. At the top of the diagram we have dates estimated for individuals (like Arruda N) with stable isotope values indicating a large marine component in the diet. At

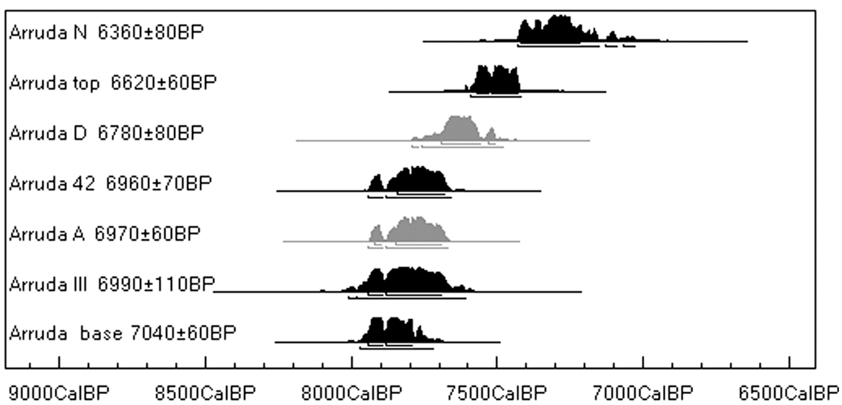

Fig. 7. Arruda dates (*Lubell et al. 1994; Roksandić in press*). The probability ranges in grey are individuals with low δ13C values.

7 A single further Arruda date with –19 $\delta^{13}C$ has been published (*Cunha et al. 2003.185*) which suggests that this pattern was established 600–800 years earlier, although the other Muge dates also published here are more congruent with previous information.

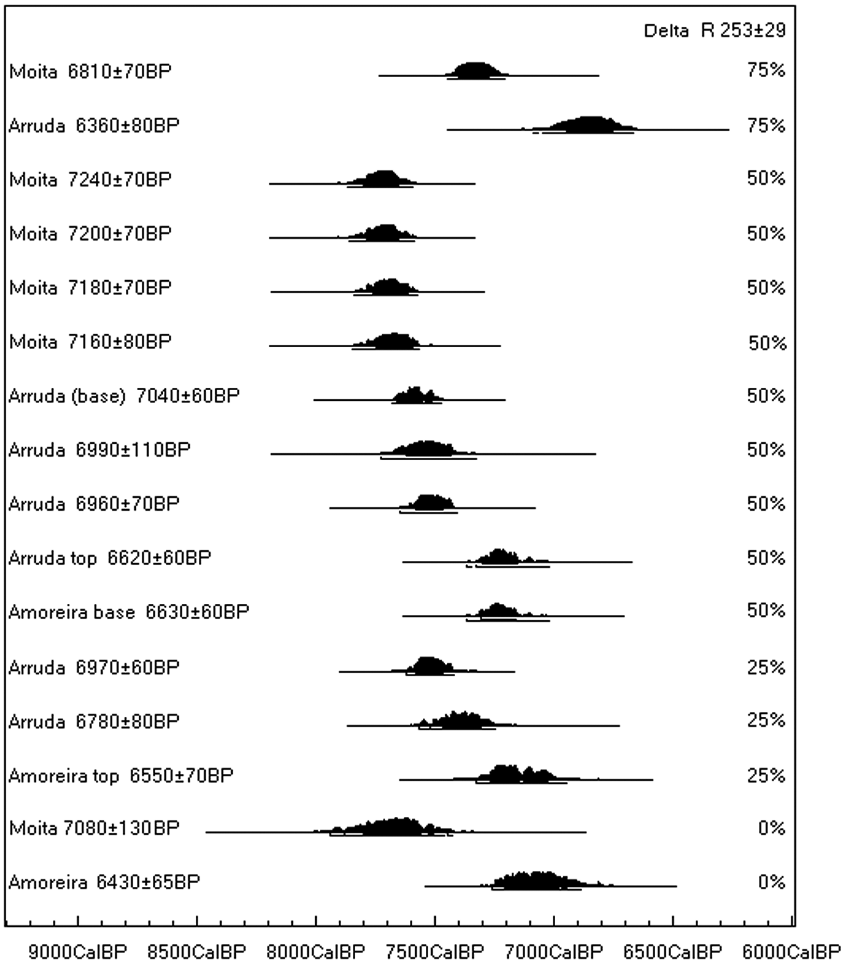

Fig. 8. Human bone from Muge Mesolithic middens with dates recalibrated by mixing curves based on estimates from the stable isotope data for the same individuals. With 50% the intcal 98 and marine 98 curves are mixed equally. The material with 0% marine resources considered in the date calibration are charcoal samples: Moita H2119/ 1546 basal breccia level (**Roche, Veiga Ferreira 1972/73*****); Amoreira Hv-1349, basal level 39 (*****Soares, Cabral 1984; Kalb 1989*****).***

the bottom are dates calibrated without a marine shift, because the dated samples are charcoal. Thus, from bottom to top of the diagram, we have increasing degrees of marine correction based on stable isotope figures, within the four groupings, showing no reservoir effect and marine corrections for 25 percent, 50 percent and 75 percent marine diet respectively (these are no more than rough estimates of the percentage of marine dietary component). The dates on human bone are from our own database, with the analyses undertaken by Henry Schwarcz (McMaster University) and by Isotrace (University of Toronto). No early Saclay dates are shown. It is of interest that, using reservoir effect corrections, Arruda N (together with Samouqueira, TO-130 6370±70 bp) is found to be a little younger than Mesolithic dates from Vidigal (Gx-14557 6030±180 bp charcoal) and Fiais (ICEN-141 6180±110 bp faunal bone), and equivalent in age to TO-953 (5990±60 bp, a human bone date from Casa da Moura), when the latter is calibrated with a 25 percent marine correction[8]. All these five dates calibrate as younger than the earliest Portuguese Neolithic date, Oxa-1033 (6130±90 bp on Ovis bone from Caldeirão). The conclusion is that an assumed gap in time and stable isotope values between the Mesolithic and Neolithic in Portugal may be an artifact derived from incomplete analyses.

THE ARRUDA SKELETAL SAMPLE AS A BASE FOR DISCUSSION OF THE MESOLITHIC/NEOLITHIC TRANSITION

With the above discussion demonstrating Mesolithic heterogeneity and the difficulty of pinpointing a "moment of transition" to the Neolithic, we turn to the more specific question raised at the beginning of the paper, can the human skeletal data from the site of Arruda be used to develop a method for examination of the demography of the Mesolithic/Neolithic transition? We look at the history of the site and then at the extant skeletal sample that we have been working with for twenty years.

The site of Arruda is a large, roughly oval, midden on the north side of Muge River valley. At the edge of the valley flood plain, it was 95 by 40 m, with a maximum depth of deposits of 5 m (*Pereira da Costa 1865*) or 100 by 60 m, with about 7 m depth of deposit (*Ribeiro 1880*). The excavations by Pereira da Costa in 1863-1864, and by Roche and Veiga Ferreira in 1964 and 1965, identified four Mesolithic phases below the plough zone and disturbed soil, from top to bottom, levels A to D. Only half the mid-

8 Information on radiocarbon dates cited can be found at http://intarch.ac.uk/antiquity/jackes/dates.html

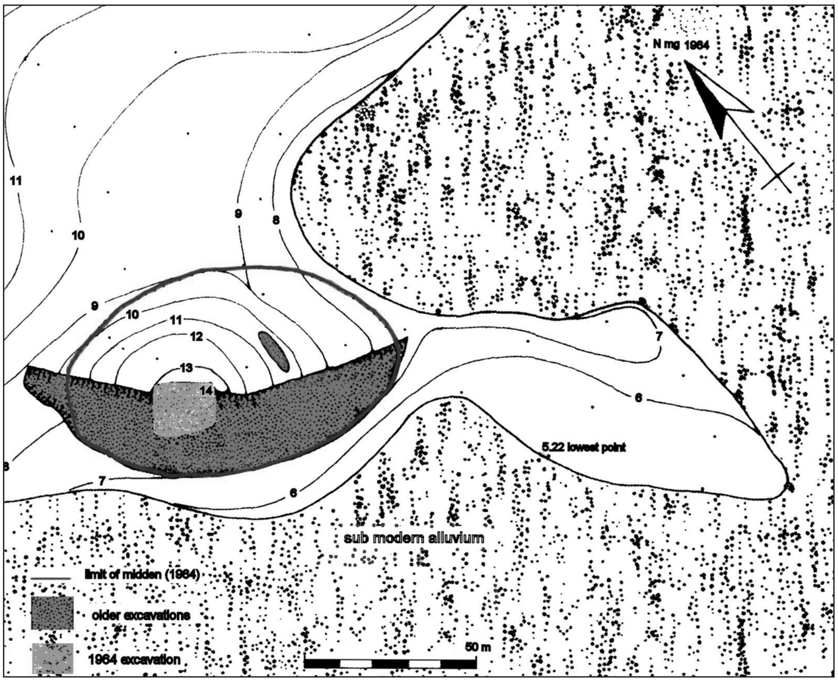

Fig. 9. Plan of Arruda, illustrating that about half of the midden has been excavated (modified after* Cardoso, Rolão 1999/2000. Fig. 56*).

den has been excavated to date (Fig. 9), and the skeletons from that half have an extremely convoluted excavation and curation history.

The initial excavation of the site, by F.A. Pereira da Costa of the Serviços Geológicos de Portugal, followed the discovery of several shell middens along the Muge by Carlos Ribeiro in 1863. This excavation apparently unearthed around 45 individuals mostly recovered from the base of the site in level D (*Pereira da Costa 1865.7,13*) (Fig. 10). It appears that the material from the original excavations was destroyed by fire in the last quarter of the 20th century[9]. However, even in the late 1920s Vallois could not find the first skull, that of a male, from the 1860s excavations, and considered it likely that it was already lost in the 1880s (*Vallois 1930.353*). He found only four other Arruda skulls in the Zoological Museum (*ibid. 356*) and it appears that he found no post-cranial remains whatsoever. A number of the finds were illustrated in the original publication (*Pereira da Costa 1865*) and we can confirm that the illustrated mandibles are not now in the Serviços Geológicos museum (Fig. 11). Studies of Arruda dentitions used only material in the Serviços Geológicos museum (*Sueiro, Frazão 1959; LeFèvre 1972*)[10].

There is then a gap of fifteen years until the reopening of the site in 1880 associated with the International Prehistoric Anthropology and Archaeology Congress that was held in Lisbon in that year. Ribeiro opened up a further area of the site in order to provide a field trip for attendees at the Congress. This excavation again made it clear that the burials were not randomly distributed across the site (Fig. 12) but were grouped in the southwest part of the mound (*Paula e Oliviera 1889.74*). The skeletal material again came from a single level, presumably

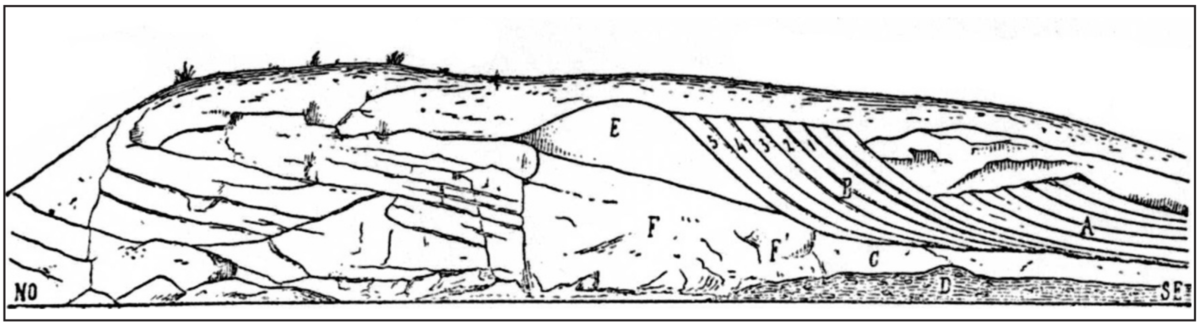

Fig. 10. Cross section of 1865 Arruda excavation showing localization of skeletons in one section of the basal layer of the midden – layer D on the lower right. The section goes from the north west (left) to the south east (right) and was first published (without a scale) by Pereira da Costa (*1865.6.Fig. 2*).

9 The material was stored at the Escola Politécnica which became the Faculty of Sciences of the University of Lisbon. On 18th March, 1978 the Museu e Laboratório Zoológico e Antropológico da Universidade de Lisboa (Museu Bocage) was destroyed by fire.

10 This was true even though Sueiro had assisted Vallois in searching for material at the Faculty of Sciences museum where he worked in the 1920s (*Vallois 1930.339*).

the same level as the material recovered in 1865 (Fig.13, level D). In addition, Ribeiro suggested that the skeletons were roughly aligned (*Ribeiro 1880.286*). Pereira da Costa (*1865.13*) had in fact suggested that the skulls were oriented to the NW). The number of skeletons recovered at Arruda in 1880 is unclear: over 120 individuals were said to have been recovered jointly from Arruda and Moita (*Ribeiro 1880. 285*).

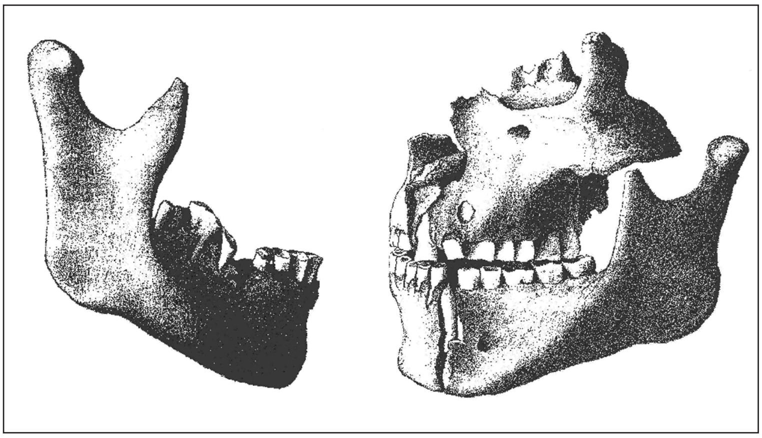

Fig. 11. Some of the Arruda skeletal material excavated in 1865 (selections from* Plate I and Plate II Pereira da Costa 1865*). The illustrated specimens are distinctive so that it can be confirmed that they are now lost.

Again in the mid 1880s more excavations were undertaken, this time by Francisco de Paula e Oliviera, Ribeiro having died in November 1882. Further remains were recovered, in June 1884 "13 human skeletons, some in truth very damaged, of individuals of various ages", and in June 1885 "the remains of 39 individuals for the most part in a very good state of preservation" (*Paula e Oliviera 1889. 59*). However, it is very likely that none of the 1885 skeletons came from Arruda. Paula e Oliviera indicated that "I barely got one skeleton in bad shape" (*Paula e Oliviera 1889. 59*) from Arruda[11]. Later excavations also recovered far fewer remains. The remains associated with the excavations of the 1930s were deposited in Porto and when examined by the authors were not in a condition to permit study. Most were removed en bloc and had not been cleaned and prepared, but original reports suggested 11 individuals had been excavated. Roche and Veiga Ferreira recovered only 13 graves in 1964 and 1965 and the finds have not been studied. As a result, any discussion of the human skeletal material from Arruda is largely concerned with finds recovered in the 1880s. In the late nineteenth century, it was believed that the Arruda skeletons stored in the Muge collection in Lisbon numbered no more than 41 individuals (*Hervé 1899. 267*).

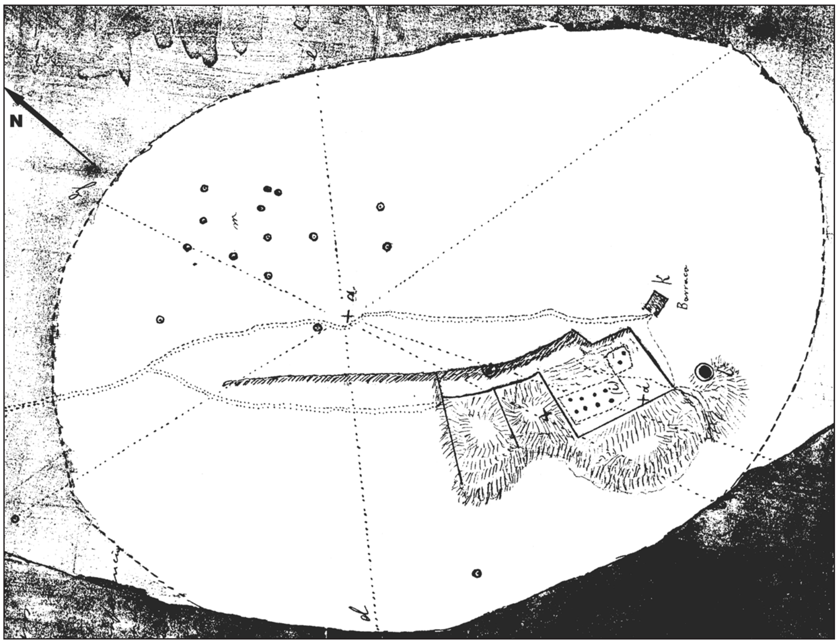

Fig. 12. After a plot by Carlos Ribeiro of the Arruda midden excavations in 1880. We are shown the locations of skeletons among the piles of back dirt. Another plot dated 15th April, 1880 detailing the location of 15 skeletons makes it clear that the points marking the skeletal finds here are extremely approximate. This and a number of other records of the 1880 excavations were found in the archives at Serviços Geológicos de Portugal and copied by David Lubell, 20th June 1989. It is believed that this material has now been deposited in the archives of Instituto Geológico e Mineiro, but has not been accessioned (*Pedro Alvim pers. comm. 13. II. 2004*).

11 A letter dated 4th June 1885 from Paula e Oliviera to Nery Delgado indicates that all the human material excavated in 1885 is likely to have come from Moita (*Alvim pers. comm. 13.II.2004*), neither Arruda nor Amoreira having produced results. For further discussion see *Alvim and Jackes in prep.*

The study of Arruda has presented logistical problems for the authors of this paper. Neither the full site nor the associated skeletal remains have ever been published in a single definitive study comparable to that of Moita (*Ferembach 1974; Roche 1972*). Meiklejohn first inventoried the collection in 1969 as part of an earlier study (*Meiklejohn 1974*). We both studied the material in 1985, and Jackes reexamined the collection during work at the Serviços Geológicos that extended from 1986 to 1989. As part of the research reported here we have recently spent 3 months in a re-examination of the mandibles, using photographs taken by the two of us, records of detailed observations and measurements, radiographs and field notes.

The major problem is that, although the material has been consistently curated in the same facility at the museum of the Serviços Geológicos in Lisbon, the material has been mixed. Extensive examination of the historical records shows three different potential bases for this. The earliest may relate to the original conditions of burial. Perhaps these were not always the single inhumation burials that are usually inferred, a question raised in the early publications, but it is most likely that the grouping of burials led to disturbance of earlier by later inhumations, to the extent that the original report spoke of skeletal elements found "pell-mell" and "in the most bizarre positions imaginable" (*Pereira da Costa 1865.15*). A second potential source of mixing is at the original time of excavation and subsequent deposition in museums. The 1880 excavations involved the exposure of the burials considerably prior to the International Congress, and participants at the Congress were permitted full access to the burials during the field trip, so mixture may have occurred at that time. The materials excavated in the 1880s were then subject to over 120 years of curation under circumstances such that mixture of material was almost inevitable. Individual bones were never labelled and the open drawer system (in place until we reorganized the material in closed boxes from 1984 to 1986) invited misplacement of bone. We thus have a situation where the material is curated as individual inhumations but many of these are not "individuals". One "individual" has 66 metatarsals, including 13 left second metatarsals and another includes nine right and six left clavicles[12]. Yet a third ("individual" M) has 41 separate maxillary and mandibular fragments actually representing 21 separate individuals.

The photographs from Arruda in 1880 (e.g. Fig. 13) give a reasonable sense of the distribution of the finds within a single level and they also help us understand that there were problems made obvious by the following quotations: "One sees also bones here and there, placed in confused heaps as if they had been gathered together once the flesh was gone; but *in the majority of cases* they are in their natural articulations..." (*Cartailhac 1886.57*) and "Because the bones were *generally* grouped according to their natural articulations, it is possible, *most often*, to collect separately those of each individual..." (*Paula e Oliviera 1889.72;* our emphasis). The problems can also be seen in the plots from the 1964 excavation of Roche and Veiga Ferreira (Fig. 14). Whether the skeletons numbered 6, 7 and 9 in this diagram represent two or three people could only be confirmed by detailed study.

The suite of problems stemming from the history of the site can be summarized as follows:

❶ In the 1860s it was already obvious that there were "bones not belonging to the skeletons" (*Pereira da Costa 1865.16,18*) and that the complete ske-

Fig. 13. One of two photographs of the 1880 Arruda skeletons known from various publications. This photograph appeared in 1908 (*Anon. 1908*). The view is towards the south east along the excavation face and across the skeletons marked schematically by dots in Figure 12.

12 These were unnumbered individuals, called TO and SH by our project.

letons had, mixed among them, other bones (*ibid. 18*). Since no material from the 1860s is extant, we can no longer judge the extent to which material was selectively retained.

❷ However, it is clear from the descriptions that not all bones were kept in the 1880s: "...the number of human skeletons that were recovered, *even leaving aside the bones which were abandoned because of their bad condition*, is truly considerable." (*Paula e Oliviera 1889.71,* our emphasis).

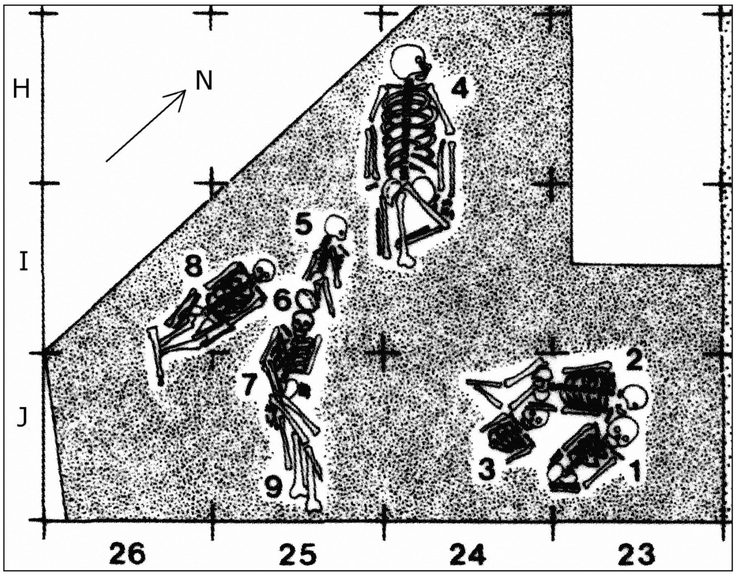

Fig. 14. After a plot from the 1964 Arruda excavation of Roche and Veiga Ferreira (Cardoso, Rolão 1999/2000.Fig. 57:227).

❸ At the time of the study by Vallois there were 42 drawers of Arruda material in the Serviços Geológicos museum (these remained until the early 1980s), but parts of two or three individuals were found in some drawers (*Vallois 1930*). Mixing was already a problem. Vallois also stated that he could not find a skull, a female, which had been deposited in the Serviços Geológicos museum. Vallois saw 20 to 25 Arruda skulls and some further cranial fragments (*ibid. 340*). He also studied some postcranial material, writing that he hoped someone would undertake the work of trying to redress the errors and reconstruct the bones (*ibid. 365*). Vallois considered that there was no possibility of matching skulls with postcrania (*ibid. 364*).

❹ The material recovered in the excavations of the 1930s was sent to the Instituto de Antropologia Mendes Corrêa, Universidade do Porto. We attempted, independently, to inventory these materials: Meiklejohn in 1969 and Jackes in 1984. Although 10 or 11 individuals were said to be present (*Cardoso, Rolão 1999/2000. 172–179*), fire and subsequent flooding in 1974 (Huet Baçelar pers. comm.: August 1984) have complicated matters. When inventoried in 1984, it was clear that labels had been lost: most material at the Mendes Corrêa Institute was from Moita so that it could be checked against an earlier Moita inventory (*Ferembach 1974*), and there was obvious confusion after the fire. Of four Arruda individuals inventoried in 1969, one child from 1933[13] and three adults from 1937 can be clearly recognized in the 1984 inventory. In 1969 the adults had had skulls and mandibles: the skulls and mandibles were not found in 1984. In addition, other material was found with Arruda labels in 1984, including a child aged about 7 and a child aged about 13, both with dentition. Other material was unlabelled, and it could have come from either Arruda or Amoreira[14].

❺ In 1964 and 1965 Roche and Veiga Ferreira excavated 13 "skeletons", apparently from the basal levels of Arruda (*Newell et al. 1979,* based on conversations with Roche in Paris in 1978). These had been placed in a rented storeroom separate from the Serviços Geológicos premises, and there was apparently no recollection of this, either in 1969 or in the period 1983–1989. They were rediscovered in 2000, and therefore have not been examined in detail[15].

❻ By the 1980's, when we began our work at the Serviços Geológicos, there was obvious mixing among individuals in the drawers. There was also loss of identification due to mixture and loss of labels[16]. In some cases material from a single individual had been dispersed, some elements being kept

13 A limited amount of work was done at Arruda in 1933 (*Cardoso, Rolão 1999/2000.170*).

14 Lentacker (*pers. comm. 8.III.2004*) confirms that problems caused by the fire were exacerbated when some of the faunal collection labels were destroyed by the water used to extinguish the fire. Meiklejohn worked on human material in a storage area which was later damaged by the fire. By 1984 this material was widely dispersed throughout the building.

15 All dental elements were photographed in detail by David Lubell (23 April, 2002).

16 Individual bones were never labelled with specimen numbers. Some, but not all, crania and mandibles were labelled. Detailed notes kept by the authors allowed us to track mixing which occurred during the visits of one or two other researchers even within the short period 1984–1986. Further mixing had occurred by April, 2002 (*Lubell pers. comm.*).

in glass cases for display. The absence of any previously published inventory complicates any attempt to provide a catalogue raisonée. However, comparison with the similar problems in the Moita collection is illuminating. Ferembach prepared an apparently complete inventory of Moita prior to 1965 (*Ferembach 1974*). The same material was independently inventoried by Meiklejohn in 1969, without knowledge of Ferembach's results. When both of us did a third inventory in 1984 and 1985, the discrepancies became apparent. While some of the descriptions were in agreement for all three inventories, all other possible agreements and discrepancies were observed, the most discrepant being totally different number associations in the three inventories. In addition it became clear that no inventory prior to 1984 had involved full cleaning of the material. We cleaned material in 1984 and 1985 that could not previously have been inventoried accurately. An example of this can be seen in the reported number of Moita teeth: Ferembach (*1974*) reports only 428 teeth, whereas preliminary estimates from the inventory of 1984 and 1985 list 889 teeth (*Meiklejohn et al. 1988; Meiklejohn, Zvelebil 1991*).

ARRUDA AND CASA DA MOURA: HOW CAN WE COMPARE THEM?

In studying the Portuguese Mesolithic/Neolithic transition we must compare Casa da Moura, a Neolithic ossuary burial cave (by definition a site with disarticulated and mixed individuals), with a Mesolithic site, traditionally regarded as having individual in-flesh burials. Even without the problems of Arruda, for which questions surround the burial practices, the excavations and the post-excavation history of the material, we would need careful consideration of methods in dealing with samples for demographic analysis. This is the core problem set up in the introduction to the paper and we will use mandibular counts as a basis for discussion of demographic questions at the Mesolithic to Neolithic transition.

Palaeodemography demands exceptional care. In making statements based on inadequate and possibly incomplete samples, covering periods of time which are, at best, partially defined and generally too long for satisfactory demographic study, anything less than extreme caution is injudicious. To compare skeletal samples from different sites, it is necessary to use comparable methods of analysis for each site; methods of calculating the numbers of individuals must be comparable; methods of age assessment of both adults and subadults must be comparable, because different methods give different results (*Jackes 1985*). Consistency is critical.

Taphonomic studies show that mandibles provide the highest number of elements in most skeletal collections, whether human or non-human. Use of mandibles allows for the maximum estimate of numbers in a site, different in many ways from the "minimum number of individuals" (MNI). Mandibles are more sensitive to details than other skeletal elements, carrying a great deal of information, and the use of mandibles also allows refitting even when clean reconstructable breaks are absent.

Delgado (*1867.46*), in writing about Casa da Moura, recognized that the number of mandibles would give a much higher count of individuals than would the number of skulls, whole or fragmented, and especially the number of maxillae. But in sites where teeth are not retained in the alveoli, it is necessary to enquire also: 1. whether mandibular teeth are more often retained in the jaws and 2. whether mandibular teeth are more likely to be represented in the deposits than maxillary teeth, whether in situ in alveoli or loose. Neolithic sites contain many loose teeth and it becomes clear that more teeth are retained in the mandibles than in the maxillae. Figure 15, in which loose teeth are plotted as a percentage of total teeth, shows that fewer mandibular teeth are found loose in all tooth classes. As a result, this means that the lower teeth can be studied in more

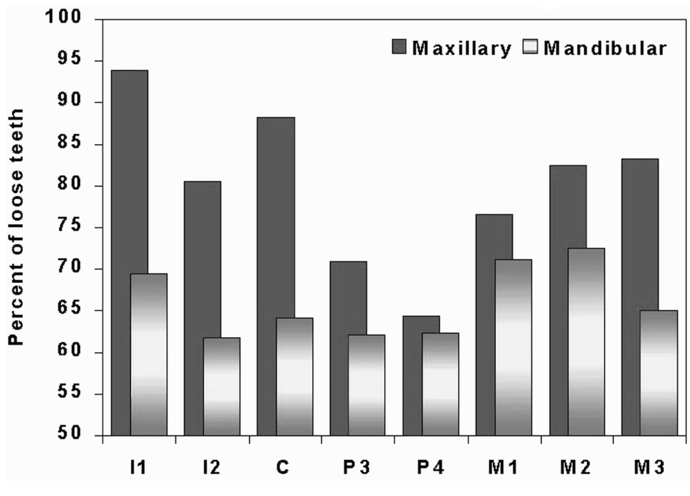

Fig. 15. Percent of loose teeth in Casa da Moura, comparison of maxillary and mandibular dentitions (*after Jackes, Lubell 1995.Fig. 8a*).

detail, that their identification is more certain, and that fewer will be left unrecovered from the back dirt piles of an excavation. In fact, Delgado clearly stated that "maxillae are very rare while on the contrary mandibles are very abundant, and above all mandibular teeth..." (*1867.46*) and drew attention to parallel findings by Lartet with regard to non-human remains at Aurignac. This pattern is now well documented in vertebrate taphonomy.

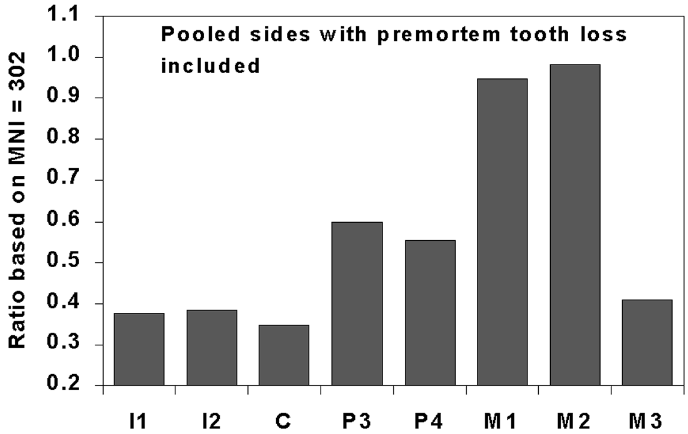

*Fig. 16. Preservation of information on permanent mandibular teeth at Casa da Moura (***after Jackes, Lubell 1995.Fig. 10***).*

Furthermore, we have concentrated on molar teeth because, in Neolithic sites, up to 30 percent more molars are preserved than the next most common tooth types (premolars and canines). This is true of other Portuguese Neolithic sites that we have studied, besides Casa da Moura (*and see e.g. Jackes, Lubell 1995. Fig 9* for comparison with a site studied independently, though using the same dental identification methodology). Figure 16 shows the ratio of the observed to the expected number of teeth based on the MNI for Casa da Moura. If all teeth for the total MNI were present, the ratio shown on the y axis would be 1.0: the second mandibular molar representation approaches an observed versus expected ratio of 1.0.

Figure 16 reminds us that we need to look at more than the intact teeth that have been recovered and thus can be directly studied. We need to consider teeth that have been lost pre-mortem, from pathology or accident[17]; thus, the more alveolar sockets, the better. Unfortunately, such an approach means that the estimated number of older adults based on a sample partially made up of loose teeth will always be slightly wrong. The estimate of the ratio of subadults to adults may be too high for the Neolithic sites with many loose teeth, because information on premortem tooth loss may be gone. This must be emphasised – **it is very possible that the number of older adults in Neolithic sites will be underestimated and the effect of this will be to give an apparent increase to the rate of fertility in the Neolithic in comparison with the Mesolithic**.

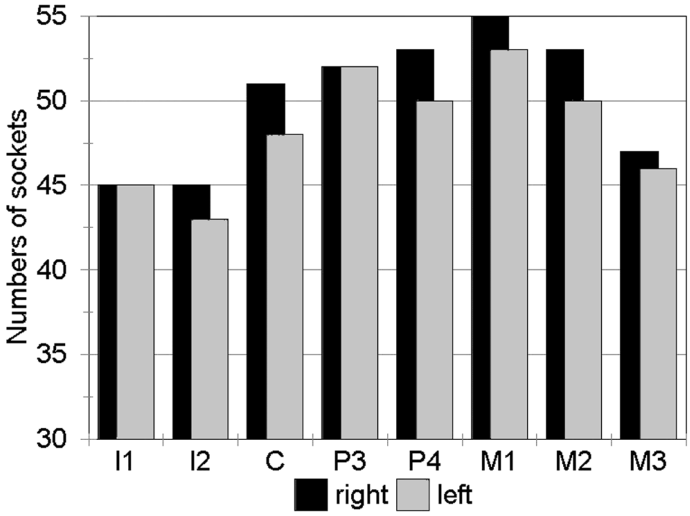

Fig. 17. Classic MNI study of Arruda mandibular sockets allows us to examine not just intact teeth, but also antemortem tooth loss and postmortem tooth loss. MNI based on Arruda adult mandibles in the Serviços Geológicos, Lisbon 1984–1989.

For Casa da Moura we obtain an MNI of 302 individuals with adult molars, derived from both the right lower M1 and the left lower M2. This is based on teeth with root development at least half completed or teeth fully erupted.

Figure 17 provides a classic MNI type study for Arruda. This figure illustrates sockets so that we can examine not just intact teeth, but also both antemortem and postmortem tooth loss (in this case loose teeth are not involved, so that empty sockets can be taken into account). We can immediately see that the 42 skeletons that were assessed as the total number of all ages from infants to adults between 1880 and the late 1920s when Vallois (*1930*) looked at them, can-

17 Naturally, sockets that have lost teeth postmortem cannot be counted, since the shed teeth will be present in the deposits and must be assumed to have been counted.

not encompass the full number of individuals represented in the Serviços Geológicos museum. The figure clearly indicates that the MNI for adults alone must be around 55, based on the value for RM_1. However, the use of mandibles allows one to go beyond the classic MNI count for a site, since MNI depends on the side with the highest count.

Our results are based on the reconciliation of three different inventories undertaken by the two of us, together and independently, from 1984 to 1989. Our records also include photographs, details of tooth status, attrition, pathology, measurements, notes and reviews of the refitting of mandibular fragments found in separate drawers and glass cases. We have obtained a remarkably consistent picture regarding the representation of sides and tooth types, based on 85 mandibular fragments aged 15 and above (including intact and fractured teeth, empty sockets, cases of premortem tooth loss and agenesis). And the use of mandibles clearly produces a result that is higher than the just derived MNI of 55 adults (Fig. 17).

Primary work had in fact already shown us that 55 was not the maximum number of adult individuals. In 1986, 62 mandibles of individuals judged to be adults over age 15 were seriated (Figs. 18a, b, c). Furthermore, there were at least 8 other mandibles in the collection, mostly associated with skulls in the display cases in the museum.

Of those under 15 years of age, 25 were initially seriated (Fig. 19), to which six were added from among the material on display in the museum. The estimate of subadults has some questionable individuals – perinatal infants who are often represented in the collection by long bones rather than mandibles. Our methodology takes account of these infants despite the absence of mandibles. But, in fact, the

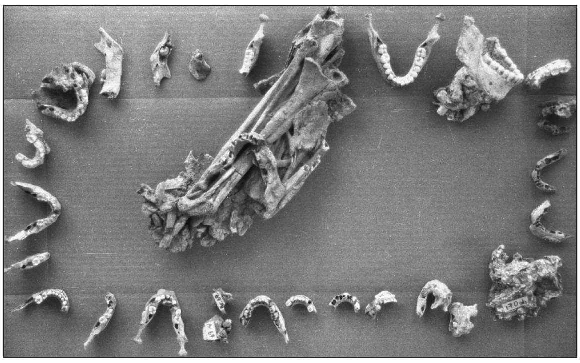

Fig. 19. Seriation of subadults based on eruption sequence and attrition.

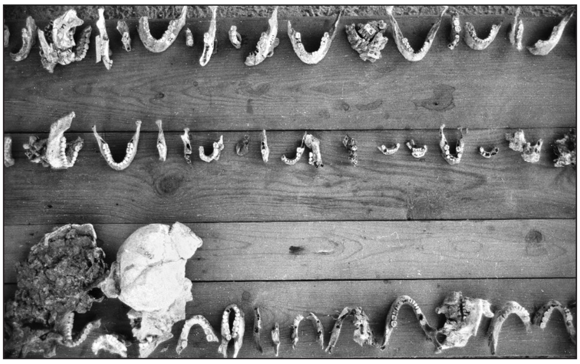

Fig. 18 a, b, c. Seriation of Arruda mandibles 15 years of age and older, based primarily on attrition with attention to pathology and preservation. This allowed reconstruction of separated mandibular fragments (some juveniles are shown in the centre of the images).

demographic method we use ignores children under 5, because infants and young children are markedly under-represented in Neolithic skeletal collections, and are generally poorly preserved. Thus the uncertainty surrounding young children is not critical.

The seriation of mandibular secondary teeth (Figs. 18 and 19) was based on observation of wear of the three lower molars, with secondary consideration of more anterior teeth. The initial seriation was visual, and undertaken by several people over a number of days, the placement of each fragment being discussed. The same process had been previously undertaken on Moita adult mandibles. Arruda wear seems slightly reduced compared to what we had observed in the Moita series, and the Casa da Moura attrition is reduced from Arruda (*see e.g. Lubell et al. 1994*). However, the same sequence of attrition stages can be used: it covers eight wear levels, from 1, where the molar tooth has only just come into occlusion, to 8, with a rim on less than three sides, or all enamel removed and wear progressing down onto the tooth root (*see Lubell et al. 1989 for details*). Because Casa da Moura wear is slower than in the Mesolithic, more attention was paid to variations within wear levels. For example, wear level 3 lasted longer within a person's adult life, and it was possible to discern gradations within level 3 that were not obvious in the Mesolithic, especially with Moita (*Jackes 1992*). Finally, the Arruda subadults were seriated separately (Fig. 19)[18].

The seriation process provided other benefits. Some identification problems were sorted out. In 1986 the process allowed the refitting of nine mandibles across drawers, that is, two or three fragments of each of nine mandibles were found dispersed over separate drawers. The drawer with label "M" was particularly problematic. It contained 13 maxilla fragments, 21 mandibular fragments and 27 loose teeth in 1984. There were actually 21 individuals represented by the M mandibular fragments. The R series identified and reported by LeFèvre (*1972*) remains unidentifiable, but may have included material now labelled "M".

As noted above it was necessary to add further individuals to the visual seriation. These included mandibles in the display cases in Lisbon that could not be removed for study with the seriated specimens. Post facto seriation was possible though a variety of means that included photographs, measurements of the cemento-enamel junction height above the alveolar margin, and attrition scores. To the mandibles on museum display we can now add the material excavated by Roche and Veiga Ferreira in 1964, stored away and apparently forgotten. None of it was available in 1969 or in the 1980s. The dentitions were photographed by David Lubell and from those photographs attrition and status can be accurately recorded, at least to the level of comparison with material previously studied (Fig. 20). None of the 1964 mandibles match with any of the 1880s mandibles. This material represents eight new individuals, four under 18 and four over 18. Veiga Ferreira had actually plotted 13 individuals (*Cardoso, Rolão 1999/ 2000.Fig. 57:227*), but half of them were incomplete, so it is not surprising that we do not have 13 full individuals.

The age of subadults is both very important and problematic. In the demographic approach used, it is important that we know which individuals are under 5 and which are 5 and over. Radiographs help with the question but a complete reassessment of dental age in Mesolithic and Neolithic Portuguese children is being undertaken because there are some questions about the timing of eruption sequence events. Figure 21 shows the type of information used in this study. Arruda M (41) is probably under 5 years of age, with the adult first molar unerupted, and the second premolar (P4) crown not yet visible below the 2nd deciduous molar. In Arruda 176, already 5 years of age, the first molar is advancing towards eruption, the premolar crowns are apparent, the second molar is forming, and the roots of the central incisors are developing.

We arrive at a maximum estimate of 71 adults over 15 years of age present in 1984–1989 in the collection of the Serviços Geológicos, Lisbon. Adding subadults and the eight newly found individuals recovered from storage in 2000, the total is 105, based on mandibles.

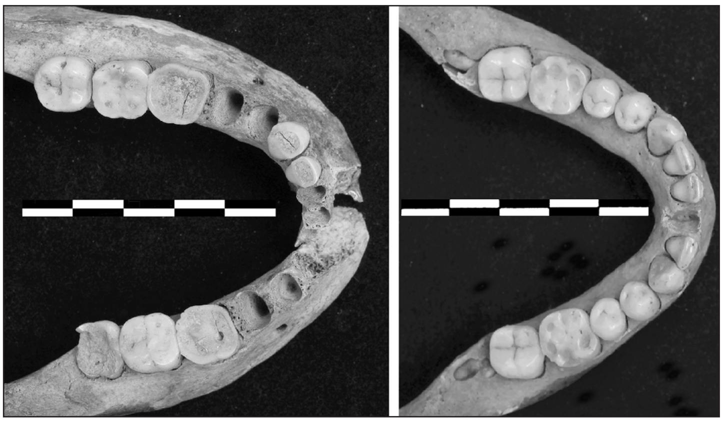

Fig. 20. Examples of mandibles from the 1964 Arruda excavations now in the Serviços Geológicos, Lisbon: Sk 17 8.2.311 on the right, Sk 18 on the left. Detailed colour photography (David Lubell) allows confirmation that none of this material was in the collections in the 1980s.

18 Examine the child still partially en bloc: in a North American site the interpretation would be that secondary bundle burials were present.

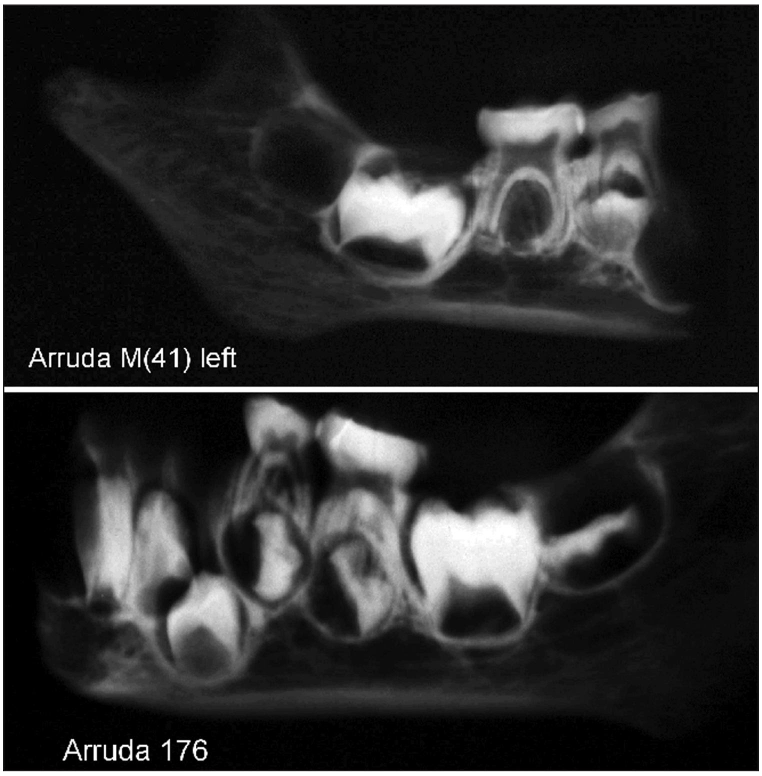

Fig. 21. Radiographs of juvenile dentitions: Arruda 176 (x-ray Sintra 90–2.VIII.86) and Arruda M(41) (x-ray Sintra PMD.1–5.XI.85).

Our sample is shown in Table 1, with totals of 77 for Moita, 105 for Arruda and 340 for Casa da Moura. The previous publication of Casa da Moura (*Meiklejohn et al. 1997*) was based on an MNI of the loose right lower molars. Here we include a more complete set of data, including loose and in situ right lower molars, together with correction for premortem tooth loss (*Jackes 1998; Arnaiz-Villena, Lubell 2000*). The Moita sample includes those mandibles inventoried in Porto in 1984. There were a number of very young children in the Porto collection: the fact that they could not be seriated visually with the other Moita material is less important since our methodology ignores those under 5 years of age[19].

COMPARING ARRUDA, MOITA AND CASA DA MOURA

The results of our study of the mandibles from Arruda, Moita, and Casa da Moura (Fig. 22) have implications for research on the demography of the Mesolithic/Neolithic transition. In order to provide a context, we have a large database of archaeological sites that have sample sizes of at least 100[20]. To that we have added historical data, for example some of the excellent French and French Canadian historical demographers' analyses of parish records (*e.g. Charbonneau 1970*), allowing for an understanding of the biological realities underlying demographic data – something that has not always been considered by palaeodemographers (*Jackes 1994*). The plotted variables are the mean subadult mortality quotient (probability of death age 5–19, MCM or mean childhood mortality) and the ratio of children between 5 and 15 years to adults 25 and over. This approach to palaeodemography, the ratio of children to adults, was first suggested by Angel (*1969*), and has been systematized over a number of years through the work of Bocquet-Appel and Masset (*e.g. Bocquet and Masset 1977*). We use Bocquet-Appel's index of juvenility, which we term the J:A. For further discussion of the approach see Jackes (*e.g. 1992; 2000; Meiklejohn et al. 1997*).

To provide further external control we have used the model data of Coale and Demeny (*1983*) and the United Nations (*1982*). These data are marked on Figure 22 as representing populations that are

Age Categories	Moita	Arruda	Casa da Moura
0–4	14	17	42
5–9	6	9	31
10–14	1	5	33
15–19	3	4	18
20–24	8	8	64
25+	45	62	152
Total	**77**	**105**	**340**

Tab. 1. Demographic data used in the analysis: age at death distributions.

19 Note that the Arruda material that was in the Mendes Corrêa Institute in Porto, now being studied by Eugénia Cunha at the Institute of Anthropology, University of Coimbra, is not included. This is because of questions arising from differences between the inventories of 1969 (Meiklejohn) and 1984 (Jackes and Huet Baçelar) and on what was destroyed in the 1974 fire/flood. A complete reassessment of Moita material is now being undertaken (*Jackes and Meiklejohn in prep.*), and it is to be noted that our publications on Moita have sample sizes varying from 77 to 79 in advance of this reassessment.

20 The Iron Gorge (Djerdap) samples of *Jackes et al. in press* are not included.

stationary, increasing or decreasing. The archaeological and historical data fall comfortably close to the model data: in those cases where the archaeological sites fall far from the expected, we can suspect or demonstrate sample problems (biases which might result from site chronology questions, age assessment error, partial excavation, preferential burial etc.).

The diagram includes the full curve for populations that fall within the limits of reasonable demographic interpretation. As discussed elsewhere (*Jackes 1994*), the J:A ratio axis also provides a proxy measure for fertility. Populations at the upper right hand corner of Figure 22 would represent some of the highest recorded examples of natural human fertility. Some rare and exceptional archaeological populations do in fact provide calculated values beyond this apparent limit (e.g., Nea Nikomedia, *Angel 1971*). It seems likely that if they are to be interpreted as representing something other than samples unsuitable for demographic analysis by reason of their small size, they can be understood to illustrate exceptional circumstances. For example, one is a site in which there is ethno-historical evidence, not of high fertility, expected at the high end of the graph, but of high mortality associated with an influx of refugees from war and famine, preferentially of women and children (*Jackes 2000b*). Another is of freed slaves returned to Liberia in the 19th century (1820–1843), a situation where young adults and children made up the bulk of the population (*McDaniel 1992*). The total fertility (henceforth TF) calculated for the Liberian emigrants from the US would provide values far beyond any possible human biological capacity for child-bearing, nearly 14 times higher than the actual Liberian TF rate at the end of the 20th century.

In fact, the high end (at the upper right) of Figure 22 gives a total fertility estimate of about 12. The average woman in such a society would, between 15 and 45 years of age, have 12 live born children – an acceptable type of figure for maximum "natural fertility". To assume that all women under a "natural fertility" regime[21] will produce, say, 20 children is not reasonable: it is most likely to occur under unusual circumstances, for example, when an epidemic has killed all the children in a family and a "replacement family" is achieved. But it is not the rule for the average woman. Examples of immigrant populations that did not practice contraception and emphasized child bearing (e.g. Mormons and the Quaker immigrants to the north east coast of North America) never reached such figures. The best data on "natural fertility" comes from North American Hutterites early in the 20th century, suggesting 12 or 13 as the upper limit of TF. That the Hutterites had some limits on childbearing – some restrictions on sexual activity – is clear; nonetheless such an upper limit for TF is reasonable in the face of known social and biological constraints on human fertility. Coale's Index of marital fertility is a basic demographic value by which the Hutterites of 1921 to 1930 are taken to represent the maximum potential level of childbearing within marriage, exceeded only under rare and unusual conditions. The figure given is 12.4 children.

We must emphasize that we are talking here about the number of children possible under some circumstances

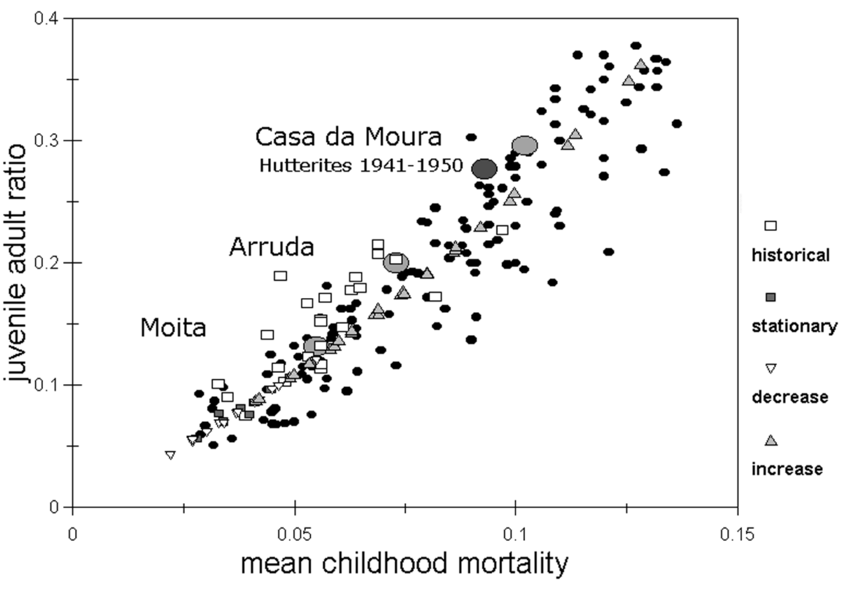

Fig. 22. Archaeological data, model data (*Coale, Demeny 1983 *West 1–10 increasing/decreasing/stationary and* United Nations 1982*) and historical samples provide the context for interpretation of information on the demography of Moita, Arruda and Casa da Moura. The Hutterite age at death distribution for the period 1941– 1950 (*Eaton, Mayer 1953.238*) provides the test for the method.

21 One not practising contraception.

and that – in order to make comparisons – we are using a theoretical figure that may overestimate actual fertility. It is important to note that not all women in a population will have 12 children and that such a value for TF is, in fact, highly unusual. We are discussing a demographic parameter, the average number of live born children per woman in a population. Not all women are equally fertile, foetal loss occurs, some husbands are sterile, not all women marry, not all marry young and are continuously sexually active from age 15 to age 45, not all women survive to menopause (see *Jackes et al. in press; Jackes 1994* for discussion on the factors limiting fertility). Even French Canadian first settlers, few women though there were and with a strong incentive for large families, had a TF of around only eight (derived from data in *Charbonneau 1970*). Much of premodern western Europe, before antibiotics and with some crude contraception, relatively late marriage and with a less than 100% marriage rate, probably had a general population TF rate of well below eight. The Canadian Iroquoians were noted by the first Europeans who lived with them as having few children (*Jackes 1994*), perhaps five as a maximum (similar to Moita, and maybe to the total Iron Gates Mesolithic (*see Jackes et al. in press*)).

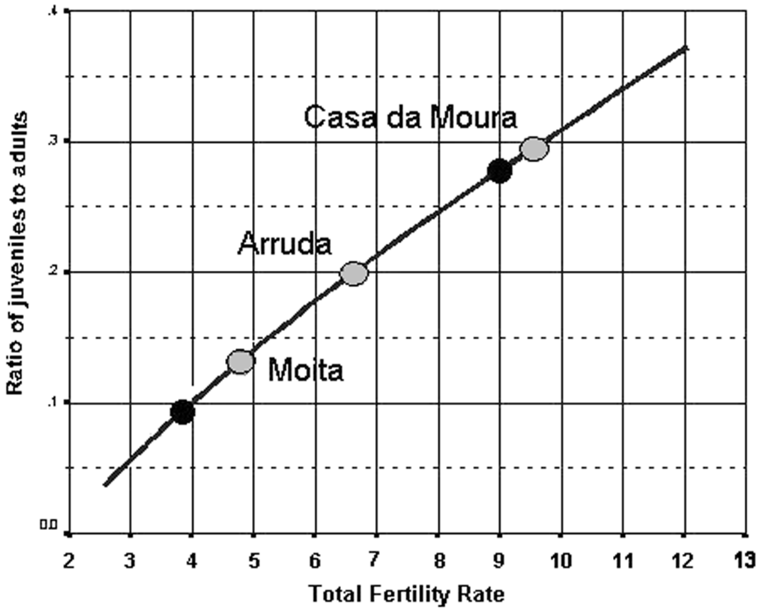

Fig. 23. Loess local regression fit line derived from model age at death and fertility data (**Coale, Demeny 1983** ***West 1–10 increasing/decreasing/stationary) demonstrates the placement of the estimated TF rates for the Portuguese archaeological sites. The fit line is pegged at either end by test data: to the left !Dobe Kung (*****Howell 1979*****), at the right Hutterites dying in the period 1941–1950 (*****Eaton, Mayer 1953*****).***

Stationary and decreasing populations fall at the lower left (Fig. 22), with Moita just at the upper end of stationary limits. In contrast, Arruda has already gone beyond that, and Casa da Moura would be beyond that again, firmly within the group of increasing populations. The values derived from the Hutterite age at death distribution for the period 1941–1950 (*Eaton and Mayer 1953.238*) fall close to Casa da Moura. Remember, however, that Casa da Moura, especially, has an inbuilt error within it. Because we do not have a full understanding of the number of old people who had lost their teeth premortem, because of the problem of loose teeth and destroyed mandibles, we must assume that there were actually more adults than we have shown here. Casa da Moura would probably fall a little lower on the curve, closer to 0.25 on the J:A (y) axis than its current position of ca 0.30.

In Figure 23 we have a loess line (a local regression based fit line) derived from the fertility rates associated with the series of Coale and Demeny model tables we have used. The J:A ratio is again on the y axis. The x axis now represents the TF rate. On the line we have added two points shown in black. The point to the lower left represents Nancy Howell's work on the Dobe !Kung (*Howell 1979*), with a TF estimate of just under four children derived from the J:A of the age at death distribution. This accords with Howell's own estimate of 4.3 for the period from 1963–1973. Note the position of the Hutterite estimate of nine for the TF rate estimated by regression from the age at death distribution J:A for the period 1941–1950 (*Eaton and Mayer 1953.238*, ages redistributed into standard age units). Summing the age specific fertility rates of all Hutterite women of reproductive age between 1936 and 1940 gives a TF rate of 9.4, and for 1946 and 1950 the TF value was 8.1 (*Eaton and Mayer 1953.227*). It is then very reasonable to estimate nine as the overall TF value to associate with those who died between 1941 and 1950.

Thus our Figure 23 is tied to some sort of reality, but there are caveats. Firstly, the sex ratio is assumed, for purposes of discussion, to be 1:1. The model populations from which this is derived actually have a slightly lower TF. Secondly, Moita sample size is not really adequate. Other problems have been laid out. Moita requires further consideration and has not been finalized. With Arruda we have the issue of partial excavation; some of the skeletons were lost; most skeletons have been mixed since excavation. With Casa da Moura we have a burial cave with multiple mixed disarticulated skeletons, smashed bones and skulls, and thousands of loose teeth. Despite these problems we feel we have at least one meaningful result. Fertility appears to have already been increasing in the late Mesolithic and on into the Neolithic. Our results suggest an increase in fertility of around two children per woman within the Mesolithic. We do not know the exact fertility, though our figure suggests a shift from ca. five to ca. seven, but we have some idea of the differential. Our figure suggests a slightly larger increase between Arruda in the Mesolithic and Casa da Moura in the Neolithic, to a fertility perhaps approaching nine. Above all, we have a method by which we can test whether samples provide demographic parameters that are within or outside the bounds of biological reality.

There is independent evidence of the change proposed for the Mesolithic/Neolithic transition in Portugal – a change that begins within the Mesolithic and continues on into the Neolithic, so that a continuous process rather than an "event" must be the interpretation. Dental attrition levels altered (*Lubell et al. 1994*), suggesting a switch to a progressively softer diet. Independent evidence, based on dental metrics, suggests that the weaning period was shortened (*Jackes et al. 1997*); along with softer food this would argue for reduced birth intervals. Arruda females were doing something different from Moita females, a shift towards a more sedentary pattern is suggested (*Jackes, Lubell 1999*), the evidence for this deriving from the internal geometry and density of femoral bone and external features of the femora and tibiae (with a control over the method being provided by Nordin's Index derived from femoral x-rays and control for age by attention to dental wear, and especially by a study of femoral neck x rays). This again suggests circumstances under which more frequent pregnancies would be likely. There is also the suggestive fact that Arruda contains foetal and neonate individuals, based on long bones rather than mandibles. We believe that Arruda was probably a near permanent residential site.

Bocquet-Appel's newly proposed value:

$$P = (5–19)/(\text{Total 5 and over})$$

is useful in avoiding some age assessment errors (*Bocquet-Appel 2002*). Logically, and in actual fact when tested on model data, it is perfectly correlated with mean childhood mortality (MCM) of Figure 22 (x-axis). It has a slightly non-linear relationship with J:A when tested on model data. Its valid upper value is likely to be 0.350 which is the equivalent of ca 0.380 J:A, predicting a TF of 12 children. We note that most of Bocquet-Appel's sites fall below P = 0.350 and we would suggest this as a cut-off value, beyond which bias must be suspected. It is interesting that Bocquet-Appel's high values all derive from samples of small size.

Bocquet-Appel's suggestion of a stationary population for the Mesolithic appears to us justified in general terms based on our work on sites in Scandinavia and in the Iron Gates region of the Danube valley (*Meiklejohn et al. 1997; Jackes et al. in press*).

We believe we have provided evidence in support of Bocquet-Appel's argument that there was an increase of fertility in the early Neolithic. However, we suggest that the possibility of a demographic trend through time from Moita to Arruda is noteworthy, since independent evidence suggests that the two sites have differences in terms of dental attrition, dental pathology, tooth size, stable isotope central values, cortical thickness and femoral morphology. We absolutely agree that a reduction in the birth interval is the mechanism of population increase, but we see that reduction beginning in the late Mesolithic with an increasingly sedentary life. The differences between the sites are specific and scaled to trends rather than absolutes. We see no evidence of genetic change accounting for the biological differences, no evidence of an incoming population (*e.g. Jackes et al. 2001*). Absent biological evidence for large-scale population movement, continuity of demographic trends is suggested, and no small group of precursor males would explain the apparent fertility increases in the development and transition from late Mesolithic to early Neolithic.

We have focused here on samples that cover around 2000 years, from 8000 to 6000 calBP, a period of sea level change and some climatic variation. Fertility rates in Europe could have reached our theoretical maximum according to the data used by Bocquet-Appel from Wandersleben (*Bach 1986*) and Grossbrembach (*Ullrich 1972*), sites that have adequate samples and fall within the limits of biological reality. But these sites are from the very late LBK or the Bronze Age, and the Early Bronze Age of Central Europe provides sample sizes and age distributions of such diversity (*Berner 1992*) that the period of agricultural intensification appears to require a separate study focusing on the interpretation of the variations.

Leaving aside questions surrounding such later sites, Casa da Moura provides the best data for the European Neolithic in which a considerable increase in fertility can be discerned: yet the site is not ideal because it covers a long period of time (our two dates alone cover 1000 years). We propose that studies of the transition be focused on sites within a restricted geographical area, in which the demographic and biological variations introduced by population movements can be excluded, where there is tight control over dating. The earliest Casa da Moura date calculated at 25% marine diet certainly overlaps the latest Mesolithic dates for central Portugal, so that we have some assurance that our data are directly relevant to the question of the demography of the transition.

CONCLUSION

In pointing out the problems associated with the sample of human skeletons from Arruda, we have done no more than is absolutely necessary. Without careful consideration of the nature of the samples, and the methods used to arrive at the estimates of sample size, and without methods of comparison among samples, discussion of Mesolithic/Neolithic transition demography is an unstable foundation. We propose that the methods used across sites of different types must take into account problems arising from burial practices, from excavation and curation and that such methods must be applied with the greatest of care. Far from destroying confidence in the sample, we have developed a method that suggests that our data have some biological validity. It is important that the Portuguese data be approached in such a cautious manner because it is so important in providing us with reasonably large samples across the Mesolithic/Neolithic transition. Although internally consistent, the evidence of a stationary Mesolithic population with low fertility, as previously presented (*Meiklejohn et al. 1997; Jackes et al. in press*), was based on Scandinavian samples that are not adequate and on Iron Gates material about which some questions remain. More detailed work on the Iron Gates sites presents the best hope of confirming our hypotheses.

The situation in Portugal is simpler than in the Iron Gates region. There is no evidence for large population replacement and if there were some transcoastal arrivals these seem to have provided no detectable genetic input. It is unlikely that the biology of the indigenous population would have been altered (absent some unknown founder effect) without either population replacement or differential fertility. However, the increase in fertility appears to have been established prior to the Neolithic and increased fertility must be attributed to some alteration of life-way. A reduced birth interval, suggesting earlier weaning, is likely (*Jackes et al. 1997*). Increasing sedentism and changes in weaning food would be sufficient explanation for this. The evidence thus suggests that the base-camp type settlement at Arruda does indeed provide the appropriate scenario and it appears that Arruda may be more likely than Moita to provide the timing for this along the Muge valley. It is to be noted that a slow and steady increase, rather than a sudden leap in fertility, is proposed. It is also to be noted that total fertility (TF) levels of around eight can be considered as biologically feasible for the early Neolithic in Portugal. At the same time, it is essential to realize that this is a demographic parameter, not an actuality. It is inconceivable that every woman would have had eight children and that every one of those eight children would have grown to reproductive age and had eight children. Nevertheless, we have come closer to an understanding of the timing, mechanism and scale of population increase in central Portugal over the period 8000 to 6000 calBP.

NOTE ADDED IN PROOF

Material from the 1964 excavation has now been moved, and stored with earlier Arruda finds at the Serviços Geológicos in Lisbon. Prior to 2000, the material had undergone at least two periods of flooding (*Rolão pers. comm.*) and had become mixed. On the basis of a brief examination of the material by Jackes and Lubell in September 2004, we can confirm the number of mandibles seen by Lubell in 2002. However, when the material was moved to the new storage facility, a previously unrecorded skull and mandible were found. Furthermore, another very fragmentary mandible, with a label indicating that it was collected in 1965, has been located by José António Anacleto, Serviços Geológicos, to whom we are indebted for his assistance.

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We wish to acknowledge the work of Portuguese archaeologists during the 19th and early 20th centuries. They were truly ahead of their time. The problems of working with material excavated long ago are legion and it is necessary to document the problems so that we can judge the value of the collections. Material that has been lodged in museums for over 120 years has naturally been subject to the vicissitudes of time. That so much has been preserved and the records are as good as they are demonstrates the sophistication of these early archaeologists.
The work reported here has been done with the assistance of many people over a period that now approaches 35 years. Meiklejohn's work in 1969 was supported by a Canada Council Doctoral Fellowship. The work of Jackes and Meiklejohn in the 1980s was supported by two Social Sciences and Humanities Research Council of Canada grants (410–84–0030 and 410–86–2017) in collaboration with David Lubell. Over the years a number of students have assisted us in data collection. Meiklejohn would especially like to thank Catherine T. Schentag, while Jackes would like to acknowledge Pamela Mayne-Correia, Cidália Duarte and Gary Tait for work on Casa da Moura loose teeth. Deborah Ross worked on the methodology of tooth identification. Dr. Gerd Weih's professionalism and general assistance with our Moita and Arruda analyses were invaluable.
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contents

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Documenta Praehistorica XXXI

Current debates on the Mesolithic-Neolithic transition in Britain and Ireland

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ABSTRACT – *In this contribution I address a series of recent publications which present revisionist accounts of the beginning of the Neolithic in the British Isles. New evidence suggests that we need to reconsider issues of population movement, diet, mobility and residence patterns. However, I conclude that a return to a model of colonisation by an agricultural population from the continent is premature, and seek to stress the distinct patterns of change that characterised Britain and Ireland respectively.*

IZVLEČEK – *V članku omenjamo serijo novejših objav, ki predstavljajo nov pogled na začetek neolitika na britanskem otočju. Novi podatki kažejo, da moramo na novo pretresti vprašanja o premikih prebivalstva, prehrani, mobilnosti in vzorcih poselitve. Menim, da je še prezgodaj, da bi se vrnili na model, pri katerem je kolonizacijo izvedlo kmetovalsko prebivalstvo s celine in skušam poudariti različne vzorce sprememb, ki so značilni za Britanijo in Irsko.*

KEY WORDS – *Mesolithic; Neolithic; Britain; Ireland; population movement; diet; Achnacreebeag; identity; timber buildings*

INTRODUCTION – THE 'ISOLATION' OF MESOLITHIC BRITAIN AND IRELAND

Since Stuart Piggott's Neolithic Cultures of the British Isles (*1954*), and Humphrey Case's seminal article, 'Neolithic explanations' (*1969*), there has been more or less continuous debate over the nature of the inception of the Neolithic in Britain and Ireland. These arguments have revolved around the alternative possibilities of population replacement and the indigenous adoption of domesticates and Neolithic material culture; the relative importance of social, environmental and economic factors; the time-scale involved in the transition; and the degree of regional variation in the process of change. The problem has always been that the direct evidence relating to the period concerned has been very limited, and consequentially that what is known can be equally easily used to support a variety of quite different interpretations. In the past five or ten years, a range of new information has started to become available, from scientific analysis, from new excavations, and from the reconsideration of older finds. However, rather than providing a conclusive answer to the problem of the first Neolithic in Britain, the new evidence is contradictory, and points in a number of different directions. Probably what this tells us is that the Mesolithic-Neolithic transition was a more complex process than some earlier interpretations allowed for, and that we should be wary of generalisations that are based on the evidence from single sites, on single classes of data, or on small samples. In this contribution, I will offer one attempt to reconcile recent discoveries, in the full awareness that other accounts could be, and will be, presented.

The principal issues that I want to point to are the swiftness of the beginning of the British Neolithic, its simultaneity with that in Ireland and southern Scandinavia, the similarity of Neolithic material culture over wide geographical areas, and the apparent contrast with the growing evidence for economic diversity. The abrupt beginning of the British Neolithic has sometimes been attributed to the sea-borne colonists from the European continent, bringing with them domesticated plants and animals, polished stone tools, pottery, and monumental architecture. This view was supported by Roger Jacobi's argument that the British Isles had been entirely culturally isolated from the continent during the later Mesolithic, from around 6500 BC onwards, following the loss of the land connection (*Jacobi 1976.80*). Jacobi's evidence was the non-appearance of trapezoids, rhomboids and 'Feuilles de Gui' in British lithic assemblages: all types that were found in the latest Mesolithic industries on the continent. It is the correlation of stylistic variation in material culture with the degree of contact between human communities that lies behind Alison Sheridan's argument that: '*Advances in our understanding of Mesolithic communities in Britain and Ireland do not lead us to believe that there had been... a significant amount of prior contact between communities on either side of the Channel (or indeed the Irish Sea) such as would facilitate exposure to novel resources and lifeways*' (*Sheridan 2003.4*).

Similar arguments have been maintained in Ireland: '*The Irish later Mesolithic has distinctive characteristics such as the lithic assemblage and a focus on fishing and gathering which do not suggest much contact with either Britain of adjacent continental Europe*' (*Cooney 2000a.13*).

However, in the Irish case the presence of bones of domesticated animals dating to the final centuries of the Mesolithic (if not earlier) from Ferriter's Cove, Kilgreany, Sutton and Dalkey Island demonstrate that some form of contact with the continent must have taken place (*Woodman and McCarthy 2003. 36*). Not only were wild cattle absent from post-glacial Ireland, but it appears that even in Britain the domesticated bovids of the Neolithic were entirely of continental origin (*Tresset 2000.21*). Yet again, a reliance upon material culture as an index of social isolation results in this evidence being interpreted in particular ways: '*Given what we already know about Ireland's Late Mesolithic inhabitants, with their relatively insular horizon, it would appear wholly far-fetched to posit that local Mesolithic groups sailed to the continent and brought back domesticated animals*' (*Tresset 2003.25*).

Because there were no Neolithic artefacts to accompany these animal remains, Tresset suggests that the creatures concerned may have escaped from the settlements of continental pioneer agriculturalists. Tresset's argument chimes with Gabriel Cooney's hypothesis concerning 'small-scale movement of farming groups from Britain and/or the continent into Ireland...' which would '...have set up an on-island interaction zone with the indigenous inhabitants' (*2000a.13*). Yet if such colonists existed in a horizon prior to 4000 BC, inadvertently releasing appreciable numbers of their stock into the Irish landscape, they have left no archaeological trace. On the other hand, on the North European Plain and in Scandinavia it seems that Mesolithic people were highly selective as to which elements of the Neolithic 'package' they should adopt from Bandkeramik and Rössen communities to the south (*e.g. Fischer 1982; Domanska 1989*). It may therefore be only a prejudicial view of hunter-gatherers as incapable of complex logistics, and a faith in artefact style as a measure of social interaction which support the view that Mesolithic populations in Britain and Ireland were 'isolated' on the eve of the Neolithic era.

It is worth reflecting on the latter of these assumptions. In the culture-historic archaeology of the mid-twentieth century, the stylistic attributes of material culture were understood as a straightforward reflection of norms held in common by human communities, and transmitted from generation to generation. However, the influence of one population on another might result in the diffusion of stylistic traits across space. With the emergence of the New Archaeology in the 1960s, attempts were made to place the study of stylistic variation on a firmer footing, within the broader project of casting material culture as a means of adaptation. In the context of the Pueblo pottery of the American South-West, Deetz (*1965*) and Longacre (*1966*) argued that the appearance of particular motifs on ceramic vessels from different settlements might directly reflect the degree of contact between them. However, later work cast this view into question. Martin Wobst (*1977*), for instance, suggested that stylistic variation in material culture was a means by which people might selectively signal their identities to specific target populations. Finally, Ian Hodder's (*1982*) ethnoarchaeological work in the Lake Baringo area of Kenya demonstrated that people were generally aware of the stylistic variation of artefacts, and could use it strategically to construct and negotiate identities for themselves in changing contexts. For instance, Hodder observed that it was possible for women to marry into a new tribe, adopting a new style of dress and set of artefacts and thereby transforming their identity. Consequentially, quite abrupt boundaries in the distributions of artefact types provided no indication of the intensity of social interaction across those boundaries. There is no sense, then, in which the existence of mutually-exclusive assemblages of artefacts in different geographical areas can be taken as an index of the degree of contact between the human populations involved.

Seen in these terms, arguments for the seclusion of Britain and Ireland in the later Mesolithic are somewhat threadbare. This is all the more so when we consider that the emergence of distinctive and mutually exclusive styles of lithic artefacts was a characteristic of the later Mesolithic throughout North-West Europe. Peter Gendel (*1984.125*) has demonstrated that in North-East France, Belgium, the Netherlands and western Germany there was patterned variation in stone tools, which he relates to the development of increasingly distinct social groups.

'*Through the course of the Middle and Late Mesolithic periods, discontinuities in the distribution of style were maintained in spite of interaction between neighbouring groups*' (*Gendel 1984.131;* my emphasis).

In much the same way as Hodder described in the Lake Baringo study, identities were being constructed and maintained irrespective of contact within and between groups. For the most part, the distinctions that Gendel identifies relate to different styles of microliths. While these are rather small artefacts, projectile points can be a highly effective symbol of identity amongst hunting and gathering communities, as Wiessner (*1983*) demonstrates. Within the British mainland itself the Late Mesolithic saw the development of distinctive lithic assemblages (again principally distinguished amongst the microliths) in different regions: the Sussex Weald, East Anglia, the Pennines, and so on (*Edmonds 1995.26*). Remarkably, the Irish Late Mesolithic flaked stone industry was homogeneous throughout the island, and quite distinct from any other European assemblage. However, as should be evident by now, this is no indication of a lack of contact with the 'outside world'.

Another important indication of the relationship between Britain, Ireland and the continent at the end of the Mesolithic is provided by Bryony Coles' recent discussion of sea-level change in the North Sea. This indicates that at around 4000 BC the area between Britain and the Netherlands was not open sea, but occupied by an easily-navigable archipelago of islands. It is even possible that a land-bridge survived until 3800 BC (*Coles 1998.76*). This further weakens the notion that Britain at least was disengaged from developments in northern France and the North European Plain. At the same time, current developments in strontium, oxygen and lead isotope studies have given us cause to reconsider human mobility in prehistory. It is arguable that throughout the past century our conception of population movements in prehistoric Europe has been one that is more appropriate to the Dark Ages and the Medieval period. People are imagined to have spent their entire lives in a small area, rarely finding their way as far as the next valley. Sporadically, though, whole populations or ethnic groups stirred themselves and migrated from one area to another. This assumes both that people in the distant past lived in large, endogenous, bounded groups (see *Thomas 2004. Chapter 5*), and that movement was an all-or-nothing affair. Alternatively, a continuous process of 'demic diffusion' is sometimes imagined, in which agricultural settlement expanded gradually and continuously across the continent, pushed forward by population growth.

Recent isotopic studies of human remains from Neolithic contexts challenge these views. For instance, work on a group of burials from an enclosed monument at Monkton-up-Wimbourne in Dorset (*Budd et al. 2003*), and on the Amesbury 'archer' Beaker burial nest Stonehenge (*Chenery 2003*) together suggest that particular people may have travelled considerable distances in the Neolithic, and not as part of any generalised population movement. More suggestive still are the results from a series of Bandkeramik cemeteries in southern Germany: Flomborn, Schwetzlingen, Vaihingen and Dillingen (*Bentley et al. 2003.484*). All of these sites contained a significant minority of burials that were of 'non-local' origin, and in each case there was a preponderance of females. The possibility that these were exogamous communities, and even that indigenous Mesolithic people may have married in to Bandkeramik groups, is an obvious conclusion. To this we can add the ethnographic observation that hunters and gatherers, particularly in northern climes, often have networks of kinship, sharing, exchange and visiting contacts that spread over hundreds of miles, and may sometimes embark on extensive hunting, fishing or trading trips (*Balicki 1968.80*). So while at any given time there may have been particular populations who were formally 'Mesolithic' or 'Neolithic', foragers or farmers, it is highly likely that single persons continually crossed back and forth over any boundary (spatial or conceptual) that existed between the two. The implication is that prehistoric societies in

Western Europe were porous rather than bounded, and that there was continuous interchange of personnel, rather than a unidirectional flow of agricultural colonisers from south-east to north-west.

ACHNACREEBEAG AND THE 'IMMIGRANT COMMUNITY' HYPOTHESIS

It is in the context of these arguments that we should reconsider Alison Sheridan's recent discussion of the pottery from the megalithic chambered tomb at Achnacreebeag in western Scotland. In a series of recent papers, Sheridan (*2000; 2003; 2004*) has drawn attention to what appears to be a very early ceramic assemblage, from the primary filling of an open orthostatic chamber added in the course of the enlargement of a small megalithic structure (*Ritchie 1970. 35*). The antiquity and cultural affinities of the pottery are presented as evidence for an intrusive continental Neolithic presence in western Scotland at an early date, providing a point of origin for a series of later developments. It is on this basis that Sheridan concludes that: '*For most of Britain and all of Ireland, the evidence against Julian Thomas' model of a gradual transformation, with indigenous forager communities being the main agent of change, appears overwhelming – at least to this author*' (*2004.11*).

It is worth pointing out in passing that this is actually a misrepresentation of the argument that I have consistently made through a number of publications: '*This slow trend towards agrarian subsistence had superimposed upon it a much more rapid introduction of Neolithic material culture*' (*Thomas 1997.59*).

'*The very sudden cultural change from Mesolithic to Neolithic appears to be superimposed upon a much more long-term shift from food-gathering to food-production*' (*Thomas 1999.16*).

That is to say, the beginning of the Neolithic in Britain involved a series of conjoined processes which nevertheless proceeded at different speeds, and any adequate explanation will need to address these overlapping temporalities.

Sheridan's principal claim concerning the Achnacreebeag ceramics is that one vessel is highly comparable with the late Castellic pottery of the Morbihan area of Brittany, and in particular with a vessel from Vierville in Normandy, which shares its carinated form and nested-arc decoration. On this basis, she argues that the decorated bipartite bowls of the Beacharra II, Drimnagh and Ballyalton styles in Scotland and Ireland are all to be derived from the Castellic tradition (*Sheridan 2000.1*). A second pot from the Achnacreebeag chamber is argued to be Pinacle Ware, a style contemporary with Catellic and found principally in the Channel Islands. A third was a plain carinated bowl, and it is suggested that this too would not be out of place in Northwest France (*ibid. 4–7*). The monument itself, a simple passage tomb with a slab roof, also finds close parallels in Brittany. Sheridan concludes that both ceramic style and monumental form were spread to western Scotland by 'a small farming population'. '*The Achnacreebeag monument may well have been constructed by an immigrant community (or descendants thereof) from Brittany*' (*Sheridan 2003.5*).

Sheridan cites three principal reasons why a migrant population should be held responsible for the Achnacreebeag tomb and its pottery. Firstly, there was no existing tradition of either ceramic manufacture or megalithic tomb building in western Scotland before the start of the Neolithic. These material forms must thus have been introduced. Secondly, there was a lack of contact between Mesolithic groups in the areas around the Irish Sea, and none of these had links with Northwest France. Finally, there is no compelling reason why these indigenous communities should have adopted tomb-building and pot-making (*Sheridan 2004.10*). Now, as the first section of this essay will have made clear, the second of Sheridan's arguments can be discounted: it is highly likely that there was continuous contact and interaction between societies around the coasts of Britain, Ireland and Brittany throughout the Late Mesolithic and into the Early Neolithic. I will seek to demonstrate that the other two points are equally unsustainable, but first it is important to point to some of the other flaws in Sheridan's case.

We can begin with the composition of the Achnacreebeag assemblage. As Sheridan argues, the plain carinated bowl might be found in a Breton Early Neolithic context: but it is equally at home in the Scottish Early Neolithic. If the other two pots had not been present, its attribution would not be in doubt. The remaining vessels do not form a coherent grouping: Castellic and Pinacle Wares were characteristic of different parts of Armorica. If we for the moment accept Sheridan's identification of the pottery styles, the picture conjured up is one of the 'small farming population' from the Morbihan 'stopping off' in the Channel Islands to pick up some pots, on their way to the west of Scotland to build a tomb. The similarity between the Achnacreebeag and Vierville bipartite vessels is intriguing, but it is as well to remember the difficulties that attend the identification of stylistic affinity. From the time of Montelius onwards, typochronological ordering and cross-dating provided the basis for an understanding of European prehistory that was eventually demonstrated to be wholly erroneous by radiometric dating. Similarly, the identification of similar motifs and practices in different contexts around the world lay behind the excesses of hyperdiffusionism (*e.g. Smith 1929; Crawford 1957*). We therefore have to be very certain of the likeness of any two artefacts in distinct geographical regions before basing an interpretation on it.

The similarity of the Achnacreebeag and Vierville vessels may not be as precise as Sheridan suggests. The Achnacreebeag pot bears a motif composed of three nested arcs, as opposed to two in the Vierville case. These arcs are gently curved, while the Vierville ones are deeply concave, and are composed of narrow, irregular incisions, as opposed to the broad, regular grooves on the Vierville pot. The parallel short vertical lines running around the Achnacreebeag vessel immediately below the carination line are entirely absent from the Vierville pot, although they are by no means out of place in the Castellic tradition. Consequentially, it may be more appropriate to speak of a broad family resemblance between these artefacts. Furthermore, it is important to note that in both Ireland and Scotland the decorated carinated bowls of the earlier Neolithic were rather specialised vessels, which do not appear to have formed an homogeneous and exclusive assemblage. That is to say, they tend to be found in small numbers in 'special' contexts or in mixed assemblages. Thus the Beacharra bowls of Scotland have been recovered from chambered tombs (Beacharra itself, Clachaig, Bicker's Houses and Brackley) or as a minor element in assemblages of plain carinated or hemispherical bowls (*Kinnes 1985.48*). In northern and eastern Ireland, decorated bipartite bowls of various kinds have been found in various kinds of megalithic tombs, with cave burials and with single grave burials of the Linkardstown series (*Sheridan 1995.11*). Thus, even if we were to accept the culture-historic view of ceramic style as the manifestation of the cultural norms of a distinct population, these pots would be poor candidates for the diagnostic material culture of an immigrant population. It may be that ceramic petrology will eventually demonstrate that the Achnacreebeag bipartite bowl was of Breton origin. But even then, its presence in a mixed assemblage suggests the exchange of exotica, skills and personnel between communities, rather than population migration. Indeed, passage tombs with slab (as opposed to corballed) roofs are not appreciably earlier in Brittany than in Britain (*Boujot and Cassen 1992; 1993*), and it may be overly simplistic to imagine that they were merely transferred from one region to another, whether by migrant groups or by adoption on the part of passive indigenous communities. I believe that it is more helpful to consider processes of emulation, symbolic entrainment, appropriation and hybridisation to explain these connections.

COLONISATION OR NEGOTIATION?

Another problem with Sheridan's model is raised by the very swiftness of the onset of the Neolithic (or particular aspects of it) to which she refers. Recently, Mike Richards (*2003.33*) has drawn an illuminating parallel between the Mesolithic-Neolithic transition in Britain and the Norse colonisation of Greenland. In the latter case, a small Scandinavian population arrived on the coast and established agrarian settlements. Yet they made little or no impression on the economy or material culture of the indigenous foragers, and over time they themselves gradually adopted the marine-based diet of the natives. Once we recognise the probability that Mesolithic populations in Britain and Ireland will have had at least a degree of familiarity (and quite possibly well-established social relations) with continental Neolithic groups for many generations, it is utterly implausible that the arrival of a few small agricultural communities could have induced them to adopt new cultural and economic practices at a stroke. But equally, it is impossible to imagine how anything other than a colossal invasion of Neolithic people could have completely displaced the indigenes within a couple of centuries (allowing for the resolution of radiocarbon chronology). I submit, then, that small-scale colonisation is the *least* likely explanation for the abrupt beginning of the Neolithic in Britain.

In his contribution, Richards (*ibid. 34*) proceeds to compare the British Neolithic with the spread of maize agriculture in the Americas, which was extremely gradual. He concludes that the most likely mechanism for the introduction of Neolithic innovations into Britain is the spread of a new religion. However, as Barrett (*1994.50*) points out, there are difficulties with the notion of a 'Neolithic religion'. We can certainly identify commonalities of artefactual form and cultural practice that spread over enormous distances and great depths of time in Neolithic Europe. Yet the proposition that these were underlain by a shared structure of belief is problematic. The 'world religions' with which we are familiar today (Islam, Hinduism, Christianity, Judaism, Buddhism) are all 'religions of the book'. That is to say, their cardinal beliefs are set in scripture, while their forms of worship and ritual may be liturgical in character. In non-literate societies, oral tradition can successfully reproduce customary knowledge over very long periods of time. But equally, matters of eschatology and metaphysics may be the subject of continuous debate, and religious practices can be repeatedly transformed in the process of reconstituting them from memory (*Barth 1987*). So rather than material culture representing the outward manifestation of a fixed set of beliefs, it can provide the focus around which myths and ideas of the sacred are reconstructed. In these circumstances, the idea that stable religious beliefs were shared across regions or through generations during the Neolithic is questionable.

Discounting the idea that Britain in the early fourth millennium BC was subject to a sudden and overwhelming sea-bourn invasion, we are left with needing to explain why the indigenous Mesolithic communities should have abruptly taken up Neolithic cultural and economic resources. This question is particularly acute if we accept that there must have been a continuous flow of contact and exchange of personnel with continental Neolithic groups for centuries before 4000 BC. While the decorated bipartite bowls discussed above are a very minor element in the earliest ceramic assemblages in Britain and Ireland, fine, plain carinated bowls are founded in larger numbers, throughout Ireland, England, Scotland and Wales (*Herne 1986*). Broadly similar vessels are known from areas along the northern Atlantic coast of Europe, yet as Sheridan (*2003.5*) accepts, there are no examples of this style of pottery on the continent that are appreciably earlier than the British ones. The closest parallels, as at Hazendonk near Rotterdam in the Netherlands, are broadly contemporary with the British Grimston bowls (*Louwe Kooijmans 1976*). Sheridan further acknowledges that the artefacts and monuments found in early Neolithic Britain suggest connections with a variety of different regions in Europe. Passage tombs like that at Achnacreebeag have affinities with those in Brittany, yet the trapezoidal long cairns of the Cotswold-Severn region are more easily paralleled in Normandy. Grimston bowls are related to Dutch Hazendonk or Belgian Michelsberg pottery, but the globular pots of the southwest of England are more redolent of the Chasséen of western France. The earthen long mounds of eastern Britain, and certainly the linear timber mortuary structures that they contain, find close parallels in southern Scandinavia (*Madsen 1979*). Individual causewayed enclosures in Britain suggest affinities with those of western France, the Paris Basin, or Scandinavia (single or multiple rings of ditches; high-lying or low-lying locations; earthen banks or timber palisades). Faced with this cultural variation, Sheridan hypothesises 'multiple movements from various points of origin' (*2003.5*). Setting aside the objection that such small incursions could not have lead to sudden and sweeping cultural change in Britain, why should groups of people from Brittany, Normandy, Holland and Denmark all have set sail simultaneously for these islands, especially if some of them had already been established on the Atlantic coast for hundreds of years? Why did they wait so long, and then all go at once? And why did the arrival of these separate populations not result in a series of distinct cultural regions, each with a separate set of artefacts and monuments, rather than the multiple overlapping distributions that we actually observe? Is this pattern not more likely to have been generated by intensive contact and interaction between regions, including the movement of persons in both directions?

It is revealing that we can identify only broad similarities between continental material culture of the mid-fifth millennium BC and that of the British Neolithic. Megalithic tombs, earthen long mounds, causewayed enclosures, polished stone tools and pottery all occur earlier in continental Europe. But more precise parallels, seen in plain carinated bowls, simple passage tombs, portal dolmens, embanked linear mortuary structures and shaft-and-gallery flint mines, seem to date to a horizon around 4000 BC throughout Atlantic north-west Europe. My suggestion is that these cultural forms were not simply transferred from one region to another, but emerged out of a phase of cultural negotiation between communities of different kinds, including the indigenous population of Britain.

In this respect, it is instructive to contrast northern Atlantic Europe with the Bandkeramik occupation of inland central Europe. The Bandkeramik represented a relatively homogeneous combination of material culture and subsistence practices. While it is likely that Bandkeramik communities absorbed indigenous personnel, there is a strong argument that it spread by population movement, with new settlements being located in preferred landscape zones throughout the loess country (*Bakels 1982; Lüning 1982; Modderman 1988*). By contrast, the Neolithic communities that developed on the North European Plain can reasonably be claimed to have developed out of the interaction between agricultural colonists and indigenous foragers. The clearest example of this process is provided by the Dutch Swifterbant groups. Here, a continuous sequence of change demonstrates the adoption of first pottery and then domesticates by Mesolithic communities (*Raemaekers 1999. 182*). I suggest that the post-Bandkeramik horizon in northern Europe, the Cerny, Rössen and Lengyel, saw a reformulation of the Neolithic, in which novel forms of material culture were no longer coupled to a fixed and unvarying subsistence base. Many Neolithic societies in north-west Europe combined cereal agriculture with the keeping of domesticated animals, but not all did.

The consequence of this development was that as a cultural phenomenon, the Neolithic became a means by which social identities could be constructed, maintained, and transformed. I submit that this is the reason why it became attractive to the indigenous communities of Britain, Ireland and south Scandinavia, and why they chose to 'buy in' to the system at around 4000 BC. It is hard to see how this kind of transformation, over such a wide area, could be accounted for by population movement.

DIET AND IDENTITY

Another significant development in recent British Neolithic studies has been the extensive use of stable isotopes in human bones to study diet (*Richards and Hedges 1999*). This method has apparently demonstrated that in the period after 4000 BC, no skeleton that has been studied has any trace of marine protein in their diet: no sea fish, no shellfish, no marine mammals. This has been taken by some as evidence of a swift change from a Mesolithic subsistence economy that made extensive use of shoreline resources, to an agricultural economy based on horticulture and stock-keeping (*Schulting 2000*). However, there are several problems with this argument. In the first place, if Neolithic people in Britain were not eating food from the sea, this was apparently not because scheduling conflicts embedded in an agricultural lifestyle precluded it. Intensive cultural contacts around the Irish Sea indicate that people were frequently travelling in boats, but choosing not to take deep-sea fish, while the chambers of megalithic tombs routinely contain large quantities of marine shells (*Fowler and Cummings 2003*). This suggests an explicit rejection, or cultural prohibition on marine foods, rather than a missed opportunity (*Thomas 2003.69*). If the scientific analyses are to be believed, this same pattern of rejection is also detectible in Scandinavia, Brittany and Iberia (*Richards, Price and Koch 2003*). This implies that the pattern was neither a response to a particular environmental factor, nor an attribute of a specific Neolithic economy (given the diversity of subsistence practice across Atlantic Europe). The notion of a dietary prohibition is further substantiated by Niall Sharples' arguments concerning the restricted and prescribed consumption of the meat of red deer in Neolithic Britain (*2000.114*). Like marine foods, venison may have carried the connotations of a Mesolithic identity that was now being repudiated.

Furthermore, stable isotope studies can discriminate between marine and terrestrial foods, and between plant and animal protein, but not between domesticated and wild resources. So although we may be entitled to say that people began eating exclusively terrestrial foods at the start of the British Neolithic, we cannot say whether they were wild or tame. This is important, because there is strong evidence that wild plants continued to contribute to diets. For instance, at the Whitwell Quarry long cairn in Derbyshire, a study of the dentition of six skeletons dated to c. 3900 BC demonstrated angles of occlusal wear indicating a diet including a high proportion of tough, fibrous material: wild plants rather than cereals (*Chamberlain and Witkin 2003.55*). This study is supported by Wysocki and Whittle's (*2000*) evidence from a series of skeletal populations from chambered tombs in southern Britain, which indicates that the dental pathologies (including caries) associated with a high carbohydrate diet were very rare in Neolithic Britain.

The dental evidence is consonant with the work of Mark Robinson (*2000*) and others, who have repeatedly demonstrated that the majority of charred plant assemblages throughout the British Neolithic are dominated by gathered fruits and nuts, such as hazel-nuts, apples, blackberries and sloes. Robinson stresses that his results do not indicate that cereals were unimportant in Neolithic Britain, but simply that the relevant evidence contrasts with that from the Balkan and central European Neolithic on the one hand, and the British Bronze Age on the other. In both of these contexts, cereal remains are considerably more common that on British Neolithic sites. Recently, a number of arguments have been raised which suggest that the scarcity of cereals in the British Neolithic may be an artefact of taphonomic forces, to mixed effect. Jones (*2000.80*) and Monk (*2000. 74*) both point out that the factors affecting the preservation of carbonised cereal grains and hazelnut shells are different: nut shells are discarded after the consumption of the nut, and may be used as fuel, while cereals are less likely to find their way into fires. This is a fair point, and it is reasonable to assume that the overwhelming dominance of the record by hazelnuts presents an inaccurate picture. Nonetheless, it does not explain why Bronze Age or Iron Age contexts, often on the same sites and in the same kinds of features as the Neolithic deposits under discussion, produce much greater quantities of cereal remains (*Hey, Mulville and Robinson 2003. 82*). Similarly, Monk's argument (*2000.74*) that pit-fills may be tertiary infills swept into features long after their primary use seems to betray a lack of familiarity with British Neolithic pits, which are generally small, and usually deliberately backfilled soon after opening (*Thomas 1999.64–74*).

Rowley-Conwy (*2003.303*) has criticised attempts to read the lack of cereals from Neolithic contexts in Britain 'at face value', and advocates a more taphonomically sensitive approach to the problem. Yet paradoxically he, Jones and Monk all proceed to interpret the carbonised plant remains from a number of large Early Neolithic timber buildings 'at face value', as representing a snapshot of a household-based subsistence economy. Indeed, Rowley-Conwy suggests that the best known of these, at Balbridie in Scotland, represents 'the tip of the iceberg', one of many Neolithic farmsteads that still wait to be found (*2002. 24*). This rather flies in the face of the established wisdom of economic archaeology, which holds that the significance of any faunal or botanical assemblage can only be assessed in relation to the context from which it was retrieved (*Dennell 1978.20; Meadow 1975*). Thus, we can consider Jones' statement that: '*Accidents involving cereal grains or whole hazelnuts are likely to occur only when houses destroyed by fire are discovered. In these circumstances, both hazelnuts and cereal grains stand similar chances of recovery and, in a cereal-based economy, one would expect to find more cereals in these contexts*' (*2000.81*).

It is evident that Jones is assuming both that sites like Balbridie and Lismore Fields were 'houses' (that is, domestic dwellings), and that their destruction by fire was accidental, resulting in an assemblage which is representative of a broader economic pattern (*Garton 1991*). As we will see below, both of these assumptions are questionable.

The rejection of marine foods, the restricted consumption of deer, and the perhaps sporadic or uneven access to cereal foods are indications that the diets of people living in Britain at the start of the Neolithic were by no means homogeneous, and that understanding them will be a complex task. The pattern that is emerging is one of diversity, and this is underlined by the stable isotope data, which demonstrate that some people had diets dominated by meat, while others eat mostly plant foods (*Richards 2000*). Assemblages of animal bones are comparatively plentiful in southern Britain, and are dominated by domesticated cattle. But these are overwhelmingly derived from ceremonial sites, such as causewayed enclosures and long barrows. Cattle were undoubtedly of profound social and symbolic value, and represented a form of mobile wealth, but it is worth questioning how often their meat was eaten in other than ceremonial or ritual contexts (*Ray and Thomas 2003*). Recent work on lipids from Early Neolithic pottery in Britain has demonstrated that cow's milk may have formed an important food (*Copley et al. 2003.1527*). Most of the ceramics studied were again from causewayed enclosure contexts, but it is worth considering whether cattle milk (and indeed blood) was often an everyday element of diet, while cattle meat was reserved for special occasions. This is not to say that as a 'ritual' food beef would have been of purely symbolic value. In societies like the Betsileo of contemporary Madagascar, cattle are primarily slaughtered for funerals and other ceremonial events, but people generally enhance their diet by attending as many funerals as possible (*Kottak 1980*). As Whittle (*2003.31; see also Halstead, this volume*) points out, adult cattle provide over 200 kilograms of meat, and this is more than a small community can generally consume in the absence of technologically-sophisticated storage technologies. Such a large animal is more likely to be killed and consumed for an event at which large numbers of people will have been present, and in Early Neolithic Britain such events will have been overwhelmingly ritual or ceremonial in character. Given that Early Neolithic faunal assemblages are dominated by cattle rather than sheep or pig (which come in smaller 'packages', and could be eaten more frequently by smaller groups), it seems probable that, like cereals, the consumption of meat was sporadic rather than continuous for many communities. Eating foods derived from domesticated plants and animals may not have been an everyday experience for all people in Neolithic Britain. But eating them in contexts of great social visibility might have been an important way of affirming a particular identity, as much of a statement of 'being Neolithic' as was the rejection of marine foods.

TIMBER HALLS AND THE NEOLITHIC IN BRITAIN AND IRELAND

Recent debates on the character of Neolithic economies in Britain and Ireland have to some extent become polarised between two points of view: one which stresses mobility and subsistence diversity, and one which emphasises sedentariness and the universality of a mixed farming economy. The former view is predominantly associated with archaeologists who work in southern Britain (*Barrett 1994; Edmonds 1998; Pollard 1999; Thomas 1999; Whittle 1996*), the latter with scholars of the Irish Neolithic (*Cooney 2000a; 2000b; 2003; Monk 2000*). The 'mobility and diversity' view originated as a critique of generalised models of the Old World Neolithic, which tended to presume that Neolithic economies were composed of much the same elements throughout Eurasia. These conflicted with the evidence from southern Britain, which gave little indication of the presence of settled farming communities, despite decades of research conducted in the conviction that they would eventually be located. Yet scholars of the Irish Neolithic complained that any supposition that this new view could be applied to their material amounted to a quasi-colonialist imposition. In Ireland, the evidence for Neolithic sedentism and a more thorough reliance on domesticated resources are seemingly stronger than in Britain. However, having pointed out that a model generated in Wessex is inappropriate in the Irish context, these authors generally reproduce the 'colonialist' argument in reverse, and suggest that the British Neolithic was sedentary and universally horticultural too (*e.g. Monk 2000.77; Cooney 2003.48*). In the light of the debates discussed above, it is now worth considering whether the ostensibly contrasting character of Early Neolithic activity in Britain and Ireland is purely attributable to differences in preservation and landscape history, or whether there was some fundamental disparity between the two (a possibility raised by *Barclay 2003.71*).

Ironically, the possibility that there were significant differences between Britain and Ireland in the Neolithic arises just as a series of cultural similarities between the two have begun to be appreciated. While archaeologists in the 1920s to 1960s were keen to stress the different cultural affinities of the British and Irish Neolithics, more recent work has emphasised the unity of the carinated bowl series on both sides of the Irish sea, and the similarities between the middle Neolithic Impressed Ware traditions in both regions. Portal dolmens and long cairns occur in both Ireland and Britain, and henge monuments, timber circles, cursus monuments and Grooved Ware have all now been identified in Ireland as well as Britain. Yet despite this growing sense that the 'Northwest European archipelago' may have represented an undivided cultural landscape during the Neolithic, rather than two hermetically sealed entities, there remain some important contrasts. For instance, although causewayed enclosures are characteristic of the Earlier Neolithic in southern Britain, there is at present only one 'true' causewayed enclosure in Ireland, at Donegore Hill (*Cooney 2002.80; Sheridan 2001*). Similarly, while the two coaxial field systems at Céide Fields have long been claimed as Neolithic, and there are a growing number of field systems in the west of Ireland that may also be of very early date (*Cooney 2000a.25*), the only serious contender for a Neolithic field system on the British mainland, at Fengate, has been refuted. The Later Neolithic Grooved Ware from the ditches at this site has now been demonstrated to have been redeposited (*Cleal 1999.6*).

The third and most significant contrast lies in the large number of rectangular timber buildings of Early Neolithic date that have been identified in Ireland in recent years as a consequence of intensive salvage archaeology generated by the current economic boom. Similar structures have been found in Britain, but there are two important distinctions between the two islands. The British buildings are far less numerous, and they are also somewhat larger than the Irish examples – in some cases very much larger (Figs. 1 and 2). Comparing the Irish evidence with that from Scotland, Barclay (*2003.71*) cites several reasons why Neolithic houses should have been more readily identified in Ireland. The reconstruction of civil and commercial infrastructure in Ireland has been accompanied by high levels of professional archaeological intervention; Ireland did not see the same degree of agricultural intensification as Britain during the twentieth century; some buildings in lowland locations may have been mas-

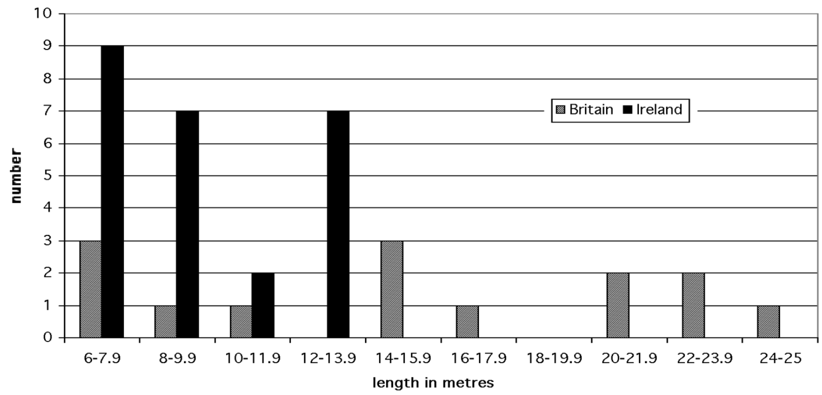

Fig. 1. Dimensions of Neolithic timber buildings in Britain and Ireland.

ked by denser deposits of alluvium in Britain. To this, Monk (*2000.77*) adds that some structures on slopes may have been eroded or truncated, removing traces of structures. These are all good points, but they can all be questioned. It is true that the post-war rebuilding of Britain was not always accompanied by adequate rescue archaeology. However, the extensive construction of pipelines and roads during the 1970s and 1980s was generally subject to archaeological monitoring (including the high quality work of Gas Board archaeologists connected with the construction of North Sea gas infrastructure), and yielded few Neolithic dwellings. Similarly, while the main taphonomic factors held responsible for the non-discovery of Neolithic houses in Britain are attributable to relatively recent (that is, post-prehistoric) agricultural practice, houses of Middle and Late Bronze Age and Iron Age date are very numerous indeed, even though they are often represented by ephemeral features such as eves-drip gullies. To give an example, one of the most recent discoveries of a rectangular Neolithic building was at Yarnton in Oxfordshire. Yet the same area of intensive investigation yielded no fewer than fifteen Bronze Age houses (*Hey, Mulville and Robinson 2003.81*). Unless we are to hypothesise some erosive agency that has preferentially destroyed rectilinear structures while preserving circular ones, the contrast between the Neolithic and later prehistory is a real one.

In both Ireland and Britain it is possible to question whether the 'timber halls' were representative of domestic settlement as a whole. Indeed, Sarah Cross (*2003*) has raised cogent arguments to the effect that the Irish buildings are more likely to have been feasting halls than domestic dwellings. It is also worth considering that in contrast to the timber houses of the early Neolithic in continental Europe, these buildings are seldom found in clusters or 'villages', and are most often isolated (*Topping 1996. 159*). Furthermore, a number of authorities have pointed out that these structures are not characteristic of the Irish and British Early Neolithics as a whole, and may be concentrated in the first two or three centuries of the period (*e.g. Whittle 2003.41*). Of those buildings with radiocarbon dates, Yarnton, Claish, Lismore Fields and Llandegai in Britain, and Ballyharry, Tankardstown 2, Enagh, Newton and Corbally in Ireland all fit into this early horizon. Pepperhill and Ballygalley had carinated bowl assemblages which might mark them as equally early. Only Ballyglass and Littleour (which was probably not a roofed 'house' at all) are appreciably later. One is tempted to speculate that this dating might identify these structures not as a standard attribute of a Neolithic settlement pattern, but as some feature of the transition from Mesolithic to Neolithic. In Andrew Sherratt's (*1995*) terms, might they represent 'instruments of conversion'? This might explain their distinctiveness in the Irish context, where all other domestic structures, permanent or temporary, throughout prehistory were small and circular (*Cross 2003.196*).

However, the case that I wish to make is not that all of these structures were exclusively non-domestic in character. It is simply that those in Britain are larger and less numerous than those in Ireland, and that while many of the Irish buildings may well have been dwellings, it is unlikely that any of the British ones were. If the 'idea' of the rectangular house was a continental one, it may have been adopted by indigenous British and Irish communities and put to a variety of uses. We might say that this formed part of a broader picture in which rectilinear spatial arrangements were introduced, transformed and elaborated, producing mortuary structures, cursus monuments and palisaded enclosures. Structures that are readily identified as 'houses' were only one aspect of this development, and it may be that dwelling in such buildings was only one amidst a number of possibilities: feasting, holding council, exchanging, laying out the dead, storing and redistributing domesticated and wild resources (*see Barclay 2003. 75*). It certainly seems that the artefactual assemblages associated with these structures are sometimes not those that one would expect in a living space. For instance, the structure at Ballygalley had an ex-

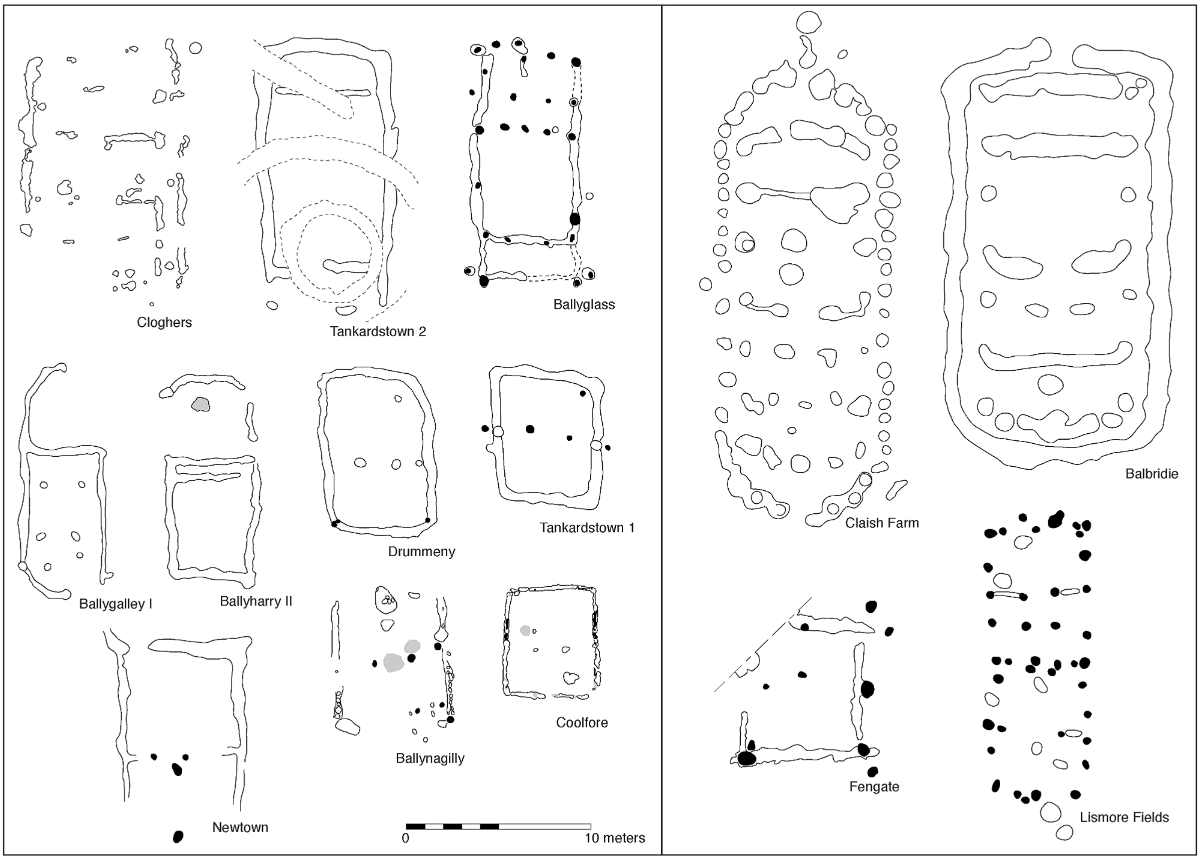

Fig. 2. Plans of a selection of Neolithic timber buildings from Ireland (left) and Britain (right).

tremely rich lithic assemblage, including fragments of porcellanite, Cornish greenstone, Aran pitchstone and Langdale tuff (*Simpson 1996.129*). At Yarnton, the bone assemblage contained both animal and human remains, the animal element being dominated by meat-rich body parts (*Hey, Mulville and Robinson 2003.81*). A similar pattern of meat-dominance was identified at Tankardstown (*Cross 2003.199*). Moreover, at sites like Yarnton, some structures appear to have served as foci for deliberate pit deposits for centuries after they had fallen into dereliction. The implication is that these were special enough places to have survived in memory or tradition for generations.

That at least some of these structures were not dwellings, or not exclusively so, appears to refute Monk's argument that: '*while building structures per se does not indicate sedentism, the size of these buildings and the building timbers used, mainly oak, suggest a level of investment in energy unlikely to be expended by a nomadic or pastoral society*' (*Monk 2000.80*).

For if such buildings were council halls, feasting places, cult houses or mortuary structures, one might expect them to be monumental in character. Furthermore, oak was the wood that appears to have been used for preference in mortuary structures, post-defined cursus monuments, post alignments and palisaded enclosures throughout the Neolithic, and it is to be supposed that it had a particular significance.

The individual structures of some of the Neolithic timber buildings in Britain and Ireland also mark them out as somewhat more complex than might be expected for a purely functional dwelling. Tankardstown, for instance, had been rebuilt on the spot, while Ballyglass and Ballygalley had both been systematically demolished, the latter having a cobbled surface constructed over it (*Simpson 1996.124; Topping 1996.167*). Ballyharry I had been rebuilt following its destruction by fire, and an arrowhead and a basalt axe had been deposited in the foundations. Following final demolition, a number of shallow pits had been dug on the site, containing deliberate deposits including a jadeite axe (*Moore 2003.158*). Other sites, like Lismore Fields, Balbridie and Claish had also been burned down (*Fairweather and Ralston 1993.314*). Indeed, Claish appears to have been rebuilt after burning, and then burned again (*Barclay, Brophy and McGregor 2002.72*). If these fires were accidental, this would seem to indicate uncommon carelessness on the part of Neolithic people in Britain. Indeed, it is interesting to contrast the relatively high proportion of the timber buildings in Britain and Ireland that had been burned with the large timber houses of the Bandkeramik in central Europe, which appear to have seldom if ever caught fire. Instead, most Bandkeramik houses seem to have been left to gradually fall into dereliction after occupation had ceased (*Bradley 1997.247*). Of course, the probability that the British and Irish structures had been deliberately destroyed by fire does not necessarily mean that they were not dwellings. In Southeast Europe, houses in Neolithic tell settlements were routinely burned, and Ruth Tringham has argued that this may have taken place upon the death of the head of the household (*Tringham 1991*). However, it does strengthen the pattern of timber structures being purposefully destroyed rather than left to decay, and it also emphasises that the botanical remains recovered from them cannot be treated as the chance product of a domestic accident. Any deliberate burning of a major timber structure is likely to have taken place with great ceremony, and the contents of the building will probably reflect this, rather than its previous use.

The intentional burning of timber buildings also underscores the connection between such structures and 'ritual monuments', which are conventionally assumed to relate to an entirely different sphere of practice. The timber mortuary structures beneath earthen long barrows, post-defined cursus monuments, and fenced or palisaded enclosures were all often burned during the Earlier Neolithic (*Barclay and Maxwell 1991; Kendrik 1995; Thomas 2000*). In a sense, colossal structures like Claish and Balbridie are better considered under the heading of 'monuments' than 'houses'.

IRELAND AND BRITAIN: CONTRASTING NEOLITHICS?

Whatever the proportion of Neolithic timber structures that were routinely occupied, it appears that the Irish examples were at once more numerous and more diminutive. We have argued that this pattern is not an artefact of preservational conditions and archaeological recovery, and that it may be connected with some other contrasts between Britain and Ireland: the presence of field systems, and the comparative paucity of causewayed enclosures and formal pit deposits in Ireland. Both of the latter two phenomena have been associated with the characteristic activities of mobile communities: periodic fission and aggregation for ceremonial activities, and the 'marking' or 'fixing' of significant locations with cultural media (*Edmonds 1998*).

If, on this basis, we were to hypothesise a British Neolithic which, while diverse, regionalised and heterogeneous, overall contained a greater degree of mobility than an equally diverse Irish Neolithic which had a greater overall investment in a fully agricultural way of life, can we establish any reason why this should have been the case? We might begin with Peter Woodman's recent observation that although the Neolithics of Britain and Ireland are broadly comparable, the late Mesolithic period was very different on each island (*2000.247*). For Woodman, then, the question is one of how two disparate situations converged with the opening of the Neolithic. If, however, we argue that the differences between Britain and Ireland in the Neolithic were deeper than appearances suggest, we should ask whether these differences can be attributed to preceding Mesolithic conditions. In Britain, the later Mesolithic saw diverse economic activities, ranging from encounter hunting of red deer and aurochs to the intensive exploitation of fish, shellfish and seals. But as we have seen above, the later Mesolithic in Ireland saw the development of a distinctive lithic assemblage based around large flakes and blades, while microliths were not used (*Woodman and Mc Carthy 2003.31*). Scrapers and burins were also absent, and this has been related to the absence of red deer in post-glacial Ireland (*Anderson 1993.16; Woodman 2000.237*). Indeed, there were no aurochs, elk or roe deer either, and this is the principal reason why Mesolithic activity became focused almost exclusively on riverine, lacustrine and shoreline resources. Pig was the only mammal of appreciable size found in Ireland during the Mesolithic period.

The singularity of the Irish later Mesolithic has therefore been attributed to the restricted variety of natural resources that were available. It seems probable that migratory fish were of considerable importance, and that both marine and freshwater contexts were made use of, but there is little agreement over the degree of mobility that was involved in this way of life (*Anderson 1993.17; Cooney and Grogan 1994.22*). There is certainly no evidence for the development of large sedentary communities of the sort that are familiar from southern Scandinavia (*Kimball 2000.33*), and it is possible that seasonal moves took place between coasts and river valleys.

The indications are that the start of the Neolithic in Ireland saw radical discontinuity and displacement from the Mesolithic. While in the Ballyloch area of Waterford there are suggestions of continuity in settlement patterns from Mesolithic to Neolithic, for the most part the lithic scatters from the two periods are found in entirely different areas (*Cooney and Grogan 1994.26; Cooney 2000.56*). Likewise, finds of Early Neolithic carinated bowl pottery are quite distinct from Mesolithic sites (*Sheridan 2004.12*). This discontinuity can be connected with radiocarbon evidence that the shift from Mesolithic to Neolithic was, in pan-European terms, exceptionally swift in Ireland (*Gkiasta et al. 2003.60*).

In a variety of ways, this pattern is at variance with that in Britain. The British Neolithic chipped stone industries replace microliths with leaf-shaped arrowheads, and have polished stone axes, but in technological terms there is much continuity. Assemblages remain flake- and blade-based, and there is considerable similarity in reduction sequences (*Edmonds 1995.37*). This is quite unlike the demise of 'Bann flakes' in Ireland. In many parts of Britain, traces of occupation are found in much the same parts of the landscape in the Early Neolithic as in the Late Mesolithic (*Holgate 1988.31; Barrett, Bradley and Green 1991.31*), while Neolithic artefacts such as leaf-shaped arrowheads are often found on Mesolithic sites (*Edmonds 1995.35*). There are strong indications that particular locations maintained their significance across the Mesolithic/Neolithic divide. For instance, many Neolithic chambered tombs have scatters of Mesolithic artefacts located beneath them (*e.g. Saville 1990.13–14; Case 1986.24*). Arguably, some aspects of established patterns of mobility survived into the Neolithic, and people continued to return to clearings, campsites and landmarks that had been frequented for generations.

These different pathways followed between Mesolithic and Neolithic begin to be comprehensible when we consider that the principal economic change experienced by communities in Britain was the substitution of cattle (and to a much lesser extent pig and sheep) for large wild mammals such as red deer and aurochs. People may have used the same places and pathways, but they now herded domesticated stock rather than hunting wild beasts. Yet as we have argued, the meat of those beasts may only have been eaten periodically, and wild plants may have continued to be of considerable importance to some communities. Some may have relied on cereals from early on, while for others grain may have been a special food, infrequently eaten. In Ireland, though, the substitution of one species for another was not an available option. Domesticated animals could not be fitted into an established routine: adopting cattle and cereals involved abandoning Mesolithic practices altogether. It was for this reason that settlement and residential patterns seem to show such complete dislocation. In Ireland, the beginning of the Neolithic may have involved entire communities 'buying in' to a sedentary and agricultural way of life to a far greater extent that was the case in Britain.

What we should perhaps take from this is an indication of the flexibility of the kind of Neolithic that developed in Atlantic Europe. The rejection of foods from the sea was a widespread marker of Neolithic identity – a cultural phenomenon which is to be distinguished from the more localised variations in subsistence practice. Like mortuary monuments, pottery, enclosures and polished stone axes, it forms one element of an apparatus which enabled people to craft group and personal identities for themselves. Unlike the central European Bandkeramik, these material culture forms and cultural practices were not attached to a particular economic formation. It was the translatability of the Atlantic Neolithic that enabled in to be adopted by very diverse Mesolithic societies in Britain, Ireland and Scandinavia, resulting in highly distinctive Neolithic patterns in each of these regions.

CONCLUSION

I end by recapitulating a series of related points:

❶ The assumption that Britain and Ireland were isolated in the Later Mesolithic is unwarranted, and appears to be undermined by the presence of early domesticated animals in Ireland;

❷ Consequentially, Mesolithic populations in Britain and Ireland will have been aware of the various elements of the Neolithic 'package' long before 4000 BC. The adoption of domesticates and novel forms of material culture by indigenous people cannot be explained in terms of the sudden arrival of boatloads of continental people in these islands;

❸ In these circumstances, it is simply unfeasible that the abrupt spread of pottery, monumental funerary structures and polished stone tools throughout Britain and Ireland could have been triggered by the movement of small groups of agriculturalists from the north-west seaboard of Europe;

❹ Only two scenarios could explain the suddenness of the Neolithic transition: either a colossal movement of population from the continent, swift and thorough enough to entirely displace the indigenous foragers within a couple of generations, or an equally sudden adoption of the Neolithic cultural repertoire on the part of Mesolithic communities;

❺ In the absence of any single donor population identifiable on the continent, the only realistic possibility is that Mesolithic societies in Britain and Ireland (and, for that matter, in southern Scandinavia) 'became Neolithic' in the two centuries after 4000 BC;

❻ If, as we have argued above, these foraging communities had long been aware of the character of the Neolithic, and had interacted with continental Neolithic groups over a prolonged period of time, some critical factor must have changed for the shift to a new way of life to have proved so universally desirable. I have argued that this was a change in the character of the Neolithic, which rendered it suitable as a means through which personal and group identities could be constructed and maintained;

❼ As a consequence of the radically different developmental pathways followed by Later Mesolithic groups in Ireland and Britain, the ways in which they drew on and made use of the Neolithic repertoire at this point were equally distinct;

❽ In Britain, domesticated cattle were substituted for wild ungulates, maintaining patterns of mobility and sociality across the Mesolithic-Neolithic boundary. The extent to which cereals were adopted may have varied from region to region and community to community. Some groups of people certainly grew cereals in small fixed plots, but probably not all. In Britain, timber halls were large and few in number; possibly none of them were used as dwellings at all. From these beginnings, the shift to a fully agricultural landscape and a fully sedentary population may have been quite gradual;

❾ In Ireland, the change to the Neolithic was just as sudden as in Britain, but involved the total relinquishment of existing patterns of subsistence, residence, and landscape use. Consequentially, the degree of investment in a fully agricultural way of life may have been much more complete than in Britain, from the very start of the Neolithic.

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contents

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Documenta Praehistorica XXXI

Early polished stone tools in South China evidence of the transition from Palaeolithic to Neolithic

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ABSTRACT – *The appearance of polished stone tools has been taken as one of the important indicators of the beginnings of the Neolithic. Early polished stone tools excavated in South China are discussed in this paper. The polishing technology developed from stone tools with polished blades to whole polished stone tools. Different kinds of polished stone tools appeared at different times. The earliest polished stone tools are axes, adzes and cutters, with only the blades polished. They date to 21 000–19 000 cal BP. The whole polished stone tools appeared thousands of years later. The relationship of the polishing technology with other factors during the transition from the Paleolithic to the Neolithic should be discussed after more detailed information has been obtained.*

IZVLEČEK – *Pojav poliranih kamenih orodij je eden glavnih znakov za začetek neolitika. V članku obravnavamo zgodnje polirano kameno orodje, ki smo ga izkopali na jugu Kitajske. Tehnologija poliranja se je razvijala od kamenih orodij s poliranim rezilom do v celoti poliranega kamenega orodja. Najzgodnejše polirano kameno orodje so sekire in sekači, ki imajo polirano le rezilo. Datirano je v čas od 21 000 do 19 000 calBP. V celoti polirano kameno orodje se pojavi tisočletja kasneje. Povezava med tehnologijo poliranja in drugimi dejavniki prehoda iz paleolitika v neolitik bo mogoča, ko bomo imeli več podrobnejših podatkov.*

KEY WORDS – *China; Palaeolithic; Neolithic; polished stone tools*

INTRODUCTION

Because of its eco-geographical diversity and archaeological/cultural complexity China is now becoming more important to serve as a source for the research of constructing new analytical methodologies for properly understanding the Palaeolithic-Neolithic transition. The research on the models of Neolithization in China is still in the early stages. In this paper, we focus on early polished stone tools excavated in South China in order to investigate more detailed information about Neolithization.

The function of polished stone tools has been discussed since the middle of the 19th century when a French archaeologist divided stone tools into chipped ones and ground ones. The ground lithic implements were accepted as one important characteristic of the Neolithic by archaeologists and prehistorians following a book published in 1865 in which the late period of polished stone tools was regarded as part of the Neolithic period. The appearance of polished stone tools has been taken as one of the indicators of the beginning of the Neolithic ages for some time (*Glyn Daniel 1987*) and some archaeological scholars still insist that their appearance is what distinguishes the Neolithic from the Paleolithic. In fact, abundant materials excavated in recent decades reveal that new models will be required to describe the transitional period. The ground or polishing technologies were not only applied to stone, but also to wooden tools. These tools were used various activities: agriculture, fishing, hunting, food processing and weaving etc. It is difficult to correlate them with different (micro)regional cultural backgrounds and environmental conditions. The cultural trends in China can be divided into two geological regions, South China and North China, during the Paleolithic-Neolithic transition. In this paper, we investigate early polished stone tools found in South China.

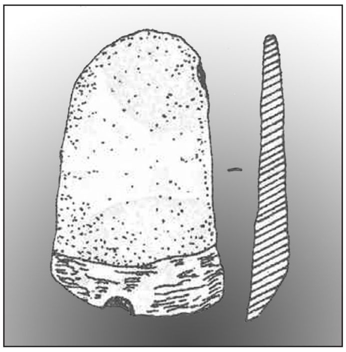


Fig. 1.2. Adze with polished-blade from the Bailiandong site (*Zhou Guoxing 1994*).

THE EARLY POLISHED STONE TOOLS FOUND IN SOUTH CHINA

In the last 20 years, many important sites have been excavated in China, which provided plenty of materials for researching the Paleolithic-Neolithic transition. According to excavation reports, more than 10 archaeological sites dated to ten thousand years ago have been found with polished stone tools. Most are cave sites, except the Liyuzui in Dalongtan and Shangshan in Zejiang, which are open-air sites. Typical sites are listed in Table. 1. The polished stone tools mentioned here include axes, adzes, chisels, knives, sickles, spearheads, and arrowheads. Stone rollers, stone saddle-querns and perforated ground stone tools should not be included among the polished stone tools. So the earliest polished stone tool in Figure 1.1 is the polished peddle cutter from the west layer No. 4 at Bailiandong cave site in Liuzhou (*Scientific Museum of Liuzhou Bailiandong Cave 1987; Liuzhou Museum 1983*). This cutter is 4.5 cm long, 2.7cm wide and 1.2 cm thick and made of metamorphic siltstone. A flat small peddle was ground, which formed an inclined arc-shaped knife-edge. The whole artifact is in the form of a triangle. The uncalibrated radiocarbon dates assigned to the west layer No. 4 are 19 350±180 BP and 20 960±150 BP. A stone adze with polished blade or adze-shaped cutter (Fig. 1.2) was excavated from the east layer No. 4. It was made from an arc-topped, flat trapezoidal pebble of quartz siltite by chopping and polishing the bottom to form the knife-edge. It is 8.3 cm long and 1.2 cm thick and the knife-edge is 5.1 cm wide. The uncalibrated radiocarbon age is 13 170±590 BP (*Zhou Guoxing 1994*).

The site of Liyuzui in Dalongtan can be divided into two cultural strata (*Qiu Licheng et al. 1982*). In the lower stratum most of the stone tools are chipped; they were excavated with a few sandy pottery shards with corded decoration and lightly calcified animal bones. Only one polished stone tool was found, a stone axe with a polished blade (Fig. 2.1). The blade was polished on one side only. It is small and incomplete, 11cm long and 5cm wide in the middle. The lower layer of this site, which is 100–170 cm thick, should be divided into more sub-layers, but at present we can give the age of the polished stone axe within a range of uncalibrated radiocarbon dates as somewhere between 21 025±450 BP and 11 450±150 BP.

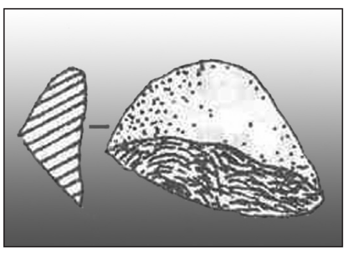


Fig. 1.1. Cutter with polished-blade from the Bailiandong site (*Zhou Guoxing 1994*).

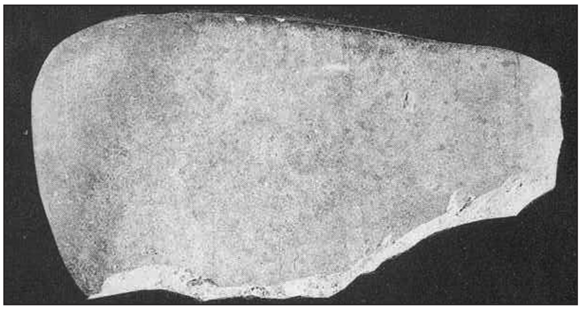


Fig. 2.1. Axe with polished blade from the Liyuzui site (*Liuzhou Museum 1983*).

The deposit at the Dushizai cave site is 4 meters thick, with five strata, and has been excavated four times from 1960 to 1983. Strata 2, 3, and 4 correspond to the upper, middle and lower cultural layers. Most stone tools are for chopping, with some ground perforated stoneware. The materials are sandstone, argillaceous rock, quartzose sandstone, quartzite and so on, with sandstone predominating. All of the 7 stone cutters with polished blades were excavated from the upper cultural layer. Their forms are not very uniform. Most of them are made from flakes and cores by chopping and polishing to form the blade. Cutter (Fig. 3.1) was made after chiseling and polishing the edge. It is 5.4 cm long and the blade is 3.2 cm wide. Its radiocarbon date without calibration is 12 845±130 BP.

In the Huangyandong cave site beside chipped stone tools, a fragment of perforated stone ware, and in-

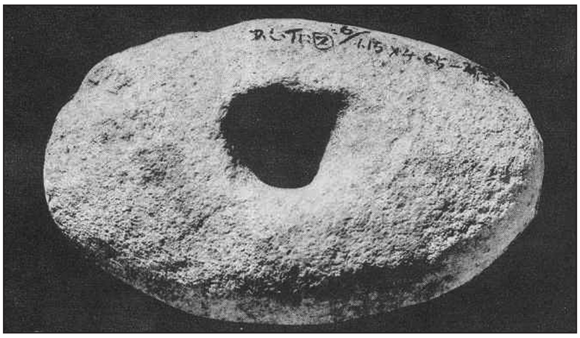


Fig. 2.2. Perforated stone ware from the Liyuzui site (**Liuzhou Museum 1983*****).***

complete polished stone tool were found. The remains of pig, deer, snails and shells have been recorded (*Song Fangyi et al. 1983*). The incomplete stone axe is made from quartzose fine sandstone, with a fine polished arc-shaped blade. The incomplete length of the axe is 6cm, with a 4.5 cm wide blade. The shells from this deposit gave uncalibrated radiocarbon dates from 10 640±300 BP to 11 580±300 BP.

Xianrendong and Diaotonghua are two cave sites 800 m apart in the small and humid Dayuan Basin. Five excavations were carried out at Xianrendong from 1962 to 1999. Diaotonghuan was excavated in 1995. Abundant upper Paleolithic and early Neolithic cultural deposits were found at these two sites. The cultural deposits of the Stone Age were divided into two strata following excavations in 1962 and 1964. More strata were assigned to the deposit after 1995. According to the information from the excavation of 1962 and 1964, most stone tools are chipped (scrappers, choppers, cores, and plate-shaped artifacts) and embedded in the lower cultural layers (*Jiangxi Provincal Committee for Administration of Cultural Relics 1963; Jiangxi Provincal Museum 1976*). The polished stone tools assemblage consist of celts, shuttle shaped (Fig. 4.2) or cone-shaped (Fig. 4.1) wares and perforated stones (Fig. 4.3). They are made from roughly polished sandstone. The materials of the excavation after 1995 have not been published so far. But according to someone's introduction, there were 625 stone tools, 318 bone wares, 26 perforated shells, 516 pottery shards, tens pieces of human bone, and more than ten thousand pieces of animal bone excavated at the sites of Xianrendong and Diaotonghuan. Most of the stone tools are pebbles. A small number of them are flint and quartz flakers. There are scrapers, points, choppers, blades and micro-blades and several polished stone tools. There is no radiocarbon date related directly to layer F, in which the ground shuttle shaped stone artifact and polished conical stone tool were found. The radiocarbon date of layer D is 15 090±210 BP (the calibrated age is 16 900–15 300, BA00014) at the same site. So the radiocarbon date of the polished stone tools found in Layer F should be older than 15 090±210 BP. We can see very clear from

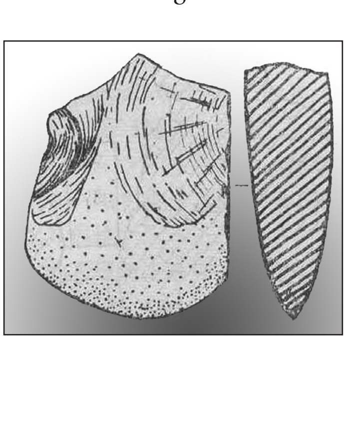


Fig. 3.1. Cutter with polished-blade from the Dushizai site (**Qiu Licheng et al. 1982*****).***

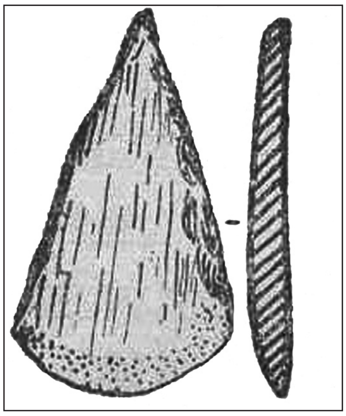
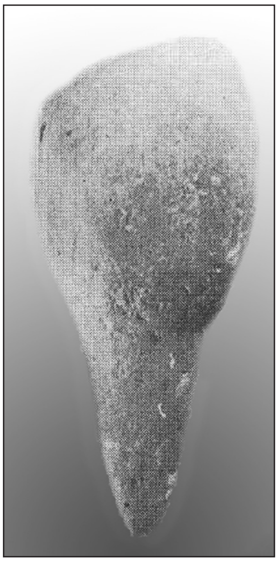


Fig. 3.2. Cutter with polished-blade from the Dushizai site (**Qiu Licheng et al. 1982*****).***



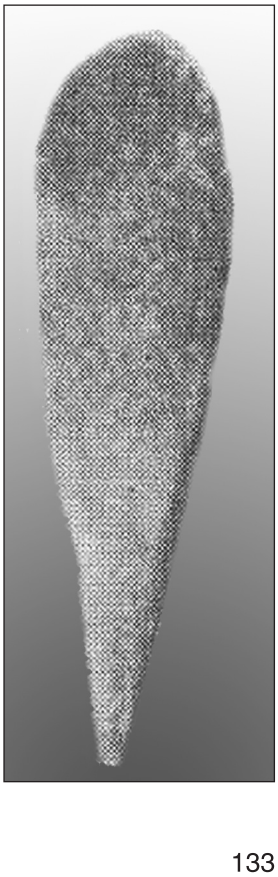


Fig. 4.1. Polished and tapered stone tools from the Xianrendong site (**Jiangxi Provincal Committee for Administration of Cultural Relics 1963*****).***

these two site that the early polished stone tools appeared earlier than the early pottery.

Shangshan site in Pujiang county in Zejiang province is a hill site excavated in 2001. There were abundant cultural remains with local cultural characteristics (*Jiang Leping et al. 2003*). The layers No. 3 to 7 are Neolithic, 40–50 cm thick. The typical wares are a stone ball, an irregular flat, and long rectangular roller, a large shaped stone saddle-quern and red surfaced pottery shards with charcoal tempering. There are wholly or partially polished adze, axe and perforated stone wares and flakers (Fig. 5). The rice husks in the pottery shards have yielded evidence of early cultivated rice. The radiocarbon dates from the rice husks are 9610±160 uncal BP and 8050±110 uncal BP.

Pengtoushan is a hill site by a river, excavated in 1988. The excavated relics are tombs and house remains, with a large quantity of stone wares, pottery shards, and rice. Most of the stone tools are chop-

Stratum	Material	^{14}C age (yr, BP)	Calibrated age Cal BP (±2σ, 95.4%)	Lab code	Note
Bailiandong in Liuzhou, Guangxi Province, Phase II					
West No. 4	Calc-sinter	19345±180*	23950–22150	BK82097	Peddle Cutter and adze shaped cutter with polished-blade, associated with chipped stone tools, animal bones and shells.
West No. 4	Calc-sinter	20965±150		BK92039	
East No. 4	Charcoal	13165±590*	17250–14050	BK93017	
Layer No. 3	Bone	8700±240 (Pa–231) 8000±800 (Th–230)		BKY82239	Polished axe
Liyuzui in Dalongtan County in Liuzhou, Guangxi Province					
Lower	Shell	22670±250*		BK82091	Adze-shaped cutter with polished-blade, associated with chipped stone tools, sandy terracotta, shells.
Lower	Shell	20430±450*		PV0379(1)	
Lower	Shell	18035±300*	22450–20450	PV0379(2)	
Upper	Shell	12515±220*	15750– 14050	BK82090	Axe and adze with polished-blade, associated with sandy terracotta.
Upper	Bone	11450±150*	13850–13000	PV0402	
Upper	Bone	10205±150*	12650–11250	PV0401	
Dushizai in Yangchun, Guangdong Province					
Layer No. 4	Bone	16205±570*	20850–17850	BK83018	Peddles with polished edge and cutter with polished blade, associated with perforated stone wares and shells.
Layer No. 3 lower	Bone	14915±250*	18650–17050	BK83017	
Layer No. 3 lower	Shell	16680±180*	20650–19050	BK83011	
Layer No. 3 upper	Bone	13855±130*	17250–16050	BK83016	
Layer No. 3 upper	Shell	17200±200*	21350–19650	BK83010	
Layer No. 3 upper	Shell	14480±300*	18250–16450	ZK0714	
Layer No. 2	Shell	12845±130*	15950–14350	BK83009	
Huangyandong in Fengkai, Guangdong Province					
Cave Hall	Shell	11580±300*	12050–13150	ZK0676	A piece of incomplete polished stone tool and perforated stone tools.
Cave Hall	Shell	10640±300*	13250–11350	ZK0677	
Zengpiyan in Guilin, Guangxi Province					
BT3⑦	Charcoal	8790±170	10250–9450	BA01224	Polished adze
Shangshan in Pujiang, Zejiang Province					
2001PKF2	Pottery	8740±110	10200–9500	BA02235	Partial or entirely polished axe and adze, with stone balls, chopper, pottery.
2001PKH31F	Pottery	9610±160	11350–10400	BA02236	
2001PKT2⑥	Pottery	8620±160	10200–9250	BA02237	
2001PKT3②	Pottery	8050±110	9300–8550	BA02238	

*The dates were originally published in T1/2 5730 in China. Here we use T1/2 5568 to recalculate them.

Tab. 1. The dates of earlier polished lithic implements in China (*Wu & Zhao 2003*).

Fig. 4.2. Polished shuttle-shaped stone tools from the Xian-rendong site (**Jiangxi Provincal Committee for Administration of Cultural Relics 1963*****).***

pers. Several of them are polished, mostly rollers and perforated stone tubes (Fig. 6.2). The raw material they used to produce them is black shale, which is not very hard. Only one axe was found (Fig. 6.1), of uncertain function, is of grayish-green claystone, entirely polished with one cutting edge, which has been damaged by use. It is 8 cm long 4 cm wide and 0.85 cm thick.

CONCLUSION

According to the discoveries of polished stone tools in South China, different kinds of polished stone tools appeared at different times. The earliest polished stone tools are axes, adzes and cutters, all having only the blade polished. The cone-shaped or shuttle-shaped polished tools, used for perforating, are also among the earliest polished stone tools. According to the radiocarbon dates from the sites of Bailiandong and Liyuzui, the ages assigned to these kinds of stone tools are about 24 000–22 000 calBP, based on samples of calc-sinter and shells. If we consider the "dead carbon factor" concerning the calc-sinter and shells in the limestone area of South China, we should subtract some years from those dates. The dead carbon factor in aquatics and hydrophytes in South China has been measured before. It changes from a hundred years to two thousand years or more. The mean value of the factor is about 1500 years (*14C Laboratory of Archaeological Department 1982; Zhang Xuelian 2003*). Here we use 3000 years as the greatest factor. Then the ages of the earliest stone tools with only the blade polished are about 21 000–19 000 cal. BP. Cone-shaped or shuttle-shaped polished stone tools appeared at almost the same time. The evolution of polished stone tools followed steps: blade polished only; entire tool roughly ground, with blade finely polished; entirely polished. The completely polished stone tools appeared about 10 000 cal BP. Those from the Zengpiyan site date to 10 250–9450 cal BP. The polished adze was embedded in 5, upper layer. The stone tools from phase 1–4, lower layers, are all chipped. The dates of Pengtoushan culture and Chengbeixi culture along the Yangtse River are 9800–7500 cal BP. A few polished stone tools were found there. The stone assemblage consists of chipped tools and a large number of adornments, and very few tools such as small axes, adzes and chisels.

Fig. 4.3. Perforated stone tool from the Xian-rendong site (**Jiangxi Provincal Committee for Administration of Cultural Relics 1963*****).***

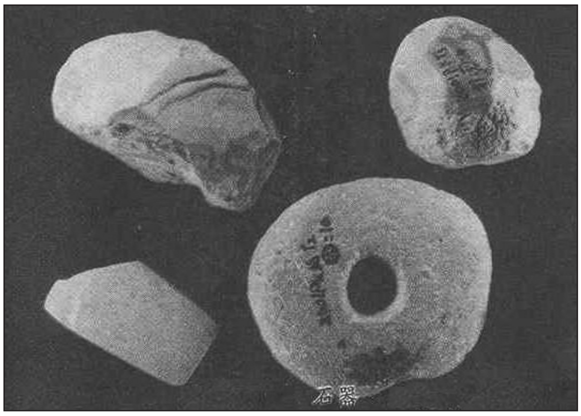


Fig. 5. Polished adze and perforated stone ware found in Shangshan site (**Jiang 2003*****).***

The development of stone polishing technology can be seen from changes in the materials of stone wares. The earlier polished stone tools were usually made of sandstone, shale and tuff, which are all soft and easily worked. Metamorphic rock and other hard rocks were used to make stone tools later. Of course, the selection of stone material was also limited by local resources. Anyway, the hard material used for stone tool making show the progress of polishing technology. Usually the stone tools used for felling, cutting, scraping and digging were made from the hard rock. Most of the early polished stone tools were made of pebbles after polishing. The natural surface of the pebble can be seen from the axe, adze and cutter with the blade polished only.

According to finds made so far, the appearance of the polishing technology predates the cultivation of

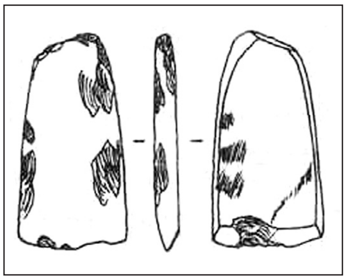


Fig. 6.1. Polished axe from the Pengtoushan site (*Institute of Cultural Relics and Archaeology in Hunan Province 1990*).

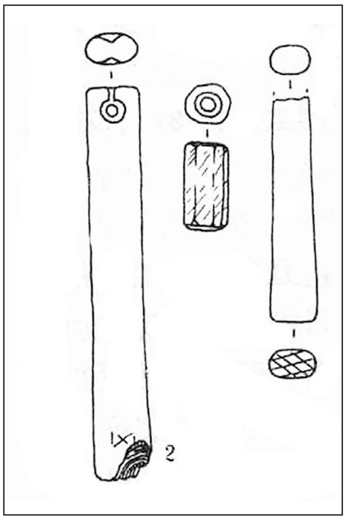


Fig. 6.2. Stone club-shaped pendant stone tube and stone club-shaped pendant from the Pengtoushan Site (*Institute of Cultural Relics and Archaeology in Hunan Province 1990*).

rice. Because of insufficient dates it is still difficult to make a comparison between the appearances of polished stone tools and pottery. It seems that the polished stone tools were earlier than the pottery in some places. But we also found contrary evidence, such as at the Zengpiyan site. The pottery shards were excavated from phases 1–4, lower layers, without any polished stone tools. The polished stone tools appeared later, in phase 5, upper layer.

There is no doubt that the appearance of polished stone tools is a Neolithic characteristic in South China, because polished stone tools were found in almost every Paleolithic-Neolithic transition site in South China. But the function of the polished stone tools in the transition is still uncertain. The development of the polishing technology covered a long period from its appearance to its wider distribution. The process varied from place to place. More detailed information is needed in order to understand the relationship between the appearance of polishing technology and economic development, the relationship with living conditions and the environmental background, the relationship to the appearance of pottery, agriculture and husbandry. We must also investigate the process in the context of the global development of stone tool making technology.

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contents

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Documenta Praehistorica XXXI

An aspect of Neolithisation in Mongolia: the Mesolithic-Neolithic site of Tamsagbulag (Dornod district)

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ABSTRACT – *The article outlines the first results of the French Archaeological Mission to Mongolia centered on the Neolithic. The topics discussed include general aspects of the initial Neolithisation in Eurasia, and the use of state-of-the art archaeological techniques in studies of Prehistory, with special reference to the Mesolithic/Neolithic interface, as exemplified by a survey and excavations in the area of Tamsagbulag site (Eastern Mongolia, aimak/district of Dornod) originally investigated by a Soviet-Mongolian mission directed by Professor A. P. Okladnikov, a renowned Russian archaeologist.*

IZVLEČEK – *V članku orišemo prve rezultate francoske arheološke misije v Mongolijo, ki se je osredotočila na neolitik. Obravnavamo splošne vidike začetne neolitizacije v Evraziji in uporabo najboljših arheoloških tehnik pri raziskavah prazgodovine, posebno v zvezi z razmejitvijo mezolitika in neolitika. To ponazorimo s terenskim pregledom in izkopavanji na območju najdišča Tamsagbulag (vzhodna Mongolia, aimak/okrožje Dornod), ki ga je prvotno raziskala rusko-mongolska odprava pod vodstvom profesorja A. P. Okladnikova, slovitega ruskega arheologa.*

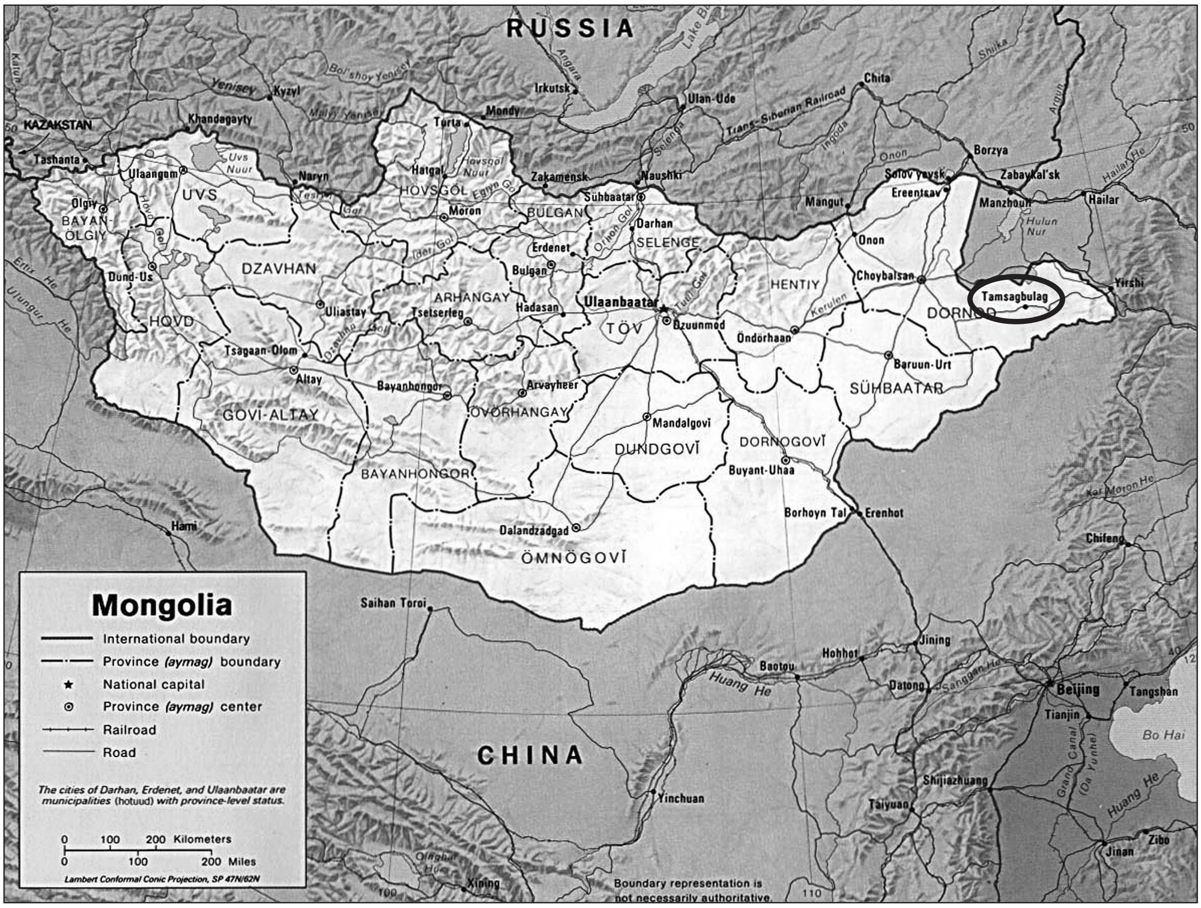
KEY WORDS – *Mongolia; Tamsagbulag surveys and excavations; Neolithisation; Mesolithic; Neolithic*

INTRODUCTION

I would like to discuss here the project of the French Archaeological Mission in Mongolia for the Neolithic Period. This project covers Outer Mongolia, half way between Russia (Siberia) to the north, Kazakhstan to the west and China (Inner Mongolia and Manchuria), Korea and Japan to the south and east (Map 1).

Despite the fact that more than a thousand Paleolithic sites are recorded and that the period is relatively well known there, this was not the case of the Neolithic (a fortiori for the Mesolithic) (Map 2). In the words of my colleague and friend Professor Jacques Legrand (INALCO, Paris): "Research into the Neolithic of Mongolia should provide informations and essential hypotheses which would improve our knowledge of the rise and formation of Central Asiatic nomadic pastoralism (particularly Mongolian), a phenomenon which dominated the historic period throughout the central and eastern part of Eurasia." At the beginning and concurrently with the North-Pontic and Danubian areas, waves of nomadic pastoralists (Proto-Indo-Europeans in the opinion of many of my colleagues) disrupted the established economic and social structures of the sedentary Neolithic and Eneolithic groups (the Cucuteni-Tripolye, Gumelnitsa, Karanovo VI, etc.), introducing, among other novelties, the horse and wheel.

Amazingly, more is known of dinosaurs' fossil eggs and bones in the Gobi Desert than of the Neolithic of Mongolia. But despite the paucity of publications, there is a fair amount of actual data available. At the Department of Archaeology of the Institute of History at Ulaan Baatar, with the help of my Mongolian colleague B. Gunchinsuren, I started a personal inventory of Mesolithic and Neolithic sites, putting



Map 1. Location of Tamsagbulag (Dornod aimak/district of Eastern Mongolia).

them on the map. I also started to study the stone tools and ceramic assemblages, primarily from unpublished and poorly known Soviet and Mongolian surveys and excavations.

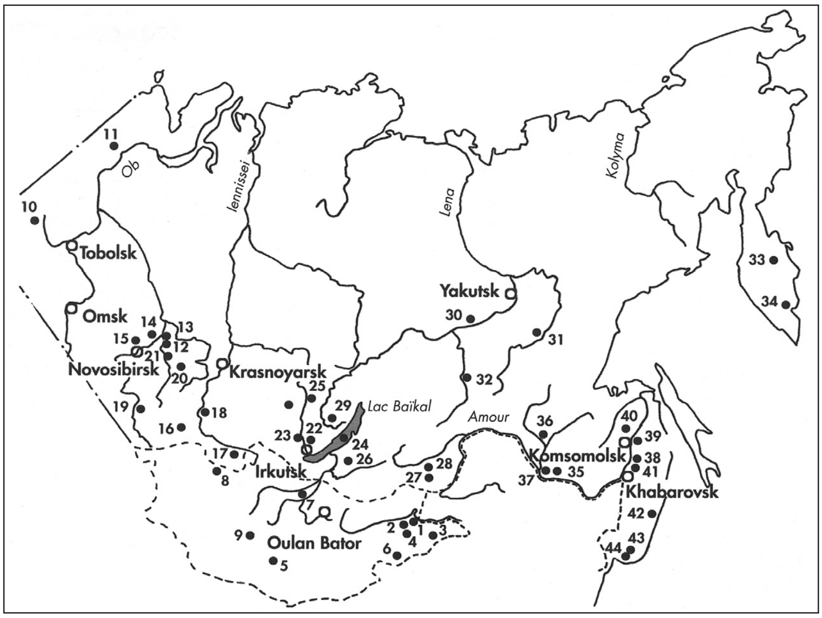
On this basis, I identified four regions of Mesolithic and Neolithic socio-economic and cultural entities:
❶ The region west of the Altai and west of the Khangai Mountains.
❷ The north-central region south of Lake Baikal.
❸ The southern region of northern of China (the Northern Gobi).
❹ The eastern region of north and western Manchuria.

Yet this pattern results rather from the state of our knowledge than a carefully designed research strategy. It is mainly based on surface finds (stone tools, sherds, etc.). Results from systematic excavations are few, especially in chronostratigraphic sequences. The only excavation worthy of the name is that of the Soviet Mission directed (first in 1949 and then 1967) by the renowned Russian archaeologist A. P. Okladnikov at the Mesolithic/Neolithic site of Tamsagbulag (eastern Mongolia, Dornod aimak).

THE FRENCH ARCHAEOLOGICAL MISSION IN MONGOLIA FOR THE NEOLITHIC PERIOD

The French Archaeological Mission in Mongolia for the Neolithic Period was established in 1996 under the auspices of the French Foreign Office and the Mongolian Academy of Sciences (Institute of History), with the intention, as its first objective, of undertaking remote sensing, excavations, and surveys at Tamsagbulag. Despite the brevity of reports on earlier Soviet excavations (essentially by *Okladnikov, Derevianko 1970; Dorj 1971*), it became clear that this was a key Mesolithic/Neolithic site in Central Asia, and this was confirmed by both the materials from these excavations and by two recent syntheses by A. P. Derevianko and D. Dorj (*1992*) and A. P. Derevianko (*1994*).

Tamsagbulag is the key site for the Tamsagbulag Culture, which, in my opinion (see below), dates to the 5th millenium BC. The occupants were both sedentary hunter-fisher-gatherers and farmers. Semi-subterranean dwellings (with posts supporting the roof) oriented south-east to north-west (around 40 m^2: 7.60 m long, 5.60 m wide and 0.60 m deep), with



Map 2. Most important Neolithic sites in central and northern Asia (after* A. P. Derevianko 1994*): 1. Yamat Nuur, 2. Ovoot, 3. Tamsagbulag, 4. Khuitynbulag, 5. Shabarak, 6. Daringanga, 7. Arshan-Khad, 8. Chandman, 9. Uldzit, 10. Andreyevskoe lake, 11. Chestyi-yaga, 12. the Samus burials, 13. the Tomsk burials, 14. Alexandrovskoe, 15. Zavjalovo, 16. Ust-Khemchik, 17. Toorakhem, 18. Khadynnykh, 19. Kuyum, 20. the Vaskovskoe burial, 21. the Tomsk petroglyphs, 22. Lenkovka, 23. the Chastaya and Khinskaya valleys, 24. Olkhon, 25. Kamennye isles, 26. Mukhinskoe, 27. Chindant, 28. Budulan, 29. Shishkino, 30. Kullaty, 31. Belkachi, 32. Krestyakh, 33. Ushkovskaya, 34. Tarya, 35. Novopetrovka, 36. Gromatukha, 37. Osinovoe lake, 38. Malyshevo, 39. Voznesenska, 40. Kondon, 41. Sakachi- Alyan, 42. Rudnaya, 43. Zaisanovska, 44. Kirovskoe.

storage pits and burials inside the houses were found. The stone (chipped and polished) and bone tool assemblages, and ceramic materials are rich, as are the paleobotanical and faunal samples (millet, large fish, bird, cattle, pig, horse, etc.). A bull cult inherited from Paleolithic times (see *Sériadès and Stanko 2000*) has been identified from a pit filled with the bones of this animal.

THE 1997 FIELD SEASON

Tamsagbulag ("bulag" meaning "spring" in Mongolian) lies south-east of the town of Choibalsan, in the desert-steppe region just a few kilometers from the Chinese border (Manchuria), a region that was abundant in black-tailed gazelles and saiga antelopes before (so people say) the Soviet Army finished them off. It forms part of a large lake, which today is almost completely dry, one-two kilometres wide between the higher southern terraces (Tamsagbulag 1) and the lower northern ones (Tamsagbulag 2). In the north, we were able to locate the remains of the village of Tamsagbulag, built of mud-bricks and abandoned some fifty years ago (?). A few kilometres to the North-East one may note a series of small lakes located south of the larger Lake Buir.

Tamsagbulag 1

With some difficulty we are able to locate the site of Tamsagbulag 1 on the basis of its position in relation to a cliff ten-twelve metres high with a spring at its foot, mentioned in a brief publication of A. P. Okladnikov and A. P. Derevianko.

It seems possible that Mesolithic and Neolithic hunters of gazelle and antelope were based here in much the same way as Magdalenian hunters awaited reindeer on the left bank of the Seine at Pincevent; and during the Late Upper Paleolithic, on the Bug terrace in Ukraine, bison herds were taken at Anetovka more than ten thousands years ago (*Sériadès and Stanko 2000*).

During the first campaign (August/September 1997), two complementary strategies were adopted:

❶ Intensive surveys yielded several hundred stone tools, including several polished ones, and a significant number of potsherds suggesting an affinity with the Neolithic of the Lake Baikal and Amur region of Siberia and contemporary groups in southeast Asia.

❷ Four trenches (A, B, C and D) from 1 to 4 m^2 in size were dug:

Trench A (4 m^2) on the higher terrace, a few metres from the cliff facing the spring yielded no archaeological material, but provided excellent stratigraphy for sedimentological and palynological analyses (Fig. 1). Two stratigraphic exposures to the east-west and north-south provided a sequence for the upper terrace occupied during the Neolithic: below the vegetal topsoil (20 cm) there was a sequence of sand (90 cm) resting on compact clayey soil. The latter caused us to stop the excavations. The stratigraphy provided information on the formation of the upper terrace, the palaeoclimate, the landscape, and biotopes and ecosystems of semi-sedentary Mesolithic/Neolithic groups at the beginning of the Holocene.

Trenches B and C were located two hundreds metres south of the spring. Only trench B yielded chipped stone artefacts (Neolithic).

Trench D (3 m²) at the foot of the terrace, not far from the spring, yielded the upper part of the brown and yellow Neolithic layer mixed with charcoal and ash (with chipped stone tools, fragments of pottery). A ^{14}C date from this trench (Gif. 10949) of 5590 ± 120 BP (cal 4753–4155 BC) was obtained. This date is of the same order as the dates for Neolithic sites obtained in China.

Fig. 1. Tamsgbulag 1. Trench A seen from the South. Spring ("bulag" in Mongolian) at the foot of the terrace (12m high); the marshy area and the soviet built milatary road through the ancient lake; on the background, the opposite terraces (Tamsagbulag 2) and the steppe.

Tamsagbulag 2

Tamsagbulag 2 is a new site, discovered on the opposite (northern) bank of the ancient lake. There, over one hundred metres on both sides of the remains of the "Soviet Army bridge", a brief investigation yielded chipped stone artefacts and ceramic assemblages which belong predominantly to historic times. A few metres to the west of the military bridge, the remains of a Tibetan monastery (?), a temple, and a sort of clay hearth with numerous vases and other cultural objects were found.

Tamsagbulag 3

Tamsagbulag is yet another new site, discovered on the eastern side of the ancient lake; it lies to the north- north-east of Tamsagbulag 1 (Fig. 2). A small lake, almost completely dried up to-day, is surrounded by small sand dunes. Intensive reconnaissance on the eastern bank of the lake, below the small terrace and on the gentle (windward) slope of the dune, has yielded important lithic and ceramic materials. The artefacts collected came from a Neolithic camp or habitation site located not far from the terrace. The chipped stone industry and sherds were concentrated at the foot of the terrace.

In the areas of a dense concentration of lithics and pottery, a long bone of gazelle or antelope (which appeared to be a fossil, given the state of preservation) was recovered. The ^{14}C date obtained places the site in the third millenium BC – more recent than Tamsagbulag 1. Presumably, groups of Mesolithic hunters who became more sedentary in the process of Neolithisation, moved from the large dried-out lake area of Tamsgbulag 1 of the fifth millenium, to the residual lake of Tamsagbulag 3 in the third millenium, prior to having to opt once again for a nomadic way of life – this time definitively.

Fig. 2. Tamsagbulag 3. The Mesolithic/Neolithic site (palaeo-shorelines) discovered in 1997 during the first mission.

ARCHAEOLOGICAL MATERIAL

Chipped stone industry

The several hundreds of pieces recovered suggest the occurence of a rich assemblage. Raw materials consist of local flint (opaque and translucent) and semi-precious stones of various

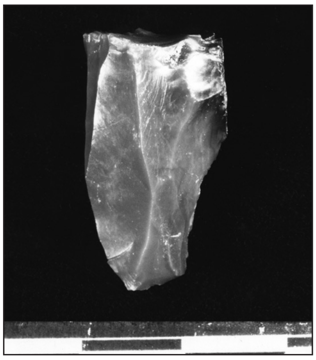


Fig. 3. Tamsagbulag 1. Microlithic industry: Nucleus.

colours (chalcedony, quartz, crystal, jasper, etc.). The microlithic industry dominates the secondary-chipped lithics. Small lake pebbles are notable, and are being analysed. One should note: prismatic nuclei, pyramidal nuclei, sub-pyramidal nuclei, bladelet nuclei (Fig. 3), the products of pressure flaking, standardised production using homogeneous raw material, morphologically varied blades and bladelets (for example, sickle microblades inserted into knives) (Fig. 4), blade scrapers, thick endscrapers carinated endscrapers, thumbnail (micro)scrapers (Fig. 5) and Tamsagbulag scrapers (Fig. 6), first recognised by A. P. Okladnikov (small plaquettes or fragments thereof of different shapes. Their edges are abruptly retouched). Burins and piercers are also present. A unifacially flaked leaf point in black stone (phtanite) (Fig. 7) and quartz arrow-heads come from Tamsagbulag 1. Typical microliths (geometric) seem absent.

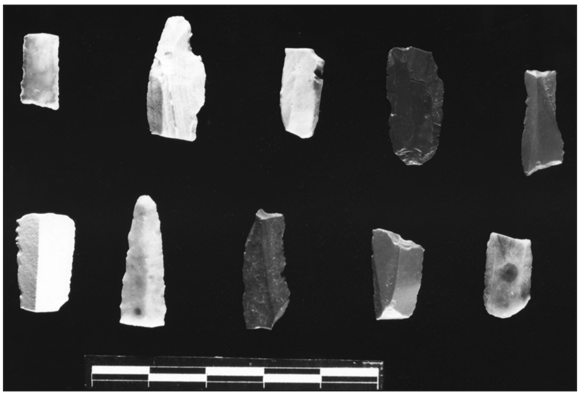


Fig. 4. Tamsagbulag 1. Microlithic industry: bladelets.

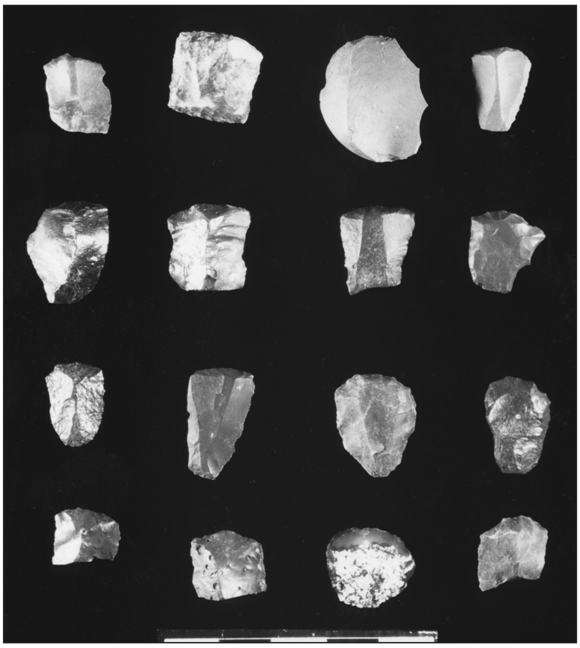


Fig. 5. Tamsagbulag 1. Thumbnail (micro)scrapers.

Polished stone industry

Only five pieces have been recovered: an axe or adze fragment, a pestle fragment, fragments of a large disc and a heavy perforated circular tool (for digging sticks?) in volcanic rock from Tamsagbulag 3 (Fig. 8). A. P. Okladnikov's excavations yielded a similar piece and millstones also in volcanic rock.

Bone industry

No bone tools werefound among the surface collection, but knives, dagger knives, or sickles (stone bladelets mounted in a bone haft) (Fig. 9) are well represented in A. P. Okladnikov's excavation assemblages as items of jewellery (beads) (Fig. 10).

Ceramics

The surveys and excavations at Tamsagbulag 1, 2 and 3 have yielded fragments of Neolithic and Early (?) Bronze Age pottery. Neolithic/EBA sherds are distinguished by their friable raw material, with a high content of sand (and shell?) and grey surface, incised or impressed surfaces (also corded ware), with elementary geometrical motifs, some of which look like pottery from southern Siberia, the Amur valley, northwestern China, Inner Mongolia and Manchuria, Korea, and southeastern Asia (Fig. 11). The discs

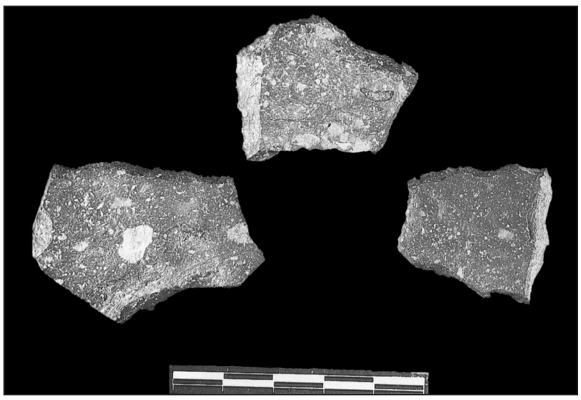


Fig. 6. Tamsagbulag 1. Tamsagbulag-type scrapers (small plaquettes with abruptly retouched edges).

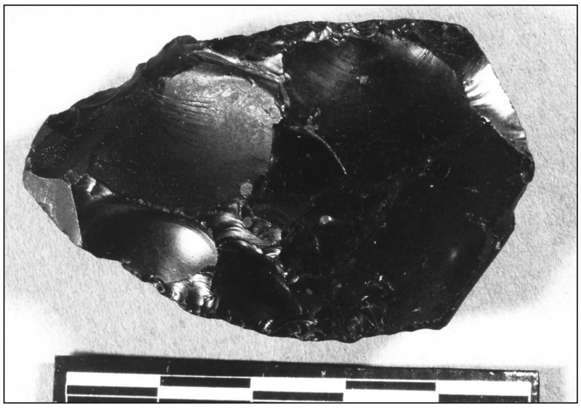


Fig. 7. Tamsagbulag 1. Unifacially flaked leaf point in black rock (phtanite).

were probably used for cereal pancakes or bread cooking (Fig. 12).

Metallurgy

Metallurgy is represented by bronze and iron objects and fragments which are dated to the Iron Age and modern period.

Long-distance exchange

Two pieces of obsidian, the millstone and the "brise-mottes" of volcanic tuffaceous rock, also fragments of jade (?) and several sherds of decorated pottery indicate the occurrence of medium- and long-distance exchange network patterns. One should also note a pendant (exhibited in the Museum of Ulaan Baatar) from one of the burials excavated by A. P. Okladnikov (?), presumably lapis lazuli of Afghan origin.

TAMSAGBULAG DEATH

A. P. Okladnikov (*Okladnikov and Derevianko 1970*) reported burials found under house floors, with a series of grave goods (bone knives with inserted stone bladelets, necklaces of Maral incisors, and bone or mother of pearl beads (Unio), etc.) (Figs. 9 and 10). Remarkably, the skeletons were found in a sitting position! (Fig. 13). Unusual similarities with the mummies of Ancient Peru (Chachapoyas, Chancay, Paracas, etc.) come to mind. Flexed and sitting positions are unknown anywhere, and especially in Europe, West, Central and South-East Asia. They may suggest an emigration through the Bering Strait from the primary Eurasian area (Mongolia and northeastern Siberia) to the Americas (Alaska and the North American east coast) and then south to Central and South Americas.

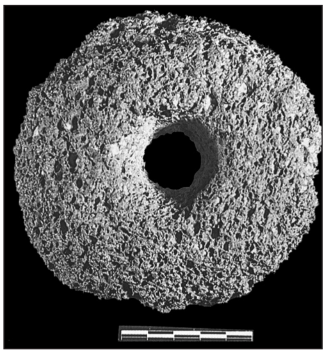


Fig. 8. Tamsagbulag 3. Perforated circular tool (for digging sticks?) in volcanic rock.

FIRST CONCLUSIONS

The study of the site and its surroundings is indicative of a particular eco-system. Our field observations were corroborated by an analysis of satellite imagery (Landsat TM). E. Fouache, geomorphologist, points out (1998) that the terrain consists of a huge plateau at an altitude of 700 m, with two large

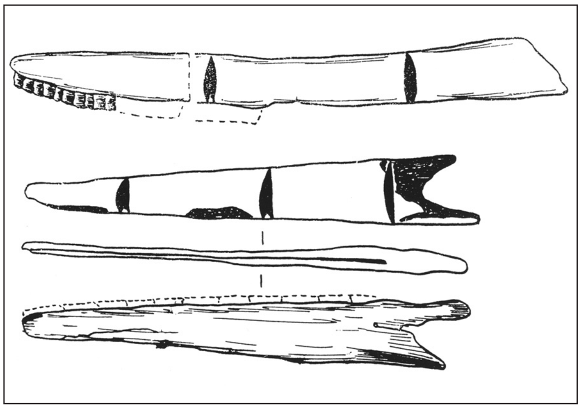


Fig. 9. Bone industry (knives, dagger knives or sickles) (after Dorj 1974*).*

depressions, one in the North, with Lake Buir, and another in the south, with a string of small lakes. The Neogene sediments form the base of the plateau, the Quaternary deposits filling in the depressions. Satellite imagery shows that the present-day lakes were interconnected (certainly at the beginning of the Holocene) by what is today a dry valley. Landsat images show clearly at Tamsagbulag a system of palaeo-shorelines indicative of a regression of the lake, which was never deeper than 12 m (Fig. 14). Intensive evaporation in this dry steppe environment was the likely cause of this regression. This site is highly appropriate for the study of Holocene climate fluctuations and their effects on the topography and human settlement.

The extension of the Palaeo-lakes forms a key element in the prospecting of Neolithic sites in this area

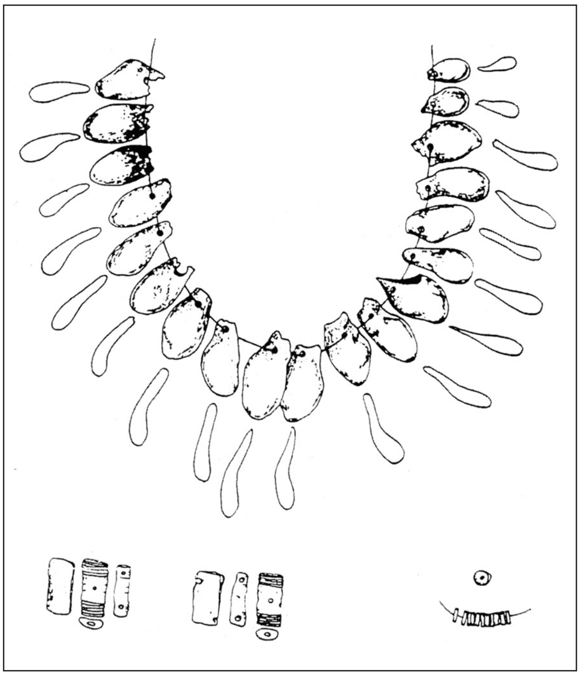


Fig. 10. Tamsagbulag 1. Necklace of stag canines, plate and tubular beads of pearl (Unio) from the graves (after **Okladnikov and Derevianko 1970*).***

Fig. 12. Tamsagbulag 1. Fragments of discs allegedly used for cooking cereal pancakes or bread.

of the Dornod district (aimak) of Mongolia. Images taken during our first mission in 1997 clearly show that sites were closely associated with the former hydrological network. However, in the absence of a strict topographic control, the map shown here is only a first approximation of the disposition of rivers and lakes in the past.

It looks as if the Mesolithic-Neolithic inhabitants of Tamsagbulag and neighbouring sites existed in an environment favouring partially predatory-type subsistence (hunting, fishing, and food-gathering), their biotope being equally proper for food-producing (domestication of plants and animals). The process of Neolithisation was well under way, highlighting a new type of sedentariness which accompanied the initial farming mode of subsistence in this part of eastern central Mongolia.

Fig. 11. Tamsagbulag 1. Corded ware.

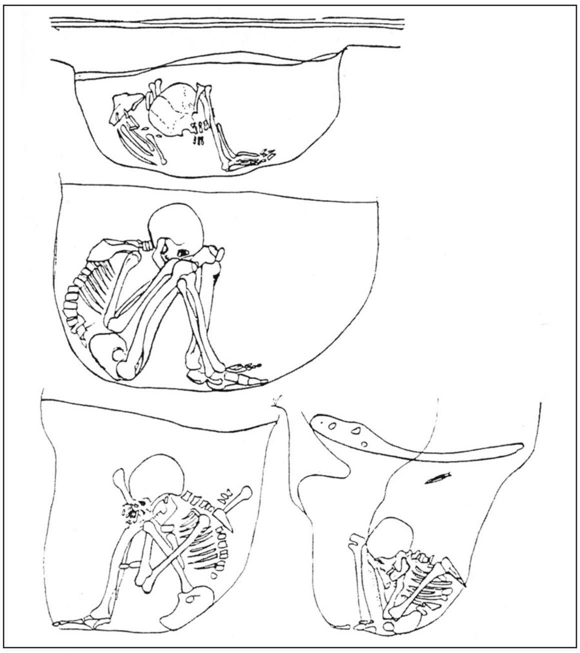
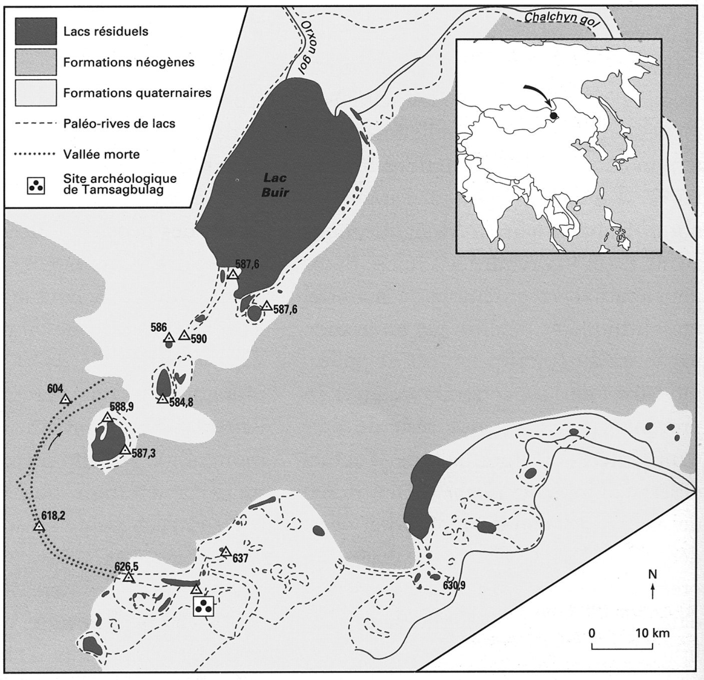


Fig. 13. Tamsagbulag 1. Types of graves discovered beneath the house floors (after **Okladnikov and Derevianko 1970*).***

The presently monotonous steppe-desert looked quite different during the three millennia that began 7000 years ago. The climate then was mild and humid, the boundless grassland was abundant in marmot (tarbagan in Mongol), wolf and eagle; stag and boar thrived in the forests; small plots were located close to villages. Tamsagbulag consisted of se-



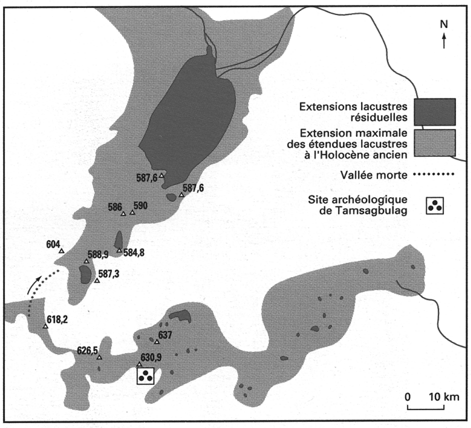


Fig. 14. Analysis of satellite imagery (Landsat TM) by E. Fouache (University of Paris-Sorbonne 1998) showing a clear system of palaeo-shore-lines indicative of a regression of the lake during the Holocene.

veral well-separated houses located on the border of the elevated terrace, near a spring, and stretching over a distance of 2–3 km. From there, its inhabitants could observe the herds of wild animals roaming around the lake: black-tailed gazelle (xarsuult zeer), antelope saiga (boxon), and kulan (xulan). The hunters and fishers were direct heirs of their Mesolithic predecessors (arrows or spears with chipped stone or bone points; also harpoons with notches on one side). The local inhabitants were also farmers (they cultivated millet, likewise their counterparts in northern China), and stock-breeders, rearing cattle and, possibly horses (*Okladnikov and Derevianko 1970*).

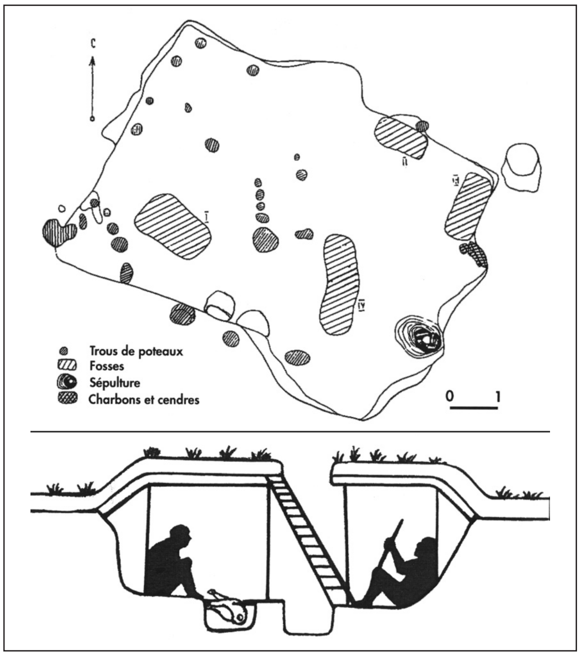


Fig. 15. Tamsagbulag 1. Plan of a semi-subterranean house (after* Okladnikov and Derevianko 1970*).

Their rectangular wattle-and-daub semi-subterranean houses were 30–40 m² in size (*Okladnikov and Derevianko 1970*) (Fig. 15). Wooden houses were also found similar to the winter dwellings used by the Ainou on the Kuril Islands in the early 20th century. It seems that none of these houses had doors or windows, the only way of access being an aperture in the roof that was also used to remove the smoke, and stairs consisting of an inclined tree trunk with incised steps. Similar structures were used until recently in the winter dwellings of various peoples in Manchuria and Siberia, as well as the Koriaks in the Northern Pacific. For these peoples, as well as for those of Alaska reported by Cook in the course of his third journey two centuries ago, such stairs had sacred connotations, and were viewed as the guardians of the house (Figs. 16 and 17).

Both Soviet-Mongolian digs and our own investigations have yielded a rich archaeological assemblage that sheds light on early communities in Central Asia, who were hunters, fishers, and food gatherers, and, at the same time, sedentary farmers and stock-breeders.

Seven thousand years ago, the people in that presently forgotten area of Central Asia, took part in their own manner in the process of Neolithisation

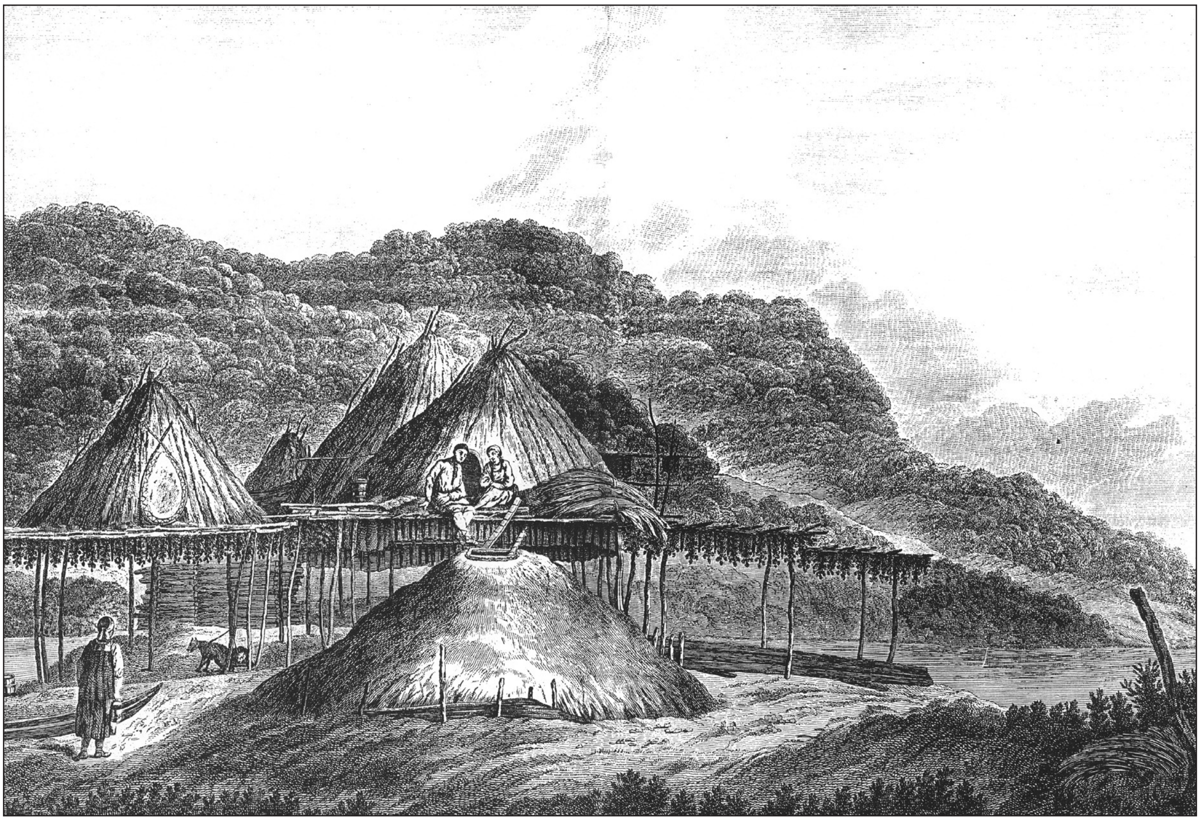


Fig. 16. Village of Kamchatka with a winter semi-subterranean house. The only way of access is via an aperture in the roof (after **Cook 1785*).***

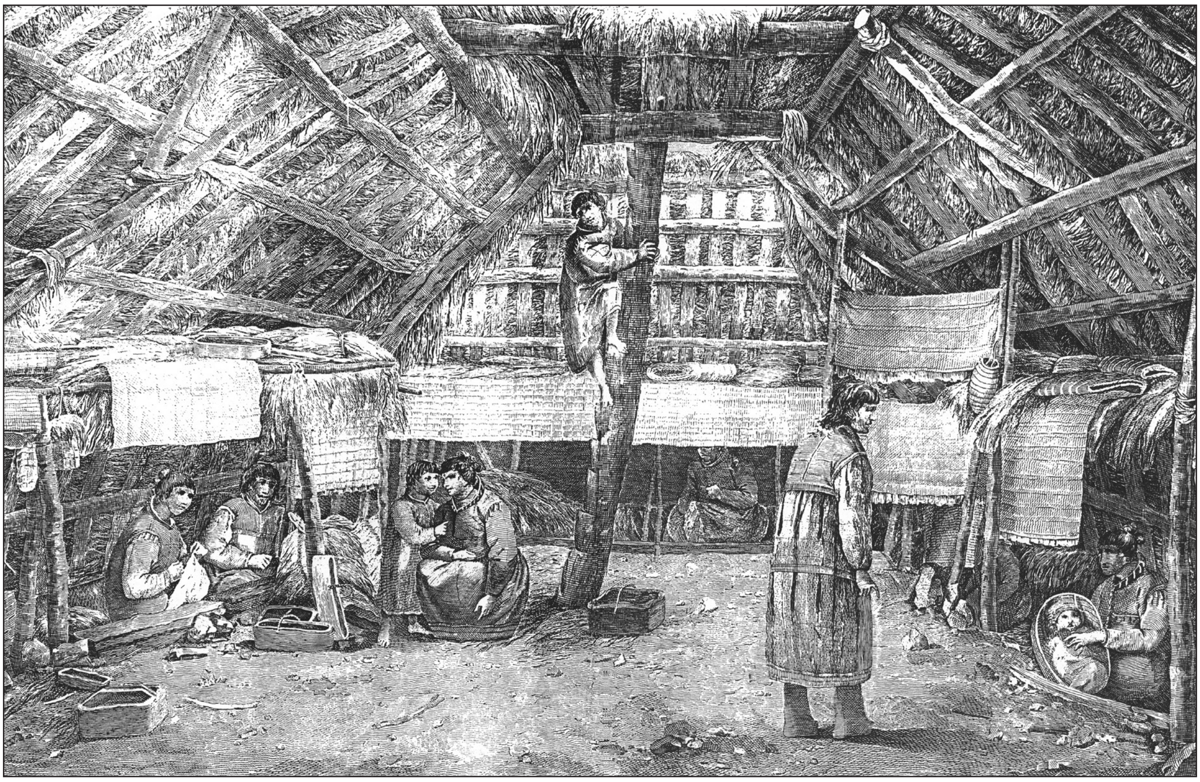


Fig. 17. Inside look of a house from Alaska. The only way of access, using a trunk with incised steps, is also via an aperture in the roof (after **Cook 1785*).***

that encompassed the whole of Eurasia. Adapting to a very special local environment, they chose an original form of food-producing economy, comparable to the broadly contemporaneous great civilizations of Yangshao and Longshan in China, Jomon in Japan, as well as those of southern Siberia, Kazakhstan, Central and Eastern Europe, and the European early Neolithic complex (exemplified by 'Linear pottery'), which extended from the Carpathian Mountains to Armorica. They were both hunter-gatherers and farmers. At present it is difficult to assess which branch of their economy played a leading role; this remains one of the main objectives of our project; we may only suggest that these branches were mutually complementary. In contrast to their predecessors, they were rather sedentary dwellers than nomads. And they remained so, until the new change of climate and the advance of the steppe made them change their mode of subsistence: they became hunters and, more importantly, stock-breeders once more, who increasingly led herds of goat, sheep, camels, and horses still farther beyond the endless horizon.

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Documenta Praehistorica XXXI

Farming and feasting in the Neolithic of Greece: the ecological context of fighting with food

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ABSTRACT – *Fine Neolithic ceramics from Greece are widely interpreted in terms of ceremonial eating and drinking, while the spatial organisation of settlement suggests that such commensality played a significant role in shaping social relationships. Faunal evidence implies consumption of many domestic animals in large-scale commensality and supports the view that this promoted competition as well as solidarity. This paper explores the ecological context of such 'fighting with food'. Feasting, and ceremonial consumption of livestock, was enabled by and helped to reinforce domestic strategies of surplus production and labour mobilisation that were driven as much by 'economic' as 'political' imperatives.*

IZVLEČEK – *Fino neolitsko grško keramiko ponavadi povezujejo s ceremonialnim uživanjem hrane in pijače, prostorska organiziranost naselbin pa kaže, da so bili skupni obedi zelo pomembni pri oblikovanju družbenih odnosov. Po živalskih ostankih lahko sklepamo, da so uživali številne domače živali na velikih pojedinah, kar naj bi pospeševalo tekmovalnost pa tudi solidarnost. V članku raziščemo ekološke vidike 'tekmovanja s hrano'. Gostije in ceremonialno uživanje živali je bilo možno zaradi načrtovanja viškov proizvodnje in organiziranega dela in ju hkrati utrjevalo. Motiv za to pa je bil tako 'gospodarski' kot 'politični'.*

KEY WORDS – *Neolithic; Greece; feasting; domestic animals; overproduction*

INTRODUCTION

A concern with feasting is currently fashionable in the archaeology of various periods and regions, but there are solid empirical grounds for emphasising this topic with respect to the Neolithic of southeast Europe. First, fine and sometimes elaborately decorated ceramic vessels, in shapes suitable for serving or consuming food and drink and perhaps other stimulants, indicate that Neolithic societies accorded considerable cultural significance to at least some acts of consumption (*e.g., Vitelli 1989; Pappa at al. in press*). And, as Sherratt (*1991*) has noted, the provision of some fine vessels with flat bases may literally indicate their use as 'tableware', thus further underlining the importance of certain consumption events. Secondly, the broad distribution of many ceramic styles (*e.g., Washburn 1983*) and growing evidence that at least some fine vessels were exchanged over considerable distances (*e.g., Tomkins, Day 2001; Hitsiou 2003*) imply that ceremonial consumption may have played an important role in social interaction on a supra-local as well as local scale.

Moreover, while many forms of exchange may serve to initiate or maintain amicable social relationships (*Mauss 1970*), the giving and receiving of food and drink are widely regarded as symbolising particularly close and binding social relationships (*e.g., Richards 1939; Sahlins 1974.215–219*). The archaeological record from the Neolithic of Greece provides circumstantial clues to some of the social contexts in which commensality is likely to have played an important role. First, despite legitimate cautioning against the simple equation of Neolithic with sedentary (*e.g., Whittle 1997*), the available bioarchaeological evidence suggests that many or even most known Neolithic sites in Greece were occupied on a more or less year-round basis (*Halstead in press*). The evident long-term continuity of many such sedentary communities implies mechanisms for resolving or counteracting the inevitable tensions between neighbours that are often defused through fission in a more mobile population. Moreover, the gradual development of many Neolithic settlements into long-lived 'tells' is accompanied by increasing architectural segregation of constituent 'households' or 'neighbourhoods' (*Hourmouziadis 1979; Theochares 1980; Kotsakis 1982; Halstead 1995*) and indeed it has been argued persuasively that these two processes are causally related (*Kotsakis 1999*). At an intra-settlement level, commensality between neighbours is likely to have played a central role in promoting community solidarity in the face of these inevitable tensions and tendencies to residential segregation. Secondly, at least in Thessaly, some long-lived sites were located sufficiently close together (*e.g., Perlès 1999*) to imply significant investment in the maintenance of peaceful relations and avoidance of the endemic warfare characteristic of recent horticultural villages in parts of New Guinea (*Forge 1972; Brown 1978*) and South America (*Chagnon 1968*). At this inter-settlement level, commensality may again have served to affirm such peaceful relations.

On the other hand, the example of highland New Guinea underlines how feasts may be an important arena not only for alliance building, but also for competition both within and between communities (also *Dietler 2001.72*). Such competitive commensality may be reflected in the recent discovery at LN Makriyalos in Central Macedonia of the remains of what seems to be a short-lived episode or phase of consumption, involving the slaughter of hundreds (probably thousands) of domestic animals (*Pappa et al. in press*). The implied consumption of many tons of meat over a period of several months suggests participation on at least a community-wide and perhaps regional scale and raises the possibility of spectacular cycles of herd expansion and mass slaughter such as accompany pig feasts in parts of highland New Guinea (*Rappaport 1968; Brown 1978; Wiessner 2001*).

There are thus reasonable grounds for claiming that ceremonial commensality, probably on a range of social and temporal scales, played a major role in the Neolithic of Greece both in helping to shape the development of some distinctive forms of material culture and in negotiating vital but potentially contentious social relationships. Both these points have been made elsewhere (*e.g., Vitelli 1989; Halstead 1995; Andreou et al. 1996*). The present paper seeks to develop these themes and then to explore the ecological context of the relationship between feasting and early farming and, more particularly, the role therein of domestic animals. The discussion is cast in terms of the Neolithic of Greece, but could in large measure be extended to adjacent parts of southeast Europe and Anatolia, which share a broadly similar Neolithic archaeological record and broadly similar ecological conditions for early farming.

FEASTING, COMMENSAL POLITICS AND FARMING

Thus far, in asserting that feasting may have played a significant role in the Neolithic societies of Greece, it has been tacitly assumed that 'feasting' refers to 'ceremonial commensality'. Essentially similar definitions have been offered by Hayden – 'any sharing between two or more people of special foods (i.e., foods not generally served at daily meals) in a meal for a special purpose or occasion' (*Hayden 2001a. 29*) – and Dietler – 'public ritual activity centered around the communal consumption of food and drink' (*Dietler 2001.67*). In addition, Dietler has emphasised the political dimension of feasting or 'commensal politics' (*Dietler 2001.73*) and, as already indicated, this dimension is of central interest in the context of the Neolithic of Greece.

This emphasis on commensal politics highlights the importance of the distinction between host/ provider and guest/consumer (*Hayden 2001a.44*) and the fundamental enabling role of the provision of food and drink in abundance (*Wiessner 2001.117*). As Hayden observes, the opportunities for political manipulation of commensality are thus restricted among 'generalized' foragers (*Hayden 2001a.44–45*): an ethos of collective rights to consumption downplays the distinction between host/ provider and guest/consumer (*Barnard, Woodburn 1991; Ingold 1983; Kent 1993*), while scope for the provision of abundance is modest in the absence of both food production and large-scale storage. Conversely, food production and large-scale storage greatly facilitate the provision of abundance and, in turn, are predicated on significant circumscription of collective rights to consumption. Indeed, Ingold has argued that the most fundamental difference between a wild animal and its domestic counterpart is that the latter *belongs* to some person(s) (*Ingold 1986.*

113). Among generalized 'immediate-return' foragers, therefore, with an ethos of collective rights to consumption, the sharing out of a kill may earn prestige for the hunter; among hunters or farmers heavily dependent on storage, with more limited collective rights, the giving of food tends to leave the recipient indebted to the donor (*Ingold 1980.172–176; Barnard, Woodburn 1991*). This shift in the relationship between donor and recipient is crucial to commensal politics.

While a capacity for abundant provision may be more likely, and the distinction between host/provider and guest/consumer generally clearer, among farmers than generalized foragers, is there any evidence that Hayden's two suggested preconditions for dynamic commensal politics were met by the Neolithic communities of Greece? We may begin by considering the capacity for abundant provisioning of feasts in the Neolithic of Greece. Rare direct evidence for such a capacity is provided by the massive dump of animal remains at Makriyalos, referred to above, but circumstantial arguments suggest that periodic abundance may have been endemic to Neolithic communities in Greece. Bioarchaeological evidence from habitation sites in this region suggests that Neolithic subsistence was overwhelmingly dominated by cultivated grains and domestic animals, with only a modest contribution from gathered plants and hunted animals, but leaves open to debate the relative contribution of crops and livestock. Many of these sites, however, take the form of villages comprising numerous 'houses' and probably representing between several tens and a few hundreds of inhabitants; available bioarchaeological evidence for seasons of human presence favours year-round occupation. The combination of village settlement and year-round habitation strongly favours dependence on *stored* cereal and pulse grain crops rather than livestock as the basis of Neolithic subsistence (*e.g., Halstead 1989a*). The difficulty of detecting the impact of early farming in regional pollen records (*Bottema 1982; also Willis, Bennett 1994*) also makes extensive animal husbandry unlikely, while there is circumstantial evidence that Neolithic cereal and pulse cultivation was intensive (*Halstead 1989a*; for more direct evidence from other regions, see *Jones 1992; Bogaard this volume*). Such intensive cultivation, especially if closely integrated with the rearing of livestock, should theoretically have been capable of high yields per unit area (*cf. Bogaard this volume*) and, given sufficient labour (see below), significant levels of overproduction. In practice, as has been argued elsewhere, the early summer harvest of cereals and pulses will have been subject to significant fluctuations in yields, as a result of variable growing conditions, forcing cultivators dependent on such crops into regular overproduction and the generation of a 'normal surplus' (*Allan 1965; Forbes 1982; Halstead 1989b*). In sum, unless the foregoing arguments as to the size and permanence of Neolithic village communities and their primary dependence on grain crops are *radically* wrong, periodic agricultural surpluses sufficient to finance large-scale feasting will have been endemic to the Neolithic of Greece.

Turning to the clarity of distinction between host/provider and guest/consumer, rights to consumption are not easily recognised in the archaeological record, but *claims* to such rights are often exercised through the spatial organisation of residence and so are amenable to archaeological investigation. For example, in the ethnographic record, non-storing foragers live at higher residential densities than storing hunters or farmers (*Fletcher 1981*): in the former case, close proximity helps peer pressure to enforce sharing; in the latter case, wider spacing reduces such pressure and facilitates hoarding (*cf. Whitelaw 1983*). Habitation density is difficult to assess archaeologically, but a striking characteristic of Neolithic material culture in Greece and adjacent regions is architectural and symbolic emphasis on 'houses' (*Hodder 1990; Kotsakis 1999*). Whether or not such structures are seen as representing the emergence of some form of 'family household', they imply segregation of small residential units. Associated facilities suggest circumscription of activities that included at least some storage and cooking of food (*Hourmouziadis 1979; Halstead 1995; 1999*), while the elaboration of 'domestic' material culture (*cf. Hodder 1990*) may indicate that this social fragmentation was contentious. Similar arguments have been advanced on comparable empirical grounds for early farming communities in other regions (*Flannery 1972; Wright 2000*). There is thus at least circumstantial evidence that early farming communities in Greece met both of Hayden's preconditions for dynamic commensal politics: periodic overproduction of staple grains was almost certainly endemic, while food was arguably private property at least to the extent that any ethos of collective rights to consumption was constrained and contested by domestic architecture and portable material culture.

The existence of periodic agricultural surpluses does not, of course, mean that such surpluses necessarily had to be used to finance feasting. Among generalized foragers, the egalitarian ethos of sharing, especially of large carcasses, is at least reinforced by practical considerations: if meat given away would otherwise have spoiled, the hunter's generosity costs nothing; and, given the relative rarity with which large animals tend to be killed, even the most successful hunter stands some chance of benefitting from a future reciprocal act of generosity. Among storing hunters and farmers, however, surpluses tend to comprise foods that have been, or could be, preserved for future consumption; in such cases, given some uncertainty as to future returns from hunting or farming and some variability in the 'shelf-life' of stores, it is far harder for the prospective host to be sure that generosity is cost-free – that food given away would not otherwise have been consumed before it spoiled. The generous host thus risks either running out of stored food or incurring unnecessary future labour costs in food procurement and processing for storage. Admittedly, work may be regarded as a virtue (*e.g., Malinowski 1921*). In societies dependent on bulk storage of seasonal abundance, however, the need for human labour can be subject to sharp peaks and additional demands on labour during peak periods may pose a threat to survival, rather than merely eating into leisure time. It is argued below that this will have been the case for Neolithic communities in Greece.

The potential costs and risks of giving away stored food are integrally bound up with the limited collective rights to consumption found in the ethnographic record of societies dependent on storage. Not only does restriction of collective rights to consumption facilitate hoarding and storage, but the linkage between generosity and indebtedness increases the likelihood that the opportunity costs of giving away surplus food will, sooner or later, be balanced by tangible benefits. Again, the new conditional ethos must be sought rather indirectly in the archaeological record. First, the widespread emphasis, in the early Neolithic record of Greece and adjacent regions, on production of ceramic 'tableware' suggests that particular importance was attached to *cooked* (as opposed to *raw*) food. Indeed, many of the shapes, decorative motifs and forming techniques of the early Neolithic ceramic repertoire mimic wooden or basketry prototypes (*Childe 1957; Tomkins 2001*) and it is possible that the initial proliferation of ceramic tableware was due not to any functional superiority of fired clay, but to the symbolic homology between firing and cooking. Either way, the high cultural value placed on cooked food is at least compatible with its being subject to greater obligations of collective enjoyment than was raw food. Such a contrast between raw/private and cooked/public, widely encountered in the ethnographic record (*e.g., Sahlins 1974.125–126*) and even in modern western society, helps to mediate the contradiction between obligations to share food and rights to accumulate stores. Secondly, if Neolithic 'domestic' architecture arguably served to identify a small group of co-residents with unconditional rights to consumption of stored food, the variable location of cooking facilities both indoors and outdoors suggests some flexibility as to the social distance over which rights to commensality were recognised (*Halstead 1995*). As in modern European society, the boundaries of commensality were probably extended on 'special' occasions and the frequent co-existence of elaborately decorated and plain, but functionally comparable, ceramic vessels may well reflect the attribution of greater or lesser social significance to different consumption events.

If rights to commensality in the Neolithic were indeed conditional and flexible, is there any evidence that hospitality was reciprocated? In the ethnographic record, hospitality is commonly reciprocated in kind or with labour, and both forms are at least compatible with the archaeological record from the Neolithic of Greece. First, ceramic tableware exhibits similar shapes and decorative styles over substantial distances in space (≤50–75 km) and time (several decades to a few centuries) (*e.g., Washburn 1983; Cullen 1984; Rondiri 1985*). Such far-flung and long-lasting committment to a shared material culture of commensality might, in a more obviously hierarchical social context, be interpreted in terms of regional emulation of a notably generous elite (*cf. Wright in press*), but is more plausibly comprehended here in terms of webs of reciprocal hospitality. Secondly, if Neolithic domestic architecture does represent something like a household, it will have defined a group that shared obligations of labour as well as rights of consumption (*cf. Sahlins 1974*). In this context, the flexible social boundaries, implied by the existence of external as well as internal hearths, may well reflect col*laboration* as much as com*mensality* between neighbours and kin. Similarly, by joining the workforce of a household, distant kin or even non-kin may have gained access to hospitality on which they would otherwise have had no claim. Thus, on a range of social scales, hospitality may have been reciprocated both in kind and with labour, the former representing interaction between social equals and the latter something closer to a patron-client relationship (*cf. Dietler, Herbich 2001*).

The dynamic behind both types of relationship may be better understood by considering the risks faced by early farmers in Greece and the probable buffering strategies adopted to mitigate these risks. In effect, it will be argued that routine practices of early farmers in this region not only made feasting possible, but strongly disposed it to become an important arena of social competition.

AGRICULTURAL RISK AND RISK-BUFFERING: THE IMPORTANCE OF HUMAN LABOUR

For early farmers in Greece, supplies of staple grain crops will inevitably have been at risk to natural hazards at four successive stages (*Forbes 1982; Halstead 1990*):
❶ unfavourable weather in autumn-early winter might result in crops being sown on an insufficient scale or on inadequately prepared ground;
❷ unfavourable weather or crop pests during winter and spring might harm or, occasionally, even destroy growing crops;
❸ ripe crops in early summer might be decimated in the field by birds or spoiled during threshing by a sudden storm;
❹ at any point in the year, stored grain might be lost to insect pests or damp (as well as cultural hazards such as fire or theft).
At the first and third of these stages, in particular, the impact of natural hazards might be mitigated or magnified by an abundance or scarcity, respectively, of human labour. For recent non-mechanised farmers in Greece, the autumn-winter period of tillage and sowing and, even more so, the early summer harvesting and processing period for staple grain crops placed major strain on human labour (*Halstead, Jones 1989*), to the extent that either unfavourable weather conditions or a reduced workforce might result in the partial, inadequate or delayed completion of tasks. In such a seasonal environment, even delayed completion of some tasks carried serious risks: for example, late sowing makes crop yields less reliable – as the modern Greek saying goes, 'the early-sown crop is blessed by God, the late-sown crop by fortune'. Moreover, for Neolithic farmers, the demands on human labour during tillage may have been significantly higher, if little or no use was made of plough-animals (*cf. Sherratt 1981*). Thus, any loss of human labour (or increased demands on labour) during the autumn-winter or early summer peak periods of agricultural activity could have dangerously exacerbated the risks to crop production posed by natural hazards.

In combination, these hazards will have constituted a serious threat to survival and, in response, early farmers will almost certainly have deployed a range of buffering strategies:
❶ *Diversification* The role of crop diversification in cushioning the effects of growing-season hazards has been discussed at length elsewhere (*Forbes 1976; 1982; 1989; Halstead 1990*) and there is some evidence that Neolithic farmers in Greece did indeed grow a range of cereal and pulse crops (*Halstead 1992a*). Growing a range of crops may also have extended the sowing and harvesting seasons and so helped to ease the pressures on human labour in autumn-early winter and early summer. On the other hand, there is surprisingly little evidence for foraging at early farming villages in Greece (*e.g., Halstead 1999*), although a potentially important contribution of domestic animals to subsistence diversification is discussed below.
❷ *Overproduction and storage* As was noted above, regular overproduction of grain may reasonably be regarded as an essential element of grain-based subsistence in strongly seasonal environments. Overproduction also increases stress on the human workforce during the autumn-early winter and early summer peaks of labour input, however, and so may be unachievable if key tasks are curtailed by unfavourable weather. Partly for this reason, overproduction may be insufficient to cushion farmers against a run of bad years. Ironically, a run of good years might also cause problems: if farmers' estimates of the level of overproduction required for security were determined by both traditional norms ('grandfather responses' – *Forbes 1989*) and personal experience, repeated failure to consume costly surpluses is likely to have led to less cautious behaviour.
❸ *Exchange* One means of extending the 'shelf-life' of surpluses is to give them away in the expectation of future reciprocation. Although food may be exchanged for valuables, especially between distant social contacts and in circumstances of extreme scarcity (*O'Shea 1981*), reciprocation in kind and reciprocation with labour are more commonplace and possible evidence for both from the Neolithic of Greece has already been noted. The implications of, and interplay between, reciprocation in kind and with labour are of particular interest in the present context.

Clearly, shortage of labour at crucial points in the agricultural year could restrict the scale and compromise the reliability of grain production and could also undermine attempts to enhance subsistence security through overproduction. Conversely, access to additional labour at the same crucial points in the year could boost overproduction and enhance subsistence security.

In the Neolithic, as in the recent past, neighbours and kin probably provided mutual assistance, to the benefit of both parties, in laborious tasks such as field clearance. Reciprocal hospitality too doubtless played an important, and often mutually beneficial, role in initiating or affirming social (as opposed to anti-social) relations within and between Neolithic communities. Exchanges of labour for food at times of peak agricultural activity, however, will have promoted social inequality. Households with disposable surplus will have been able to acquire additional labour and so to minimise the risk that future overproduction be jeopardised by time stress during the critical sowing and harvesting periods; the use of surplus food to secure additional labour will also have reduced the risk that overproduction might come to be regarded, after a run of good years, as an unjustified burden. Conversely, households forced to export labour will have been more likely to fall foul of unfavourable weather during sowing or harvesting and so to end up underproducing. The clear implication of this self-reinforcing assymetry is that the giving away of food may have been especially advantageous if at least some of the recipients were unable to reciprocate in kind. One means of achieving this end may have been to escalate the cost of hospitality, by sponsoring large-scale feasts or serving 'party food' (e.g., beer or meat rather than staples such as bread or gruel). The following section considers the possible significance of domestic animals in such competitive commensality. At this juncture, however, it should be noted that, in the Neolithic of Greece, feasting may not only have been predicated on the existence of surplus, but may equally have justified and facilitated the production of surplus. Moreover, feasting may have been so integrally bound up with the risk-buffering strategies of early farmers that it was as essential to their economic viability as to social reproduction.

LIVESTOCK, MEAT AND FEASTING

Domestic animals doubtless played a variety of roles in Neolithic farming. They were a source of food, perhaps including milk (*e.g., Rowley-Conwy 2000*) and blood as well as meat, and also provided raw materials, including hides, hair, horn and bone. Their manure probably boosted crop yields, while their contribution to clearance (*cf. Rowley-Conwy 1981*) and possible use as pack- or plough-animals (*cf. Sherratt 1981*) may have helped farmers to make the most of favourable weather at sowing and harvest times. In the event of scarcity of staple grains, fattened livestock may have been a vital alternative source of sustenance, while the feeding of unwanted or spoiled grain to livestock (*e.g., Robinson, Rasmussen 1989*) may have provided a welcome means of 'indirect storage' (*cf. Flannery 1969; Halstead 1993*). In addition to this wealth of 'practical' uses, livestock may have been valued for less obviously material reasons. First, if surplus grain was fed to domestic animals, then fattened livestock will have been a very visible and immediately intelligible symbol of the wealth of their owner. Secondly, a range of ethnographic and historical evidence suggests that the *killing* of domestic animals will have been an event of far greater cosmological significance than is a visit to a modern butcher's shop or supermarket (*e.g., Burkert 1983*); the consumption of meat, therefore, may well have been a profoundly meaningful experience in the Neolithic. Thirdly, since it is unlikely that individual Neolithic households could maintain viable breeding populations of all four common domestic animal species (sheep, pigs, cattle and goats), livestock were almost certainly exchanged between different productive units within, and perhaps between, villages (*Halstead 1992b*). Given that such exchanges are likely to have reaffirmed or reshaped existing social relationships, it is inherently likely that livestock thus served as a metaphor for Neolithic society (*cf. Dahl 1979*).

One context in which many of the practical and symbolic values of domestic animals may have been combined is in feasting. Meat is likely to have been esteemed simply because it was less regularly available than foods based on staple grains and, in a physically active population, particular appreciation of animal fat is likely to have been dictated by human biology, if not also by cultural values. In addition, the killing of domestic animals may have been regarded as a sacrificial act, leading to conspicuous consumption of something that simultaneously represented accumulated wealth and perhaps a particular nexus of social relationships. The meat of domestic animals would thus have been a highly valued form of 'party food' and so an important ingredient in competitive feasting. Were domestic animals consumed in such commensal contexts in the Neolithic of Greece?

Circumstantial evidence in this direction comes from consideration of the practicalities of consuming domestic animals. Whereas most plant foods can be prepared for consumption in quantities appropriate to an individual consumer, a family household or a community-wide feast, an animal cannot be slaughtered piecemeal. In recent Greek rural communities, prior to the widespread availability of refrigerators, a family household might eat a chicken or a suckling lamb or kid, but an older lamb or kid would usually be shared with neighbours and a yearling of the same species was likely to be slaughtered for an extended social gathering such as a wedding. An adult sheep might be consumed at a wedding, or preserved and stored for domestic consumption over a period of months; a yearling or older pig similarly tended to be preserved and stored. A steer might be slaughtered for a village-wide festival, but most cattle were sold in urban markets.

Much of this oral history refers to the mid-twentieth century, when rural households were often large and carcass weights of livestock often low. Surviving and recovered faunal remains from Neolithic villages in Greece indicate high levels of later first- and second-year slaughter of pigs; high levels of later first- and second-year and also older slaughter in sheep and goats; and perhaps even older average age of slaughter in rather poor samples of cattle (*Halstead in prep.*). Thus almost all the available evidence for slaughter of domestic animals is derived from animals too big to have been consumed fresh by a single household, even if these were rather more extended than their recent counterparts. There is little if any hint in Neolithic mortality data that age of slaughter was heavily shaped by the desire for secondary products (milk, wool or traction). On the contrary, the high proportions of older juveniles, subadults and young adults represented are suggestive rather of emphasis on the *raising of large carcasses for consumption*. It might be argued that many of these animal carcasses were preserved for long-term domestic consumption, but in the recent past slaughter for storage typically took place in the cold winter months to minimise the risk of meat spoiling while being salted, smoked or sealed in fat. Available mortality data suggest that slaughter was more or less staggered through the year (*Halstead in press*), implying that many carcasses were consumed fresh. Finally, studies of butchery traces offer no hint of a high level of wastage of carcasses (*Pappa et al. in press; Isaakidou 2004*).

In sum, it is likely that many, perhaps most, of the domestic animals slaughtered at Neolithic villages were consumed by a social group larger, and often much larger, than the household. Moreover, a high proportion of these animals could have been slaughtered at a substantially younger age, without any loss of secondary products, and could then plausibly have been consumed by a smaller social group without sharing with outsiders. The implication is that these animals were not merely consumed at large-scale feasts, but were reared for this purpose. As in recent rural society, the slaughter of cattle will have been appropriate for especially large commensal occasions, perhaps marking particularly important points in the life-cycle of a household or larger social group. This may be one source of the apparently exceptional cultural value of cattle in Neolithic society, implied by their dominance in the repertoire of zoomorphic figurines (*Toufexis 2003*).

CONCLUSION: THE POLITICAL ECOLOGY OF FEASTING IN THE NEOLITHIC OF GREECE

It has been argued here that feasting, in the sense of commensality on a social scale larger than the basic unit of agricultural producers, was an important practice in the Neolithic of Greece. This claim finds some empirical support in the Neolithic material culture of Greece, in which decorated ceramic 'tableware' is prominent. Attempts to model society and economy in the Neolithic of Greece suggest that feasting will have served, *inter alia*, to mobilise additional agricultural labour, to negotiate and affirm social relationships at both an intra- and inter-settlement level, and to convert agricultural surpluses into symbolic capital in the context of social competition. All of these roles are well exemplified in ethnographic accounts of feasting in recent horticultural societies (*e.g., Richards 1939; Allan 1965; Dietler 2001; Dietler, Herbich 2001; Hayden 2001a*).

It has also been argued that the large size of many or most of the domestic animal carcasses represented on Neolithic settlements in Greece implies consumption in the context of large-scale commensality. Most of these domestic animals *could* have been slaughtered at a younger age, at a carcass size appropriate to consumption by a much smaller social unit, equivalent perhaps to a 'household' group of producers. In this respect, it might be argued that domestic animals in the Neolithic of Greece were raised *for* consumption in feasting – again a suggestion that has already been made for other cultural contexts (*e.g., Keswani 1994; Hayden 2001b*).

As Dietler and Hayden have recently emphasised (*Dietler, Hayden 2001*), feasting is a very widespread phenomenon, takes a great variety of forms in different cultural contexts, and has significant potential to generate social change. This paper has attempted to develop this last point by exploring the ecological context of competitive commensality. Dietler and Hayden draw attention to some fundamental paradigmatic divergences between those, such as Dietler, who see feasting primarily as a competitive *political activity*, and others, including Hayden, who emphasise the 'practical' benefits of feasting. As Dietler and Hayden acknowledge, however, there is room for manouevre between these perspectives and this paper seeks to exploit this potential rather than to endorse either paradigmatic pole.

The starting point for this attempt is the observation that feasting expends substantial surpluses and that such surpluses are often accumulated as a risk-buffering measure in societies dependent on storage and living in environments characterised by marked seasonality and inter-annual variability. In such contexts, food production, and even more so *over*production, tends to place significant strain on human labour resources, to the extent that the expenditure of unused food surpluses to mobilise additional labour may significantly enhance survival prospects as well as leisure time. In a highly seasonal environment, where the scheduling of tasks may be both tightly constrained and critical to their success, reciprocal exchanges of labour may reduce the drudgery of agricultural labour. The acquisition of human labour in return for surplus food, however, is highly beneficial to the 'host' and potentially disastrous for the 'guest'. Moreover, the transition from egalitarian reciprocal hospitality to inegalitarian exchange of food for labour may have been subject to few cultural constraints, precisely because such patronage can be construed as no more than the welcoming of an additional member to the household.

In this context, conspicuous feasting may play an important 'economic' role both in driving less successful households into indebtedness and subservience and in enabling successful farmers to compete with each other for the position of preeminent host and labour-beneficiary. Feasting is thus enabled by, but also helps to promote and perpetuate, overproduction. In this respect, competitive feasting could be regarded as a political strategy for promoting subsistence security. Whether the goal of overproduction and feasting, as perceived by the Neolithic inhabitants of Greece, was subsistence security or political advantage is arguably unimportant and certainly unknowable. In this ecological context, however, not only does overproduction have the potential to enhance subsistence security and enable feasting, but the hosting of feasts can justify and facilitate overproduction and subsistence security.

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contents

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Documenta Praehistorica XXXI

Cueva de El Toro (Antequera, Málaga-Spain): a Neolithic stockbreeding community in the Andalusian region, between the 6th and 3th millennia BC

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ABSTRACT – *The occupation evidence shown by the cave El Toro, is that of a unique stockbreeding community in the Andalusian region. The calibrated dates for this occupation period go from the second quarter of the sixth millennium up to the second millennium BP. There is also evidence of occasional occupation throughout later millennia up to the Hispano-Muslim period. The nature of this occupation is determined by the close link between the cave and the community which occupied it, both continuously and periodically. Throughout the occupation levels, the community's skillful control of technical processes and its remarkable knowledge on how to transform local primary resources, have shown that this community reached a high level of technological development. However, its main economic activity was related to agricultural and farming exploitation, particularly to stockbreeding.*

IZVLEČEK – *Podatki o naselitvi jame El Toro kažejo na edinstveno živinorejsko skupnost v andaluzijski regiji. Kalibrirana datacija naselitvenega obdobja sega od druge četrtine šestega tisočletja do drugega tisočletja BP. Obstajajo tudi dokazi za občasno poselitev v naslednjih tisočletjih vse do špansko-mavrskega obdobja. V vseh naselitvenih plasteh opazimo, da je skupnost vešče obvladovala tehnološke procese in je imela obsežno znanje, kako izrabljati lokalne primarne vire, kar kaže, da je dosegla visoko stopnjo tehnološkega razvoja. Njena glavna gospodarska dejavnost pa je bila povezana s kmetovanjem, posebej še z živinorejo.*

KEY WORDS – *beginnings of production; recent Andalusian prehistory; palaeo-economy; exploitation strategies*

Cueva de El Toro is a cave site in the Sierra del Torcal, a wide mountain range that separates two very different areas: Mediterranean Andalusia and the Subbetic System (Fig. 1). It runs along 27 km and has some height bench marks between 800 and 1400 m above sea level. The morphogenesis of the Sierra is determined by limestones and diaclast systems that have conditioned the flow directions of karstic modelling. Within these, typical *simas* are found, in many cases, old cavities, some of which were inhabited for long periods.

Cueva de El Toro is 36° 57' 23" north, 4° 32' 10" west, and at a height of 1190 metres above sea level. From the access and entrance to the cave, it is possible to see the natural bed and the outlet of the river Guadalhorce. It also allows a view of the lowlands of the Sierra, where there is a suitable fertile area for various agricultural activities.

In front of the entrance a long cavity of reduced dimensions is located. Following its tectonic and topographical study, this so-called *Sima del Pasillo* has been shown to be a continuation of the Cueva de El Toro, implying that they were once part of the same structural complex (Fig. 2).

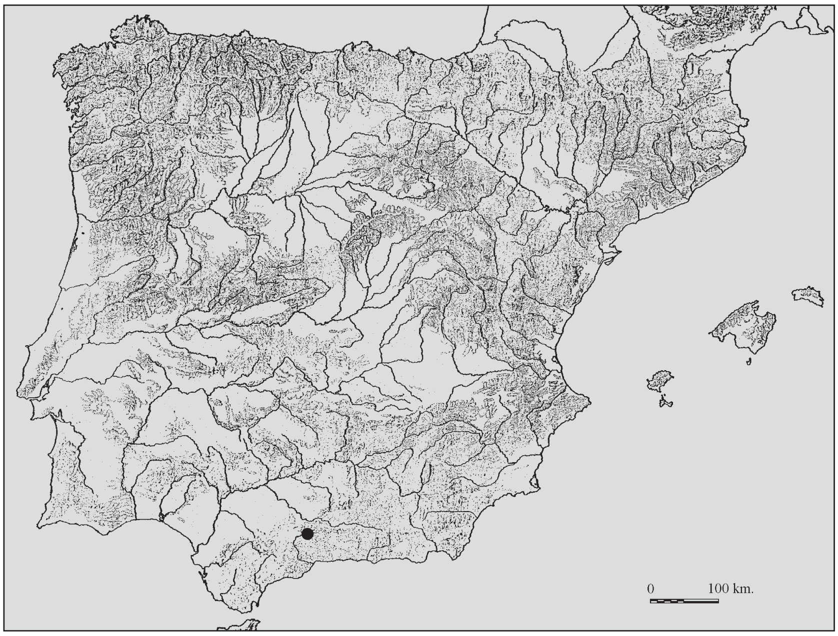

Fig. 1. Cueva de El Toro site.

The study of both cavities has shown that a tectonic movement that affected the whole Penibetic System probably sank part of the original complex. Among other events, the fall of big blocks partially affected a sector of the interior of the cave that can be dated to around the middle of the third millennium BC.

The consequence of this movement is the current disposition of the cave: its interior structure with large collapsed blocks, the formation of a *sima* of more than 30 m inside the cave, and its actual entrance. It has been possible to infer that the original cave entrance, used at least during the Neolithic and part of the Copper Age occupation, was to the south near the *sima*, since it is in this area that the most important stratigraphic continuity and the highest concentration of combustion structures associated with the Neolithic phases are found. Later on, human occupation moved toward the north of the cave, where the current access lies. It is here that most of the evidence corresponding to the societies that occupied the cave after the third millennium BC is concentrated.

Five systematic excavation campaigns (1977, 1980, 1981, 1985 and 1988) were carried out. The stratigraphic and the occupational sequences (2.40 m of deposit) correspond to different periods. These are structured in four phases that have been dated to belong from the middle of the sixth millennium back to the middle of the fifth millennium BC. Phase IV is the oldest, and corresponds to the Middle Neolithic in the conventional cultural sequence in the area. The following one, that corresponds to the Recent Neolithic, is divided into two periods: the earlier sub-phase IIIB, which would have developed between the mid- and late fifth millennium, and the later sub-phase IIIA, which is limited to the first quarter of the fourth millennium BC. After a hiatus in occupation, the cave was re-occupied (phase II) from the first third of the third millennium BC, according to the calibrated ^{14}C dating (Fig. 3).

However, the cave's final occupations are not as easily defined. According to the material indicators, it can be settled to the first quarter of the second millennium BC. Phase II is also subdivided into two periods marked by the structural change to the cave. The oldest (sub-phase IIB), which corresponds to the Copper Age, poses an evaluation problem associated with the alteration generated by the change in the general structure of the cavity, with an inclination toward the south, where the current *sima* opens up. As a result of this parts of the sedimentary units were altered. A more recent problem is that of erosion of the upper layers caused by speleological groups, who use the *sima* for practice.

From this moment on, the cave was to be occupied only occasionally, particularly at the end of the third and first half of the second millennium BC (sub-phase IIA), the Late Copper Age, with Bell Beakers, and the Bronze Age. This occupational dynamic was irregular throughout the second millennium, so that the final moments of the prehistoric occupation of the cave of El Toro (phase I) can be placed between the mid- and final part of the second millennium BC. A similar situation, documented by scarce surface finds, continued during Roman and Medieval times.

Archaeological work, including different analytical methods and excavations, was also done outside the cave, according to the requirements of the developing studies, particularly, on the plain located immediately before the cave entrance and also under a type of porch, also called *viseras*, which had abundant collapse material that seemed to be associated with the closing of the original entrance. In this area, different materials corresponding to the different phases of occupation of the cave were identified, particularly fragments of clay-pots with vegetable prints that denote the existence of dwelling structures nearby.

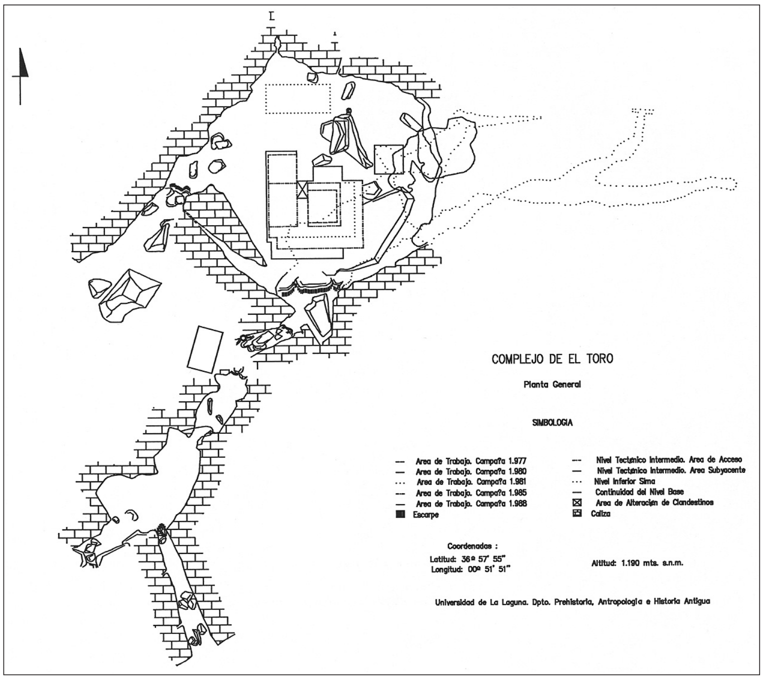

Fig. 2. Plan of Cueva de El Toro.

The structure of the cave divides the interior into two areas: one near the *sima* (sector 1) and the other, connected with the current entrance, which is illuminated by natural light (sector 2).

As a result of the excavation works, as already indicated, four main phases determined by the structural changes in the spatial arrangement of the cave were identified. Each phase indicates the differentiated uses that they made of the site during the historical periods. For the same reason, the two intermediate phases are, in turn, subdivided into sub-phases A and B, where a clear internal cohesion exists between the two.

In accordance with this documentation, the first evidence of the occupation would have been deposited in a historical context where the development of agricultural communities had already begun in the area. Consequently, it is appropriate to place this location in the context of the beginnings of Recent Prehistory in the Andalusian area.

However, at present, trying to include the occupation of Cueva de El Toro within the framework of a wide network of settlements in southern Iberian Peninsula is a complex task. The problem arises not only from the difficulties posed by the theoretical debate about the conditions and circumstances of settlement and the processes of animal and plant domestication, but from a total lack of some minimal levels of empirical data. A lack of systematic field work – filed surveys and excavations – the absence of well-recorded collections and of datings, analytical problems of sediment samples to determine the duration of the *hiatus* in the occupation of the different places, inadequacy of analytical techniques, etc. In addition, in the region of Málaga many sites have been destroyed by looters.

There has also been a misguided tendency to recreate standardised archaeological and geographical representations, which has severely constrained analysis of the region's first agricultural societies. This has created an interpretative flaw which, nowadays, and considering the importance of geographical determinism and the fact that each site is interpreted as an independent and isolated analysis unit, is difficult to maintain.

As result, the standard interpretation is that the development of these societies was determined by the changes produced by new, external factors, by influences from outside the peninsular region. These would have given a new character to the local societies, defined by a significant economic value, but mainly determined by "type fossils", especially pottery, such as the cardial in the oldest periods, red slips (*almagra*) for the intermediates, and ornamented and large receptacles in the final stages. In these later periods, a certain developmental level had already been reached, which has been interpreted, among other factors, from the establishment of the first outdoor settlements – provided the last two periods were not integrated into one, called the mid-end Neolithic.

It is not for us to discuss in this article the origins of the first sedentary formations and of the development of the first agricultural communities, which is the subject of future studies, but it is appropriate to point out that, according to the new evidence being generated in the whole southern region of the Peninsula, and especially in the south-western area, the dynamics of these societies is more complex and diversified than has been traditionally inferred.

Indeed, the studies and datings of menhirs from different settlements in the south of Portugal (*Calado et al. 2003a; Gomes and Cabrita 1997*) seem to demonstrate that their development began from the mid-seventh millennium BC, that is to say, before the first signs of cultivated cereals and domestic animals were identified in the Iberian Peninsula (*Calado et al. 2004*).

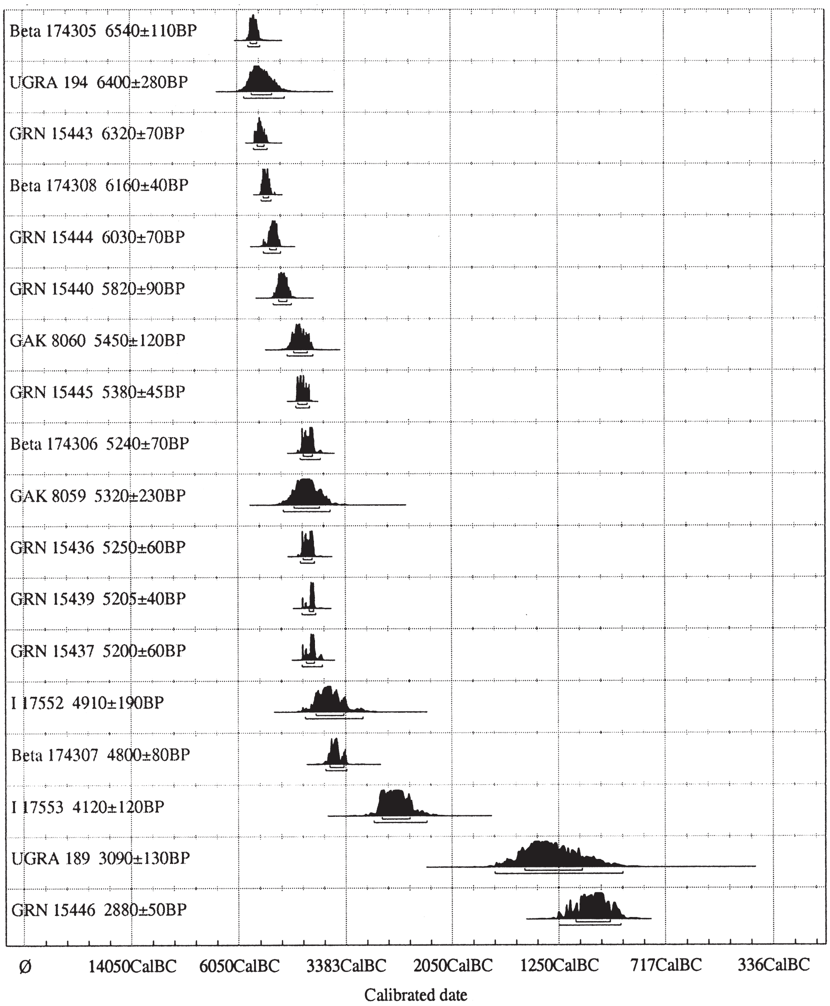

Fig. 3. Cueva de El Toro. Distribution plot of radiocarbon dates.

Although it is true that more evidence is required, the current data implies this, which creates the need to revise the traditional models and the interpretation of the transformation process from complex hunter-gatherer societies to the first agricultural communities. At the same time, there would have been, at least for this area (although this is most probably a common phenomenon and not unique to this zone), the independent development of the sedentary/settlement process and all its consequences, including the first attempts at cereal production or herding animals. This would have taken place in this region around the mid-end of the seventh millennium BC at the latest.

For this last case there is a controversy concerning the chrono-cultural evaluation of the initial period of food production in the region, since the dating results have yielded extremely old dates at several sites; these include La Dehesilla (Cádiz) (GAK 8953: 7670 ± 400 BP, cal 7574–5742 BC, with a correction that would place the site in the first quarter of the eighth millennium) (*Pellicer and Acosta 1982; Acosta 1987; Acosta and Pellicer 1990*). This was why the researchers proposed an autochthonous development process in the western area for this period. According to these authors, the pottery is the main indicator, and its development was interpreted as a result of a process of internal evolution of the epipaleolithic substrate of the region, prior to the expansion of the cardial horizon which originated in the Levant. Among the critics, Fortea and Martí (*1985*) stand out with their refusal to accept either such an old dates or the explanatory model.

The problem of this proposal, apart from the aforementioned duality between the settlement process and the beginnings of food production, is that the findings in a large group of Neolithic sites in the region contradict this hypothesis, and reconfirm the interpretation of the arrival of farming and cattle-herding communities, or, at least, some of its knowledge (*Zilhâo 1997; 2000*), sometime after its appearance in the Levant. This would be in accordance with the consolidation and southern expansion of these communities which would finally reach the Atlantic coast, from the first half of the sixth millennium, in calibrated dates.

As has already been pointed out, one of the main problems with the current evidence is that the number of sites studied systematically is very low, but also, of those published, some present dilemmas in their interpretation, whilst other unpublished works have only been explained partially or superficially. Thus it is easy to understand the current confusion. In the caves of La Carigüela (Granada) (*Pellicer 1964; 1979*), Nerja (Málaga) (*Pellicer 1963; Pellicer and Acosta 1982; 1986; 1995; 1997*), as well as in the latest studies of the settlement at Los Castillejos (Granada) (*Pérez Bareas et al. 1999*), it has been possible to contrast the evidence and to confirm that, in the sequences, the lower levels of production were characterized by the presence of indicators such as geometric microliths and impressed ceramics, either cardial or made with dentated matrix, associated with others that feature the signs of what has conventionally been considered the initial moments of the Middle Neolithic.

In the same way, through the traditional sequence pattern for the Andalusian communities associated with the cardial pottery, these were interpreted as troglodytic, their development being restricted essentially to the eastern area and rarely in the inland regions (*Navarrete Enciso 1976*). However, and in spite of the problems that the reliability of the published information poses due to the inconsistency of the methods used during its analysis (*Pérez Bareas et al. 1999*), in the last few years there has been new evidence which offers a different panorama. This new theory does not lack problems either, because of a relatively wide variability in the types of settlements, both in the coastal areas (i.e. Cabecicos Negros) (*Goñi et al. 2003*) and inland – whether in valleys, on hill tops (i.e. La Esperilla) (*Gutiérrez et al. 1996*), or in mountain areas (i.e. Los Castillejos) (*Arribas and Molina 1977; Sánchez 1999; Afonso et al. 1996*), and across the whole region.

In general, and considering the large sedentary settlements that are found in southern Portugal (*Calado et al. 2004*), these seem to coincide with smaller camps in the Andalusian region, usually located in small elevations and next to water courses, which reveal settlements of seasonal and periodic timing typical of small communities (although their real dimensions are difficult to determine). These communities, which maintained a close association between the number of their members, their mobility and the potential use of their environment, are characteristic of the social formations in these initial periods.

Their location must be understood as being directly related to a subsistence economy, that is to say, an agricultural system derived from the available resources. Territorial expansion was widespread for these social formations that, little by little, consolidated and enlarged their production structures, at the same time as they took control of the whole territory. In this sense, they generated new strategies, which had the tendency to diversify the use of subsistence and primary resources. However, in spite of their widespread distribution over the region, the existing information is very scarce, fragmentary and impossible to contrast in a reliable way. In addition, the evidence is centred fundamentally on the results obtained in cave locations, in inland regions, and in mountainous environments. In consequence, they present an image based on the almost absolute prevalence of cattle exploitation, due to the presence of some differential features that are traditionally found for these populations in the other regions of Iberia, which does not necessarily have to correspond to the general norm for all Andalusia.

The reason for this interpretation is largely because the evidence published on carpological remains for this initial period is very thin and refers exclusively to cereals, although the possible existence, in the final periods, of leguminous cultivation should not be discounted. The presence of hand mills, axes and adzes, as well as of sickle blades with cereal remains, indicate the practice of subsistence and complementary agriculture, which accords with the mountainous character of most of the locations published up to now. On the other hand, it is inferred that this agricultural system was supplemented by some other activities.

However, and in spite of the poor data, it seems that the activity of the communities located in the plain areas or in the lowlands was primarily agricultural, cereal-based, perhaps of short-cycle rotation, where gathering wild foods and raising cattle would have been complementary strategies.

The subsistence economy is, in general, an agricultural system derived from the various resources found at the locality, complemented with the continuity of previous traditions, such as hunting and gathering. In some areas, for example, the coastal regions due to their particular features, there was a tendency towards the use of marine resources, especially molluscs.

On the other hand, and although the identification of the locations of the first agricultural social formations has been carried out by the presence or absence of the type fossil of the recipients with cardial ornaments, we know that in this region the different technical and ornamental expressions would have been gradually incorporated from the mid-sixth millennium BC. The rest of the tool finds were thin sílex blades of micro-laminar thickness, stone axes, and a few ornaments that, on occasion, were not from the same area. Up to now, it is not known whether the separate origin of these ornaments was due to the mobility of these semi-sedentary communities, or if they came from a short distance, via intra-regional exchange, either inland or in the coastal zones.

The pressure that these activities exercised on the environment has always been overestimated. This is why the traditional hypothesis is that the introduction of agricultural production in Andalusia did not significantly transform the vegetation. This would have been more substantial during the Copper Age and, especially, during the Bronze Age. In turn, this would have generated a process towards aridity in some areas and of desertification in others, the main example being the changes in the southeast. However, research is demonstrating that the effects of the strategies related to the origin, development and consolidation of farming and/or herding in Andalusia begin to show from the middle of the sixth millennium BC, since it has been verified that this occurred in the surroundings of the Cueva de los Murciélagos (Zuheros, Córdoba) (*Rodríguez 1996*).

Thus it would have been by the middle of the sixth millennium BC that the first occupation of the Cueva de El Toro had begun.The stratigraphy of the phase IV is characterized by a series of sediments deposited on the cave's base which are formed by a great quantity of collapsed flagstones, typical of this type of karstic formation.

Taking into account the features of the different sedimentary units, a series of successive thin coal and ash strata were recorded. In some cases these were associated with large shallow pits, probably related to the use of fire, which unevenly affects the distribution of the occupation of the space. From their characteristics, and given the results obtained for diverse studies, the hypothesis is that they correspond to combustion areas related to the smoking of meat products in order to generate a surplus. There was also an outstanding quantity of burnt and dismembered human remains, in particular a jaw.

In conclusion, this community corresponds to a society with some productive activities based on the raising of livestock, from which primary and secondary products could be obtained, such as meat and skin-based products. Hunting and obtaining plant resources would have contributed to stabilizing and supplementing the diet and to providing raw materials for the making of some products.

Moreover, handicrafts did not develop significantly in this area, with the exception of leather working. Indeed, the signs on these items suggest that they were carried out preferably as repairs on tools manufactured elsewhere. Of smaller importance, the carved lithic tools reflect their use in the transformation of wood and plant fibres and clay or minerals.

Therefore, the Cueva de El Toro was initially occupied by a community with a subsistence economy based on livestock exploitation integrated with the mountain environment as is that of Sierra del Torcal. However, at present, the presence of different types of oak woods denotes an important forest environment, although this has no anthropic influence, which implies that in the initial stages of occupation of this territory there were no woods (Fig. 4). On the other hand, in the Cueva de los Murciélagos (Zuheros, Córdoba), the thicket woods denote both a humid and thermophile atmosphere, and also the first stage in the degradation of the vegetation.

This importance of livestock management is clearly reflected by the faunal sequence, which is possibly typical of the pattern of livestock exploitation in Andalusia during this period, with a marked presence of the caprines. Sheep would have been more abundant than goat by a proportion of 2:1, and pig would have been next in importance. The pattern of the mortality profile indicates that this was subsistence strategy directed to the consumption of meat rather than to the production of other products such as milk or wool. As for the contribution of the hunting activity in the meat diet, it would have probably been small and mainly comprised of hares and rabbits.

This exploitation regime, basically oriented towards the generation of a meat surplus, through the and smoking of the meat (Fig. 6.1) to conserve it, steaking apart from the uses of the hide (Fig. 6.6), is suggested by the carved lithic toolkit production.

The carved lithic toolkit production shows a high degree of technical skill, but it is also clear that the finished products were not manufactured in the cave, but arrived ready for use, which explains their continuous re-use (Figs. 6.2-5, 7; 7.2-3), and, also, that some were reserved for later use.

This panorama is not exclusive to carved lithic tools, but can be extended to other items, such as the bracelets of various rock, or the malacological industry, for which there are no signs of on-site production. The same pattern can be recognized in the quantity and types of processed carpological products.

It is evident that there was a level of dependence on external communities for the production of goods, which implies an exchange regime that, considering the possible origin of the primary resources, is probably connected in most cases with other communities in the same region. The marble bracelets (Fig. 8. 2-3) and malacological records (Fig. 8.1, 4-10) could be examples of this. However, there is proof of the production of tools from bone (Fig. 7.1), wood (Figs. 6.3; 8.2, 4-5) and vegetable fibres, although it has not been shown to be production intended to generate a surplus.

The indicators of the Cueva de El Toro in phase IV do not seem to show the existence of a conventional exchange regime of inter or intra-regional character. It could be assumed that activities allied to the butchering, tanning of hides, and smoking of meat were to generate a surplus that overcame the necessities of the community that inhabited the cave and, therefore, that they were also exchange goods. It would then be necessary to accept that the connections recognized in other sites, where certain socio-economic situations and similar technical activities are observed, point to some social formations of tribal character whose mobility gave them a clear territorial control over the whole region. At the same time, this would imply a chain of product circulation, which has not still been well defined, but that seems to encompass large distances and where, undoubtedly, there would be an explanation for the significant development of the specialized handicraft products. This evolution would serve as a starting point for the important transformation that took place from the middle of the fifth millennium BC.

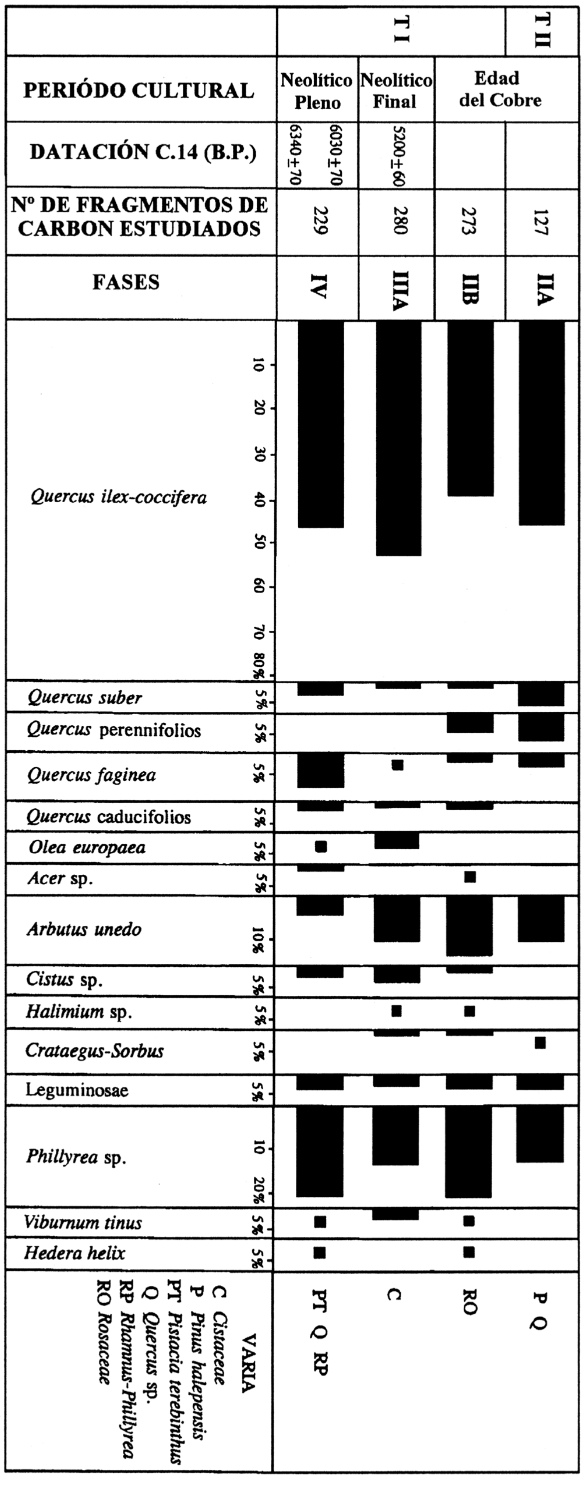

Fig. 4. Cueva de El Toro. Antracological diagram.

Indeed, this situation would have changed considerably, particularly during the last quarter of the fifth millennium, as can be seen from the fact that it was the moment of highest human occupation of the Cueva de El Toro. At the same time this process of demographic aggregation was happening in general in the whole region, together with a division of labour and a hierarchization phenomenon that somehow eliminated the previous organizational model.

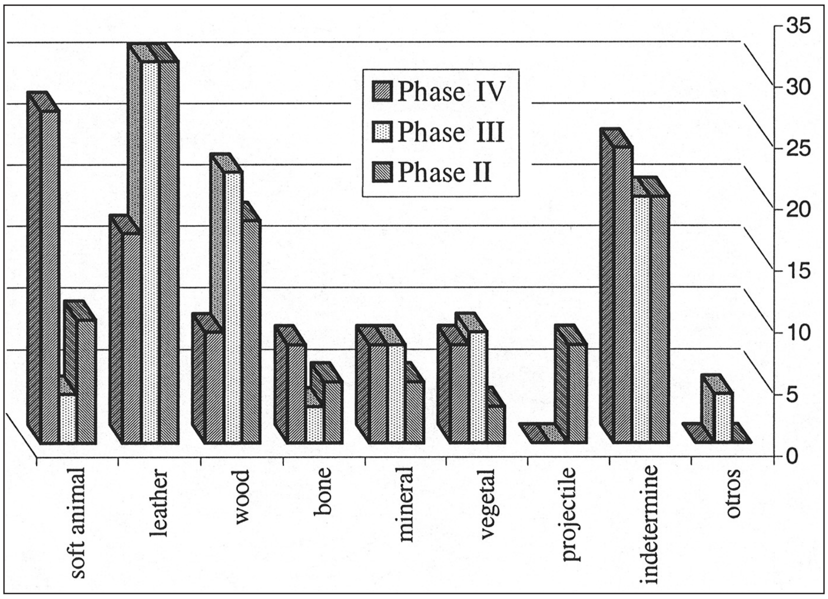

Fig. 5. Cueva de El Toro. The raw materials and handicrafts.

The first consequences of this change are seen in palaeo-ecological indicators at the Sierra del Torcal.

Thus, in Toro it is observed that, after a hiatus in its occupation, the cave was again inhabited from the mid-fifth millennium BC, in Phase III.

As a result, there is a greatly differentiated stratigraphic development in the sedimentary units with respect to the previous phase, by a level of loamy, granulated, reddish clay, the *terra rosa*. This was not part of the cave's material structure, but was introduced from the nearby exterior zones in order to condition and to level the floor. This conditioning of the living space, in opposition to that in phase IV, extends to the whole of the platform that became independent as sector one.

Directly over this level, six combustion structures are found. From their disposition, it can be said that they were organized in relation to the original access to the cave. Of these, five are defined by small spaces delimited by stones and forming irregular plans, although the main tendency is a circular or oval shape. The remaining one is determined by the construction of a small pit.

In this phase, two clearly defined situations can be recognized in differentiated uses of the cave, which would have had clear effects on the organization of the space.

The first, or oldest, sub-phase IIIB, would have been, according to the datings of available calibrated ^{14}C data, between the middle and end of the fifth millennium BC. This phase is established by the use of the interior of the cave as a stable for livestock, which would explain, on the one hand, the distribution of the combustion structures directly related to the sector of the access area. On the other, it explains the continuity of that disposition, in such a way that the remaining combustion structures recorded in the vertical development of this subphase are placed directly on the previous ones. In addition, there is the fact that certain tools related to crafts such as pottery or textile manufacture have been found in the same zone (Fig. 11).

As has been pointed out, from the end of the fifth millennium BC the moment of maximum development in the Cueva de El Toro took place, leaving an imprint on the paleo-ecological record of the Sierra del Torcal. It would have been in this period, especially the end of the fifth and the beginnings of the fourth millennia BC, when the first evidence of the impact of people’s activities can be observed on the vegetation. This phenomenon is also identified in the results obtained in the Cueva de los Murciélagos (Zuheros, Córdoba) and in the Polideportivo de Martos (Jaén), where the first evidence of human impact already appear on the vegetation, generating a first degradation stage, as bush and heath species become widespread.

It has been proven that the raw materials used for combustion were the same as those used for the byre: *Quercus ilex* L., *Quercus coccifera* L., and *Phillyrea* sp., which are very abundant species in this mountainous area. Nevertheless, the presence of other plant remains such as heaths (*Erica* sp.), lentisk (*Pistacia lentiscus* L.), and Pistacia sp. indicate a wider gathering of plants that were not located in that same environment, but grew on decalcified substrates, as in the case of the heath, or in areas warmer than that of the mountains, such as in the case of the lentisk, which would have been brought from the lowland zones.

There are also some species such as *Quercus faginea* Lam., the olive, and other hard woods that re-

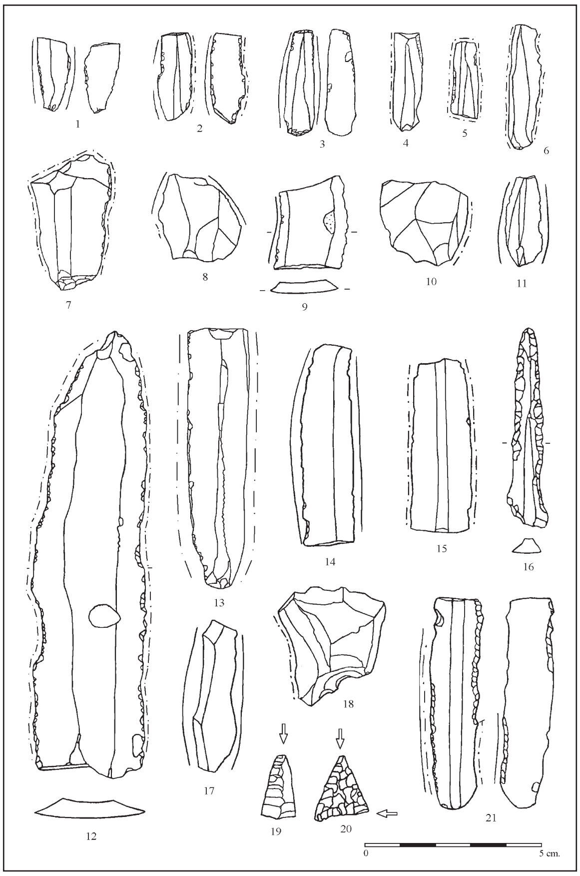

Fig. 6. Cueva de El Toro. Stone tool assemblage. 1–8: Phase IV; 9–12: Sub-phase IIIB; 13–18 and 21: Sub- phase IIIA; 19–20: Sub-phase IIB.

sist combustion and burn slowly. In the case of the olive (*Olea europaea* L.), and that of the holm oak (*Quercus ilex*), their presence in living areas could have been due to two particular activities. On the one hand, the bush branches were gathered as food for domestic livestock and, on the other, the spare remains were used as firewood.

It can be deduced that the landscape was beginning to be altered by human action, resulting from new economic strategies which would in time develop even further. These were characterised by specialized production, such as rearing livestock and growing cereals that would lead to a significant reduction of the vegetable cover (either that of herbaceous plants or of bush formations; simultaneously, species such as arbutus developed). Evidence of these activities is found in substantial quantities in most of the sites, from then onwards. This would have created a landscape of open areas, where bushes and heaths cohabit, dense forest areas, and enlarging arable land.

Both lithic and bone production (Figs. 6.9–18; 9. 5–8; fig. 7.5–12) continue to be important in understanding changes in the dynamics of the montane society, which has been observed in the strong development and diversification of handicrafts in relation to the small amount of evidence of those activities that would correspond to the gathering of subsistence resources. This growth is manifested, fundamentally, by the exceptional evidence of specialized handicraft production, such as textiles (Figs. 7.5, 8, 11–12; 11.2), skin (Fig. 6.10, 13, 17), woodcrafts (Figs. 6.9, 15, 21; 9.6, 8), or pottery (Figs. 6. 12; 7.9–10; 12.1–3), that seem to have been carried out in within the cave or its surroundings.

This situation is not general for the whole period, since in its first stages a part of the cave was used as a byre marking a radical change from its previous function.

The changes that can be observed from the beginnings of this period in connection to the fauna are a distinct reflection of the functional modification of the cave, which, in turn, is a result of the transformation of the economic system prevailing until then in the whole region during the Recent Neolithic.

This can be determined by, among other factors, changes in animal management, where caprines were prevalent relative to pigs. This is already a development with regard to the basic level of subsistence and meat or milk consumption. Indeed, there is an important change in the pattern of the goat mortality profile: a high proportion of very young, new-born and fetal animals appear, such that approximately half the animals died under a year old, while half of those that survived were sacrificed before three years. This evidence assumes that the animals were not slaughtered and then brought to the cave to be consumed, but rather that there was systematic occupation by the living animals, which has been confirmed by the presence of a disproportionate number of milk-teeth fallen during their lifetime. In addition, the fauna sequence shows a slightly higher presence of goats over sheep.

It is difficult to specify how many of the young animals were slaughtered rather than dying from natural causes, which could give an idea of milk production. Anyway, the evidence seems to indicate that the sacrifice of most animals would have been prior to the period in phase IV.

On the other hand, the presence of a very specific butchery pattern for the caprinos, marked by a parenthesis in the mortality rate between the age of approximately two and five months, constitutes the most interesting phenomenon in sub-phase IIIB. Pérez Ripoll (*1999*) defines it as a pattern of meat production, although in El Toro it is necessary to add wool production, which has two possible explanations: on the one hand, that the mortality rate ceased or decreased as the animal grew or, on the other, that the animals were not in the cave during that period. With respect to the first of the possibilities, there is evidence that the mortality of young animals was high just after birth and in the first weeks, and although mortality is much lower after the first months, it does not cease completely. For this reason, the gap in the mortality of the young caprines of the Cueva de El Toro suggests that the animals were intermittently in the cave, possibly during certain seasons. This is confirmed by finds of worn teeth of individuals of nine to thirteen months of age.

As for determining seasonal occupation, it is known that the lambing season can vary depending on the climate and livestock practices. If one keeps in mind what happens at present in the area, lambing can occur between August and March, although more usually between November and February. As for goats, in the mountains, the *malagueña* produces kids in November or December. Data from the Roman period indicates that the most favourable time for lambing is from mid- October until the end of December, while for goats the main season would be the spring. The reason for early autumn births would be that this would allow the small animals to take advantage of autumn pasture and become stronger before the winter.

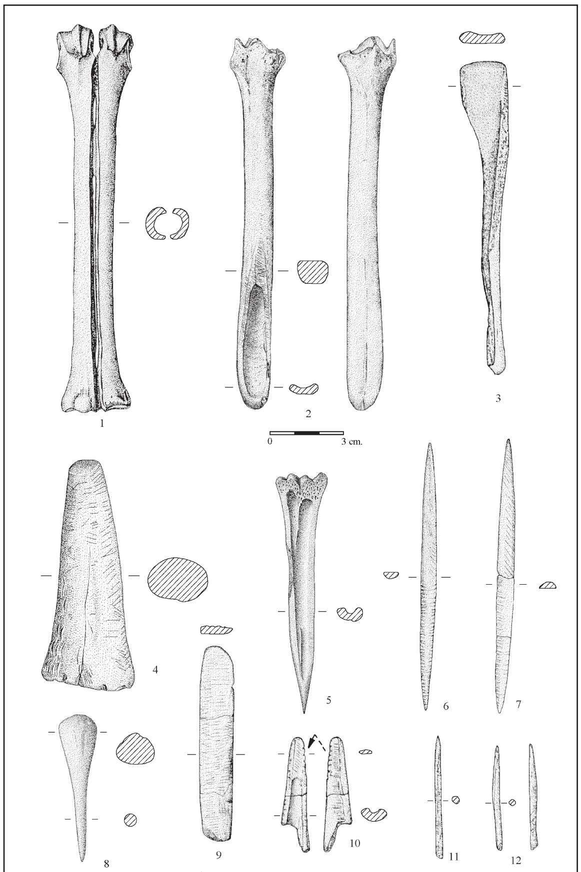

Fig. 7. Cueva de El Toro. Bone tools set. 1–4: Phase IV; 8: Sub-phase IIIB; 5–7 and 9–12: Sub-phase IIIA.

If the animals were present in the Cueva de El Toro a couple of months before the birth season and a couple of months afterwards, as the bone deposits seem to indicate, the cave would have been occupied during the autumn and in the middle of winter. This phenomenon can also be confirmed by the plant records of this period.

The study of this change in the management of the scale of animal exploitation should consider the factors that affect it, such as climatic conditions, the duration of the photo-period, the type of vegetation, and consequently, the state of the grass. This will allow for an evaluation of those parameters that at present are evaluated in the analysis of this activity, such as the length of a shepherding day, the distance of itineraries, and possible speed, always as a function of the different seasons.

In accordance with the current data for mountain *malagueñas* (*Blanco 2002*), there is a clear relationship between the intensity of solar radiation, temperatures, quality and quantity of grass and the duration of a shepherding day. In autumn and winter these are characterised by an increase in rainfall, a marked reduction in the hours of sunlight, 5-hour shepherding days, and the fact that the average travelling speed is around 0.95 to 1 km per hour.

This means that there would have been full mobility for a certain number of animals in the mountains of El Torcal, which would explain the effects of the first degradation stage of its vegetation. This is demonstrated by an anthracological diagram, confirming a process that has also been observed in the Polideportivo de Martos (Jaén) (*Rodríguez 1996*), where pastoralism was the economic base.

The fact that livestock were kept inside the cave in the initial period is confirmed by a decrease in the amount, variety and quantity of carved lithic tool kits. Moreover, there was ovicaprine excrement in some of the associated living places. On the other

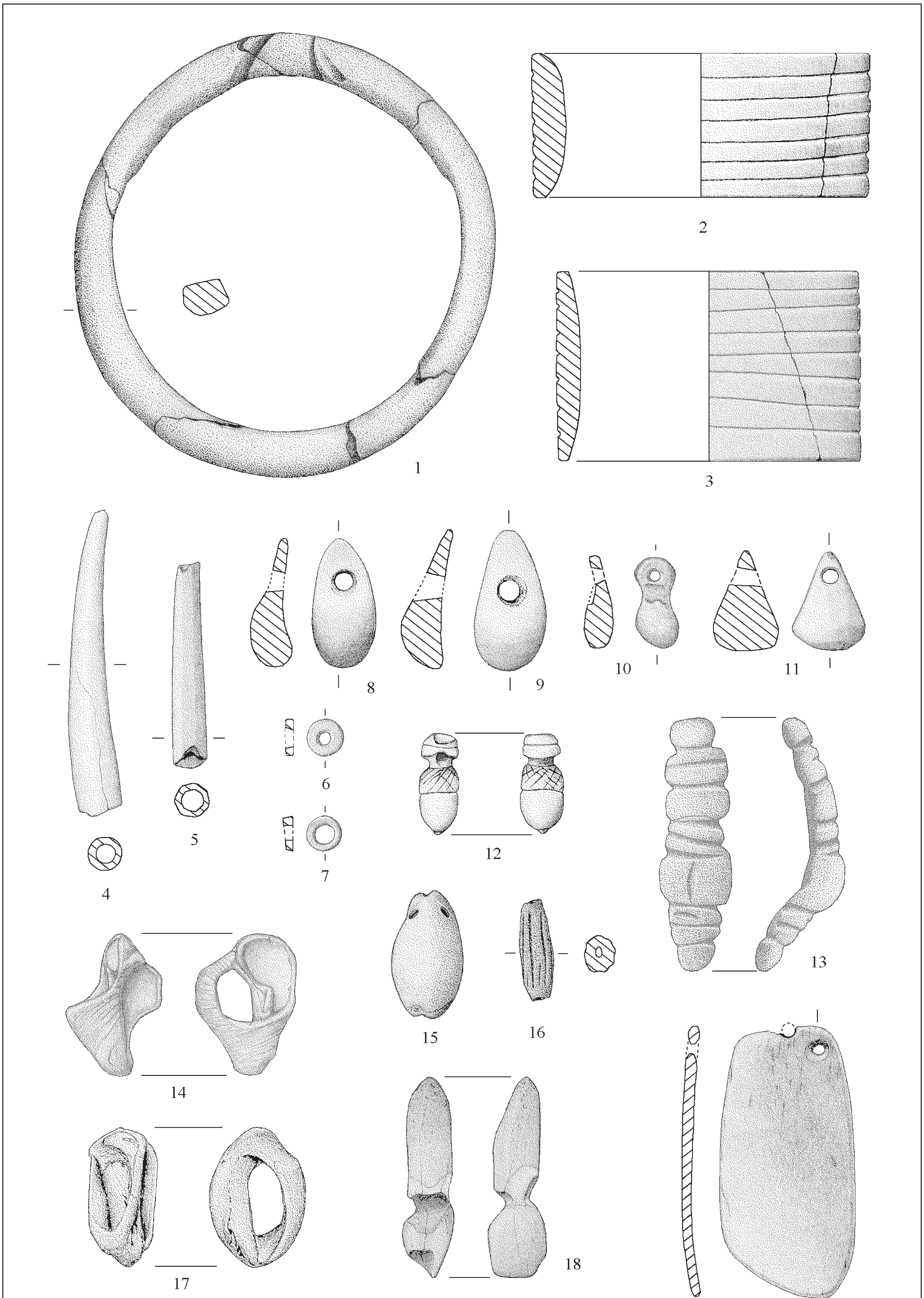

Fig. 8. Cueva de El Toro. Items personal adornment 1-13 and 15-16: Phase IV; 14 and 17-18: Sub-phase IIIB; 19: Sub-phase IIIA.

hand, the older age of slaughtered animals in the latest period implies the development of greater control over the livestock, and increased variety in the type of production. The use of the derived products, mainly wool, became more widespread and, consequently, textile production also prospered. Thus, before and after slaughter, the animals would provide secondary products of outstanding importance, judging by the evidence.

Indeed, the textile production was closely linked to livestock raising, manifested through a group of weaving separators identified in El Toro (Fig. 9.2), as well as in caves at Nerja (Málaga) (*González Tablas 1982*), El Gato (Málaga) (*Mora 1976*), and La Murcielaguina (Córdoba). The use of these was not limited to animal fibres, but also included plant fibres such as esparto, which has been confirmed in different sites, such as the caves at El Toro, Los Murciélagos (Albuñol, Granada) (*Góngora 1868; Alfaro 1980*), or Hoyo de la Mina (Málaga) (*Such 1919–20, Pellicer and Acosta 1986*).

In consequence, it can be said that the community that occupied this cave continued to be primarily livestock breeders and as such, there is an absolute prevalence of ovicaprines over pigs and bovines, species usually linked to an agrarian subsistence system. However, the consolidation of agricultural activities, as much in the production sense as in that of its profitability, justifies the importance that its products had in relation to the other resources developed in El Toro.

Some interesting interpretations can be obtained regarding the plant indicators and their evaluation within the framework of the agrarian subsistence system. Besides the plants already mentioned for combustion purposes, on the one hand there were very few cultivated species, such as naked wheat (*Triticum aestivum/durum*), naked barley (*Hordeum vulgare* var. *nudum*), whole barley (*Hordeum vulgare*), and some leguminous species, such as beans (*Vicia faba*), and lentils (*Lens culinaris*), and on the other, also scarce, there were wild species (only oak (*Quercus* sp.) and olive (spp *Olea europaea*) have been identified). If the cultivated plants were harvested throughout several seasons and taken to the living quarters as clean grains ready for consumption, then their presence cannot be argued as dependent on the season. Moreover, it is evident that acorns are gathered only in autumn and, therefore, their consumption in Toro confirms the winter occupation of the cave.

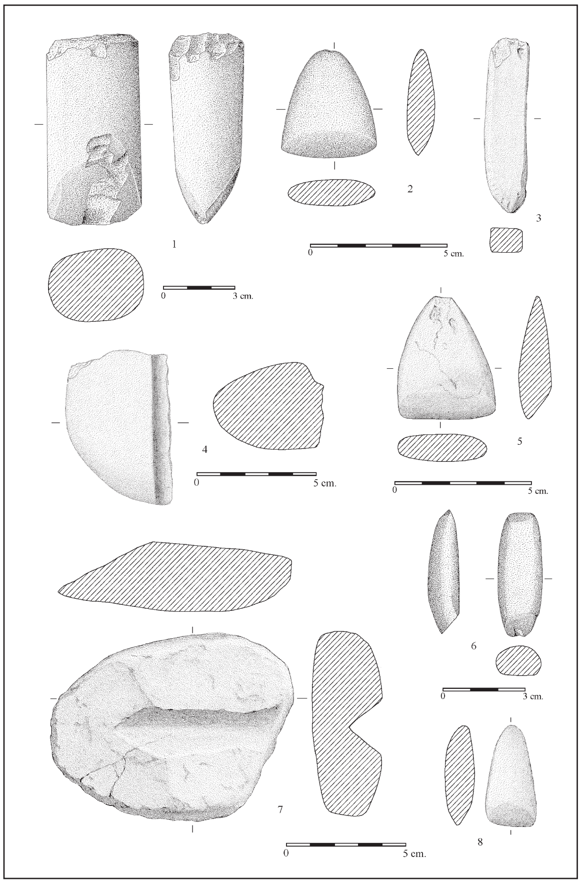

Fig. 9. Cueva de El Toro. Polished stone axes and implements. 1–5: Phase IV; 7: Sub-phase IIIB; 6 and 8: Sub-phase IIIA.

The presence of selected seeds for consumption and grains that were cleaned before their arrival in the cave imply an existing knowledge of the cultivation process. The plant indicators clearly denote this improvement in agrarian methods, particularly in the rotation of winter and spring crops to improve output, as in the case of alternating a winter cereal crop with a leguminous crop. At the quantitative level, the significant presence of closed groups of beans together with winter cereals in Toro can be interpreted as the remains of earlier cultivation of leguminous crops in the same field and, therefore, the remains of a rotation. In slash-and-burn agriculture, where evidence is scarce and where different crops have been grown, we could expect to find some associations such as wheat or naked barley with a leguminous crop, from more to less nitrogen-demanding, and from less to more wild. However, it is a hypothesis that has to be contrasted with an empirical base that at the moment does not meet expectations.

Although leguminous species in El Toro's records are too scarce to consider a regular and systematic

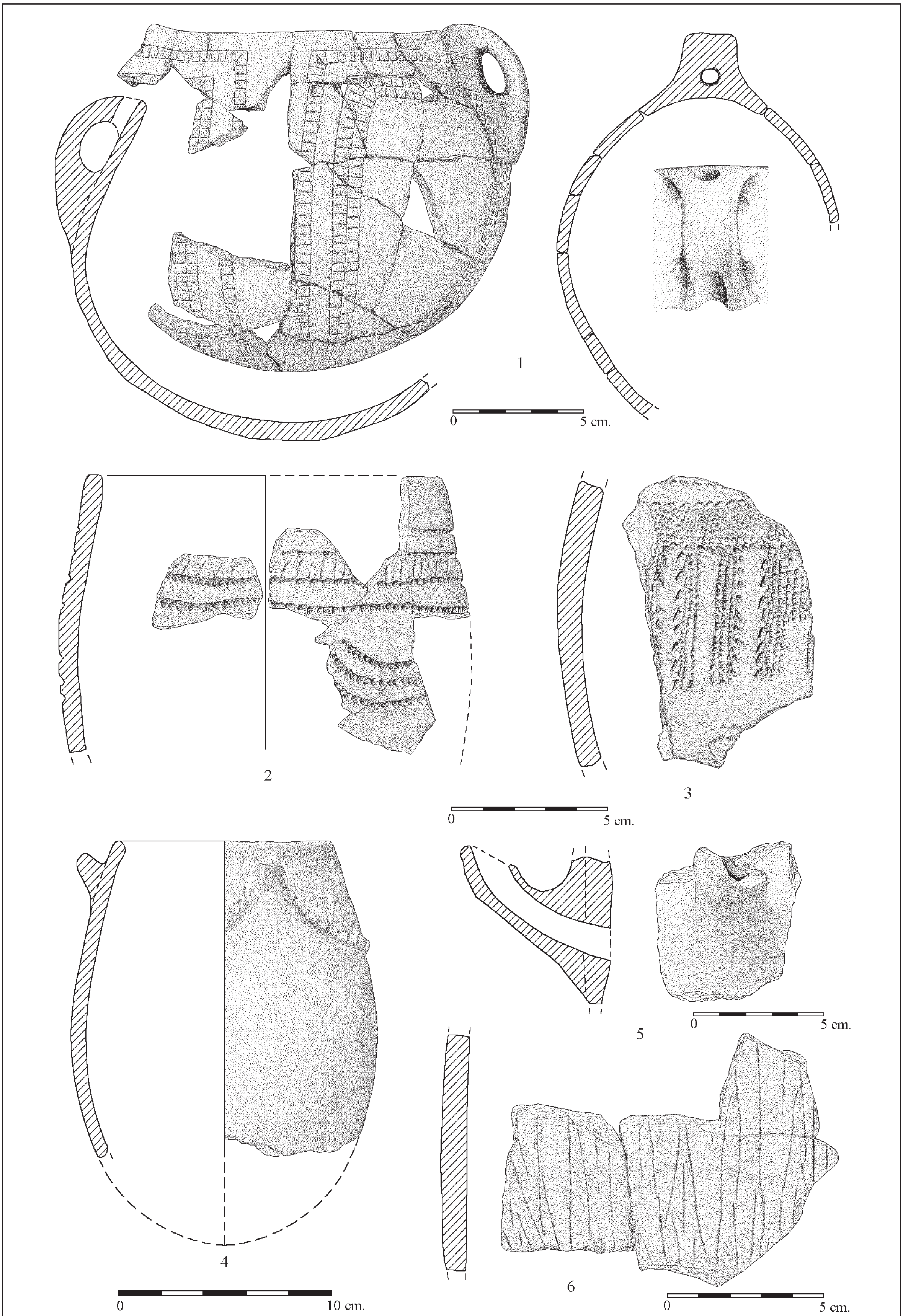

Fig. 10. Cueva de El Toro. Pottery, Phase IV.

rotation in Neolithic cultivation, this does not prevent us from thinking that this agriculture could have developed some rotation pattern in the cultivation of cereals and leguminous spp. The simple and continuous presence of legumes in small quantities at the sites in this period does not necessarily entail a rotation, but it outlines the existence of a cultivation system which somehow included this. If beans, lentils, or peas were sown in a ploughed parcel at the same time as cereals, it is quite reasonable to assume that these products did not have the same importance as the cereals and that their cultivation was closer to a horticulture strategy. If in another parcel legumes are alternated with cereals, the characteristics are the same as in the previous system. Therefore, we admit that the two systems have their own logic and their own dynamics, but they are not mutually exclusive, and, therefore, they would have been able to coexist until the agricultural system had become stable.

Finally, some agrarian practices can be inferred from the presence of weeds, which should be analysed depending on the cleanness of the crops, although their state can be also determined largely by the gathering method. In Toro, most of the weeds are low-lying species, although they are mixed with taller ones. From this, a hypothesis can be proposed that the crops must have been harvested by cutting low down the stem.

Although the evidence for this period from the excavations at Toro is quite outstanding, it cannot be overestimated, since this is an outlying, montane population, and it was a small and diffuse part of the great transformation that took place within the agricultural communities from the beginnings of the fourth millennium BC in the south of the Iberia.

In general terms, this transformation was marked by the consolidation of the sedentary process that should be understood parallel to the considerable division of labour. The economic system would have become more complex, not because of a considerable increase in agricultural activities, especially the production of cereal crops, but also because new and unrelated livestock procedures were adopted. For these, the site at the Polideportivo de Martos (Jaén) is the best known example (*Lizcano et al. 1996; Lizcano 1999*).

The settlement process has to be interpreted as the result of a gradual structural reorganization of these populations, with a tendency to diversify produc-

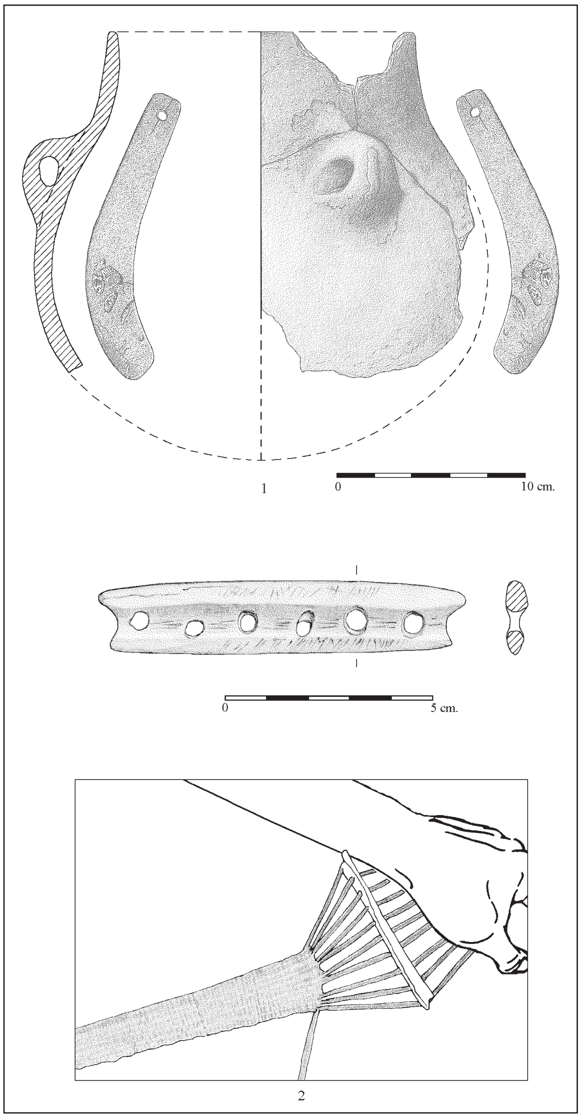

Fig. 11. Cueva de El Toro, Sub-phase IIIB. Pottery and weaving separator.

tion. This led to an increasing rupture in the previously homogeneous society, generating the mechanisms of power for the development of hierarchies and changes that would be accentuated during the third millennium. This transformation would be represented by a new settlement model, and more particularly with the appearance of new organizational centres, large specialized settlements throughout the whole Andalusian region. It is thus seen that there were signs of an increasing strictness and far-reaching control process, more than has been observed in previous periods. This control was exercised from a power structure, where the settlement locations are determined by visualising the whole economic area and by the domain of the most important communication roads. These routes, which had already been used in the past for the same purpose, were axes of exchange activities and the exploitation of some specific natural resources, where products and raw materials changed with time. Silex mines and their exploitation have been one of the most important subjects of traditional studies (*Ramos 1986; 1999*).

A more complex and consolidated economic scenario was, therefore, created. This would confirm the current interpretation of the role of the different specialized productions in this period and of the dynamics of an economy with a surplus policy aimed at exchange, at least at a regional level. At the same time, the aforementioned development of social hierarchy outlined by F. Nocete (*1989; 2001*) would consequently have placed cereal production in the third millennium in a dominant position.

These sites are to be understood as a result of the phenomenon of demographic aggregation – such as would occur later, in the second millennium, during the development of the Bronze Age – which would mean, in some cases, the abandonment of settlements of the previous period; and in others, the modification of activities and the occupation regime. Settlements would become only occasionally or circumstantially occupied, particularly in the mountainous areas that would have then become considered as outlying settlements, such as would have been the case of the Cueva de El Toro.

Consequently, a clear general reinforcement of production processes, and of food production in particular, took place from the beginnings of the fourth millennium BC in the Andalusian region. This yielded an important increment in the diversity of cultivated species, both cereal and leguminous. This is a sign of a sedentary life, where there is a strong augmentation of agricultural practices.

An increment is thus observed in grain size and the development of a surplus, a larger volume than that required for subsistence. This would have led to the construction of large storage spaces, the *silos*, and containers, just as observed in different sites along the valley of the River Guadalquivir. This seems to be the axis around which the large nuclei of agricultural exploitation developed, implying that the settlements were located depending on the quality of the soil, both because of higher productivity and for the recovery of the vegetable cover in relation to the humidity indices. They were also located close to water sources, particularly in the outlet zones, and the countryside around Seville, Córdoba and Jaén. The areas beside the Guadiana, Tinto and Odiel Rivers were also occupied; the Morales site (Córdoba) (*Carrilero et al. 1982*) and the Cerro de la Plaza de Armas de Sevilleja (Jaén) (*Contreras et al. 1985; Nocete 1989*). This location shows the new aims that developed, particularly the tendency to settle on the best lands, near water sources, and to develop profitable agricultural exploitation.

At the same time, there was a change in sheep herding. Ovicaprines were still predominant, but their flocks were being controlled by means of folds and the consumption of very young animals. This, together with finds of important quantities of tools used for textile production, like the aforementioned weaving separators, are signs of the exploitation of secondary products, such as milk and wool. This would confirm the hypothesis of a stronger emphasis on livestock profitability, at least of ovicaprines. Thus, settlements like that of Polideportivo de Martos (Jaén) were established in order to control the grass lands. This situation would continue in a similar way throughout the Copper Age, with variations in the proportion of animals: more balance between ovicaprines, pigs, and bovines.

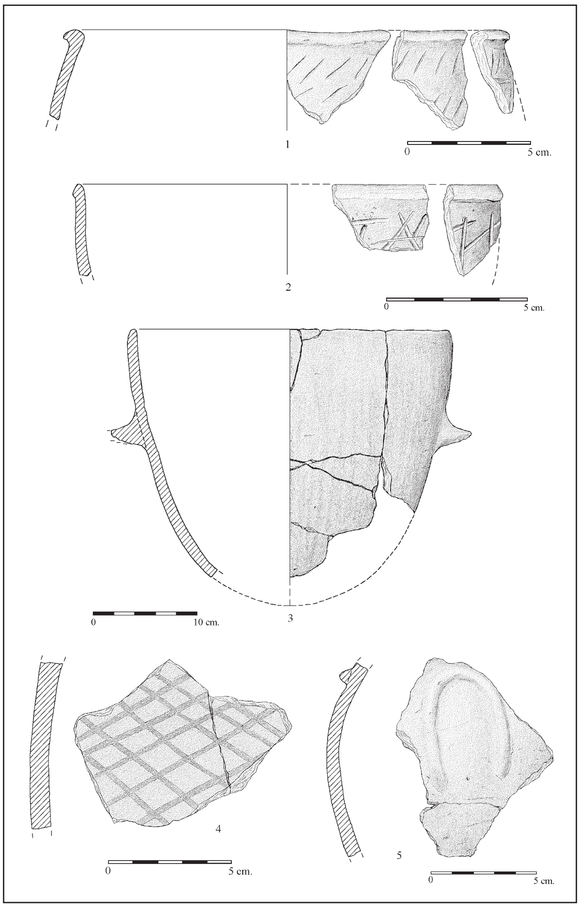

Fig. 12. Cueva de El Toro. Pottery, 1–3: Sub-phase IIIB; 4–5: Sub-phase IIIA.

After this intensive period of occupation and economic impulses, the development of copper working at the beginning of the third millennium did not seem to cause profound transformations in the economic dynamics of these societies. However, a gradual process of demographic centralization began, along with a more exhaustive and hierarchical control of the territory. The result of this was the appearance of the first fortified towns and of small nuclei, specialised in non-subsistence activities, in various areas of Andalusia.

In Cueva de El Toro this meant a less intensive occupation, which is confirmed by the presence of small mammal remains, mainly of nocturnal birds of prey, especially owls. This new socio-historical situation, shown in phase II, began in the middle of the third millennium BC, and is characterised by an important hiatus in the occupation. The formation of this phase reveals a natural sedimentary unit, with clay and a large quantity of small stones.

As in the previous phase, this is divided into two subphases, IIB and IIA, due to its inherent characteristics, which refer not only to the circumstances of its use, but also, as was mentioned before, to the structural change of the cave due to tectonic movements. On the other hand, the actual datings confirm that a long period, about half a millennium, elapsed between the one and the other.

The evidence of these modifications is observed, in the first place, in the displacement of the living space from sector one, which had been dominant until then, towards sector two. Sector two, as has already been pointed out, is where the new entrance to the cavity lies. On the other hand, the evidence also shows that the occupation of Toro became less intense as it was inhabited occasionally and at specific times.

The evidence is fragmentary, but sufficiently complete for several moments of occupation corresponding to the first metallurgic phases – those that in the area's archaeographic sequence are associated with the Copper Age, the Bell Beakers, and the Early

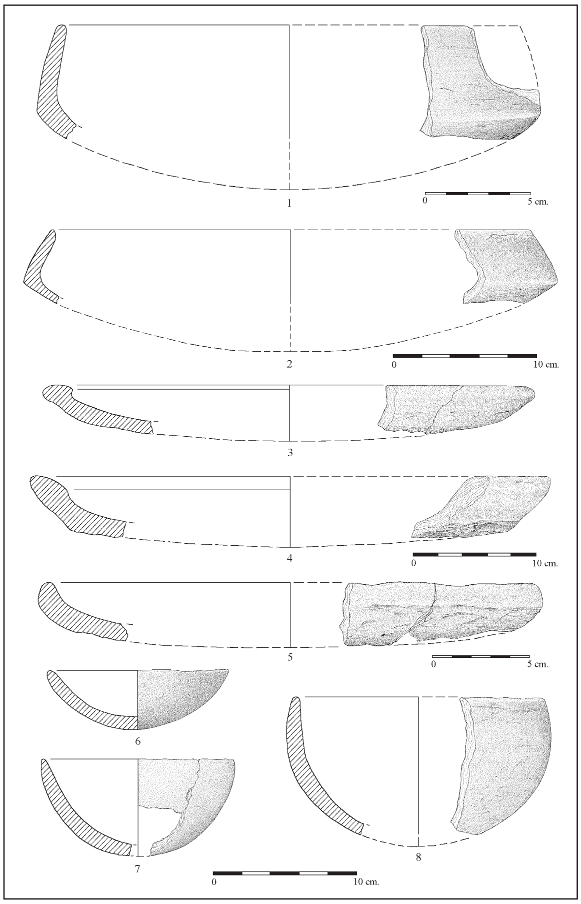

Fig. 13. Cueva de El Toro. Pottery, 1–2: Sub-phase IIIA; 3–8: Sub-phase IIB.

Bronze Age. The material indicators (Figs. 6: 19–20; 12: 3–8) demonstrate that these communities were clearly related to the hierarchical social formations which controlled the valley of the Guadalquivir at around the mid-third and mid-second millennia BC.

Finally, in Roman times, as well as in Hispano-Islamic times, the cave was once again busy, especially in the late periods, as shown by several fragments of identified *T.S.A.D.* Coinciding with the Roman stage, the occupation would have had its maximum development in the riverine area to take advantage of its high agricultural potential. The mountains were, therefore, used for livestock, as well as for the extraction of limestone for construction purposes, as seen in the quarry identified in the northern zone.

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contents

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Documenta Praehistorica XXXI

The Neolithic in Almería: the valley of the Almanzora river and Vera basin

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ABSTRACT – *The valley of the Almanzora River and Vera Basin (Almería) shows an intense dynamics of occupation in Prehistory, particularly between the Early Neolithic and the Late Bronze Age. Several factors, such as the recurrent associations between diverse productions – including the presence of cardial-impressed pots in Cabecicos Negros (Vera) – and the distinctive characteristics of the type of occupation, indicate that the oldest phase of occupation took place during the Andalusian Early Neolithic. The socio-economic pattern is defined both by the exploitation of numerous resources in an area of variable size, and by the temporary occupation of settlements, with seasonal or periodical variations. This constant mobility was aimed at obtaining different subsistence goods, as well as obtaining and/or transforming primary resources for manufacturing crafts and exchanging excess production with communities in the same area or from other regions.*

IZVLEČEK – *Dolina reke Almanzora in kotlina Vera (Almería) kažeta veliko dinamiko poselitve v prazgodovini, še posebno med zgodnjim neolitikom in pozno bronasto dobo. Medsebojna povezanost različnih produkcij – vključno z navzočnostjo impresso-cardium keramike v Cabecicos Negros (Vera) – in jasne značilnosti tipa naselitve kažejo, da je najstarejša faza poselitve potekala v času andaluzijskega zgodnjega neolitika. Za družbeno-gospodarski vzorec sta značilna izkoriščanje številnih virov na različno velikih površinah ter začasna (sezonska oziroma periodična) poselitev naselbin. Namen stalne mobilnosti je bil pridobiti različne dobrine za preživetje in pridobiti oziroma predelati primarne vire za proizvodnjo izdelkov ter menjevanje viškov proizvodnje s skupnostmi na istem območju ali s skupnostmi iz drugih regij.*

KEY WORDS – *Andalusia; Neolithic; social interactions; palaeoeconomy*

When approaching the analysis of the dynamics of social formations in the context of Recent Prehistory in the so-called lowlands of southeast Iberia, one of the first problems is the tradition of the studies of E. and L. Siret and P. Flores and of the archaeological data recovered at the end of the 19th and beginnings of the 20th century. This documentation constitutes the fundamental empirical support for studies of settlement patterns in the region. It was basically interpreted from a traditional point of view as the result of the maritime movements of Mediterranean and other settlers.

We consider that the analysis of P. Bosch Gimpera (*1932; 1944; 1965; 1969*) in the 30's was the first important systematic study of the Neolithic and early

Chalcolithic societies in the region. He introduced concept of genesis of two communities in Western Andalusia – *Cultura de las Cuevas*, with a wide influence in the peninsular territory, and *Cultura de Almería*, restricted to the southeast, where the main centre was located. Within the five phases into which he divided the evolution of this culture, the first phase was defined by the social formations of the Final Neolithic, with its North African origin. The appearance of metallurgy was closely connected with *Cultura de los Millares* and its origin in the peninsular Neo-Eneolithic.

Nevertheless, as determining a period depends on the presence or absence of metals, the present discussion will focus on whether the *Cultura de Almería* corresponds to the last Neolithic phases societies or to the first Chalcolithic ones. In fact, throughout almost the whole of the 20th century, investigations were focused on explaining how to access this technological innovation, which was considered as the impulse for the process of complexity and hierarchy in these societies. In the area of the *Cultura de El Argar* there is an example of the climax of this process.

The resolution of this problem is imposed by each researcher's interpretation. If the pattern is diffusionism and colonialism, the *Cultura de Almería* will be considered as representative of the Ancient Chalcolithic; whereas, if the proposed pattern is an evolutionist-lineal one, it will be identified as a Neo-Eneolithic culture. And both of these interpretation patterns use almost exclusively the same empirical base: the archaeological evidence unearthed by E. and L. Siret.

From the 80's, new theoretical and methodological patterns replaced diffusionism. Approaches were focused on establishing which factors played a role in the configuration of such a complex society of the Southeast region beginning in the middle of the third millennium BC.

Therefore, there are three initial and closely interrelated problems to solve:

- The origin and the causes of the impulse for agricultural colonisation in the lowlands of Almería;
- The origins of metallurgy, their internal dynamics and their consequences through the development of each prehistoric period and;
- The importance of this southeast area in this whole transformation.

To solve these initial problems and, mainly that of agricultural colonisation, environmental characteristics have been taken as a first consideration. Traditionally, it was accepted that the environment had very similar characteristics to that of the present: an arid or semi-arid climate, with a deforested landscape and a very active erosive action (*Gilman and Thornes 1985*). Within this general framework, some authors have adopted an intermediate position. They agree with the existence of small oscillations, with a small increment in humidity during the second millennium, coinciding with the development of the Bronze Age. (*Walker 1985; 1986; Chapman 1991*, although this author in previous publications, 1978 and 1984, has defended the absence of significant climatic changes).

Lately, due to the available paleo-ecological evidence for this region, the situation has changed. The existence of a more humid climate during the Neolithic and the Copper Ages, with a vegetation climax quite well conserved during the Neolithic that would begin to suffer an important deterioration starting from advanced moments of the Copper Age (the period between the third to the second millennium BC) has now been highlighted. On the other hand, the presence of water courses was documented by the identification of ripisylvae species in settlements dating to the third millennium BC, like El Puente de Santa Bárbara (Huércal-Overa) and Los Millares (Santa Fé de Mondújar) (*Rodríguez Ariza 1992; 1996; Pantaleon Cano et al. 1996; Yll et al. 1995; Cámalich Massieu and Martín Socas (drt.) 1999*).

Nevertheless, we will defend different models for explaining at which moment the occupation takes place, as well as the interpretation of the strategies developed by these societies in the first periods of the Recent Prehistory of the peninsular Southeast. As we consider agricultural activity a priority factor in a subsistence lifestyle, the settlement choice will depend on soil and/or water resources. Thus a settlement and exploitation pattern of the territory focuses on the growing complexity of these social formations, starting from agricultural production or control of water resources.

On the other hand, the appropriate conditions for early agricultural colonisation in such a hard environment did not exist because of the absence of indispensable technological support. It is the reason this occupation was dated as subsequent to that of the more humid inland areas, as well as the western lands of Granada and Málaga (*Chapman 1978; 1991*). Consequently, the occupation of these lowlands of the peninsular Southeast took place at the end of the Neolithic. The *Cultura de Almería* has been again representative in this area of this chronological and cultural period, as the process of organizational complexity begins, coinciding in time with the first development of metallurgical activity.

Furthermore, to understand the surge of global change of third millenium social formations, most researchers have interpreted southeast Iberia as one of the central areas of activity. The representative settlements at Garcél and Purchena and the Cantoria necropolis of the Late Neolithic in the area feature simple circular or oval single-floored tombs. Since Siret's excavation at the beginning of the 20th century and after G. and V. Leisner's (*1943*) and P. Bosch Gimper's (*1969*) comprehensive studies, the Almizaraque site has been recognized as highly ranked in the early copper production in the region. Consequently, this interpretation clearly reflects the importance attributed to east Almería, and also to the gap in understanding of the processes of transformation, consolidation and evolution of the different social formations that took place during the sixth and second millenia BC, and, particularly, understanding when, how, and why this process began.

To answer all these questions Cámalich Massieu and Martín Socas (*1983; 1986*) presented in 1985 a research project on the development of social formations in late Prehistory in the Vera Basin and the valley of the Almanzora River (Fig. 1). It was carried out under the Junta de Andalusia's public convocation for regulating interventions on Archaeological Heritage. In fact, its aim was to analyse the transformation of the area from the beginnings of fishing and agricultural production to the development of social hierarchy in the Bronze Age (*Cámalich Massieu et al. 1993*).

Consequently, the general and priority aims were:

❶ To carry out a comprehensive study, including all the useful factors for debating its analysis and its general interpretations; and

❷ to determine how these factors take part in the configuration of this historical process.

The project develops from four types of field actions: 1 Study of territory; 2 stratigraphic surveys; 3 Systematic archaeological excavations; and, 4 Rescue interventions.

The development of the project was divided into successive phases, due to the aforementioned aims and its application over a large area. The first phase was focused on the area of the mouth of the Almanzora River, and covers all the area of the Vera Basin (Fig. 1), limited to the south by the Sierra de Cabrera, to the north by the Sierra of Almagrera y Almagro, and to the west by the municipality of Cantoria.

Work has been done on:

❶ Systematic excavation of the settlements of Campos and Zájara (Cuevas de Almanzora). The latter is still under study.

❷ Prospecting with stratigraphic surveys on the site of Cabecicos Negros-El Pajarraco (Vera).

❸ Rescue excavations on the sites of Puente de Santa Bárbara (Huércal-Overa), Las Pilas/Huerta Seca (Mojácar), and Cabecicos Negros (Vera).

❹ A study of a large part of the territory of the lowlands and midlands of the Almanzora River – with complements from the previous documentation and the later bibliography in 1985. It has permitted a detailed listing of more than 600 archaeological sites.

Regarding the results, the area of this study maintains an intense occupation dynamics during the different periods of Prehistory, from the middle of the sixth millennium BC until the end of the second millennium BC. This means, in the traditional scale of this area, the Middle Neolithic until the development

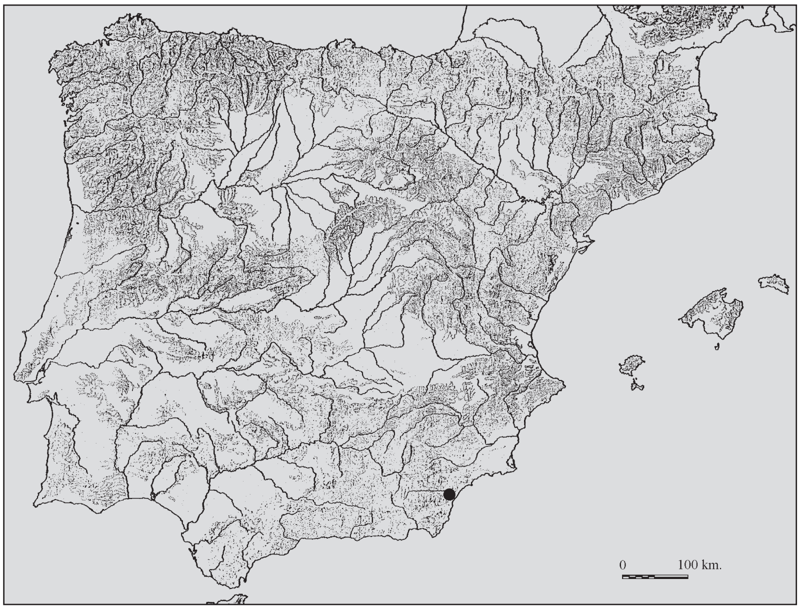

Fig. 1. Area of study.

of the Final Bronze Age, where its climactic moments would take place starting from the Copper Age. Consequently, the main characteristic of the dynamics of social formations is the continuity of settlement pattern in the territory. The modifications that took place in the development of this pattern can be explained by the search for a location according to the socio-political and economic conditions for each moment. Consequently, internal dynamics become the essential factor in the development of these communities.

Therefore, the oldest evidence in the prehistorical context is associated with the Neolithic, as the chrono-stratigraphic layers of the Andalusian central and eastern regions and radiometric datings from the Cerro Virtud show. However, the principal researchers defend the hypothesis that this context is correlated to the beginning of the process of metallurgical production in the southeast. Its development would have taken place, at least, from the mid sixth millennium until the end of the fifth and the beginning of the fourth millennium BC, in calibrated dates, between 6160 ± 180 BP (4120 BC) and 5300 ± 120 BP (3710 BC) (*Delibes de Castro and Montero 1997; Montero Ruiz and Ruiz Taboada 1996; Ruiz Taboada and Montero Ruiz 1999*).

In general, as is typical of other Andalusian areas, they are outdoor settlements of small dimensions. The small residence structures were probably built from perishable materials, evidencing seasonal occupation, also associated with river beds, elevations, or coastal sites and, exceptionally, caves or shelters.

It is necessary to highlight the results obtained in the first of our excavations of the villages of Zájara (1987 and 1990) and Cabecicos Negros (1991 and 2000) during the initial phase of the Project (*Cámalich Massieu and Martín Socas 1999; Goñi Quinteiro et al. 2003*).

The present location of Cabecicos Negros (Vera) is 20 m above sea level, on the left bank of the River Antas, and about 2 km from its outflow in the Mediterranean. In the Neolithic the site was located on the coast, as the results of the *Proyecto Costa* (*Arteaga and Hoffman 1987*) demonstrated. Thus, their immediate environment was a wide bay. It forms part of a group structured with the so-called El Pajarraco, although it is now divided by the Vera-Garrucha road. The two interventions, in 1991 and 2000, at this location were carried out in a special context because it was partially affected by the urban expansion plans of the Vera coastal area agricultural works. Consequently, the objectives were, besides elaborating a precise delimitation of the location, the realization of stratigraphic polls in the different sectors because the superficial archaeological survey identified a wide time-span for occupation over a large area.

The results obtained for the oldest period of occupation specify small settlement nuclei distributed on the six hills on the left bank of the Antas River and across the plain, which are a result of recurrent occupation of the same territory. Of the different excavation areas, the northeast hill site stands out because it helped to determine that this was a single occupation layer site. It allowed an analysis of the special topography of the hillside, which has a series of natural steps that could have been used for the grounding of small structures, built with stone and mud walls, with roofs made from vegetation, as the collapsed constructions indicates.

In these ceramic groups (Figs. 2; 3.1–4; 4.5–17), the most abundant are decorated in different techniques with a wide variety of ornamental motifs. Regarding the impressed ceramics, there is abundant cardial ceramic, as well as specimens obtained from other matrices or with a pointed tool, resulting in very different ornamental motifs that are either isolated or mixed with intertwined and grooved lines, both curved and rectilinear. The relief decorations are made with cords and most have impressions. It is necessary to equally highlight the presence, in some of these decorations, of engobe filled with red-coloured slips (*almagra*). There are different types of handles, with flattened or solid protuberances, but mainly spout-shaped. With respect to the form and size of these, analysis is limited because there are few complete reconstructions, due to the high degree of fragmentation and erosion. However, in some cases it has been possible to infer narrow borders, and necks of varied dimensions.

Among these ceramic records from *Cabecicos Negros*, the impressed cardial decorations stand out. This pottery corroborates the hypothesis that the characterisation of the Neolithic in this area correlated with the settlement process in the High Andalusia region and in the Central-Eastern coast. (*Cámalich Massieu and Martín Socas 1986*). In addition, these were open-air settlements, which again emphasises the importance of this occupation type rather than the traditional view of a preferential cave settlement.

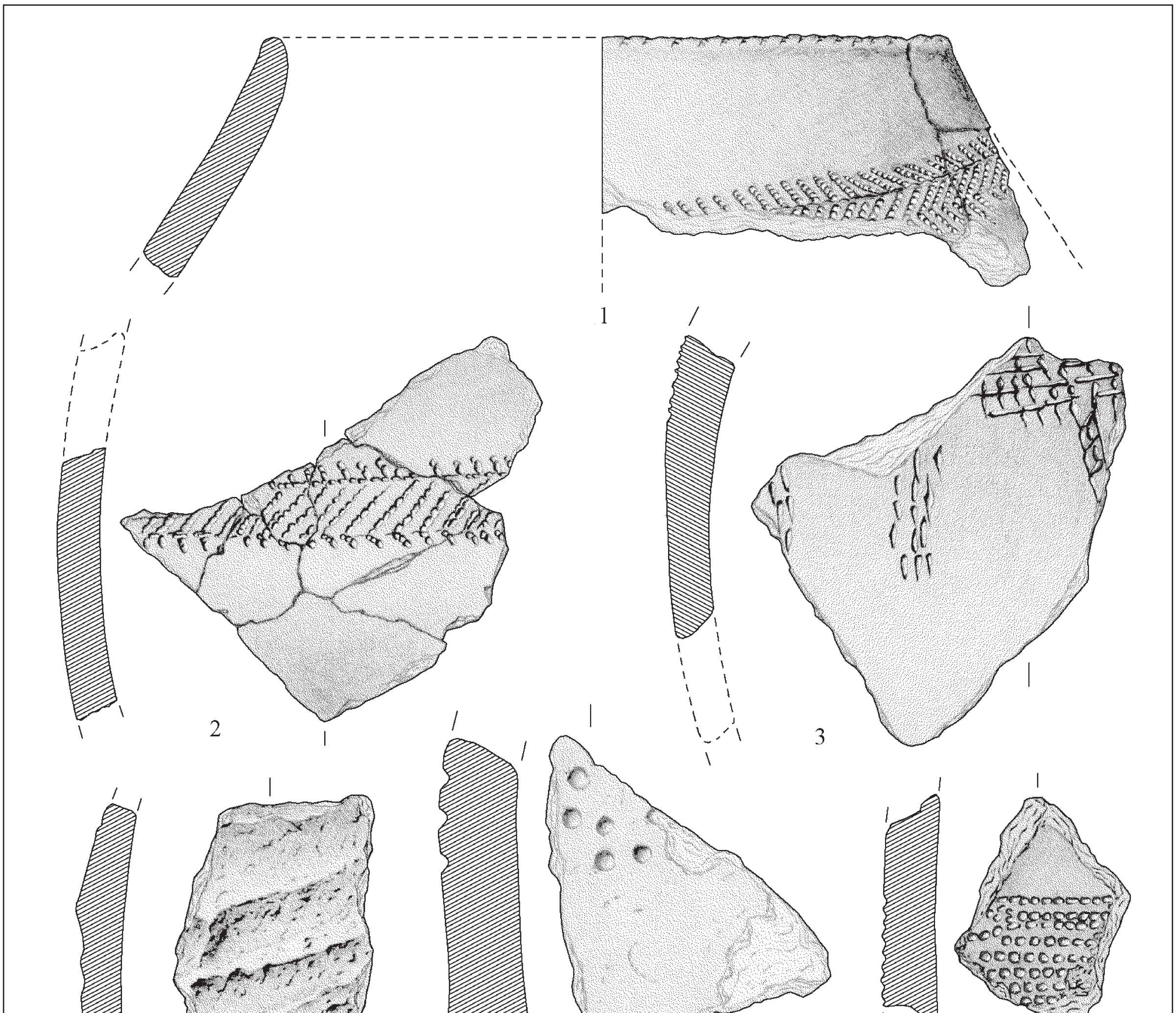

Fig. 2. Pottery. Cabecicos Negros.

Indeed, the presence of impressed cardial ceramics is not new in the Andalusian Neolithic, although its proportion in the general ceramic record is not the most abundant, as is the case in the peninsular Levant region, where cardial ceramics characterize the Early Neolithic. On the contrary, in the south of Iberia the cardial ceramics appear in the initial phases of the Andalusian Neolithic, coexisting with other impression types: the use of other matrices, such as the combed, pointed or blunt object decorations, and also those with relief cords, as well as incised and graffiti ceramics, and the characteristic use of *almagra*, either as a slip or to fill incised or impressed decorations.

Lithic production (*Martínez Fernández and Afonso Marrero 1999*) forms an important assemblage of more than 1300 pieces, of which almost half are semi-finished products from the manufacturing process, and where a considerable amount of lithic nuclei have been identified. Among these there are abundant flakes from local rock materials and from foraminiferous radiolarian siliceous rocks, whose origin is located in the Vélez region. As already mentioned, flakes are dominant (over 50% in Cabecicos Negros); therefore, considering that the flakes constitute 38% of the sub-products, this industry could qualify as a laminar manufacturing type.

The production techniques recorded are the same as those used in other areas of Andalusia, that is to say, by means of pressure on the previously heated nuclei, prismatic flakes are produced. The method may have been either direct or indirect percussion, although this is still not known (*Martínez Fernández and Afonso Marrero 1999*).

The traceological analysis carried out on the lithic production (*Rodríguez Rodríguez 1999*), has contributed information on different aspects of the manufacturing process itself and its role in everyday activities. Although a considerable part of the worked lithic material presents post-depositional alterations that hinder its study, a significant number of pieces still exists with use prints that testify to diverse types of activities in the settlement and its surroundings (*Goñi Quinteiro et al. 1999*) (Fig. 3.5–16).

The low percentage of lithic tools related to the acquisition of consumption products is outstanding. Only one piece was used as a sickle in cereal harvesting, whilst three geometrics were employed as projectile points, presumably in hunting activities. Meat processing and hide treatment are scarcely represented. The handicraft activities left a large quantity of artefacts, in which the transformation of diverse mineral materials stands out. Indeed, perforators, flakes and thin modified sheets, as well as unmodified flake products were used to perforate, saw, groove, scrape and, possibly, to crack marine shells and rocks of varying hardness, although soft materials such as slate stand out. It is seen that the presence of a significant quantity of personal ornaments elaborated from these same raw materials corroborates the importance that this craft must have had. This work was carried out with two types of tool: some very elaborate, such as the micro-perforators, and others of more expeditious manufacture, such as unmodified or slightly worked flakes and laminar sheets. In this latter group, there were also recycled pieces, as is the case of two micro-laminar nuclei which were used as scrapers. This dichotomy shows that the most complicated part in these production chains was, undoubtedly, the perforation process, which is also the case with the ornaments, many pendants being abandoned during manufacture due to perforation failures.

Leatherwork was also important at this site and, with the exception of leather which was worked when the hide was fresh – supposedly from a recently killed animal – most was done on dry leather that could be stored or brought from another place. However, the transformation of wood or bone has left scarce evidence in the analyzed material.

In this settlement, personal adornments had great relevance. They are mainly small discoid or elongated beads made from shells (Fig. 4.8–14), and a great variety of bracelets (Fig. 4.1–7), with different types, sizes and materials used, including local slate, and marble-like stones from the Almanzora River. We must stress that an important part of this group is in different stages of manufacture, which means that it had reached a very high degree of standardisation. It was the result of a very specialized activity directed towards trading surpluses at regional and interregional levels.

Polished stone tools are not very abundant, and consist of axes, adzes, and chisels, mainly of circular or oval cross-section, with simple bevel sharp ends, and grinding elements, used in food processing.

The bone tools also lack variety and, being mainly perforation implements, such as punches, that could be related to the leather works.

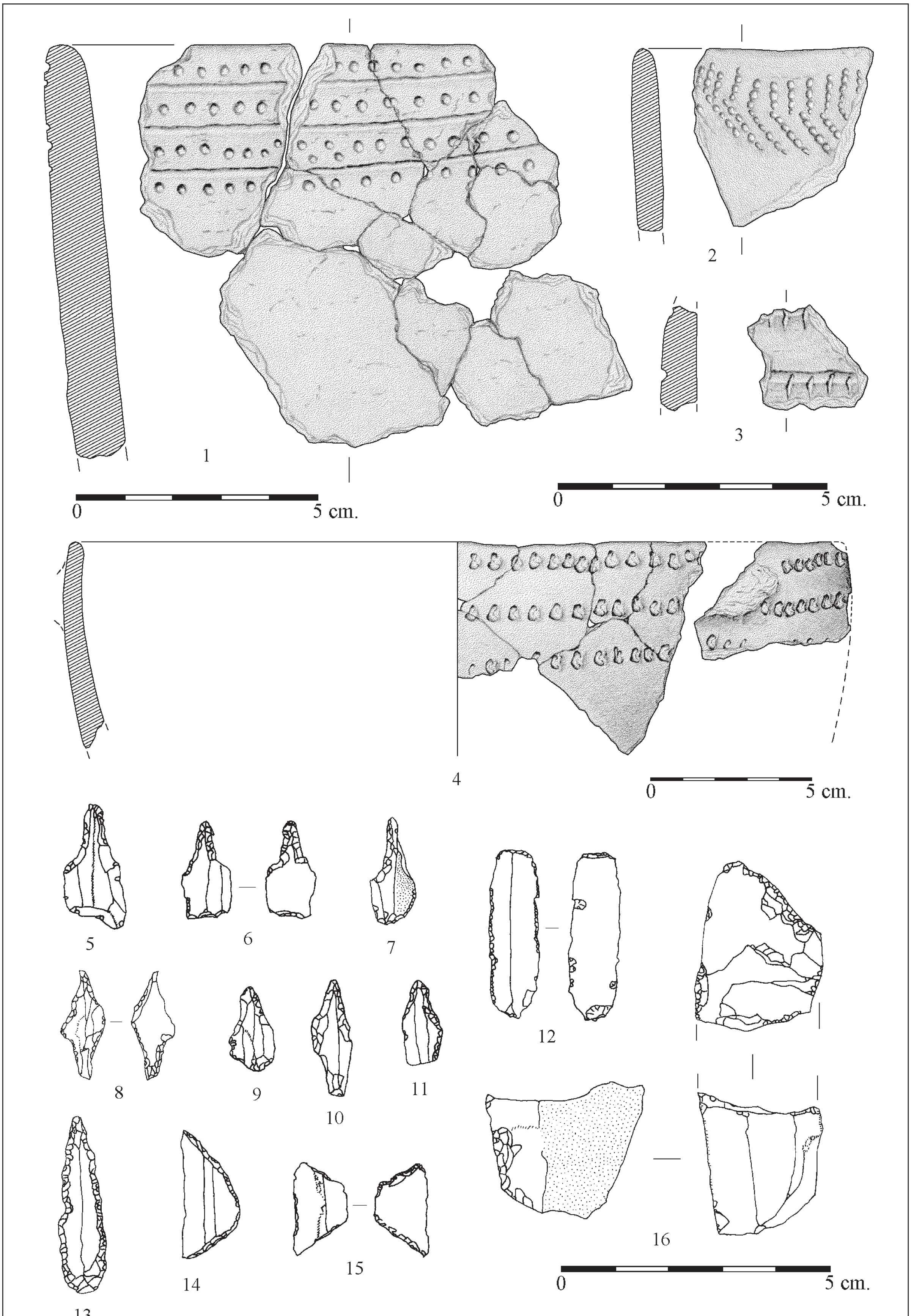

Fig. 3. Pottery and carved lithic productions. Cabecicos Negros.

Therefore, in the village of Cabecicos Negros certain surplus craft activities were carried out to the detriment of others more related to subsistence. This would imply that the community was integrated within a wider territory, where its inhabitants would be able to subsist, either by means of seasonal movements to exploitable areas, or from an exchange network of local products between communities.

In this context, the recurrent association of the various productions, where the presence of cardial ceramics in Cabecicos Negros should be highlighted, supports the hypothesis of an occupation of the Almerían lowlands since the oldest phases of the Neolithic. This corresponds to findings from other Western Andalusia locations such as the cave of Carigüela (Piñar, Granada), the site of Las Majolicas (Alfacar, Granada), the caves of Malalmuerzo (Moclín, Granada), and Los Murciélagos (Zuheros, Córdoba), or occupation Phase I of the site at Los Castillejos (Montefrío, Granada) (*Martín Socas et al.1998*). On the other hand, the date proposed for these moments coincides with the last chronologies contributed by Cerro Virtud (Cuevas del Almanzora) that, as already pointed out, date the Neolithic occupation of this village to the second half of the sixth millennium and throughout the fifth millennium BC, calibrated date (*Ruiz Taboada and Montero Ruiz 1999*).

Consequently, the traditional interpretation of the beginnings of production in this area, in which the first cohesive population structure would correspond to the Late Neolithic and would be in some way associated with the *Cultura of Almería* (*Fernández Miranda et al. 1993*), cannot be accepted.

Regarding the site of Zájara, located on an elevated plateau at the convergence of the River Almanzora and the Alifraga ravine, at 111m. above sea level, its study has added fundamental information with respect to the general aims of the project. Apart from the clearly particular characteristics of the Copper Age settlements, the presence of a Neolithic occupation could be inferred, thanks to information from materials deposited in the National Archaeological Museum which came from one of the caves excavated by L. Siret, as well as those on the higher sector of the plateau.

Indeed, this possible occupation, prior to the development of the initial phases of the metallurgy, is the one that we are interested in highlighting in this work, was documented during the 1990 excavation campaign. There was a pit, with a large ceramic receptacle (approximate capacity 38 litres) inside, located in the central area of the plateau. The pot has been identified as a water container, with an ellipsoid body, a slightly conical bottom, three flattened handles with double perforations distributed regularly around the body, and a cylindrical neck. Its mouth was level with the floor and it had been covered by a fragment corresponding to the paunch of another ware, of equally large dimensions, that had impressed cords as a relief decoration. Inside the pot, there was another receptacle of smaller dimensions (approximate capacity, 1 litre). This group, from its technological, formal and ornamental characteristics is indicative of the Neolithic occupation of the site whose intensity cannot yet be evaluated, since work at this location is continuing.

A series of large excavated structures stand out and, given their construction and morphological features, as well as to the identification inside the only partially registered one of a domestic combustion structure, they were shelters with very similar characteristics to those documented in various sites of the valley of the Guadalquivir, in the final stages of the fourth and beginnings of the third millennia BC. Such is the case, among others, of the Polideportivo de Martos (Jaén) (*Cámara Serrano and Lizcano Prestel 1996; Lizcano Prestel 1999*). Here, we must point out that almost 150 pits at the El Garcél settlement described in P. Flores' field notebooks could be linked to this function.

In consequence, the current documentation available from the structures and the identified evidence allow us to date the beginnings of the occupation of Zájara to the Middle and Late Neolithic.

Taking into account the data we have for the low valley area of the Almanzora River and Vera Basin, the Neolithic settlements of Los Cabecicos Negros, as well as the village of Zájara can not be isolated phenomena. They are indeed clearly correlated both with the general characteristics of the settlement type and with the different groups of materials also observed in other well-known sites in the area (Fig. 5). Consequently, we can indicate that there were two fundamental types of settlement located in elevated sites. The first is recognized as a small hill settlement, close to streams, river mouths and ancient coastlines (*Arteaga and Hoffman 1987; Schubart et al. 1988*). This type of settlement could be represented by villages like Almizaraque on the Almanzora River, Cabecicos, Negros-Pajarraco in the Antas, and La Isleta, or the Loma del Campo in the basin of

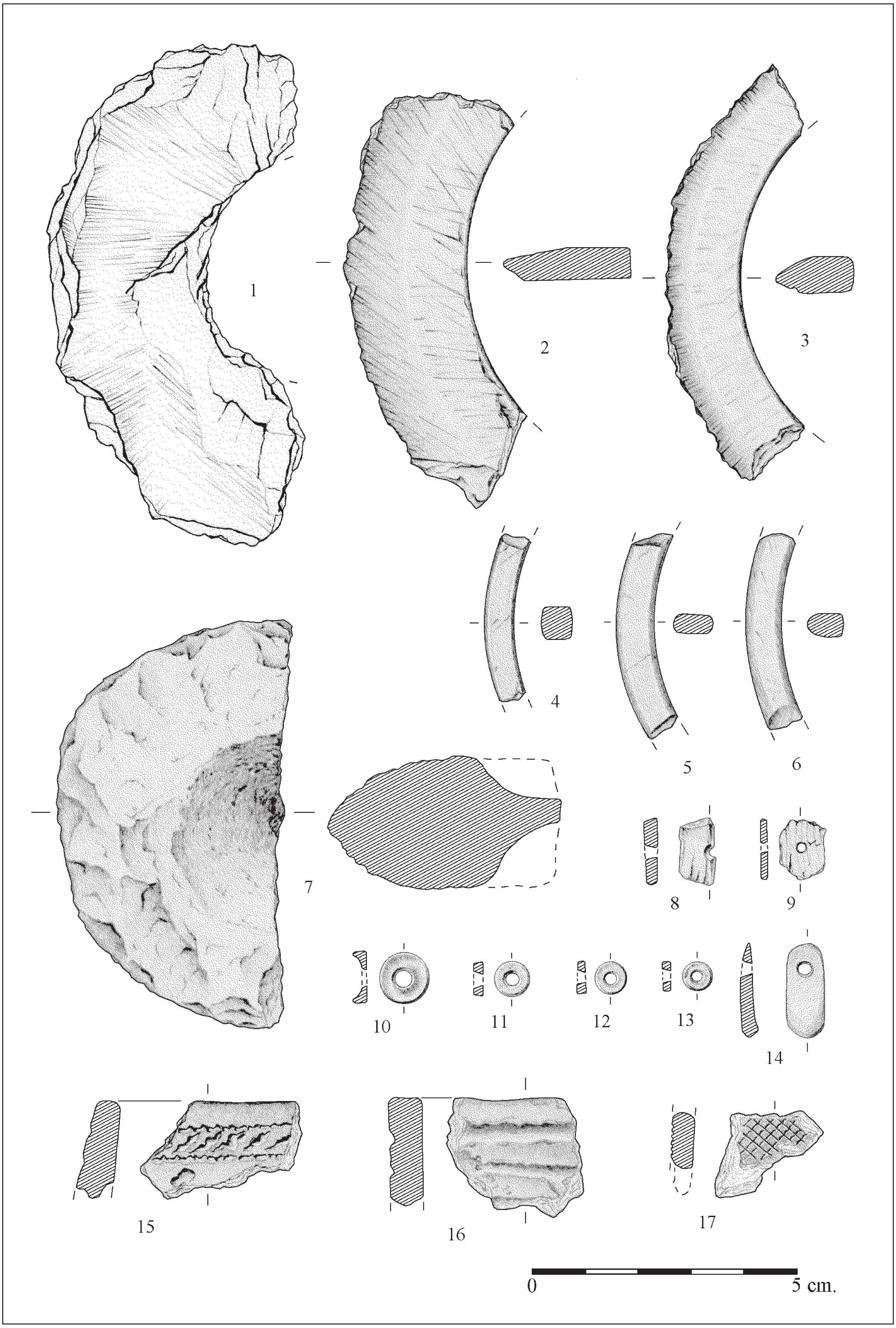

Fig. 4. Lithic personal ornaments and pottery products. Cabecicos Negros.

the Aguas River (Fig. 5. Nos. 147, 155 and 19 (respectively), 58, 52). At the same time, there was a second type of settlement on elevated sites, such as single hill-tops which dominated basal areas, whose occupation in some cases continued during the Late Neolithic. Some examples of this type of habitat are: El Peñascal, Cerro Virtud, Zájara, Raja Ortega, Cuartillas, Moro Manco, Cerro Guevara, Cerro del Cortijo de Gatas and, probably Cerro María and Cerro del Espíritu Santo (Fig. 5. Nos. 347, 146, 144, 66, 42, 26, 62, 34, 7 and 163). After this period, an intense period of Late Roman and Hispanic-Muslim occupation can be identified. The main characteristic was the interrelationship between these different and separated settlements by visual oversight of the whole basin, which meant considerable control over this extensive area.

In the high and middle basins of the Almanzora River, the open-air settlements are situated in the mountain areas of the Sierras de Filabres or of Las Estancias, such as La Cerrá, Macael or Partaloa. Others, like El Palo or El Castillico de Cobdar, are cave settlements (Fig. 5. Nos. 371, 620, 136). All of them, including Los Cabecicos Negros, have a very defined and representative group of materials belonging to the Neolithic of southern Iberia. This evidence coincides with results obtained in settlements with wide stratigraphic layers, such as the caves of Carigüela (Granada), Nerja (Málaga), El Toro (Málaga), or Los Murciélagos (Córdoba) (*Martín Socas et al. 1998*).

In relation to what has been said, the socio-economic formation was based on the exploitation of the environment through itinerant occupation of territory variable size, which depended on the communities and the seasons. Consequently, this seasonality or periodicity allowed for the acquisition of various resources through a strong tendency to move and to set up seasonal settlements. Therefore, these were small, and aimed at obtaining subsistence goods as well as towards the transformation/exploitation of raw materials for the production of handicraft surpluses which were traded with other communities in the same area or from other regions. This would largely explain why the archaeological evidence indicates a large number of manufacturing crafts from local raw materials. It could also explain, in the case of Cabecicos Negros, the presence of a single tool for the harvesting of cereals. It is also true that we chose

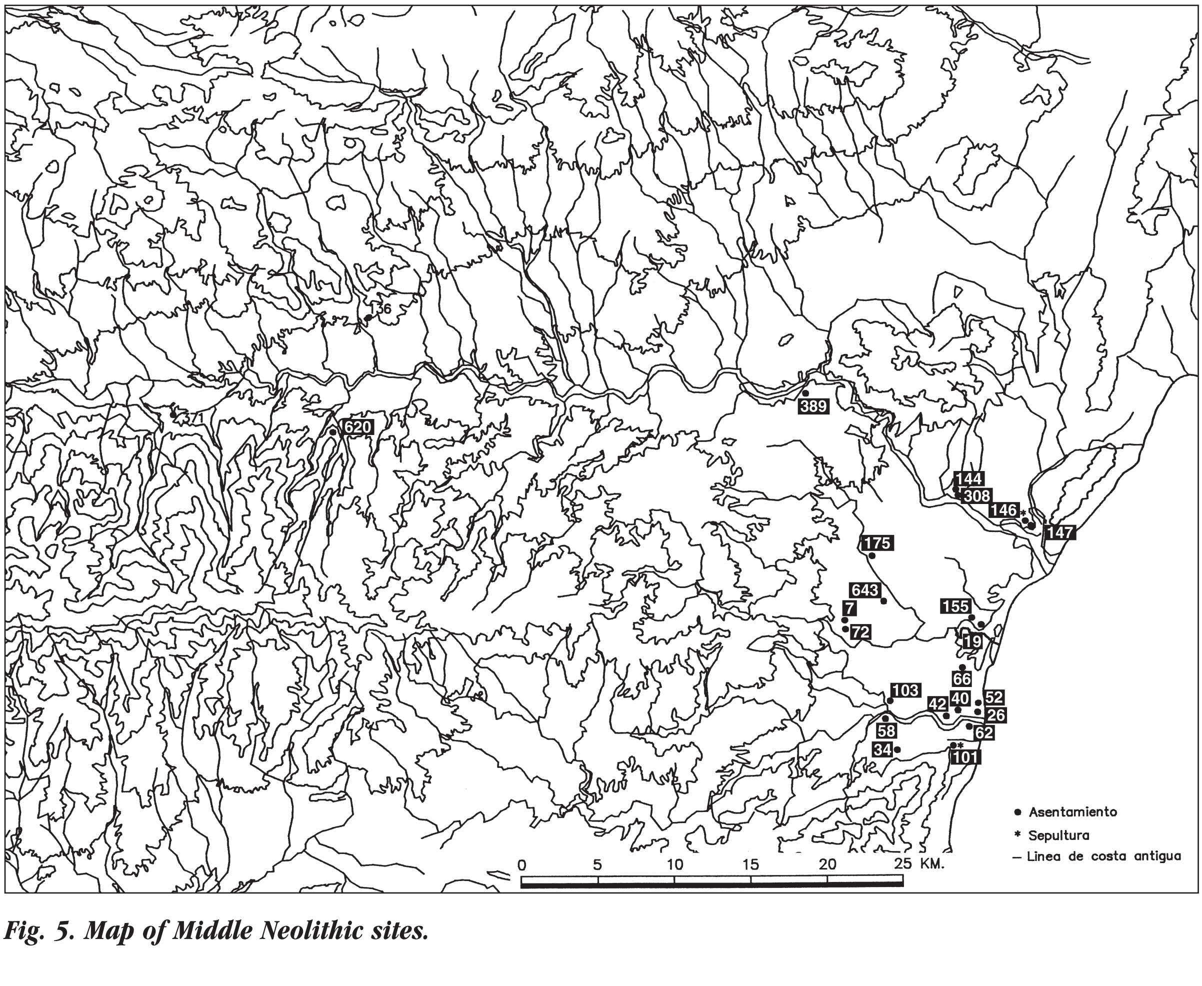

Fig. 5. Map of Middle Neolithic sites.

the agricultural factor as the priority element in the hypothesis to understand the first Neolithic occupation (*Fernández Miranda et al. 1993*), as well as its being the cause of the transformation process towards the complexity of later social formations in this large area. In this context, we would have to use the terms "agricultural colonisation or intensification". A good example is the Neolithic village at the Polideportivo of Martos (Jaén)[1].

Therefore, the traditional importance assigned to the agricultural variable in these communities does not seem to correspond to all the findings, which, in turn, has meant that its systematic and mechanical application has generated in some recent research work a strong rejection of the evidence of such an old settlement in the Alto de Almanzora. The weight of this reasoning is based on strong natural or anthropic erosion that would have affected the elevated areas chosen by these communities (*Román Díaz et al. 1996; Román Díaz and Martínez Padilla 1999*). This assumes a certain occupation pattern based on a reduction in farming.

Nevertheless, there must be initiated/completed further studies on these various activities in order to gain knowledge on the development of these social formations. Moreover, both the existent relationship between them and the dynamics of the trade exchanges and how these would influence the transformation processes, especially during the Final Neolithic, could be identified.

Gradually, it is observed how the aggregation and settlement processes were established at this period through the appearance of excavated living and storage structures, the *silos*, increasing the stability of occupation, and the exploitation of the territory. Parallel to the settlement process and, consequently, that of land appropriation, the normalised independent burial zones become reinforced as a result of the wider and deeper structuring and organisation process of these social formations.

The final phase of the Neolithic, which in many aspects is undistinguished from what has become known as an Early Copper Age and determined by the presence of metallurgical evidence, consolidates this mechanism of doubling of settlements – that is, neighbouring sites were closely interconnected – and, the demographic pattern as seen in the previous phases (Fig. 6). Thus, together with the continuity of some of the previous occupational nuclei such as Cerro María, Cuartillas, Loma del Campo, Zájara, Cerro Virtud, Almizaraque, and Cueva de Zájara, there were some settlements on elevated plateaux over the fluvial bed (Fig. 6. Nos. 7, 42, 52, 144, 146, 147 and 308). These sites had more useful horizontal surface areas for the construction of semi-excavated rooms that, on occasion, had a central post, as well as storage structures, *silos*, which probably had different uses, as could have been the case with water containers. The aforementioned villages, as well as the Tres Cabezos, La Torrecica-Cortijo Soler, El Arteal, and those already mentioned at El Garcel, Zájara, and Las Pilas/Huerta Seca, in the Vera Basin – which coexisted with high dominant sites – and the Muela del Ajo or Cañada del Herrero – in the middle and high basins of the Almanzora – are good examples of these dynamics (Fig. 6. Nos. 159, 298, 100, 179, 595 and 596, 372 and 402).

Consequently, larger communities were established in diverse environments, spanning various biotopes, and with a pattern that implies a strong relationship between them, possibly depending on a work force that integrated into larger units. At the same time, a process of social dissymmetry and of a differentiated appropriation of subsistence or non-subsistence goods developed. Even though the smallest groups were self-sufficient in order to cover basic necessities, this cannot be considered a general rule, because they could not have been so in all aspects: firstly, obtaining certain primary resources; secondly, the possibility of guaranteeing the whole production cycle of animal and agricultural products in the event of failure or accident; and thirdly, the fact that they would have been too far from the main route connections which would facilitate access to the valley, where the main sites were located. In consequence, the dynamics of power structures would have consolidated in the Copper Age.

At present, it is difficult to obtain a correct chronological and evolutionary sequence of the Copper Age in the region, although the research in the last few years has contributed very outstanding data. The hypothesis is that, with the beginning of settlement and the political delimitation of the territory – in parcels smaller than those inferred for the previous

1 "...demonstrates that the settlement nuclearisation process at the beginning of the third millenium was not unilineal and could be explained by other models in which agriculture is not the main factor in changes in the relationship between production and social formations" (*Cámara Serrano and Lizcano Prestel 1996*).

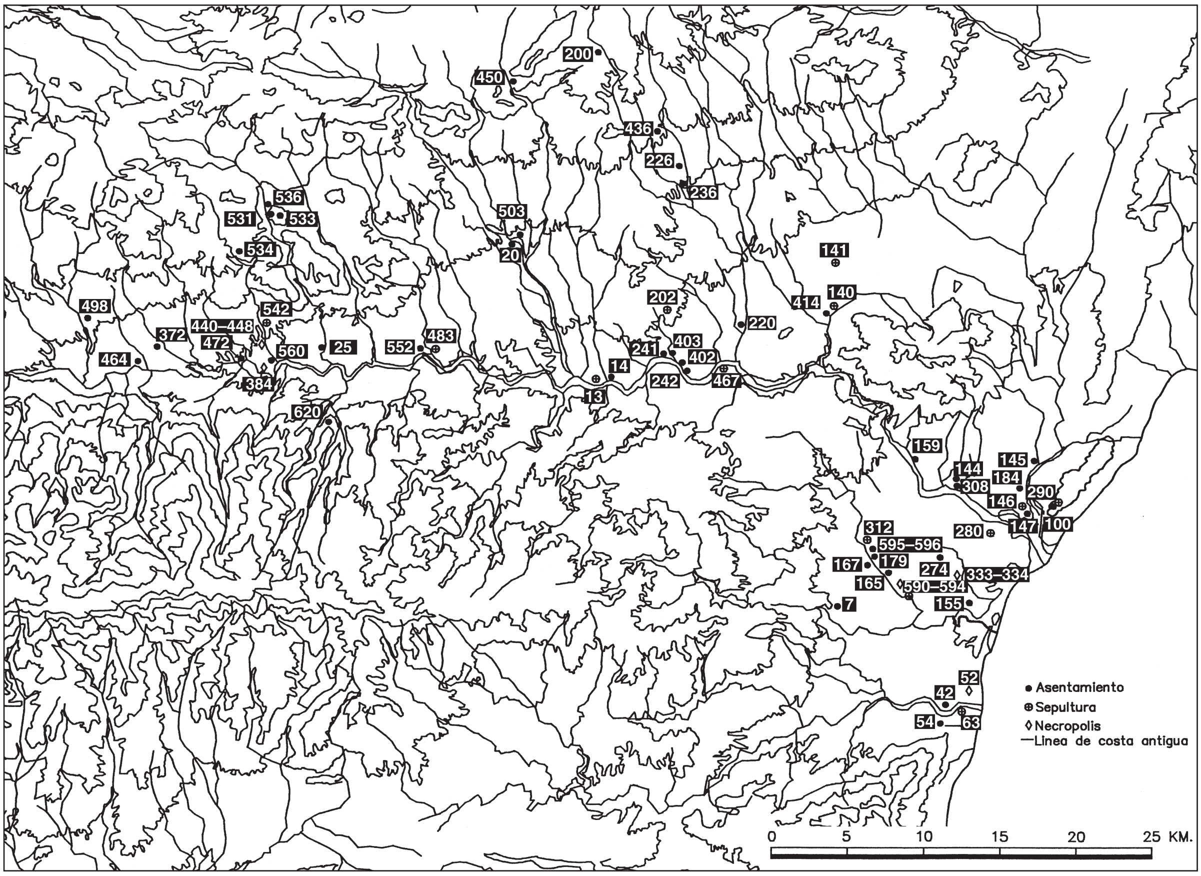

Fig. 6. Map of Late Neolithic/Early Copper Age sites.

phase – there would be continuity in the exploitation pattern. However, it seems that now the river courses of the Almanzora, Antas, and Aguas, would have become the axes of new settlement patterns. These were characterized by larger settlements, with funerary zones of concentrated burial structures, which symbolise centralisation and land ownership, as well as by a series of interdependent and complementary villages. This model would be represented in the Vera Basin by LasPilas/Huerta Seca site which, with the village of Cuartillas, has the associated sepulchres of the Las Lomas del Campo and of El Cerro de la Mata, located at the outlet of the River Aguas (Fig. 6. Nos. 54, 42, 52, 63). In the area of Antas, the pattern would be the group of El Garcel, with which the villages of Las Ramiras and Alto de la Cañada del Cura are related, together with the sepultures of the Lomo de la Rutilla and the La Pernera-1 (Fig. 6. Nos. 179, 595 and 596, 165, 167, 590-594, 312). In the lower basin and outlet of the River Almanzora, Almizaraque is the most important site, with which the site and the burials sites of Cerro Virtud, the village and the cave of Zajara, Tres Cabezos, La Torrecica-Cortijo Soler, Los Sifones, and the tomb of El Arteal are associated (Fig. 6. Nos. 147, 146, 144 and 308, 159, 184, 145, 290)

In the middle and high river basin there would have been, on the one hand, the Llano de los Pedregales/Casablanca, with which the sepulchre of the Cabezo de la Copa is associated, as well as the villages of La Quinta, Terrera Alcaina and El Llano de las Ánimas-3, that control access from the high areas of the Sierra de Las Estancias toward this sector of the Valley (Fig. 6. Nos. 14, 13, 236, 20, 503). On the other hand, there was the Churuletas group, which included the village of the Cerro de los Navíos, and the associated necropolis of El Llano de Turuletes/Churuletas, of Llano de la Lámpara/Loma de la Estación, and of Loma de la Jocalla/Cortijo Jocalla (Fig. 6. Nos. 560, 440-448, 420-421, 424-425).

These settlement and centralisation processes in the study area could be partly related to the development of new agricultural and pastoral techniques, which tended towards the restriction of the movement of large livestock, and to the practice of transhumance of ovicaprine flocks. R. Buxó (*1997*) in his study of the cave de El Toro (Málaga) points out that the differences in the agricultural activities inferred from the carpological remains for the Middle and Late Neolithic indicate an evolution from a primitive agriculture to a more evolved one. This is shown, in the higher layers of the Late Neolithic in the south-eastern region, by the change of frequencies of naked barley and bean that seem to point out a pattern of alternating exploitation of the two cultivated species. This agricultural model, observable in Toro from the Late Neolithic, is based on the use of cereals and leguminous crops, which implies that the cultivable land was stable (*Martín Socas et al. 1999; 2004*). This fact, together with other factors such as demography, production and organization during the end of the Late Neolithic/Early Copper Age, consolidated a system of dependent relationships between social groups, which would distinguish the political connections of the Copper Age in the area. Therefore, it can be said that the process of development was long and that this process of change was characterized by a convergence of multiple factors of different nature. The acquisition and transformation of different products not exclusively used for agricultural production acquire an important role in this change. We have to admit that data on this whole process is incomplete, although we must not forget that these studies – particularly the significant excavation at Las Pilas/Huerta Seca – have shed more light on the final periods of the Neolithic and its connection with the beginnings and the development of the Copper Age (*Cámalich Massieu and Martín Socas 1999*).

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Documenta Praehistorica XXXI

Usewear analysis of Mesolithic and Neolithic stone tools from Mala Triglavca, Trhlovca and Pupičina peć

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ABSTRACT – *In this paper the results of the usewear analysis of Mesolithic and Neolithic stone tools from three cave sites – Mala Triglavca and Trhlovca in the Slovenian Karst and Pupičina peć in Croatian Istra will be presented. Stone tools were examined under the light microscope at 50 – 200 x magnifications, and some additional physical and chemical analyses were undertaken. Various uses of the tools were determined and conclusions regarding the economies at those sites were drawn.*

IZVLEČEK – *V članku predstavljamo rezultate preiskav sledi uporabe na mezolitskih in neolitskih kamenih orodjih iz treh jamskih najdišč, Mala Triglavca, Trhlovca in Pupičina peć. Orodja smo preiskali pod mikroskopom pri povečavah 50- do 200-krat. Naredili smo tudi fizikalno-kemijske analize. Določili smo različne načine uporabe, povezane z različnimi paleogospodarstvi.*

KEY WORDS – *usewear; stone tools; Mesolithic; Neolithic*

METHOD

There are two kinds of usewear traces on stone tools: flaking of the working edges and polishes, which appear on the working edge, but can also extend further over the surface. The most important property of the polish is its increased brightness compared to the surrounding surface. The polish has other features which enable us to identify the material that caused its formation. Flaking is the direct result of mechanical pressure, while the physical and chemical formation of polish is not successfully explained yet.

The most common method for the analysis of usewear traces is optical investigation under a microscope with incident light at 50–600 x magnifications. The stone tools from Mala Triglavca, Trhlovca, and Pupičina peć were examined at 50–200 x magnifications, and some additional physical and chemical analyses were undertaken.

In collaboration with the Jozef Stefan Institute in Ljubljana a trace element analysis of the working edge was done with the PIXE (proton induced X-ray emission) method. Most of the results have already been published (*Šmit et al. 1996; Petru 1997*); here I will present the results of the microbeam PIXE mapping technique, which was done at the University of Oxford and at the R. Bošković institute in Zagreb.

The analysis was carried out on some experimental tools and on three end-scrapers, and one flake from the Mesolithic layers of Mala Triglavca. The results of the analysis of the deposit on experimental tools were similar to those in previous research (*Šmit et al. 1996; Petru 1997*).

In the deposit on the working edges of two end-scrapers and the flake from Mala Triglavca, sulphur, potassium and calcium were the most important elements (Fig. 1). Such a combination of elements in the deposit can be connected with the scraping of hide (*Šmit et al. 1999*).

On one of the end-scrapers, there was also a point where phosphorous was present together with calcium. Their ratio was close to the value found in the deposit on experimental stone tools used for bone working, so it was conclused that this tool was used for butchering rather than for scraping.

On the working edge of the third end-scraper the most important elements were phosphorous and calcium. Their ratio was similar to the ratio of these elements in bone tissue (*Šmit et al. 1999*), so the end-scraper was probably used for some sort of bone fashioning (Fig. 2).

In collaboration with the Institute of Chemistry in Ljubljana, an Infra Red Spectroscopy of macroscopically detected organic residue on one of the stone tools from Trhlovca was made (Fig. 3). At first, the presumption was that the residue might be wax or some other glue used for fastening the blade to a haft. The analysis of the residue indicated that our presumption was wrong. The residue was a mixture of inorganic and organic components. It was not possible to fully identify the organic fracture, but it was composed of stereates which originated from some sort of plant oil or animal fat. The inorganic fracture represented the sediment in which the tool was buried.

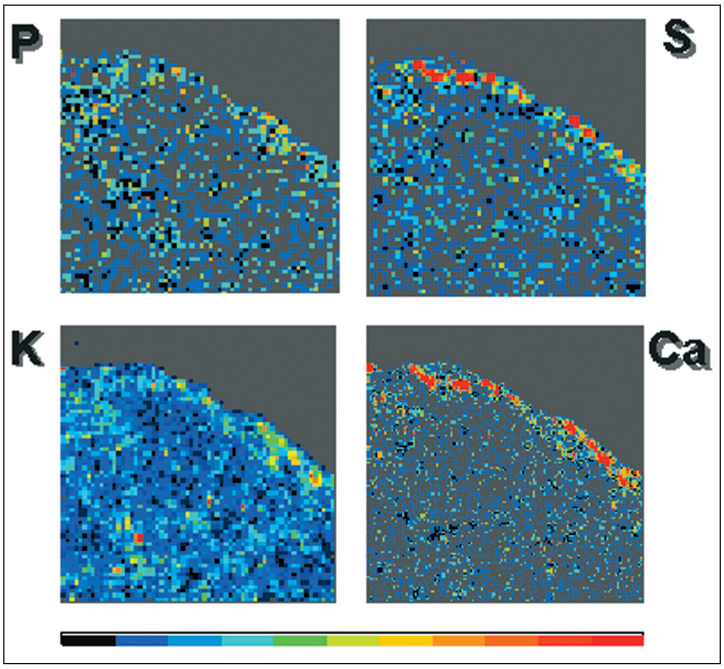

Fig. 1. Elemental mapping on the working edge of the end-scraper from Mala Triglavca (MT 8), used for hide scraping. Size of the examined area is 1.2 x 1.2 mm.

MALA TRIGLAVCA

At Mala Triglavca, below the younger layers, there was 1m thick prehistoric complex in which neolithic pottery and stone and bone tools were found. The bones of domesticated animals were mixed with the bones of wild animals. Next to the cave wall fragments of a human skull were found. Beneath this complex lie the oldest holocene layers, with Mesolithic microlitics. Antler and bone tools were also present (*Leben 1988.69–71*).

Mesolithic

Analysis of the usewear on Mesolithic stone tools from Mala Triglavca indicates that the most important activity was hunting. Projectile tools and tools for processing animal remains (meat cutting, hide working) prevail in this complex. (Fig. 4).

There was a lot of hide working usewear on the Mesolithic end-scrapers and also on other stone tools from Mala Triglavca. Less important was wood working – they probably used tools for making the wooden handles for projectiles. It is notable that there were many antler and

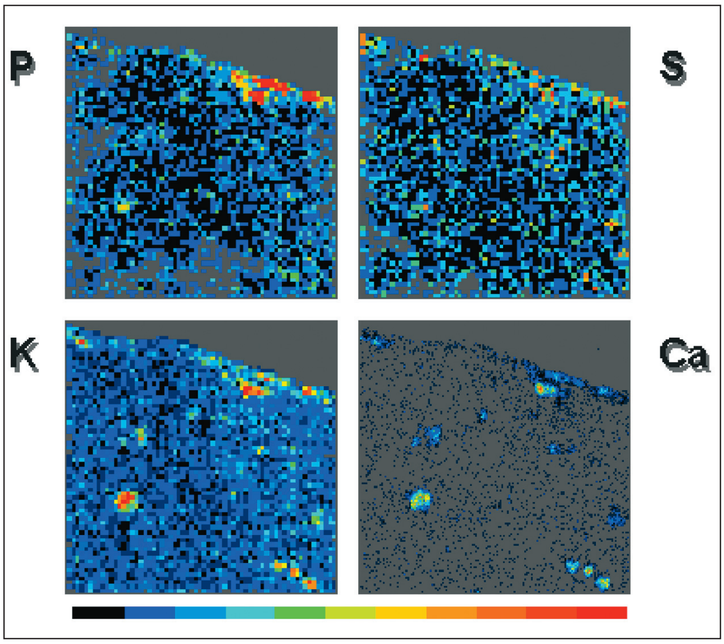

Fig. 2. Elemental mapping on the working edge of the end-scraper from Mala Triglavca (MT 15), used on bone. Size of the examined area is 1.2 x 1.2 mm.

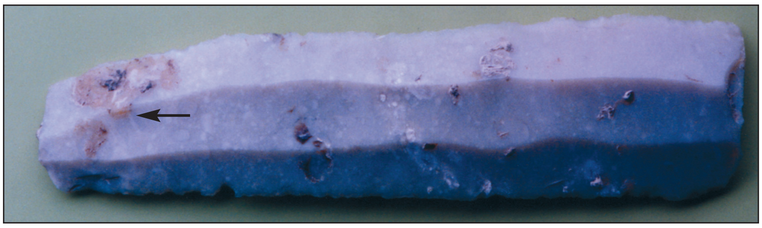

Fig. 3. Trhlovca – macroscopic residue on the blade.

bone tools in the Mesolithic layers (*Leben 1988.71*), while just a small number of accompanying stone tools was used for working bone.

Damage on the trapeses is characteristic of projectile points, while microburins were not merely unused byproducts of geometric tool manufacture, but were intensively used, since there are a lot of striations and microflaking present. One tool might even be a projectile point. Flakes were intensively used for different tasks. The mode of their use depended on the form of the working edge of the flake (*Petru 1997. 84, 85*).

Neolithic

In the Neolithic the increase in the number of the tools used for plant and wood working reflects the appearance of new activities at the site (Fig. 4), one of which could have been the cutting of trees and creating clearings for herding and pasture. The tools from Mala Triglavca are large enough to be used as axes. Pollen analysis confirms that during the Neolithic in the Karst region, clearings were made for pasture (*Culiberg 1995.204*). Human influence on plants is also known from the Karst site at Podmol pri Kastelcu (*Turk et al. 1993.70*).

There are not enough stone tools in Mala Triglavca to indicate long occupation during the Neolithic. The site was probably a temporary shelter for herders and their animals, while they exploited pasture in the vicinity of the cave. This is confirmed by the bones of domesticated animals in the Neolithic layers. The occupants of the cave sustained themselves with mostly by hunting, since wild animals bones exceed those of domesticates (*Leben 1988.70*). Tools for processing animal remains are rare. There are two possible explanations for this – the site was not occupied long enough for such activities to be accomplished or the herders took most of the stone tools with them when they left the site.

In Northern Italy Neolithic stone tools with a sickle gloss were found together with tools used for wood working (*Biagi and Voytek 1992. 275–276; Biagi et al. 1993.63*). Since herders needed grass for winter supplies for their animals, sickles can be related also to herding, not only to cultivation.

Sickle gloss appears on one of the blades from Mala Triglavca. This blade was found in the highest part of the Neolithic complex with some bronze age pottery, and it is possible that it is not Neolithic, but younger. This coincides with the pollen analysis, since the first cereal pollen in the Karst region is known from the Eneolithic *(Turk et al. 1993.71*). Even if the blade is Neolithic, this single find indicates that agriculture had just started at that time and was far from being a well established practise. The blade is made from very good material which is not known locally, so it is also possible, that it was used as a sickle elsewhere and the herders bought it to Mala Triglavca.

There is a huge difference in the numbers of Mesolithic and Neolithic stone tools found at Mala Triglavca. While in the Mesolithic layers more than 800 stone tools were found, there were just 16 in the Neolithic layers. The raw material had also changed. In the Mesolithic, local chert was used, whereas the Neolithic stone tools were made mostly from much better chert not known locally. In the Mesolithic there is a lot of unused flakes and a lot of by-products of flaking, while in the Neolithic almost all the

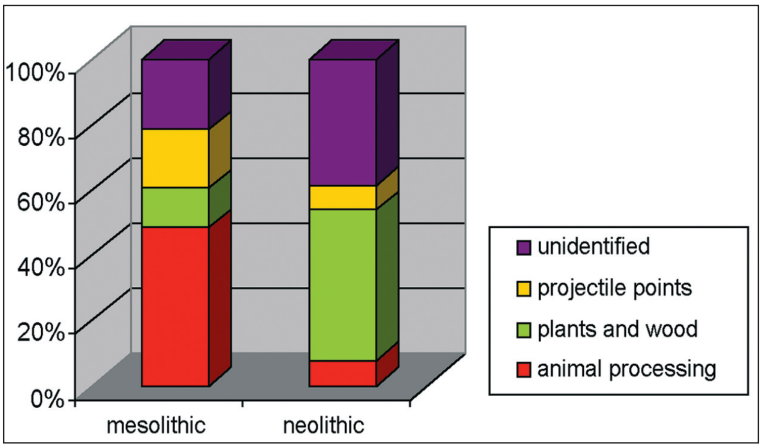

Fig. 4. Mala Triglavca – usewear results for Mesolithic and Neolithic stone tools.

stone artefacts have usewear. One possible explanation is that since the Neolithic tools are of imported chert, people tried to make as much use of them as possible. Since herdsmen did not stay in cave for long, they also had little time for the production of new tools.

The activities were also different – while in the Mesolithic, Mala Triglavca was a typical hunting site, occupied long enough to process animal remains and manufacture stone tools, in the Neolithic site was used by herders for short periods during their seasonal movements. While in the Mesolithic the tools were used for hunting and processing animal remains, the Neolithic saw new activities, probably connected to herding, which can be detected from the stone tools.

TRHLOVCA

In Trhlovca, the Neolithic layers were covered by younger ones, dating from prehistory up to the modern era. In the Neolithic layers F, G and H, pottery, stone and bone tools were found with the bones of wild and domesticated animals, with wild species prevailing (*Leben 1988.69*).

There is a similar amount of processing of animal remains and of plant working usewear on the stone tools from the Neolithic layers (Fig. 5). The number of tools used for woodworking is a little bit lower than in Mala Triglavca, but it is still possible to connect them with tree cutting and making clearings for pasture, since the presence of herdsman is confirmed by the bones of domesticated animals (*Leben 1988.69*). They were hunters also, because a projectile point and wild animal bones were found in the Neolithic context. Similar conditions are known from North Italian sites, where subsistence strategy was based on the hunting of wild animals and the rearing of domesticates (*Biaggi et al. 1993. 58*). No signs of cereal harvesting were found on the stone tools from this period, but two tools from succeeding Eneolithic layers have sickle gloss. Since cereal pollen is known from the Eneolithic layers at the Karst site of Podmol pri Kastelcu (*Turk et al. 1993 .71*), it is possible that at that time cereals were raised somewhere in the vicinity of Trhlovca.

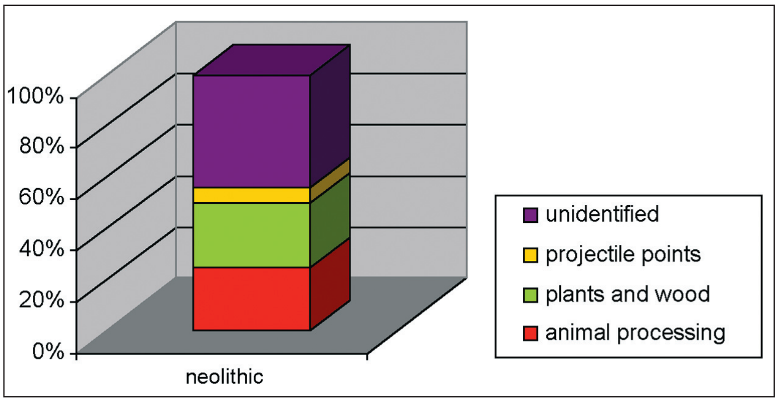

Fig. 5. Trhlovca – usewear results for Neolithic stone tools.

The small number of stone tools and the absence of flaking by-products in the Neolithic layers may indicate that visitors to the cave brought most of their tools with them and that the site was temporary – inhabited by nomadic herders for s short period or periods of time. Later, in the Eneolithic, when signs of agriculture are already present, Trhlovca might have been a pen for domesticates. Since the first domesticates in this area are known from late Mesolithic contexts (*Budja 1996.73, 74*), it is possible that the tradition of herding, which started in the late Mesolithic, continued and was intensified in the Neolithic and later periods.

PUPIČINA PEĆ

Pupičina peć is located in the Vranjska Draga canyon beneath Mt Učka in Croatian Istria. The cave was settled from the Paleolithic onwards. An analysis of usewear on stone tools from the Neolithic and Mesolithic layers was carried out.

Mesolithic

In the Mesolithic, stone tools were used for hunting and the processing of animal remains. Hunting as the main activity is confirmed by the presence of projectile points among the stone tools and also by the bones of wild animals found at the site. Plant and wood working usewear was found just on few tools (Fig. 6).

Neolithic

The tools from the Neolithic layers were used for hunting, butchering, hide working and for wood working (Fig. 6). Some were used for more than one task, since they display more than one variety of usewear.

Neolithic stone tools do not greatly differ from Mesolithic ones (*Miracle 1997.46*). Continuity in the typology of stone tools is also known from Northern Europe, where it is almost impossible to distinguish late Mesolithic from early Neolithic types. The only difference is the occurrence of polished tools (*Price, Gebauer and Keeley, 1996.115–119*).

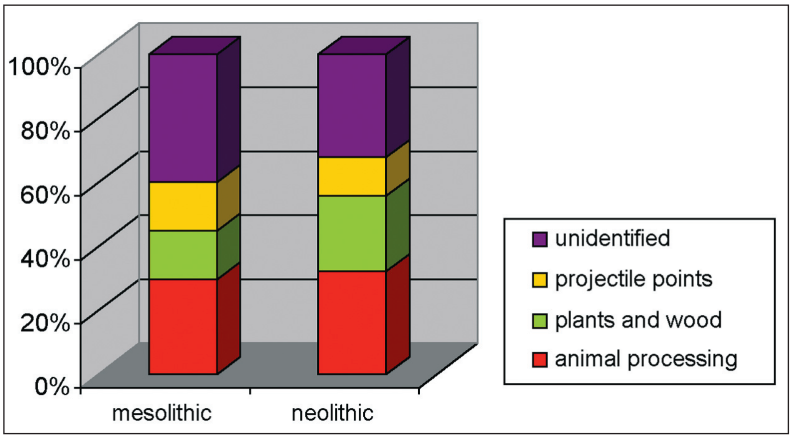

Fig. 6. Pupičina peć – usewear results for Mesolithic and Neolithic stone tools.

In Pupičina peć similar conclusions can be drawn as to their use – in both periods they were used for the same tasks, mainly hunting. The main difference is that in the Neolithic there is a small increase in the number of tools used for wood working. This might reflect the introduction of a new activity, probably herding, but this activity is not so obviously reflected in the stone tools as in Mala Triglavca. Herding is confirmed by the bones of the domesticates, which outnumber those of wild species, which means that domestication was fully established at the time, but the beginning of the process is not known, due to a hiatus between the Mesolithic and Neolithic layers (*Miracle 1997.46*).

The projectile points among the stone tools indicate that the Neolithic visitors were also hunters. The butchering tools may be connected to hunting, or butchering domesticates. Hide working was not extensive, with hide polish found on only two implements. There are no traces of bone or antler usewear on the stone tools. There are also no signs of usewear traces from grass cutting or cereal harvesting.

An examination of the usewear found on the stone tools indicates that the Neolithic visitors to Pupičina peć were hunters and herders, but there are no signs of agriculture in the vicinity of the cave. The only traces of plant usewear were those of wood. Because the hilly hinterland of the Adriatic coast was not suitable for agriculture, the inhabitants of those areas were probably not sedentary farmers, but seasonal nomadic pastoralists. The animal remains indicate that during the Neolithic the cave was occupied primarily in spring (*Miracle 1997.57*), which could coincide with seasonal movements of herders. In later periods Pupičina peć continued to keep the role as animal pen (*Miracle 1997.48*).

CONCLUSION

A usewear analysis of Mesolithic and Neolithic stone tools from the Karst sites at Mala Triglavca and Trhlovca, indicates that new activities were introduced during the Neolithic. In the Neolithic fewer tools are used for processing animal remains, while tools for wood working become more frequent. New activities may be connected to herding – tools were needed for cutting down trees, so that clearings for animal grazing could be created. The number of hunting tools decreases in the Neolithic contexts of Mala Triglavca and Trhlovca. But at the Croatian site at Pupičina peć usewear indicates that hunting was almost as important in the Neolithic as in the Mesolithic.

Nomadic hunters and gatherers might more easily develop herding than agriculture, which demands a sedentary way of life. The late appearance of agriculture in the Slovenian Karst region probably also reflects unfavourable conditions for raising crops. Similar conditions are found at early Neolithic sites in Iberia, where agriculture first appeared in more favourable areas and later expanded to more marginal areas. The process was gradual, early farmers coexsisted with hunters and gatherers in both the marginal and more favourable areas (*Bernabeu Auban 1997.13*).

All three caves probably remained animal shelters even in the Eneolithic, although the sickle gloss on stone tools from Mala Triglavca and Trhlovca indicates that agriculture was already present in the Karst region by that time.

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Documenta Praehistorica XXXI

Archaeometrical analysis of Neolithic pottery from the Divača region, Slovenia

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ABSTRACT – *The results of the mineralogical and chemical analyses of pottery from the Neolithic period from the Divača region are presented. Pottery samples from two rock shelters, i.e. Mala Triglavca and Trhlovca, were included in the analyses, as well as sediment samples from other rock shelters, caves and rivers around this area. The mineralogical and chemical composition of the ceramic is uniform in most of the samples; the differences between the clay pastes of the vessels are in the use of a tempering material, mostly calcite grains. The sediment samples, especially from the cave deposits, point to a local production of the Neolithic pottery on the Karst plateau.*

IZVLEČEK – *Arheometrične analize neolitske keramike iz področja Divače. Predstavljeni so rezultati mineraloških in kemijskih analiz neolitske keramike iz okolice Divače na Krasu. V analizo so bili vključeni vzorci keramike iz dveh spodmolov, Male Triglavce in Trhlovce, pa tudi vzorci jamskih in rečnih sedimentov iz bližnje okolice arheoloških najdišč. Mineraloška in kemijska sestava keramike je enotna v skoraj vseh vzorcih; glavne razlike pa se pojavijo v tehnologiji neolitskih lončarjev, ki so naravni glineni masi dodajali mineralna zrna, predvsem kalcitna zrna ali sigo. Analiza sedimentov iz jamskih najdišč pa kaže na lokalen izvor naravne glinene mase na Krasu.*

KEY WORDS – *mineralogy; Neolithic; pottery; provenience studies; transhumance*

INTRODUCTION

Although investigations of the mineralogy and chemistry of pottery and other materials in archaeology are widely used (*Rice 1987; Shepard 1965; Spataro 1999; 2002*), they have not been extensively applied to the study of pottery technology in Slovenia (*Osterc 1975; 1986; Zupančič and Bole 1997*). These studies, although also carried out on samples of Neolithic pottery, have never reached beyond the mere technological aspect of the results. This paper will show that such applications are not just essential for the study of technology, but useful also in the study of social structures in the Neolithic period and the palae-oeconomy in the region.

Pottery samples of the Neolithic and Eneolithic period from two cave sites near Divača in the south west part of Slovenia, located on the Karst plateau, were used for the archaeometrical studies in the present paper. The pottery of the Neolithic period was attributed to the Danilo culture, originating in the eastern Adriatic, according to J. Korošec (*1960*), Š. Batović (*1973; 1979*) and F. Leben (*1973*). Similar assemblages in the Triestine Karst in Italy, on the other hand, are usually ascribed to the so-called Vlaška group, which was first described by L. H. Barfield (*1972; 1999*), and is still used as a description for certain pottery types in Italian archaeology (*Gilli and Montagnari Koklej 1993; 1994; Montagnari Kokelj 2001*). These vessels are predominantly found in caves all along the Karst plateau, mostly on the Italian side of the border, in the Triestine Karst region. Nevertheless, this group has many similarities with the middle Neolithic Danilo culture on the Dalmatian coast. The samples from the Eneolithic period were selected for comparison with the Neolithic pottery.

As a first, step all the pottery fragments were analysed on a macroscopic level in order to describe the potsherds according to their technological and typological properties. Within this range of information, samples for a detailed mineralogical description and analysis were selected. The samples were chosen according to their technological groups, their stratigraphic position, and their typological and cultural properties. For a first provenience study, some samples of clays and sediments around the two archaeological sites were also sampled and analysed.

THE ARCHAEOLOGICAL SITES

The rock shelters at Mala Triglavca and Trhlovca, sited only one kilometre apart, are located on the Karst plateau near the town Divača (Fig. 1). The caves were excavated from the mid-1970's to the mid-1980's by the Ljubljana Institute for Archaeology under the supervision of Dr. France Leben. In both caves there was a long stratigraphic sequence of layers dating from the Neolithic to the Modern Era; in Mala Triglavca there were also layers containing archaeological finds dating to the Mesolithic (*Leben 1988*). The principles of arbitrary excavation were employed, and all the material remains were documented in this context; in Mala Triglavca the finds are attributed to horizontal sections[1] and in Trhlovca as layers. The Neolithic layers[2] included pottery, various bone and stone artefacts, and numerous animal bones, both wild and domestic species. Wild animals yielded the majority of bones: stag, wild boar, and brown bear; among the domestic species were many sheep, goat, cattle and dog bones (*Budja 1995; 1996; 2001; Leben 1967; 1988; Petru 1997; Pohar 1990*). The pottery assemblage from the Neolithic and Eneolithic layers is quite modest, since only 690 fragments were found in Mala Triglavca and 785 potsherds from Trhlovca[3]. The assemblage included some typical ceramic vessels of the Neolithic period in this region, including bowls ornamented with triangles and tulip shaped cups (*Dacar 1999; Tomaž 1999.18–57; Žibrat 2002*). A *rhyton* fragment has been excavated at Mala Triglavca that has similarities with the rhyta of the Danilo culture on the Dalmatian Coast (*Žibrat 2002.t.19:8*), as well as a potsherd ornamented with barbotine, a decorating technique traditionally attributed to the Starčevo culture in the central Balkans (*Dacar 1999. t.18:1; Žibrat 2002.t.6:7, t.12:4*).

METHODOLOGY

The macroscopic observation

We observed three main groups of ceramic matrixes on the macroscopic level (as described by *Horvat 1999*)[4] at Mala Triglavca. The group with calcium carbonate is by far the most abundant, since 78.3% of all the samples from the Neolithic and Eneolithic period belong to this group. The group with calcium carbonate and quartz was 18.9%, and the group with quartz only 2.7% of the total assemblage that is of the 690 potsherds analysed. In the oldest Neolithic layer all the samples (i.e. 215 fragments) belong to the group with calcium carbonate. In the second Neolithic layer the group with calcium carbonate comprised 97.6%, and the group with calcium carbonate and quartz 2.4% (of 329 potsherds from this layer). The group with quartz, but no calcium carbonate, comprised 0.7%, and for the first time appears in the Eneolithic layer; the group with calcium carbonate nevertheless still predominates, with 94.5% from a total of 146 potsherds (*Žibrat 2002.sl. 8–9, 14–17, 60*).

At Trhlovca most of the potsherd from Neolithic layers H and G also belong to the group with calcium carbonate (98.5% from 68 fragments from layer H, and 98.5% from 212 fragments from layer G). The group with quartz and calcium carbonate is represented by 1.5% each in layer H and G. The vessels from the younger layer, F, also contain calcium carbonate, but in a smaller part of the assemblage

1 The assemblage from Mala Triglavca is especially problematic since the material from some of the horizontal planums is evidently mixed (*Žibrat 2002.68–73*).

2 In Mala Triglavca the oldest Neolithic layer includes the horizontal planums 3,05–3,25m/2,90–3,25m; the second Neolithic layer includes planums 2,70–3,00m/2,70–2,90m/2,75–2,90m and the Eneolithic layer includes planums 2,70m/2,60–2,75m (*Žibrat 2002.60–61*). In Trhlovca the layers H, G and F are all Neolithic layers, only layer F has material with similarities to the Eneolithic layer E at this site (*Tomaž 1999.47–50*) (Tab. 1).

3 The pottery assemblage from both cave sites has been already sorted by the excavation team in the 1980's, mostly according to known typological finds. Therefore we must stress that all the later analyses on pottery were done on a smaller sample than originally excavated.

4 The technological description on the macroscopic level included the presence of mineral and organic inclusions, their size and frequency in the vessels, but also the surface treatment, hardness, colour and the firing methods and atmosphere (*Horvat 1999. 159–161*).

(79.6% from a total of 505 fragments). A higher percentage of potsherds, i.e. 19.2%, were attributed to the group with quartz and calcium carbonate on the macroscopic level in this layer. The group with quartz inclusions was 1.2%, and appears for the first time in layer F (*Tomaž 1999. 26, sl. 9*).

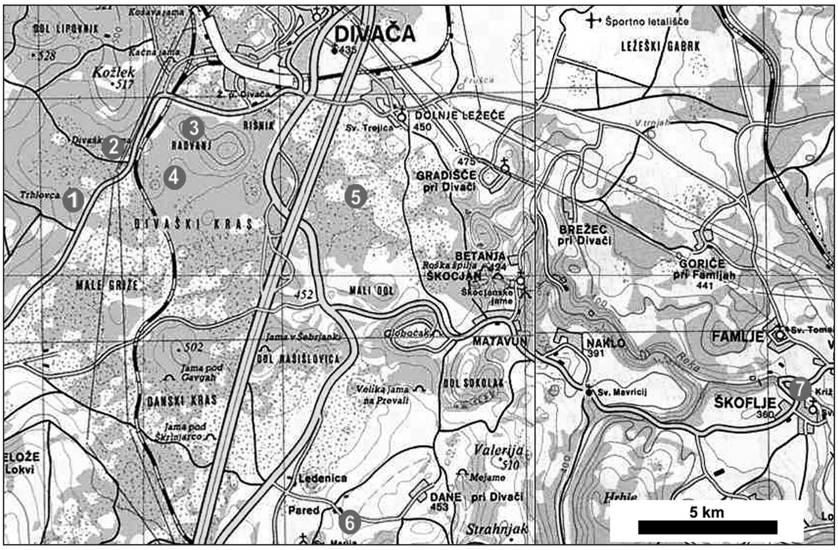

Fig. 1. Locations of the archaeological sites and the locations of the sediment samples: 1 – Trhlovca; 2 – Divaška jama; 3 – dolina Radvanj; 4 – Mala Triglavca; 5 – Lipove doline; 6 – Pared near Dane; 7 – Škoflje (river Reka).

In the pottery assemblages from both rock shelters the group with calcium carbonate inclusions predominates according to results of macroscopic observation. Only in layer F from Trhlovca does the percentage of such potsherds drop to below 90%. The group with quartz and calcium carbonate was approximately 2% at both sites, but increases in layer F in Trhlovca to 20%. This group appears only in the second Neolithic layer in Mala Triglavca, but is not present in the oldest layer. The group with quartz inclusions appears in the Eneolithic layer at Mala Triglavca and in layer F at Trhlovca for the first time, but forms only some 1% of the total assemblage in these layers.

Sampling

We analysed 43 pottery samples from both rock shelters (24 from Mala Triglavca and 19 from Trhlovca cave) (Tab. 1) and 6 sediment samples from different locations in the microregion (the site catchment analysis was carried out within a radius of 5 km) (Fig. 1). One of the sediment samples was taken directly from the archaeological layer at Trhlovca, the other from Divačka jama and two samples were taken from denuded caves[5] called Radvanj, near the Mala Triglavca rock shelter, and Lipove doline. Also, two alluvial samples were taken from a stream, Globoki potok near the village of Dane and another from the River Reka near Škoflje (Tab. 4). Pottery samples were chosen from the macroscopic observations, on the basis of their stratigraphic position, the typology of the vessels, and their cultural relevance (Fig. 2). The sediments were gathered according to their proximity to the archaeological sites in question, their workability (high clay content) and origin. Only the alluvial sediments failed to meet the workability criterion, since they were mainly composed of quartz sand.

The analyses

Various methods of analysis were used for the determination of minerals in the pottery and sediment samples. The mineralogical composition was determined by means of optical microscopy, X-ray powder diffraction, and scanning electron microscopy. The pottery and sediment samples were analysed for their chemical composition with the inductively coupled plasma optical emission spectrometry (ICP-OES) method (*Bishop et al. 1982; Nölte 2003*) in the ACME Laboratory in Vancouver, Canada.

The optical mineralogy and X-ray powder diffraction techniques applied at the Department of Geology in Ljubljana. For the optical microscopy we used samples, prepared as polished thin sections, which are useful for the identification of different kinds of minerals and other grains in pottery, their abundance and associations, particle orientation, void size, shapes and locations, surface treatments, and alterations due to firing or post-depositional factors. One of the more useful characterizations was granulometry and heavy mineral analysis (*Barić and Tajder 1967; Grimshaw 1971; Rice 1987.348–350; Whitbread*

5 Caves, in which denudation had removed their upper parts, yet are recognized as caves due to the typical sediments they contained and other features. There are three types of relief features controlled by denudation of rocks above the caves. One of the types are roofless caves, that present a longer section of passages and have been filled by flowstone and allochthonous fluvial sediments that have been deposited in a cave environment (*Mihevc, Slabe and Šebela 1998.167–170; Mihevc 2001.15–41*).

1986). With this method we could determine the mineralogical composition of pottery, distinguish between clay pastes and temper, discover secondary minerals, and estimate the firing temperature. We also analysed the sediments with optical mineralogy, although we could only observe individual grains under the microscope. Smaller particles of the sediment samples were sieved out (i.e. particles smaller than 0.063mm or 630μm).

With the X-ray powder diffraction technique we analysed the bulk mineralogical composition of the pot-

SAMPLES	YEAR OF SAMPLING	THIN SECTION NUM.	SITE	LAYERS	DESCRIPTION
1	2003	1	Mala Triglavca	3,05-3,25m	the wall of the vessel
2	2003	2	Mala Triglavca	3,05-3,25m	the wall of the vessel
3	2003	3	Mala Triglavca	2,70-2,90m	the wall of the vessel
4	2003	4	Mala Triglavca	2,70-3,00m	the wall of the vessel
5	2003	5	Mala Triglavca	2,75-2,90m	piece of plain rim with wall
6	2003	6	Mala Triglavca	2,70m	piece of rim with wall
13	2000	15	Mala Triglavca	3,05-3,25m	the wall of the vessel
14	2000	13	Mala Triglavca	2,70-3,00m	the wall of the vessel
15	2000	3	Mala Triglavca	2,70-3,00m	handle
16	2000	5	Mala Triglavca	2,70-3,00m	the wall of the vessel
17	2000	10	Mala Triglavca	2,75-2,90m	the wall of the vessel
18	2000	14	Mala Triglavca	2,70-2,90m	the wall of the vessel
19	2000	11	Mala Triglavca	2,70-2,90m	the wall of the vessel
20	2000	4	Mala Triglavca	2,90-3,05m	the wall of the vessel
20	2003	144	Mala Triglavca	2,90m	the wall of the vessel
21	2000	16	Mala Triglavca	2,75-2,90m	the wall of the vessel
22	2000	9	Mala Triglavca	2,90-3,05m	bowl
22	2003	119	Mala Triglavca	2,90-3,05m	the wall of the vessel
23	2000	7	Mala Triglavca	2,70m	piece of rim with wall
23	2003	68	Mala Triglavca	2,90-3,05m	plate
24	2000	1	Mala Triglavca	2,90-3,05m	the wall of the vessel
24	2003	148	Mala Triglavca	2,70-3,00m	handle
25	2003	153	Mala Triglavca	2,70-3,00m	piece of plain rim with wall
29	2003	374	Mala Triglavca	2,60-2,75m	piece of base with wall
1	2000	28	Trhlovca	H	the wall of the vessel
2	2000	26	Trhlovca	H	the wall of the vessel
3	2000	27	Trhlovca	H	the wall of the vessel
4	2000	29	Trhlovca	F,3,4	footed bowl
5	2000	30	Trhlovca	G	the wall of the vessel
6	2000	18	Trhlovca	G	the wall of the vessel
7	2003	7	Trhlovca	G	the wall of the vessel
8	2000	24	Trhlovca	G	the wall of the vessel
8	2003	8	Trhlovca	G	pot
9	2000	25	Trhlovca	H	the wall of the vessel
9	2003	9	Trhlovca	G	the wall of the vessel
10	2000	2	Trhlovca	F	piece of plain rim with wall
10	2003	10	Trhlovca	G	the wall of the vessel
11	2000	21	Trhlovca	G	bowl
11	2003	10109	Trhlovca	F	the wall of the vessel
12	2003	10115	Trhlovca	F, E	piece of plain rim with wall
13	2003	10123	Trhlovca	F,D	dish
14	2003	10101	Trhlovca	F	dish
15	2003	10066	Trhlovca	G	bowl

Tab.1. Pottery samples for optical and x-ray analysis from Mala Triglavca and Trhlovca, the description of pottery types and their stratigraphic context.

tery and sediment samples (*Grimshaw 1971; Klein and Hurlbut 1993*). Approximately 2g of a sample was ground into fine powder for this method. All the results were presented on the computer as diagrams and detailed data. Since this technique gives the results of the bulk composition of a sample, we could not distinguish between natural and added inclusions. Nevertheless, we were able to identify most of the minerals present in the samples.

The analysis with the scanning electron microscope (*Goldstein et al. 2003; Reed 1996*) was provided by the Institute Jožef Stefan in Ljubljana at the centre for electron microscopy. Six samples of pottery from both sites have been analysed with this technique so far. We also performed a point chemical analysis using an energy dispersive spectrometer (EDS) for a detailed study, in which we were interested not only in the chemical composition of calcite and quartz grains, but also in limestone and chert grains in the samples. We tried to establish whether these grains are of a uniform composition in the pottery. We will present only some of the preliminary results obtained by electron microscopy, since only a fraction of the samples have been analysed (i.e. 5 samples).

Some of the pottery samples from both archaeological sites (i.e. 10 samples from Mala Triglavca and 10 samples from Trhlovca) and all the sediment samples were sent to ACME Laboratory in Vancouver, Canada for a chemical analysis. All the samples were crushed into powder and some 5g of each sample were sent for analysis by inductively-coupled plasma emission spectrometer for major, minor, and trace elements[6]. In this paper we present only some preliminary results of this analysis (Tab. 5).

THE RESULTS

Pottery

The mineralogical composition of the pottery samples contained quartz, mica (i.e. muscovite) and feldspar in all of the analysed samples (Tab. 2; 3). Hematite was determined in 6 out of 24 samples from Mala Triglavca and 7 out of 19 samples from Trhlovca. We also found grains of clay pellets, argillaceous rock fragments, limestone, chert, and quartz sandstone in various quantities by optical mineralogy (Tab. 2). Argillaceous rock fragments were present in 8 samples from Mala Triglavca and 10 samples from Trhlovca; clay pellets were present in all of the analysed samples. Limestone was present in 11 samples from Mala Triglavca, and 9 samples from Trhlovca. Chert grains were present as individual grains or as part of quartz sandstone; these grains were discovered in 18 samples from Mala Triglavca and 16 samples from Trhlovca. In most of the samples (i. e. in 22 samples from Mala Triglavca and 14 samples from Trhlovca) calcite grains[7] were found in various quantities (Fig. 3), but it was most probably added as temper; only on rare occasions were calcite grains naturally included in the clay (for example, in sample 6/2003 from Mala Triglavca). In a smaller percentage of samples, secondary calcite was observed inside pores or on the surface of the vessels, i.e. in 3 samples from Mala Triglavca and in 6 samples from Trhlovca. Calcite grains were present abundantly or very abundantly in 75% of all samples from Mala Triglavca and in 42.1% of all samples from Trhlovca (Tab. 2). The grains are of angular shape, poorly sorted, and of an average size of around 0.35mm (350μm), but they can be a few millimetres in some samples; these criteria are usually attributed to tempering materials (*Rice 1987.406–411*). In our opinion most of the grains, especially in the sand and pebble grain range, can be attributed to human activity, and that calcite was indeed used as a tempering material in the manufacture of the Neolithic pottery in this area.

Calcite grains can be a problematic material in pottery making, because of its decomposition into quicklime in firing, and the effect of "lime popping" when the vessel is being cooled. Many solutions have been proposed for this problem, from wetting the vessels after heating, to adding salt to the paste and firing the vessels below the decomposition temperature, which means less than 850°C (*Grimshaw 1971. 280; Rice 1987.97–98*). This last solution applies to the pottery from Mala Triglavca and Trhlovca, since we already proved that the firing temperature for vessels with calcite temper rarely exceeded this level. Again, the question remains whether this was done deliberately, or the potters were not able to reach a higher firing temperature with their firing technology. Nevertheless, calcite can be very useful in cooking pots, as assumed by other researchers (*Rice 1987.410; Rye 1981.33*).

6 A major or main component means that the concentration of a given element in the sample is at least 10%; the minor component means that the concentration is between 10 and 0,01%; and a trace element means that the component has a lower concentration, less than 0,01%, therefore usually expressed in part per million (ppm) (*Nölte 2003.8*).

7 The calcite grains in these samples are in fact composed of calc-sinter.

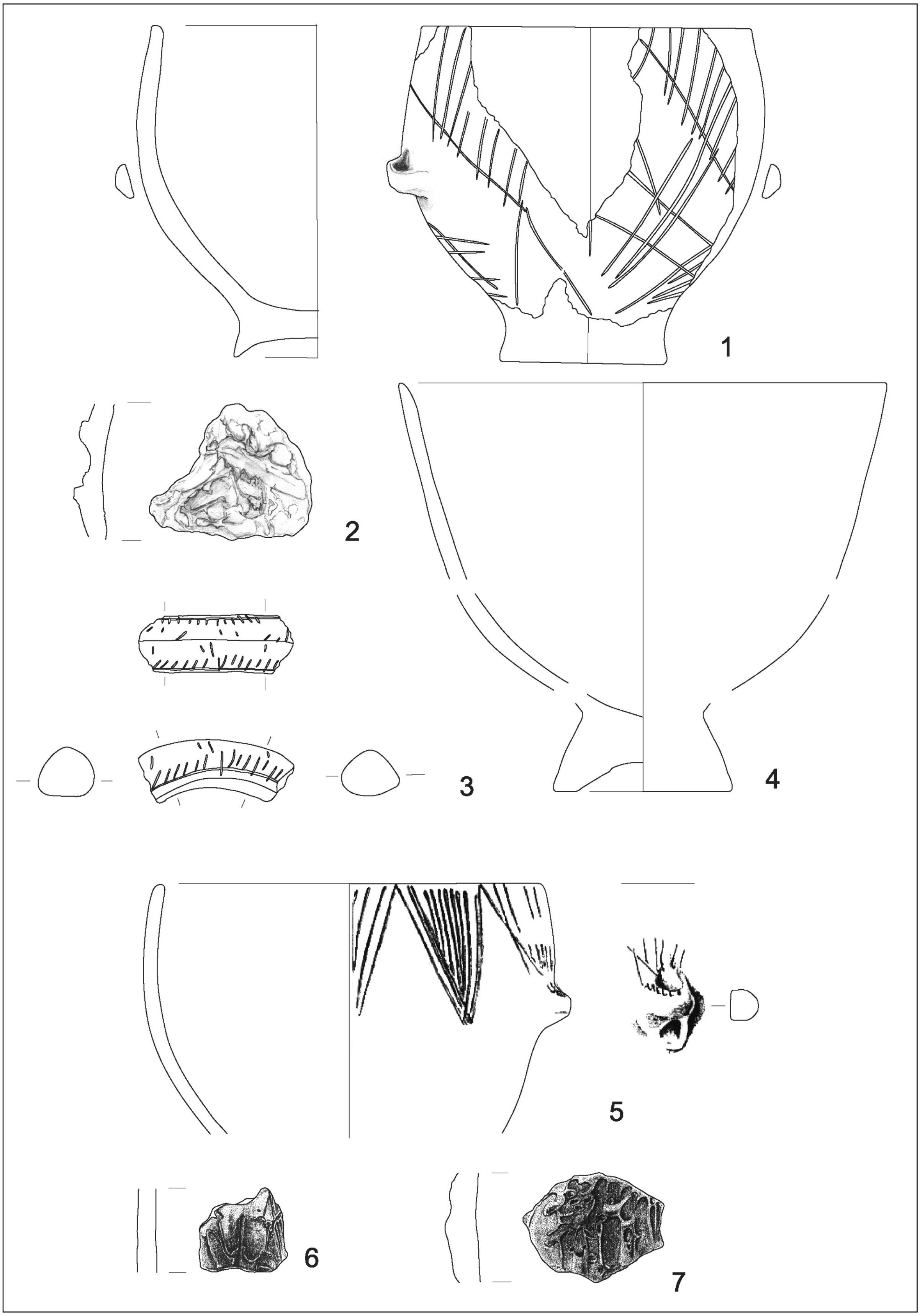

Fig. 2. Neolithic pottery from Mala Triglavca (1 – sample 22/2000; 2 – sample 24/2000; 3 – sample 24/2003; Žibrat 2002.t.7:4, 12:4, 19:8*) and Trhlovca (4 – sample 4/2000; 5 – sample 11/2000; 6 – sample 9/2000; 7 – sample 11/2003;* Dacar 1999.t.3:2, 18:1-2, 34:2*). (1:2)*

The vessels from the Neolithic and Eneolithic period have great strength[8] and this may be due to two reasons: the formation of secondary calcite on the surface and inside the walls of the potsherds in post-deposition; and the relatively high content of mica, i.e. muscovite flakes in the natural pastes of these vessels. Strength is associated with the ability of a material to withstand pressure being applied to it without rupturing or deforming (*Grimshaw 1971. 832*).

The pottery from both rock shelters shows many similarities in terms of technological properties and a more uniform mineralogical composition than previously hypothesised on the basis of macroscopic observation. The basic mineralogical composition is essentially the same in most of the vessels analysed, in those with calcite temper as well as in vessels without any tempering materials (Figs. 3, 4). Even in terms of chronological differences, we could establish almost no variation in the mineralogical composition of the ceramic pastes; the use of calcite as a temper is somewhat less popular in the Eneolithic than in the Neolithic period, but this was already determined on the macroscopic level of observation (*Žibrat 2002.52–58*). When we consider the stylistic and typological data and the composition of such pottery, we can establish that all the typical Neolithic vessels from this region that have similarities with the Danilo culture are of a similar mineralogical and chemical composition (Fig. 2:1, 3–5). In terms of production centres and trade we can say that the Neolithic pottery from the Karst plateau was manufactured in this area by using locally available mate-

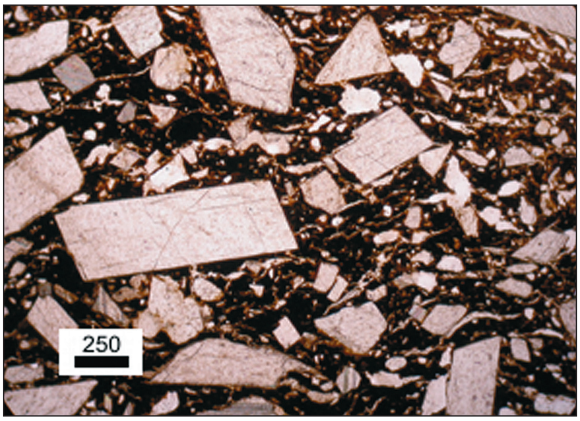

Fig. 3. Thin section photomicrograph of sample 14 (2000) from Mala Triglavca. The clay matrix contains calcite grains (x40; || N; the black line is 250 µm wide).

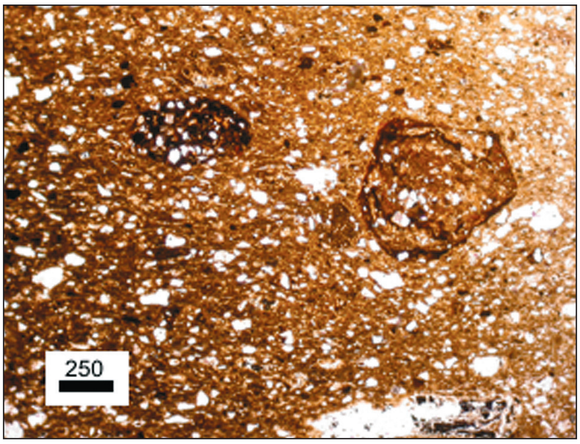

Fig. 4. Thin section photomicrograph of sample 9 (2000) from Trhlovca. The potsherd is decorated with barbotine and the clay matrix includes quartz grains and clay pellets (x40; || N; the black line is 250µm wide).

rials for all kinds of pottery. This is proved by a certain type of pottery, namely that of the barbotine decorated potsherds (Fig. 2:2, 6–7), which can be best linked to the Starčevo and Starčevo-Impresso culture in the eastern and central Balkans. These potsherds from Mala Triglavca and Trhlovca do not differ in any way from the rest of the ceramic assemblage and were as such also manufactured on the Karst (Tab. 2; 3).

On the other hand, there is one pottery sample from Trhlovca (i.e. sample 10/2000; Tab. 1–3) – dating to the Eneolithic period – that has a somewhat different chemical composition than all the other pottery and sediment samples analysed with the inductively coupled plasma optical emission spectrometer (ICP-OES). The composition of major and minor elements is similar to the other samples, but there is a significant change in the quantity of some trace elements (manganese, molybdenum and lead among others). These results could point to a different natural clay source having been used for this vessel, since none of the sampled sediments contained a similar quantity of these elements. There was a slight difference in the amount and variety of clay pellets and argillaceous rock fragments than was observed on the macroscopic and microscopic levels in this sample, but only the chemical analysis pointed to such diversity in composition.

One aspect that is common in pottery analysis is archaeothermometry, i.e. the determination of the

8 Strength is a measure of the response to stresses involving the entire ceramic body, while hardness denotes deformations affecting the surface of the vessel (*Rice 1987.354*).

temperature at which the pottery was initially fired. For the estimation of the initial firing temperature we can use different techniques (*Rice 1987.426–435*). In our analysis we also tried to establish the working firing temperature for pottery from the physical properties and mineralogy of the samples. Our results show that the temperature was below 700°C for most of the pottery, because of the very

SAMPLE	YEAR OF SAMPLING	SITE	quartz	quartz sandstone	chert	calcite	limestone	seconday calcite	muscovie	hematite	feldspars	chlorite	anhydrite	zircon	clay pellets	ARF[1]
1	2003	Mala Triglavca	A	R	R	VA	R		R		R				P	
2	2003	Mala Triglavca	VA	R	R	VA			P		R				P	R
3	2003	Mala Triglavca	A			A	R		P	R	R				P	
4	2003	Mala Triglavca	VA	R	R				A	R	R				P	R
5	2003	Mala Triglavca	A		R	A			P						A	
6	2003	Mala Triglavca	A		R	R	R	R	P	R	R				A	R
13	2000	Mala Triglavca	A		R	A			P						A	
14	2000	Mala Triglavca	P			VA	R		R						A	
15	2000	Mala Triglavca	VA	R	R	P	R		P		R				A	
16	2000	Mala Triglavca	P		R	VA	R		A						A	
17	2000	Mala Triglavca	A		R	A			P						A	R
18	2000	Mala Triglavca	VA		R	P			R						A	
19	2000	Mala Triglavca	A	R	R	A	P		P		R				A	
20	2000	Mala Triglavca	P			A			P						A	
20	2003	Mala Triglavca	P			P		R	R						P	R
21	2000	Mala Triglavca	A		R	A			R						A	
22	2000	Mala Triglavca	P			A			P						A	
22	2003	Mala Triglavca	VA		R	VA		R	P						A	
23	2000	Mala Triglavca	A	R	R				R		R				ZO	R
23	2003	Mala Triglavca	P	R	R	A	R		R						P	
24	2000	Mala Triglavca	R			A	R		R						A	
24	2003	Mala Triglavca	A		R	A			R						P	
25	2003	Mala Triglavca	P	R		VA	R		R						P	
29	2003	Mala Triglavca	VA	R	P	A			R						P	R
1	2000	Trhlovca	VA		R	P			R		R			R	A	
2	2000	Trhlovca	P	P	R	A	R		R		R				A	
3	2000	Trhlovca	A		R	VA			P						P	
4	2000	Trhlovca	P	R	R	P			R						A	
5	2000	Trhlovca	A	R	R	R	VA		R		R				P	R
6	2000	Trhlovca	A			A			R						P	
7	2003	Trhlovca	VA		R				P		R				P	R
8	2000	Trhlovca	R			A	R		R						A	R
8	2003	Trhlovca	A	R	R	A	R	P	P		R				R	
9	2000	Trhlovca	VA		R				P		R				A	
9	2003	Trhlovca	A	R	R	VA	P	R	R	R	R				P	
10	2000	Trhlovca	VA	R	R				P		R				VA	P
10	2003	Trhlovca	A	P	P	P	R	R	P		P	R	R	R	A	R
11	2000	Trhlovca	R			A					R				R	
11	2003	Trhlovca	VA		R				A						A	R
12	2003	Trhlovca	VA		P			R	P		R				A	P
13	2003	Trhlovca	A	R	R	R	P	R	P						P	R
14	2003	Trhlovca	P		R	VA	R	A	R						P	R
15	2003	Trhlovca	A		R	P	R		P		R				P	R

Tab. 2. The results of the optical microscopy analysis for the pottery samples (VA – very abundant; A – abundant; P – present; R – rare; [1] – argillaceous rock fragments).

good state of preservation of calcite grains, which did not decompose[9], as observed under the microscope. In addition, most quartz grains in our samples were cracked because of the volume change in quartz inversion around 573°C[10]. Therefore, we conclude that most of the pottery was fired at low temperature, only around 600 to 700°C. Only a small number of potsherds contained calcite grains that were partly decomposed, and those vessels could have been fired to a higher temperature, that is, up to 800°C, but not higher, since the grains did not decompose completely. These firing temperatures could only be estimated for the potsherds containing calcite grains – for the rest of the pottery we do not have enough information to ascertain the firing temperature. The only guideline in the samples without calcite is quartz, and its inversions to β–quartz around 573°C and tridymite around 870°C (*Grimshaw 1971.158*). Since tridymite was not discovered in the samples we can estimate that most of the samples were fired at around 600 to 800°C.

Sediments

All of the sediment samples were composed of quartz, feldspar, mica (i.e. muscovite, biotite) and chlorite, according to the mineralogical analyses (Tab. 4). Ferrous oxides, such as hematite and goethite, were discovered only in the cave sediments. A similar mineralogical composition has been attested for sediments from doline on the Karst (*Zupan Hajna 1998. 279–290*). Sediments from Trhlovca, Divaška jama and both of the alluvial samples showed traces of calcite or calcium oxides according to the X-ray diffraction and chemical analyses (Tab. 4; 5). The alluvial sediments contained some minor quantities of calcite, but this can be explained by the presence of mollusc shells in these samples, as was observed on the macroscopic level. Mollusc shells were not discovered in the cave sediments or the pottery sample – therefore, we conclude that these alluvial sediments were not used for pottery production at Mala Triglavca and Trhlovca. Nevertheless, all the sediments show a similar mineralogical composition, which is not surprising since those sediments all originate in the same type of rock, flysch[11]. Flysch rocks are common around the Karst plateau, as they are present along the Slovene coastal region, in the Vipava valley to the northeast and in the Brkini and the Reka valleys to the southeast (*Gams 1988, 81–83*).

According to our results, the mineralogical composition of pottery from Mala Triglavca and Trhlovca can be better compared with the composition of the analysed cave sediments than with the alluvial samples (Tabs. 2–5). Our main arguments for this are the much higher quartz sand content, the lack of hematite or other ferrous minerals, and the presence of mollusc shells in the alluvial sediments, as opposed to the cave sediments and the pottery. In contrast, we have to stress that the alluvial sediments we sampled did not contain enough clay for pottery manufacture to begin with.

Discussion

Our results can be best compared to archaeometric studies of pottery from Edera Cave/Stenašca in the Triestine Karst (*Spataro 1999*) and from various open air and cave sites along the eastern Adriatic Coast (*Spataro 2002*). Most of the pottery analysed from these sites are Neolithic and Eneolithic. In Edera, which is located some 25 km away from our two archaeological sites, the potsherds could be divided into two main groups according to thin section and X-ray diffraction analyses. The best represented group includes vessels made from local materials, as demonstrated by the inclusion of many calcite grains; and the second group is that of imported ware. In the fabrics of the second group several chert, granite and quartz sandstone grains were detected. The granite grains, part of an igneous rock, contained minerals K-feldspar, quartz and biotite. Some traces of chlorite were also discovered (*Spataro 1999.70–72*). The main problem with this analysis is the fact that no real provenience studies took place, since no samples of locally available sediments, clays or rocks were analysed. The author concluded that one group was comprised of locally-made vessels only on the present of calcite in the samples. No real comparison was made between both groups on the basis of their pastes without considering calcite grains, which were probably added as temper.

The pottery from layer 2a at Edera/Stenašca that was attributed to the Vlaška group (*Biagi et al. 1993. 49; Spataro 1999.70–72*) is typologically and stylistically similar to the vessels from Mala Triglavca and Trhlovca. The local group of clays as described at Edera/Stenašca, which contained calcite grains, and the clay pastes from the rock shelters Mala Tri-

9 The calcite decomposition happens in the temperature range from 700 to 900°C (*Rice 1987.98*).

10 The first inversion of quartz occurs rather rapidly around this temperature and is a chamge from low to high quartz (*Rice 1987.95*).

11 Flysch rocks of this region are composed of layers of sandstone and carbonate marl.

glavca and Trhlovca, also have a similar mineralogical composition. The presence of the non-local group with granite grains as described in Edera/Stenašca was discovered in the pottery samples from the Slovene Karst region. Some of the vessels with this non-local composition are from the late Castelnovien layer 3a in Edera/Stenašca (*Biagi et al. 1993.47–49; Biagi and Spataro 2001.32–35; Boschin and Riedel 2000*). Whether granite grains in the clay pastes are in fact a non-local material should have been tested with an appropriate sampling of sediments and rocks in this region.

SAMPLES	YEAR OF SAMPLING	SITE	quartz	calcite	muscovite	plagioclase	K-feldspars	chlorite	hematite
1	2003	Mala Triglavca	xx	xx	x	x			
2	2003	Mala Triglavca	xx	xx	x	x			
3	2003	Mala Triglavca	xx	xx	x	x	*		x
4	2003	Mala Triglavca	xx	x	x	x			*
5	2003	Mala Triglavca	xx	xx	x	x			x
6	2003	Mala Triglavca	xx	x	x	x	x		x
13	2000	Mala Triglavca	xx	xx	x	x			
14	2000	Mala Triglavca	xx	xx	x	x			
15	2000	Mala Triglavca	xx	xx	x	x	*		
16	2000	Mala Triglavca	xx	xx	x	x			
17	2000	Mala Triglavca	xx	xx	x	x	*		*
18	2000	Mala Triglavca	xx	xx	x	x	*	*	
19	2000	Mala Triglavca	xx	xx	x	x	*		
20	2003	Mala Triglavca	xx	xx	x	x	*		
21	2000	Mala Triglavca	xx	xx	x	x	*		
22	2000	Mala Triglavca	xx	xx	x	x			
22	2003	Mala Triglavca	xx	xx	x	x	*		
23	2000	Mala Triglavca	xx	x	x	x	*		
23	2003	Mala Triglavca	xx	xx	x	x			x
24	2000	Mala Triglavca	xx	xx	x	x			
24	2003	Mala Triglavca	xx	xx	x	x			
25	2003	Mala Triglavca	xx	xx	x	x			
29	2003	Mala Triglavca	xx	xx	x	x	*		x
1	2000	Trhlovca	xx	xx	x	x	*		
2	2000	Trhlovca	xx	xx	x	x			
3	2000	Trhlovca	xx	xx	x	x			
4	2000	Trhlovca	xx	xx	x	x			
5	2000	Trhlovca	xx	xx	x	x	*		*
6	2000	Trhlovca	xx	xx	x	x	*		
7	2003	Trhlovca	xx	x	x	x	*		*
8	2000	Trhlovca	xx	xx	x	*	*		
8	2003	Trhlovca	xx	xx		x			*
9	2000	Trhlovca	xx	*	x	x			x
9	2003	Trhlovca	xx	xx	x	x			
10	2000	Trhlovca	xx		x	x	*		*
10	2003	Trhlovca	xx	xx	x	x	x		*
11	2000	Trhlovca	xx	xx	x	x	*		
11	2003	Trhlovca	xx		x	x			x
12	2003	Trhlovca	xx	x	x	x	*	*	*
13	2003	Trhlovca	xx	x	x	x	*		
14	2003	Trhlovca	xx	xx		x	*		x
15	2003	Trhlovca	xx	xx	x	x			

Tab. 3. The results of the X-ray diffraction analysis (xx – major quantity; x – minor quantity; * – trace).

SAMPLES	SITE	DESCRIPTION	MACROSCOPIC DESCRIPTION	quartz	calcite	muscovite	biotite	feldspars	orthoclase	chlorite	clay minerals	gibbsite	hematite	goethite	pyrithe
1	Trhlovca	cave sediment	brown colour; calcite; bones	X	X	X	X	X		X		X	X		X
2	Divaška jama	cave sediment	yellow colour	X	X	X		*		X	*	X	*	*	
3	Dolina Radvanj	cave sediment	brown red colour	X		X		X		X			X		X
4	Lipove doline	cave sediment	brown red colour	X		X	X	X		X			X		
5	Dane (Globoki potok)	river sediment	grey brown colour; shells	X	X	X		X		X					
6	Reka	river sediment	grey colour; quartz sand	X	X	X		X	X	X					

Tab. 4. The mineralogical composition of the sediment samples according to the optical microscopy and X-ray diffraction method (X – major component; * – trace quantity).

The analysis of the *rhyton* from Edera/Stenašca has demonstrated its local production as well as the analysis of the *rhyton* from Mala Triglavca. These vessels are found in numerous caves and rock shelters on the Triestine Karst and have typological similarities with the Danilo Culture in Dalmatia and the Kakanj Culture in central Bosnia (*Montagnari Kokelj and Crismani 1993*). Chapman has proposed that these were salt containers and argued that their symbolic meaning could be transferred between different groups not as whole pots, but only as fragments (*Chapman 2000.65–68*). Nevertheless, the *rhyta* were probably transported as ideas, not as real vessels or parts of vessels to the northern parts of the Adriatic, the Caput Adriae, since most of the rhyta found in this region were produced locally (*Spataro 2002.199*).

Spataro analysed the mineralogical composition of potsherds from Neolithic and Eneolithic sites on both sites of the Adriatic coast. Samples were taken from 13 sites according to their stratigraphic sequence and typology, but no preliminary macroscopic studies of all the pottery assemblage were undertaken. As the results show, most of the pottery was made from locally available material. Calcite grains and rare organic material, were used as temper in the pottery from the eastern Adriatic coast sites, mostly in the middle Neolithic period; in one sample from Vela Špilja on the island Korčula grog temper was also found in the pottery. (*Spataro 2002.193–199*).

In this study Spataro sampled local clays for her provenience study, but mostly used only one sample in the proximity of a given archaeological site. The potsherds were selected according to typology and ornamentation techniques characteristic of the Impresso and Danilo cultures on the eastern Adriatic coast. So our main criticism is of sampling techniques, which could not include all the possible clay matrixes within a site, since no technological observations were made beforehand.

Some mineralogical and chemical analyses of pottery samples from this region were also carried out in Slovenia. The best example is the scientific study of Roman amphorae from Sermin near Koper on the Adriatic coast, beneath the Karst plateau. The samples were analysed for their chemical and mineralogical composition using similar techniques – inductively coupled plasma emission spectrometry, X-ray powder diffraction, and optical mineralogy. For the analysed amphorae the authors proposed an Adriatic origin on the basis of the mineralogical composition of the samples and their comparison to the geological structure in the eastern Adriatic, namely the composition of flysch rocks (*Zupančič, Bole 1997.98–99*). The mineralogical composition of the pottery and flysch rocks is indeed similar on the general level, but in our opinion for a thorough provenience study, locally available clays should have been sampled.

CONCLUSIONS

Within the different pottery groups we were able to identify three 'recipes' employed by the Neolithic potters: one had no artificially added temper (Fig. 4); the predominant group had calcite grains added as temper (Fig. 3); and one possible group had grains of lime sandstone with micritic calcite cement added as temper (sample 5/2000 from Trhlovca; Fig. 5). Even potsherds that have a clear cultural reference to the Dalmatian coast, in the Danilo culture, such as the rython (Fig. 2:3; Fig. 7), or others with

SAMPLE	YEAR OF SAMPLING	SITE	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	TiO_2 (%)	P_2O_5 (%)	MnO (%)	Cr_2O_3 (%)
1	2000	Trhlovca	49,8	12,6	6,22	1,5	12,4	0,72	2,21	0,65	0,39	0,12	0,026
2	2000	Trhlovca	34,9	11,41	5,33	1,02	23,2	0,13	1,78	0,53	0,49	0,11	0,019
3	2000	Trhlovca	45,7	11,44	2,15	0,52	18,1	0,03	1,33	0,73	0,47	0,02	0,026
4	2000	Trhlovca	43,9	13,28	5,18	1,13	15,3	0,18	2,22	0,71	0,42	0,14	0,024
5	2000	Trhlovca	58,5	12,2	5,12	1,41	9,72	0,81	1,99	0,67	0,17	0,16	0,018
6	2000	Trhlovca	38,6	9,42	2,13	0,52	25,3	0,05	1,29	0,57	0,09	0,02	0,024
8	2000	Trhlovca	33	12,48	5,69	0,98	23,2	0,06	1,85	0,51	0,38	0,13	0,015
9	2000	Trhlovca	62,6	14,94	6,79	1,69	1,85	0,7	2,77	0,79	0,71	0,18	0,031
10	2000	Trhlovca	60	15,48	8,25	0,91	2,25	0,43	1,79	1,01	0,71	1,58	0,021
11	2000	Trhlovca	30,1	13,56	5,42	1,12	21,4	0,11	1,42	0,57	1,09	0,08	0,015
13	2000	Mala Triglavca	44,6	12,52	4,88	0,83	15,4	0,16	1,58	0,72	0,97	0,15	0,025
14	2000	Mala Triglavca	28,2	11,46	5,56	0,5	23,5	0,15	0,64	0,55	0,9	0,1	0,018
15	2000	Mala Triglavca	60,7	12,95	5,84	1,04	7,14	0,87	1,71	0,79	0,55	0,1	0,03
16	2000	Mala Triglavca	36,8	11,06	4,86	0,5	22,6	0,2	1,27	0,58	0,49	0,06	0,024
17	2000	Mala Triglavca	44,1	12,59	5,11	0,85	14,8	0,19	1,54	0,77	1,66	0,14	0,029
18	2000	Mala Triglavca	51,9	13,27	5,89	0,77	9,22	0,23	0,89	0,84	1,37	0,05	0,029
19	2000	Mala Triglavca	42,9	8,72	4,36	1,18	20,2	0,78	1,36	0,52	0,24	0,14	0,018
21	2000	Mala Triglavca	48,9	11,15	4,77	1,04	13,1	0,41	1,59	0,63	0,49	0,1	0,021
22	2000	Mala Triglavca	43,2	13,2	6,83	0,89	13,6	0,16	1,73	0,7	0,88	0,21	0,026
24	2000	Mala Triglavca	35,1	11,61	5,02	1,17	22,7	0,15	1,6	0,5	0,33	0,21	0,013
1	2004	Trhlovca	42,5	15,48	6,01	1,28	9,94	0,55	1,58	0,89	1,08	0,25	0,02
2	2004	Diva_ka jama	65,6	15,38	6,64	0,77	0,9	0,19	1,27	0,89	0,12	0,16	0,038
3	2004	Dolina Radvanj	56,9	18,28	7,81	1,3	0,85	0,52	1,64	1,02	0,05	0,12	0,03
4	2004	Lipove doline	76,4	9,93	4,18	0,67	0,44	0,17	1,12	0,67	0,04	0,06	0,036
5	2004	Pared	62,8	10,35	5,68	1,26	6,22	0,58	1,77	0,56	0,07	0,65	0,024
6	2004	Reka	82,6	6,29	2,97	0,82	1,03	0,79	0,94	0,41	0,05	0,06	0,024

Tab. 5. The results of the chemical analysis for the pottery and sediment samples. Only the major oxides are presented in form of percentage of mass.

a reference to the Balkans, namely barbotine (Fig. 2:2,6; Fig. 6), were made of local clays and tempering materials.

Some potsherds contained grains of lime sandstone with micritic calcite cement[12] (Fig. 5) in the fabric, and this type of rocks can be found over a very limited area on the plateau. The nearest location of these lime sandstones is near Tomaj, a town located northwest ofthe Divača region and only 15 km from our two archaeological sites (*Otoničar 1999.32–33*). These sandstone grains were probably naturally present in the clay matrix of the pottery from Mala Triglavca and Trhlovca, but could have been added as temper according to the size and angularity of these grains[13]. Nevertheless, these materials point to the possibility of transhumance on the Karst plateau and the gathering of material for the vessels in different places, not just around the two rock shelters. Mala Triglavca and Trhlovca are located some 15 km away from the coastline near Trieste/Trst in Italy. Hence the distance between the coast and the plateau and the distances around the plateau rarely reach more than 30 km. All major communications in this region can be carried out over short distances. Therefore, the lime sandstone temper could have been used in pottery manufacture near the geological area of these rocks, and the finished products transported by herders to the caves around modern-day Divača, with other goods and the herds. Transhumance, i.e. the seasonal transfer of grazing animals to different pastures, often over substantial distances, can be an interpretative postulate for these groups as was shown by other studies (*Sterud 1978. 381–384; Halstead 1996.21–26*).

By using the scanning electron microscope for some of our pottery samples we also found a phosphorite grain in one of the pottery samples from Trhlovca. Phosphorite is a sedimentary rock with a high con-

12 Lime sandstone is composed of quartz, chert and limestone grains, which are combined with micritic calcite cement.

13 The angularity of the grains can be a result of the overall hardness of such grains due to quartz inclusions.

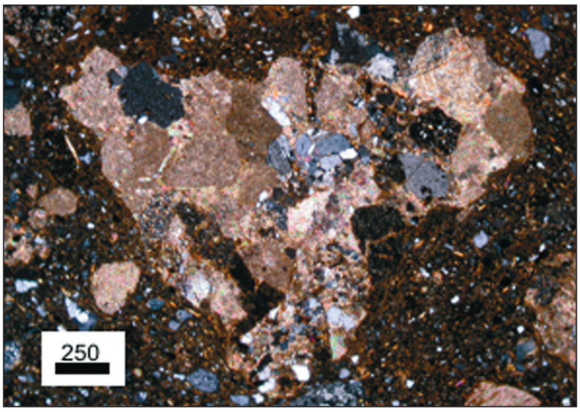

Fig. 5. Thin section photomicrograph of sample 5 (2000) from Trhlovca. In the middle is a grain of lime sandstone with micritic calcite cement (x40; + N; the black line is 250µm wide).

centration of phosphates in nodular or compact masses; one type of phosphorite is coprolites, fossilised animal or fish excrement. Phosphorite can be formed inside pottery in the sediment post-deposition, or may be naturally present in the clay that the potters used for their manufacture. In some potsherds from Mala Triglavca chemical analysis revealed a higher phosphorous content and similarly, in the clay sample from the deposit in Trhlovca. Phosphorus is closely associated with animal and human activity, because bones and teeth contain large amounts of this element. High concentrations of phosphorous in the soil often accumulate where humans have congregated and have discarded the bones of wild or domestic animals (*Brady, Weil 1999.540*). The presence of phosphorous minerals and the element itself in our samples links the potsherds to human and animal activities that took place after the deposition of the material in the caves and rock shelters, or indicates that the clay used for the manufacture of this potsherd was perhaps taken from a place in which these activities took place, for example from Trhlovca.

New soil micromorphological data from four rock shelters in the Trieste Karst (Grotta Azzurra/Pečina na Leskovcu, Edera/Stenašca, Caterina/Katrna pejca and Lonza) show that all post-Mesolithic deposits were coprolitic; that is, they are made up of thoroughly disaggregated and burned herbivore droppings, mostly of sheep and goat dung. The authors' suggestion is that shepherds in the Karst would have used the rock shelters in a system of transhumance pasturage almost exclusively as stables. The low number of remains of material culture (mainly pottery) in the layers offers some evidence for such behaviour. Furthermore, if the specialized use of rock shelters is assumed, it might be reasonable to believe that people moved around (*Boschian and Montagnari-Kokelj 2000.345–350*). The presence of phosphorite, of which coprolites are one of the varieties, in one of the pottery samples links our results with those made in Italy. Although detailed soil micromorphological research has not as yet been carried out in the Slovene Karst region, we may assume that results similar to those from Mala Triglavca and Trhlovca can be expected, since they both contain many animal bones and fewer artefacts, of which mainly pottery was found. Also, many white to grey ash layers are found in the stratigraphic sequence of these sites, which could contain phytoliths and coprolitic aggregates (coprolitic deposits have been proven for Mala Triglavca according to the preliminary results of the soil micromorphological data; Budja, pers.comm.).

The detailed study of the mineralogical and chemical composition of the Neolithic and Eneolithic pottery from two sites around Divača on the Karst plateau has shown that we have very uniform vessel pastes used in the pottery technology. We could find almost no difference in pottery composition within one of the sites or between the two sites, by using tempering material, at least not in the Neolithic and Eneolithic pottery from this micro-region. The use of calcite grains as the predominant temper seems to be not only a technology typical of the Neolithic period in the Karst plateau, but also typical for a wider area in this period. Calcite grains are a common temper in pottery also on the Triestine Karst in layers with the so-called Vlaška group pottery (*Spataro 1999.70–72*) and along the Adriatic coast in the context of the Danilo culture (*Spataro 2002.197*).

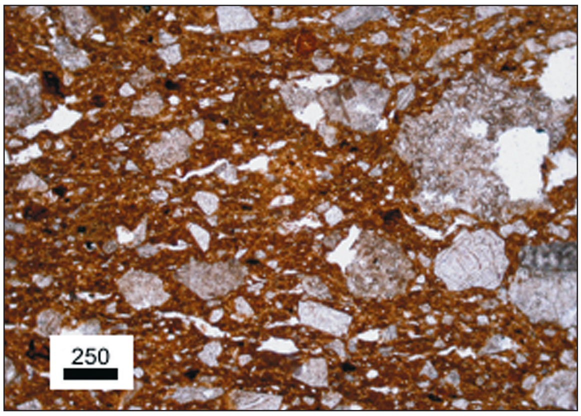

Fig. 6. Thin section photomicrograph of the sample 24 (2000) from Mala Triglavca. The potsherd is decorated with barbotine, The clay matrix includes calcite and few quartz grains (x40; || N; the black line is 250µm wide).

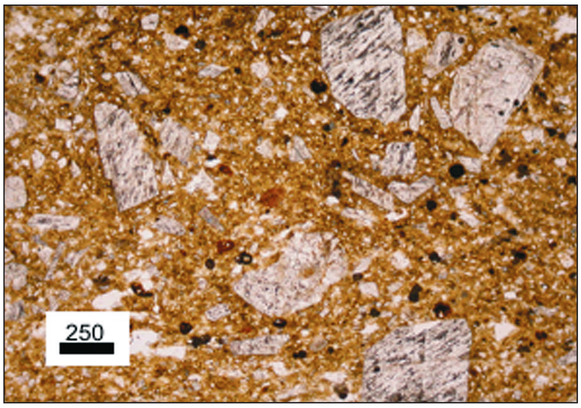

Fig. 7. Thin section photomicrograph of sample 24 (2003) from Mala Triglavca. The* rhyton *includes calcite and quartz grains and clay pellets (x40; || N; the black line is 250µm wide).

Pottery from Mala Triglavca and Trhlovca from the Neolithic period was made from local clays that were taken from cave sediments, but not from the deposits near the river as shown by our investigation. The main tempering material was calcite, a mineral that is abundantly available on the Karst and can be easily removed from cave walls and crushed. The clay already contained a lot of mica (muscovite) flakes that added significantly to the overall strength of the pots. The materials were locally available, calcite is abundant in caves, and the clay pastes were also taken from cave deposits as shown by our provenience study. The content of phosphorous in some samples and a phosphorite grain in one of the samples from Trhlovca also show that the rock shelters could have been used as stables for animals by Neolithic shepherds. Thus we conclude that most of the Neolithic pottery was produced on a local scale and from locally available materials on the Karst plateau. On the other hand, some of the pots have lime sandstone with chert grains, which proves that people were mobile, and with them went materials around the Karst plateau. Clays from the region around Tomaj will have to be sampled in the future to establish the original location of this material. Since one of the potsherds from Trhlovca (i.e. sample 10/2000; Tab.1; 5) has a different chemical composition than the other analysed pottery and sediment samples, a different natural clay source has to be assumed. For this reason sediment samples from the Slovene coast region, which is not far the two archaeological sites, would also have too be sampled. New sediment samples and analyses will therefore be needed to produce a more accurate picture of Neolithic pottery technology, mobility, and transhumance in this area.

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