Systèmes techniques et communautés du Néolithique précéramique au Proche-Orient
Technical Systems and Near Eastern PPN Communities
sous la direction de Laurence Astruc, Didier Binder et François Briois
Éditions APDCA, Antibes, 2007, p. 153-165

The evolution of technology during the PPN in the Middle Euphrates: A view from use-wear analysis of lithic tools

Juan José IBÁÑEZ*, Jesús GONZÁLEZ URQUIJO**, Amelia RODRÍGUEZ RODRÍGUEZ***

Abstract. Use-wear analysis of lithic tools carried out in some PPN sites of the Middle Euphrates (Tell Mureybet, Jerf el Ahmar, Tell Halula and Akarçay Tepe) allow us to show some technical changes taking place in the area between 10.000 and 7.800 cal. BC. We relate these technical changes to the economic and social evolution taking place during this time period.

Keywords. PPN, use-wear, Technology, Agriculture, Craftwork.

Résumé. L'analyse fonctionnelle de plusieurs échantillons d'outils lithiques provenant de quelques sites datant du PPN au Moyen Euphrate (Tell Mureybet, Jerf el Ahmar, Tell Halula et Akarçay Tepe) nous a permis de documenter quelques changements dans le domaine technique qui ont eu lieu dans cette région entre 10000 et 7800 cal. BC.

Mots-clés. PPN, tracéologie, technologie, agriculture, artisanat.

INTRODUCTION

The PPN represent a period of quick economic and social changes. The invention of agriculture and livestock was accompanied by other major economic, social and mental changes in the first Neolithic communities. The study of how the tools were used allows us to shed some light on the way in which the new economic challenges were faced, but also on how the work was organized.

Thus, we are dealing with the economic and social changes taking place in the PPN through the use-wear analysis of stone tools coming from 4 sites located in the Middle Euphrates (fig. 1): Tell Mureybet (Cauvin, 1997; Ibáñez, à paraître; Ibáñez *et al.*, à paraître), Jerf el Ahmar (Stordeur, 2000; Brenet *et al.*, 2001), Tell Halula (Molist, 1998; Molist *et al.*, 2001) and Akarçay Tepe (Arimura *et al.*, 2000). First, we will show the characteristics of the use of lithic tools in the different technical domains and later we will discuss the technical evolutions observed and the possible causes of the process.

HUNTING TOOLS

Segments are one of the main components of the flint industry in the Natufian levels of Tell Mureybet (Cauvin, Abbès, à paraître). The use-wear analysis of 57 segments has shown that they were used for hunting activities, inserted as projectile points or barbs. Striations, linear abrasions and fractures on the cutting edges are the result of the projectile impact into the target (fig. 2.1).

The location and orientation of the use-traces indicate that the segments were inserted in two different positions. The edge of most of them was placed in oblique while some others were placed transversally. It is difficult to know what the head of a Natufian projectile

* Institución Milá y Fontanals. Consejo Superior de Investigaciones Científicas, Egipciacas 15, 08001, Barcelona, Spain <ibanezjj@bicat.csic.es>

** Instituto Internacional de Investigaciones Prehistóricas de Cantabria (Unidad Asociada al CSIC), Avda. de los Castros, sn., 39005, Santander, Spain <gonzalje@unican.es>

** Grupo Tarha. Departamento de Ciencias Históricas. ULPGC. C/ Pérez del Toro nº 1. Las Palmas de Gran Canaria. 35003, Spain <arodriguez@dch.ulpgc.es>

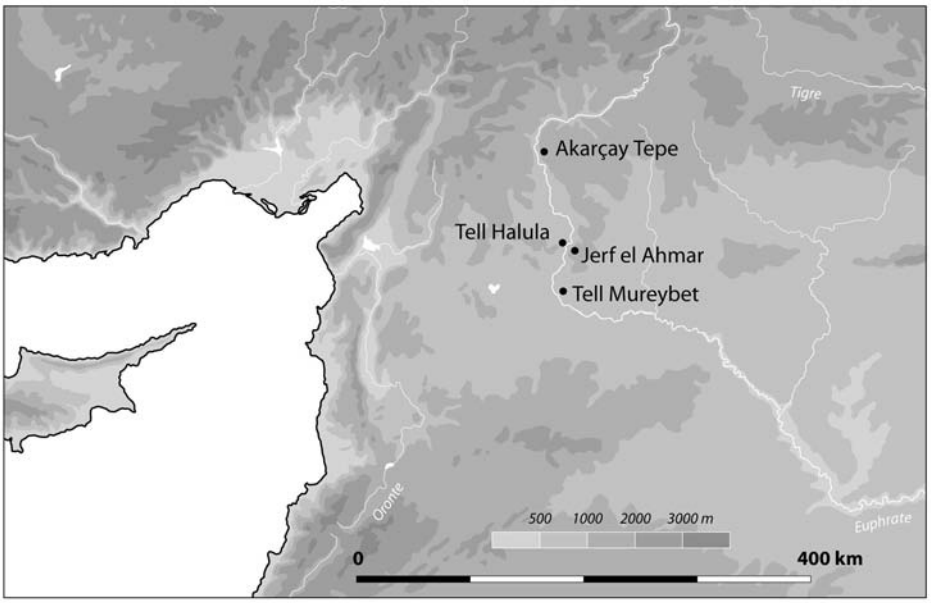

Fig. 1. Map of cited sites.

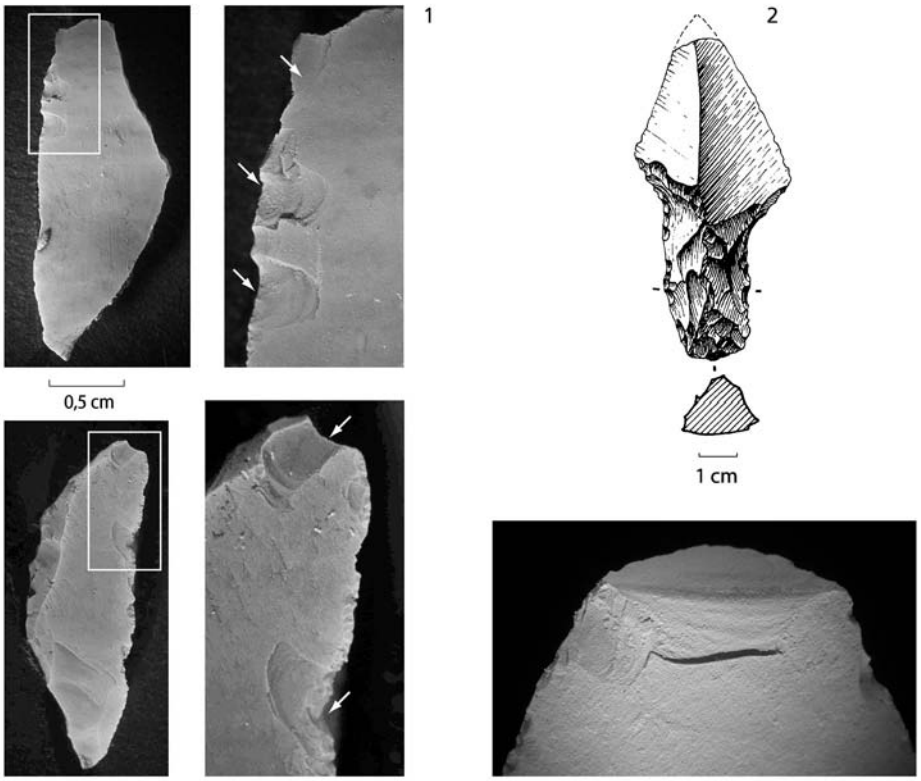

Fig. 2. 1. Impact fracture in one segment (Natufian, Mureybet); **2.** pointed tool used as dagger or pike (Natufian, Mureybet).

could look like, although the Egyptian examples dating from the 3rd millennium BC (Clark *et al.*, 1974) could fit well with our use-wear data. In these arrowheads one central segment is placed transversally, working as the proper head of the projectile, while two other lateral segments placed obliquely work as barbs. The small segments must have been inserted in a type of light projectile that should have based its effectiveness in the speed of penetration instead of in its mass. These projectiles were probably arrows to be thrown with a bow (Bar-Yosef, 1987; Valla, 1987). One segment was found inserted into a vertebra of an individual, in the Early Natufian levels of Kebara Cave. The position of the segment shows that it was put as an arrowhead element, placed as a transversal arrowhead or as a lateral barb (Bocquentin, Bar-Yosef, 2004).

The hunting and butchering tool kit was complemented with a kind of dagger or pike (fig. 2.2). Some

pointed tools, showing a thick tang for hafting, were used for killing or finishing animals, as the impact traces in the point indicate. The sides of the tools show butchering activities, so it was a tool with a double function.

In the older Khiamian levels of Tell Mureybet a wider variety of projectile types can be observed. The small segments are still used, while some other bigger segments are also present[1]. These tools also bear impact traces, and they were probably inserted obliquely into the shaft of the projectile (fig. 3.1). The different size of both types of projectile elements suggests that two different types of hunting tools were in use; the heavier elements probably used as spear heads. Beside these impact traces in the cutting edges, we did observe some use-traces from cutting soft animal tissue. These spear elements could be unhafted when needed and used as tools for butchering the prey. These big segments are far less numerous than the small ones.

Khiamian arrowheads appear in these levels for the first time, towards 9.700 cal. BC (Cauvin, Abbès, à paraître). Some of these points show impact fractures, so their use as projectile heads is clear. None of these points were recycled for another activity through retooling by retouch. These points are very light, so the change from arrowheads made with segments to arrowheads made with Khiamian points did not necessarily modify the technology or archery. During the end of the Khiamian period, in the second half of the 10th millennium cal. BC, the use of geometric projectile elements ended. The arrowheads, either the Khiamien or the new Mureybet and Helwan points, became the only type of projectile in use (Cauvin, Abbès, à paraître).

The analysis of the faunal remains in Tell Mureybet (Gourichon, Helmer, à paraître) shows a clear continuity between the Natufian and the Khiamien levels. Gazelles are the dominant prey in both periods. The hunting pattern indicate that a mass killing of females and young gazelles could have taken place, probably resorting to collective hunting and to the use of traps (type desert kites). A similar pattern has also been observed in the nearby and a bit older Natufian site of Abu Hureyra (Legge, Rowly-Conwy, 2000).

Some important changes in hunting technology take place during the PPNA. Bipolar knapping allows the elaboration of thicker and longer pointed blades, many of them being used for making arrowheads, although unipolar blades are also used for making this type of tool (Abbès, à paraître). These heavier arrowheads must have been thrown with more powerful bows. These changes in archery can be related to some changes in the hunting techniques. During the PPNA the importance of mass hunting of gazelles decrise, and the hunters tend to concentrate more on bigger prey (onagers, aurochs) and they also hunt groups of males (Gourichon, Helmer, à paraître). The more powerful bows and the heavier arrows were the more effective for hunting bigger animals, allowing shooting them from longer distances.

When the point of the arrowhead got broken by impact, it could be repaired by retouch, that is, by remaking the broken point. During the PPNA of Tell Mureybet arrowheads would often be recycled (fig. 3.2). They show traces of many other activities, as bone working, stone drilling, wood sawing, etc. In some cases, these were the result of recycling broken arrowheads that could not be used for hunting anymore, but in many other cases it seems that they would recycle some arrowheads that were not broken for different activities other than hunting. The analysis of the faunal remains shows that hunting was mainly seasonal (Gourichon, Helmer, à paraître). We believe that the elaboration of arrowheads could have been seasonally concentrated in the periods of the year previous to the hunting season. After the hunting season the need for arrows would go down so the arrowheads would have been used as simple blades for other activities.

From the PPNB onwards, upward trends in the use of arrowheads which are seen during the PPNA occur. The predetermined bipolar blades are chosen for making the heavier Byblos points. These points are more often recycled than the PPNA points. The recycling of Byblos points has been observed in some PPNB sites, as Tell Mureybet, Tell Halula, Akarçay Tepe, Çayönü (Coşkunsu, Lemorini, 2001) and Abu Hureyra (Moss, 1983).

The PPNB hunting and butchering tool-kit was complemented with a type of dagger/knife made with predetermined bipolar blades. The morphology of this dagger looks like a Byblos point without tang, being the point detached by retouch. The edges of these tools were used for butchery, but also for many other activities related to cutting and scraping. It was probably a multifunctional tool that was carried by the worker in contexts where a variety of technical activities would be carried out.

HIDE WORKING

For the moment, we have no data on hide working during the Natufian and Khiamian periods in the Middle Euphrates. During the PPNA of Tell Mureybet end-scrapers were mainly used for hide scraping. End-scrapers were employed for cleaning hides, scraping them fresh or soaked, and for softening and scraping them dry. Besides the traces of dry hide scraping some end-scrapers bear also traces of bone scraping in some small areas of the end-scraper front. We think that the softening of the hides was made with flint end-scrapers and with bone spatulas, so the end-scrapers used for

1. These segments are called "*lames à dos courbe*" by M.-C. Cauvin in order to distinguish them from the small segments.

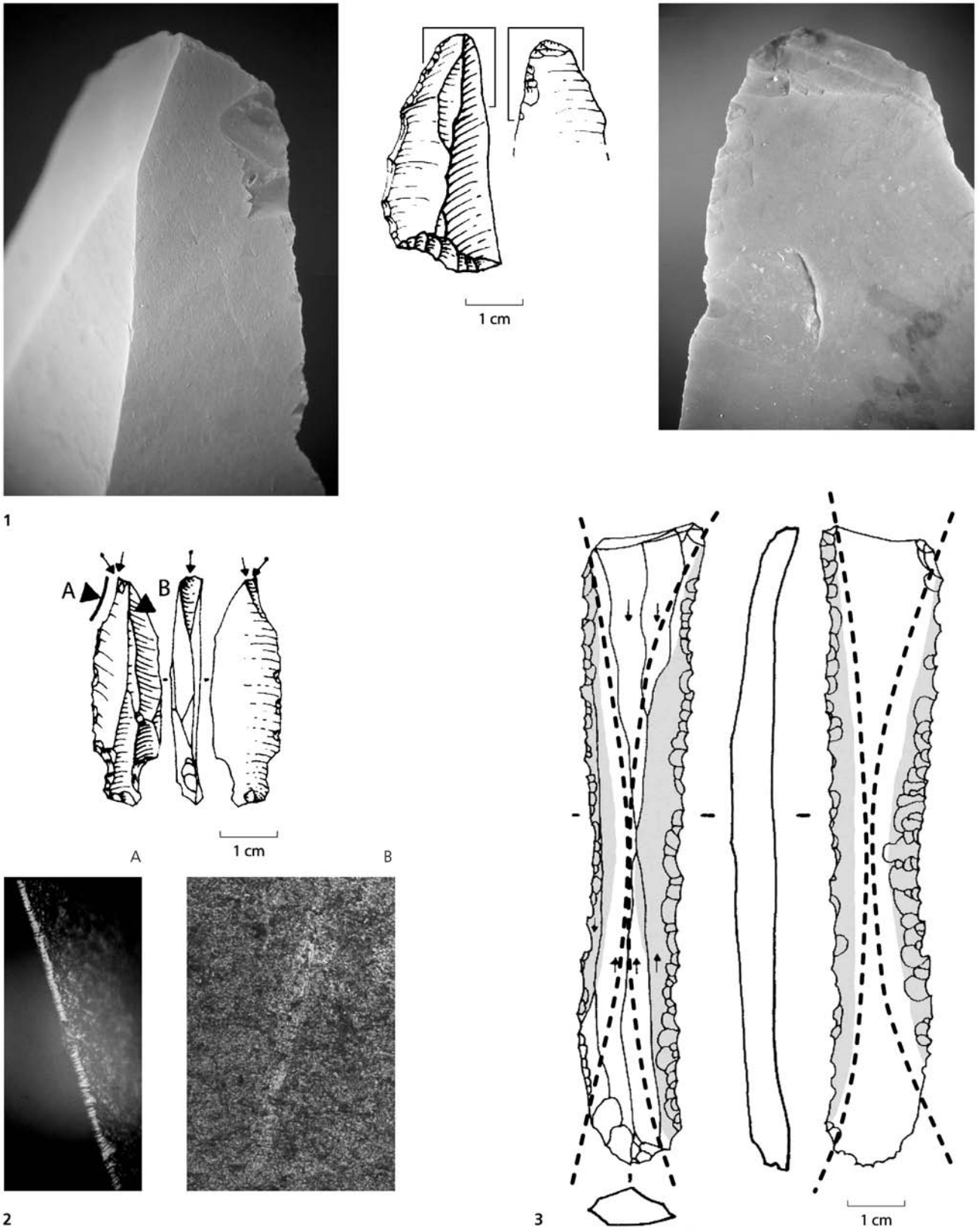

Fig. 3. 1. Use-wear traces in big segments (Khiamian, Mureybet); **2.** recycling of arrowheads (PPNA, Mureybet); **3.** sickle blade, parallel insertion in a bent sickle (Early PPNB, Mureybet).

scraping hides were incidentally used for re-sharpening the bone tools. The hides were cleaned with flint end-scrapers, dried and later softened with flint end-scrapers and bone tools. The softened hides were cut with flint blades. Many of these tools show very abrasive traces and ochre residues, indicating that before cutting, the hide had been impregnated with ochre powder. The ochre may have an antiseptic function, thus helping to the preservation of the hides (Audoin, Plisson, 1982). The use of ochre for hide processing is known in some Upper Palaelothic contexts, and its use in the PPNA would indicate that other more stable methods for preserving hides (tanning) were not known. Any symbolic meaning for the use of ochre shouldn't be ruled out. A similar technical process of hide processing is documented ethnographically in Ethiopia for elaborating ritual kilts. Hides are scraped with end-scrapers, dried and covered with ochre before elaborating the kilts, by cutting with knives (Brandt,Weedman, 2002).

End-scrapers are used in hide working during the whole PPNB, both for cleaning and softening hides. However, from the Early PPNB a major change in hide working takes place dealing with the use of ochre. The blades with traces of cutting ochred hides which are so common in the PPNA levels are gone. It seems that ochre was no longer used for impregnating hides. Bearing in mind the function of preservation attributed to ochre, this change could mean that other methods of preservation were invented. These newer methods might have included some kind of mineral or vegetal tanning. Other possibilities include changes in the symbolic meaning of ochre.

Stone bead making

Beads are very abundant in the PPN. Stones for making beads were cut and scraped with flint blades and perforated with drillers. These drillers are especially abundant in the Khiamian levels of Tell Mureybet, as well as other Khiamian sites of Southern Levant (Bar-Yosef, 1998). Their prevalence indicates the importance of bead making in this first period of the Neolithic Revolution. Both local and exotic rocks were used for making beads (Santallier *et al.*, 1997). The analysis of the stone residues detected in some drillers of the Khiamian levels of Tell Mureybet has shown that both local and exotic rocks were perforated in the site (Ibáñez *et al.*, à paraître).

During the Khiamian of Tell Mureybet, the use-wear traces in the drillers show two types of drilling techniques: hand and mechanic drilling. This could indicate that two different levels of technical knowledge were put forward in the elaboration of beads. Drillers used in hand drilling are shorter and thicker and are not as symmetrical as the ones used for mechanical perforation.

Stone beads continued to be made during the PPNA and the PPNB, and the asymmetric and short drillers disappeared, indicating that mechanical drilling substituted hand drilling methods. During the Late PPNB some drillers bear very intensive use-wear traces, the ridges of the retouched point being completely eroded so the point shows a cylindrical morphology. These type of drillers are quite abundant in the site of Teleilat (G. Coskunsu, pers. comm.) and they are also present in the neighbouring site of Akarçay Tepe. These very intensive traces can only be generated if a very abrasive material was involved in the perforating activity. Moreover, as the ridges of the point are worn off by the friction, the perforating capacity of the point should have been considerably reduced, except if an abrasive element (like sand) was added in the perforating activity.

Harvesting activities

In the Middle Euphrates, important proportions of domestic cereals are not observed up to the Middle PPNB (Willcox, 1996). During the previous periods agriculture occurred though cereals remained in their original wild morphology, in a phase that has been called pre-domestic agriculture (Cauvin, 1997).

During the Natufian period of Tell Mureybet, harvesting tools were scarce, and although they were slightly more common in the Khiamian levels, they remain a small part of the whole lithic industry in both periods. Some of these sickle elements were used for harvesting wild cereals (Anderson-Gerfaud, 1983).

During the PPNA (Mureybetian) the proportion of sickle elements was considerably increased and they showed more intensive use-wear traces. This growing importance of sickle elements in the PPNA can be related to a period of pre-domestic agriculture (Willcox, 1997). The economy of the PPNA communities in Tell Mureybet shows the evolution from a broad spectrum economy based on wild resources, to a peasant economy based on agriculture and suplemented by wild resources. In both economies, the morphology of the PPNA sickles does not seem to have changed from the Natufian, as the flint elements are still inserted in parallel into straight hafts.

The morphology of sickles began to change in the Early PPNB. The distribution of the sickle gloss in the sickle elements shows that they were inserted parallel into curved shafts (fig. 3,3). The PPNB sickles in the Middle Euphrates should have looked like the one found in Nahal Hemar Cave (Bar-Yosef, Alon, 1988). This morphology of sickle is also present in Middle PPNB levels of Tell Mureybet and Tell Halula.

R. Unger-Hamilton (1992) pointed out that the quantity of striations present in the use-wear polish was related to the tilling of the soil, so the more striated polish

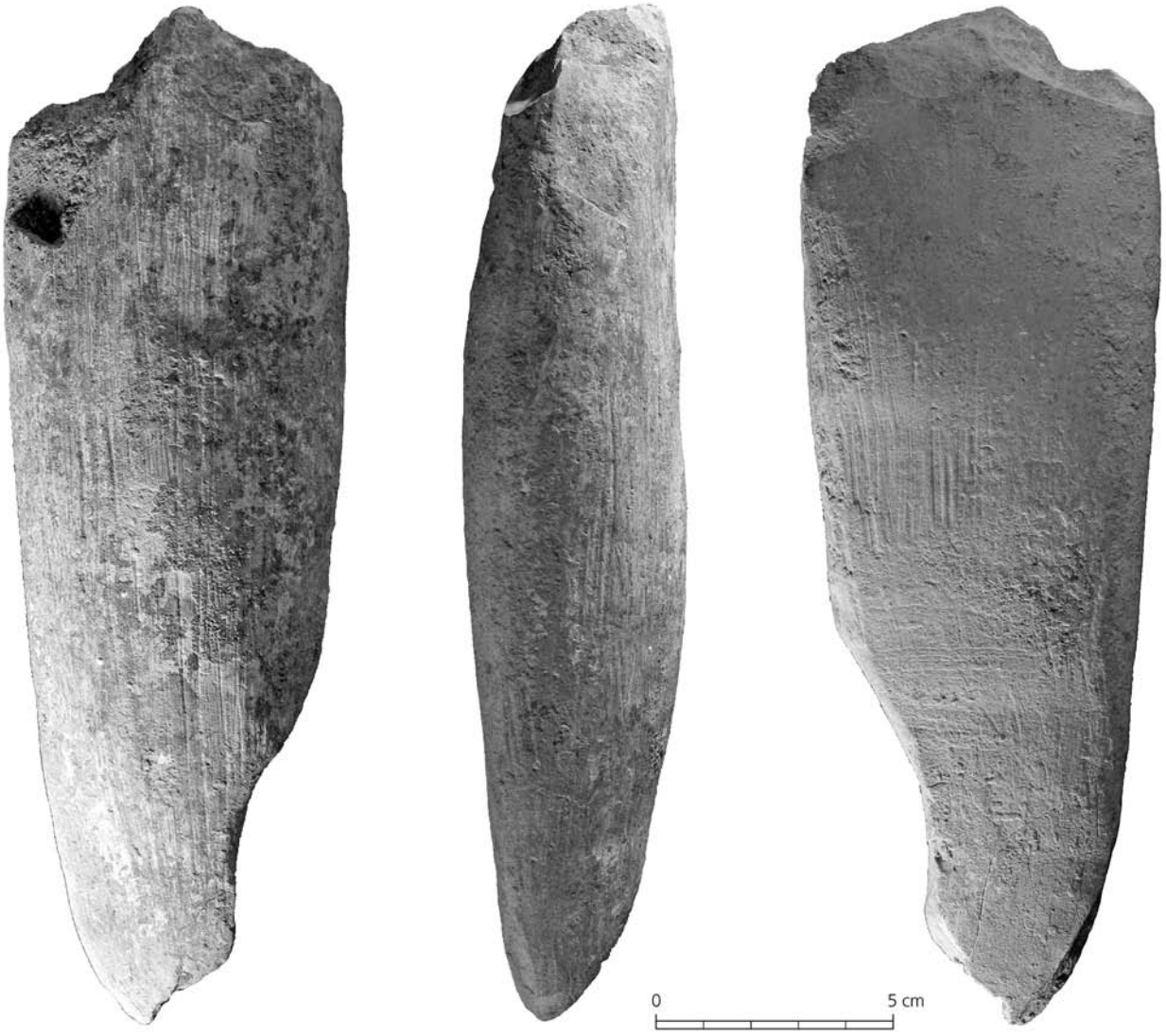

Fig. 4. Hoe made in limestone (Middle PPNB, Tell Halula).

in the sickle elements of the more recent periods could show the practice of agriculture. P. Anderson (1992) replied that the quantity of striations in the use polish was related to the height of the stem cutting (more striated polishes as a result of cutting near the ground), so the quantity of striations was not a good indicator of ground tilling. Dealing with the characteristics of harvesting polish during the PPN we can see an evolution from more brilliant, domed and less striated polishes to duller, flatter and more striated ones. For us, the quantity of striations depends on different factors including: the height of the cutting (lower cutting generates more striations), the type of soil (*i.e.* looser volcanic soil produces more striations), the intensity of use (longer uses generate more striations) and the degree of humidity at the moment of harvesting (drier contexts produce more striations). The topography and brightness of use polish is also related to the degree of humidity of the cereal when harvesting, since drier harvesting contexts generate flatter and duller polishes. The presence of flatter, duller and more striated polishes is more abruptly evident during the Middle PPNB. We believe that these changes in the harvesting polish can be related to main changes taking place in the agriculture of the period. In the Middle PPNB the cultivation of domestic cereals seems to be a very important economic activity in peasant communities (Willcox, 1996). These growing importance of domestic cereals should imply the harvesting of more extended extensions of cereal fields (more intensive traces), the cutting of dry stems (domestic cereals being harvested at the beginning of the summer, when the cereal is completely ripe) and perhaps the cutting near the ground for using the straw in different activities[2] (roofing, craftwork, livestock bed or feeding, etc.).

2. The use of the straw for covering the floor of some rooms is well

New changes in the morphology of the sickle can be observed during the Late PPNB. Blade fragments were used as sickle elements showing oblique use-wear polish distribution. These Late PPNB sickles should have looked like the Karanovo examples, that is, a curved shaft with several sickle elements in oblique insertion.

Soil tilling

We have no information on tilling tools during the Natufian, Khiamian and PPNA periods in the Middle Euphrates. A new type of stone hoe (fig. 4) has been documented for Tell Halula, in the Middle PPNB, once domestic cereals were well established (Ibáñez *et al.*, 1998).

The presence of hoes has been mentioned for other contemporaneous sites in the Near East. Similar tools made of limestone have been found in the cell-plan phase of Çayönü (Davis, 1982:108) and in some sites in the Zagros (Hole *et al.*, 1969: 189-192). Bone tools probably used for working the land are also known in the mid PPNB levels of Beidha (Stordeur, pers. comm.). In all these archaeological contexts we find a dominant proportion of domestic cereals in comparison to the wild types.

The stone tools used as hoes, consisted of extended pieces worked in limestone, displaying an active edge at one end, which is covered with an asphalt layer (Ibáñez *et al.*, 1998). We have found fifteen of these objects in the middle PPNB of Tell Halula. The stone from which the objects are made is relatively soft, so they were shaped using flint tools.

Bone working

Bone and more marginally antler were scraped and cut with flint tools during the Natufian, Khiamian and PPN periods. The burin was the most specific tool used in bone working. It was used to scrape bone with the edges of its lateral facets. These active zones are very effective for bone working as they have very solid edges and they can be rejuvenated with another burin blow. Contrary to the Upper Palaeolithic burins, the tip of the burin was not usually used for engraving. This is probably due to the fact that the groove and splinter technique, so much used in the Upper Palaeolithic, is not common in the PPN.

Wood working

The first Natufian communities that settled down in Tell Mureybet used a type of flint adze for working wood in percussion, the *herminette* (Sánchez-Priego, à paraître). This tool was also in use during the Khiamian period. At this moment the herminettes were mainly used for working wood and secondarily for working stone, probably for elaborating stone vessels. During the PPNA wood is still worked with herminettes, as it is documented in the *47 building* of Tell Mureybet, where posts are clearly cut by percussion (Cauvin, 1977). However, these adzes are also used for shaping the limestone into « pierres en cigare », oval shaped stones used for making the walls of the houses (Brenet *et al.*, 2001). During the PPNB herminettes were not being used any more, as they were replaced by the polished adzes and axes in wood working activities.

From the PPNA, some long ant thick perforators show traces of wood boring. L.H. Keeley (1983) has suggested that these wood boring activities could be related to a new technique of wood assembling invented during the Neolithic.

Most of the activities of wood working documented by use-wear analysis during the PPN were carried out with unretouched tools, blades or flakes. In general these are not very intensive activities that seem to be related mostly to the last steps of the technical processes of elaboration of wood objects, that is, the finishing or the repairing phases. Wood objects were probably roughed out and shaped by percussion. Only the last steps of the technical process, the most detailed work, was carried out with flint tools.

Plant working

Blades used for cutting plants other than cereals are present form the Natufian period and all along the PPN. These tools were probably used for collecting reeds or rushes in order to carry out some technical activities (making nets, roofing, etc.).

Some other blades show a type of plant scraping polish (fig. 5.1). Active zones in these tools are short (less than 1 cm) and usually present a concave outline, as if they would have been used for scraping one cylindrical material. We have documented ethnographically the scraping of reeds with iron concave edges for basketry in Northern Morocco (fig. 5.2). Reeds are split along using a small wooden stick and the ribbons are later scraped with an iron concave knife in order to smooth the sides before weaving the basket with them. These types of tools are present, at least, from the Khiamian to the Late PPNB. We think that they were used for basketry, a type of technical activity that has been documented by other methods, especially through the analysis of imprints in clay (Stordeur, 1989).

Stone working

The bowls made in white limestone are present from the Natufian to the Middle PPNB. From the Late PPNB

documented in Tell Halula, due to the layers of cereal phytoliths found in the excavation (Molist, pers. comm.).

Fig. 5. 1. Tool used for scraping plants (PPNA, Mureybet); **2.** Scraping reeds for basketry in Northern Morocco.

other harder types of stones are more often used for making recipients. Limestone bowls show the traces of elaboration in the surface (Lebreton, à paraître). The exterior face of the bowls was shaped by percussion. The interior side of the recipient was made by scraping, if the bowl was not too deep. For deeper bowls, first deep holes were made with thick drillers and the hole was later deepened with pointed blades used as reamers. The inside and outside of the bowls were finished through scraping. We have found different types of retouched and unretouched tools used for working limestone. Many of the tools are unretouched blades or flakes whose edges could be rejuvenated by retouching them. Burins could also be used for scraping stone, as their lateral facets are very apt for working hard materials. The proportion of stone working tools is higher in the Middle PPNB of

Tell Halula than in previous periods, so it seems that stone bowls were more often made in this period than before.

As we mentioned earlier, from the Late PPNB harder stones were used for making bowls (Roodenberg, 1986). This change can be observed in the Late PPNB tools of Tell Halula, as the tools used for working stone show very intensive traces, including the rounding and scratching of the edges. This would indicate that these types of stone bowls were made in the site.

CONCLUSIONS

The use-wear analysis of stone tools has allowed us to document some technical changes taking place during the PPN in the Middle Euphrates. Some different causes may explain this evolution. One possible cause is the appearance of new technical needs, as those related to the origin of agriculture or the shifting role of hunting. Another possible cause is the general process towards more complex technologies that we relate to the origin of craftsmanship, that is, the production made by specialists in order to exchange it.

Agriculture demands four types of technical development that must be carried out with tools: planting (soil tilling), harvesting, processing and transport/stocking. As it has been pointed out (Cauvin, 1997) the technology needed for agriculture was already invented before the first agricultural experiences in the PPNA. Soil tilling was probably carried out with wooden tools, so we do not have any information about this question. Harvesting knives and straight sickles in the PPNA do not differ significantly with respect to their Natufian predecessors. Both the technology of processing (milling stones, boulders…) and stocking crops (basketry, stone recipients, stocking pits…) are also well documented in the Natufian. Thus, the first agriculture only implied resorting to a more intensive use of some techniques that were already known.

During the middle PPNB, domesticated cereals are dominant compared to the wild species, and the signs of intensification of agriculture are evident (Willcox, 1998). At this moment, we can observe the first fully peasant communities in the Middle Euphrates, with an economy mostly based on agriculture and livestock. This is the period when we document some changes in the morphology of sickles and the appearance of stone hoes. As agricultural production intensified, the same fields began to be used year after year, so it became necessary for the job of turning the earth over to be done more intensively, in order to mitigate the effects of the loss of soil productivity (Harris, 1996). In this context, the hoe could have been adopted as a tool that allows the soil to be dug over in a more intense and systematical way (Sigaut, 1996). Archaeobotanical studies carried out at Tell Halula (Willcox, Catalá, 1996) point to the appearance of a wide variety and diversity of weeds alongside the crops. This evidence implies that crops were continuously cultivated in the same working fields. During the middle PPNB, the hoes made on relatively soft limestone could be used for tilling the non-stony alluvial fans on the edges of the freshwater swamps (Araus *et al.*, 1999, p. 184). From the Late PPNB the use of hoes made on harder stones should have made possible the spreading of cultivation to other more stony lands.

Some changes in the morphology of sickles are also documented in the Middle PPNB. The straight morphology of the Natufian and PPNA sickles implied a harvesting gesture consisting of gathering and taking the cereal stems with one hand and cutting them with the sickle. In the Middle PPNB we observe the first curved sickle shafts, what can be called Nahal Hemar sickle type (Bar-Yosef, Alon, 1988). This change represents a considerable technical advance, as the sickle shaft can be used both for gathering the stems and cutting them, allowing a more continuous and effective harvesting gesture (Ibáñez *et al.*, 1998). During the Late PPNB, sickle shafts were more intensively curved, and the way of inserting the flint elements changed. Up to the Late PPNB sickle elements of flint were inserted parallel to the shaft, but, at that moment, the elements were inserted obliquely. In this way sickles showed an indented edge which is very effective for cutting the plant fibbers, allowing the sickle to penetrate more deeply in the cereal bundle when cutting it.

The changes in the morphology and size of arrowheads should be related to major shifts in hunting techniques. In the Natufian and the Khiamian, hunting was a basic resource based on the massive slaughter of gazelles, especially in spring. During the PPN, this punctual, specialized and collective hunting tended to be substituted for the non massive killing of bigger animals (especially equines and aurochs) (Gourichon, Helmer, à paraître). During this process, hunting progressively lost its economic importance, becoming a complementary resource and probably gained symbolic meaning (Cauvin, 1997). Heavier arrowheads and, consequently more powerful bows seem more suited for the hunting of bigger and more dangerous animals carried out by small groups of hunters. The signs of violence are still scarce in the Natoufian and Neolithic of the Near East (*i.e.* Bocquentin, Bar-Yosef, 2004), so, as far as we know, war should not have played a major role in the evolution of weaponry during that period.

Beside the new technical needs related to the shifts in the economic resources (agriculture and hunting) we observe, during the PPN, the evolution from more expedient technologies towards more curated ones.

First, we can observe a growing tendency towards more technical investment in the elaboration of tools

or finished objects. Percussive tools (herminettes) are made by direct percussion on flint, but, from the PPNB, these adzes are substituted by polished axes and adzes. Unipolar blade knapping during the Khiamian is changed for bipolar knapping during the PPNA, when the first predetermined pointed blades appear. The knapping of these predetermined blades becomes a rule during the PPNB (Abbès, à paraître). The same technical evolution of flint knapping is also documented in the elaboration of obsidian tools. However, from the Middle PPNB, a particular knapping technique, pressure flaking, was used for making obsidian bladelets. Pressure flaking was also used for making flint blades from the Late PPNB. During the Khiamian, hand boring and mechanical boring were used for drilling beads; the former being more common. From the PPNA mechanical drilling generalizes and from the Late PPNB more sophisticated drilling methods including the use of abrasive elements were incorporated in this technical process. If the lack of use of ochre for the processing of hides from the PPNB was related to the invention of new methods of hide tanning, as we suggest, we could deal with a new context of improved technical investment.

The new more complex tools were used more intensively than before and they were resharpened more often. This is evident for polished celts in comparison with herminettes, as the polished tools are continuously rejuvenated by abrading the edge. The recycling of tools gets more and more common during the PPN, as we showed for arrowheads and other blade tools (Ibáñez *et al.*, à paraître). In other cases, the new techniques were not intended for obtaining tools of longer use, but for getting more specialized tools. For example, pressure flaked obsidian bladelets were used for cutting soft animal tissue. So, from the Middle PPNB, Anatolian obsidian was knapped with a specific technique (pressure flaking) in order to obtain very thin and sharp blanks used as hide/meat knives.

In the more expedient older technologies (Natufian, Khiamian), the elaboration, use and discard of the tools was a process more continuous in time and space. In the more curated PPN technologies, the stocking, transport and exchange of the tools seemed to play a more important role in lithic technology. The *caches* of lithic tools are a phenomenon that gets more and more common along the PPN. During the PPNA we can find stocks composed by the different steps of the lithic technology (raw material, cores, blanks, tools), showing that this caches were immediate sources of tools ready for the moment of need. During the PPNB other types of caches composed of blade blanks or finished tools can be found, indicating the existence of more distance between the moment of elaboration and use of the tools. The quantity of blanks found on some of these caches would indicate that these concentrations of blanks were ready for exchange (Quintero, 1998; Astruc *et al.*, 2003). This could also be the case of some caches of finished tools, as the stone recipients found in the burned house of Tell Bouqras (Roodenberg, 1986), concentrated in a big number and placed in a way that seem to be intended for exchange.

The complexity of some of the technical processes put forward in the PPN, the caches of end-products (blanks), and the exotic origin of some raw materials (*i.e.* obsidian) suggests the existence of specialized lithic productions intended for exchange. This hypothesis has already been pointed out for bipolar knapping in the PPNB (Quintero, Wilke, 1995; Quintero, 1998). This incipient craftsmanship can be observed in other technical domains, as the chlorite recipients. These objects were made with Anatolian raw material and they can be found in PPN Anatolian sites at the end of the 10th millennium cal. BC (Rosenberg, Peasnall, 1998, fig. 3; Rosenberg, Davis, 1992, fig. 7-8), although some of them *traveled* up to some PPNA sites in the Middle Euphrates (Stordeur, 2004). The technical complexity needed for making the objects and the standardization of the decoration suggests that we are dealing with a technical process made by specialists. Their presence in the Middle Euphrates indicates that they were elaborated for being exchanged.

All in all, we think that the evolution towards more complex technologies is showing a process of technical specialization and of generalization of exchange. We suggest that the PPN specialization could be inserted in what has been defined as domestic craftsmanship (Peacock, 1982, p. 8; van Der Leeuw, 1984; Rice, 1987, p. 184; Perlès, 2001; González *et al.*, 2001), that is, technical processes carried out by specialists that are primarily peasants and secondarily artisans who work at small scale inside the domestic dwelling.

Bibliography

ABBÈS F., à paraître.– Analyse technologique des industries de Tell Mureybet, *in*: Ibáñez J. J. (éd.), *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

ANDERSON P. C., 1992.– Experimental cultivation, harvesting and threshing of wild cereals and their relevance for interpreting the use of Epipaleolithic and Neolithic artefacts, *in*: Anderson P. C. (éd.), *Préhistoire de l'agriculture: nouvelles approches expérimentales et*

ethnographiques, Paris, Éditions du CNRS (Monographies du CRA, 6), p. 179-210.

ANDERSON P. C., 1998.– The history of harvesting and threshing techniques for cereals in the prehistoric Near East, *in*: Damania A. B., Valkoun J., Willcox G., Qualset C. O. (eds), *The Origins of Agriculture and Crop Domestication*, Aleppo, ICARDA/IPGRI/GRCP/FAO, p. 141-155.

ANDERSON-GERFAUD P. C., 1983.– A consideration of the uses of certain backed and lustred stone tools from Late Mesolithic and Natufian levels of Abu Hureyra and Mureybet (Syria), *in*: Cauvin M.-C. (éd.), *Traces d'utilisation sur les outils néolithiques du Proche-Orient*, Lyon, Maison de l'Orient méditerranéen, (TMO, 5), p. 77-106.

ARAUS J. L., FEBRERO A., CATALA M., MOLIST M., VOLTAS J., ROMAGOSA I., 1999.– Crop water availability in early agriculture: evidence from carbon isotope discrimination of seeds from a tenth millennium BP site on the Euphrates, *Global Change Biology*, 5, 2, p. 201-212.

ARIMURA M., BALKAN-ATLI N., BORRELL F., CRUELLS W., DURU G., ERIM-OZDOGAN A., IBÁÑEZ J. J., MAEDA O., MIYAKE Y., MOLIST M., OZBASARAN M., 2000.– A new Neolithic settlement in the Urfa region: Akarçay Tepe, 1999, *Anatolia Antiqua,* 7, p. 227-255.

ASTRUC L., ABBÈS F., IBÁÑEZ ESTEVEZ J. J., GONZÁLEZ URQUIJO J. E., 2003.– « Dépôts », « réserves » et « caches » de matériel lithique taillé au Néolithique précéramique au Proche-Orient : quelle gestion de l'outillage ?, *Paléorient*, 29, 1, p. 59 78.

AUDOIN F., PLISSON H., 1982.– Les ocres et leurs témoins au Paléolithique en France: enquête et expériences sur leur validité archéologique, *Cahiers du Centre de recherches préhistoriques*, 8, p. 33-80.

BAR-YOSEF O., 1987.– Direct and indirect evidence for hafting in the Epi-Paleolithic and Neolithic of the Southern Levant, *in*: Stordeur D. (éd.), *La main et l'outil: manches et emmanchements préhistoriques*, Lyon, Maison de l'Orient méditerranéen, (TMO, 15), p. 155-164.

BAR-YOSEF O., 1998.– The Natufian Culture in the Levant - Threshold to the Origins of Agriculture, *Evolutionary Anthropology*, 6, 5, p. 159-177.

BAR-YOSEF O., ALON D., 1988.– Nahal Hemar Cave: The Excavations, *'Atiqot*, XVIII, p. 1-30.

BOCQUENTIN F., BAR-YOSEF O., 2004.– Early Natufian remains: evidence for physical conflict from Mt Carmel, Israel, *Journal of Human Evolution*, 47, 1-2, p. 19-23.

BRANDT S. A., WEEDMAN K., 2002.– The ethnoarchaeology of hide working and stone tool use in Konso, Southern Ethiopia: an introduction, *in*: Audoin-Rouzeau F., Beyries S. (éd.), *Le travail du cuir de la Préhistoire à nos jours*, XXII^{e} rencontres internationales d'archéologie et d'histoire d'Antibes, Antibes, APDCA, p. 113-130.

BRENET M., SAÑCHEZ-PRIEGO J., IBÁÑEZ J. J., 2001.– Les pierres de construction taillées en calcaire et les herminettes en silex du PPNA de Jerf el Ahmar (Syrie), analyses techno-logiques et expérimentales, *in*: Bourguignon L., Ortega I., Frère-Sautot M. (éd.), *Préhistoire et approche expérimentale,* Montagnac, Éditions Monique Mergoil (Préhistoire, 5), p. 121-164.

CAUVIN J., 1977.– Les fouilles de Mureybet (1971-1974) et leur signification pour les origines de la sédentarisation au Proche-Orient, *Annuals of the American School of Oriental Research*, 44, p. 19-48.

CAUVIN J., 1997.– *Naissance des divinités, naissance de l'agriculture. La révolution des symboles au Néolithique*, nouvelle édition, Paris, CNRS Éditions.

CAUVIN M.-C., ABBÈS F., à paraître.– Analyse du mobilier retouché, *in*: Ibáñez J. J. (éd.), *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

CLARK D., PHILLIPS J. L., STALEY, P. S., 1974.– Interpretation of prehistoric technology fron Ancient Egypt and other sources. Part I: Ancien egyptian bows and arrows and their relevance for African prehistory, *Paléorient*, 2, 2, p. 323-388.

COŞKUNSU G., LEMORINI C., 2001.– The function of Pre-Pottery Neolithic projectile points: the limits of morpho-logical analogy, *in*: Caneva I., Lemorini C., Zampetti D., Biagi P. (eds), *Beyond Tools. Redefining the PPN Lithic Assemblages of the Levant,* SENEPSE, 9, Berlin, ex oriente, p. 145-160.

DAVIS M., 1982.– The Çayönü ground stone, *in*: Braidwood L., Braidwood R. (eds), *Prehistoric Village Archaeology in Turkey*, Oxford, Archaeopress, BAR International Series, 138, p. 73-174.

GONZÁLEZ URQUIJO J. E., IBÁÑEZ ESTÉVEZ J. J., ZAPATA L., PEÑA CHOCARRO L., 2001.– Estudio etnoarqueológico sobre la cerámica Gzaua (Marruecos). Técnica y contexto social de un artesanado arcaico, *Trabajos de Prehistoria*, 58, 1, p. 5-31.

GOURICHON L., HELMER D., à paraître.– Étude archéozoologique de Mureybet , *in*: Ibáñez J. J. (éd.), *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

HARRIS D. R., 1996.– The origins and spread of agriculture and pastoralism in Eurasia: an overview, *in*: Harris D. R. (ed.), *The origins and spread of agriculture and pastoralism in Eurasia*, University College London Press, p. 552-573.

HOLE F., FLANNERY K. V., NEELY J. A., 1969.– *Prehistory and human ecology of the Deh Lurah Plain: An early village sequence from Khuzistan, Iran,* Memoirs of the Museum of Anthropology, Univ. of Michigan, n^{o} 1, University of Michigan Press, Ann Arbor, p. 189-192.

IBÁÑEZ J. J. (éd), à paraître.– *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

IBÁÑEZ J. J., GONZÁLEZ URQUIJO J. E., PALOMO A., FERRER A., 1998.– Pre-Pottery Neolithic A and Pre-Potterty Neolithic B lithic agricultural tools on the Middle Euphrates: the sites of Mureybit and Tell Halula, *in*: Damania A. B., Valkoun J., Willcox G., Qualset C. O. (eds), *The Origins of Agriculture and Crop Domestication*, Aleppo, ICARDA/ IPGRI/GRCP/FAO, p. 132-144.

KEELEY L. H., 1983.– Neolithic novelties: the view from ethnography and microwear analysis, *in*: Cauvin M.-C. (éd.), *Traces d'utilisation sur les outils néolithiques du Proche-Orient*, Lyon, Maison de l'Orient méditerranéen, (TMO, 5), p. 251-256.

LEBRETON M., à paraître.– Les récipients en calcaire, *in*: Ibáñez J. J. (éd.), *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

LEGGE A. J., ROWLEY-CONWY P. A., 2001.– The exploitation of animals, *in*: Moore A. M. T., Hillman G. C., Legge A. J. (eds), *Village on the Euphrates. From Foraging to Farming at Abu Hureyra*, Oxford, Oxford University Press, p. 423-471.

MOLIST M., 1998.– Espace collectif et espace domestique dans le Néolithique des IX^{e} et VIII^{e} millénaires BP au nord de la Syrie: apports du site de Tell Halula (vallée de l'Euphrate, *in*: Fortin M., Aurenche O. (éd.), *Espace naturel, espace habité en Syrie du Nord (10^{e}-2^{e} millénaires av. J.-C.)*, actes du colloque tenu à l'Université de Laval (Québec), 5-7 mai 1997, Toronto, Canadian Society for Mesopotamian Studies (Bulletin 33), Lyon, Maison de l'Orient Méditerranéen (TMO, 28), p. 115-130.

MOLIST M., FERRER, A., GONZÁLEZ URQUIJO J. E., IBÁÑEZ J. J., PALOMO, A., 2001.– Élaboration et usage de l`industrie lithique de Tell Halula (Syrie du nord) depuis 8700 jusqu`à 7500 BP, *in*: Caneva I., Lemorini C., Zampetti D., Biagi P. (eds), *Beyond Tools. Redefining the PPN Lithic Assemblages of the Levant,* SENEPSE, 9, Berlin, ex oriente, p. 243-256.

MOSS E. H., 1983.– A microwear analysis of burins and points from Tell Abu Hureyra, Syria, *in*: Cauvin M.-C. (éd.), *Traces d'utilisation sur les outils néolithiques du Proche-Orient*, Lyon, Maison de l'Orient méditerranéen (TMO, 5), p. 143-157.

PEACOCK D. P. S., 1982.– Pottery in the Roman world: An ethno-archaeological approach. Longmans, London.

PERLÈS C., 2001.– *The Early Neolithic in Greece*, Cambridge University Press, 370 p.

QUINTERO L. A., 1998.– *Evolution of Lithic Economies in the Levantine Neolithic: Development and Demise of Naviform Core Technology*, PhD dissertation, University of California, Ann Arbor, University Microfilms.

QUINTERO L. A., WILKE P. J., 1995.– Evolution and Economic Significance of Naviform Core-and-Blade Technology in the Southern Levant, *Paléorient*, 21, 1, p. 17-33.

RICE P. M., 1987.– *Pottery analysis. A Sourcebook*, Chicago, The University of Chicago Press.

ROODENBERG J. J., 1986.– *Le mobilier en pierre de Bouqras, Utilisation de la pierre dans un site néolithique sur le Moyen-Euphrate (Syrie)*, Leiden, Netherlands Institute for the Near East, 207 p.

ROSENBERG M., PEASNALL P. L., 1998.– Report on the soundings at Demirköy Höyük : an aceramic neolithic site in eastern Anatolia, *Anatolica*, 14, p. 195-207.

ROSENBERG M., DAVIS M. K., 1992.– Hallan Cemi Tepesi, a site of early aceramic neolithic in eastern Anatolia: some preliminary observations concerning the material culture, *Anatolica,* 18, p. 1-18.

SÁNCHEZ PRIEGO J. A., à paraître.– Analyse technologique et fonctionelle des herminettes de Mureybet, *in*: Ibáñez J. J. (éd.), *Le site Néolithique de Tell Mureybet (Syrie du Nord). En hommage à Jacques Cauvin*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

SANTALLIER D., MARÉCHAL C., VÉRA R., 1997.– Éléments de parure du Néolithique syrien. Identification et provenances des matériaux, *Revue d'archéométrie*, 21, p. 55-65.

SIGAUT F., 1996.– Crops, Techniques and Affordances, *in:* Elben R., Fukui K. (eds), *Redefining Nature, Ecology, Culture and Domestication*, Oxford, p. 417-436.

STORDEUR D., 1989.– Vannerie et tissage au Proche-Orient néolithique : IX^{e}-V^{e} millénaire, *in* : *Tissage, corderie, vannerie* : *approches archéologiques, ethnologiques, techno-logiques*, actes des IX^{e} rencontres internationales et d'archéologie et d'histoire d'Antibes*,* Antibes, APDCA, p. 19-39.

STORDEUR D., 2000.– Jerf el Ahmar et l'émergence du Néolithique au Proche-Orient, *in* : Guilaine J. (éd.), *Premiers paysans du monde. Naissance des agricultures*, Paris, Errance, (Séminaire du Collège de France), p. 33-60.

STORDEUR D., 2004.– « Small finds and poor babies ». Quelques objets « divers » du Mureybétien de Jerf el Ahmar, *in*: Aurenche O., Le Mière M., Sanlaville O. (eds), *From the River to the Sea. The Paleolithic and the Neolithic on the Euphrates and in the Northern Levant*, Oxford-Lyon, BAR International Series-Maison de l'Orient méditerranéen.

UNGER-HAMILTON R., 1992.– Experiments in harvesting wild cereals and other plants, *in*: Anderson P. C. (éd.), *Préhistoire de l'agriculture: nouvelles approches expérimentales et ethnographiques*, Paris, CNRS Éditions, (Monographie du CRA, 6), p. 211- 224.

VALLA F. R., 1987.– Les Natoufiens connaissaient-ils l'arc?, *in*: Stordeur D. (éd.), *La main et l'outil. Manches et emmanchements préhistoriques*, Lyon, Maison de l'Orient Méditerranéen, (TMO, 15), p. 165-174.

VAN DER LEEUW S. E., 1984.– Pottery manufacture: some implications for the study of trade, *in*: Rice P. M. (ed.), *Pots and potters: current approaches in ceramic archaeology*, University of California Press, p. 55-69.

WILLCOX G., 1996.– Evidence for plant exploitation and vegetation history in three early Neolithic pre-pottery sites on Euphrates (Syria), *Vegetation History and Archaeobotany,* 5, p. 143-153.

WILLCOX G., 1997.– Archaeobotanical evidence for the beginnings of agriculture in southwest Asia, *in*: Damania A. B., Valkoun J., Willcox G., Qualset C. O. (eds), *The Origins of Agriculture and Crop Domestication*, Aleppo, ICARDA/IPGRI/GRCP/FAO, p. 25-38.

WILLCOX G., CATALA M., 1996.– Análisis Paleobotánico, *in*: Molist M. (ed.), *Tell Halula (Siria) Un yacimiento neolítico del valle medio del Eufrates. Campañas de 1991 y 1992*, Ministerio de Education y Cultura, Madrid, p. 135-142.