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A Revolution in Food Preparation?

Grinding and Pounding Plants in the First Farming Communities of Western Europe and the Mediterranean Region*

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Abstract
The spread of the Neolithic way of life to Western Europe is characterized by two parallel strands of colonization that spread through the continental (LBK) and Mediterranean (Impressa-Cardial) regions during the sixth millennium BC. Together with the introduction of novel agricultural systems, new food preparation practices were developed. Combined interdisciplinary (technology, anthropology, archeobotany) and archaeometrical approaches (use-wear and residue analyses) have made it possible to characterize the way in which plants, especially cereals and legumes, were processed for daily consumption. By looking at examples from both strands of European Neolithization, it has also been possible to highlight the economic, cultural and social significance of the various grinding systems.

Keywords
Grinding technologies, Neolithic, Impressa-Cardial, Linearbandkeramik, Mediterranean Region, Continental Europe, cereals, plant food, domestic space, cultural habits.

Résumé
La diffusion du Néolithique vers l’Ouest de l’Europe se caractérise par deux voies parallèles de colonisation à travers l’Europe continentale (Lbk) et méditerranéenne (Impressa-Cardial) durant le 6e millénaire BC. De nouvelles habitudes alimentaires accompagnèrent l’introduction d’un nouveau système agricole. Une approche interdisciplinaire associant la technologie et l’anthropologie à des analyses archéométriques (tracéologie, résidus microbotaniques) a permis de caractériser les procédés par lesquels les céréales et légumineuses étaient transformés pour l’alimentation quotidienne. À travers des exemples pris dans les deux courants de néolithisation, il est possible de caractériser la valeur culturelle et sociale des différents systèmes de broyage.

* We would like to thank all those who provided access to the macrolithic tool series from Linear Pottery Culture and Impressa-Cardial contexts.
The Neolithization process represents a major global paradigm change in the relationship between prehistoric communities and food. The so-called “Neolithic revolution” relied, at least partly, on a fundamental modification of modes of food production, of which plant domestication was a key element. It is expressed by the increasing selection of certain plant species followed by the intensification of their cultivation within specific ecosystems. Plant species emblematic of these deep changes vary from one region to another: millet in China first domesticated around 10 000 cal. BC, legumes and wheat in the Near East by the end of the ninth millennium BC, pearl millet in Africa around 2500 cal. BC, maize and cucurbitacea in MesoAmerica around 6500 cal. BC.

While climatic and demographic constraints played a major role in the emergence of Neolithic societies, these deep mutations also have roots in the social and ideological spheres. The desire to settle permanently in a territory favourable to the new needs of sedentism and to control more restricted territories is expressed through increased control of food resources, whether of animal or vegetal origin. This change in the social structure of the first Neolithic societies finds a direct expression in the relationship between prehistoric communities and food.

We will explore this question through the archaeological record and specifically through objects that allow us to reconstruct part of the technical systems. This approach is in the French tradition of cultural technology as defined, among others, by Leroi Gourhan. The intensive consumption of certain foods, in particular cereals, by the first agricultural populations was accompanied by the unprecedented use of grinding systems and tools for food preparation. Study of these artefacts allows us to reconstruct many of the techniques and food preparation practices of the first Neolithic farming populations. The omnipresence of grinding tools on Neolithic sites not only reflects their fundamental role as utilitarian objects for reducing large quantities of cereals to flour, but also the way in which they structured daily tasks. Cereal grinding, which, on the basis of ethnographic examples, probably occupied several hours of each day, thus played a role in structuring both time and space in Neolithic settlements.

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No primary core of Neolithization existed in Western Europe. Instead, it can be seen as a process of simultaneous diffusion of several techno-economical innovations, introduced by the movement of populations, ideas and know-how following the principle of a colonization wave. Grouped together under the term “Neolithic package”, these innovations include agricultural techniques, sedentary settlement, but also the production of pottery and polished stone tools and the introduction of grinding tools. This model is distinct from a model of progressive introduction of these innovations over different timescales, a pattern which characterizes Neolithic core areas such as China and Africa for example.

The spread of the Neolithic way of life to Western Europe was characterized by at least two parallel waves of colonization that, throughout the sixth millennium BC (fig. 1), spread (1) from the Aegean along the northern coasts of the Mediterranean, and (2) through continental Europe from Hungary. Far from being homogeneous, the cultural, economic and symbolic aspects of these communities testify to distinctive historical trajectories. In particular, both strands exhibit different ways of occupying and settling territory and of structuring circulation and exchange networks (fig. 2).

(1) The earliest farming populations belonging to the Impressa culture settled on open-air sites or in rock shelters within the Mediterranean region between 5800 and 5600 cal. BC. They were organized in small family units whose economy was based on caprine breeding and the cultivation of emmer. Around 5400 cal. BC, the Cardial cultural complex developed; it is associated with significant demographic expansion into a wide variety of landscapes including mountainous coasts, lagoons, broad alluvial valleys and adjacent plateaux. This expansion involved the development of structured and fully connected networks, as suggested by the management of mineral resources. After 5200 cal. BC, significant regionalization occurred.

(2) The arrival of the Linear Pottery Culture (LBK) culture in Western Europe occurred later, around 5300 cal. BC; it originated from Transdanubia where it emerged around 5500 cal. BC. Alluvial valleys and related plateaux were favoured for the establishment of small villages that form a dense and continuous occupation network; villages were sometimes only a few kilometres apart. Cereal cultivation and animal rearing (cattle, caprines, pigs) constituted the basis of the economy. Around 5050 cal. BC, the emergence of post-LBK groups attests, here also, to the development of regionalization (e.g., in the Blicquy-Villeneuve-Saint-Germain sphere, BVSG).

Together with the introduction of novel agricultural systems associated with permanent settlements within both Neolithization spheres, new food practices were developed. Focusing on the technical innovations that accompanied these major shifts in subsistence strategies, our study aims to characterize the way in which plants, especially cereals and legumes, were processed and ground for daily food consumption in the different early Neolithic contexts that arose in Western Europe.

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Making the grinding tools speak in prehistory: an open window on Neolithic economies

Prehistoric technology and the development of grinding-tool studies

From a historical point of view, the perception of grinding tools in prehistoric archaeology appears to be highly paradoxal. Their ubiquity on Neolithic sites all over the world made them one of the strongest symbols of the innovations related to agricultural production in the collective representations of prehistoric lifeways. On the basis of ethnographical comparisons with non-mechanized societies there has been a tendency to link these tools to certain social and economic contexts and to associate them too closely with the processing of plants, particularly cereals, within the sedentary domestic sphere. For too long the overly simple equation linking grinding tools to cereal processing has limited research of these implements on Neolithic sites. For this reason, it is only recently that prehistoric grinding-stone studies have developed within a comprehensive technological approach.10

During the 1980s, the first typo-technological studies were carried out in the context of the Near Eastern Neolithization core area where questions regarding the transformation and consumption of domesticated cereals were much debated. In this context, the first classification and detailed descriptions of Natufian and Neolithic grinding implements were undertaken with the aim of discussing their chrono-cultural characteristics and evolution.11 In parallel, the emergence of ethnoarchaeology has created a favourable theoretical framework for detailed surveys of the socioeconomic systems behind quern production and use, thanks largely to the fact that such tools continue to be used in many parts of the world today.12 In the 1990s, grinding-stone studies integrated more archaeometric methodologies in two ways: (1) the exploration of sources and mechanical properties of raw materials,13 and (2) use-wear and residue analyses which borrow much from tribology, archaeobotany and chemical analysis.14

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On the basis of these different advances, grinding-tool studies have adopted a more comprehensive approach since the 2000s, in order to reconstruct the complete biography of tools, from their acquisition to their abandonment, within specific technical systems. Raw material properties have been studied in terms of durability, resistance, rugosity and natural abrasiveness, relative to their efficiency in grinding actions; this aids our understanding of rock selection strategies, the level of investment in blank acquisition, the organization of raw material circulation and of possible exchange networks. (2) Studies of shaping know-how and strategies inform discussions regarding standardization processes, specialization of craftspeople and the context of production. (3) Use-wear analysis helps us to reconstruct the detailed functioning (gesture, action mode) and the material transformed in the framework of broader *chaines opératoires* and activities, while microresidue studies, focusing on phytolith and starch analysis, throw light on the treatment, structure and types of plants processed (fig. 3).

These combined interdisciplinary approaches (technology, anthropology and archaeobotany), associated with archaeometric methods (use-wear and residues analysis), have allowed us to consider the role played by grinding implements within prehistoric food practices.

How have grinding-tool studies contributed to our understanding of prehistoric food habits?

The development of use-wear analysis of Palaeolithic and Neolithic grinding tools is closely linked to specific questions concerning subsistence strategies and economies. As regards the Early Palaeolithic, the use of crushing stones has been discussed in relation to the dietary behaviour of the very first hominids during the Early Palaeolithic in Africa. The cracking of nuts using a hammerstone against an anvil has been documented in ethnological studies, including studies of present-day chimpanzees. Parallels have been established with early hominids and allow us to state that the opportunistic use of cobbles was probably one of the very first examples of tool use in Prehistory. In this context, the use of...
heavy stones to process vegetal food can be considered to be among the most universal and oldest examples of tool use. Focusing on more recent Palaeolithic contexts, the existence of different kinds of grinding tools has been documented in Europe by De Beaune and González and Ibáñez. These studies suggest that such tools were multifunctional, in other words used either for the crushing and cutting of animal matter (meat, tendons and bones) or for the grinding and mixing of pigments. More recent studies have suggested that Neanderthals used some pestle and grinding tools to process roots and tubers although the consumption of these materials as food is debated. In the same vein, starch grain analysis suggests the grinding of wild plants, including wild “cereals”, in different Palaeolithic hunter-gatherers contexts in the Levant and in China. In Oceania, the works of Field and Fullagar have revealed the large range of wild seeds processed and consumed by hunter-gatherers and the importance of plant processing within these communities.

Macrolithic tool analysis conducted on Epipalaeolithic and Mesolithic contexts has essentially explored the intensification of exploitation of local territories, including the increasing gathering and selection of vegetal resources for craft and food production. This issue is particularly important for exploring possible stages in the transition from hunting-gathering to an agricultural system of subsistence. The intensive consumption and transformation of a number of plants have been highlighted in different contexts, such as nuts in continental Europe, or legumes in the Natufian of the Levant.

In Europe, the Neolithic witnessed a widespread generalization of grinding systems. Grinding tools were used in several fields of the economy and were especially, but not exclusively, employed for the processing of cereals and other cultivated plants. While they were also used for pigment processing and in ceramic production, they were employed more broadly in food transformation. This marked increase in the use of grinding techniques in many aspects of daily activity has to be directly linked to the high level of sedentarity and the

19 Sophie A. DE BEAUNE, Pour une archéologie du geste ...
20 Jesús Emilio GONZÁLEZ URQUIJO, Juan José IBÁÑEZ, “The use of pebbles …”.
23 Li LIU, Maureece J. LEVIN, Michael F. BONOVO et al., “Harvesting and processing wild cereals …”.
24 Richard FULLAGAR, Judith FIELD, “Pleistocene seed-grinding implements …”.
26 Laure DUBREUIL, “Long-term trends in Natufian subsistence …”.
demographic expansion which characterized the Neolithization process in these regions. The anchoring of grinding tools within the technical system transformed these utilitarian items into objects with greater cultural significance. Along with other elements of material culture such as ceramics and flint tools, the evolution of grinding-tool types became an indicator of cultural influences and belonging during the Neolithic period.28

This evolution reflects both the evolution and increasing role of plant consumption and transformation in the food supply and also the major social shifts in Prehistory. With the Bronze Age, the increasing control, accumulation and centralization of wealth by elites influenced the organization of food production, especially cereal processing. This activity became part of a more centralized production context, as is witnessed, for example, in the El Argar culture.29

This trend is evidenced in an increase in the size of the grinding tools in order to deal with the higher quantities of cereals produced. The status of this activity, and of the individuals responsible for it, slowly grew as it passed from Neolithic domestic scale production, catering for an extended family unit, to larger scale production, at the scale of a group or an elite, undertaken either by slaves or specialized craftspeople.

Indeed, recent work on grinding tools throughout European and Mediterranean prehistory has opened up a brand new field of research focused on exploring the evolution of technical systems. This work reveals how these technologies followed the main economic and social transformations, which are related to the evolution of food production from a purely hunting and gathering system to a centralized and highly controlled agricultural one.

Grinding techniques as a window on Neolithic food and cultural practices

The evolution of grinding-tool technologies was directly related to the major economic and social mutations that occurred throughout Prehistory. Emblematic of important food practices, grinding tools are of particular interest during the transitional and abrupt mutation phases, such as within the early part of the Neolithic. Consequently, the study of grinding implements in the context of Neolithization provides key information regarding the deep changes that took place in food production and consumption habits, in the same way as botanical and faunal remains, ceramics and isotope analysis.

Moving beyond the monolithic and simplistic image of Neolithic populations processing cereals on a daily basis in order to prepare bread, a series of detailed questions emerge from the study of grinding actions and processes. What exactly was being ground and how? Behind this simple question, the importance of cereal consumption in the diet is questioned at several levels. Did the introduction of a Neolithic economy imply a complete dominance of cereals in the diet?


While the introduction of cereal cultivation in Europe undoubtedly brought a significant change in diet it does not necessarily mean that cereals played a central role in the daily diet, at least not to the same extent throughout the period. Did all of the cereal species identified in the macrobotanical remains make an equal contribution to the diet? The cultivation of barley, for example, is still the subject of debate as it could have been consumed by either humans or animals, or by both. The study of the use-wear traces and microresidues preserved on the surfaces of grinding tools also allows us to identify the way in which cereals and plants were prepared and treated before consumption. We must also consider the issue of cereal treatments, especially the possible complete or partial dehusking of hulled cereals prior to consumption.

The soaking or roasting of grains prior to dehusking or grinding is also possible to detect through use-wear and micro-residue analyses, thereby greatly adding to our knowledge of the chaine opératoire for the treatment of cereals.

Other important questions relate to the status of the grinding activity: were grinding tools specialized implements for the processing of cereals within the domestic space? Were they associated with the preparation of other foodstuffs, such as other plants or animal material (bone, grease, marrow), which could have been combined in various dishes? In terms of cereal processing, the use of grinding tools may be associated with other wooden tools, especially pestle and mortar systems. Cereals can be processed to produce different qualities of products, depending on the dish being prepared; the coarseness of the end-product depends greatly on the preparation of the grains but also on the tools used. Finer flour can be obtained by using stone grinding implements, while wooden mortars can be employed to produce coarser flour. The properties of the grains themselves also play a central role, in other words their hardness, the ease with which they can be digested and the speed at which they deteriorate in contact with oxygen. However, the choices made and the ways in which cereals were prepared, stored and finally consumed are directly related to food preparation practices and cultural habits.

In fact, behind the purely organic and mechanical action of grinding plant food, grinding tools are a powerful medium through which to explore the social background of food preparation at both short and long timescales. Firstly, the number of grinding tools on a particular site can be considered as an indirect demographic indicator: it is closely linked to the number of people to feed within a family unit, but also to the number of women who used the implements. Grinding activities are also quite gender specific: in most documented ethnographic contexts this is a predominantly female activity. Food grinding by men is generally linked to their particular social status and may be undertaken by elderly men, travellers, religious men, among others. In this sense, the context in which grinding is practised is particularly revealing of the sharing of tasks within the domestic space. Beyond the gender aspect, the location of the grinding activities within Neolithic domestic spaces is also highly relevant when exploring relationships between neighbouring domestic units. The grinding of foodstuffs can be an individual or collective practice carried out at various scales: family unit, neighbouring units, social group, village. The spatialization of grinding activities is also a reliable indicator of the structuring of activities within the domestic space: it highlights strategies of waste management, the functioning of the inhabited space and even the structuring of private/public spaces within the house.

However, the longevity of querns also has very long-term implications: throughout the world grinding implements are considered as one of the

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31 Caroline HAMON, Valérie LE GALL, “Millet and sauce …”.

basic elements of marriage arrangements in which property is governed by complex inheritance rules, linking generations of women and families around the memory and transmission of the responsibility for feeding, raising and perpetuating the social order symbolized through food processing.

**Grinding systems in the first Neolithic contexts of western Europe during the sixth millennium BC**

A brief overview of the grinding systems and traditions used in the different Neolithic cultural contexts of Western Europe highlights their specific role in the economy of the first farming societies. Given the scarcity of studies of Early Neolithic grinding tools from the western Mediterranean area, we have chosen to highlight their specificities through a comparison with grinding techniques used in the Neolithization contexts of continental Europe during the sixth millennium BC. In fact, the regional differences between the grinding systems of the two strands of Neolithization result from parallel and distinct economic and cultural dynamics. All aspects of the grinding activities, including the quality of the final product, the technical system chosen and the associated cultural context are used as a means to explore food processing practices.

**An evolution of the Early Neolithic grinding systems in the western Mediterranean**

Apart from recent work on archaeobotanical remains,33 few studies have been conducted on Early Neolithic grinding tools in the western Mediterranean area. This means that we have an incomplete picture of the dispersal of these technologies and the spread of the Neolithization process from Anatolia and the Levant towards the southwestern Mediterranean. Naked wheat (*Triticum monococcum* and *Triticum dicoccum*) and barley (*Hordeum vulgare var. nudum*) as well as legumes (*Fabaceae, Pisum*) constituted the core of domesticated food plants, together with a series of wild plants.

Stroulia’s work on a number of early Neolithic contexts in Greece,34 with a particular focus on Franchthi cave (middle of sixth millennium BC35), stressed local raw material supply strategies as well as the generally small dimensions and the deliberate breakage of the grinding tools. Adopting a more experimental approach, Valamoti et al.36 (2003) tested the hypotheses

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34 Anna STROULIA, *Flexible Stones: Ground Stone Tools from Franchthi Cave. Fascicle 14, Excavations at Franchthi Cave, Greece*, (Indianapolis, 2010).


that these small-sized tools were used for the processing of pulses and cereals into coarse fraction and/or for the processing of other plants. Both works suggest that these small grinding implements were probably used for the processing of cereals into coarse rather than fine flour and that they could also have been used for a large variety of seeds and plants. These observations would support the secondary place of cereal grinding within food preparation activity in Franchti and a certain degree of multifunctionality for the grinding tools. However, grinding tools from other Early Neolithic sites demonstrate that, in other contexts, similar small grinding tools coexisted with larger and quite different implements, suggesting differences in cereal treatment in different areas and settlement types during the Early Neolithic of northern Greece.

Following the westward spread of farming along the European shores of the Mediterranean, available documentation for grinding stones is scarce and difficult to integrate into a broader economic framework. Grinding-tool studies for the Impressa–Cardial complex, which spans the area from Liguria to eastern Iberia, are alone in providing new evidence for the use of such implements on early Neolithic settlements in the western Mediterranean area (fig. 4).

In the Pendimoun rock shelter,\(^{37}\) grinding tools from the Impressa and Cardial levels are represented by small grinders made out of cobbles, with shaping only occurring on the active grinding surfaces. In the Impressa levels (5800-5600 cal. BC), grinding tools were principally used for processing pigments. In the Cardial levels (dating to the second half of sixth millennium BC), grinding tools were more numerous and were mainly used in a circular motion; they are generally considered to be opportunistic tools because of the low intensity and duration of their use. In the same occupation levels, fragments of concave querns made out of cobbles sometimes display a distal edge. Some querns and grinders display double active surfaces suggesting optimization in the use of blanks. Use-wear analysis reveals that most of the Cardial grinding tools were used for cereal processing, possibly for deshusking. This would indicate that cereals made a minor contribution to the diet during the first Impressa occupations of the rock shelter but that cereal consumption increased in subsequent levels.

The Pont-de-Roque-Haute site in Portiragnes (Languedoc)\(^{38}\) yielded about 35 quern and grinder fragments which were made from blocks of vacuolar basalt from sub-local sources. Most of the tools are of ovoid to semi-circular shape and are small in size. However, a single fragment from a massive quern and a quadrangular grinding slab indicate the coexistence of different systems using circular and back-and-forth gestures. Use-wear analysis conducted on a reduced sample of tools confirms their use for the processing of cereals using a back-and-forth motion. This indicates that the first pioneer populations to reach the western coast of the Mediterranean maintained food habits based on an important contribution of cereals in the diet. The presence of other kinds of grinding tools raises the possibility that other plants were

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\(^{38}\) Caroline HAMON, Thierry GIRAUD, “L’outillage de broyage, percussion et polissage de Pont de Roque-Haute”, in Jean GUILAINE, Claire MANEN, Jean-Denis VIGNE (eds), Pont de Roque-Haute (Portiragnes, Hérault). Nouveaux regards sur la néolithisation de la France méditerranéenne (Toulouse, 2007), pp. 87-96.
processed using circular motion grinding on concave slabs and that these plants played an important role in the diet.  

Another perspective on the role of grinding tools within the technical system is provided by the Cardial occupation levels of the Taï rock shelter in the lower Rhone Valley. Within the successive occupations, large quadrangular grinding slabs with circular active surfaces have been found together with smaller ovoid grinding tools made from cobbles and used in a multidirectional gesture. At least two size categories of grinding tools were found. Short grinders were predominant and were frequently used on their dorsal surfaces as crushing tools. This toolkit displays considerable durations of use and a high level of morphological distortion, arising from the processing of cereals and other plants using both back-and-forth and circular motions. It highlights the wide range of grinding tool types and possible functions. The Taï settlement site has yielded a very wide range of grinding tools which contrast with the smaller more portable tools found on other Cardial sites in the region. This suggests that variations in tool types are related more closely to the importance of cereals in the diet than to the types of sites on which they are found (rock shelter versus open-air settlements).

These examples illustrate the specificities of grinding tools from Impressa and Cardial contexts in the northwestern Mediterranean region. Variations in the tool types echo different functions and occupation contexts (duration, seasonality). The large variety of tool types, both in terms of size and the grinding gesture employed, indicates that a wide range of plant processing techniques were used for food production within these settlements. Since the very first installation of pioneering agricultural populations in open-air settlements, cultivated cereals formed an important component of the diet. The relatively small size of the Impressa tools, together with the systematic use of local raw materials which underwent little transformation, fits with a pattern of permanent settlements which evolved quite rapidly in the neighbouring territory. On some specialized settlements, such as Pendimoun, the low quality of the grinding-tool manufacture and the poor quality of the raw materials used suggest that cereal and plant processing occupied only a secondary place in the economies and daily diet of the inhabitants. The low level of effort invested in the production of these tools, their lack of typological development and low duration of use seem to suggest that grinding tools were not seen as an important element in the identity or social order of the first agricultural populations who settled in the Mediterranean area; this contrasts with what has been observed in many other Neolithic contexts of the sixth millennium BC.

**Grinding tools in the LBK culture of continental Europe**

In contrast to the Early Neolithic of the Mediterranean region, by the mid-sixth millennium BC hulled cereals (*Triticum dicoccum/monococcum* and *Hordeum sp.*) are predominant within LBK and post-LBK sites, together with peas (*Pisum sativum*) and lentils (*Lens culinaris*), flax

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40 Caroline HAMON, “Le macro-outillage du Taï”, in Claire MANEN (ed.), *Premières sociétés agropastorales du Languedoc méditerranéen (6e-3e millénaires avant notre ère)* (Toulouse, in preparation)

(Linum usitatissimum) and wild fruits, especially hazelnuts (Corylus avellana). In these contexts, the central role of grinding tools within LBK sites (5300-4900 cal. BC) is illustrated by the fact that they are found in large quantities in waste pits alongside houses and also by their intrinsic characteristics.

First of all, a single raw material appears to be emblematic of this cultural area: quartzitic sandstone. This raw material was favoured in most LBK contexts for its hardness and durability, its natural renewal properties and its ability to be shaped by flaking or pecking. This particular attractivity of sandstone is also revealed by the long distances involved in its procurement in certain regions; often suitable sandstone was transported over distances of 40 to 50 kilometres. More rarely, basalts and granites were selected simply because abundant and suitable resources existed locally. To date, no quarries have been identified but detailed analysis of grinding tools has shown that blanks were gathered in alluvial deposits and also extracted from outcrops. The production of querns seems to have occurred away from the villages as very little waste material or roughouts have been found in association with LBK domestic areas.

Secondly, LBK grinding-tool assemblages are characterized by the coexistence of different sizes and types throughout the vast LBK territory. A study of the grinding tools from the site of Langweiler 8 (Rhineland-Palatinate, Germany) demonstrated that at least three main types of associated querns/grinders were used: the first consists of short convex grinders, the second features flat active surfaces and the third consists of overlapping concave grinders. This work partially borrows the terminology and classification system defined for the BVSG culture in Hainaut (Belgium). The coexistence of these different types throughout the LBK has since been observed in different contexts. To this morphological classification has been added a size criterion: at least two sizes of grinder/quern associations coexisted on the sites (with length per width of approx. 40 x 22cm and 30 x 15cm for querns), possibly related to specific functions or social meanings.

To the west, on the margin of the LBK territorial expansion at the end of the sixth millennium BC, a particular phenomenon has been identified: the complete abandonment of the overlapping grinder system which was replaced by a shorter grinder system for a period of at least 800 years. Overlapping grinders are identified in the middle LBK of Belgium, the Rhine

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45 Caroline HAMON, Broyage et abrasion au Néolithique ancien ...
46 Andreas ZIMMERMANN, “Steine …”.
valley and Champagne, but seem to be completely absent from Late LBK and post-LBK assemblages from 5100 cal. BC onwards in the same region and further west. While the reasons for this major shift in 500 years of grinding technology have not yet been identified, two hypotheses dominate the debate. If the coexistence throughout Europe before 5100 cal. BC of these two types of grinding tools was linked to a functional complementarity, then a change in food habits at the end of the sixth millennium BC might explain this shift. Moreover, we know that naked cereals (wheat and barley) are common in the macrobotanical remains throughout the LBK but start to increase significantly on the western margins of the late LBK expansion (5000-4900 cal. BC) and even more so during the following BVSG culture (4900-4750 cal. BC). However, it is difficult to demonstrate conclusively that overlapping grinders were preferentially used for the dehusking of cereals; if this were the case then the disappearance of overlapping grinders could be linked to a decrease in the need for dehusking prior to the grains being ground into flour. Alternatively, their disappearance may be a direct consequence of cultural changes if we consider quern morphology to be a function of cultural traditions. However, the coincidence of these two phenomena – disappearance of a traditional type of grinding tool and increase of naked cereals – on the western margins of the late LBK expansion may reveal an important shift in the dietary habits of the LBK culture throughout Europe during the second half of the sixth millennium BC. Considering the very slow rate at which grinding tools evolved throughout the Neolithic, this shift appears to have been a major one at the scale of food preparation and cultural habits.

Use-wear analyses conducted on late LBK grinding tools from Western Europe have stressed the diversity in the functions of these tools and also their complex role in the chaine opératoire for cereal processing. The analysis of approximately 250 grinding tools from LBK and BVSG contexts in the Paris Basin and Hesbaye has confirmed that 65% of the grinding tools were involved in cereal processing. More surprising is the fact that 14% were used for processing mineral material, of which pigments (1.2%) and soft minerals (3.6%) constitute a low combined percentage. The grinding and crushing of temper for ceramic production could explain this high rate of mineral processing. 4.8% of grinding tools bore evidence for the grinding of animal material which may have been part of food preparation. Among the grinding tools of short type employed for cereal processing, a distinctive use-wear signature has allowed us to differentiate between small grinders, which were preferentially used for dehusking operations, and larger grinders, which were preferentially used for grinding cleaned grains into flour. These results suggest that quern/grinder systems were specialized in terms of size for either dehusking or grinding operations. To complete this general pattern of LBK grinding-tool function in Western Europe, several phytolith analyses have been conducted together with use-wear analysis on two series from the LBK sites of Le Vieux Tordoir, in Berry-

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50 Caroline HAMON, Broyage et abrasion au Néolithique ancien …; Caroline HAMON, Eric GOEMAERE, “Outils de broyage …”; Anmelou VAN GIJN, Annemieke VERBAAS, “Reconstructing the life history…”.

au-Bac and Loison-sous-Lens. As already demonstrated by previous studies, the combination of both methodologies increases the potential for identifying the function of the tools and the pre-consumption stages of cereal treatment. Despite the small quantities of preserved phytoliths, the results suggest that the grinding tools were all used to process cereals and dicotyledons, within the framework of multifunctional use for food preparation. In fact, part of the cereal dehusking process could have been carried out using different kinds of equipment, such as wooden tools, prior to the grinding of the grains with grinding stones. These studies greatly add to our understanding of food practices and the function of grinding tools.

The high percentage of grinding tools used for the processing of cereals and plants for consumption allows us to discuss the social context of this activity after a detailed overview of the characteristics of these tools and their spatial distribution within the domestic and village areas. The distribution of querns within the domestic space suggests that grinding tools were stored at the back of the house and that cereal processing took place in at least two different areas: (1) in an open space in front of the house which is considered to have been a fully public zone of the domestic area; and (2) in a central place inside the house where food preparation activities were concentrated around a hearth, which was the centre of the daily private life of the family groups that occupied the LBK long houses. These two areas illustrate the socialization role of this activity, both in the private and the public spheres, which is also supported by numerous ethnographic examples. This would also explain the deliberate breaking of grinding tools which may attest to a ritual act carried out to mark the death of their owner or the abandonment of the house by the family group.

The structuring role of querns within LBK domestic space also allows us to estimate the numbers of people, particularly women, living in large houses. Taken together with other elements, such as storage ceramics and domesticated fauna, the study of grinding tools contributes to refining our perception of the food strategies developed by LBK people in response to their demographic evolution, economic maturity in the development of agricultural products and the development of a sedentary social structure organized around the village unit.

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54 Caroline HAMON, Broyage et abrasion au Néolithique ancien ...

55 Anne-C. VAN GIJN, Annemieke VERBAAS, “Reconstructing the life history …”.

Grinding systems as economic and cultural markers for the first Neolithic cultures of Western Europe and the Mediterranean

By examining the archaeological contexts it is possible to highlight the economic and social value of the different grinding systems used by the cultural groups involved in the Neolithization processes of the western Mediterranean.

Status of grinding systems on the first Neolithic settlements

A comparison of the grinding systems in the Impressa-Cardial and LBK cultures of Western Europe highlights their specificities in relation to the types of settlements and to the organization of food preparation within domestic activities.

The Impressa-Cardial tools in the western Mediterranean region are characterized by their generally small size, limited shaping and considerable diversity. This has several economic implications. First of all, their small size suggests greater mobility and a less important role for grinding equipment in the structuring and organization of domestic space. This is also underlined by the frequent absence of fine pecking on the back of the lower element which could be interpreted as indicating that aesthetic considerations were not a priority for grinding tools. Instead they are believed to have been primarily utilitarian implements, with relatively short lifetimes by comparison to other Neolithic contexts, which could be easily replaced by gathering new blanks and cobbles. Their rate of replacement would have been quite high, perhaps comparable to cooking ceramics whose use life would have been in the order of a couple of months to a year or two. These observations fit perfectly with our knowledge of the first Neolithic populations that settled in the western Mediterranean area: they either lived in permanent but quite unstructured settlements, or in more specialized and seasonal sites, which suggests that the groups were, to a certain extent, mobile within a given restricted territory.

This particularity is even more evident if we draw comparisons with the status of grinding tools within LBK settlements at the end of the sixth millennium BC. The very structured organization of the LBK settlements corresponds to a completely different conception of the living space that has implications for the status of grinding tools within the domestic sphere. It appears clear that the permanent character of the LBK villages favoured the production of large querns used for daily processing of cereals. The central role of querns in LBK domestic activities probably partly explains the effort invested in the designing and finishing of the querns; this effort surpasses the primary utilitarian function of many of these implements and suggests that they played a role in structuring the internal domestic space, in much the same way as certain items of modern furniture.

The intrinsic technological characteristics of grinding tools are key when considering the status of food preparation, especially cereal processing, within the domestic realms of the first sedentary farming populations of Western Europe and the Mediterranean.
Grinding systems and Early Neolithic economies

According to technological and use-wear studies of grinding tools, the importance of cereal processing varies from one type of site to another, but also from one cultural context to another. While agricultural resources, particularly cereals, were processed on all of the site types, their contribution to the diet appears to vary depending on the cultural context.

The significant diversity in the grinding systems used by Impressa-Cardial populations highlights two main aspects of food preparation. Firstly, while studies of macrobotanical remains reveal that the first agricultural pioneers in the Languedoc undoubtedly cultivated cereals, use-wear analysis of grinding tools reveals that there was diversity in the processing and consumption of these cereals. The diversification of grinding tool types and associated gestures (back-and-forth, circular, multidirectional) suggests that plants other than cereals were also processed, intensively or otherwise, for consumption. It also suggests that cultivated food stuffs could be used in a wide range of dishes.

For the LBK culture, functional analysis conducted on grinding tools provides a much more complete and well-defined picture of the practices related to plant food processing. Cereal grinding appears to have played a central role in daily food preparation at a domestic level. At least two sizes of grinding tools were used simultaneously in the houses. According to use-wear analysis, they were operated using a back-and-forth motion to process cereals at different stages of the chaine opératoire, from complete or partial dehusking to grinding of cleaned grain. The products obtained also probably varied from coarse fractions to finer flour. It is highly probable in this context that different species of cereals were consumed. Phytolith analysis completes this picture by suggesting that while querns were predominantly used for cereals, they were also occasionally used for processing other plants.

The plant food processing strategies employed in these two cultural contexts are quite different. While both contexts saw the introduction of agriculture and cultivated food plants by pioneer and sedentary populations, the cereal preparation strategies and habits have little in common. In the Impressa-Cardial, the diversity of plant food consumed can be interpreted as a strategy of adaptation to the various Mediterranean ecosystems – including seashores, moutainous regions and arid areas – occupied by these populations. While these groups systematically introduced an economy based on agriculture with domesticated plants and cereals, they also maintained a certain degree of flexibility in their culinary traditions in order to facilitate their settling in a very wide range of Mediterranean landscapes. In contrast, LBK populations appear to have been highly dependent on cereals to meet their dietary needs. In terms of technology this dependence is expressed in quite standardized types of grinding tools within LBK villages throughout Europe. This also fits with the image of a very stable, controlled and reproducible model of agricultural production throughout the large fertile plains of continental Europe.

The cultural and identity value of querns among early agricultural populations

Despite regional variations and local adaptations of the grinding systems to the available natural resources – for blanks and for processing – and to specific types of settlements, there is considerable homogeneity in the strategies concerning food grinding within a single cultural group. Far from the archaic idea that grinding systems were simply two stones, used one against the other, to crush food plants, the complexity of the grinding systems used on Early Neolithic
sites indicates that these implements played an important role in the overall technical system of the first agricultural populations. Given the late arrival of Neolithic groups on the western shores of Europe, this observation might appear trivial. Nonetheless, what is more surprising is the cultural value attached to such grinding tools by these first agricultural populations. This means that when Neolithic groups arrived in the western Mediterranean and Europe, new technologies connected to food processing were directly integrated into the technical system. We can therefore suggest that these technologies were vested with a cultural significance similar to that of other technical domains.

However, the cultural value of grinding tools has very different expressions within the technical systems. In the Impressa-Cardial sphere, what appears of most cultural significance is the complementarity of the grinding techniques and motions, and the great diversity of plant food and final products involved in the daily diet as a reflection of varied economic strategies. This contrasts once again with the cultural value of grinding tools within the LBK sphere. In this context, the cultural value of cereal processing is revealed by several symbolic practices. Their deposition in Early LBK funerary contexts demonstrates their status as markers of identity within the first agricultural communities of central Europe and possibly reveals a gendered distribution of tasks within LBK households. The deposition of grinding-tool hoards in the late LBK and BVSG area in northwestern Europe can also be interpreted as a codified practice of considerable cultural significance. Such hoards involve the deliberate arrangement of complete grinding systems, in piles or in circles, in order to protect, store and preserve entire tools. Between three and six lower grinding stones are generally deposited together with their associated grinders. This careful deposition of complete sets of grinding tools strongly suggests that the intention was to retrieve them for further future functional or symbolic use. About 20 LBK quern hoards have been discovered, mostly on the northwestern margin of the LBK territory, in the area located between the Seine and Meuse rivers. The material culture and objects associated with these hoards allow them to be attributed to the LBK and BVSG cultures, between approximately 5200 and 4650 cal. BC.

Last but not least, the evolution of grinding tool types and their possible transfer from one cultural area to another attest to their cultural significance. In the Early Neolithic of northwestern Europe, the disappearance of overlapping grinders from late LBK and BVSG technical systems could be interpreted from a cultural perspective: (1) as the result of north-south contacts between the Cardial and Dunubian cultural regions; or (2) as a fusion of the two main technical and cultural traditions, which would have resulted in a sharing of the same technical processes between the two cultural areas.

Conclusion

Taking examples from both streams of Neolithization (LBK and Impressa-Cardial) it has been possible to highlight the utilitarian and cultural significance of grinding techniques within the

economy and food preparation practices of the first agricultural populations of Western Europe and the Mediterranean. Such research makes a valuable contribution to our understanding of subsistence strategies linked to the spread of agricultural economies from the eastern Mediterranean during the sixth millennium BC. Despite the scarcity of available data, the study of several Impressa-Cardial grinding implements offers a complementary perspective on food preparation practices which completes the picture provided by botanical remains, chemical analysis and technological studies of cooking equipment. It highlights the diversity in grinding techniques used in the processing of cereals and other plant foods, which are interpreted as adaptive solutions to the colonization of new Mediterranean territories and ecosystems. Through studies of grinding-tool systems, it has also been possible to gain a better understanding of the functioning of settlements in the context of the introduction of sedentism and the first permanent settlements. Such an approach can also throw light on the organization of the domestic space and of daily food preparation activities. Finally, it has been demonstrated that one of the major technical innovations that characterized the Neolithic had considerable cultural and symbolic significance. The diffusion of various grinding tool types reflects the complex sociocultural dynamics that accompanied the expansion of the first agricultural populations.
Figure 1. Map of the different routes for the colonization of Europe by the first farming populations (revised after Bostyn 2007).
Figure 2. Photographs illustrating the diversity of landscapes and settlements of the first farmers in Western Europe (after Manen and Hamon 2018): a. Mediterranean coastal plain and lagoon complex of the Leucate region (Aude); b. Open-air dwelling of Peiro Signado (Hérault); c. The open-air site of Cuiry-lès-Chaudardes in the Aisne valley (Aisne, cliché M. Ilett-ASAVA); d. House 690 at Cuiry-lès-Chaudardes under excavation (Aisne, cliché M. Ilett-ASAVA).

Figure 3. Synthetic schema of combined use-wear and microbotanical residues analysis for functional interpretation of grinding tools use (photos: C. Hamon, C. Cagnato)
Figure 4. Example of Early Neolithic Mediterranean grinding tools a. Pendimoun rock shelter, grinding tool in coarse sandstone (after Binder in press); b. Pont-de-Roque-Haute (Portiragnes) grinding tools in basalts (after Hamon, Giraud 2007); c. Tai, basin quern and grinder in limestones (Gard) (after Hamon in press).
Figure 5. *Linearbandkeramik* (LBK) grinding system: a. with overlapping grinder and narrow quern (Belgium, photos: IRSNB); b. with short grinder (Loison, Northern France after Praud et al. 2018).

Figure 6 The BVSG grinding tools hoard from Saint-Denis, rue du Landy (after Hamon, Samzun 2004; photos: S. Durand, Inrap.)