Stones That Made Food: A Lithic Viewpoint on Food Production Practices in the Early Mediterranean Neolithic

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Abstract
Food gathering and production are daily and fundamental activities for the reproduction and development of human societies, now and in the past. Food practices are deeply embedded in social, cultural, environmental and technological settings. During prehistory, for example, the most important changes in lithic technology were linked to the appearance of new techniques for obtaining food: more effective, requiring less time and fewer raw materials or simply better suited to the environmental and cultural framework. With the transition towards a farming economy, new food practices appeared, which gave rise to new skill sets, technologies and knowledge. This article focuses on the flaked stone tools of the Early Mediterranean Neolithic and their use for the obtainment of foodstuffs from both vegetal and animal resources. In particular, this article concerns the stone tools and techniques associated with hunting, animal slaughter and butchering, as well as with crop harvesting tasks. How were those tools made and how were they used? Were those tools crucial for food production? What factors influenced their geographical and chronological variability? What can we learn about early farming societies and their economic organization by studying them?

Keywords: Early Neolithic, Mediterranean, Western Europe, Iberian Peninsula, Southern France, Italian Peninsula, Food practices, Hunting, Butchering, Harvesting, Stone tools

Résumé (Please add)

Mots clés (please add)

Introduction

Stone tools are one of the most common pieces of evidence of prehistoric human societies. For a long time, archaeologists have mainly regarded stone artefacts as the result and evidence of certain cultural choices. The technological and morphological variability of stone (or lithic) artefacts was therefore used to identify cultural entities and to build archaeological taxonomies. This approach was mainly based on a typological analysis of the archaeological record and focused on retouched artefacts (i.e., lithic blanks with edges intentionally modified by fracturing in order to achieve a specific shape).[1] Starting in the 1950–60s, however, researchers grew interested in the relationship between chipped stone assemblages and the subsistence and settlement practices of prehistoric groups.[2] This was mainly achieved through analogical comparisons between certain archaeological types of tools (e.g., end-scrapers, points and arrowheads) and ethnographic and modern tools.

In this direction, a main methodological and theoretical advance has been the development of a "functional" approach to archaeological artefacts, thanks to the pioneer work of S. A. Semenov.[3] The work of Semenov – and of several scholars who followed his example – allowed archaeologists to empirically approach the question of the function of prehistoric artefacts.[4] Semenov showed that through

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1 George H. ODELL, *Lithic analysis*. Manuals in Archaeological Method Theory and Technique (New York, 2004).

2 Paul MELLARS, "Some comments on the notion of 'functional variability' in stone-tool assemblages", *World Archaeology*, vol. 2, no. 1 (1970), pp. 74–89; Francois BORDES, Denise de SONNEVILLE-BORDES, "The significance of variability in Palaeolithic assemblages", *World Archaeology*, vol. 2, no. 1 (1970), pp. 61–73, DOI: 10.1080/00438243.1970.9979464; Bernardino BAGOLINI, Giampaolo DALMERI, "I siti mesolitici de Colbricon (Trentino). Analisi spaziale e fruizione del territorio", *Preistoria alpina*, vol. 23 (1987), pp. 7–188.

3 Sergei A. SEMENOV, *Prehistoric Technology* (London, 1964).

4 João MARREIROS, Niccolò MAZZUCCO, Juan F. GIBAJA et al., "Macro and Micro Evidences from the Past: the state of the art of archeological use-wear studies", in Juan F. GIBAJA, João MARREIROS, Nuno BICHO (eds), *Use-wear and residue analysis in archaeology* (Heidelberg, 2015), pp. 5–26; Ignacio CLEMENTE CONTE, "El porqué y para qué de la 'Traceología' en la Arqueología prehistórica", *Cuadernos de Prehistoria y Arqueología de la Universidad de Granada*, vol. 27 (2017), pp. 27–53, DOI: 10.30827/cpag.v27i0.8163.

the microscopic observation of their surface it was possible to recognize specific wear traces (i.e., use-wear) left by ancient uses and to replicate them experimentally, thus gaining important information about those artefacts' use in the past. During the last fifty years, traceological research (from "traceology", as Semenov called the discipline) has highlighted how prehistoric artefacts – and in particular stone tools, which are one of the categories of artefacts traceologists have studied the most – were used in a broad range of economic activities, such as food gathering, production and processing tasks.

The aim of this article is to provide an overview of how lithic stone tools were integrated into Neolithic food production systems. A summary of the data obtained from the traceological analysis of lithic collections during the last 20 years will be discussed in order to demonstrate how the study of stone tools can provide relevant information on prehistoric subsistence practices. Three main domains of food production will be discussed: 1) agriculture, through the study of Neolithic cereal harvesting techniques; 2) animal butchery and meat processing with knives of different shapes; 3) meat procurement by hunting with spears, bows and arrows, and other weapons characterized by one or multiple stone tips. The limitations and viewpoint of a traceological approach to stone tools will be explored, including the most recent methodological approaches to the study of flaked stone collections.

The geographical area taken into consideration in this article (fig. 1) corresponds to the central and western sectors of the Mediterranean Basin, from the eastern coasts of the Adriatic Sea to the westernmost Atlantic coasts of Europe; that is, the territories of present-day Croatia, Italy, France, Spain and Portugal. The earliest farming communities settled in that area between 5900 BC and 5300 BC. Those groups introduced a new way of life into occupied territories, including domesticated animals and plants, new housing technologies and settlement strategies, and new tools and technologies: in sum, a new kind of relationship with the natural environment. Occupied territories were inhabited by communities of hunter-fisher-gatherers, in different degrees of density depending on the regions. Although the economic organization of these last Mesolithic groups is still relatively unknown, it is nowadays accepted that they were characterized by a broad-spectrum economy, including not only hunting and fishing, but also a diversity of plant and animal resources.

In this context, in the central and western Mediterranean, flaked stone tools have long been regarded as an element of continuity between Mesolithic and Neolithic societies, as proof of technological transfers and contacts between them. However, the Neolithic way of life implied the introduction of new economic tasks, new techniques and new crafts. All of this is reflected in the Neolithic flaked stone assemblages, which, as a whole, appear to be quite different from the lithic production of the previous period. It is for this reason that the traceological analysis of stone tools can provide important insight into the transition from hunting and gathering to farming and animal husbandry, highlighting continuities and discontinuities in food practices between the last hunter-fisher-gatherers and the first farmers in the central and western Mediterranean Basin.

The analysis of use-wear not only allows us to specify the function of a given stone tool, but also provides a better understanding of the entire technical system associated with food production and processing. The study of the technology associated with ancient food is as important as the study of food remains themselves, as it can provide information about the scale of production, the skills involved, the existence of specific traditions and cultural diversity among different prehistoric groups and also about other symbolic, gender and social aspects connected with food.[5] Thus, the functional classification of stone tools allows us to approach the following questions: In what ways were stone tools involved in food production? What factors influenced their geographical and chronological variability? What can we learn about early farming societies and their economic organization by studying them?

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5 Niccolò MAZZUCCO, Ignacio CLEMENTE CONTE, Ermengol GASSIOT et al., "Insights into the economic organisation of the first agro-pastoral communities of the NE of the Iberian Peninsula: a traceological analysis of the Cueva de Chaves flaked stone assemblage", *Journal of Archaeological Science: Reports*, vol. 2 (2015), pp. 353–66; Juan José IBÁÑEZ, Jesus E. GONZÁLEZ-URQUIJO, *From tool use to site function: use-wear analysis in some final upper Palaeolithic sites in the Basque country,* B.A.R. International Series DCLVIII (Oxford, 1996); Ignacio CLEMENTE CONTE, *Los instrumentos líticos de Túnel VII: una aproximación etnoarqueológica* (Madrid, 1997); Juan F. GIBAJA, *Comunidades Neolíticas del Noreste de la Península ibérica*, B.A.R. International Series MCXL (Oxford, 2003); Juan José IBÁÑEZ, Jesus É. GONZÁLEZ-URQUIJO, "Social and symbolic meanings of lithic technology during the PPN in the Middle Euphrates", in Elizabeth HEALEY, Stuart CAMPBELL, Osamu MAEDA (eds), *The state of the stone: terminologies, continuities and contexts in Near Eastern lithics* (Berlin, 2011), pp. 147-56; Annelou VAN GIJN, "The ritualization of agricultural tools during the Neolithic and the Early Bronze Age", in Annelou VAN GIJN, John WHITTAKER, Patricia C. ANDERSON (eds), *Exploring and Explaining Diversity in Agricultural Technology* (Oxford, 2014), pp. 311-18.

Methods of Analysis: Advantages and Limitations

Traceological analysis refers to the study of wear traces and residues on the edges and surfaces of objects caused by use. Traditionally, two main categories of use-wear are distinguished: macroscopic, including edge damage, diagnostic impact fractures and microscopic traces, which includes striations, polishes, hafting traces and residue remains. The current protocol for traceological studies includes the analysis of both categories of traces, as follows: 1) a first evaluation of the conservation of the archaeological assemblage is done through stereoscopic microscopy (magnifications between 5× and 60×). The aim of the macroscopic analysis of edges and surfaces is to identify possible active edges, allowing a first level of inference; 2) when active edges are detected, artefacts are then submitted to a detailed microscopic analysis using reflected-light microscopy (magnifications between 50× and 400×). The objective of this phase of analysis is to prove the nature and consistency of the microtraces. Microscopic use-wear traces (also called "polishes") are classified based on semi-qualitative variables (e.g., texture, topography, distribution and location) and compared with the experimental reference collections.

An interpretation is then proposed, including the type of action that was carried out with the tool, the type of material that the tool was used to work with, and, in some cases, even the way it was handled/hafted. Different degrees of confidence are possible, depending on the state of preservation of the lithic surfaces and the development and readability of the wear. The worked material, for instance, can be determined at a general level (e.g., soft or hard substance) or according to more specific categories (e.g., meat, hide, plants, wood, bone or mineral matter). Sometimes, an even more detailed interpretation can be proposed, including the moisture and state of the worked material (e.g., fresh hide, dry hide, ripe cereals or soaked bone or antlers). Microscopic polish and residues have the greatest discriminative capacity for the differentiation of tasks related to food production. Tools with the so-called cereal polish, for example, can be confidently attributed to the practice of crop harvesting activities. Impact traces have also been studied in detail through both experimental and archaeological traces, making it possible to identify with certitude stone tools used as hunting weapons. However, the analysis of both polish and residues has certain limitations. The visual appearance of the polish caused by working tasks on different materials can in some cases be very similar, which makes it very difficult to classify the evidence accurately; such overlap has already been widely described in literature.[6] Use-wear caused by meat processing, for example, can be very difficult to recognize and to distinguish from polish caused by soft tissues, and also from unused surfaces, given the minimal development of wear.

New approaches through confocal microscopy have been developed recently to overcome such limitations by statistically distinguishing polishes of similar appearance through confocal microscopy and texture analysis. This approach has allowed researchers to identify the harvesting of wild and domestic cereals at different stages of ripeness.[7] The integration of polish analysis with the study of residues follows the same direction. Some techniques (i.e., FTIR and Raman spectroscopy) make it possible to characterize residues on-site, without extracting them, thus allowing a real integration of polish and residue analysis.[8]

Furthermore, if we compare it with other archaeological disciplines studying organic remains, the traceological investigation of stone tools has the advantage that, since flaked stone artefacts are generally

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6 Patrick VAUGHAN, *Use-Wear Analysis of Flaked Stone Tools*. University of Arizona Press (Tucson, 1985); Monique VAN DEN DRIES, Annelou VAN GIJN, "The Representativity of Experimental Usewear Traces", in Antonio RAMOS-MILLÁN, María de los Ángeles BUSTILLO (eds), *Siliceous Rocks and Culture* (Granada, 1997), pp. 499–511.

7 Adrian A. EVANS, Randolph DONAHUE, "Laser scanning confocal microscopy: a potential technique for the study of lithic microwear", *Journal of Archaeological Science*, vol. 35, no. 8 (2008), pp. 2223–30, DOI: 10.1016/j.jas.2008.02.006; Juan José IBÁÑEZ, Talia LAZUÉN, Jesus E. GONZÁLEZ-URQUIJO et al., "Identifying experimental tool use through confocal microscopy", *Journal of Archaeological Method and Theory*, vol. 26 (2019), pp. 1–40, DOI: 10.1007/s10816-018-9408-9.

8 Cristina LEMORINI, Stelle NUNZIANTE (eds), *An Integration of the Use-Wear and Residue Analysis for the Identification of the Function of Archaeological Stone Tools*, B.A.R. International Series MMDCXLIX (Oxford, 2014); Anders HÖGBERG, Kathryn PUSEMAN, Cgad YOST, "Integration of use-wear with protein residue analysis – a study of tool use and function in the south Scandinavian Early Neolithic", *Journal of Archaeological Science*, vol. 36, no. 8 (2009), pp. 1725–37, DOI: 10.1016/j.jas.2009.03.030; Luc BORDES, Richard FULLGAR, Linda C. PRINSLOO et al., "Raman spectroscopy of lipid micro-residues on Middle Palaeolithic stone tools from Denisova Cave, Siberia". *Journal of Archaeological Science,* vol. 95 (2018), pp. 52-63, DOI: 10.1016/j.jas.2018.05.001; Luc, BORDES, Linda C. PRINSLOO, Richard FULLAGAR et al., "A key to identify use-related micro-residues on prehistoric stone artefacts using Raman spectroscopy", *Journal of Archaeological Science: Reports*, vol. 31 (2020), e102329, DOI: 10.1016/j.jasrep.2020.102329 [Accessed 22-04-2021].

well preserved in archaeological sites, archaeologists and traceologists can count on a large corpus of collections, even from old excavations. This allows them to make comparisons on a large geographical scale, identify diachronic changes and compare the food practices of different archaeological cultures and places. Despite these advantages, traceology is time-consuming and there are few specialists worldwide that can carry out this type of analysis. In addition, experimental replicas of ancient food and craft productions are needed to properly interpret use-wear traces. Experiments carried out in the past decades and currently stored in various use-wear laboratories in European and non-European countries can be used as reference; however, new, updated and detailed experiments are constantly needed to advance in the interpretation of stone tool use. All this has made use-wear and residue analysis one of the most promising fields of research for the study of ancient food, as was also recently demonstrated by research providing new insights into hunter-gatherer and farming societies' food practices.[9]

Stone Tools Used for Food Production and Processing in the Early Neolithic of the Central and Western Mediterranean

Harvesting Tools and Cereal Cultivation during the Early Neolithic

Agriculture undoubtedly represents one of the main innovations linked to the so-called Neolithization process. Neolithic farming communities introduced near-eastern cultivars into the central and western Mediterranean; moreover, along with the seeds of the domesticated plants, a complex set of tools and knowledge necessary to sow, grow, collect, process and store the crop were diffused as well. Among them, sickles are one of the most representative elements of the Neolithic farming package. Harvesting is a strategic and delicate phase of agricultural production and, from prehistory to contemporary times, the choice of an appropriate harvesting technique has always represented a fundamental aspect of agrarian production.[10] Prehistoric sickles were composed of a wooden or bone/antler haft with one or more stone inserts used as cutting edge. The shape of the haft, the dimensions of the stone implements and the way in which they are fixed to the handle can vary significantly from one region to another and from one period to another. Unfortunately, in most archaeological sites, organic matter is poorly conserved and, therefore, only the stone part of the tool is preserved. These stones are commonly known as "sickle blades". The analysis of sickle inserts has a long tradition in prehistoric research: they are easily recognizable elements among a lithic complex because of their sheen or gloss, which is often easily visible to the naked eye, and so have always caught archaeologists' attention. Thanks to experimental and functional studies, it is nowadays accepted that the sheen is the result of a wear process caused by the contact between the stone edge and the plant while harvesting.[11]

Sickle inserts represented a new tool type, introduced by Neolithic colonists into Europe. Mesolithic hunter-gatherer groups probably gathered plants by handpicking or uprooting, as no similar tools have been identified so far in Europe. Vice versa, the Epipalaeolithic hunter-gatherers of the Near East were using stone tools for collecting wild cereals more than ten thousand years before the first appearance of Neolithic cultures.[12] Some authors believed that harvesting techniques even played a role in

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9 Iris GROMAN-YAROSLAVSKI, Ehud WEISS, Dani NADEL, "Composite sickles and cereal harvesting methods at 23,000-years-old Ohalo II, Israel", *PloS One*, vol. 11, no. 11 (2016), e0167151, DOI: 10.1371/journal.pone.0167151 [Accessed 22-04-2021]; Anna REVEDIN, Biancamaria ARANGUREN, Roberto BECATTINI et al., "Thirty-thousand-year-old evidence of plant food processing", *Proceedings of the National Academy of Sciences*, vol. 107, no. 44 (2010), pp. 18815–19, DOI: 10.1073/pnas.1006993107; Natalya SOLODENKO, Andrea ZUPANCICH, Stella NUNZIANT CESARO et al., "Fat Residue and Use-Wear Found on Acheulian Biface and Scraper Associated with Butchered Elephant Remains at the Site of Revadim, Israel", *PloS One*, vol. 10, no. 3 (2015), e0118572, DOI: 10.1371/journal.pone.0118572 [Accessed 22-04-2021]; Niccolò MAZZUCCO, Ignacio CLEMENTE CONTE, Ermengol GASSIOT, "Lost in the mountains? The Cova del Sardo and the Neolithisation of the Southern Central Pyrenees (fifth-third mill. cal bc)", *Archaeological and Anthropological Sciences*, vol. 11, no. 4 (2003), pp. 1461–75, DOI: 10.1007/s12520-018-0603-0.

10 George COMET, *Le Paysan et son outil. Essai d'histoire technique des céréales (France, VIII^e^-XV^e^ siècle),* Publications de l'École française de Rome CLXV (Rome, 1992); François SIGAUT, "Les techniques de récolte des grains: identification, localisation, problèmes d'interprétation", in Marie-Claire CAUVIN (ed.), *Rites et rythmes agraires,* Travaux de la Maison de l'Orient XX (Lyon, 1991), pp. 31–43.

11 Patricia C. ANDERSON, "Comment préciser l'utilisation agricole des outils préhistoriques?", *Cahiers de l'Euphrate*, vol. 3 (1982), pp. 149–64.

12 Ainit SNIR, Dani NADEL, Iris GROMAN-YAROSLAVSKI et al. "The origin of cultivation and proto-weeds, long before Neolithic farming", *PloS One*, vol. 10, no. 7 (2015), e0131422, DOI: 10.1371/journal.pone.0131422 [Accessed 22-04-2021].

the domestication process, bringing about an unconscious selection of plants, favouring non-shattering specimens over shattering morphotypes.[13]

Thanks to a broad research project including more than 80 sites, it has been well demonstrated that in the central and western Mediterranean, early Neolithic sickles were small, slightly curved tools, characterized by a coarsely serrated cutting edge (we are speaking, for example, of the sites of Pokrovnik, Torre Sabea, Fornace Cappuccini, Arene Candide, Peiro Signado, Guixeres de Vilobí, El Barranquet and Murciélagos de Zuheros) (fig. 2, a). The cutting edge was made by hafting a series of small stone inserts obtained by fracturing lithic blades into pieces. Those blades – stone blanks characterized by parallel straight edges – were the result of specific flaking processes, notably pressure flaking and indirect percussion techniques. However, in sites where blades and bladelets are lacking or scarce, flakes were used. Overall, this type of harvesting tool can be regarded as a highly adaptable and exportable technology. Indeed, the production of the small blades or flakes needed to compose the sickle's cutting edge did not require highly skilled specialists and very good quality raw materials but was probably a relatively simple process. Neolithic farmers were moving into unexplored and largely unknown territories and therefore needed a harvesting technology with reduced technical requirements. Thanks to the materials recovered from waterlogged and submerged sites where wooden artefacts are conserved, such as La Marmotta in Italy, we can conclude that early Neolithic sickles were rather small, with a cutting edge between 8 and 15 cm long.[14] This data fits well with the harvesting of small quantities of cereals, in the context of a small agricultural production. Use-wear data confirms this view as well. Most of the earliest sickle blades show barely developed traces, indicating a relatively brief utilization of the tool; stone inserts were probably changed quite often over time, to keep the sickle sharp. Nevertheless, the low percentage of sickle inserts in the archaeological assemblages seems to suggest that harvesting activities were still carried out on a small scale, not intensively.

A major change in the harvesting toolkit is observed around the end of the sixth millennium BC, in the northwestern Mediterranean arc (e.g., at the sites of Sammardenchia, Fagnigola, Isorella and Le Baratin) (fig. 2, b). In this area, serrated sickles were gradually abandoned in favour of harvesting tools characterized by straight cutting edges; this was achieved by replacing the small stone inserts with larger and wider blades, hafted singularly or in pairs. In some contexts, this type of harvesting insert was occasionally used earlier (i.e., at the beginning of the sixth millennium BC), co-existing with diagonally-hafted inserts; however, its employment initially remained limited. It might have been an innovation proceeding from the Balkan area, more specifically from Greece, where parallel-hafted inserts were already in use since 6300–5900 years BC.[15] It should also be remarked that those blades were generally the result of more skilled production, as more complex flaking systems and better quality raw materials were needed to obtain products of greater size.[16] In many of the sites characterized by this type of tool, the flaking process did not take place only locally, but a part of the production – especially blades – was imported from elsewhere. A good example of this new type of harvesting tools is provided by the waterlogged site of La Draga, in northeastern Spain. Two variants have been discovered at this site: one with a blade or pair of blades inserted in parallel to the main axis of the haft, one with a blade hafted diagonally to it.[17]

Thanks to use-wear and experimental data, it has been noted that reaping knives with parallel-hafted blades, like the ones found at La Draga, in Catalonia, were better suited to harvest the ears only,

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13 Dorian Q. FULLER, Robin G. ALLABY, Chris STEVENS, "Domestication as innovation: the entanglement of techniques, technology and chance in the domestication of cereal crops", *World Archaeology*, vol. 42, no. 1 (2010), pp. 13–28, DOI: 10.1080/00438240903429680.

14 Juan Francisco GIBAJA, Niccolò MAZZUCCO, Juan José IBAÑEZ et al., "Reconociendo el camino seguido por las primeras comunidades neolíticas asentadas en el Mediterráneo centro-occidental a través del análisis de sus hoces", *Arkeogazte*, vol. 7 (2016), pp. 41–57.

15 Niccolò MAZZUCCO, Juan José IBÁÑEZ, Giacomo CAPUZZO et al., "Migration, adaptation, innovation: the spread of the Neolithic harvesting technologies in the Mediterranean", *PLoS ONE,* vol. 15, no. 4 (2020), e0232455, DOI: 10.1371/journal.pone.0232455 [Accessed 22-04-2021].

16 Pelegrin JACQUES, "New experimental observations for the characterization of pressure blade production techniques", in Pierre M. Desrosiers (ed.), *The emergence of pressure blade making, From Origin to Modern Experimentation* (Boston, 2012), pp. 465–500.

17 Antoni PALOMO, Juan Francisco GIBAJA et al., "Harvesting cereals and other plants in Neolithic Iberia: the assemblage from the lake settlement at La Draga", *Antiquity*, vol. 85, no. 329 (2011), pp. 759–71, DOI: 10.1017/S0003598X00068290.

while the serrated sickles were most likely used for cutting at a low height, for collecting straw.[18] Carpological analysis partially confirms this scenario. Sites characterized by parallel-hafted blades are often associated with a scarcity of weed seeds. This could result either from harvesting only the cereal spikes or from a thorough cleaning prior to storage.[19] In addition, in some sites (e.g., La Draga, Sammardenchia), the presence of climbing weeds in several refuse pits in association with charred crop remains, whereas low weedy plants are absent, also points out towards an ear harvesting technique.[20]

The observed switch is possibly related to a more general change in harvesting tool design and maintenance as well. While sickles were previously kept sharp by frequently replacing the stone implements with new ones, now the cutting edge was resharpened by retouching the stone edge; that is, by removing the dull, used area and providing a new sharp edge. At least in some areas, such as the Dalmatian coast (e.g., at the sites of Pokrovnik and Danilo Bitinj), it seems that this change in insert morphology was associated with an intensification of harvesting practices between the end of the Early Neolithic and the beginning of the Middle Neolithic, possibly in relation to changes in farming production.[21] Nevertheless, the contribution of new migrating groups to the diffusion of technical innovations should not be ruled out, since the northern Mediterranean arc was an area characterized by multiple influences during the sixth and fifth millennia BC: a crossroads for groups of diverse origins, as attested by pottery and archaeozoological record.[22] The chronology of such a change in the agricultural toolkit varies from region to region and, if we look at current data, it seems to have been a gradual process, not an abrupt switch. However, the employment of sickles with straight cutting edges seems to have spread to most of the northern Mediterranean Basin from about the middle of the fifth millennium BC onwards, with the Middle and Late Neolithic cultures.[23]

Butchering Tools and Meat and Fish Processing

Butchering is very often a culturally oriented practice. The choice of foods and style of preparation are means by which cultural identities are established and maintained across time and space. However, while butchering patterns during the Palaeolithic and, alternatively, the Metal Age periods have been extensively studied, available information regarding the Neolithic is still scarce.[24] Meat was undoubtedly a

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18 Niccolò, MAZZUCCO, Giacomo CAPUZZO, RAQUEL PIQUÉ et al., "Harvesting tools and the spread of the Neolithic into the Central-Western Mediterranean area", *Quaternary international*, vol. 470 (2018), pp. 511-28, DOI: 10.1016/j.quaint.2017.04.018.

19 Laurent BOUBY, Philipphe MARINVAL, Frédéric DURAND et al., "Early Neolithic (ca. 5850-4500 cal BC) agricultural diffusion in the Western Mediterranean: An update of archaeobotanical data in SW France", *PLoS ONE,* vol. 15, no. 4 (2020), e0230731, DOI: 10.1371/journal.pone.0230731 [Accessed 22-04-2021].

20 Antolín, FERRAN, Ramon BUXÓ, Stefanie JACOMET et al., "An integrated perspective on farming in the early Neolithic lakeshore site of La Draga (Banyoles, Spain)", *Environmental Archaeology*, vol. 19, no. 3 (2014), pp. 241-255, DOI: 10.1179/1749631414Y.0000000027; Mauro ROTTOLI, "I resti vegetali di Sammardenchia-Cueis (Udine), Insediamento del Neolitico Antico", in Alessandro FERRARI, Andrea PESSINA (eds), *Sammardenchia—Cûeis. Contributi per la conoscenza di una comunità del primo Neolitico* (Udine, 1999), pp. 307-26.

21 Niccolò MAZZUCCO, Denis GUILBEAU, Sonja KAČAR et al., "The time is ripe for a change. The evolution of harvesting technologies in Central Dalmatia during the Neolithic period (6th millennium cal BC)", *Journal of Anthropological Archaeology*, vol. 51 (2018), pp. 88–103, DOI: 10.1016/j.jaa.2018.06.003.

22 Louise GOMART, Allon WEINER, Marzia GABRIELE et al., "Spiralled patchwork in pottery manufacture and the introduction of farming to Southern Europe", *Antiquity*, vol. 91, no. 360 (2017), pp. 1501–14, DOI: 10.15184/aqy.2017.187; Jean-DenisVIGNE, "Exploitation des animaux et néolithisation en Méditerraneée nord-occidentale", in Jean GUILAINE, Claire MANEN, Jean-Denis VIGNE (eds), *Pont de Roque-Haute (Portiragnes, Hérault). Nouveaux regards sur la néolithisation de la France méditerraneéenne* (Toulouse, 2007), pp. 221–301.

23 Juan Francisco GIBAJA, "Las hoces neolíticas del noreste de la península ibérica", *Préhistoire Anthropologie méditerranéennes*, vol. 10-11 (2002), pp. 83–96; Bernard GASSIN, Nuno F. BICHO, Laurent BOUBY et al., "Variabilité des techniques de récolte et traitement des céréales dans l'Occident méditerranéen au Néolithique ancien et moyen : facteurs environnementaux, économiques et sociaux", in Alain BEECHING, Éric THIRAULT, Joël VITAL (eds), *Économie et société à la fin de la Préhistoire. Actualité de la recherche. Actes des 7e Rencontres méridionales de Préhistoire récente, Bron, 3-4 novembre 2006* (Lyon, 2010), pp. 19–37; Paolo BIAGI, Renato NISBET, "The Earliest Farming Communities in Northern Italy", in Jean GUILAINE (ed.), *Premières communautés paysannes en Méditerranée occidentale* (Paris, 1987), pp. 449–53.

24 Silvia M. BELLO, Chris STRINGER, "Quantitative micromorphological analyses of cut marks produced by ancient and modern handaxes", *Journal of Archaeological Science,* vol. 36, no. 9 (2009), pp. 1869–80, DOI: 10.1016/j.jas.2009.04.014; Haskel J. GREENFIELD, "Slicing cut marks on animal bones: diagnostics for identifying stone tool type and raw material", *Journal of Field Archaeology* vol. 31, no. 2 (2006), pp. 147–63, DOI:

fundamental food outcome for the first farming communities of the Mediterranean, but collected data on butchering practices (in particular of cut marks on bone surfaces) is still fragmentary and not enough to highlight the existence of specific traditions for animal carcass processing and treatment.

As a contribution to this topic, traceological research has so far succeeded in highlighting the existence of specific tool types used for meat processing. In most Early Neolithic sites of the central and western Mediterranean, unretouched bladelets or small blades were selected to carry out butchering tasks.[25] This type of blank, regular and thin, was characterized by acute cutting edges, which made the tools ideal for cutting soft substances, such as meat and other animal tissues (fig. 3). Therefore, no modification of the blanks was generally required; only occasionally, blades would be broken to reduce their length and remove the distal curvature. At the current state of research, there is little or no evidence of the hafting of Neolithic butchering knives. Some authors have suggested that butchering bladelets of the southern France Middle Neolithic (i.e., Chassey culture) were most probably hafted into wooden or bone sticks. The small size of the blanks would indeed make it very difficult to handle them; however, traceological and archaeological evidence is not conclusive on this point and further research is needed.[26]

Thanks to a comparative analysis of use-wear data, it has been possible to highlight some territorial and spatial variability in butchering practices. Butchering tools are not equally represented in all sites, but it seems that, in some settlements, animal slaughtering and processing had greater importance. Such differences were probably due to "site function" issues; there were specific locations or spaces where animals were slaughtered during certain seasons of the year. Sheepfold caves (e.g., Els Trocs and Murciélagos de Zuheros) and other temporal refuges (e.g., Abrigo de la Dehesa and Cova del Vidre) are some of the sites more often characterized by a relative abundance of butchering tasks, probably related to the annual pastoral cycle, at least in certain geographical zones (i.e., mountainous ones: Pyrenean area, Iberian System).[27] Nevertheless, we must take into account that meat-related traces are some of the most complicated traces to be recognized microscopically. Most traceologists agree that the number of stone tools used for butchering is probably underrepresented in use-wear studies, given the specific nature of this type of use-wear. Microscopic wear is indeed difficult to identify and can be easily masked by taphonomic alterations; macroscopic evidence is easier to detect, but it is less indicative, as it can be related to a broader array of contact materials and working tasks. Recently, research integrating use-wear and residue analysis through FTIR spectroscopy has been conducted at the Neolithic sites of Masseria Candelaro and Sant'Anna di Oria, in South Italy, obtaining promising results that could lead to a more precise identification of meat and bone working activities.[28]

Efforts have been made as well to differentiate use-wear produced by butchering terrestrial mammals from that which is the result of fish cleaning and processing. Experimental data suggests that wear produced by fish processing tasks (e.g., scaling, gutting and decapitating) presented characteristic features distinguishable from other use-wear categories such as butchering, bone or hide working.[29] The

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25 Bernard GASSIN, Dider BINDER, INGRID SÉNÉPART, "Statut et fonction des productions d'éclats au Néolithique : exemples provençaux", in Pierre BODU, Claude CONSTANTIN (eds), *Approches fonctionnelles en préhistoire* (Paris, 2004), pp. 167–79; Juan Francisco GIBAJA, Niccolò MAZZUCCO, "Conociendo la función del utillaje lítico tallado: Veinticinco años de análisis traceológicos aplicados a contextos neolíticos del noreste de la Península Ibérica", *Journal of Lithic Studies*, vol. 2, no. 2 (2015), pp. 67–93, DOI: 10.2218/jls.v2i2.1432.

26 Loïc TORCHY, *De l'amont vers l'aval : fonction et gestion des productions lithiques dans les réseaux d'échanges du Chasséen méridional* (thèse, Université Toulouse 2 Le Mirail, 2013), esp. p. 171.

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employment of stone tools for fish processing is mainly related to its preparation for conservation and storage practices (i.e., drying, smoking and salting), while it is unnecessary for its direct consumption. Therefore, use-wear analysis can provide indirect evidence not only of fish exploitation, but also of the modalities and extent of the exploitation. So far, the presence of fish-related traces has been proposed only for a few sites, located in the southern Atlantic coast of the Iberian Peninsula (e.g., Vale Pincel).[30] At this site, the presence of a relevant percentage of traces bearing the characteristic features of fish polish suggests that fish was not only consumed on this site, but also processed, presumably for its conservation and storage. Nevertheless, judging by current data, the input of fish resources in the diet of the first Mediterranean farmers seems to have been minimal. Isotopic analysis also suggests minimal input of marine resources in the diet during the Neolithic in the Mediterranean.[31] Despite that, it should be remarked that the number of individuals from the Early Neolithic isotopically analysed is still low and geographically sparse.

The marginal exploitation of fish resources by the first Mediterranean farmers is still hard to understand; it might respond to cultural and dietary choices (e.g., food taboos and food preferences, specific beliefs and hierarchization of food consumption). Despite that, in many archaeological excavations, little attention has been paid to the recovery of fish remains and their representation might be biased. In addition, the limited number of use-wear and residue studies carried out on a Mediterranean scale might distort our perception of fish consumption as well.

Projectile Tools and Hunting Toolkit

The cultural, economic, social and symbolic status of hunting activities in the Early Mediterranean Neolithic has been long debated among archaeologists. The Mediterranean Neolithic is indeed characterized by a specific category of stone tools: backed geometric tools or geometric microliths. Those tools were generally produced by fracturing a blade (by means of different blade-breaking techniques) into small pieces and retouching them into a trapezoidal, lunate-shaped, triangular or rhomboidal shape. Those instruments have been considered one of the guide fossils for chronological and cultural units in prehistory. For the Early Neolithic, geometric microliths have been mainly interpreted in terms of "archaic" versus "innovative" features, based on the comparison between Mesolithic and Neolithic assemblages and the hypothesis of mutual influences and technical transfers between local hunter-gatherers and colonial farming communities. Typo-technological classifications of geometric microliths have proved the existence of a rich geographical diversity (fig. 4, a). In the southeastern façade of the Iberian Peninsula, Neolithic microlith assemblages are dominated by lunate-shaped microliths, also called segments, shaped through unifacial abrupt retouch. In the Basque Country and in the Ebro Valley, the appearance of segments characterized by plain bifacial retouch is one of the main features associated with the Neolithization process.[32] In the northwestern Mediterranean arc, Neolithic microliths are mainly of trapezoidal, symmetrical shapes. They are made on wide blades, sectioned by flexion, creating two inverse bitruncations. However, regional variations exist. In the eastern sectors of the Iberian Peninsula, trapezoidal forms shaped by abrupt retouch tend to prevail, followed by triangles and segments. Neolithic

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31 Domingo Carlos SALAZAR-GARCÍA, María FONTANALS-COLL, Gwenaëlle GOUDE et al., "To 'seafood' or not to 'seafood'? An isotopic perspective on dietary preferences at the Mesolithic-Neolithic transition in the Western Mediterranean", *Quaternary International*, vol. 470 (2018), pp. 497–510, DOI: 10.1016/j.quaint.2017.12.039.

32 Grégore MARCHAND, "Les traditions techniques du Mésolithique final dans le sud du Portugal: les industries lithiques des amas coquilliers de Várzea da Mó et de Cabeço do Rebolador (fouilles M. Heleno)", *Revista portuguesa de arqueologia*, vol. 4, no. 2 (2001), pp. 47–110; Alfonso ALDAY, "Regiones y transferencias en el camino del Neolítico ibérico: el caso de las armaduras líticas", *SAGVNTVM*, vol. 50 (2018), pp. 9–33; Amelia RODRÍGUEZ-RODRÍGUEZ, Juan Francisco GIBAJA, Unai PERALES BARRÓN et al., "Comunidades campesinas, pastoras y artesanas. Traceología de los procesos de trabajo durante el neolítico andaluz", *Menga. Revista de Prehistoria de Andalucía*, vol. 4 (2013), pp. 35-50.

assemblages of southwestern France are mainly characterized by symmetrical transverse arrowheads shaped by bifacial flat retouch, while southeastern France is mainly characterized by symmetrical trapezes shaped by direct retouch.[33] The North Italian Neolithic is characterized by large rhomboidal microliths, while trapezoidal symmetrical forms, with both rectilinear and concave edges, characterize most of the sites in peninsular Italy.[34] Such variability reveals the existence of diverse technical and cultural choices, but is still hard to interpret in terms of hunting practices.

Traceological analysis has shown that those tools were hafted into arrows, as tips or lateral elements or barbs, probably in a wide array of combinations (transversal arrow, single-tipped arrow, multiple tips, only barbs, tip and barbs, etc.) (fig. 4, b).[35] The analysis of the fractures and microstriations caused by the impact against the target allows the identification of used zones and of possible hafting modes. Variability in hafting modes has also been suggested on the basis of the hunting scenes represented in the Levantine rock art record in the northeast of the Iberian Peninsula.[36] Regarding the possible relation between microlith shapes and game type and size (e.g., small-game or big-game hunting and bird hunting), further research is still necessary, as archaeological data is controversial. In this sense, one of the main issues concerning the study of hunting practices is undoubtedly the creation of a controlled yet realistic experimental reference framework. The variables involved in the formation of impact traces on projectile tools are many (target distance, arrow speed, angle of penetration, type and dimension of the bow, type and size of the game, etc.) and controlled experiments can be complex and time-consuming.[37]

The amount of microliths in Neolithic flaked stone assemblages is always quite limited. A comparison of traceological data on a Mediterranean scale has suggested that hunting was mainly an occasional practice in the Neolithic. Sites with a high ratio of used geometric microliths are rare (e.g., Atxoste, Zatoya, Abrigo de la Dehesa and Grotte Lombard) and they are usually temporary camp sites (e.g., caves or rock shelters) located in specific environments (e.g., mountainous or high-hill areas). In most Neolithic, open-air, villages, the presence of projectile tools is rare, which suggests that hunting activities most likely took place on a sporadic basis and did not represent the main subsistence activity.[38]

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33 Thomas PERRIN, Claire MANEN, Nicolas VALDEYRON et al., "Beyond the sea… The Neolithic transition in the southwest of France", *Quaternary International*, vol. 470, no. B (2018), pp. 318–32 ; Didier BINDER, Jean COURTIN, "Nouvelles vues sur les processus de néolithisation dans le sud-est de la France: "Un pas en avant, deux pas en arrière"", in Jean GUILAINE (ed.), *Premières communautés paysannes en Méditerranée occidentale* (Paris, 1987), pp. 491–99.

34 Bagolini, BERNARDINO, Paolo BIAGI, "The first neolithic chipped stone assemblages of northern Italy", in Janusz KOZLOWSKI, Stefan K. KOZLOWSKI (eds), *Archeologia Interregionalis* (Warsaw/Krakow, 1987), pp. 423–48; Niccolò MAZZUCCO, Juan Francisco GIBAJA, Jean GUILAINE et al., "Il sito Neolitico antico di Torre Sabea (Gallipoli, LE): nuovi dati sulla pratiche agricole e venatorie attraverso l'analisi funzionale dell'industria litica", *Rivista di scienze preistoriche*, vol. 63 (2013), pp. 5–20.

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As other authors have stated, hunting probably played an important social and symbolic role within Neolithic groups and was not merely a food procurement activity. Indeed, hunting probably contributed relatively little to the alimentation of Neolithic communities. Political and prestige factors were possibly implicated; the consumption of wild game meat may have been restricted to a few individuals or houses or concentrated in specific periods in relation with communal practices. In other instances, a specific value may have been attached to the species being hunted, in either energetic or symbolic terms.[39]

Conclusions

This article has provided an overview of food-related practices in the central and western Mediterranean Early Neolithic as inferred from the traceological study of stone tools. The employment of specific and well-adapted tools was undoubtedly a fundamental part of the technical systems associated with food. Stone tools were used in strategic tasks, such as cereal harvesting, animal butchering and hunting, and played a very important role in the production process. The geographical and chronological diversity in the technical systems associated with food procurement and processing has been highlighted. These differences were probably the result of multiple factors, including cultural and identity-based aspects. However, other factors seem to have had an influence on the type of tool used: the scale of production, raw material availability, the type of occupation and the environmental framework, among others. In addition, such diversity was not limited to the flaked stone toolkit but involved other categories of archaeological remains. For example, the observed variability in cereal harvesting techniques goes together with the spatial and temporal variation in the species of cultivated plants. The charred remains of some crop species (i.e., glume wheats emmer and einkron) seem to significantly decrease with the westward expansion of farming in France and Spain, while other species (i.e., free-threshing wheat) seem to become important. Such changes can also be interpreted as the result of a combined role of founder effect and adaptive change.[40] In the future, the combination of bioarchaeological and technological data will hopefully allow us to gain a better understanding of the changes of the farming package as a whole, possibly relating changes in the cultivated species to changes in the techniques used to work and process them.

Similar conclusions can be drawn regarding other archaeological records, such as archaeozoological remains. The spectrum of exploited animals varied considerably among regions and sites. This concerned not only the ratio of wild game to domesticated animals,[41] but also the exploited species and their characteristics. For example, the morphological traits of domesticated sheep seemed to diverge among the Impressed Ware and the Cardial groups. Sheep at the Impressed Ware sites of southern France and central Italy were more robust and their horns were hollow, while at Cardial sites sheep were smaller and lighter, with solid horns. This latter group of sheep might have been of Balkan origin, arriving through northern Italy.[42] Our data on butchering and hunting practices in the

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Une économie de chasse au néolitique ancien. Le Grotte Lombard à Saint-Vallier-de-Thiey (Alpes Maritimes). Monographie du CRA V (Paris, 1991).

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42 Jean-Denis VIGNE, "Exploitation des animaux et néolithisation en Méditerranée nord-occidentale", 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. 221–31.

Mediterranean is still too fragmentary to discuss whether cultural, economic or environmental factors had an influence on the observed variability. For the moment, it seems that, while differences from one site to another can often be explained in terms of a functional variation between settlements, observed variability on a larger scale seems to be an expression of different technical and cultural systems. Only by broadening our dataset and increasing our capacity to identify and distinguish use-wear traces will it be possible to make progress in this direction.

In conclusion, use-wear data represents a fundamental source of information without which it would be impossible to understand the role played by stone tools within food production. The incorporation of stone tools (as well as other categories of tools) in the research on ancient foods is an opportunity to broaden the focus, thus integrating data obtained from the study of food and bioarchaeological remains (charred seeds, faunal remains, isotopic data, etc.). A greater integration of disciplines would be advantageous in order to approach food production from a systemic point of view. This would allow us to discuss the changes observed in a specific archaeological record in relation to changes (or the absence of them) in other domains. To this end, it is very important to extend traceological analysis as much as possible, including more sites, more assemblages and a larger selection of tools, so as to create a solid database of stone tool use in different parts of the Mediterranean. Only a more systematic application of traceology will allow us to carry out more detailed analyses of the evolution of food production and consumption during the Neolithic and of the way it was interconnected with cultural and economic factors.

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Captions to Figures
Figure 1. Map including the main Early Neolithic sites studied by means of traceological analysis in the central and western Mediterranean. The red dots indicate the sites cited in the text: 1: Torre Sabea; 2: Sant'Anna di Oria; 3: Masseria Candelaro; 4: La Marmotta; 5: Fornace Cappuccini; 6: Danilo Bitinj; 7: Pokrovnik; 8: Sammardenchia; 9: Fagnigola; 10: Isorella; 11: Arene Candide; 12: Grotte Lombard; 13: Le Baratin; 14: Peiro Signado; 15: La Draga; 16: Guixeres de Vilobí; 17: Cova del Vidre; 18: Els Trocs; 19: Zatoya; 20: Atxoste; 21: Abrigo de la Dehesa; 22: El Barranquet; 23: Murciélagos de los Zuheros; 24: Vale Pincel.

Figure 2. a) On the left: wooden sickle from La Marmotta. On the right: examples of sickle blades with a diagonal gloss. b) On the left: wooden haft from La Draga. On the right: examples of blades with a parallel distributed gloss.

Figure 3. Selection of tools used for animal butchering from Els Trocs (a) and Vale Pincel I (b). Macroscopic and microscopic use-wear traces are shown.

Figure 4. a) Main typologies of geometric microliths found in the Early Neolithic sites of the central and western Mediterranean. 1: Segments shaped by direct abrupt retouch; 2: Segments shaped by bifacial flat retouch (*double bisel*); 3: Transverse arrowheads shaped by bifacial retouch; 4: Symmetrical trapezes produced by inverse bitruncation; 5: Rhomboidal geometric tools; 6: Trapezes with both concave and rectilinear sides. b) Main modes of Neolithic microlith hafting on the arrow shaft as inferred by traceological analysis.