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# Lithic economy in south western France during the Neolithic: A case study from a coastal site - La Lède du Gurp (Aquitaine)

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## Abstract:

The prehistory of South-western France is known worldwide for its rich record of Palaeolithic sites, especially from the Dordogne region. However, while research on the Palaeolithic is extremely prolific, the Neolithic was at the same time relegated to the background. Since the beginning of the discipline, few researchers worked on the Neolithic from SW France. Besides, they focused on ceramic typological analyses to describe cultural groups, rarely considered lithic tools and armatures, and never performed any techno-economical study of lithic productions. For over thirty years, rescue archaeology excavations revealed a large presence of Neolithic sites for this period; nonetheless Neolithic research remains little developed in relation to its potential. As part of my PhD thesis, the aim will be to fill this gap by characterizing lithic productions through techno-economical analyses, in order to describe the cultural groups existing in Northern Aquitania during the 4th and the 3rd millennia. With the example of La Lède du Gurp, a littoral occupation site dated to the Middle and Late Neolithic, I will try to highlight in this paper what the study of lithic industries can say about a cultural group at a local scale.

The reconstitution of the operating chains and the statistical analysis of small assemblages of non-standardised lithic reduction, allowed us to highlight a similar low investment in lithic production between the Middle and the Late Neolithic of La Lède du Gurp. Our approach has enabled us to observe that a low investment in lithic production may reflect the complexity of the Neolithic groups and the complementarity of lithic industry with other technical subsystems directly related with the group's natural environment, as may it be the case for salt production during Late Neolithic at La Lède du Gurp.

**Keywords:** lithic reduction; technical subsystems; recycled head axes; Middle Neolithic, Late Neolithic; Aquitania, Medoc

## 1. Introduction

The prehistory of South-western France is known worldwide for its rich Palaeolithic record, especially in the Dordogne region. This rich record has resulted in extremely prolific research on the Palaeolithic in the area, and research on the Neolithic often takes a backseat.



Moreover, according to the records registered in the regional archaeological database, the evidence of both Neolithic exploitation and occupation in the region can be quite abundant, varying in accordance with the different phases of the period (Figure 1).

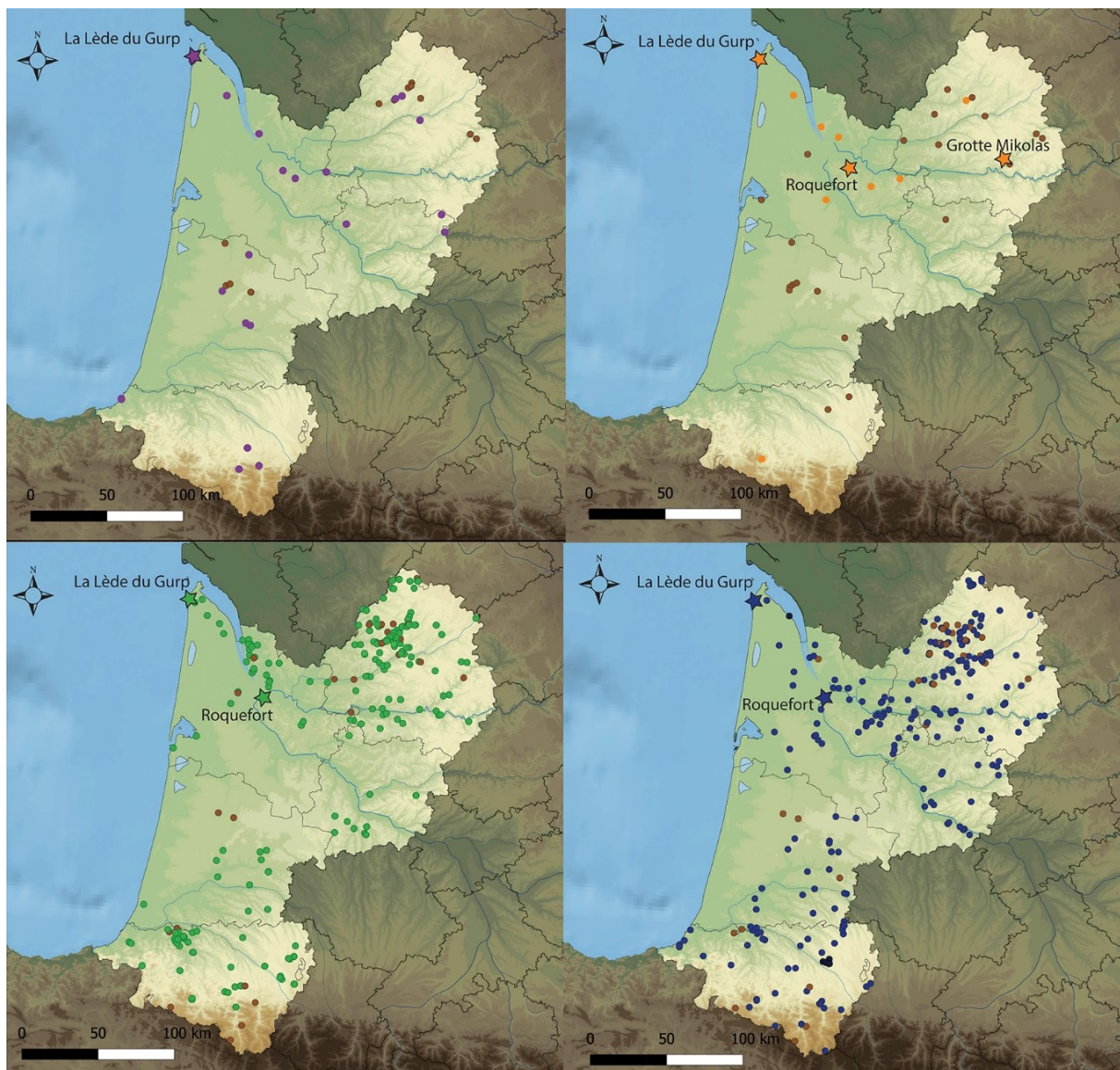


Figure 1. Early Neolithic to Late Neolithic occurrences in the Aquitaine region. Starred sites are discussed in the text of the article. (purple dots: Early Neolithic; orange dots Middle Neolithic; green dots Late Neolithic, blue dots Final Neolithic, brown dots sites with multiple phases. Map made after regional archaeological database.

### 1.1. Previous research

Instances of the Early and Middle Neolithic are rare and the data available is old. Most of the evidence consists of isolated finds from field surveys beginning in the nineteenth century, and most of the actual excavations that occurred were conducted under the direction of amateur archaeologists using dated techniques. When these factors are combined, the reliability of the currently available data is left wanting (Gernigon 2013; Marchand 1999: 13). Academic research on Neolithic archaeology was primarily conducted by Julia Roussot-Larroque, who excavated several habitation sites and was the only researcher working on this period in the Gironde and Dordogne region from the 1970s through to the 1990s. Before the work of Roussot-Larroque, Marie-Claire Cauvin (1967) had initiated research on the Neolithic in the Dordogne but had focused on the analysis of polished stone axe head shaping

sites. Since the 1990s, the only academically oriented Neolithic excavations in this area are two funerary sites, la Grotte Mikolas at Le Bugue (Dordogne) (Chancerel & Courtaud 2007; 2016; Courtaud & Chancerel 2009) and, more recently, Roquefort at Lugasson (Gironde) (Ard 2019, 2020). Amateur and rescue archaeology has, moreover, contributed significantly over the last twenty years. Such excavations have revealed important sites providing precious new data, especially for the Late and Final phases of the Neolithic. Both archaeologies have contributed significantly to our pool of raw data, and this data remains to be completely exploited. The data in lithic technology has progressed due to P. Fouéré. (e.g., Fouéré 1994; 2008, 2011; Fouéré *et al.* 2012) and rescue archaeology. He had previously underlined our collective blind spot relative to the lithic industries of the Middle to the Late Neolithic while summarizing primary results from rescue excavations (Dias-Meirinho & Fouéré 2008). He has also analysed axe head production workshops in the area (Fouéré 1994: 407; 2006; Fouéré *et al.*, 2012). While such research on this specific Neolithic craft activity has been well developed (Delage 2004; Thirault & Labriffe 2012), it remains disconnected from other research conducted on more generalized lithic industries.

A generally out-of-date bibliography accompanies the old data outlined above. In fact, most of our information on the Neolithic of the northern Aquitaine comes from Roussot-Larroque's multiple excavations. Her investigations were focused on the interpretation of complex stratigraphies from several sites, yet these stratigraphies were never officially published and only appeared in excavation reports. While her work permitted her to establish several distinct Neolithic cultural groups in the area, she emphasized ceramic typologies and did not integrate data on the techno-economic organization of lithic industries into her definitions. This work did nevertheless permit Roussot-Larroque to seriate her different features into an established chronology of Neolithic phases in south-western France (Table 1). (e.g., Roussot-Larroque 1976; 1989; 1991; 1998).

Roussot-Larroque considered that the process of Neolithization in this region had a local origin, defending a culture known as the Roucadourian (*Roucadourien*) (Roussot-Larroque 1987; 1990; 1998; Roussot-Larroque & Burnez 1992) that demonstrated influences from other regions. La Lède du Gulp (LDG) was important for the definition of another of Roussot-Larroque's Neolithic groups, the Atlantic Cardial culture (*Cardial atlantique*) (Roussot-Larroque 1976; 1998; Roussot-Larroque & Burnez 1992). Later in the chronology at LDG, during the Middle Neolithic, Roussot-Larroque described the Atlantic Chassey culture (*Chasséen atlantique*) which was apparently contemporaneous with a culture she labelled the Roquefort group (Roussot-Larroque 1986; 1991; 1995; 1998). The Roquefort group subsequently gave rise to the following culture, the Matignon which then gave rise to the Peu-Richard (Roussot-Larroque 1976; 1986; 1998). Another group was defined at the end of the Late Neolithic, known as the Dordogne Isle (*Isle Dordogne*) culture. Finally, she considered that the Artenacian (*Artenacien*) culture was the result of multiregional influences (Roussot-Larroque 1973; 1976; 1989; 1998).

Work conducted by Marchand and Manen (Marchand & Manen 2006) demonstrated, however, that the process of Neolithization in France actually follows a path with origins in the south-east, likely expanding through the corridor of the Garonne River. Ultimately this undermines Roussot-Larroque's hypotheses regarding the Atlantic Cardial culture at LDG and has led to its general rejection given its isolation and presence at a single site (LDG). Other researchers have reassigned the Atlantic Chassey culture to the Atlantic Middle Neolithic (*Néolithique moyen atlantique*, NMA) (Dias-Meirinho & Fouéré 2008; Fouéré 1998, Gernigon 2013). Both the Roquefort and the Dordogne Isle cultures require further study in order to validate or disprove their existence in respect to more recent data. The geographic boundaries of these different groups have been poorly articulated, and to date the lithic economy remains to be accurately described. For the Matignon and Peu-Richard cultures,

their chronological evolution from the Roquefort culture cannot be formally rejected until new studies have not been conducted and new dated sites have not been explored in the region. Finally, the Artenacian (*Artenacien*) have been proven to exist at multiple sites in the region, yet lithic production and circulation networks (Burnez 1976:285-310; Laporte 2008), again, require some much-needed attention in this region.

Table 1. Correspondence between Roussot-Larroque's and recently updated chronologies of the Neolithic in the north-western Aquitaine Basin. \*The Roucadourian was the result of a mixed stratigraphy between Mesolithic and Bronze Age artefacts (Valdeyron 1998). Dates (Roussot-Larroque 1998). Current dates (Dias-Meirinho & Fouéré 2008; Fouéré 1994; Marchand & Manen 2006).

Neolithic phase	Roussot-Larroque's cultural chronology	Current cultural chronology	Dates	Current dates
Early Neolithic	Rocadourian (Rocadourien)	No longer exists*	7200-4900 cal BCE	
Early Neolithic	Atlantic impressed ware (Cardial Atlantique)	Central Atlantic Early Neolithic (Néolithique ancien centre atlantique [NACA])	5500-4500 cal BCE	5300-4450 cal BCE
Middle Neolithic	Atlantic and Western Chassey culture (Chasséen atlantique or Chasséen de l'Ouest)	Atlantic Middle Neolithic (Néolithique Moyen Atlantique [NMAπ])	4600-3800 cal BCE	4800-3750 cal BCE
Middle Neolithic	Roquefort	Roquefort?	4780-3500 cal BCE	No mention
Late Neolithic	Matignon	Matignon	3600-3300 cal BCE	3800-3100 cal BCE
Late Neolithic	Peu-Richard	Peu-Richard	3300-2900 cal BCE	3400-2900 cal BCE
Late Neolithic	Isle-Dordogne	Isle Dordogne?	2800-2500 cal BCE	No mention
Final Neolithic	Artenacian (Artenacien)	Artenacian (Artenacien)	3000-2400 cal BCE	3000-2400 cal BCE

## 1.2. A resurgence of interest

Lately, several research projects have contributed to a resurgence of interest in the Neolithic of the northern Aquitaine Basin, including the MONUMEN project, under the direction of V. Ard, as well as several ongoing doctoral theses re-exploring Neolithic material culture in this area (such as R. Suso's ongoing thesis on late Neolithic ceramics). My own doctoral research project also aims to reinvigorate research on the Neolithic by filling the current lacunae that exist regarding our knowledge of the lithic industries and techno-economic organization of societies occupying the northern Aquitaine Basin during the 4th and the 3rd millennia.

The lithic industries from LDG present an ideal opportunity to provide initial guidelines for the characterization of Neolithic cultural features in the northern Aquitaine Basin. The stratigraphy contains multiple phases. Some are directly dated with radiocarbon, and all are dated relatively using several different markers. The site is situated by the sea; it is currently directly on the shore, yet at the time of occupation it was a bit removed from the actual shore. It could still be considered coastal. Within the lithic material, two complete operational schemas (*schémas opératoires*) have been documented, allowing us to compare between the

Middle and Late Neolithic. Our main intention in studying this material is to determine the production strategy conditioning the lithic industry, and how these choices reflected group organization (Perlès 1991). More than simply reflective of economic decisions, the organization of the lithic economy can also reflect the structural elements of a group, ultimately revealing aspects of social organization that translate lived cultural traditions into material cultural traditions (Lemonnier 1983; 1991; Mauss 1923: 223-233; Mauss 1947: 22). The study of manifest operational chains (*chaînes opératoires*) allow us to broach such other topics as degrees of group investment, in terms of time and effort, and whether some forms of production can be considered to be the product of specialized artisans (Karlin 1991; Karlin *et al.* 1991; Pelegrin 1991; Pelegrin *et al.* 1988). We know that such specialization likely exists during the Neolithic as workshops, and notably polished stone axe workshops, become increasingly widespread at a continental scale during this period (Gauthier & Pétrequin 2017), as do specific raw material acquisition sites. For instance, during the Middle Neolithic, Bedoulian (Early Cretaceous) flint heat treatment sites can be observed, and these objects circulate widely afterwards (Léa *et al.* 2004; 2012). Later, during the Late Neolithic, Grand-Pressigny (Turonian) flint is mined and transformed at specific sites, and the objects produced are circulating quite widely as well (Mallet *et al.* 2012). Local and regional environmental contexts can also constrain group activities in certain ways and therefore orient the lithic economy, either directly or indirectly. In order to understand whether trade between groups with specialized workshop sites was frequent, we must first understand how lithic production occurs locally and what its organization reflects in terms of strategic decision-making processes. And independently of whether the lithic production system appears emphasized within a group's economy or not, it can still be reflective of other economic spheres (Perlès 2009). These preliminary results can show some leads to pursue the investigation.

## 2. Materials and methods

### 2.1. Site history and context

The specific location of the site, situated between the sea and coastal marshlands, is an important factor for understanding its function and operation. Firstly, LDG is not a single occupation site, but rather is a vast archaeological deposit where different sections have been progressively destroyed by the action of the tides. These different sections were excavated over decades, though not always continuously in one area. This explains in part why there were no Early or Late Neolithic deposits explored during recent excavations, and also why there was very little Middle Neolithic discovered during earlier phases of excavation (Frugier 1979; 1983; Roussot-Larroque 1984; 1989; 1994). Secondly, while LDG is, today, a coastal site, the coast was located several hundred metres further during the Neolithic, and paleoenvironmental reconstructions point towards a marsh land type environment (Faye *et al.* 2019; Marambat & Roussot-Larroque 1989; Verdin *et al.* 2018). Thirdly, Neolithic activities in the area may have been dependant on the marine and wetland resources that were locally available. These three factors are to be kept in mind when interpreting artefact analysis results.

LDG was previously excavated from the late 1960s through to the 1990s, first by Moreau, then by Frugier, and lastly by Roussot-Larroque. The first Neolithic discoveries were made by Frugier in 1979. Between the end of excavations during the 1990s and the beginning of recent excavations, as of 2014 under the direction of F. Verdin, Roussot-Larroque analyzed the ceramic collections from the earlier phases of excavation. During these various phases of excavation and study a stratigraphy spanning from the Mesolithic to the Bronze Age was documented, and Roussot-Larroque's aforementioned Neolithic cultural entities were described and defined. The principal studies can be found in excavation reports, and a



summary of Roussot-Larroque's definitions can also be found in the atlas of South-Western France (Roussot-Larroque 1998).

Recent excavations were conducted within the Litaq project by F. Verdin, which aims to study the evolution of coastal environments, and were also rescue excavations, given that marine erosion once again threatened the integrity of the archaeological remains. Excavations were conducted for one month, during which the ever-present tides sometimes impeded our progress, but sufficient data was collected to revive our interpretations of LDG. The stratigraphy consists of several superimposed layers of peat, all sitting within a depression that is reminiscent of a marshland. The lower levels experienced a slight post-depositional disturbance, as Early Neolithic material was found in these oldest Middle Neolithic levels. The lithic and ceramic artefacts collected during recent excavations were additionally located near the occupation levels explored from the late 1960s to the 1990s. While the nature of the sediment, reflective of a marshland context, rendered it sometimes difficult to distinguish between distinct stratigraphic units, several broad cultural phases were discernible. The Middle Neolithic is present, consisting of ten distinct stratigraphic units dated between 4400 and 3600 cal. BCE (based on three dated samples), as is the Late Neolithic, as materialized by one stratigraphic unit attributable to the Matignon culture and three attributable to the Peu-Richard culture, collectively dated between 3400 and 3000 cal. BCE. The radiocarbon dates were conducted using carbonized residues found on ceramic fragments (Verdin *et al.* 2018).

## 2.2. Lithic material

The lithic material collected consists of roughly 300 objects (Table 2), and only 50 of them were piece-plotted in three dimensions as the constant threat of the tide impeded finer grained recording methods. This low statistical representation of piece plotted artefacts also impeded a proper spatial analysis. The generally small sample size meant that counts per stratigraphic unit (SU) were too reduced to allow for between SU comparisons, meaning we treated the assemblage by chronological attribution. We judged the sample size for the Matignon level ( $n = 9$ ) too small and therefore it was excluded from our analyses. In grouping the material per chronological period rather by individual SU, we hoped to collect adequate information to determine, with a reasonable statistical reliability, the general organization of lithic production at LDG during the Middle Neolithic ( $N=168$ ) and during the Late Neolithic ( $N=150$ ), and therefore analyse the degrees of technological recurrence or divergence diachronically. After the exclusion of the Matignon and the disturbed Middle Neolithic levels from our analyses, the count of pieces studied for the present article was 312.

Table 2. Number of lithic artefacts per period and per Stratigraphic Unit.

Stratigraphic units	Periods	Number of lithic artefacts
1019	Peu Richard (Late Neolithic II)	24
1020	Peu Richard (Late Neolithic II)	50
1021-1022	Peu Richard (Late Neolithic II)	76
1025	Matignon (Late Neolithic I)	9
1023=1042=1045	Middle Neolithic	98
1024=1046=1047	Middle Neolithic	19
1026-1027	Middle Neolithic	15
1028	Middle Neolithic	30
1029	Middle Neolithic	3
1038	Middle Neolithic	3
<b>Total</b>		<b>327</b>

### 2.3. Methods

The reconstruction of operational chains (*chaînes opératoires*) is a tried and true method for understanding lithic production systems during the Neolithic and other chronological periods (Inizan *et al.* 1995: 13-15; Pelegrin 1995). By taking a technoeconomic approach to lithic industries, we can explore the choices flint knappers made regarding the selection of different raw materials, say how materials were transformed, and how the resulting objects or tools were used and eventually abandoned. A thorough analysis of each step of production systems allows us to determine which phases show a particular investment by knappers, which in turn permits us to diachronically compare Middle and Late Neolithic lithic traditions.

Following the organization of any lithic production system, the first step entails the acquisition of raw materials. These can be mined or collected from natural quarries, and the implications for time and effort invested are significantly different for these two options, potentially reflecting distinct societal or group organizations (Perlès 1991). Analyses of the LDG lithic materials were conducted at three scales. The first macroscopic approach considered the nature of the cortex, such as its width (thick, moderate, thin, absent), its degree of transformation (smooth, showing multiple natural impact marks, rolled, chalky, neocortex), the matrix transparency (transparent, opaque, *etc.*), its colour (dark, blond, grey, *etc.*), and finally its grain (fine, moderate, rough). This allowed an initial sorting into likely geological stages (Cretaceous, Paleogene, Neogene, *etc.*) and substages (Turonian, Coniacian, Campanian, Maastrichtian). Some sampling of materials in proximity to the site was also conducted in order to compare between archaeological and contemporary samples. Macroscopic analyses were conducted with the stereoscopic microscope by S. Caux. Such an approach entails the analysis of bioclasts (microfossils) and other features at scales of 1 mm, 500 µm and 250 µm, and allows the analyst to determine the geological origin of the material (primary source), in addition to where the material was actually collected (primary outcrop, altered deposits, alluvial or colluvial deposits, *etc.*), following the “evolutionary chain” (*chaîne évolutive*) approach (Caux 2015: 38; Delvigne 2016: 67; Fernandes 2012: 123).

Secondly, we must understand how the flint procured was knapped in order to reconstruct, from the various operational chains present on site, the idealized operative schema (*schéma opératoire*) (Tixier 1978 [2012 re-edition]: 121-123). Knapping techniques and their transmission are especially important to consider, as are their modalities of reduction, ultimately allowing to interpret distinct operational schemas, and the organization of the lithic economy in general (Binder 1987: 31; Pelegrin *et al.* 1988; Pigeot 1991). There exists a multitude of ways to reduce a block of flint and produce tools, but the selection of knapping techniques can be understood as the combination of environmental constraints and the weight of sociocultural tradition (Tixier 1978 [2012 re-edition]: 40). The transmission of traditions, in both current and prehistoric contexts, can be observed through the study of material production in artisanal systems (Leroi-Gourhan 1945: 391-397). During the Neolithic there existed several different artisanal production systems, the implication being that many traditional knowledge systems also existed, whose comparative study can reveal the complex socioeconomic organization of past societies (Perlès 2009). As previously underlined, lithic industries in certain Neolithic contexts have been studied as an afterthought and often been considered as accessory or completely opportunistic behaviours. They have therefore an undeniable place within Neolithic economies, which in turn implies that they can also be considered as traditions. The question then is not whether lithic industries are opportunistic or not, but rather how the lithic system, regardless of complexity, is integrated within the global economy of the group.

Our hope is to detect the elements that form the backbone of the Middle and Late Neolithic lithic traditions, via a typo-technological analysis of the lithic industry present at LDG. In order to decipher these traditions, we conducted diacritical analyses on cores, coupled with an analysis of the various blanks produced during different steps of the operational chains. Given the lack of blank standardization observed in the collection, morphometric analyses allowed us to explore whether specificities existed regarding the selection of ideal products, and whether these varied across the two time periods investigated. Morphological, typological and stylistic similarities observed with the assemblages in turn allowed us to compare at an inter-site scale. This allows us to begin deciphering whether artisanal traditions were shared between contemporary groups. By comparing the different operational chains across periods and site, we ideally understand how lithic production is integrated into the greater economy, and how this reflects one, or multiple, traditions.

To evaluate our analytical approach, basic statistical analyses were conducted, though small sample sizes require us to treat results with a degree of a caution. Statistical evaluation count data was conducted using the Fisher exact test, which is adapted to small sample sizes. Simple Student's *t* tests were used to compare morphometrics such as the length, width, and thickness of cores, products, and tools.

### **3. Data results**

#### **3.1. Ceramics and other non-lithic materials**

In addition to the lithic assemblages, Middle Neolithic ceramics, with no other cultural affiliation possible, were also discovered. There were also ceramic elements characteristic of the second phase of the Late Neolithic (Late Neolithic II). Among this was a fragment attributable to the “Champ Durand” style, characteristic of salt production sites where the Maritime Peu Richard cultural group dominated, dated to the beginning of the third-millennium BCE (Ard & Weller 2012; Verdin *et al.* 2018). This fragment was discovered in the same level as a wicker-ware basket, which has been interpreted as a tool related to salt production. This is the only evidence for salt production during the Late Neolithic, and within the Maritime Peu Richard cultural group, south of the Gironde estuary. While based on a single sherd, these results from LDG nevertheless allow us to extend the known boundaries of this cultural group.

The rest of the ceramic assemblage, as well as the faunal remains and fragments of grinding tools and burned stones, all point towards a similar interpretation for the areas excavated, that of a dump zone related to the various activities having been conducted in the habitation site in near proximity (Verdin *et al.* 2018).

#### **3.2. Lithic Industry**

The composition of the assemblages demonstrates clearly that nearly every step of the production sequence was conducted on site (Table 3). The composition of the assemblages does not vary statistically across the chronological periods evaluated, *i.e.*, blank and tool proportions are distributed similarly regardless of phase (Fisher exact test,  $p = 0.476$ ).

##### **3.2.1. Raw material origins and acquisition**

The cortex observed on many lithic elements is characteristic of cobbles collected on the shore (Table 4), as it is often smooth and rolled, and moreover, presents some neocortical surfaces. This is consistent with our local survey and confirms that material was collected in proximity to the site, while observations with the stereoscopic microscope confirm that these



highly evolved raw material matrices had multiple geological, and therefore geographical, origins.

Table 3. Broad technological category of lithic industry per chronological phase.

<b>Technological category</b>	<b>Middle Neolithic</b>	<b>Late Neolithic</b>
Flake	86	91
Tool	37	33
Core	27	18
Block	10	8
<b>Total</b>	<b>160</b>	<b>150</b>

Table 4. Proportion of Middle and Late Neolithic pieces by cortex types.

<b>Cortex</b>	<b>Middle Neolithic</b>	<b>Late Neolithic</b>
Smooth	41	61
Rolled	39	23
Porous	21	18
Neocortex	7	8
Indeterminate	10	2
Absent	44	39

In addition to the similarities observed in terms of cortexes on the shore collection and archaeological sample, the size of cobbles collected in proximity to the site does not exceed 8-9 cm, providing an idea of volumetric constraints that may have equally applied to Neolithic knappers at LDG.

Several distinct geological sources of flint were identified (Figure 2): Santonian flint; Santonian and Coniacian flint from deposits found around the Jonzac anticline in the Saintonge region, often called *Grain de Mil*; Turonian flints also found in deposits from the Saintonge region; two other sources of Turonian flint, one located in the Poitiers region, known as Coussay flint, and another from Grand Pressigny. The first variant of Santonian flint, though poorly represented within the assemblage, had non-deteriorated fossils, possibly indicating primary or only slightly altered outcrops located more closely to the site than others. Additionally, given the small number of elements in this particular type of flint (N=4), it is possible that they all come from the same block, though no refits have been discovered to date. The *Grain de Mil* had very deteriorated bioclasts and very thick porous cortexes, indicating a significant loss of material. Both features are characteristic of flints collected in secondary contexts. The Coussay and Grand Pressigny flints are exceedingly rare. Despite their rarity, their presence within the assemblage is not incoherent, as these sources are located along the Loire River basin. The most abundant raw material identified, however, are cobbles of indeterminate Senonian flints, whose precise geological origins (Maastrichtian, Campanian, Santonian, or Coniacian) are difficult to determine because of their deteriorated bioclasts, meaning the possibilities for their geographic origins with the Charente and Dordogne basins are multiple. Flints contain very deteriorated bioclasts, characteristic of a very advanced stage in the evolutionary chain of the flint, underlining that the cobbles that washed up on shore are quite far from their geological origins.

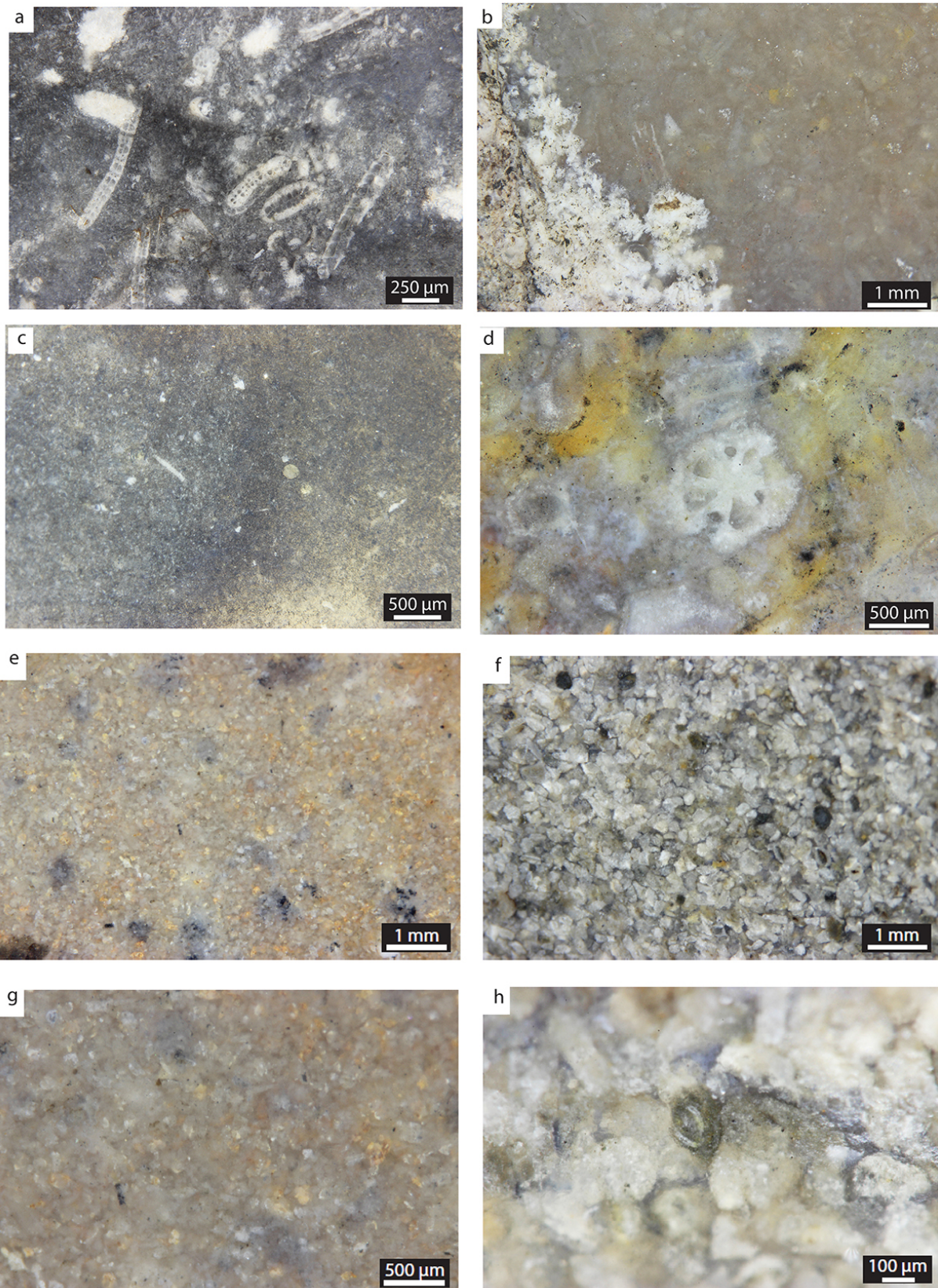


Figure 2. a: middle Santonian flint from Charentes with a Bryozoaire; b and d: Grain de mil Flint with Bryozoaires; c: Indeterminate Senonian flints with sponge spicule fragments; e and g: Grand Pressigny flint; f and h Coussay flint with Miliolidés. Photographs taken by S. Caux.

Whereas other raw materials were introduced as transformed tools, two polished stone axe heads were recycled into tools on site (See Section 3.5. Recycled polished stone axe fragments: Figure 7: 9 and 17). One, from the Late Neolithic layer, was made on Turonian flint from Saintonge, while the other, from the Middle Neolithic layer, was made on Upper Campanian flint from the Bergerac region (Fernandes *et al.* 2012; Platel & Gourdon-Platel 2012). Each of these examples were produced in specific workshops (Delage 2004: 3-89; Fouéré 1994: 448). A scraper in the same Bergeracois flint was also introduced on site already shaped (See Section 3.5. Recycled polished stone axe fragments: Figure 7: 4). We are able to suggest this with a high degree of confidence as it is highly improbable that Bergeracois flint could arrive near LDG by natural means.

### 3.2.2. Knapping techniques and reduction methods

Knappers generally used freehand percussion with a stone hammer at LDG, though bipolar reduction with the use of an anvil is also present (Table 5).

Table 5. Knapping techniques observed within the assemblage, divided by period.

Knapping Technique	Middle Neolithic	Late Neolithic
Freehand with a hammer	89	88
Bipolar with an anvil	34	25
Indeterminate	26	28

The most well represented knapping technique during both periods is freehand percussion with a stone hammer. The only slight difference between the two periods is a slightly higher proportion of bipolar percussion on an anvil during the Middle Neolithic. The methods of reduction are multiple (Figure 3), with multidirectional examples dominating, especially for the Middle Neolithic (Table 6). The subsequent method consists of a core that demonstrates a shift from unidirectional to bifacial reduction. The Fisher exact test, however, does not validate these differences as statistically significant ( $p = 0,966$ ), though sample sizes are admittedly small. The distribution of different reduction methods may be a reflection of the influence of pebble morphology on technique and method selection.

Table 6. Reduction methods observed within the assemblage, divided by period.

Reduction method	Middle Neolithic	Late Neolithic
Multidirectional	14	8
Unidirectional	5	5
Bifacial	4	2
Subsequent	3	2
Undetermined	1	1



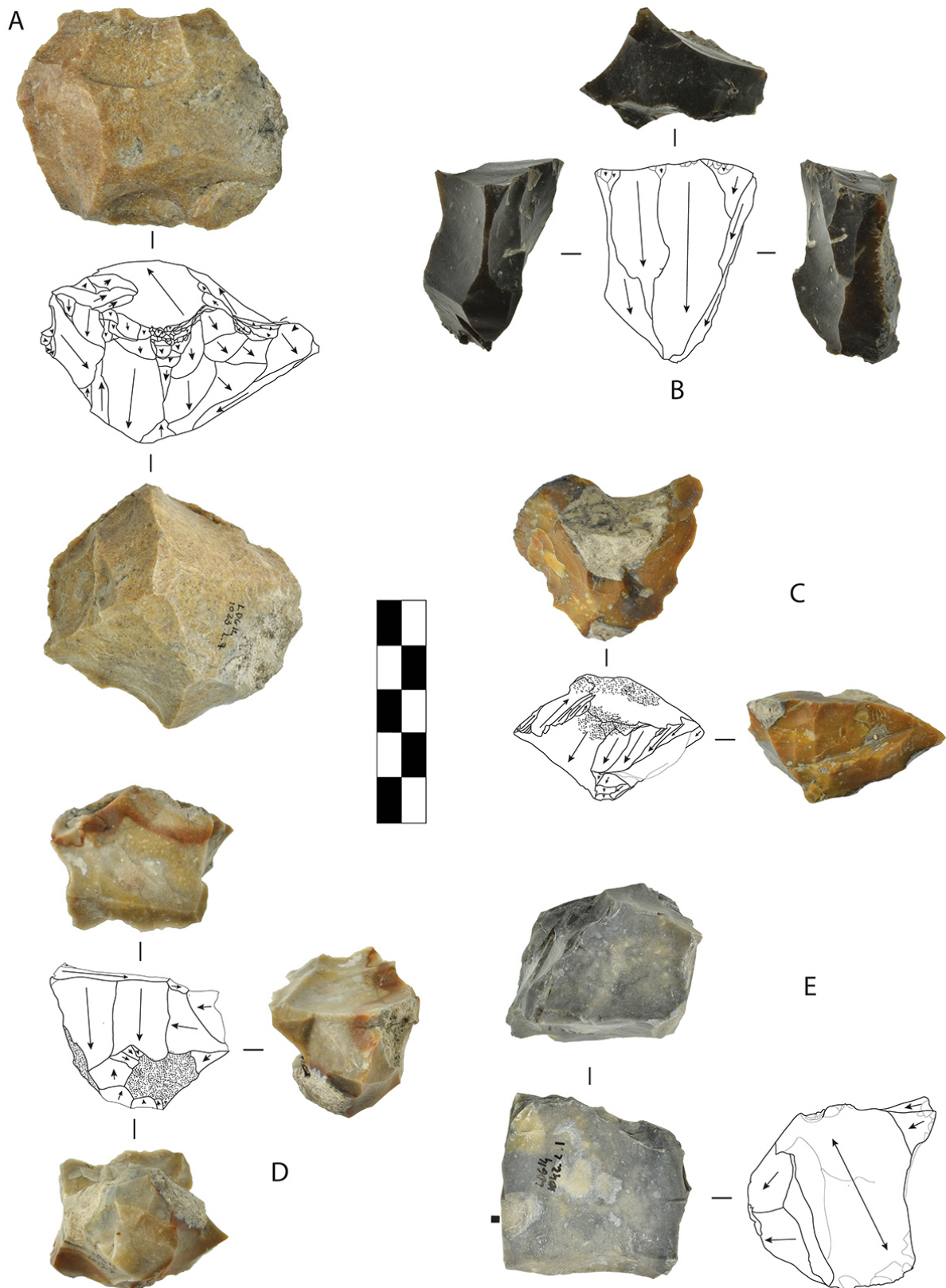


Figure 3. Core assortment of LDG with diacritic schemas: Middle Neolithic A and E: A, freehand bifacial model, E bipolar multidirectional model; Late Neolithic cores B, C and D: B freehand unidirectional model, C, freehand subsequent model, D freehand multidirectional.

Interestingly, the techniques and reduction methods observed at LDG are not reflective of what has been previously described at other sites. For example, cores from the Atlantic

Middle Neolithic are abandoned with much regular surfaces, indicating a greater care, investment, or general structure of the overarching operational schema (Dias-Meirinho & Fouéré 2008). For the Late Neolithic unidirectional and bidirectional operations are quite recurrent (Dias-Meirinho & Fouéré 2008; Fouéré 1994: 462), but bipolar reduction on an anvil, as observed at LDG, had not been previously observed in the area. However, such a percussion technique has been documented at Neolithic coastal sites in middle-western sites in France, as described by Guyodo and Marchand (2005), yet reduction is generally unidirectional. At LDG, however, bipolar percussion on an anvil is most often associated with a multidirectional reduction method. It may be that the reduced volume of the available matrices imposed such a constraint, impeding knappers from proceeding in the more typical unidirectional fashion, which would imply that the operational schema deciphered at LDG is a local adaptation of an already described lithic tradition. These results provide hypotheses to explore in future work.

### 3.2.3. Flake, blank and tool production

Given that the reduction method that seems to have been favoured was multidirectional, the standardization of the resulting products is quite difficult to investigate. The system documented, which is poorly organized and regularly uses stone hammers for freehand percussion in addition to bipolar reduction on an anvil, is simply non-conducive to the production of standardized products.

We were thus forced to investigate the representation of the different steps of the documented operational chains by other means, notably via the percentage of cortex remaining on the dorsal surface of flakes. Using this estimate, it would appear that all phases of the reduction are present: the first phase produces flakes with between 100 and 25% cortex on their dorsal surfaces, while the second phase of production, sometimes referred to as full debitage (*plein débitage*) for certain operational schemas, results in flakes with between 25 and 0% cortex on their dorsal surfaces (Figure 4).

After conducting the above analysis, it would appear that the percentage of cortical or natural surface on a blank was not a pertinent criterion for ultimate blank selection for further transformation during the Middle Neolithic, and this seems to be corroborated via the statistical tests used in the present study (Fisher exact test,  $p = 0.583$ ) (Figure 4a and 4b). Furthermore, the phase of production (phase 1 or 2) does not seem to be correlated with blank selection for transformation into tools. The same can be said for the Fisher exact tests for the Late Neolithic (percentage of cortex by reduction phase,  $p = 0.541$ ) (Figure 4c and 4d), as well as for when the two chronological phases are compared (percentage of cortex versus reduction phase on flakes,  $p = 0.852$ ) (Figure 4a and 4c; percentage of cortex versus reduction phase on selected blanks,  $p = 0.832$ ) (Figure 4b and 4d). It would appear therefore that our separation of the various blanks produced into 1st and 2nd phases of production, to facilitate analysis, was ultimately slightly arbitrary, meaning that for the productions described here we cannot really clearly dissociate a phase of full debitage from the rest of block reduction. While the number of blanks selected for transformation from the second phase of production was absolutely larger, this result was not statistically validated, though again, we prefer to be cautious regarding the finality of such statistical solutions as the sample sizes were relatively small.

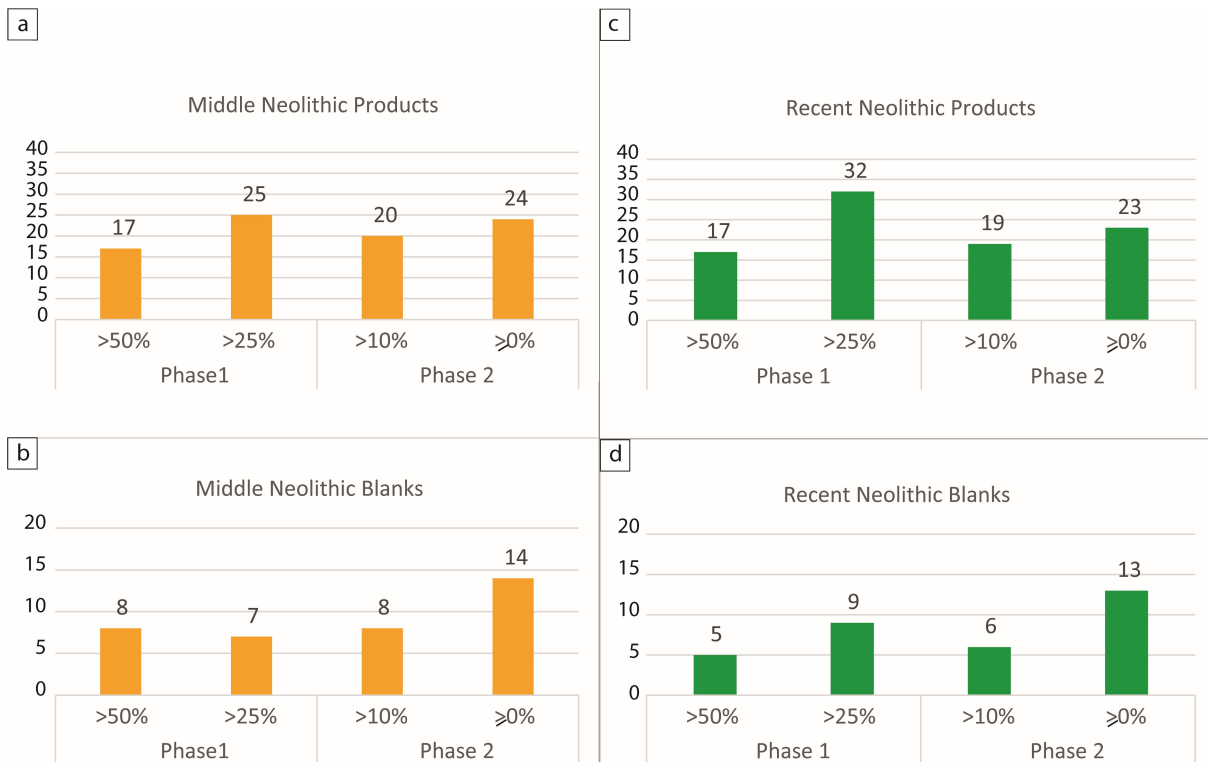


Figure 4. Middle Neolithic and Late Neolithic proportions of products and blanks by percentage of natural surface area.

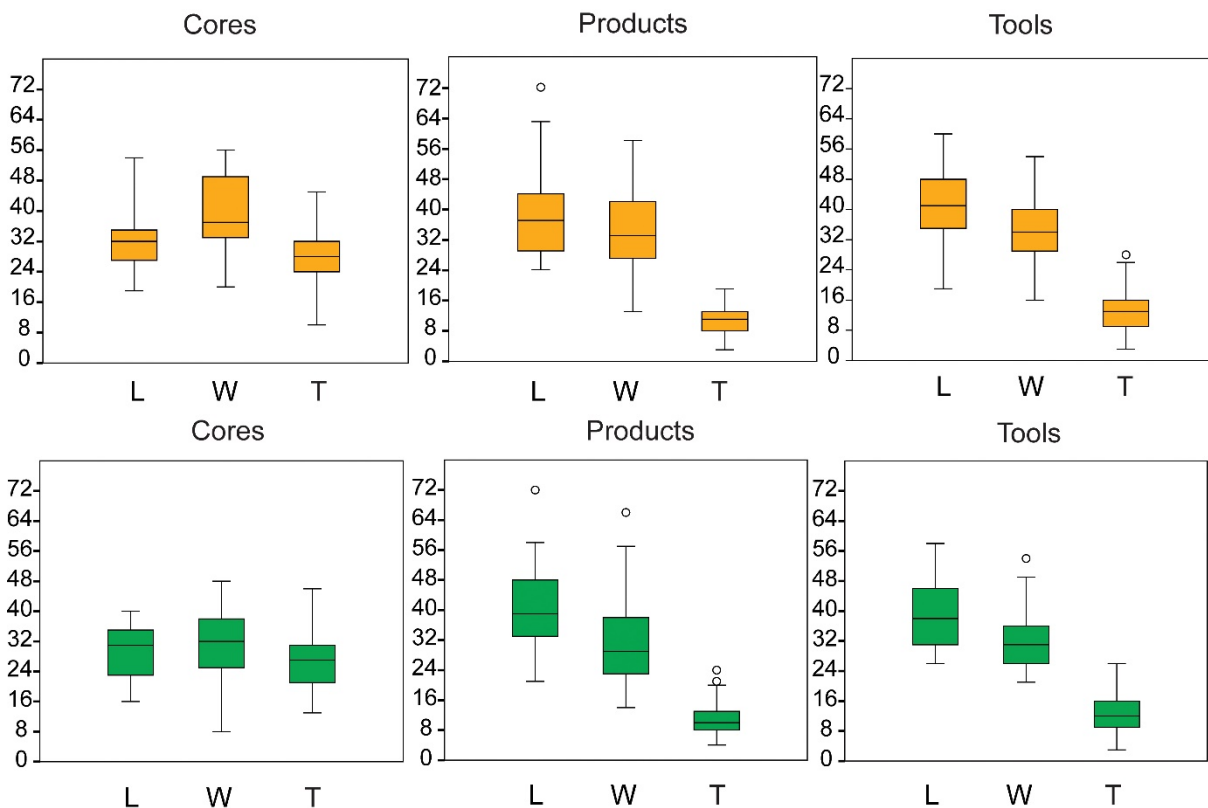


Figure 5. Morphometric analysis for length (L), width (W) and thickness (T) of cores, products and tools (Middle Neolithic in yellow, Late Neolithic in green; all measurements presented in millimetres).



### 3.3. Morphometric analysis

Morphometric analysis allows us to determine whether certain dimensional parameters conditioned the selection of blanks for further transformation. Furthermore, these can be used to evaluate the homogeneity of the assemblage: neither the Middle nor Late Neolithic collections show particularly important morphometric outliers, with each axis of measurement showing a relatively normal distribution. These observations support the argument that there are no significant pollutions from other chronological periods (Mesolithic for example) in the assemblages treated in the present study (Figure 5).

#### 3.3.1. Cores

Slight differences were observed between Middle and Late Neolithic cores (Figure 6). While averages presented in boxplot comparisons suggest that the length of production surfaces, in addition to striking platform thicknesses, are different between phases, these results are not corroborated by t-tests ( $p = 0.168$  for length comparison and  $p = 0.524$  for thickness comparison).

#### 3.3.2. Products versus selected blanks

Metric analysis shows that Middle Neolithic tools are statistically shorter and thicker than the average for all products, which means that thicker blanks seem to have been preferentially selected. T-tests were conducted in order to consider whether the small differences observed on the boxplots were statistically significant. It would appear that length and thickness of blanks are pertinent variables influencing selection for tool transformation during the Middle Neolithic, while specific selection tendencies were not observed during the Late Neolithic (Figure 6). While the small sample sizes could have introduced some biases, the tendency observed regarding Middle Neolithic blank selection does merit further investigation using larger sample sizes.

### 3.4. Typological analysis

While one could hope to find distinct toolkit assemblages as a function of period, this does not appear to be the case with those studies here. No recurrent tool styles (Figure 7) are identifiable, though this analysis is limited by the lack of comparative bibliography on the subject. Tool proportions do not appear to be related to chronological periods ( $p = 0.555$ ; Table 7).

Table 7. Proportion of tools by period.

<b>Tool</b>	<b>Middle Neolithic</b>	<b>Late Neolithic</b>
Scraper	12	11
Retouched pieces	13	8
Denticulate	4	3
Notched piece	2	5
Borer	1	3
Burin	1	0
Microdenticulate	1	0
Truncation	1	0
<b>Total</b>	<b>35</b>	<b>30</b>

t test results			Tools					
			Middle Neolithic (N=41)			Late Neolithic (N=32)		
			length ( $\mu=41.8$ )	width ( $\mu=34.3$ )	thickness ( $\mu=13.2$ )	length ( $\mu=39.1$ )	width ( $\mu=33.5$ )	thickness ( $\mu=18.8$ )
products	Middle Neolithic; (N=65)	length ( $\mu=37.8$ )	0.031					
		width ( $\mu=33.6$ )		0.664				
		thickness ( $\mu=10.5$ )			0.007			
	Late Neolithic (N=65)	length ( $\mu=39.9$ )				0.699		
		width ( $\mu=31.5$ )					0.350	
		thickness ( $\mu=10.8$ )						0.580

t test results			Middle Neolithic					
			Products (N=65)			Tools (N=41)		
			length ( $\mu=37.8$ )	width ( $\mu=33.6$ )	thickness ( $\mu=10.5$ )	length ( $\mu=41.8$ )	width ( $\mu=34.3$ )	thickness ( $\mu=13.2$ )
Late Neolithic	Products (N=65)	length ( $\mu=39.9$ )	0.204					
		width ( $\mu=31.5$ )		0.258				
		thickness ( $\mu=10.8$ )			0.666			
	Tools (N=32)	length ( $\mu=39.1$ )				0.216		
		width ( $\mu=33.5$ )					0.659	
		thickness ( $\mu=13.2$ )						0.743

Figure 6. T-test results comparing average of length, width and thickness between products and tools, within and between periods.

Two elements are nevertheless stylistically comparable with elements described for the Atlantic Middle Neolithic. A scraper (Figure 7: 1) presents a regular and rounded front, while a retouched and notched knife (Figure 7: 7) presents a back with crossed retouch, and these are both stylistic features that are characteristic of the Atlantic Middle Neolithic toolkit (Dias-Meirinho & Fouéré 2008). Two other retouched pieces provide more pertinent chronological results (Figure 7: 9 and 17); not because of the style of the retouch in and of itself, but rather because the blanks for said tools are recycled fragments of polished stone axe heads.

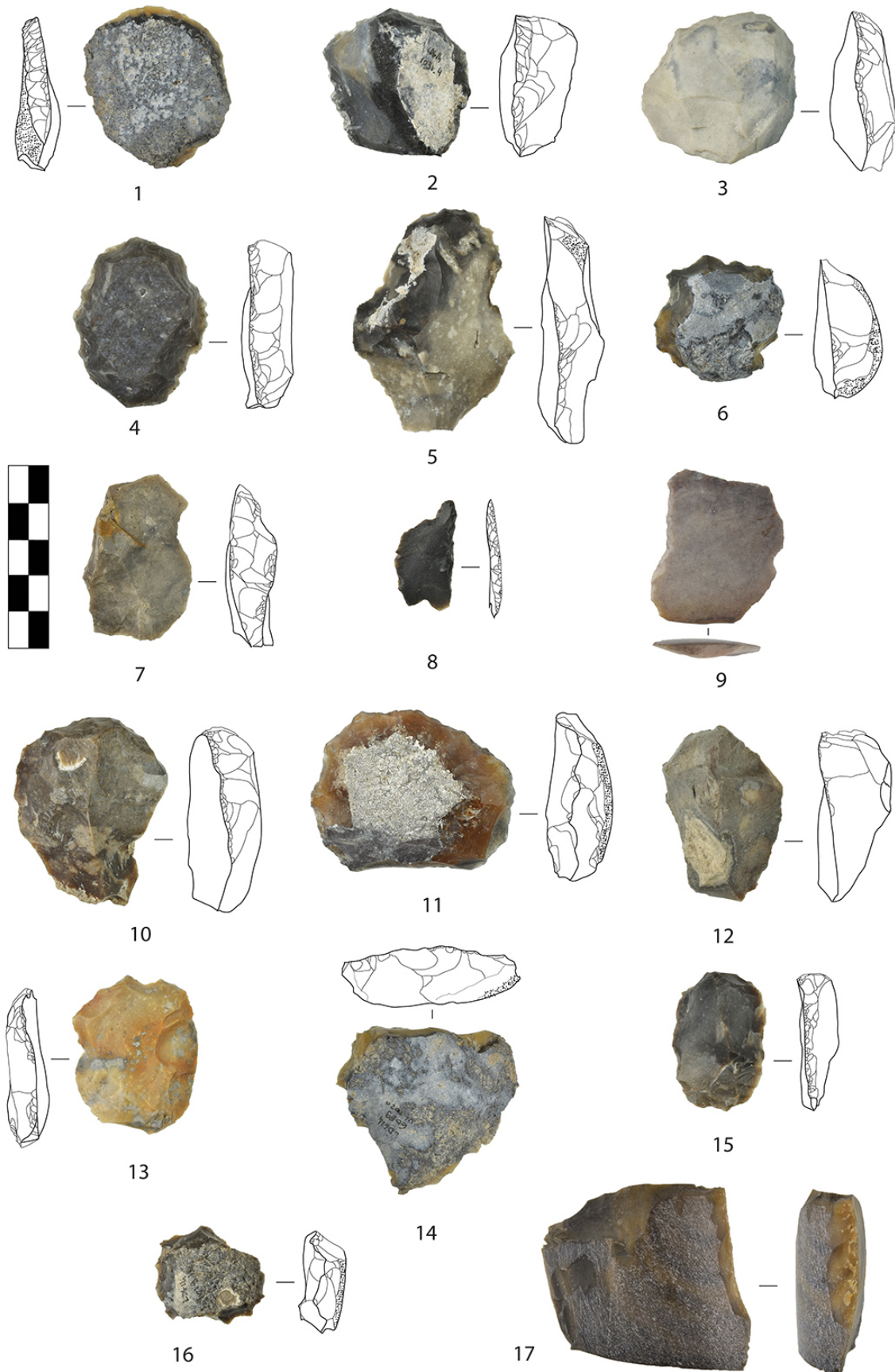


Figure 7. Tool assortment of LDG Middle Neolithic 1 to 9: 1 to 5 scrapers, 6 denticulate, 7 notched piece, 8 borer, 9 polished axe fragment retouched; Late Neolithic tools 10 to 17: 10 to 15 scrapers, 16 denticulate, 17 retouched polished axe fragment.

### 3.5. Recycled polished stone axe fragments

One of the tools created using a recycled polished stone axe fragment as a blank is made on Turonian flint from Saintonge, a region known for its polished stone axe workshops in the same flint, localized during surveys in the 1980s and synthesized by Fouéré (1994:385-396). Unfortunately, it is difficult to date these workshops, and the only method known to date them is through the use of relative dating: by discovering similar axes in habitation contexts where more precise dating is possible. Such habitation sites often contain these polished stone axe heads made at Turonian workshops, which demonstrates a considerable network of diffusion along the Atlantic coast. While most of these instances permit an association with the Late Neolithic, and more specifically the Maritime Peul Richard cultural group, many axe heads are in fact isolated finds, bereft of a secure (Fouéré 1994: 436-437). The example discovered at LDG is the only specimen known south of the Gironde estuary that provides a secure chronological context.

The second example of polished stone axe recycling is in Upper Campanian flint from sources near the city of Bergerac. Several workshops, spread over an area of no more than 40 km<sup>2</sup>, are known in the Dordogne department. The same dating issue arises as observed with the Turonian examples, most polished stone axe heads in Bergeracois flint are isolated finds, meaning that their dating is relative. Nevertheless, the oldest known polished stone axe heads in Bergeracois flint were discovered in habitation sites dated to around 4000 BCE. The example from LDG is located at the western limit of the known Bergeracois axe diffusion area (Delage 2004: 13), and this newly discovered object, located in SU 1023, has been securely dated, using radiocarbon, to roughly 3700 BCE.

## 4. Interpretations of the data

Every stage of the operational sequences has been described. We must now reconstruct and synthesize them in order to understand the organization of production and the lithic economy more generally for the Middle and Late Neolithic II groups at LDG. In terms of the management of raw materials, similar patterns were observed for both phases: the occupants of LDG, regardless of chronological phase, procured cobbles from the shore and produced blanks (flakes) and transformed them into tools on site. The chosen percussion techniques and production methods appear to be adapted to the size and shape of the volumes selected; these in turn may have imposed a natural constraint, impeding knappers from employing more traditional operational schemes that have previously been described. This means that the operations observed at LDG may not necessarily be the most representative of Middle and Late Neolithic knapping traditions, though the small sample size impedes us from exploring this line of questioning further. However, even with the volumetric constraints imposed by the cobbles available on site, multiple types of production are possible, and despite this Middle Neolithic knappers used a system to produce a specific type of non-standardized product - thick flakes that were potentially preferentially selected to be transformed into tools. While a seemingly preferential selection of thick blanks does not continue during the Late Neolithic, all other aspects of the simplified production system are very similar to those described for the Middle Neolithic. There are no statistical differences between the toolkit composition between the two phases, yet some stylistic specificities suggest associations with other described cultural groups, such as the particularly rounded and regular scraper that evokes the Atlantic Middle Neolithic (Dias-Meirinho & Fouéré 2008).

Lastly, two fragments of polished stone axes, recycled into tools, allow us to link the Middle and Late Neolithic occupations of LDG with larger contemporary Neolithic groups. The first piece, in Bergeracois flint, permits us to situate the Middle Neolithic of LDG within greater contemporary diffusion networks centred on the Dordogne region. The second

fragment, in Turonian flint, fits with Late Neolithic II diffusion networks documented along the Atlantic coast and corroborates the results from ceramic analyses, linking this level at LDG to the Maritime Peu Richard group. These finds are dated and provide new information on the geographical extension of these diffusion networks.

## 5. Conclusions

The knapping techniques and methods described here do not demonstrate rigid conceptual models or result in highly standardized operational chains and products. The blanks that are ultimately transformed into tools do not appear to be selected using stringent morphological or metrical criteria. The reduction methods used here have often been characterized as simple or opportunistic, but why should such labels exclude these production systems from discussions of tradition? This is in fact an argument that has been used to exclude such productions from discussions of group markers in time and space, but they appear nevertheless to have been thought from acquisition for production and tool transformation - what are these regularities if not traditional? After all, as Maigrot and Plisson (2006) astutely noted, complexity in no way guarantees tradition.

The operational chains described here show little technical investment; they are simplified and do not demonstrate in turn a heavy investment in the lithic economy in general, meaning that there is little argument here for a specialized lithic production. During the Middle and Late Neolithic, it would appear that artisans invest little in knapping, perhaps at the benefit of being able to invest more heavily in other economic pursuits, such as salt production during the Late Neolithic at LDG. Some would call this opportunistic behaviour, but it is perhaps more apt to talk of inter-dependant activities with different degrees of investment, logically dependant on the local economy, but all still subsumed within integrated production systems that are inherently traditional. For the Middle Neolithic such an economic investment is not observed in either the lithic or ceramic productions, yet could have been present among spheres whose remains are no longer preserved. Such an eventually co-dependant activity, though to date remains unidentified, may be related to the environmental context of the site: marshland is often conducive to the raising of livestock, while the proximity to the sea affords multiple economic opportunities. Regardless, the question is not whether a lithic tradition is opportunistic or not, but rather what a reduced investment in the lithic production system reflects in terms of the constraints or general organization of the rest of the cultural system (Perlès 2009).

The shift of social and ideological weight from one production sphere to another would have repercussions within the group, but would also result in cascading changes in the relations and exchanges with other groups with known specialized production systems (polished stone axe production, for example) at regional and inter-regional scales. It is not hard to imagine complementary exchange systems between communities who have invested in distinct forms of economic, and therefore technical, specialization. Such specializations are clearly observed at polished stone axe production sites, and may equally be the case for contemporary salt production during the Late Neolithic at LDG. As outlined above, such a complementarity in specializations is not clearly distinguishable among the lithic or ceramic artefacts at LDG during the Middle Neolithic, but use-wear analyses could be helpful to link material culture with the marshland and coastal environment and therefore provide further avenues to explore such hypotheses.

In conclusion, despite the succinct nature of our results, two elements are particularly pertinent. Firstly, while it is delicate to characterize entire industries from small sample sizes, such an approach can nevertheless be useful for generating preliminary results and working hypotheses. They can therefore fuel novel research paths, encourage new excavations, and

incentivize the study of old collections to enrich comparisons. Secondly, while described operational chains and interpreted operational schemas provide one avenue for evaluating cultural systems, their analytical power is exponentially multiplied when correlated with other technical subsystems. An understanding of the articulation between all the subsystems is thus essential to defining, exploring, and comparing the technical traditions of different groups in time and space.

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### Data accessibility statement

The author confirms that the data collected for this article was carried out as part of her doctoral thesis at the University of Toulouse 2 Jean Jaurès. All other data are cited. The material is preserved and managed by the Service Régional d'Archéologie of the Aquitaine region.

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# Économie lithique dans le Sud-Ouest de la France durant le Néolithique, une étude de cas à partir d'un site côtier : La Lède du Gulp (Aquitaine)

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## Résumé:

La préhistoire du Sud-Ouest de la France est connue dans le monde entier pour la richesse de ses sites paléolithiques, notamment en Dordogne. Cependant, si les recherches sur le Paléolithique sont extrêmement prolifiques, le Néolithique a été dans le même temps relégué au second plan. Depuis le début de la discipline, peu de chercheurs ont travaillé sur le Néolithique du Sud-Ouest de la France. En outre, ils se sont concentrés sur les analyses typologiques de la céramique pour décrire les groupes culturels, ont rarement considéré les outils et armatures lithiques, et n'ont jamais réalisé d'étude techno-économique des productions lithiques. Depuis plus de trente ans, les fouilles d'archéologie préventive ont révélé une présence importante de sites néolithiques pour cette période ; néanmoins, la recherche néolithique reste peu développée par rapport à son potentiel. Avec l'exemple de La Lède du Gulp, site d'occupation littoral daté du Néolithique moyen et récent, étudié dans le cadre de ma thèse de doctorat, il s'agira de mettre en évidence dans cet article ce que l'étude des industries lithiques peut dire d'un groupe culturel à l'échelle locale.

Le site de la Lède du Gulp initialement fouillé par J. Roussot Larroque dans les années 1980-90 a été repris par F. Verdin en 2014 dans le cadre du projet Litaq. La nouvelle fouille a livré plusieurs niveaux d'occupation Néolithique moyen et néolithique récent daté au radiocarbone. Les études de mobilier céramique associé au Néolithique récent ont révélé la présence d'un fragment de vase à sel et des tessons caractéristique du Peu Richard maritime. La céramique du Néolithique moyen, n'est pas discriminante d'une culture particulière. Par ailleurs dans les niveaux Néolithique récent un panier tissé conservé dans la tourbe dont l'utilisation est associée à la production de sel s'avère un élément déterminant dans nos interprétations tout comme le contexte géographique et géologique du site, implanté dans des marécages maritimes.

La reconstitution des chaînes opératoires, par l'analyse de l'économie de la matière première, des techniques de débitage et l'étude des supports, nous ont permis de mettre en évidence une utilisation des matières premières locales des techniques de débitage sur enclume et en percussion directe dure. Pas de choix délibéré des supports transformés. Ceci complété par des analyses statistiques adaptée aux petits assemblages lithiques non standardisés. Les résultats obtenus reflètent un faible investissement dans la production lithique, similaire entre le Néolithique moyen et le Néolithique récent de La Lède du Gulp. En revanche on a pu distinguer entre les périodes une différence dans les réseaux d'approvisionnement de hache polie, le Néolithique récent centré sur la région charentaise, zone d'implantation du Peu-Richard maritime auquel nous pouvons associer à l'image de l'étude céramique les industries lithiques produites ici. Enfin durant le Néolithique moyen les influences seraient orientées sur la région du Bergeracois. Notre approche nous a permis d'observer qu'un faible investissement dans la production lithique peut refléter la complexité des groupes néolithiques et la complémentarité de l'industrie lithique avec d'autres sous-systèmes techniques directement liés à l'environnement naturel

du groupe, comme cela peut être le cas pour la production de sel au Néolithique récent à La Lède du Garp.

**Mots clés:** industrie lithique; sous-système technique; hache polie recyclée; Néolithique Moyen Atlantique; Peu Richard; Médoc