Complex dressing patterns on grinding surfaces of rotary querns and millstones from Antiquity in the Paris Basin, France: state of research and perspectives

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Introduction

For millstones to grind properly, it is necessary to sharpen or “dress” their working surfaces. In most cases, dressing is undertaken by simply pecking the surface in a “random” manner. Some millstone rocks such as the porous, silicious French Burr, vesicular lavas or shell-rich sandstones are naturally abrasive and do not require frequent dressing. Some millstones dating from Early Antiquity were dressed with multiple linear furrows of varying width or pecked with small cup-shaped marks arranged in patterns.

In this paper we first present an overview of the origins of millstone dressing and its geographical distribution throughout Antiquity. This is then followed by an attempt to identify the typological tendencies of millstone dressing and the functional and technical originality of certain patterns based on examples from the Paris Basin in France.

Complex dressing: an historical perspective

Saddle querns and hopper querns

Complex dressing patterns with furrows, seems to be known in Greece since the end of Archaic times on saddle querns (Moritz 1958:37–38). Later, in Classical times, fine furrows with herringbone patterns are carefully incised on saddle querns at Athens and Olynthus. In the Hellenistic period, these patterns are known on the Island of Delos (Amouretti 1986:138). Similar patterns, combining deep longitudinal and
diagonal furrows, are also found on hopper mills (operated by alternating back and forth movement) at Olynthus in the Classical period. The grinding surfaces of both lower and upper stones (Frankel 2003:13–17) are equipped with furrows organised in a variety of geometrical patterns (parallel lines, chevrons or curvilinear lines) (Fig. 1).

Rotary querns
The oldest rotary mill known for the moment with a complex dressing pattern is a lava quern from Lattes in the south of France dating to the early 4th century BC. This rotary mill comprises a complete lower stone and an upper stone broken into four fragments. Both stones bear a similar pattern of radial furrows (Fig. 2). A bladed hammer recovered near the quern is interpreted as the tool used to carve the furrows (Py 1999:144–145 and 471).

In the Iberian Peninsula there are only a few recordings of rotary querns with furrows on their grinding surfaces. At the site of Castellet de Bernabé (Guerin 2003), in the region of Valencia, two querns with complex furrow patterns were brought to light in separate rooms (Fig. 3). These belong to the most recent level of the occupation dating to the late 3rd century BC. One was accompanied by barley seeds. Other Iberian Culture querns are also known to have been dressed with complex patterns.

Turning again to the Greek world, the detailed 1938 work of W. Déonna on the Island of Delos records that some of the rotary hand-querns of the 2nd and 1st centuries BC, as well some of the 1st century AD, are dressed with radial furrows (Déonna 1938:131–132, Plate 384–390) (Fig. 4). The work of A.-W. Parsons (1936:86, Fig. 17) and R.J. Spain (1987:351–352) on the
watermill of the Agora of Athens (second half of the 5th century to the second half of the 6th century), shows that at least two larger millstones have complex dressing. The furrows combine curvilinear and radial patterns composed of fine and irregular furrows radiating rather crudely from the eye of two lower stones (stones “d” and “c” in Parsons’ study; “d” is originally an upper stone reused as a lower stone, according to Spain). A systematic analysis of Greek rotary mills would be necessary to corroborate if these initial observations are applicable to the whole of the Greek territory and to all of the different chronological periods.

In northern Italy, in the Trentino and Alto Adige regions, dressed examples from Antiquity are reported in the Museum of Bolzano (Rachelwiltz (de) 1994:88) and the Museum of San Michele all’Adige. G. Sebasta (1997:78) refers fleetingly to this technique for the Roman period (Fig. 5). P. Galetti illustrates a Roman hand mill from the Plain of Po (Galetti 2011:210, Fig. 5) with radial furrows on its grinding faces. Further research on this technique among the millstones of these collections would be welcome.

In the southeast of Narbonnese Gaul (Aix-en-Provence), there is an example of an andesite handmill with radial furrows (Amouric 1997:Fig. 8) dating from the 2nd half of the 1st century AD. A furrowed granite upper stone also comes from a Late Empire level at Lattes (Py 1992:212–213). Future study of the rotary

querns produced at the rhyolite outcrops in the Esterel will no doubt confirm that most querns of this region are dressed with furrows. The example of Forum Voconii (Congès & Martos 2000) presented here (Fig. 6), from a level dated from the late 1st century AD, is not an isolated case. The depositories of archaeological museums in the southeast of France store a large number of millstones with this type of dressing.

The mills of Zugmantel (Fig. 7) and Saalburg in Germania are also dressed (Jacobi 1914). Baatz, who worked on this subject, writes that the basalt millstones from the volcanic district of Mayen were always dressed with different types of patterns (Baatz 1995). He proposes that, according to the patterns, only one orientation or direction of rotation was possible. Furrows are also seen on the active surfaces of the Haltern-type mills. Their dressing, according to Baatz, is always crude and does not disclose the direction of rotation. In eastern France, basalt hand-querns imported from quarries in the Eifel, also bear radial furrows (Lepareux-Couturier et al. 2011).

In the north of Gaul, a recent study of museum’s collections (Picavet 2012) shows that their grinding surfaces were also dressed (Fig. 8).

In Great Britain, furrowing is also well represented on both lava querns (Shaffrey 2003) and old red sandstones studied by Ruth Shaffrey (2003, 2006:31–34). The dating appears to be late (3rd–4th century AD) for the old red sandstones (mainly millstones). Her approach will be discussed further on in this paper.
To summarise, grinding stones, regardless of diameter, are dressed with complex patterns in many regions of Antiquity.

**Pompeian, Morgantina, Delian and ring-mills**

It is generally accepted that Pompeian mills and other similar mill types were not dressed. We differ in opinion. In Morgantina, Sicily, White describes, although does not illustrate, vertical furrows on a lower stone from the 3rd century BC (White 1963). Furthermore, radial furrows on Delian mills are carefully analysed by Brunet (1997). Helicoidal furrows are typical of olive oil sandstone mills at Volubilis (Morocco). A. Akerraz and M. Lenoir report, however, that basalt upper stone ring-mills, identical to the sandstone oil mills dressed with furrows, are grain mills (Akerraz & Lenoir 2002). We also find allusions to furrowed Pompeian lower stones in O. Williams-Thorpe’s geological survey of Mediterranean millstones (Williams-Thorpe 1988:255 and Table 1). Williams-Thorpe, however, does not examine this technique in detail.

Although most Pompeian mills are not dressed, one example (a lower stone) is depicted in an ancient bas relief (Fig. 9). L.A. Moritz affirms that the combination of the sharp slope of the grinding faces with the porous lava rendered furrowing unnecessary. Some authors have explained the vertical marks in iconography as a representation of flour. But these assumptions are not plausible, especially after the M. Brunet’s research on Delian mills, a mill-type that has the same characteristics of the Pompeian model (lava, sharp slope of grinding face). Furthermore, Moritz himself recognised that the bas relief suggests dressing of these millstones (Moritz 1958:79).

To conclude this brief survey, we can state that furrowed millstones are unevenly distributed throughout the world of Antiquity and that the spread does not reflect any specific rock type. Furrows are both present (and absent) on the main types of rocks (lava, granite and sandstone). We also note that furrowing persists over a very long period of time in Greece. We therefore conclude, at least provisionally, that the technique of furrowing has its roots in Greek milling tradition. The transfer of technology from the hopper mill, typical of the eastern Mediterranean, to the older models of rotary querns in the western Mediterranean is observed in the example of the 4th century BC rotary quern at Lattes in southern France. This settlement, not surprisingly, was a Greek trading post.

It is generally accepted that millstone dressing disappeared at the end of the Roman Era. There are, however, dressed millstones at medieval metallurgical sites such as Brandes en Oisans in the Isère Department (Minvieille-Larousse & Bailly-Maître 2011), as well as in a few illustrations in medieval manuscripts (Lepareux-Couturier et al. 2011). Archaeological evidence, nonetheless, is missing.

**Creation of a descriptive vocabulary: proposal for a typology**

We have analysed the drawings of these patterns on Roman rotary querns and millstones and observed tendencies. A descriptive vocabulary was drawn from modern and contemporary written sources (Lepareux-Couturier et al. 2011). The first reference to furrowed millstones in France is from the outset of the 18th century. Although dressing patterns are not included in the first edition of the Encyclopaedia of Diderot and D’Alembert (1765, Mill section), descriptions do appear in the plates of the Supplement of 1776. These include illustrations of both upper and lower stones with rectilinear furrows carved from the centre to the edge. In 1795, Evans insisted on the importance of dressing following geometrical patterns (Evans 1795:137 ff., Plate 11) as a condition for achieving a good milling (Fig. 10). During the 19th century, there is a multiplication of dressing patterns probably, due to the development of
patent laws in the second half of the century. We have retained some terms such as “simple furrows” (straight and curved) for furrows of identical length spanning from the eye to the edge and “composite furrows” for straight or curved furrows of different lengths arranged in sectors. It is noteworthy that the largest furrow designates the direction of rotation, whereas the flat area between furrows is referred to as the “land”.

There are, however, some patterns that are not found on modern and contemporary models. We have chosen the term “honeycomb” for multiple large peck marks and the term “mixed” for patterns that combine furrows with pecking marks. It is important to note that there are at times palimpsests of a different dressing pattern on the same millstone.

We can summarise the dressing patterns on Roman rotary querns in the following way (Fig. 11):

- Millstones with a simple “randomly pecked” dressing (type 1)
- Millstones with pecked “honeycomb” (type 2) and “mixed” dressing (type 3)
- Millstones dressed with radial furrows: “simple” straight (type 4) or curved furrows (type 5); “complex” straight (type 6) or curved furrows (type 7)

**The special cases of complex dressing**

This particularly interesting complex dressing has been the subject of observations by specialists including Lindet, Curwen, Baatz and Moritz. It is interesting to note the “mirror effect” of furrowing patterns on the grinding surfaces of complete mill finds (i.e. both stones recovered). This mirror effect can be identified when identical patterns are seen on stones placed side by side with their grinding surfaces facing upwards.

When these stones are assembled, logically, the orientation of their furrows is opposite and they cross each other. Hence, an upper stone dressed with counterclockwise furrows is driven clockwise. Correspondingly, an upper stone dressed with clockwise furrows will be driven counterclockwise. Moreover, driving the mill in the false direction would propel the grain centripetally and clog the mill (Fig. 12), as recorded in 19th century milling manuals. Furrows, using centrifugal force, channel grains toward the outer edge of the millstones. They also shear and cut the grains while the lands extend the grains. The kernels therefore travel though the millstones in a spiral movement, from furrow to furrow. The brittle endosperm is hence reduced to powder. The lands along the outer skirt grind the last kernel fragments and detach the bran.

Another interesting technical aspect, observed as early as 1899 (Lindet 1899), is that furrows of

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<th>Simple dressing</th>
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<tr>
<td>Honeycomb dressing</td>
<td>Furrowed dressing</td>
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<tr>
<td>Mixed dressing</td>
<td>Simple furrows pattern</td>
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<tr>
<td>Random pecking pattern</td>
<td>curved</td>
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<td>&quot;Honeycomb&quot; pattern</td>
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Roman millstones do not follow geometrical radii, but the tangent of an inner circle (i.e. the tangent of the eye). Lindet established a direct link, through his personal observations, between ancient and modern or contemporary millstones (see Fig. 10).

**The case of the Paris Basin**

The Paris Basin is a region of the Roman Empire where millstones were often dressed. The corpus comprises 172 Roman millstones from 29 different rural settlements and urban residential quarters. The collection is broken down into 104 upper stones, 47 lower stones, and 14 fragments for which it was not possible to determine the type of stone (meta or catillus). More than half (93 or 54%) bear complex dressing patterns. They were recovered during recent excavations where contextual data and dating is secure. Their diameters range from 34 to 66 cm and they date from the last quarter of the 1st century AD to the 4th century AD.

**Fig. 12.** Explanatory schema illustrating millstone dressing following the mirror-effect principle. The dressing of upper stone faces down. The longer furrows indicate the direction of the rotation. © Stéphanie Lepareux-Couturier.

**Fig. 13.** Graph illustrating the percentage of querns and millstones from the Paris Basin dating to Antiquity according to type of stone and type of dressing.

**Fig. 14.** Graph illustrating the percentage of querns and millstones from the Paris Basin according to their type of dressing.

**Fig. 15.** Photographs of the different types of dressing of millstones from Antiquity in the Paris Basin. © Nos. 1, 2, 3 and 5 S. Lepareux-Couturier. © No. 4: Laurent Petit, Institut National de Recherches Archéologiques Préventives 2009.
century AD. Complex dressing patterns are present, for the most part, on the examples of local sandstone known as Fosses-Belleu. It is also of note that some of these sandstones bear a simple or “randomly pecked” dressing (Fig. 13).

In the Paris Basin (Fig. 14 and 15), besides the random pecking (type 1), millstone dressing, found on both upper and the lower stones, is dominated by the complex straight furrows (type 6), as well as both the “honeycomb” (type 2) and “mixed” pattern (type 3).

The absence of simple straight furrow dressing (type 4) in the Paris Basin is noteworthy during the Roman period (in contrast to Alsace, see Lepareux-Couturier et al. 2011). The earliest millstones with a complex dressing date to the second half of the 1st century AD, whereas the most recent date to the end of the 4th century or the beginning of the 5th century AD.

Among the Parisian stones, there is one complete mill (with both its upper and lower stones) bearing poorly carved counterclockwise furrows. Following the system described above, its direction of rotation was clockwise (Fig. 16).

There are 45 other individual stones that provide data as to the direction of rotation. All, without exception, and regardless of their size and whether they are upper or lower stones, bear counterclockwise furrows. We can therefore deduce that they all were driven clockwise.

Based on the current state of research, we can conclude that the Gallo-Romans were aware of this method of shearing grains. Nonetheless, if this dressing technique was more performant and resulted in a better grinding, then why was it not adopted in other regions of the Empire? Can it be assumed that mills elsewhere were also driven clockwise? What are the reasons and implications?

In addition, identical patterns are at times found on both small hand-querns and larger millstones. A unique aspect of the Paris Basin corpus is the fragment of a Pompeian upper stone from Meaux, the capital of the Meldi tribe, with a “mixed” dressing (type 3) (Lepareux-Couturier 2011) scored from the local Fosses-Belleu sandstone alluded to previously (Fig. 17a-b).

Complex dressing of millstones seems to be particularly marked in the Paris Basin as can be seen from an ex-voto discovered amongst hundreds of others in a ditch surrounding the Roman temple in the Halatte forest (Durand & Finon 2000:90). The miniature millstone measures 13 cm in diameter (Fig. 16).

Fig. 16. Complete millstone discovered at Meaux (Seine-et-Marne). Schema based on an archaeological artefact of a complex straight furrowed dressing pattern. The depiction by using tracing paper, illustrates the technique of grain shearing. © Stéphanie Lepareux-Couturier.
and presents complex straight furrows. Tracing the furrows on the ex-voto can be interpreted as a means of underlining its function and identity.

A tool for comparison
R. Shaffrey (2006:31–34) offers several notions as to the dressing of the active surfaces in her study of Roman old red sandstone millstones from of the Bristol Channel (GB). Six surface-types are identified. Comparing the results of her study and our present work reinforces the technical adaptation to local materials and that the dressing process is identical in the two areas even though the petrographical and mechanical characteristics of the rock types are dissimilar. It is, nonetheless, difficult to compare dressing techniques in these two areas in detail as the objective of Shaffrey’s study was not millstone dressing but production as a whole. Of the ORS millstones, 66 % bear a simple dressing (type 1) described by the author as “normal pecking pattern”, whereas the most frequent complex dressing (15 % of the corpus) is type 6, described as “segmented radial grooving”. Type 6 is also the most frequent type observed in the Paris Basin and the Bristol Channel during Antiquity. Shaffrey describes other dressing types as “spaced pecking pattern” that is very similar to our type 2, and “cross concentric grooves” (type 4). Together type 2 and 4 represent 5.5% of the Bristol Channel assemblage. The terms “mixture of grooves and pecking” (type 3) and “semi cross concentric grooves” are also used (for which no percentages are given). All said, these two independent studies using different approaches have resulted in the identification of very similar dressing types. This validates the proposed models and demonstrates that the millstone dressing has a technical, functional and also cultural meaning.

Conclusions and research perspectives
In this paper we have attempted to update the state of research on the question of millstone dressing. It would be interesting in future research to gather data on a larger scale, based on a set of common guidelines (vocabulary, drawings, data bases) so as to facilitate comparison of dressing techniques from different contexts. This would allow the analysis of millstone dressing as a technical fact; that is, conduct research from the perspectives of transmission, invention and convergence of technology, so as to address the questions of why different dressing patterns occur on contemporaneous millstones and why dressing patterns change from one region to another? It also is important to focus on the concepts of efficiency, performance, and technical traditions, especially since the mechanical properties of specific rocks do not alone explain the choice of the dressing pattern. Further questions to pursue are, for example, the necessity of complex dressing. Is it related to the type of grain and to the grain’s level of moisture?

Future research also requires establishing experimental protocols in close collaboration with carpo-logists and bread making specialists, focus on reconstruction, the evolution and diffusion of dressing types, and addressing the problem of why furrowing seems to disappear during the Middle Ages and how it was later rediscovered. Future work must also attempt to explain why dressing techniques are astoundingly analogous in Antiquity and recent times, especially with identical details such as the orientation of furrows according to the tangent of the eye. Focusing research along this approach would ultimately lead to the understanding of a social fact, since complex dressing entails a savoir-faire and specific tools, as well as the development of techniques to bring to light many palimpsests of millstone dressing.
This is hence a dynamic approach to the technical fact of millstone dressing, with a focus beyond the mere description of furrowing patterns and typology, but on function and significance.

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