

Roman grinding stones from Northern Britain with two opposed perforations

John Cruse

Abstract: Two different designs are considered. The first, a rotary hand quern with characteristic D-shaped hoppers, is described and its links to the Earlier Roman military supply system are explored. The second is a powered millstone, but without hoppers, mainly from later Roman contexts. Evidence that its opposed perforations were twin feed-pipes is reviewed and its distribution along Roman roads, near good agricultural land is examined. Whilst earlier hand querns with twin feed-pipes are known in the Rhineland, the design appears to evolve independently in northern Britain. Suggestions are made for naming the two hand quern variants. Comparable millstones are also reported in Germany. As more examples of both designs are recognised, their study could improve our understanding of the Earlier Roman military support system and of aspects of later Roman economic activity.

Keywords: Rotary hand querns, opposed d-shaped hoppers, twin feed-pipe, mechanically powered millstones with opposed holes, distribution grooves, links to auxiliary forts

John Cruse, 3 Ellicott Court, Park Road, Menston, Ilkley, West Yorkshire, LS29 6PA, UK, john.cruse1@btinternet.com.uk

45

Introduction

David Peacock has observed that, compared to ceramic studies, the development of quern typologies is still in its infancy (2013a, 58). This paper provides an opportunity to examine a distinctive group of stones, to investigate their background and to review their typology. Figure 1 illustrates their main features. They range from smaller diameter upper stones, such as those from a) Bramall, Stockport (Heginbotham 1892, 135-6) and from b) Templeborough fort, S Yorks (May 1922, 124), which both have D-shaped hoppers feeding into opposed sets of perforations, but with different profiles. In contrast, the larger diameter stone from c) Wattle Sykes, W Yorks (Cruse and Heslop 2013, 173) lacks any hopper over its opposed holes. We will look in more detail at these 'variations on a theme', starting with the smaller querns.

Rotary querns - past studies

From the two examples illustrated, we can note that querns with two hoppers and a central reinforcing rib were first published over a century ago. They attracted little further attention until Eric Cowling (1969, 6) discussed three comparable West Yorkshire querns. He suggested that they were a Roman design, whose 'two feed holes were better than one' and whose central hole was 'to take the spindle'.

When similar examples were found in 1964-78 at Doncaster, Buckland and Magilton (1986, 102) described them as an "uncommon" type, which was 'widespread on Roman military sites in northern Britain' and occurred in late 1st or 2nd century AD contexts. Buckley and Major (1998, 246) saw comparable stones from Castleford in 1974-85 as a 'distinctive group' of Millstone Grit querns. They were 'a specifically northern form typified

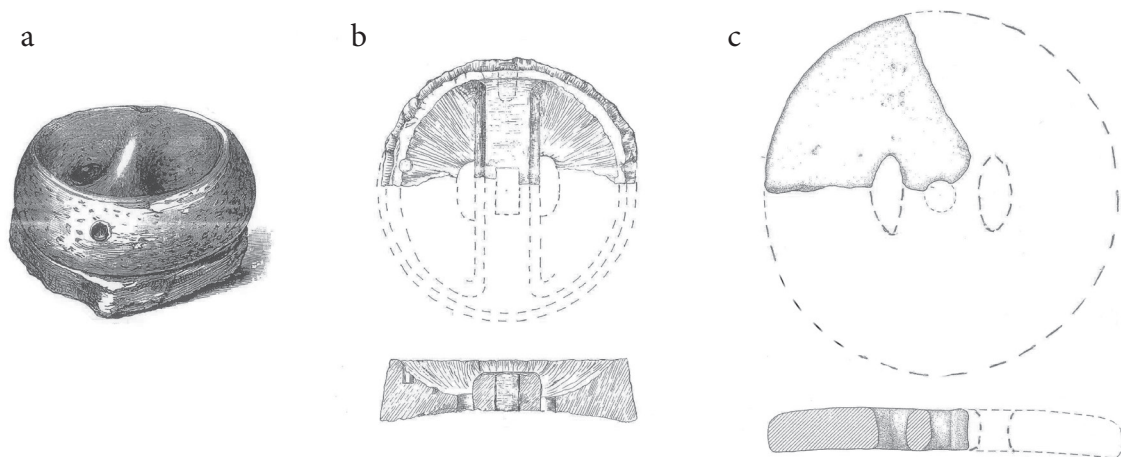


Fig. 1: Roman querns and millstones with double opposed perforations: a) Bramall, Stockport, Lancashire: Heginbotham, 1892, diameter 45 cm; b) Templeborough, South Yorkshire, May, 1922, diameter 42.5 cm; c) Wattle Syke, Bramham, West Yorkshire: Cruse and Heslop, 2013, diameter 63 cm (mid-late 4th century AD).

by a strengthening central rib', produced by local craftsmen, possibly into the 3rd century AD. Since then, further examples have been noted, but the type has not yet acquired a generally accepted name.

The main features of rotary querns

Over the last decade, the Yorkshire Archaeological Society Quern Survey has recorded an increasing number of upper stones with off-centre perforations. Initially the fragmentary nature of the evidence made confident reconstruction difficult. However, with over 50 examples now known, including intact examples, we are now starting to understand their main features. These can be summarised as follows (Fig. 2):

- The presence of opposed D-shaped hoppers to hold the grain and funnel it into the feed-pipes.

- A central 'bar' occurs with two different profiles. The first is curved such as in the cases of Bramall

(Fig. 1a and 3a) and Walton-le-Dale (Fig. 2b) while the second is flat-topped such as at Templeborough (Fig. 1b), Newstead (Fig. 2a) and Doncaster (Fig. 3b).

- The diameter is normally in the range 35-50 cm. The flat bar types are typically 40-44 cm, whilst the curved bar variants are 36-42 cm, with a smaller group around 50 cm.

- The 'eye' that restrains the spindle is usually circular and set centrally into the 'bar'. It is typically 25-30 mm in diameter. Its size does not increase with the increase of quern diameter.

- The feed-pipes are easily recognised in the hopper base. The are symmetrical with the outer edge of the 'D' shaped hole being typically about 40-50% of the overall diameter.

- The outer rims have a profile that is flat or curved and normally is parallel to the 'bar' profile.

- The rim height is initially estimated at 10-12 cm. Due to wear it can be reduced to about 5 cm.

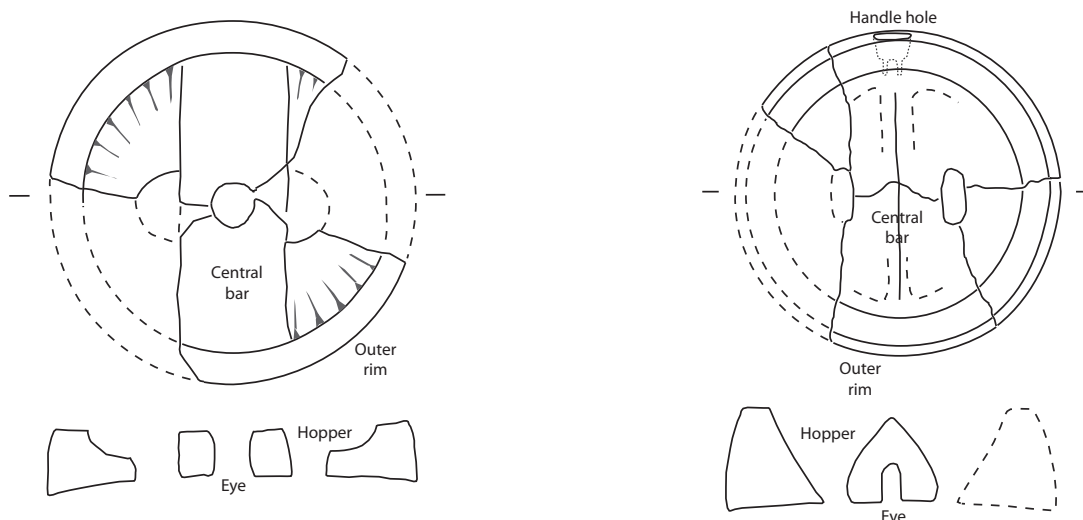


Fig. 2. Features found on two main types of twin hopper rotary querns in Northern Britain: a) Newstead, Melrose, Borders (FRA 1643), diameter 41.5 cm and b) Walton-le Dale, Preston, Lancs (SF 6300), diameter 37.5 cm (YQS archive: J. Cruse).

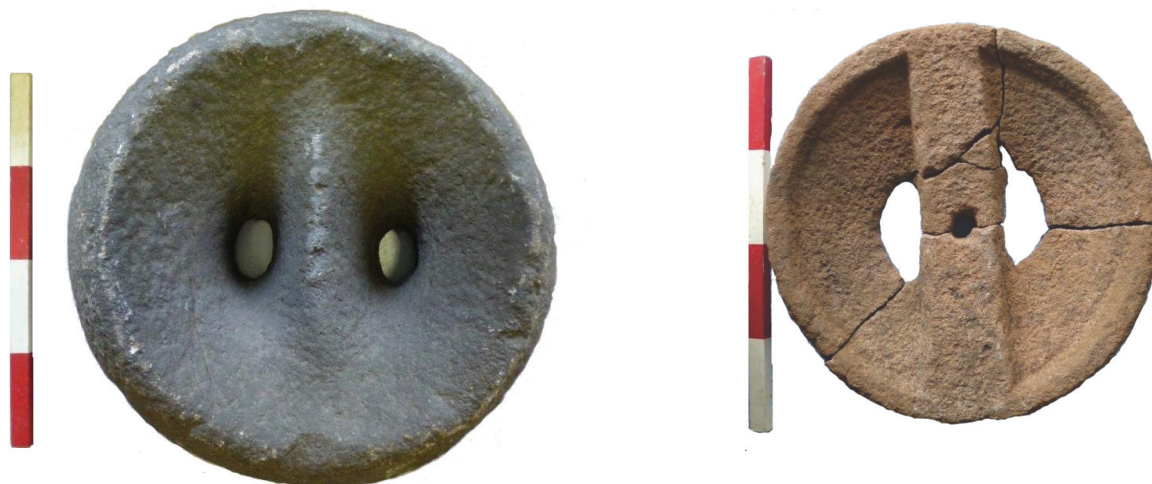


Fig. 3: Rotary Querns a) curved-bar type, Bramall, Stockport, Lancashire, diameter 45 cm, b) flat-bar type, Hatfield Lane, Doncaster, South Yorkshire, diameter 39 cm (YQS Archive: J. Cruise).

- The grinding surface is usually pecked. There are no furrows in 'harp' patterns. The curved bar type are slightly more concave (c. 13 mm +/- 5 mm max.) than those on flat types (7 mm +/- 5 mm).

- The weight of an unworn quern is about 20 kg but can be reduced to less than 10 kg by heavy use.

- The handle holes are typically 6 cm (+/- 1 cm) long and set horizontally into the side of the 'bar'. This is indicative of a manual drive. Two querns have no handle hole and are thus possibly driven by means of a handle fixed with an external band.

- The querns are predominately (85%) made from Millstone Grit (MSG), a coarse-grained feldspathic Namurian sandstone, which outcrops widely in the Pennines (for more details see Heslop 2008, 34-7), plus other local sandstones.

Two key conclusions can be drawn. The first is that their diameters are small, they are light in weight and their handle holes are consistent with manual operation. The second is that the characteristic hoppers leave no doubt that the opposed perforations are feed-pipes, with the small central hole or 'eye' only servicing the quern's rotation around the spindle.

The distribution of rotary hand querns

Apart from outliers in forts at Maryport (Cumbria) and Newstead (Borders), these querns are mainly found in a limited area of c. 150 x 100 km of the Southern Pennines between Chester and York (Fig. 4). Confirming Buckland and Magilton's observation, 19 definite and 7 probable querns have been recorded from auxiliary forts in the Pennines or from military supply bases like Wilderspool and Walton-le-Dale on the west coast.

A further 20 examples are known from non-military rural sites, often in a more fragmentary condition. These have a more easterly distribution, extending from the eastern Pennine fringe into the

Vale of York and are not found south of a line between Chester and Lincoln. No examples have yet been found from legionary contexts at York and none are known from Chester, suggesting that this type was only issued to auxiliary troops, but not apparently to the legions.

An un-provenanced Millstone Grit rough-out is known in Ribchester museum. As this curved-bar quern was discarded before its feed-pipe holes were completed and it was made of a local stone, we can reasonably suspect that it was manufactured nearby. Similarly, with the flat-bar querns being strongly represented at Castleford and Doncaster, it would not be surprising if other well established MSG sources in South or West Yorkshire, previously used for pre-Conquest beehive querns (Heslop 2008, 34) continued to be exploited. To answer the question how the quern supply was organised, we turn to a previous study into the provision of coarse wares to the Roman army.

Roman coarse ware pottery production parallels

Val Rigby (1998) assembled a distribution (Fig. 5) of coarse pottery with stamps of 'Cen', 'Sace' and 'Red(i)tas'. She described it as 'one of the most convincing and extensive regional (ceramic) groups in Britain', whose marked focus on Doncaster makes 'it an obvious candidate for one or more workshops'. These stamped wares were produced from the late 1st century AD until the construction of Hadrian's Wall in AD 122, based on 14 stamps, mainly from auxiliary forts. Using this evidence, she deduced that individual potters were acting as contractors to the army, servicing the needs of auxiliary units. Similarly in York, Patrick Ottaway has noted that, by the Hadrianic period, Ebor Ware pottery was no longer produced by legionary specialists, but was made for the army by civilian entrepreneurs (2013, 200).

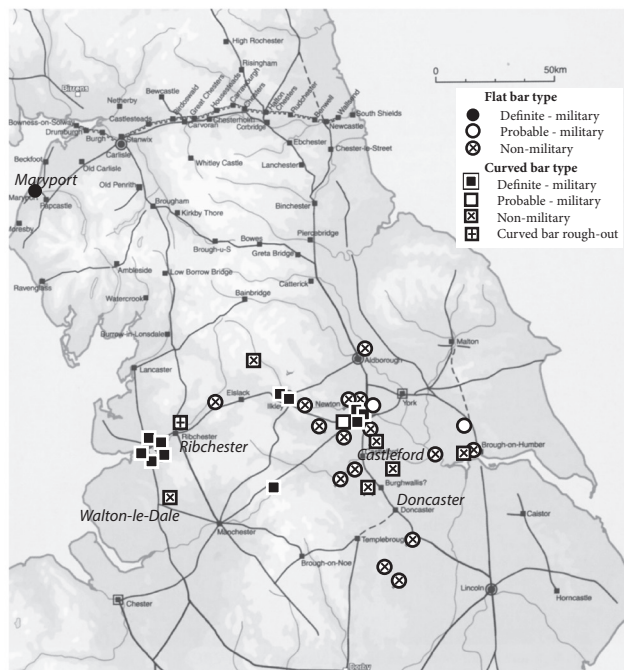


Fig. 4: Distribution of 'flat-bar' and 'curved-bar' rotary querns.

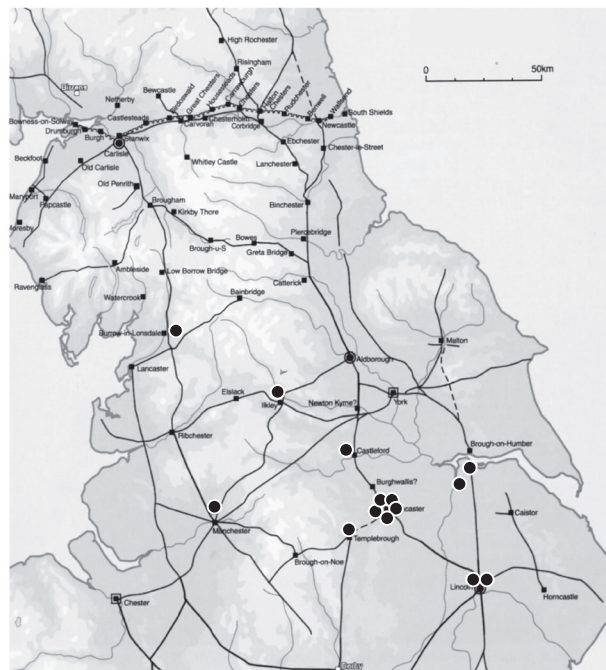


Fig. 5: Distribution of Roman coarse pots: stamped "Cen", "Reditas" and "Sage" (after Rigby, 1998, fig. 1).

As we have roughly three times more hand querns than Rigby had coarse ware stamps, and they have a very similar distribution, we similarly suspect that they were also made by army contractors. Additionally, from the lack of uniformity in their individual details, it looks as if this was a relatively small-scale artisan activity, lacking the uniformity expected from a factory.

With Castleford being an early focus for the flat-topped bar variants and also being somewhat nearer to the Millstone Grit rock sources than Doncaster, it provides a plausible manufacturing site, east of the Pennines, which geographically complements production of the curved-bar variant at Ribchester, in the western Pennines.

Rotary quern chronology

Excavated rotary hand querns are rarely found in well-sealed primary contexts. Their destiny is often to be re-used in later structures or to be fragmented into residual fills. In consequence, their chronology is poorly defined. Our hand querns largely confirm the Earlier Roman dating of Buckley and Major (1998, 246) who note that the two Castleford querns have late 1st century AD dates. A further nine examples have come from contexts which were definitely before 250 AD. Another eight are probably in this range, as their sites were little used after 250 AD. A minority of five come from post-250 AD contexts, but could well be residual (Figs 6 and 11). Without tighter dates, we cannot currently recognise any chronological difference between the flat-topped and the curved bar variants of this rotary quern type.

Rotary quern overview

As Buckley and Major (1998, 243) have noted, Mayen lava disc querns "were imported into Britain in large quantities" as a "standard item of legionary equipment". Their presence in published quern assemblages is probably understated by the tendency for lava fragments to degrade in acid

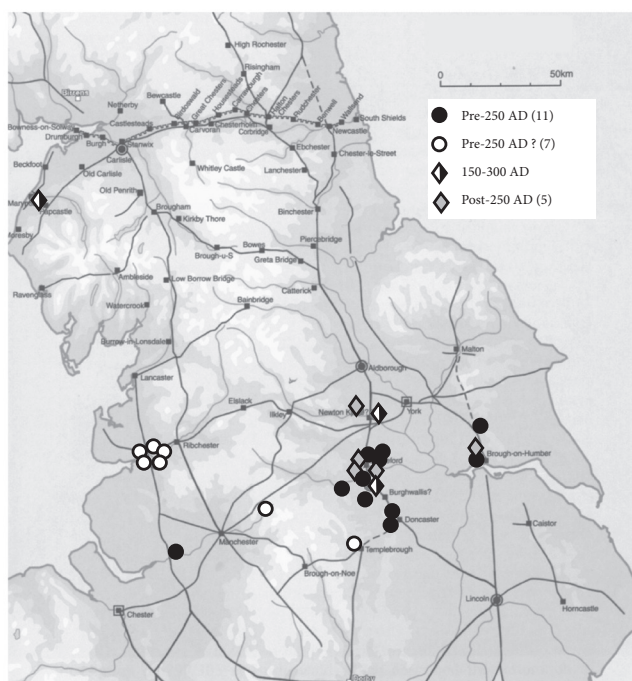


Fig. 6: Distribution of rotary hand querns by chronology.

soils and by the practice of earlier excavators to only record the semi-intact examples. Despite these limitations, such imported disc querns, together with their locally manufactured equivalents, dominate reported military quern groups. Thus, of the 492 querns recorded in the YQS archive from 20 Roman military sites in the central Pennine area (south of Hadrian's Wall), just over 75% are disc querns, of which 198 (40%) were made of imported lava and 174 (35%) of local sandstone.

The main features of a distinct type of rotary hand quern are now recognisable. Its distinguishing features are that its opposed hoppers have a diagnostic D-shape, that they are separated by a central bar and that the opposed perforations are undeniably acting as feed-pipes. There appear to be two variants of the basic design, with the dividing bar being either flat-topped or curved.

The quern type was in use at Castleford before AD 100 and deposition peaks in the later 2nd century

AD. The relative chronology of the two variants is unclear. Finds distribution and parallels from stamped coarse ware manufacture suggest that small-scale contractors were producing these querns for use by auxiliary soldiers at southern Pennine forts.

If such a link to the auxiliary units is accepted, then scholars will have a new route to investigate the workings of the military food supply system. It also raises the question how to interpret the presence of often fragmented querns in the 'civil' settlements along the Magnesium Limestone ridge and into the Vale of York. Possibly they represent 'leakage' of querns from the military supply system, perhaps being taken by veteran soldiers for personal use after their discharge. Alternatively, it could be that the producers responded to a downturn in military demand by developing sales into civilian areas. As more excavated examples are recognised, a clearer story of how such quern use developed should emerge.

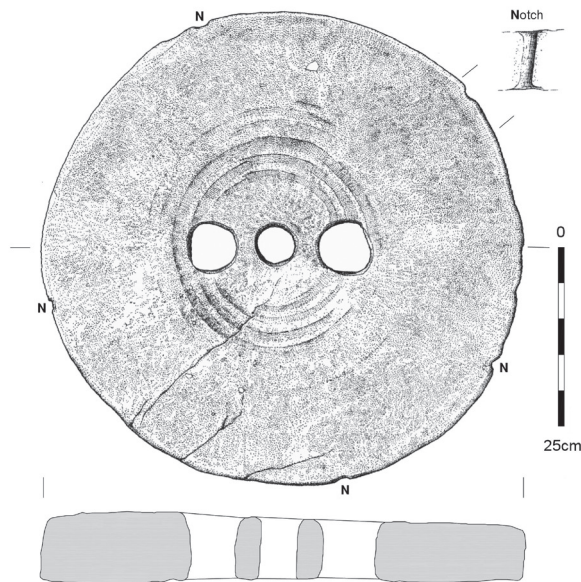


Fig 7: Healam Bridge, N Yorks (SF 28): Late Roman millstone showing the grinding surface, with 'distributor groove' around feed-pipes and notches around its perimeter (for an external band?). Diameter 65 cm (Cruse 2017, fig 244, no. 18).

Rotary querns vs millstones

Before addressing the larger diameter stone types with opposed perforations, we need first to consider how to best distinguish between rotary hand querns and powered millstones. Potential criteria were suggested in the Wattle Syke report (Cruse and Heslop, 2013, Table 30). Further work by Shaffrey (2015, 73-8) on southern English examples has expanded our range of informative features. For the purposes of this paper, Table 1 summarises the main criteria which have been found helpful to identify mechanically-powered millstones.

-The stone's diameter and the presence/absence of a handle hole for manual rotation are reasonably self-evident.

-Where the grinding surface is dressed with asymmetric patterns of narrow furrows ('harps'), they can be recognised as suitable for either clockwise or anticlockwise rotation (Watts 2002, 102). However, about 25% of dressing patterns are symmetrical, thus most suitable for operation in manual 'back and forth' mode. In the latter case, 92% of such querns have a diameter of less than 52.5 cm.

-The weight limit of 30-35 kg reflects the practicality for conveniently lifting.

-For twin 'feed-pipe' stones, the presence or absence of a D-shaped hopper.

Although these criteria usually provide a consistent determination, there are some stones, usually with diameters around 50-55 cm, where ambiguity remains. Better understanding of millstone features associated with geared manual systems (Peacock 2013a, fig. 6.14b) or perhaps with animal power (Appleby 2013, 112) may clarify our understanding of this interface.

Mechanically powered millstones with opposed holes

A second group of upper stones exist which, although they have opposed perforations, lack any grain hoppers, so they possess no 'bar'. Using the above criteria, they can usually be clearly identified as powered millstones (Peacock 2013, 110). At least 21 examples are known, whose opposed holes are distinctly separated from their central 'eye'. Such

detached perforations differ from stones with integrated 'bow-tie' central openings (discussed in Peacock 2013b, 212) that are largely found in the Midlands and Southern England. Their features are more difficult to understand and still await detailed study. Our millstone type, well represented by an intact example from Healam Bridge, N Yorks (Fig. 7), has the following features:

-External diameters extend from 50 to 80 cm, with most in the range 58-67 cm.

-Absence of any horizontal handle holes in the rim suggests a mechanical drive.

-Grinding faces are generally concave, confirming that they are upper stones.

-Upper surface is usually dressed flat or slightly domed and can be cut by pits or slots.

-Central 'eye' is round, with a typical diameter of 8 cm \pm 3 cm (a conventional millstone of the same diameter is somewhat larger, being 10.5 cm \pm 2.5 cm).

-Only one example has rynd-slots hence the means of power transmission needs more study.

-Opposed perforations are generally D-shaped or oval.

-Circular 'distributor' grooves, cut into the grinding surface, lie under the outside of the 'D'.

-Maximum rim height is 9-11cm, with worn examples being only 3-5 cm thick.

-Maximum weight is typically 60 kg, attaining 30-40 kg after wear.

-Lithologically, they use local stones. Approximately 50% are of Millstone Grit.

-Chronologically, they are usually Late Roman, with 70% from contexts dating to the 3rd or 4th century AD (Fig. 11).

Interpretation of the function of the millstone features

Publication of the fragmentary pieces of such unusual stones is quite rare. Specialist comments are normally restricted to describing their obvious features and to deciding between a quern or a millstone, with little discussion of 'how' these stones worked. A common assumption is that the central 'eye' acts as in a conventional millstone, serving both as the centre of rotation and also as

Table 1: Criteria to distinguish hand driven from mechanically powered upper stones.

Criteria	Rotary quern	Powered millstone
Diameter	< c. 55 cm	> c. 50 cm
Handle-holes	Present	Absent
Non-Directional Grinding Surface Grooves	Can occur	Absent
Estimated Intact Weight	< 30-35 kg	> 30-35 kg
For Double Feed-Pipe Stones	D-shaped hopper	No hopper

the entry point for the cereal feed (fed from an external suspended hopper). The opposed holes are implied to serve another function, often linked to a form of top-driven, power mechanism (Peacock, 2013, 118; Shaffrey, 2015, fig. 3).

To test the validity of this hypothesis, the following questions were investigated:

Q1: Is the 'eye' diameter of an ordinary millstone comparable to one with opposed holes?

A1: No. The 'eye' of a conventional 65 cm diameter millstone is typically 10.5 cm \pm 3 cm, but, for a comparable diameter opposed perforation stone, the 'eye' is smaller at 8 cm \pm 3 cm, a reduction of working area of 42% suggesting that, when the holes are opposed, the 'eye' served a more restricted function.

Q2: Do the opposed holes have any internal abrasion from the inserted drive mechanism?

A2: No. In the 12 examples personally examined by the author, there was no sign of such abrasion, or of a 'stop' to avoid a projecting insertion from rubbing against the base stone.

So the conclusion from these checks is 'not proven' (at best). An alternative hypothesis was therefore sought which might better explain the observed features. Using our previous hand quern experience (see above), we explored whether the opposed holes could also be twin feed-pipes, with the 'eye' solely servicing the rotational/power mechanism. We looked at the following areas:

Q3: Does the 'straight line' length of the D-shaped hole increase with millstone diameter?

A3: Yes: the 'D' of a 60 cm diam. stone is 9 \pm 5 cm long, but for an 80 cm stone, the 'D' is 12 \pm 5 cm, providing a roughly 75% greater area for grain

moving through the two perforations - supporting the idea that the larger stones achieved a greater grain input. It also seems that the orientation of the 'D' changes with millstone diameter. Whereas the smaller stones have oval or 'D' holes with the curved face on the outside, those larger than 65 cm diameter mainly have their 'D's flat faces to the outside, hinting that the hole's outer shape seeks to closely follow the moving arc of the grinding surface.

Q4: Where harp grooves or peck-dressing improve the milling efficiency of the grinding surface, do these features extend inwards, beyond the outer edge of the 'D' perforation?

A4: No: See Fig. 8 (Heslington East, Cruse and Heslop, forthcoming) - thus the grinding starts outside the 'D'.

Q5: Over 25 conventional millstones have now been recorded with a single circular groove, cut into their grinding face at 37% \pm 7% of overall diameter. This feature seems to occur where the grain transitions from being transported between the faces to starting to be ground between them. Are such 'distribution' grooves found on double hole stones and where?

A5: Yes: Five examples are known (i.e. Figs 6 and 7). In each case, the groove is placed immediately beneath the outer edge of the D-shaped hole and lies at 37 \pm 6% of the overall diameter. This close connection suggests that grain moves through the hole and is then routed into the effective grinding area at the same point as in a conventional millstone.

Thus there is little support for the idea that the perforations in these larger millstones are part of the drive mechanism, but strong indications that the opposed holes act as twin feed-pipes, as in the

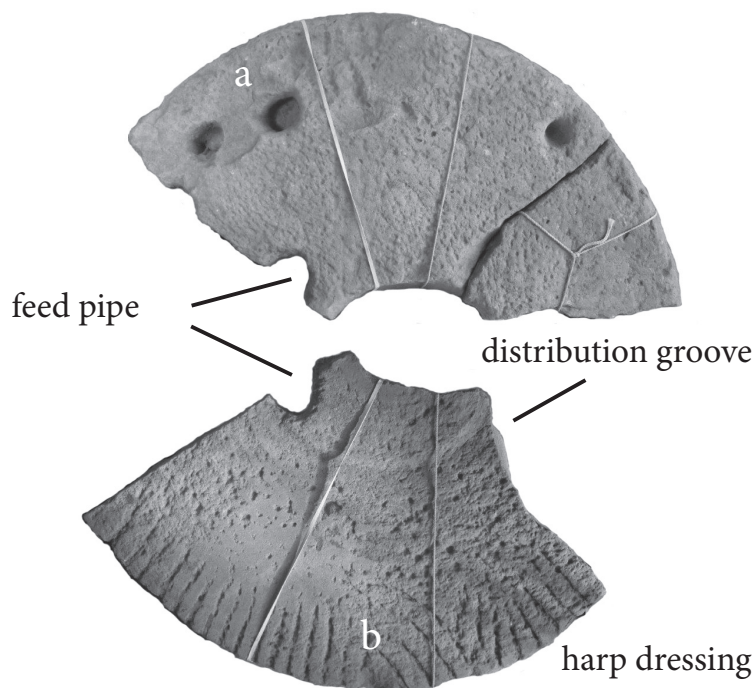


Fig. 8: Views of the upper and lower surface of a Late Roman millstone runner from Heslington East, North Yorks: a) surface pits on its upper surface, b) harps outside the opposed feed-pipes on its grinding surface. Diameter 68 cm.

to determine which size range is appropriate for each power source.

Finally, although we know that the double-hopper variant is a comparatively rare type of disc hand quern (see section 2.6), we are less well informed about the frequency of the various millstone variants. From data on the double feed-pipe variant, we seem to need at least 25% of the stone before we can be confident in its attribution; on this basis, 17 double feed-pipe examples are known. Applying the same criteria to the 'conventional' millstones (i.e. with only a central 'eye') from our study area, only 30 of the upper stones (which are only 35% of the 86 recorded) pass this test, with the remaining 65% being less than 25% intact and thus too small for their defining features to be recognisable. So, if this overall sample is representative, the double feed-pipe variant of powered millstone could be comparatively common, perhaps constituting 30-40% of all upper millstones.

Double feed-pipe rotary querns and millstones

Having studied these individual groups of hand querns and millstones, we can now look at their:

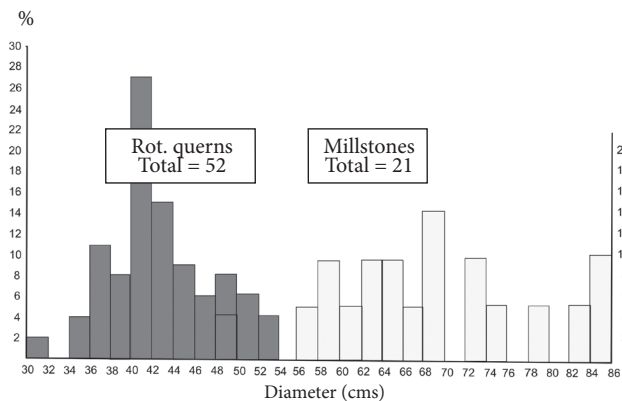


Fig. 10: Diameters of rotary hand querns and millstones.

1. Diameters: from Fig. 10, we can see that hand querns and millstones can be separately recognised by their own distinct size ranges, with the two types overlapping at around 50-55 cm diameter.

2. Chronology: Agglomerating the depositional dates for the two variants (Fig. 11), we can see that the bulk of the hand querns come from pre-AD 250 contexts, whereas the millstones are mostly used post-AD 250, with deposition peaking after 350 AD.

3. Links to the military? We have already seen that there was a strong military connection to the hand querns. Whilst Ottaway (2013, 300) has noted that 'little can be said' for the known presence of late 4th century forts along Dere Street, Moorhead and Stuttard (2012, 216) interpret the coinage

evidence as suggesting that these forts were bases for 'highly mobile, probably cavalry units'. Bland *et al.* (2013, 133) have argued that these troops could have been used 'to enforce the production of food'.

4. Links to the Cura Annonae in Rome? Now that we can more confidently recognise these fragmentary millstones, we can start to recognise where large-scale cereal processing was taking place. Initial indications from the Dere Street area suggest that Later Roman millstone use was focused on a fertile, adjacent strip of Permian limestone, which raises the question; 'who was this flour for?' Wilson (2002, 13) has noted that, between the late 2nd to mid-3rd centuries AD, the annonae system in Rome was reorganised to provide a hand-out of baked loaves, rather than of grain, and that this change was replicated at other municipal sites in the Mediterranean area. With our apparent local combination of late 4th century military enforcers and milling capacity, we can now investigate whether, as well as periodically facilitating cereal exports to the Rhine (Moorhead and Stuttard 2012, 207), this system was also tasked to deliver flour (or bread) to designated local users. Indeed, Gerrard (2013, 249) has noted that the armed body guards of local notables in the late 4th century were nick-named *bucellarii* ('bread-eaters').

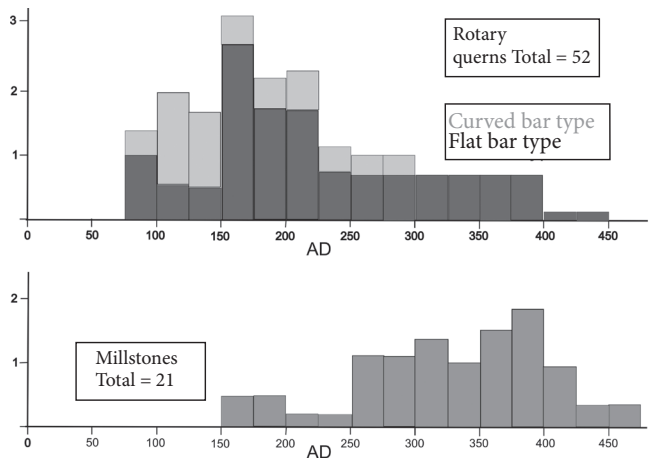


Fig. 11: Chronology of quern and millstone deposition.

Possible Rhineland precursors with double feed-pipes

Following my paper at the March 2014 colloquium, Martin Watts kindly provided a translation of Dietwulf Baatz's paper (2010, 607-14) about a similar group of upper stones from the German Rhineland. Significantly, Baatz notes that the earliest fragmentary examples from Waldgirmes (Hesse) have very early 1st century AD military dates. They are lava hand querns with a central 'eye' to align the stone and 'offset, rectangular chute-holes' which 'feed in the mill-charge', but lack the hoppers of our Pennine examples. Comparable stones, usually made from



Fig. 12: Saalburg, type B, 41 cm diameter, 2nd century AD (after Baatz, 2010, fig. 8).

local sandstone, are found elsewhere in Germany into the first half of the 2nd century AD, but thereafter are replaced by querns with triangular (or circular) 'chute-holes' (Fig. 12). Their development sequence thus differs from that in Britain, where feed-pipes are oval or 'D' shaped.

This evidence importantly demonstrates that the idea of separating the feed and rotation roles was first incorporated into military hand quern design well before the Claudian invasion of Britain and that this German design subsequently evolved differently to that in Britain. As none of these Rhineland-type lava hand querns with twin feed-pipes have been found in Britain, it appears likely that the manufacturers of these British twin feed-pipe querns chose to incorporate this pre-existing idea into their new design, which was specifically tailored to utilise the excellent milling characteristics of the local Millstone Grit.

Baatz also notes that these Rhineland 'runners' (like our British examples) do not have 'harp' dressing patterns on their grinding surface. However, they were worn into concentric grooves. Seeing this as a less efficient form of milling, he deduces that in Germany, rather than being used to grind wheat, they were used for some other purpose, such as de-husking spelt or barley (or perhaps ore grinding?).

From a British perspective, we have more than 30 examples of conventional querns and millstones with similar deep concentric grooves on their grinding surfaces (i.e. Shiptonthorpe, E Yorks: Gwilt, 2006) which may well have been used for de-husking grain or perhaps for crushing malted barley, to release the sugars prior to mashing. However, as none of these concentrically-grooved examples have opposed feed-pipes, it implies that, at least in Britain, our 'chute-holes' served some other purpose.

What should we call these distinctive stones?

Historically, British quern researchers have adopted something of an ad hoc approach to typology. Indigenous rotary quern types have been named descriptively (i.e. 'Beehive', Curwen 1937, 140), or by a regional concentration (i.e. 'Wessex', Curwen 1937, 142), or by a type site where particular diagnostic features were first noted (i.e. 'Hunsbury', Curwen, 1941, 19). No accepted name has so far emerged for our particular type of hand quern. Amongst the descriptive terms used have been "quern with crescentic hopper" (Curle 1911), "quern which had a central rib" (Buckley and Major, 1990) and "spectacle-type" (Gregory 2013, 34). This multiplicity of names cannot assist their comprehension. To improve the position, we could:

Option 1: Use a neutral catch-all term, which describes the key identifying characteristic of each of these distinctive stones, such as “Twin hopper hand quern” and “Twin feed-pipe millstone.”

Option 2: If the distinction made in section 2.6 is accepted, each variant could be named after the published location where their features were first recorded; thus:

-Twin hopper hand quern - Flat bar = ‘Templeborough’ variant (May 1922, 124).

-Twin hopper hand quern - Curved bar = ‘Bramall’ variant (Heginbotham 1892, 135-6).

Decisions about the naming of individual millstone variants is probably best deferred until a representative selection of British millstones with bow-tie ‘eyes’ have been examined and their links with Type ‘A’ examples from the Rhineland (Baatz 2010, 609) are better understood.

Conclusions

We can now recognise a characteristic group of upper stones from north Britain with opposed perforations either side of a central ‘eye’. These can be distinguished into a manually rotated ‘twin hopper hand quern’ and a powered ‘twin feed-pipe millstone’.

The idea of using separate features to rotate the upper stone and to feed the grain into the grinding space is present at Waldgirmes Fort in the Rhineland from the first decade of the 1st century AD (Baatz 2010).

When a network of auxiliary forts was established in the Pennines in the latter part of the 1st century AD, it would appear that their soldiers were provided with a new hand quern design, made from local Millstone Grit, but applying an earlier design concept, previously used for some specialised lava querns in the Rhineland. They incorporated D-shaped feed hoppers and a strengthening central bar (which removed the need for an iron rynd). These querns were probably manufactured by local army contractors.

The design of these rotary querns was developed in north Britain, largely independently of those in Germany, with their main period of use being pre-250 AD.

Two variants have been recognised, one with a flat central bar and another with a rather taller, arched bar. ‘Templeborough’ and ‘Bramall’ are suggested names for these respective variants.

Previous fragmentary evidence of the larger powered millstones with opposed feed-pipes, but no hoppers, has been confirmed by the recent excavation of a complete example. This twin feed-pipe design,

which is also known in the Rhineland, is mainly found on sites adjacent to Dere Street and along the York to Brough road from the 2nd century AD, with deposition peaking after AD 350.

One characteristic of the twin feed-pipe design is that the central ‘eye’ has a smaller diameter than for a conventional millstone and another is that its feed-pipe area is capable of expanding as its millstone diameter increases. This provided an improved ability to handle higher feed-rates than a conventional millstone, which was probably more constrained by the dual role for its eye.

Fixture points, cut into the upper surface, are comparable to those on conventional millstones and probably served to attach an external wooden hopper, which rotated with the upper stone. Similar explanations have been proposed in southern Gaul, where such large stones are considered to be water-powered. As twin feed-pipe millstones usually lack any rynd slots, these fixture points may also be associated with the drive mechanism.

The recognition that post-AD 250 millstone finds are focused on the cereal producing farmland, such as the Magnesian Limestone, traversed by Dere Street, opens up a new source of data about Late Roman economic activity in the region.

As their novel features become better appreciated by other researchers, we can be reasonably confident that more of these unusual stones will be found, both in Britain and on the Continent.

Acknowledgments

The author acknowledges the assistance of the Paul Bidwell and Nick Hodgson for their consent to reproduce Figure 9 from Bidwell and Hodgson, 2009, in the distribution maps. Museum curators at Bolton, Carlisle, Doncaster, Wakefield and Ribchester are thanked for providing access to their quern collections. I am also grateful to Janny Baxter of Stockport Museum, Dawn Knowles of NAA, Fraser Hunter of NMS Edinburgh, Cath Neal of University of York, Rachel Newman of Oxford Archaeology North and Ian Roberts of WYAS for permission to use images and to David Heslop for preparing the illustrations. Finally, editorial feedback from Timothy Anderson also helped to improve the final text.

Bibliography

- APPLEBY, G. (2013). Milling – querns and millstones. In: C. EVANS (ed.). *Process and History: Romano-British Communities at Colne Fen, Earith: An Inland Port and Supply Farm*, CAU Landscape Archive Series, The Archaeology of the Lower Ouse Valley, Vol. II: 111-3.
- BAATZ, D. (2010). Ein handmuhlenläufer aus dem Limeskastell mainhardt (Kreis Schwabisch Hall), Fundberichte Aus Baden-Württemberg, 31: 607-614.
- BIDWELL, P. AND HODGSON, N. (2009). *The Roman Army in Northern England*. Arbeia Society.
- BLAND, R., MOORHEAD, S. AND WALTON, P. (2013). Finds of late Roman silver coins from Britain: the contribution of the Portable Antiquities Scheme. In: F. HUNTER and K. PAINTER (eds). *Late Roman Silver: The Taprain Treasure in Context*. Society of Antiquaries of Scotland. Edinburgh: 117-66.
- BUCKLAND, P.C. AND MAGILTON, J.R. (1986). *The Archaeology of Doncaster: 1: The Roman Civil Settlement*, BAR, British Series, 148. Oxford.
- BUCKLEY, D.G. AND MAJOR, H. (1998). The Quernstones. In: H.E.M. COOL AND C. PHILO (eds). *Roman Castleford: Excavations 1974-85. Volume 1: Small Finds*, Yorkshire Archaeology, 4, WYAS. Leeds: 241-7.
- CASTELLA, D. (1994). Le moulin hydraulique gallo-romain d'Avenches "En Chaplix". *Fouilles 1990-1991, Cahiers d'archéologie romande*, 62. Lausanne.
- COLLINS, R. (2012). *Hadrian's Wall and the End of Empire: The Roman Frontier in the 4th and 5th Centuries*. Routledge. London.
- COULSTON, J.C.N. (1997). Milling Stones. In: T. WILMOTT. *Birdoswald: Excavations of a Roman fort on Hadrian's Wall and its successor settlements: 1987-92*, English Heritage Archaeological Report, 14. London: 290-94.
- COWLING, E.T. (1969). *Cornmills of Mid-Wharfedale*. Otley Archaeological and Historical Society. 1st edition.
- CRUSE, J. (2017). Querns and Millstones. In: C. AMBREY, D. FELL, S. ROSS, D. SPEED AND P. N. WOOD, P.N. *A Roman Roadside Settlement at Healam Bridge: The Iron Age to early medieval evidence. Volume 2: Artefacts*. Northern Archaeological Associates Monograph Series, 3. Barnard Castle: 199-212.
- CRUSE, J. AND HESLOP, D. (2013). Querns, Millstones and other Artefacts. In: L. MARTIN, J. RICHARDSON AND I. ROBERTS (eds). *Iron Age and Roman Settlement at Wattle Syke: Archaeological Investigations during the A1 Bramham to Wetherby Upgrading Scheme*. Yorkshire Archaeology, 11, WYAS. Leeds.
- CRUSE, J. AND HESLOP, D. (forthcoming). Querns and Millstones at Heslington East. University of York.
- CURWEN, E.C. (1937). Querns. *Antiquity*, XI: 133-51.
- CURWEN, E.C. (1941). More About Querns. *Antiquity*, 57: 15-32.
- GERRARD, J. (2013). *The Ruin of Roman Britain: An Archaeological Perspective*. Cambridge UP.
- GREGORY, R.A. (2013). Later Prehistoric and Romano-British Archaeology. In: R. A. GREGORY, P. DANIEL AND F. BROWN (eds). *Early Landscapes of West and North Yorkshire: Archaeological Investigations along the Asselby to Pannal Natural Gas Pipeline: 2007-8*. Lancaster Imprint, 21: 31-64.
- GWILT, A. (2006). The quernstones. In: M. MILLETT (ed.). *Shiptonthorpe, East Yorkshire: Archaeological Studies of a Romano-British Roadside Settlement*. Yorkshire Archaeological Report, 5. Leeds.
- HEGINBOTHAM, H. (1892). *Stockport Ancient and Modern: 2*. London.
- HESLOP, D.H. (2008). Patterns of Quern Production, Acquisition and Deposition: A Corpus of Beehive Querns from Northern Yorkshire and Southern Durham. Yorkshire Archaeological Society, Occ Paper No 5. Leeds.
- LONGEPIERRE, S. (2012). Meules, Moulins et meulières en Gaule méridionale du IIe s. av J.-C. au VIIe s. ap. J.-C. *Monographies Instrumentum*, 41. Montagnac.
- MAY, T. (1922). *The Roman Forts of Templeborough, near Rotherham*. Rotherham.
- MOORHEAD, S. AND STUTTARD, D. (2012). *The Romans Who Shaped Britain*. Thames and Hudson.
- OTTAWAY, P. (2013). *Roman Yorkshire: People, Culture and Landscape*. Pickering.
- PEACOCK, D. (2013a). The Stone of Life: The archaeology of querns, mills and flour production in Europe up to c. AD 500. *Southampton Monographs in Archaeology, New Series*, 1.
- PEACOCK, D. (2013b). The Problems of power mills in Roman Britain and beyond. In: H. ECKHART AND S. RIPPON (eds). *Living and Working in the Roman World: Essays in Honour of Michael Fulford on his 65th Birthday*. *Journal of Roman Archaeology, Supplementary Series*, 95: 205-15.
- RAHTZ, P.A. AND GREENFIELD, E.W. (1977). Excavations at Chew Valley Lake, Somerset, Dept. of Environment. *Archaeological Reports*, 8: 363-75.
- RIGBY, V. (1998). Where did Cen, Reditas and Sace produce pots? A summary of the range and distribution of R-B stamped wares. In: J. BIRD (ed.).

Form and Fabric: Studies in Rome's material past: in honour of BR Hartley. Oxbow Monograph, 80. Oxford: 191-8.

SHAFFREY, R. (2015). Intensive Milling Practices in the Romano-British Landscape of Southern England: Using Newly Established Criteria for Distinguishing Millstones from Rotary Querns. *Britannia*, 46: 55-92.

SPAIN, R. (2002). A Possible Roman Tide Mill. Kent Archaeological Society, Paper 005, www.kentarchaeology.ac/accontents.html accessed 1/4/10.

TILSON, P. (1973). A Belgic and Romano-British Site at Bromham. *Bedfordshire Archaeological Journal*, 8: 23-66.

WILSON, A. (2002). Machines, Power and the Ancient Economy. *Journal of Roman Studies*, 92: 1-32.

