"Give us this day our daily bread": making wheat into flour by hand

As agriculture superseded 'hunter/gatherer' methods of food production, the need to process grains became more necessary. The husks of most cereals are inedible, and make it difficult to get to the nutrient rich inner seed. By breaking apart the seeds and removing the inedible parts, man developed a way to make wheat into food, most notably flour, the key component of bread, which has been a staple of the diet ever since. With the advent of commercialization and industrialization, making flour moved away from the farmer and homestead, and the methods used for small scale manufacture disappeared from common knowledge.

This paper explores the development of flour milling technology in Europe, and includes information about my own experiments making flour using Iron Age hand milling for living history demonstrations.

History of Grinding Grain

The mortar and pestle

POUNDING GRAIN.

Man started grinding with simple stones, which evolved into the classic mortar and pestle by Paleolithic times. (Curwen 1937, 34, Forbes 145) This simple tool is still in use in the kitchen today, although better and faster methods of crushing have evolved. The mortar and pestle is very slow and laborious, but is suitable for removing the hard, non-edible outer shell from certain grains, which is necessary for the making of flour. (Curtis 373)

Figure 1: Pounding grain with a mortar and pestle. (Ashton 49)

The saddle quern

FIG. 1. EGYPTIAN STATUETTE ILLUSTRATING THE USE OF THE SADDLE-QUERN. (5th Dynasty)
After Bennett and Elton

The next innovation was the saddle quern, which uses a back and forth motion to grind the grain. Examples from Egyptian tombs show saddle querns from 2400BCE, and they are found around Europe and Mesopotamia. (Curwen 1937, 136)

Because there was no way to add grain and remove the finished flour, the saddle quern was not an efficient machine. Adding a hopper (grain holder) to the upper rubbing stone allowed for more efficient grinding. The Olynthus mill is one type of 'hopper mill', which spread throughout the Mediterranean in the 5th century BCE. (Curtis 374)

Figure 2: Grinding grain using a saddle quern. (Curwen 1937, 136)

The rotary quern

The next major improvement in grinding grain was rotary motion. A rotary quern consists of 2 stones with surfaces that fit on top of one another and grind the grain between them. The bottom stone tends to have a convex surface, with a pin (metal or wood) that sticks up from the center. The upper stone has a slightly concave surface, and has a hollow through the center. The top stone sits on the pin and can spin freely on the bottom stone, which remains stationary. The top stone has a handle on the top or side to facilitate turning. (King 420)

Figure 3: Rotary quern. (Bennett and Elton 142)

While the exact timeframe for the development of the rotary quern is unknown, examples from Ras Shamra (Syria) from approximately 1200BCE show the basic concept. (Forbes 148). There are examples throughout Western Europe from this time onwards, and the rotary quern replaced the saddle quern as the dominant technology for grinding grain into the Iron Age. (Forbes 151-52, Curtis 375)

The beehive quern was one of the variants in quern design found in Britain from at least 300BCE. (Spratt 142) The usual shape of the upper stones is hemispherical with an even curve and a deep, straight-sided conical hopper in the middle for holding the grain. The hole for the handle sometimes goes all the way through to the hopper, but not always. (Henslop 88) Dating querns can be very difficult, because they can be used for a very long time, so the age of the archaeological context may not be contemporary for when the quern was made or in use. (Buckley and Major 243) There are different types of beehive querns, named after the location(s) excavated and/or context: Hunsbury, Roman Legionary, Wessex, etc. (Curwen 1937, 137)

The beehive quern flourished in Britain until the Roman conquest. (100BCE-100CE) Later querns had flatter upper stones, with a handle on the top (rather than the side). (Curwen 1937 137-140) This later design was expanded to use animal and man-power, and then evolved into the large millstones used in water-mills and wind-mills.

Hand operated rotary querns declined in use as large-scale milling developed and flour production became commercialized. Feudal laws like the Mill Soke (England) and Thirlage (Scotland) required the local community to use the landowner's mill, and pay the miller a portion of their grain. (Bennett and Elton 210 – 221) These laws restricted the use of hand mills, and in many cases made them contraband, subject to seizure by the landlord.

As P. Rahtz explains:

> As we shall see, the powered mill, from having been an invention to save the labour of men, became an instrument of taxation and oppression: Even in monastic estates this was so - the monks of Jumièges in 1207 were breaking up handmills, whose numbers were enough to threaten feudal monopoly (Bloch 1967, 154).

> In England the same restrictions developed. When we were digging at Upton, one of the archaeological features that Rodney Hilton found exciting was the numerous quern fragments (Hilton & Rahtz 1966; Rahtz 1969) which, as a historian, he would have expected to have been little if at all in evidence. The most famous conflict was of course that at St Albans, after 1274, again on a monastic estate. Artisan tenants rebelled against the monopoly of both the lord's cornmills and his fulling-mill. Millstones and lengths of cloth were confiscated, and there was violence, but on this occasion the rebels gave in. In 1326 there was a full-scale revolt, in which the monastery was twice besieged. Stalemate followed, with the handmills still working, but a new abbot in 1331 took a more forceful line by legislation. From all over the town millstones were brought into the monastery, and the monks paved their parlours with them; one wonders whether archaeologists would have determined the origin of these curious floors. For 50 years they stayed there, but in the Great Revolt of 1381 the townsfolk again attacked the abbey. They destroyed the millstone-paved floors, broke them up, and took fragments away as a sign of victory and solidarity. The struggle went on, and as late as 1789 Breton peasants were protesting against milling exactions. In 1896 Russian villagers were still using them, hiding from strangers as they did so, from some earlier tradition of tax evasion (Bloch 1967, 156-9). (2-3)

Iron Age wheat

Several types of grain (or corn) were grown in the Iron Age. Emmer, Einkorn, and Spelt are all wheat varieties grown, as well as 'Common Wheat' (*Triticum aestivum)* which quickly predominated. (Cubadda and Marconi 154) Barley and rye were also used for breads, although their lack of gluten made flatbread which won't rise. The husked cereals: barley, emmer, spelt, and einkorn, for example, require extra processing to remove the inedible outer shell. This can be done by parching (cooking) or pounding. Varieties of wheat that didn't require this extra work quickly gained popularity and dominance. (Curtis 373)

Recreation of an Iron Age Romano-British Beehive Quern

The founder of our living history group, Jeff Scharp, decided to make a rotary quern for use in our educational demonstrations of daily life in Iron Age Britain. He based his research on the finds that correspond to the geography and time-frame of the Corieltauvi, who inhabited the East Midlands of Britain during the late Iron Age. (350BCE-100CE) He chose the beehive quern as the type most likely to be in use, based on archaeological finds. (Jeff Scharp, pers. comm.) Because I was often in charge of the quern at our demonstrations, I started my own research into the history and use of querns, conferring with Jeff about his choices in making the quern and comparing it to what different authors have said on the subject.

Extant examples of rotary quern stones in Iron Age Britain indicate they were made from local stone. (Pratt 143; Buckley and Major 243) The stone used for querns needs to be sturdy and wear resistant. In Britain, a type of 'puddingstone' was used in querns dated to the early Roman era (100CE). (Curwen 1937, 148) Puddingstone is a type of conglomerate sedimentary rock, where there is a 'matrix' rock of one type, with pebbles and inclusions of other types/colors. Some examples of puddingstone querns have very large inclusions, while others are less obvious. (Perkins)

Instead of finding a location of suitable puddingstone (not native to this area), quarrying it, and then chiseling it into shape, Jeff made molds for the top and bottom stones to be cast in puddingstone cement, a modern material that simulates real puddingstone. (Jeff Scharp, pers. comm.) The size and shape correspond closely to the Hunsbury style quern, found in archaeological contexts throughout Britain. (Curwen 1937, 142) Puddingstone cement was chosen because of its extreme similarity to real puddingstone, although there are some minor differences, particularly in the size of the inclusions. (Perkins) So the size, shape, and material are consistent with Iron Age querns, but the method of manufacture was modern.

A small metal tube was placed at the bottom of the hopper on the upper stone to control the opening and avoid wear on the stone by the metal pin. Late Iron Age and medieval querns often had a wooden or metal rynd that fit in the hole to help the grain slide past the spindle through and prevent flour buildup. Other stones show indications of a carved out area at the bottom of the hopper, which may serve the same function. The tube does help with this, but it was mainly used to ensure the hole was large enough for the metal pin, since it was being cast, not chiseled. (Jeff Scharp, pers. comm.)

Figure 4: Beehive quern. (Author)

The lower stone of the quern has a metal pin embedded in the center to act as a pivot. Since most quern stones are not found complete, it is possible that the pin would be made from wood rather than metal. However, the metal is more durable, so it was chosen for this project.

Figure 5: Picture of the lower stone. (Author)

While there are no extant handles, a simple wooden beam was chosen as the most likely candidate. (Figure 4) While not all of the querns have upper holes that go all the way through to the hopper, some do, especially in the 'Hunsbury' style. (Curwen 1937, 142) One theory with such handles is that they may have connected/aligned with the metal pin from the lower stone. (Buckley and Major 243). While this is possible, our experiment shows this is unnecessary, and that it would be complicated to align handle and pin, while allowing the grain to flow past. A small wooden pin is sufficient to keep the handle in place, while allowing for easy removal as needed.

Neither upper nor lower stone have grooves cut into them. Based on the examples in Curwen, this appears to be a later innovation, which helps the ground flour move from under the stones. (1937, 145)

The quern is used by moving the upper stone back and forth across the lower stone, crushing and grinding the grain between the stones as it falls through the hopper. The motion of the quern is rotary, and can go completely around or back and forth. It can be used by either arm, and can also be used by 2 people passing off the handle as it goes around the circle.

When using the quern, it quickly became clear that a method was needed to collect the flour as it fell from the lower stone. A small wooden table was built for this purpose. While this contained the flour, it became necessary to mount the lower stone to the table to prevent movement – the flour acted as a 'lubricant', causing the lower stone to move on the wood. Brass pins were added to the table, and the lower stone of the quern had small holes drilled in alignment, allowing the stone to be set on the table securely. It is very possible than an Iron Age household would have mounted the quern on a table or bench of some sort, eliminating this problem.

Figure 6: Wooden table showing metal pins. (Author)

There is a myth that all stone-ground flour must have large quantities of stone powder or "splinters of the millstone" contaminating the final product. (Stathakopoulos 34) While it is true that the quern

shows some signs of wear, we haven't noticed any grit or chunks of stone in the flour, and the consensus from the general public has been that we've created whole wheat flour as fine as commercial flour.

My experiments in making flour

After doing several living history demonstrations, it became clear that the flour made in such conditions was not suitable for eating – dirt and other contaminants couldn't be controlled, and people wanted to touch and feel the flour throughout the day. I took the quern home and set up my own experiments, where I could keep the flour sanitary. I have not made enough flour in my home experiments to make bread, due to time and other constraints. I have mixed it with commercial spelt flour to make experimental sourdough, and the flour looks and feels very similar, although it is not as white and has more bran flecks in it.

Choosing the grain

Spelt wheat (*Triticum spelta)* was chosen as the heritage grain for grinding, as it will make suitable bread flour, unlike barley, which has no gluten. It was purchased as whole grains from the grocery store. Spelt wheat was grown throughout Europe since it was developed in the Bronze Age. Spelt is sometimes considered a subspecies of 'common wheat' and is very similar in properties.

Figure 7: Spelt wheat (Author)

Steps to grind wheat

The hopper was filled approximately half way with grain, and then grinding started.
The first grains often roll through with no grinding, and these are put back through again. As the grinding continues, the flour starts forming more consistently, and there is less to be re-ground. Almost all of the wheat goes through the quern two times before it is ground sufficiently into flour.

Figure 8: The quern with spelt in the hopper. (Author)

As flour builds up around the edge of the lower stone, it is swept into a bowl to be sifted. Sifting removes the un-ground portions, which can be put back through the quern for additional grinding. While sifting and 'bolting' are often mentioned, the exact nature of the equipment used is unknown in Iron Age contexts. Therefore, small baskets that had different mesh were used to sift the flour.

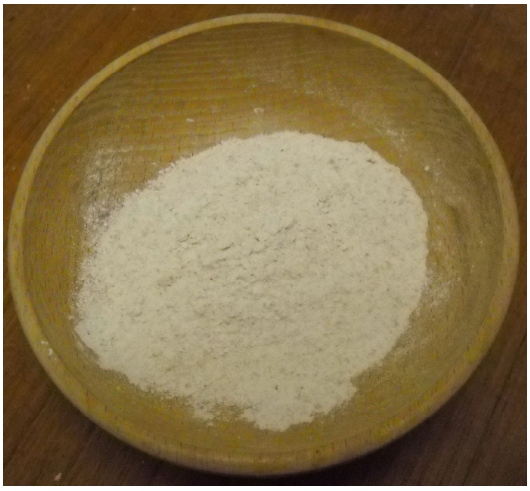
Figure 9: Ground flour. (Author)

After the first sifting, what remained was mainly bran. Large pieces of un-ground spelt were returned to the quern hopper, and the rest of the bran was set aside. (Figure 10)

Figure 10: First sifting – the bran. (Author)

The flour from the first sifting was put into the smaller mesh basket, and what came through was the finished flour, (Figure 12) while what remained was also set aside as 'rough flour' or 'seconds' (Pliny 18.20) (Figure 11)

Figure 11: Second sifting –rough flour or seconds. (Author)



These 3 levels of 'flour' (bran, rough flour, and finished flour) correspond to Pliny's description of flour making: "There were three classes of wheat; the first of which would appear to have yielded seventeen pounds of bread, the second eighteen, and the third nineteen pounds and a third: to these were added two pounds and a half of ***seconds***, and the same quantity of brown bread, with six sextarii of ***bran***." (Pliny 18.20) (Emphasis added) The Romans used 'common wheat' or its equivalent in flour making – so the descriptions of 'wheat' really refer to the flour made, not the raw material itself.

Figure 12: The finished flour. (Author)

A bolting cloth was not used in the production of this flour. While its use was suggested in historical examples, (Pliny 13.26) there is some indication that it was to be used as a flour paste to fix papyrus, not for food. Experiments with a medium-weave linen were not very successful: the weave clogged with flour and very little was able to pass through and be collected. Tapping the bag against the table (pouncing) created a cloud of flour which was next to impossible to collect, either. More time and possibly linen with a looser weave might allow more to pass through, creating even finer flour.

CONCLUSIONS

Using a hand quern to create flour is very labor intensive. With bread being a staple food for most societies, the amount of labor needed to produce 'daily bread' using such technology must have been incredible. Searching for ways to make flour faster and more efficiently led to innovations including water power, wind power, and other technological advancements. However, the essential technology of grinding grain between two stones didn't change for a very long time. Experimenting with Iron Age technology and sharing it with the modern public helps educate and reconnect us with the 'common knowledge' of our ancestors – knowledge that has been lost through innovation and advancement.

Works Consulted

Ashton, John. *The History of Bread from Pre-Historic to Modern Times*. London: Brooke House Pub. Co, 1904.

Bennett, Richard, and John Elton. *History of Corn Milling.* London: Simpkin, Marshall and Co. etc., 1898.

Buckley, D.G., and H. Major. "The Quernstones." *Roman Castleford: excavations 1974 - 85.* Ed. H.E.M. Cool and Ed. C. Wakefield: West Yorkshire Archaeology Service, 1998. 241-246.

Cubadda, Raimondo, and Emanuele Marconi. "Spelt Wheat" in *Pseudocereals and less common cereals : grain properties and utilization potential.* Ed. Peter S. Belton, Ed. John R. N. Taylor. Berlin, New York: Springer, 2002. 153-175. Print.

Curtis, Robert. "Food Processing and Preparation." *The Oxford handbook of engineering and technology in the classical world*. Ed. John Peter Oleson. Oxford: Oxford University Press, 2008. 369-392. Print.

Curwen, Cecil. "More about Querns." *Antiquity*. 1942: 15-32.

Curwen, Cecil. "Querns." *Antiquity.* 1937: 133-151.

Forbes, R. *Studies in Ancient Technology (vol III*). Leiden New York: E.J. Brill, 1993. Print.

Heslop, D. H. *The Excavation of an Iron Age Settlement at Thorpe Thewles, Cleveland, 1980-1982*. London: Council for British Archaeology, 1987: 84-89.

King, William Ross. "Notes on Querns, with special reference to one of unusual form found in a Moss near the Meikle Loch, Aberdeenshire." *Proceedings of the Society of Antiquaries of Scotland*. 1872-1874: 419-24. <http://ads.ahds.ac.uk/catalogue/adsdata/arch-35-1/dissemination/pdf/vol_010 /10_419_424.pdf>

Perkins, Steve. *Hertfordshire Puddingstone.* East Herts Geology Club, 2005. <htp://www.ehgc.org.uk/Steve_s_leaflet_ver2_.pdf>

.Pliny the Elder. *The Natural History.* John Bostock, M.D., F.R.S. H.T. Riley, Esq., B.A. London. Taylor and Francis, Red Lion Court, Fleet Street. 1855.

Rahtz, PW. "Medieval Milling." *Medieval Industry*. Ed. DW Crossley. London: Council for British Archaeology: 1981. 1-15. Print.

Spratt, D. A. (ed) *Prehistoric and Roman archaeology of north-east Yorkshire.* London: Council for British Archaeology, 1993.

Stathakopoulos, Dionysios C. *Eat, drink, and be merry (Luke 12:19): food and wine in Byzantium : papers of the 37th annual spring Symposium of Byzantine Studies, in honour of Professor A.A.M. Bryer*. Ed. Leslie Brubaker and Ed. Kallirroe Linardou. Aldershot, England Burlington, VT: Ashgate, 2007. 27-37. Print.