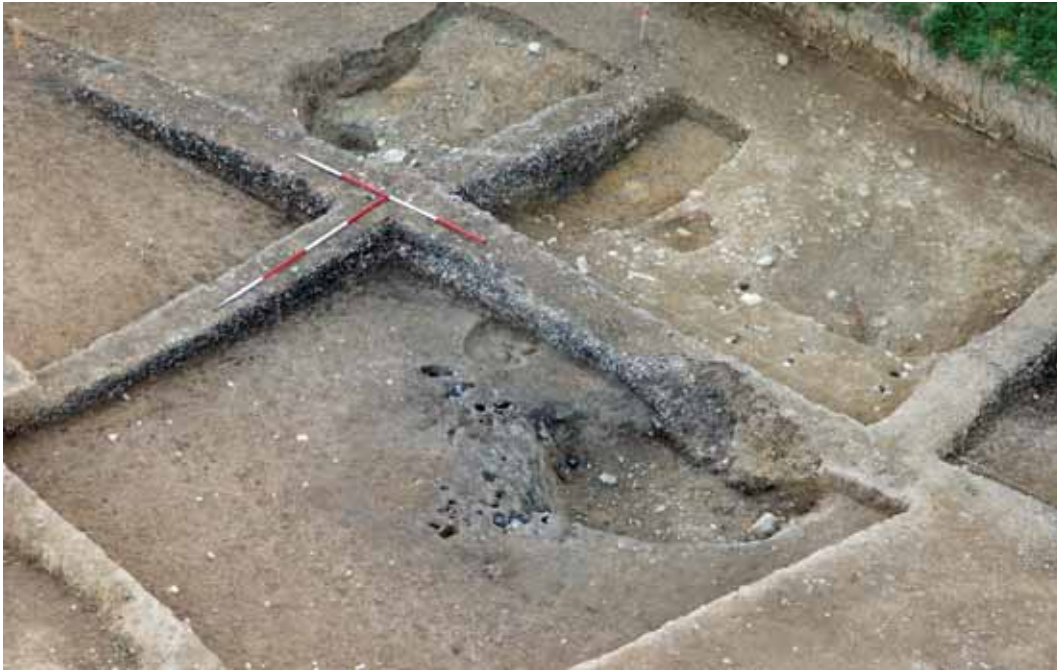


## 5. *Fulachta fiadh* and the beer experiment

*Billy Quinn and Declan Moore*



*Illus. 1—A fulacht fiadh/burnt mound excavated at Raheenagurren West, Co. Wexford, on the route of the N11 Gorey–Arklow Link Road (Valerie J Keeley Ltd).*

*Fulachta fiadh*, or burnt mounds, generally date from the Bronze Age and are one of the most widespread of Irish field monuments, perhaps numbering up to 5,000. Of the 500 or so sites currently entered in the NRA Archaeological Database ([www.nra.ie/Archaeology/NRAArchaeologicalDatabase/](http://www.nra.ie/Archaeology/NRAArchaeologicalDatabase/), accessed August 2008), 28% are *fulachta fiadh* (with associated features) or burnt mounds/spreads (with no associated features). To date, they have been excavated on road schemes in 18 counties, in all provinces. Typically, a *fulacht fiadh* site is defined by a low, horseshoe-shaped mound. Upon excavation the mound is found to consist of charcoal-enriched soil and heat-shattered stone around a central trough (Illus. 1 & 2).

The name derives from Geoffrey Keating's 17th-century manuscript *Foras Feasa ar Éirinn* and as a complete term does not appear in any early manuscripts (Ó Néill 2004). Conventional wisdom, based largely on Professor M J O'Kelly's 1952 experiments in Ballyvourney, Co. Cork, suggests that they were used for cooking (ibid.; O'Kelly 1954). Alternative theories that have been proposed include bathing, dyeing, fulling and tanning. It is, however, generally agreed that their primary function was to heat water by depositing fired stones into a water-filled trough. In this paper we would like to explore a further hypothesis, reported previously elsewhere (Quinn & Moore 2007): were some *fulachta fiadh* prehistoric micro-breweries?



*Illus. 2—Archaeologists excavating the trough of a fulacht fiadh/burnt mound uncovered at Newrath, Co. Kilkenny, on the route of the N25 Waterford City Bypass (James Eogan).*

### **So where does beer come into it?**

In order to answer this we have to look into the natural history and archaeology of intoxication. The inebriation of animals has been documented anecdotally (Dudley 2004) but has received little scientific attention. There is evidence from around the world of animals experiencing drunkenness as a result of consuming overripe fruit containing yeast (producing ethanol), resulting, unsurprisingly, in inebriation.

Indeed, what may have been drunken behaviour by howler monkeys in Panama's Barro Colorado Island was observed by Dustin Stephens, leading Stephens and Robert Dudley of the University of California, Berkeley, to the preliminary conclusion that preference for and excessive consumption of alcohol by modern humans might accordingly result from pre-existing sensory biases associating ethanol with nutritional reward (Stephens & Dudley 2004). Put simply, the so-called 'drunken monkey hypothesis' suggests that natural selection favoured primates with a heightened sense of smell for psychoactive ethanol, indicative of ripe fruit, who would thus have been more successful in obtaining nutritious fruit!

Early hunter-gatherers had an intimate knowledge of the environment around them and the effects of naturally occurring intoxicants, but the discovery of fermentation may simply have been a happy accident involving overripe fruit. As agriculture took root, however, barley and wheat became plentiful, which in turn provided good substrates for beer or ale.

There's no doubt that people were drinking beer throughout the world in prehistory. As Pete Brown says in *Man Walks into a Pub* (2003), 'even elephants eat fermenting berries deliberately to get p\*\*\*\*d and we are much more cleverer than them [sic]'.

Recent chemical analyses of residues in pottery jars from a Neolithic village in northern China revealed evidence of a mixed fermented beverage from as early as 9,000 years ago (McGovern et al. 2004). Clear chemical evidence for brewing in Sumeria at Godin Tepe (in modern-day Iran) comes from fermentation vessels where there were pits in the ground noted by the excavators (Michel et al. 1992). In the *Hymn to Ninkasi* (Civil 1964) by a Sumerian poet (dated to 1800 BC) and found written on a clay tablet is one of the most ancient recipes for brewing beer using pits in the ground:

'You are the one who handles the dough,  
[and] with a big shovel,  
Mixing in a pit, the bappir with sweet aromatics'.

In north-western Europe there is evidence of Neolithic brewing at Balbirnie in Scotland and at Machrie Moor, Arran, where organic residue impregnated in sherds of Grooved Ware pottery were described as 'perhaps the residues of either mead or ale' (Hornsey 2003, 194). Based on the highly decorated, beaker-shaped pottery vessels characteristic of the Bronze Age Beaker Culture, it has even been suggested that Beaker people traded in some sort of alcoholic beverage and that the beakers may have been high-status drinking vessels.

Regarding Ireland, the first known reference to beer is in AD 1 (Griffiths 2007, 11), when Dioscorides (a Greek medical writer) refers to 'kourmi' (a plain beer, probably made from barley), although Nelson (2005, 51, 64) relates this as a reference to Britain. Much later, St Patrick appears with 'the priest Mescan . . . his friend and his brewer'. Perhaps unsurprisingly, Patrick considers his friend and brewer to be 'without evil' ([www.mohurley.blogspot.com/2009/03/from-annals-of-4-masters-st-patrick.html](http://www.mohurley.blogspot.com/2009/03/from-annals-of-4-masters-st-patrick.html), accessed April 2007).

As Zythophile points out in his post 'St. Brigid and the Bathwater' in the blog 'Zythophile' (<http://zythophile.wordpress.com/2008/01/22/st-brigid-and-the-bathwater/>, accessed March 2008), ale was an important part of Irish society. He notes that the *Crith Gablach* (a seventh-century legal poem), for example, declared that the 'seven occupations in the law of a king' were:

'Sunday, at ale drinking, for he is not a lawful flath [lord] who does not distribute ale every Sunday; Monday, at legislation, for the government of the tribe; Tuesday, at fidchell [a popular early medieval board game]; Wednesday, seeing greyhounds coursing; Thursday, at the pleasures of love; Friday, at horse-racing; Saturday, at judgment.'

Sundays and Tuesdays must have been particularly taxing.

The following jumped out and we were surprised we hadn't noticed it:

'A record of a fire at the monastery of Clonard . . . around AD 787 speaks of grain stored in ballenio, literally "in a bath", which seems to mean the grain being soaked as part of the initial processes of malting'.

Zythophile suggests that what St Brigid drew off may have been water from the ballenium where the grain was steeping in the first stage of malt-making.

## **The great mystery of prehistoric brewing**

In prehistoric times until the late Iron Age, metallurgy was limited to small hand tools and high-status items. Throughout prehistoric Europe one of the main challenges for the brewer (in the absence of suitable metal containers) was the heating of large volumes of water to make a wort (see below). Indeed, given that brewing until the modern era was a home-based industry, sufficiently large metal mash tuns (watertight containers) were uneconomical. So how could people brew without the application of direct heat? Hot rocks are the most logical means.

A simple web search gave us some quick answers. Today the only commercial hot-rock brewery in the world (as far as we know) is Boscos Brewery in Nashville. Here the master brewer uses Colorado Pink Granite to heat the mash. The stones are heated in a brick oven and added to the mash (see below) in a process known as decoction, whereby the temperature is gradually raised over a period of time. Further evidence of hot-rock brewing comes from Finland, where *Sahti*, a vernacular, unhopped ale, is still served at rural feasts ([www.brewingtechniques.com/library/styles/6\\_4style.html](http://www.brewingtechniques.com/library/styles/6_4style.html), accessed April 2007). Again the ale is prepared by immersing hot rocks into a wooden mash tun; the resulting wort is then flavoured by filtering it through juniper branches. The brewing of *Sahti* has been traced back over 500 years. Although *Sahti* is specifically linked to Finland, ales using similar brewing methods were brewed throughout the Baltic States and as far south as Ossetia in modern Georgia.

With so many comparative ancient and contemporary processes involving pits in the ground or wooden troughs and hot-rock brewing technology, we reached the not-unreasonable conclusion that *fulachta fiadh* would make ideal micro-breweries.

## **So how do you brew a prehistoric beer?**

Beer at its simplest requires the following ingredients: milled, malted grain (preferably barley but wheat will do), copious amounts of reasonably clean water, yeast to aid fermentation and herbal flavouring. The latter ingredient is not an essential component in brewing but bitter-tasting dried leaves were traditionally added to counter the sweetness of the brew and increase palatability. At the processing stage the conditions and equipment required are a preparation area for malting (an aired, indoor floor space where the saturated grain can be dried and lightly roasted), firewood for heating stones, a large, watertight wooden container or mash tun, a paddle for stirring and some earthenware fermentation vessels (Illus. 3).

The fundamentals of brewing necessitate converting the starch in the malted grains into soluble sugars. This is achieved by adding the milled, malted grain to a container of hot water heated to a temperature of approximately 67°C. This mix is then mashed or agitated with a paddle, producing a glucose-rich syrupy solution known as a wort. The wort is then transferred into storage vessels, where the yeast and flavourings are added, and allowed to stand for several days, during which fermentation will naturally occur. During this stage the brew begins to fizz and froth as the active yeast devours the sugars and excretes alcohol. When the fizzing subsides, the fermentation is complete and the end product is unhopped ale.

Hot-rock technology has been used by primitive communities throughout the world and involves heating fist-sized stones in a fire, removing them with a tongs or a fork and



*Illus. 3—Basic equipment; note the Bronze Age replica urn-style pottery vessels (Moore Group).*

then dropping them into a water vessel. In a brewing context this process became known in Germany as '*stein beer*' (stone beer). Indeed, up until recently Rauchenfels Brewery in Marktoberdorf, Bavaria, revived this tradition by using heated graywacke to make their own distinctive beer. This dark sandstone resists shattering under the stress of superheating and is quick to cool—ideal for brewing. A beer reviewer had this to say about their product:

'The use of stones imparts wonderfully smoky, toffeeish notes to Steinbrau. When the hot rocks are added to the brew kettle (which is made from metal these days), some of the malt sugars will be caramelized right onto the stone surface. The stones, heated in a beechwood fire, will impart their own smokiness to the beer.'

Our first brewing experiment was carried out at Billy's home in Headford, Co. Galway, in August 2007. In an effort to make the experiment authentic, the equipment had to be basic. For the mash tun we used an old, leaky, wooden cattle trough that measured 1.7 m in length, 0.7 m in width and 0.65 m in depth (roughly consistent with the average trough dimensions from excavated *fulachta fiadh*). To make the trough watertight the seams were



*Illus. 4—Heating water in the trough with fired rocks in Billy Quinn's backyard brewery (Moore Group).*

caulked with moss, a technique used by Bronze Age boat-builders. The trough was then lowered into a ready-made pit and the edges backfilled. Water was then added. Despite some initial leakage, the water in the trough eventually reached a natural level by simply flooding the immediate area. When filled to a depth of 0.55 m, the trough held 350 l.

In choosing the stones for heating we consciously avoided limestone, as most *fulachta fiadh* are made up of non-limestone material. As O'Kelly (1954, 122) observed, heated limestone on contact with water turns to calcium hydroxide, known as 'milk of lime', and is dangerous to ingest. Interestingly, during excavations at Dún Aenghus on the Aran Islands, which geologically is a natural extension of the Burren, a trough was discovered with burnt granite cobbles scattered roundabout (Cotter 1993, 13). Given the lack of granite on the island, these ancient people obviously went to a lot of trouble to source this stone, either by breaking up glacial erratics or by travelling by boat to south Connemara. For the purposes of our experiment we used a mix of granite and sandstone from Clonbur, Co. Galway.

For our Bronze Age brewer, stage one in the process after harvesting and winnowing the barley crop would have involved artificially promoting growth by placing the grain in a

textile bag or perforated leather container within a stream, allowing the grains to saturate and swell. This would result in the growth of a sprout or ‘acrosipire’, visible as a rootlet at the base of the grain. At this point the grain is stunted by drying and rolling the grain in hot stones to make a starch-rich, roasted malted barley. The malt is then ready for grinding. In prehistoric times this would have been done with a saddle or rotary quern (grain that has been malted is far more suitable for grinding than unmalted grain, which would still have a water content). Our malted barley (50 kg) was provided by Aidan Murphy, a master brewer with the Galway Hooker Brewing Company. The barley arrived unmilled, and for reasons of convenience and expediency we crushed it using an electrical food-processor. Aidan also supplied us with wet yeast from his brewery. If time had permitted we could have made a simple yeast by kneading a hole in some dough, adding water and leaving it exposed, resulting in the formation of a yeast cake. Yeast is notoriously volatile, however, and we were content to use a known species.

These ancient ‘wild’ beers would have been spontaneously fermented by particular combinations of local wild yeasts and micro-organisms, as well as local plant and herb flavourings. In all likelihood they may have been somewhat tart, sour and acidic in taste, more like the Lambic beers of Belgium or contemporary Flanders red brown ales (Sparrow 2005, 5).

Echoing the role of airborne yeast, the Norse sagas have it that Odin (the chief god in Norse paganism) disguised himself as an eagle and spilled the secret of beer from the sky ([www.beerhunter.com/documents/19133-000103.html](http://www.beerhunter.com/documents/19133-000103.html), accessed April 2007). Furthermore, in Scandinavia and the Orkneys there is a tradition that early brewers realised that by reusing a stick with which they had stirred previous brews they could activate fermentation in subsequent worts; such sticks thus became valued items, and it was not uncommon for them to be willed from one generation to the next. One can imagine that



*Illus. 5—Mashing the malted barley through a wicker basket (Moore Group).*



*Clockwise from top left:*

*Illus. 6—Adding occasional heated stones while stirring the wort (Moore Group).*

*Illus. 7—The finished wort and spent grain (Moore Group).*

*Illus. 8—Decanting the wort into fermentation vessels (Moore Group).*



in prehistoric times these 'wands' impregnated with living yeast cells would have been invested with a spiritual potency.

To begin brewing our prehistoric beer, stones were heated in a wood fire for roughly two hours until superheated before being transferred into the water trough (Illus. 4). After 15–20 minutes we achieved our optimum temperature of 60–70°C. This temperature can be identified by observing the surface of the water. As the water heats it becomes thinner and gently steams, becoming glassy and mirror-still. The ideal temperature is when the reflection is clearest. At this point we half-submerged a wicker basket in the trough and began adding our barley and stirring it vigorously (Illus. 5). Over a period of 45 minutes, maintaining a fairly constant temperature with the addition of occasional heated stones, our water transformed into a sweet-smelling, syrupy wort (Illus. 6 & 7). Even at this stage the nutritional value of the beverage was obvious. If we had decided to add milk, the resultant concoction would be similar to modern-day Horlicks or could have been served as gruel.

After completing the conversion of starches to sugar, ascertained by tasting the wort, we brought the mixture to a boil and then decanted it into fermentation vessels (Illus. 8). We used plastic containers with a total capacity of 75 l. In later experiments we used two Bronze Age replica urn-style pottery vessels, each with a capacity of 30 l. The containers were then cooled in a bath of cold water before we added 350 ml of wet yeast. To counter the sweetness of the wort and lend the beer a more recognisable bitter taste, we added seasonal flavourings sourced near Billy's house. These included sprigs of bog myrtle, juniper berries and yarrow, wrapped in muslin and suspended in the wort. Within eight to nine hours after cooling, the wort audibly began to bubble. Fermentation took place over the course of a week before the beer was ready for bottling. The end result was a relatively clear, copper-coloured brew (Illus. 9), with a sharp yet sweet taste. The hot rocks had imparted a slightly smoky caramelised flavour, making it eminently drinkable. Friends and family likened it to wheat beer and compared it favourably to home-kit brews.

Our beer could best be described as a gruit ale, an old-fashioned herb mixture used for bittering and flavouring beer, popular before the extensive use of hops.

We discovered that the process of brewing beer in a *fulacht fiadh* using hot-rock technology was entirely feasible. The production took only a few hours, followed by a week for fermentation. Three hundred litres of water was transformed into a very palatable 110 l of ale with minimal effort. The spent grain provided the ingredients for a dozen malt loaves (Illus. 10) and the rest was used as cattle fodder. Other than the shattered stone and the remains of the fire, there was little detritus.

## Conclusion

So, what is the evidence for brewing? First, the experiment worked. Fermentation caused by wind-blown yeast even occurred in the leftover mash in the trough within a few hours. Secondly, a number of quern-stones have been found in association with *fulachta fiadh* (e.g. Hegarty 2005), indicating that grain-processing was taking place nearby. Furthermore, the fact that hot-rock brewing was carried out to an industrial level until the early part of the last century testifies to the efficiency of the process.

But what of the physical evidence? Should not excavated *fulachta fiadh* contain archaeobotanical remains indicative of malted barley? It is our contention that the spent



*Illus. 9—The authors enjoying the fruits (Moore Group).*

*Illus. 10—A malt loaf being made from the spent grain (Moore Group).*



grain, even after mashing, had its uses and would not have been dumped; rather it was treated as a valuable resource and may have been recycled to make bread or, as brewers do to the present day, given to animals as fodder.

The grain normally found on archaeological sites is usually charred and survives owing to its carbonised state, which makes it less susceptible to decay. Charred grain has no nutritional value and certainly has no place in brewing as it would spoil a beer mash.

Ordinary malted grain after mashing is reduced to a non-starchy material consisting of a cellulose pulp comprising the hull and pericarp (the tissue around the seeds). This pulp still contains sugar residues and, given its de-natured state and its high water content, is more vulnerable to microbiological decay if left exposed to the elements. In the archaeological record, given the time-frame, this evidence would be entirely ephemeral. Indeed, our own experience in dumping spent grain in Billy's backyard, although hardly scientific, was telling—within a matter of three months the dumped grain (approximately 125 kg) had disappeared and it was practically impossible to determine the exact dumping spot. The spent grain was eaten by animals, birds or vermin or simply decayed.

In conclusion, beer at its most basic is fermented liquid bread and is a highly nutritious beverage. Our ancestors would have consumed ale on a daily basis as a healthy, uncontaminated, comfort drink. But this does not preclude the fact that in the long Bronze Age evenings and nights, family groups likely sat around a blazing fire telling tales, interacting socially and enjoying the sense of well-being and genial companionship that ale enhances. We suggest that the *fulacht fiadh* was possibly multifunctional, the kitchen sink of the Bronze Age, with many conceivable uses. For us, however, a primary use seems clear: these sites were Bronze Age micro-breweries.

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