BREWERY HISTORY

Brewery History (2019) **178**, 49-61

SCANDINAVIAN YEAST RINGS: THE CURIOUS CASE OF THE TWISTED TORUS

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Introduction

Likely one of the first organisms domesticated by man, yeast has been kept at the ready by using many different storage techniques. One of the oldest such practices were the Ancient Egyptian yeast breads: delicately baked little loaves which, when crumbled into sweet liquid, would create a new yeast starter - for beer, or to leaven bread. As for most of man and yeast's history, bread yeast and beer yeast were identical. The user often had a clear preference, either for keeping the top yeast (barm) or the bottom yeast (lees), but this preference seems more random than geographic. For example, in Scandinavia, one farmer would prefer the top, his neighbor the bottom and some would save both - and the yeast would be used for anything that needed fermentation.[1]

Yeast preservation in Scandinavia

There are many different, and some quite unusual, methods for keeping yeast in Scandinavian. Like the Ancient Egyptians, one method mixed yeast with flour which was then kneaded it into a flat cracker, with or without a 'donut' hole. The crackers would be dried, and could be stored, strung along the length of a hanging stick.[2] In the more recent past, liquid yeast could be stored in bottles; often submerged in cold water such as in a well, which would act like a natural refrigerator.[3]

In the words of Lars Garshol:

> Brewers usually preferred their yeast fresh, and if they didn't have any, would borrow from their neighbours. This was common, and taking payment for yeast was unheard of. Some say well dried yeast could last for more than a year, and, if necessary, it could be revived with sugar and water, then dried again. Given how hard it is to keep yeast alive and working well, and how it seems to depend on a community of neighbours all helping one another it's not very surprising that kveik has disappeared in most places.[4]

Yeast logs and wreaths

An intriguing piece of Norse brewing equipment, and unique to Scandinavia, is the yeast log. From a simple piece of rough-barked birch log with a hole at the top to attach a rope,[5] to elaborately drilled and carved sculptural objects, yeast logs are facinating items. When Michael Jackson visited Norway he was mesmerized by the 'magic sticks' he encountered, functional yeast logs kept as family heirlooms long after commercial yeast became available.[6] The log would be used by lowering it into the fermentation vat to catch the yeast that would form a foam on top. Then it would be pulled out, rolled in flour, dried for a few minutes, dipped again and this process repeated a few more times. When properly covered in yeasty paste, it would be hung to dry.[7]

Another traditional piece of brewing equipment, most often found in Sweden and Denmark, is the yeast wreath. Yeast sludge would be dried on wreaths of straw[8] or braided bark,[9] as well as wreaths of small pieces of whittled wood. For this type of storage, the sludge could be dried quickly with the help of sterile hot ashes which would absorb excess water, the heat would help expedite drying, and the alkaline environment it creates would be antimicrobial.[10] When Sir Arthur Mitchell toured some of the western islands of Scotland

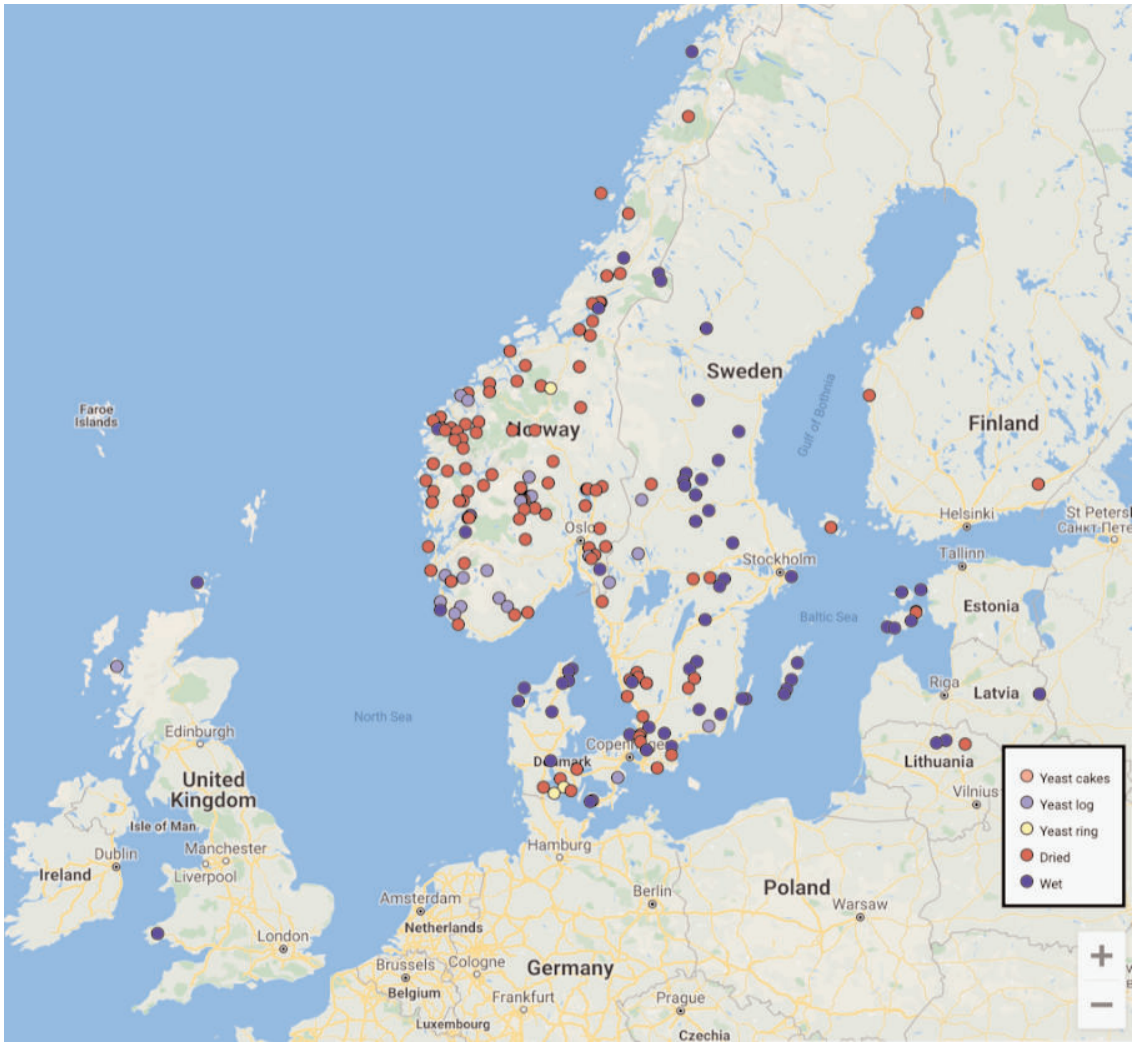

Figure 1. Distribution of yeast storage methods in Scandinavia and the surrounding areas. Graphic by Lars Marius Garshol (reprinted with permission), based on data gathered from archived questionnaires on brewing.

in 1768 he took note of how the natives of the Isle of Skye revived their yeast preserved on a wreath:

> The natives preserve their yeast in the following manner: They cut a rod of oak four or five inches in circumference, twist it round like a w[r]ythe, and steep it in fresh yeast for some hours, then hang it up and dry it. And whenever they need yeast they take down the twisted rod, and put it into a covered vessel amongst two or three pints of luke-warm wort, so in two hours thereafter they have fresh barm fit for immediate use.[11]

The two curious artifacts of Schloss Ambras

The medieval castle of Ambras on the outskirts of Innsbruck, Austria houses a number of unusual 16th century artifacts as part of its collection of rarities, including two wreaths assembled of many identical wooden pieces. While this description may sound familiar to the farmhouse brewer, especially after reading the introduction, such was not the case when the artifacts entered the collection, and both are catalogued as 'use unknown.' The wreaths are remarkably similar in design

Figure 2. A yeast log carved at the bottom with the date 1621 from Telemark, Norway NF.1928-0442
Photo: Norsk Folkemuseum CC BY-SA 4.0 https://digitaltmuseum.no/011023159380/kveikal

and construction to traditional Scandinavian yeast rings which raises the question: why are the artifacts there and what could have been their contemporary use?

The two wreaths are part of the 'Kunst- und Wunderkammer' collection - in English the 'Chamber of Art and Wonders' - a collection of rarities collected by Archduke Ferdinand II (1529-1595), Prince of Tyrol and Further Austria. He opened his court in Innsbruck in 1567 and had the medieval castle Schloss Ambras retrofitted into a Renaissance style residence. He specifically added an *Unterschloss* (lower castle) - built between 1572-1583 - to house his collections, making Schloss Ambras the oldest museum in the world still in existence. It is also the only Renaissance *Kunstkammer* of its kind still to be in its original location.[12]

This unique collection consists of armor, weapons, portraits, natural objects, rarities, 'wonders of natura', more recent scientific and musical instruments, precious items, etc., which in later times would be classified as *artificia*, *naturalia*, *scientifica*, *exotica* and *mirabilia*. The two artifacts were likely thought to fit this profile because they are visually intriguing, even for those unfamiliar with its function. Ferdinand II was the first to present his collection according to a systematic concept, within a specially constructed dedicated building. A variety of unusual artifacts such as glass figurines, coral objects, mechanical toys and clocks are on display and open to the public to this day, administered by the KHM-Museumverbands as part of the Kunsthistorisches Museum of Vienna.[13]

The extant artifacts

The artifacts in question are two wooden wreaths (*Kranz*), now located in the *Unterschloss Kunstkammer*, cabinet 10. They are both made of wood (*Holz*), without specifying the species of tree, how it was worked or if the wood was treated in any way. One has a diameter of 24 cm (9.4 inches), and the other of 27 cm (10.6 inches). The wreaths are assembled by cross-wise interconnected rectangular slotted links of wood (*kreuzweise ineinandergesteckte Blättchen*) and the resulting chain is doubled back and connected beginning to end to form a circle; a torus or a wreath.[14] Both artifacts are mentioned as part of the inventory of 1596, and were described as follows:

Ain cranz, von holz gemacht.
Ain selczames holz, so creizweis under einander gewachsen. (fol.472')
[A wreath, made of wood.
A rare [unusual] wood[en object], inserted cross-wise under each other.]

Figure 3. Yeast devices as found in museum collections (data from 198 individual artifacts). The objects are plotted either at their original location, or when unknown, at the location of the current collection. In general, yeast logs are found mostly in Norway, trivets mostly in Central Europe, and yeast rings in southern Scandinavia which consists of Norway, Sweden and Denmark.
Graphic by Susan Verberg (generated by google maps).

There is no other providence available for the artifacts, apart from them being stored in cabinet 18 of the *Kunstkammer* labeled as '*darinnen allerlei holzwerch*' (in there all sorts of woodwork).[15]

The design of the wreaths follows the then new-found interest in celebrating geometry as illustrated by the German graphic artist Johannes Lencker in his woodcut of 1567, possibly the earliest printed image of a twisted torus.[16] If the number of units is more or less than a multiple of three it will display a natural twist, e.g. 75 pieces gives an untwisted circle, while 74 and 76 links will give a twisted circle, like a mobius ring. Studying the museum's photographs shows the 24cm wreath to be an untwisted torus, and the 27cm wreath a twisted torus.

The rings are mentioned by George Hart, a recently retired research professor in the engineering school at

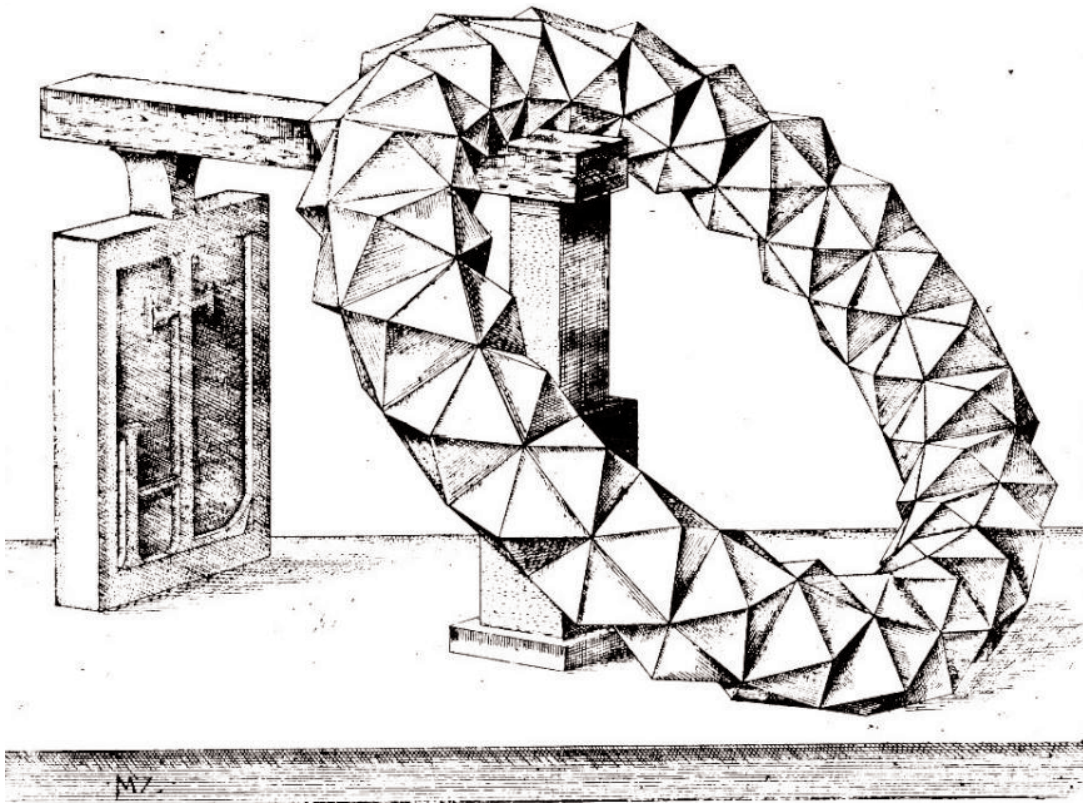

Figure 4. Woodcut of a twisted torus by Johannes Lencker of 1567. From (public domain): https://books.google.com/books?id=exMOAAAAQAAJ&dq=Perspectiva+Literaria&source=gbs_navlinks_s

Stony Brook University turned mathematical sculptor/designer. He was an early enthusiast of Rapid Prototyping otherwise known as 3D printing, and on his web page, Twisted Torus,[17] he states that he does not know what they are, but goes on to speculate:

> Was it just a visual puzzle, challenging the viewer to think about how it was assembled? Was it a "masterpiece" displayed to prove the skill of the creator? Was it functional, perhaps a trivet, or laurel to be worn on the head like a *mazzocchio*?[18] Were the parts leftover material in some workshop, perhaps a wooden furniture or carriage maker, which someone casually put together into a chain?[19]

Bret Rothstein, a philosopher interested in intellectual puzzles, wrote a couple of articles about the curious wooden objects. He argues the wreaths were intended to be visually and intellectual difficult. Rothstein theorizes that as interest in the tradition of making objects to confuse people increased around the same time the wreaths entered the Ambras collection, they could be curiosity puzzles too. He thinks that, unlike most manufactured objects in the collection, the wreaths do not actually depict anything. They are what they are - wooden pieces that interlock in a seemingly impossible way. And then goes on to say:

> However charming one may find the helical tori, they simply cannot match that sort of craftsmanship. Though their configurations are elegant as well as beautiful, their components are rough, to put it mildly: gouge marks and tearouts mark virtually every piece. Furthermore, those pieces are not really works of art in their own right, but rather seem more like mortise pieces.[20]

If the wreaths are no more than practical tools, then what could they have been used for?

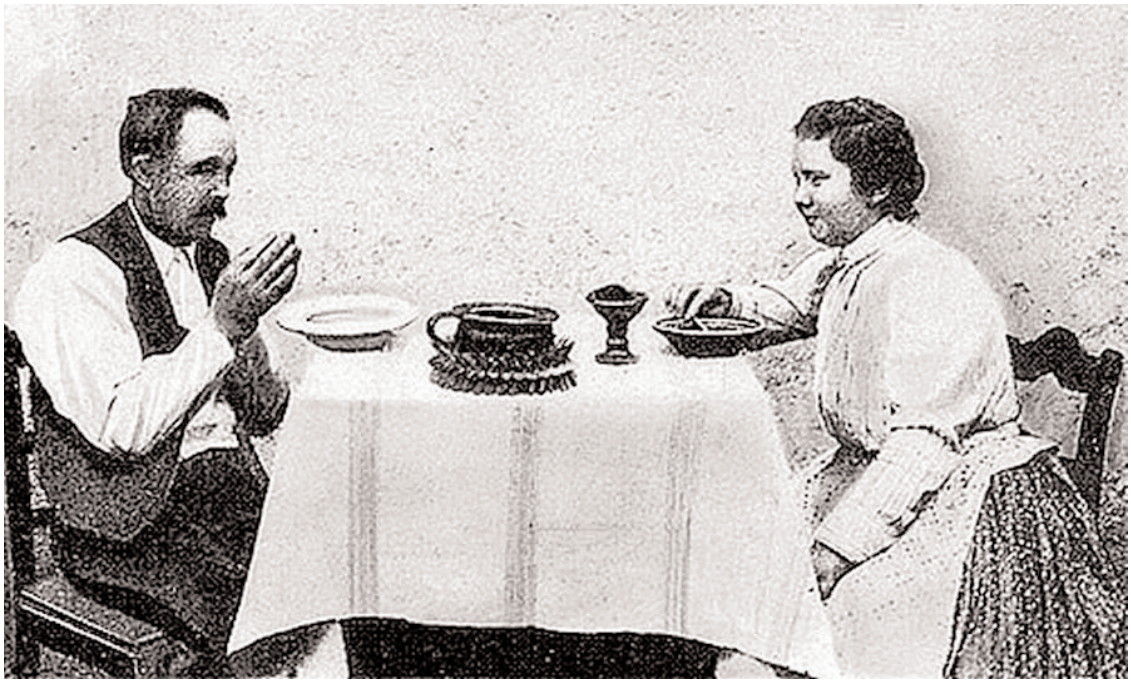

Figure 5. The Hungarian Kutyagerinc - used to keep round-bottom cooking pots from tipping. Photo: Arcanum online (copyright free); https://www.arcanum.hu/hu/online-kiadvanyok/Malonyai-malonyai-dezso-a-magyar-nep-muveszete-1174D5/iii-kotet-a-bala-tonvideki-magyar-pasztornep-muveszete-118077/a-pasztor-muveszkedese-11837F/

The practical use for a torus

Another renaissance collection of all things natural and mechanical was the Munich Kunstkammer of the Duke of Bavaria Albrecht V (1528-1579), a contemporary of Ferdinand II, and was one of the earliest universal collections north of the Alps. Albrecht had started collecting at the beginning of his reign in 1550, but by 1557 his councilors found it necessary to curtail his expenditure. In 1563 construction on a dedicated building began and even though construction continued until at least 1578, the collections were already on display by the end of the 1560s.[21] The Munich *Kunstkammer* resembles Ambras's *Kunstkammer* - and in 1598 the collection included an object remarkably similar to the Ambras Kranz:

389 (286 w) Ein hülzener Pfannenkhnecht, oder schüßelring, von clainem gestückletem holz ineinander verschrengt, umb und umb mit clainen schilten und aufgemahlten des Bayrischen Adels wappen.[22]
[A wood pot helper, or dish ring, of small slotted wood [pieces] combined together, alternating with small shields decorated with the royal arms of Bayern.]

This description from the 1598 inventory indicates that the torus was identified as a pot helper, or dish ring - basically, a trivet.

The torus as a trivet

From the 19th century onwards, it is fairly easy to find examples of wood wreath trivets, both in Scandinavian, and Hungarian cultures. The digital collections of the Swedish and Danish museums in particular list dozens of 'pannring' objects collected in the late 19th to the middle of the 20th century.[23] The same is true for Hungarian wood wreath trivets, there called cauldron wreaths - the oldest object is dated to 1860.[24] But were they not used before then or is it the case that they were simply not collected and catalogued? It looks like, unfortunately, the latter. The concept of ethnography, the systematic study of people and culture, had only

recently developed. Universities and private collectors would collect data and objects, most often from strange and foreign lands and peoples. But not until the industrial revolution was it realized by governments and universities alike that rural life was quickly fading away, replaced by modern conveniences like refrigeration and dry-goods stores. Ethnographers were sent into the field in their own countries to preserve what was left, and this push for the past is still visible in the influx of collection acquisitions in the late nineteenth century.

Hungarian trivets

An interesting example of a wood wreath trivet is the Hungarian kutyagerinc, or dog's spine, as seen on the table in the photograph of the shepherds' couple dining. In the words of Barna Gábor in his book *A pásztorok muvészete* [The art of shepherds, 1989]:

Most shepherd's apartments have chimneys, smoky kitchens and open stoves and multiple families cook on the stove. There is also a kitchen in the Keszthely Empire where six families cook on a stove. The footed cauldrons, pots and pans are designed for this, and the fire is gathered around it. It is natural that the feet and the pot are rusty, which is not a problem; the people consider, the goal with open fire is a more delicious meal and a crunchy roast.

If the soiled dish is put on the beautiful white tablecloth, it will make a mess. For this reason, the shepherd carries a tablecloth surface-saver, which is called a kutyagerinc (dog's spine) because it really resembles the backbone of the dog, but is assembled as a wreath. The kutyagerinc consists of two or three hundred parts intersecting each other, held together by the parts, so that one part is tightly connected to the other.

The good kutyagerinc is that which is cramped as close as possible. You don't need to use glue, an adhesive, for the kutyagerinc, because it holds itself together. If the as semblage of the kutyagerinc is connected with two opposing parts, it can be turned so that the heads of the parts stand in a different direction [it rotates] and the wreath has a different visual. The two ends of the wreath are so cleverly hooked up that the observer can't figure out how the hundreds of pieces are put together so wonderfully! The shepherd does something for pleasure. There is no benefit, it's just nice![25]

Scandinavian trivets

A search of the Scandinavian museum records were checked for the term wood trivets, *pannring*, brings up many results, but also something else - Ulrika Torell, curator of the Nordiska museet, (Nordic Museum) explained the *pannring* as follows:

A so-called yeast ring, or yeast wreath, originally used for brewing beer and malt drinks. The wreath is placed in the fermenter where yeast residues adhered and were allowed to dry into the hollows of the wreath. In this way, a good yeast was preserved for the next brewing. The wreaths were made of wooden sticks or straw. When the homestead brewing needs eventually declined [yeast could now be purchased, as well as beer] the wreaths instead began to be used as trivets for pots and pans and got a new name.[26]

The torus as a yeast ring

As Bret Rothstein, George Hart and even the Schloss Ambras Museum found, much to their surprise, whenever tori are displayed the Scandinavian visitors would immediately identify it as a yeast ring. The yeast ring's identity seems to be deeply ingrained within the Scandinavian mindset, bringing up the question of how old this custom could be. While there exists a Norwegian yeast log carved on the bottom with the date of 1621 (as seen above), this is not the case with yeast rings. It is the same with Hungarian *kutyagerinc*, the museum objects in the Scandinavian collections are mostly dated and/or acquired at the end of the 19th century to the middle of the 20th century. A chance encounter while leafing through the 1555 multi-volume *Historia de Gentibus Septentrionalibus* (A History of the Northern Peoples) by Olaus Magnus provided an intriguing illustration (Fig. 6).

On display: a yeast ring, hanging on a pole outside a drinking establishment, to indicate the brew was successful and ready for consumption. Apparently it was such a normal tool that the use of the ring is not mentioned in the body of the text. The earliest practical descriptions of brewing beer are from the 16th and 17th century, but interestingly, quite often the use of yeast is omitted.[27] The brewers had words for yeast and knew how to treat it - it was not surprising or new.[28] For example, the Danish cook book *Koge Bog* (1616)

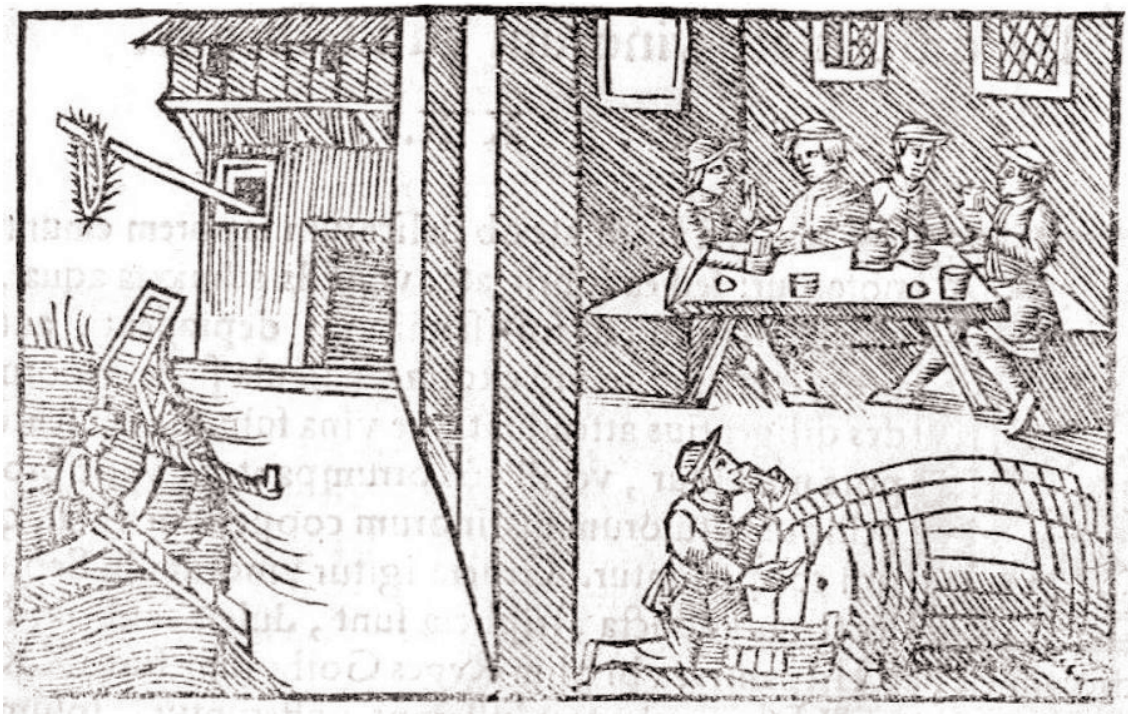

Figure 6. Yeast ring, hanging outside the brewery. The illustration on page 445 is from Olaus Magnus' Historia de Gentibus Septentrionalibus *(1555) and appears here with permission of the Silver Special Collections Department of the Library of the University of Vermont.*

instructs 'When you put the yeast in, then make careful certain that you don't put it on too hot or too cold, but when it is slightly more than lukewarm'.[29] The German brewer Christoph Kobrer (1581) includes a detailed chapter on 'keep[ing] the stuff for brewing'[30] (about preserving and reviving yeast), Olaus Magnus (1555) only mentions to use 'a small quantity of older beer'.[31] Englishman Andrew Boorde (1542) instructs to use nothing but malt and water and to never add anything to beer, except 'yest, barme, or godesgood',[32] three synonyms for yeast. And if one might find it strange to hang a yeast ring out in in the open, keep in mind brewers back then did not know yeast was a creature, only that the sun and an airy breeze would help dry out the sludge more quickly, and a process that wass beneficial. Alternatively, the ring may have just been used and cleaned, then hung out to dry and sterilize in the sun, as medieval dairies are known to have done with their wood equipment. Displaying a yeast tool to indicate a finished product is not something unusual; there is a long tradition in Europe of using yeast related utensils as early inn signs, such as besoms (twiggy sweeping brooms) and ale-poles (the medieval variant of mash paddles).[33]

An article by Nils Nilsson, 'Jästkransen' (Yeast wreaths) is of interest with regards to the practical use of the wreaths. While it is not as detailed as, for instance, Odd Nordland's *Brewing and beer traditions in Norway: the social anthropological background of the brewing industry* (1969) or Gösta Berg's *Jäststock och jästkrans* (Yeast log and yeast wreath - 1949) it does include two interesting photographs. One is of a confirmed *pannring* /trivet and the other is of a yeast ring. It is clear that the yeast ring is slathered in dried yeast, and the trivet has scorched edges from where the hot pots touched the wood. While yeast sludge can be soaked and rinsed away it is impossible to clean scorched wood. Most of the tori collected as trivets do not show any indication of heat scorching, which seems to undermine the assumption that they were used as trivets.

Figure 7. Yeast ring made by author from Swamp Birch (Betula allegheniensis).

In the words of Nils Nilsson:

Another method was to allow the yeast to dry, which gave significantly increased durability. The yeast must then be collected in a suitable way. From ancient towns in central Sweden and Norway it is known that they used to lay down a so-called yeast log or yeast stick in the yeast vessel, a piece of log of rough bark with recessed depths where the yeast mass was gathered into. The stick was then hung to dry and the yeast in the holes could then be preserved for a long time.

The same method has been applied with wreaths, which were usually straw bundles, but which in southern Sweden and Denmark were often composed of small sticks stuck into each other, or yeast rings. The wreaths could either be placed in the vessel like the yeast stick, so that the yeast flowed into the cavities, or "filled" by pouring the yeast over them. Otherwise, the approach was the same.

Wreaths composed of small wooden sticks are quite common in our museum collections. Very few of these have a clear function as yeast rings. In general, they are found as a trivet for saucepans, pots and the like. In this capacity, they still exist, usually manufactured and marketed as home-made supplies. The question is then whether the use of wreaths as a pot holder was developed only after ceasing to store yeast dried in wreaths, in other words a kind of functional retreat as it is called in scientific language. More likely, they have been used for both these purposes and that the connection with the beer yeast was forgotten after the use of brewing beer at home had disappeared.[34]

The general design of a torus

There are many different ways to make a wreath. Some are made simply from tightly twisted straw, others from

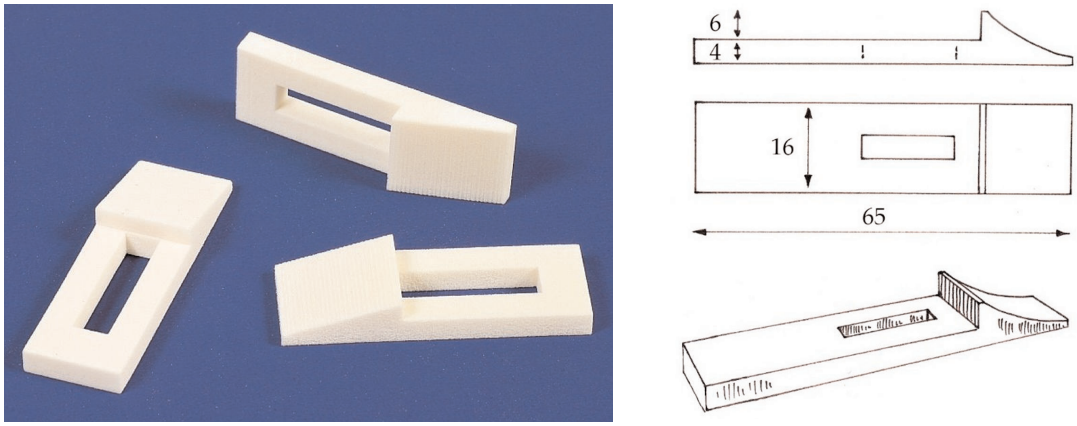

Figure 8. Two versions of a yeast ring link. Photo: George Hart, Stony Brook University; reprinted by permission.

strips of bark expertly braided together. There is one made from sheep's vertebrae, and one that looks suspiciously like the sawn-off top of a mash paddle. Most are made from wood, often birch or beech, and most are made from narrow mortise and tenon pieces which are interlinked. Some have a raised wedge head which keeps the pieces locked in, others have an indentation to the side.[35] Some are square edged, some have rounded edges, and some have a decorative serration at the top, sometimes at the bottom.[36] Most have a square wedge head when seen from the top, and the measurements are often 2 wedge lengths makes up one body length (ratio 2:1), but sometimes shorter, at one and a half to 1, and sometimes much longer. There are Hungarian *kutyagerincs* made from hundreds of individual links, some so ethereal of design it puts to question if anyone would ever attempt to put a heavy cauldron on it.[37] On average, a good ball-park design to match many of the extant artifacts is about 75 pieces, or 25 sets of 3.

Two versions of a yeast ring link are shown in Figure 8. Left is George Hart's interpretation with a short tail and a long mortise slot (ratio width to length of 1:2.5). Right is a more traditional reconstruction (ratio 1:4; suggested measurements in mm) based on illustrations from the Hungarian book on whittling titled *Remeckel a bicksa* [*The knife is great*].[38] In both versions the wedge is square, which is an often repeated design element whether the front is rounded off, serrated or left square. Hart chose to make his mortise longer than the 'tenon' link's width, likely for mobility assumed needed to make the curve of the finished wreath. This feature is not emulated in any of the historic illustrations and is likely unnecessary. The yeast ring constructed as part of this study was based on the historic instructions, with (loosely) fitting mortise openings, and the finished wreath's mobility and curvature visibly matches the extant artifacts.

The link design shown in Figure 9 uses a wedge, a raised arrow head-like point, to create the connection - link 2 is slid through the receiving slot of link 1, and is held in place by the lip of the wedge.[39]

This version seems to be the most common design and is probably indicative of the process: the copious pieces would be carved or whittled by hand, and the wedged end and slot (mortise) would not be problematic to create.

The key to the puzzle

There are several options for the key piece which closes the loop, and could theoretically open it again. It is not quite clear what the benefit of taking it apart would be, apart from perhaps a deep clean before it goes into storage. There are several museum artifacts which are disconnected (often also incomplete); the majority of the artifacts are connected and in one piece. None of the four key versions mentioned below are easy to re-open, and are all prone to damage when done so repeatedly.

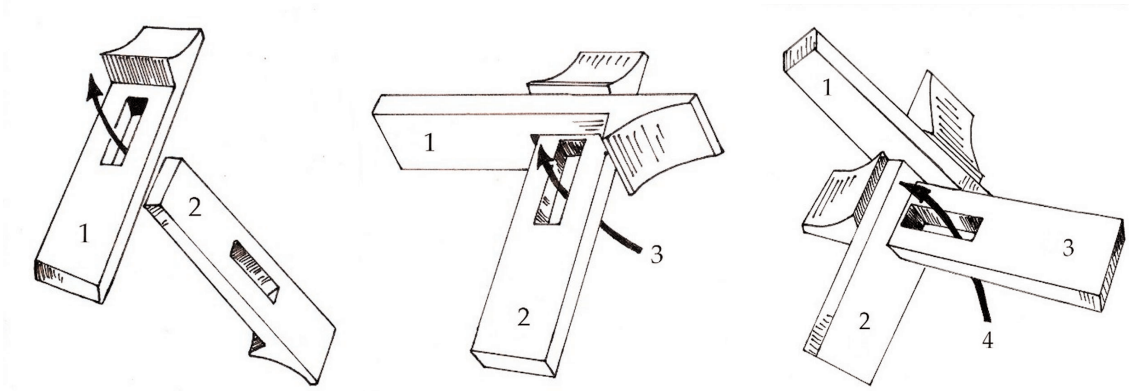

Figure 9.

Step 1 (left - Fig. 10): a piece with a minimally raised wedge, low enough so it can be pushed through the mortise. Optional: widen receiving mortise slightly as well. For cheaters: chisel the wedge completely off, insert, and glue back on. This key piece has to be the very first of the chain.
Step 2 (mid.): the tenon is split lengthwise from the middle of the back to the mortise. Then the two arms are sprung open and pushed over the body of the connecting link, similar to an old-fashioned clothes pin.
Step 3 (right): If the mortise is cut a bit longer than the link width, then it could be possible to remove just enough of the side wall to push through the other link. The part removed could be carefully glued back in to remove all traces of construction.
Step 4: steam or boil the key piece ten to twenty minutes to soften the wood. Compress the wedge in a vice to flatten the wedge and insert through slot. As it cools and dries, it will re-expand somewhat and steaming can be used to expand it further. This is a known technique for making improbable wooden objects.

Conclusion

Taking into account the above we can now speculate on the initial practical function of the tori. For instance, did the twisted torus start out as a trivet which was appropriated by an innovative brewster and the technique was subsequently emulated by fellow brewers? Or maybe the torus started out as a yeast ring but, with the invention of dried yeast in the early 1800s, lost its purpose and that by the time the ethnographers stopped by for a chat and a brew the yeast ring had already mostly devolved into a trivet? If, perhaps the torus started out as a trivet, was it appropriated in the Scandinavian lands as a yeast ring but then reverted back to its original function when it was no longer needed? Or perhaps the use as a trivet, and as a yeast ring, was fairly simultaneous, depending on the needs of the people of a particular region at a specific place in time. All we know for sure is that by the 16th century the wreath design was known to exist, and found used as a yeast wreath (1555), as well as a trivet (1598). Which one was first? Unless

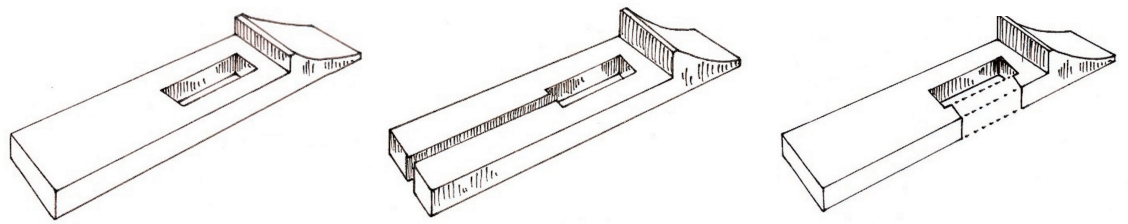

Figure 10. Redrawn by Susan Verberg 2019, based on Loránt 1958, pp.51-55.

someone stumbles over yet another piece of this puzzle - perhaps mentioned in a Viking Saga? or chiseled on a Nordic picture stone? - we might never know for sure.

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18. 'In addition to being featured in many Renaissance portraits by virtue of being the fashion of the day, the Italian cappuccio was of interest because the mazzocchio's shape made it a good subject for the developing art of perspective. The painter Paolo Uccello studied the perspective of the mazzocchio and incorporated it in some of his paintings, including his "Perspective study of a torus", c.1430-1440.' From: https://en.wikipedia.org/wiki/Chaperon_%28head-gear%29#The_cappuccio_in_Renaissance_art

19. Hart, G. (undated) op. cit.

20. Rothstein, B. (undated) *A Mechanical Puzzle from the Renaissance*. p.4.

21. Kaliardos, K.P. (2013) *The Munich Kunstkammer; Art, Nature and the Representation of Knowledge in Courtly Contexts*. Spätmittelalter, Humanismus, Reformation 73. Tübingen: Mohr Siebeck, pp.1-5.

22. Translated by Susan Verberg, 2019; Diemer, P., Bujok, E. and Diemer, D. (eds.) (200) Johann Baptist Fickler. *Das Inventar der Münchner herzoglichen Kunstkammer von 1598*. Editionsband. Transkription der Inventarhandschrift cgm 2133. Munich: Beck. http://publikationen.badw.de/de/038872411.pdf, 65

23. https://digitaltmuseum.se/search/?q=pannring

24. https://monari.vmmuzeum.hu/monaripub/monari.05.01.php?as=939&bm=1&l=1

25. Translated by Susan Verberg 2019; Gábor, B. (1989) *A pásztorok muvészete*. In: HOFER TAMÁS (sorozatszerk.): Hajdú-Bihar megye népmuvészete. Európa Könyvkiadó, Budapest. https://www.arcanum.hu/hu/online-kiadvanyok/Malonyai-malonyai-dezso-a-magyar-nep-muveszete-1174D5/iii-kotet-a-balatonvideki-magyar-pasztornep-muveszete-118077/a-pasztor-muveszkedese-11837F/

26. Translated by Susan Verberg 2019; Torell, U. (2012) Curator of the Nordiska museet (Nordic Museum). https://digitaltmuseum.se/011023413406/pannring

27. Garshol, L.M. (2018) When did people start reusing yeast? Posted 29 April 2018. http://www.garshol.priv.no/blog/390.html

28. Thunæus, H. (1968) *Ölets historia i Sverige I Från äldsta tidre till 1600-talets slut*. p.38: 'Already during the Viking Age, however, it seems to have been understood how to use yeast to brew beer' and quotes several Sagas that mention yeast by name.

29. Garshol, L.M. (2018) op. cit.; *Koge Bog: Indeholdendis et hundrede fornødene stycker etc*., 1616. http://www.notaker.com/onlitxts/kogebog.htm

30. Kobrer (Cobrer), C. (1581) *Gründliche und Nütze Beschreibung der Weinhawer und Bierbrewer-Practick und der ganzen Kellermeister-Kunst*. Burger. https://medievalmeadandbeer.wordpress.com/2018/04/28/the-keeping-of-the-stuff-yeast-for-brewing-by-german-brewer-kobrer-in-1581/

31. Foote, P (ed.) (1998) *Olaus Magnus: A Description of the Northern Peoples 1555*. Vol.III. The Hakluyt Society. pp.641-642; Garshol, L.M. (2018) op. cit.

32. Garshol, L.M. (2018) op. cit.; Boorde, A. (1542) *A Compendious Regiment or A Dyetary of Helth*. https://quod.lib.umich.edu/e/eebo/A16471.0001.001/1:12.2?rgn=div2;view=fulltext ; godesgood, or goddis good: because it comes by the grace of God: 'And wheras berme, otherwise clepid goddis good, w'oute tyme of mynde hath frely be goven or delyir'ed for brede, whete, malte, egges, or other honest rewarde to ye value only of a ferthyng at ye uttermost & noon warned, bicause it cometh of ye grete grace of God.' *Norfolk Archaeology: or Miscellaneous Tracts*, (1859).

33. http://www.schlenkerla.de/biergeschichte/brauerstern/html/ausschankzeichene.html ; 'ale pole doth but signifie that ther ys good ale in the howse / where the alepole stondyth and wyll tell hym that he must goo nere the howse / and there he shall fynde the drynke / & not stond suckynge the alepole in vayne' From *A boke made by Iohn Frith prisoner in the tower of London*. By John Frith. Imprinted at Monster [i.e. Antwerp]: Anno 1533 by me Conrade Willems https://quod.lib.umich.edu/e/eebo/A01268.0001.001

34. Nilsson, N. (1981) *Jästkransen*. Sweden, pp.45-48.

35. Højrup, O. (1964) op. cit. p.42.

36. Bringéus N-A. (2003) *Arbejde og redskaber: Materiell folkkultur på syensk landsbygd före industrialismen*. p.19; https://www.kulturarv.dk/mussam/VisGenstand.action?genstandId=397637; https://osmu.kulturhotell.se/items/show/7159

37. https://monari.vmmuzeum.hu/monaripub/monari.05.01.php?as=939&bm=1&l=1; https://mandadb.hu/tetel/157739/Kutyagerinc

38. Redrawn by Susan Verberg 2019, based on Loránt, F. (1958) *Remekel a bicska*. Budapest: Móra Ferenc Könyvkiadó. https://en.mandadb.hu/tetel/249908/Remekel_a_bicska Licence CC BY-NC-ND, pp.51-55

39. ibid.