

WHAT BEER DID ROYAL NAVY SAILORS DRINK IN THE EIGHTEENTH CENTURY? A SPECULATIVE EXPERIMENT

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In Spring 2020 this journal published a paper by Martin Kelly and Andy Plumbly exploring the Navy's troubles with brewing in Portsmouth between 1700-1756 and examining how the naval beer supply operated.¹ It highlighted: numerous complaints about beer quality and price; a major fraud by some contracting brewers; constant tension between the Victualling Board's (VB) need for capital investment and the Admiralty's need for economy; together with the ongoing problem of controlling quality in the summer (when naval activity was at its highest); all within the context of both the enormous quantity of beer required by the Navy at unpredictable intervals and the oddly belated acquisition of in-house brewery facilities at Portsmouth. It included a table setting out comparative costings for Sea beer and Petty Warrant beer.

Beer was the primary beverage consumed by the Royal Navy in the eighteenth century thus it is significant to historians in understanding how the Navy was administered. The archival record for naval victualling in the period is very good: minutes and correspondence of the VB have survived almost complete. However, these records do not specify what methods were actually used in the naval brewhouses. Therefore, one can only speculate about the true nature of the final product. Two naval historians and a brewer set out to shine further light on how Sea beer was brewed, how it might have tasted and thus to challenge some of the historiography. This article reflects the brewery historian's equivalent of experimental archaeology, trying to replicate an eighteenth-century beer.

Initial Specifications

Until the 1670s naval victualling was in a state of almost permanent chaos. For example, in September 1672, the captain of the *Newcastle* reported that he had thrown overboard the contents of 42 butts of beer, it being 'stinking and not fit

for men to drink'.² Nothing really changed until 23 January 1677 when Pepys³ gave notice of King Charles II's intention to establish a new victualling contract. From 1 January 1678, Richard Brett, Samuel Vincent and brewer John Parsons⁴ undertook to provision the King's ships. Every man was to have for his daily allowance ...

one gallon, wine measure, of beer, of such a standard as that every guile of 20 tuns of ironbound beer shall be brewed with 20 quarters of very good malt, as good as generally is to be had at the place where the said beer is brewed, and a sufficient quantity of very good hops, to keep the same for the time of its warranty, and 18 quarters of the like malt, with the like quantity of the like sort of hops to every guile of 20 tuns of woodbound beer for sea, and the harbour beer to be good, sound, wholesome, and of sufficient strength ...⁵

This remained the basis for Sea beer (iron bound), and Harbour or Petty Warrant beer (wood bound) until the beer ration was abolished in 1831.

Problems with weights and measures

The first problem the historian faces in replicating Sea beer arises from the complexity and inconsistency of contemporary weights and measures. The 1678 specification refers to wine measure, tuns, iron/woodbound casks and quarters of malt: such terms require definition. 'One gallon, wine measure', also known as the wine gallon, was smaller than the ale (or beer) gallon. It is further known as the Queen Anne gallon because it was standardised during her reign, in 1707, although it had been in use, with local variations, for centuries. It is still the basis of the US gallon.

Navy beer was purchased in beer gallons but it was issued in wine gallons. This may sound like a way of short-changing the crews, but the use of wine measure was traditional.

	Gallons in a tun	Imperial pints in	Volume (cubic	% of imperial
Wine	252	6.67	231	83%
Ale/beer	216	8.14	282	102%
Imperial	220	8.00	277	100%

Table 1. Summary of the contents of a tun with a comparison of the various measures.

Sailors would have been accustomed to a daily ration of a wine gallon.

In 1824, the imperial gallon replaced all other liquid measures used in Britain and the distinction between ale/beer and wine gallons became irrelevant. Announcement of this change prompted a plaintive comment from the VB:

We annex a Paper containing the result of some experiments which we caused to be made of the different contents of the present Wine and Beer Gallons, and of the new Standard Imperial Gallon when filled with the respective Species of Provisions, by which their Lordships will perceive that the contents of the latter are more than one sixth above those of the present Wine Gallon, and somewhat under those of the Beer Gallon (which latter however is not in use in the Navy).⁶

Although the Navy beer ration remained a gallon a day the volume of an imperial gallon was greater than a wine gallon, increasing the amount required to be provided from roughly 6.6 imperial pints to the 8 we are accustomed to today. The cost of this unexpected increase probably helped prompt the decision to abolish the naval beer ration, in favour of spirits (primarily rum), in January 1831.

The tun was a giant cask, rarely used in practice, and never by the Navy. Butts (half of a tun) or hogsheads (quarter), tended to be used instead. However, tuns were the volume basis of the Navy's beer records. Table 1 summarises the contents of a tun and compares the various measures and illustrates the potential for confusion when interpreting archival papers and particularly when trying to compare measures between historical and modern recipes.

Quarters of malt are no longer used today, although they were universal in the eighteenth century. However, the weight definition has varied over time and increased as the quality of grain and malting improved. As a unit of 8 bushels of 8 gallons each, the quarter was the standard unit of pur-

chase and defined recipe quantities. Nevertheless, the actual weight of a quarter of malt depended on the type of malt, how it was malted and many other factors. Mathias comments that pale malt 'produced the most wort' and confirms that brewers knew 'weight was a good test of quality'.⁷

Casks bound with iron hoops were necessary for beer loaded for sea service to withstand the pressures imposed by loading and unloading with block and tackle and by stacking up to three-deep in the hold. Little work has yet been done on how warship holds were managed, it is long overdue. By contrast, for casks used in harbour only, cheaper wooden hoops could be used. The different types of cask also allowed the different types of beer to be distinguished.

How much hops is 'sufficient'?

A further problem arises when the records conflict on or omit quantities. The 1678 specification fails to clarify the quantity of hops to be used. Distinguished historian John Ehrman tried to provide additional clarity. His muddled version read:

Naval beer was supposed to consist of 18 quarters of malt and 18 of hops for sea beer, and 20 quarters of malt and a sufficient quantity of very good hops, to keep for the time of its warranty, for harbour beer.⁸

Modern brewery practice shows that beer containing an equal quantity of malt and hops would be impossible to brew. However, Ehrman is right to stress the need for sufficient hops to help ensure preservation. The warranty required from its contractors by the VB was six months. This seems an absurdly long period and it did deter contractors, particularly during the summer when commercial brewing tended to be in abeyance, due to inadequate temperature control technology and (we know now) increased airborne bacteria. Inability to source naval demand during

the summer, subject to such stringent warranty, was part of the rationale for the Navy to have its own brewhouses.

Aboard ship, bulky beer absorbed a disproportionate share of scarce hold space, so quantity was restricted. For example, in 1790 beer sufficient for only three weeks comprised two-thirds of the weight of provisions required for the Channel Fleet for one month.⁹ Accordingly, beer tended to be loaded last and used first before resorting to wine or spirits; sailors preferred beer to wine, spirits were largely unavailable in home waters during most of this period.¹⁰ Despite the need to remain drinkable even for this relatively short time in the adverse conditions aboard ship, naval beer lacked the higher level of alcohol needed for its antiseptic and preservative qualities to offset infection likely to have arisen at the brewery.¹¹ The high hop rate alone would have been inadequate to ensure preservation.

Further regulations addressed the need to specify hop quantities. Around 1730, the Commissioners for Victualling issued a set of Instructions to Mr Phillip Caldecott, Clerk of the Navy's principal Brewhouse, the Hartshorn, at East Smithfield near the Thames and close to the main Victualling Office at Tower Hill. These Instructions included the following:

You are to take care that the Beere brewed at her Majesty's Brewhouse be good wholesome warrantable Beere of such standard that every guile of 20 Tunns of Iron Bound Beere shall be brewed with 20 Quarters of very good Malt and Nine pounds of Hopps to each Quarter to keep the same and 18 Quarters of the like Malt with the like Quantity of Hopps to each Quarter to every guile of 20 Tunns of first spending Beere and 12 Quarters of Malt with Ten pounds of Hopps to each Quarter to every 20 Tun of Beere for Petty Warrant Victualling and if any Complaint shall be made either of the Sea or Harbour Beere then the truth of the quantity and quality of the Malt and Hopps that shall have been used in the said Beere shall be evidenced by the Oaths of the Master Brewer and any other Credible Persons.¹²

Beer comparisons – empirical calculation

Sea beer brewed to this specification in a modern brewery would achieve an estimated ABV of 4.3%, equivalent to Sharp's Doom Bar.¹³ However, that comparison is misleading for the early eighteenth century when brewing technology was still relatively primitive. In particular: accurate thermometers necessary to measure the temperature of the mashing liquor were unavailable; the saccharometer/hydrometer necessary to measure consistency of wort gravity had yet to be adopted by brewers; there was no way to cool

fermented beer save by atmospheric evaporation at ambient temperature thus making it susceptible to infection; the mashing process was imperfect; and hop types with their different bittering characteristics had yet to be identified.

To enhance the comparison, we decided to include the beer brewed for the Greenwich Naval Hospital (GNH). Despite the name, Greenwich was really a retirement home for seamen, established in 1692, with its own Brewery from 1718. An in-house brewery was common for institutions such as Oxford Colleges although the other naval hospitals outsourced their beer supply. The GNH beer specifications were:

It is found necessary to brew small Beer once in every Week of the Year to the amount of 220 Barrels. The quality of this Beer, during four of the Summer Months is one quarter of Malt and 10 lbs of Hops to produce five and a half Barrels, & in the other eight months one quarter of Malt and 9 lbs of Hops to produce six Barrels. The Hospital also brews about 300 Barrels of Ale in the course of the Year for issuing to the Pensioners on Festival days & this is the strength of one quarter of Malt and 10 lbs of Hops to produce two Barrels.¹⁴

See the opposite page for the empirical data. The outcomes above are calculated using the higher end of the contemporary ranges for the weight of a quarter of malt. Since we cannot know what weight applied, Table 2 shows the effect on the ABV% of varying the weight assumption, for Sea beer only.

The higher weights seem more likely to have been applicable in view of the VB's insistence on best quality. Even so, the predicted ABV for Sea beer is less than 3%, which felt surprisingly low for beer brewed 'stronger' to keep. The bitterness calculation is unchanged because the quantity of liquid remains the same. The hop rate appears excessive, indicating that the desire for a longer shelf-life over-rode the need to brew a balanced beer. Certainly, modern beers hopped to this level generally have a much higher ABV with a lot more malt body.

Explanation of assumptions used

To explain some of these assumptions and results requires more contemporary context. The malt types available in the eighteenth century were Pale, Amber and Brown. Navy contract records preclude Brown and the majority of contracts do not specify type.¹⁵ Those that do are either (close dried) Amber or Pale. Production of malt would probably have been inconsistent and subject to unintended adulteration by smoke inside the malt kiln.

Predicted contemporary brewing outcomes**General assumptions**

Beer Gallons in a Tun	216
Beer Gallons in a Barrel	36
Convert Beer Gallons to Imperial	101.65%
Pounds of Malt in a Quarter	316 ¹⁶
Pounds in a Kilogram	2.20462
Litres in a Gallon	4.54609

Detailed Calculations	VB	VB	VB	GNH	GNH	GNH
Beer Type	Sea	Channel	Harbour	Summer	Winter	Ale¹⁷
Base Volume						
Tuns	20	20	20			
Barrels (in a week/year)				220	220	300
Volume (Imperial Gallons)	4,391	4,391	4,391	7,920	7,920	10,800
Raw Material Quantities						
Malt (Quarters)	20	18	12	40	36.67	150
Hops (pounds per Quarter)	9	9	10	10	9	10
Pounds of Malt	6,320	5,688	3,792	12,800	11,733	48,000
Pounds of Hops	180	162	120	400	330	1,500
Kilograms of Malt	2,867	2,580	1,720	5,806	5,322	21,772
Kilograms of Hops	82	73	54	181	150	680
Efficiency Assumptions						
Apparent Attenuation	66%	66%	66%	66%	66%	53%
Predicted Results						
Alcohol by Volume % (ABV)	2.79%	2.50%	1.77%	3.7%	3.96%	8.84%
Bitterness (IBUs)	49.05	49.05	54.53	58.0	49.0	100.0
Galls from 1 Quarter of Malt	219.6	244.0	365.9	198.0	216.0	72.0
Malt Weight (Pounds per Quarter)		316	256	220		
ABV		2.79%	2.26%	1.90%		

Table 2. Range of predicted outcomes for Sea Beer from different malt weights

The processing of malt had not progressed in hundreds of years. Furthermore enzymes, which convert starch to sugars, were not discovered until 1833. Consequently, liquor temperatures were close to boiling, or at least too hot for the efficient production by enzymes, of readily fermentable sugars. Extraction was achieved by successive soaking (partly) in hot water, with no accurate method of measuring temperature. The result was incompletely fermented worts with high final gravity. Lengthy cooling periods would have invited lactic infection.¹⁸

The hop rates are high, most likely for their preservative qualities. Such high hop rates would have gone some way to offsetting the low alcohol content of naval beers. The Greenwich Ale is extremely hoppy considering that ales traditionally had no hops or very little. This recipe is similar to October or Audit ales, which were kept for at least a year, in which time the bitterness mellowed significantly. However, Greenwich Ale was a beer for a strictly limited number of special occasions, it would never have gone to sea.

Practical experiment

Following discussion between the three authors on the theoretical aspects offered by the archival record, Steve Gibbs then attempted to replicate Sea beer using the nearest equivalent possible to what is known of mash temperatures, attenuation rates and malt quality of the time. Quantities of malt and hops were scaled appropriately for a brew of 25 litres.

In the eighteenth-century, hops were identified by region, so the type(s) used and their quality may have varied depending on which brewhouse was involved. However, it is known that hops from East Kent were in use by the VB and that most hops were sourced through London. Therefore, Goldings was selected for this brew.

Choice of malt was more problematic. Despite contracts requiring the best malt available, considering the constraints of mass production and attempted economies by contractors working to tight margins, it is likely that malt quality was compromised. The best malt, and the most expensive, was slow dried pale. However, Ellis is complimentary about amber malt: 'Its Colour is pleasant, its Taste agreeable, and its Nature wholesome ...'.¹⁹ Before Wheeler's roasting method of 1816, amber malt was an extended kilning of pale malt. Later nineteenth-century texts report that it was finished by extra heat provided by a late firing with beech faggots.²⁰ It seems likely that all malt, even pale malt, had to be dried over wood (or other aromatic fuels likely to affect taste and colour). However, it

seems that the flavour of wood smoke was considered unpleasant, even if contemporary malt production made it unavoidable.

Very few Navy contracts specify the malt type. Those that do seem to indicate the proportion of amber was at least 10%, so Steve assumed amber malt made up 10% of the grist in his Sea beer. The quantity being expressed in quarters put us in a quandary since, without more detail as to type, no definitive weight equivalent can be calculated. Clearly, less malt would reduce the ABV.

This choice of what may be a reduced amber content is significant. It is important to realise that the nature of amber malt has changed significantly, such that modern amber is quite different from its predecessor. Whereas eighteenth-century amber malt was diastatic, i.e. capable of sustaining a fermentation, modern amber is drum roasted and will sustain very little fermentation.²¹ Accordingly, nowadays amber is used primarily as an adjunct, giving flavour and colour but little additional fermentable sugar. Furthermore, Harrison claims that diastatic amber malt was paler than modern amber, hence it would have been less effective at enhancing colour.²² In part, this colour difference reflects the introduction of drum roasting. In our recipe, therefore, since too much modern amber would have disproportionately coloured the beer, the quantity of amber was reduced.

Navy administrators were concerned with the preservative qualities of their beer. Obviously, this would be affected by the quality of the malt. Combrune published a table of the keeping qualities of progressively dried malts. What he described as white malt (i.e. pale) was deemed to last two weeks; whereas amber malt was good for four months.²³ This difference helps explain the VB's preference for amber although, since amber could be purchased well in advance of intended use, it makes interpreting the amber/pale proportion from the purchasing pattern even more difficult. It is interesting to observe that although the VB was aware of the need for high quality malt to make good beer and, whilst it established its own brewhouses as a means to ensure quality, it always bought in malt.

Sambrook indicates brewers preferred coke-kilned malt since coke gave off little smoke, thus minimising any taint to the beer. Coke, which 'became reasonably easily available from the end of the seventeenth century' also 'gave the maltster increased control over the kilning temperature' enabling 'paler, less caramelised malts'.²⁴ However, Sea Beer most likely retained potentially significant quantities of wood smoked malt well into the period. To mimic this, Steve added a quantity of Weyermann's beech smoked barley malt.

Since the eighteenth-century, yeast has evolved continuously, and individual cultures have been isolated. The yeast used for Sea beer would have consisted of multiple strains, some doubtless giving off-flavours. The experimental recipe brewed by Steve Gibbs used Lallemand's Nottingham Ale Yeast, a clean, neutral English strain, as the main yeast.

Wooden casks, usually made of oak, were the essential containers for almost everything until the introduction of metal kegs etc in the 1920s. Wood can have a major impact on beer flavour but generally ceases to impart flavour after a few uses. Brewers preferred Memel oak which gives less flavour to start with. However, all wood contains micro-organisms and the extreme temperatures aboard ships would have caused oxidation and/or evaporation. Furthermore, unlined Navy casks were frequently filled with salt water once empty to maintain ballast weight aboard ship and probably imperfectly cleaned with boiling water and/or steam on their return to the brewhouse for refilling. The VB was aware of the cleanliness problem and tried to address it. For example, a Commissioner reported in 1759:

I went to South Down and examined the Brewhouses, Coolers, Utensils Casks etc belonging to the Master Brewer and Cooper, and found them perfectly clean and in good order, every cask returned, before it is refilled being first washed then left to air, with the head out after which it is fired and then scalded. ... and in short every precaution seems to have been taken that is possible to prevent the Beer from either stinking or turning sour.²⁵

Despite such periodic inspections, cleanliness of casks remained a big problem. Although the procedure outlined should have been enough to sterilise the casks, it is likely that residues either in the cask or in the beer would have been impregnated with *Brettanomyces*.²⁶

To replicate this additional character, Steve included a White Labs *brettanomyces* strain of yeast. The manufacturer's notes describe what he used as:

Originally isolated from strong English stock beer in the early 20th century, this yeast has low-intensity *Brettanomyces* character and is closely related to *Brettanomyces anomalus*. This strain produces fruity, pineapple-like aroma with an earthy hay-like background aroma and aroma note.

The full details of his chosen recipe follow:

Volume	25.74 litres
Original Gravity	1035.18
Projected Final Gravity	1013.4
Malt: Maris Otter Pale	3.8kg

	Amber Malt	0.26kg
	Beech Smoked Barley	0.45kg
Hops:	Goldings	100gms
Yeast:	Nottingham Ale yeast	11gms
	White Labs WLP 645 ²⁷	35ml
Starting Mash Temperature		80°C

Attenuation exceeded expectation: the Final Gravity was 1011. This increased the ABV marginally, from the anticipated 2.8% to 3.2%. We have no means of knowing the actual ABV of Sea beer, it's a modern concept. We think, however, that the test brew is a close match. Modern beers of this strength can easily have a Final Gravity of less than 1005, reflecting the greater fermentability of modern worts. Indeed, using Nottingham Ale Yeast at modern conventional mash temperatures a beer of this strength would normally attenuate to below 1005. However, the high mash temperature adopted to reflect contemporary practice has left a higher proportion of unfermentable dextrins (complex sugars) which gave our beer at least a little body and fullness.

The finished beer was fined and lightly carbonated prior to storage. These final steps were pragmatic and not intended to be authentic. Evidence of fining in the eighteenth century is inconclusive; isinglass is rarely mentioned in Navy records but it is itemised when costing Greenwich output in 1828.²⁸ Beer clarity was probably impossible in an environment where casks were being continuously disturbed by the rolling of a ship and would have been less necessary when drinking vessels were opaque. Steve felt that carbonation would be a proxy for cask conditioning although, again, it is difficult to predict how or when Sea beer would have been drunk. Both extremes of temperature would have been experienced and both would affect condition. We all know that, for instance, delivery from a warm cask at atmospheric pressure will result in warm flat beer. Through the universal use of wood, *Brettanomyces* was endemic to English cask beer. Its use in our beer was intended to replicate the effect.

Steve's brewing process was hygienic and sterile, therefore immune to the multiple sources of potential infection to which the use of wood and open vessels in the eighteenth-century would have exposed brewers. It is impossible (and unwise) to replicate those conditions.

Brewer's perspective

Steve considers such a low gravity beer lacks the malt body to balance the strong hop and smoke flavours. When first tasted, just after fermentation, the beer was harsh and unpleasant. However, within only a fortnight, the predominant flavours from the amber, smoke and hops had mellowed



Figure 1. Sea Beer 2021, intended as a close approximation to the eighteenth-century original, subject to all the assumptions and uncertainties detailed in the article. (Colour online).

and married greatly. It is fascinating to speculate whether beer that was required so urgently by, for example, Hawke's fleet off Brest in 1759, was supplied within this initial fortnight. It seems the timescale is too tight although it is possible that adverse delivery conditions could have lengthened the period the harsh flavours needed to marry and mellow.

Some of the immediate flavour impact was undoubtedly attributable to the yeast combination. The *Brettanomyces* did give some flavour immediately but the classic Brett flavours will take months to develop. Aboard Navy ships, scarce stowage space and the disproportionate volume of the beer ration generally precluded sufficient being carried for it to remain available for any length of time.

So, if the original beer was sound, it would have provided sailors with a welcome nutritious form of hydration. Obviously, the test brew will last much longer than the original would have done in a coopered cask, it is likely to mellow considerably and the impact of *brettanomyces* will be more pronounced. Of the small batch brewed, about 20 litres have been retained in order to see which flavours actually predominate over what time period.

Tasting

The three authors had an online tasting session on 23 November 2021, tutored by Steve Gibbs. The beer was very pale and clear. Although the smoked malt represented only 10% of the

grist, it seemed to have a disproportionate, initially slightly off-putting, effect on the taste. We agreed it was a decent session beer, with a taste that could easily be acquired.

Steve commented that 1700s malt was likely darker. Although the bulk of the malt used was a modern pale, he thought that the addition of smoked and amber malts would have darkened our beer more. Unfortunately, none of the contemporary malt or yeast is available. Welsh coal, or coke, not wood, might have been used to cure the malt, giving a different type of smoke flavour which we also cannot replicate.

Small beer?

Describing naval beer as ‘small’ is misleadingly derogatory and confusing for the historian. In one sense, naval beer was ‘small’, but not in the sense most people understand the term. Sambrook describes it thus: ‘Ale was usually made from the first two mashings of the same malt, small beer from a third mash’ and she quotes Thomas Tryon (1690) describing the ‘common quality of small beer as ... a very ill sort of drink ... nothing but a dull, heavy, gross phlegm of a tart, sour nature’.²⁹ Sambrook then goes on to refer to ‘common’ and ‘best’ small beer and compounds the confusion further:

... many variants of small beer were not brewed by the private brewer. Beer brewed by the naval victualling yards for sailors was similar to that brewed for workhouses. Both were small beer, made either after strong ale or as small ale with fresh malt.³⁰

These alternatives are very different. Since there are no references in the archival records of the VB to any superior use for the wort from the initial mash(es), the worts must have been combined. Hence, the final combination that led to this small beer contained all the fermentable sugars that could be extracted. Ellis deals with ‘Brewing entire Guile small Beer’ in some detail, indicating it was probably quite common to brew in this way.³¹ Sea beer must have resembled this type of small beer.

Combrune is unusual in treating small beer with respect:

Common small beer is supposed to be ready for use, in winter, from two to six weeks, and in the heat of summer, from one week to three. Its strength is regulated by the different prices of malt and hops; its chief intent is to quench thirst, and its most essential properties are, that in the winter it should be fine, and in the summer sound.

His emphasis is on duration, and he acknowledges the difficulty of brewing good small beer:

The duration of this kind of liquor being short, and there being a necessity of brewing it in every season of the year, dividing it into very small quantities, easily affected in its conveyance by the external heat: generally neglected, and placed in repositories influenced by every change of air, the incidents attending it, and the methods for carrying on the process must be more uncertain, various, and complicated, than those of any other liquor made from malt.³²

As a type of entire small beer, Sea beer would have been affected by all of Combrune’s ‘incidents’. In attempting to produce a staple drink that would be familiar to its clientele, the VB recognised the challenge of brewing it at all, let alone throughout the year, and acknowledged the harshness of the storing and serving environment. Accordingly, good quality raw materials were used, experienced brewers were employed and a high hop rate was adopted to try to ensure preservation for as long as possible.

The Master Brewers – experience and discretion

The specifications outlined were as laid down by the VB to its brewers and contractors. They were sufficient to control the price by defining the input: the quantities of malt and hops; and the output: the quantity of beer. The brewers were deemed to need no more detail. Since the test brew seems to indicate insufficient malt and disproportionate hops, it seems odd that there is no record of any Master Brewer suggesting modifications to the basic recipe. They may have realised that the VB would have regarded any increase to the already significant cost of malt to be prohibitive.

The experience required of Master Brewers is apparent in the recruitment process at the Hartshorn in 1743. Each candidate had to present his brewing CV and they all showed considerable experience not only in practical brewing ‘on the copperside’ but also at managing a brewery. The successful applicant, Gabriel Small, had 20 years brewing experience, with seven or eight years ‘stood at the copperside’.³³ It is also clear that the wages offered by the VB were comparable with commercial brewers in London and capable of attracting the best staff. Thus, when answering a complaint concerning some beer from London, the VB could state:

as to beer supplied from the Hartshorn ... beer raised at the said Brewhouse is made from the best materials and the Brewer is well vers’d in his business and as far as We can learn, very diligent and careful therein.³⁵

Master Brewers with such experience would have needed little guidance. Thus, unfortunately, historians have nothing

to indicate how they ensured consistency of mash temperatures or fermentation times.

Historical perspective

It is rare to find studies of the Royal Navy's victualling arrangements that go into much detail about beer. Macdonald's description is indicative of the general perception:

The official drink of seamen was ... 'small' or weak beer of 2-3% proof ... beer will last in the cask for months ... (but) does go off quite easily in warm weather, which makes it cloudy, sour and vinegary ... brewing was essentially a cool season activity ... using imperfectly cleaned casks could make the beer go sour and acidic in a few days ... the main reason for making beer the official drink was that it attracted lower excise duty.³⁶

Although this piece acknowledges that beer was the official Navy drinks ration in the eighteenth century, until 1831, it gives a misleading impression of what that beer was and why and how it was used. It also helps perpetuate the myth that Navy beer was universally of poor quality. The 'small beer' label has been discussed above. Navy beer was 'small' simply because it was of a lower strength. It left the breweries as 'good, wholesome' beer. Official rates of condemnation were actually astonishingly low.³⁷ As we all know, good quality tends to be accepted and rarely praised, the inference must be that the majority of naval beer was at least adequate.

Appropriate mashing temperatures were little understood and impossible to deliver accurately. Some contemporary beers were brewed with prodigious quantities of malt and retained a high final gravity although they could still boast an ABV of at least 10%.³⁸ Navy beers were intended to last for an adequate period. They were not uncommon in having a high final gravity and relatively low alcohol content at an estimated ABV (not proof) of about 3%. Such beers would have been full-bodied, not 'weak'. Ironically, these process deficiencies helped deliver a beer high in carbohydrate and low in alcohol, a good combination for a thirsty, hungry sailor on arduous duty.

Preservation of all foodstuffs was a big problem. Without refrigeration, eighteenth century breweries relied on ambient temperature to cool their brews within open, louvred facilities. A high hop rate and vigorous boil should have maximised the chances of preservation. However, susceptible to Combrune's 'incidents', Navy beer often does not seem to have kept well for three principal reasons, two of which Macdonald touches on:

1) Summer brewing was a well-known problem. The requirement could only be obviated, and then only partially, by extensive, suitable storage space for keeping beer brewed during the winter and spring to meet the possible needs of the fleet. This the VB requested, continuously and usually largely unsuccessfully. Purpose-built storerooms existed at, for example, the King's Brewhouse at South Down near Plymouth. However, the storehouses there were inadequate to cater for the unexpected needs of an impatient fleet and sited in the full glare of the midday sun. The VB was in an impossible situation: the Admiralty demanded beer in the summer after winter stocks were exhausted. Despite professional misgivings, it was brewed and delivered and it went off and that was deemed the VB's fault. One of the most vocal and worst affected 'customers' was Admiral Hawke off Brest in 1759. Understandably, he was not remotely interested in why his beer was bad. His Secretary made some fatuous suggestions to address the problems but all Hawke wanted was reliable beer.³⁹ This seasonality was such a problem that it appears debatable whether the expense of providing summer beer was justifiable. Even so, the Admiralty persisted with beer regardless (doubtless partly due to the erroneous perception that it helped prevent scurvy), maintaining and improving its supply throughout the long eighteenth century.⁴⁰

2) Casks were also a big issue. There were never enough of them, particularly in time of war, and they were bulky, awkward to handle, porous and susceptible to damage.⁴¹ A common practice, that the VB deplored, was to dismantle (shake) them when empty then return them as loose staves to be reassembled for refilling. Macdonald correctly highlights the impossibility of adequate sterilisation: various techniques were experimented with – largely to no avail. A bewildering variety of articles in hundreds of casks had to be stacked in ships' holds in the right order, made available at the right time, maintained as hygienically as possible in conditions that rapidly became fetid and re-arranged continuously to avoid adversely affecting a ship's stability. As a beer cellar such cramped, hot, smelly, unstable and dangerous spaces were any brewer's nightmare. Even if the beer was still in good condition when taken on board, it was unlikely to stay that way for long.

3) The third reason why beer did not last very long aboard ship was that it was never given the chance. Popular with the sailors, of little commercial value to a purser, liable to go off if kept and (at a gallon a man a day) taking up disproportionate storage space it was drunk first. Ships were routinely stored for extended voyages lasting several months and the Navy Board specified all quantities of foodstuffs a particular ship should load 'except beer, and of that as much as she can conveniently stow'. How long it lasted was determined pri-

marily by how much was carried. Subsequently, the men would have been provided with water for longer-term hydration and wine or spirits for alcoholic intake.

Conclusion

Beer played a key role in supporting the activities of the British Royal Navy throughout and beyond the long eighteenth century. This article has explored Sea beer specifically and has explained in detail what is known of the recipe(s) and explored the multiple difficulties encountered in delivering reliable beer to that specification. It has reported on a surprisingly successful trial brew of Sea beer as similar to the eighteenth-century original as possible. The authors contend that reasonable assumptions have been made about exact weights and measures, mash temperatures, malt and hop types, yeast types, fermentation conditions and finally storage to achieve a fair approximation of eighteenth-century Sea beer. They/we have also tried to address some of the undeservedly poor reputation attached to naval beer. The next stage of this voyage will be to taste this already interesting beer in a few months' time when it has had a chance to mature properly.

References

1. Kelly, M. and Plumbly, A. (2020) 'Brewing for the Royal Navy in Portsmouth 1700-1756', *Brewery History*. 182, pp.23-31.
2. A common description for naval beer at the time. A butt was a large cask, containing 108 gallons, the largest size that could be sensibly handled by a team using block and tackle. 42 butts therefore held 4,536 gallons: some indication of the huge volumes of beer necessarily carried by warships and sometimes wasted.
3. Samuel Pepys, the diarist, who was Secretary to the Admiralty under Charles II and James II
4. Sir John Parsons of the Red Lion Brewery, St. Katherine's (see Pryor, A. (2015) 'The industrialisation of the London brewing trade: Part I', *Brewery History*. 161, p.59).
5. Tanner, J.R. (1903) A Descriptive Catalogue of the Naval Manuscripts in the Pepysian Library, Volume I, NRS Vol 26, pp.151-183 .
6. The National Archives (TNA) ADM 1/3781, pp.234-240, 26 May 1825
7. Mathias, P. (1993) *The Brewing Industry in England 1700-1830*. Aldershot: Gregg Revivals, p.415 has a table of Malt Weights per Bushel varying from 39½ lb for Best Pale Kingston (316 lb per Quarter) to 27½ lb for Norfolk Long Tail Brown (220 lb per Quarter)
8. Ehrman, J. (1952) *The Navy in the War of William III, 1689-1697*. Cambridge: Cambridge University Press, p.146 Note 3 .
9. Morriss, R. (2013) *The foundations of British Maritime Ascendancy – Resources, Logistics and the State 1755-1815*. Cambridge: Cambridge University Press, p.298.
10. Wine was less popular if only because 'stinking water must be drunk with it', Hawke begged 'leave to repeat entreaties for beer', Mackay, R.F. (2019) *The Hawke Papers: A Selection 1743-1771*. NRS Vol. 129, p.264, 12 August 1759.
11. We know that at Weevil, for example, cool wort ran from the cooler into the gyle tun where the fermentation started, then it was transferred to casks for the final fermentation. The casks were kept full. Yeast purged from the bung hole ran down the side into the stillions for collection. Steve considers this is a recipe for infection. Stillions were shallow open stone troughs, see Moore, H. and Philpott, C. (2012) 'Historic brewery excavations at the former Royal Clarence Naval Victualling Yard in Gosport', *Brewery History*. 148 for the Weevil excavation record.
12. TNA ADM 114/35, p.33 – the Regulations are undated. Date range in the Discovery Catalogue is 1723-65.
13. Calculation by Steve Gibbs .
14. TNA ADM 109/41, 16 November 1829, when comparative costings were being prepared.
15. For example, the malt specified in TNA ADM 224/6 (1770s) requires it to be 'well trod and clean screened ... close dried Amber without any mixture of Brown Malt'.
16. Note 320 lb was used for the (later) Greenwich recipes
17. Channel beer was designed for shorter voyages and Harbour beer was also known as Petty Warrant. The distinction between Winter and Summer beer at Greenwich was not replicated by the naval brewhouses
18. Navy brewers experienced frequent problems with infections such as rope and foxing. For example, see ADM 110/10, p.78, 25 September 1728 in relation to Plymouth .
19. Ellis, W. (1736) *The London and Country Brewer*. Tunbridge Wells: J. & J. Fox, p.12.
- ..20. Stopes, H. (1885) *Malt and Malting, an historical, scientific, and practical treatise*. London: F.W. Lyon, p.40.
21. Courtesy of beersmith.com: diastatic power is the ability to break down starches into even simpler fermentable sugars during the mashing process. Without sufficient diastatic enzymes in a mash, sugars will not be properly converted, leaving a partially fermented very sweet beer, with very low alcohol content.
22. Harrison, J. (1991) *Old British Beers and How to Make Them*. London: Durden Park Beer Circle.
23. Combrune, M. (1804) *The Theory and Practice of Brewing*. London: Vernor and Hood, Longman and Rees, Sutherland and Martin, and J. Walker, p.97.
24. Sambrook, P. (1996) *Country House Brewing in England, 1500-1900*. London: Hambledon Press, pp.128-9.
25. Report by Captain Pett to the VB in National Maritime Museum ADM/DP/32, August 1759.
26. Protz, R. (2017) 'Fascinating confrontation with Brett', *What's Brewing*. April, p.6. The name means 'British fungus', a wild yeast

that Protz describes as a 'pesky varmint' although he welcomes the 'unmistakable funky and acidic note of Brett that brewers call 'horse blanket'. Note that the yeast strain used in our experiment might not produce the same flavour effect.

27. White Labs, *Brettanomyces claussenii*.
28. TNA ADM 109/41, 26 November 1829, An Account of the Brewings at Greenwich Hospital during 1828.
29. Sambrook, P. (1996) op. cit., pp.119-20.
30. *ibid.* p.121.
31. Ellis, W. (1736) op. cit., p.29.
32. Combrune, M. (1804) op. cit., p.181.
33. ADM 111/29 dated 7 & 14 October 1743.
34. Mathias, P. (1993) op. cit., pp.32-3.
35. ADM 111/29 dated 7 September 1743 .
36. Macdonald, J.W. (2004) *Feeding Nelson's Navy: The True Story of Food at Sea in the Georgian Era*. London: Chatham Publishing, pp.40-41.

37. Rodger, N.A.M. (1988) *Wooden World*. London: Fontana Press, p.84, the rate quoted for beer is 0.9%.

38. Cornell cites some examples of 'extremely strong sweet beers ... used by the gentry ... as substitutes for brandy', Cornell, M. (2010) *Amber, Gold and Black: The History of Britain's Great Beers*. Stroud: The History Press.

39. Mackay, R.F. (2019) op. cit., p.253 describes the beer as 'so excessively bad that it employs the whole time of the squadron surveying it and throwing it overboard'. P.269 quotes a Victualling Commissioner responding to one such suggestion with 'nor do I believe that all the reboiling in the world would make stinking beer sweet or sour sound'.

40. See Kelly, M. (2019) 'Want of Beer: Supplying Beer to the Fleet in the early Eighteenth Century'. Unpublished MA dissertation, University of Portsmouth.

41. Morriss, R. (2007) 'The Supply of Casks and Staves to the Royal Navy 1770-1815', *Mariner's Mirror*. 93.1, pp.43-50.