One yeast or two? Pure yeast and top fermentation

Part II: Brettanomyces and beyond

Enter the British yeast
Within a short time of its introduction by Emil Christian Hansen in 1883, pure yeast culture was adopted across the world but met with a mixed reception when used for top fermented English ales. Some English brewers were successful with the technique, but others complained of thinness of flavour and lack of condition in beers produced using a single strain. In 1904 the latter group received support from an unexpected and on the face of it an unlikely source, the Director of the laboratory of the New Carlsberg Brewery, Niels Hjelte Claussen (Figure 1). In the April of that year, in a paper delivered to the London Section of the Institute of Brewing entitled: “On a Method for the Application of Hansen’s Pure Yeast System in the Manufacturing of Well-Conditioned English Stock Beers”, Claussen disclosed that he had isolated the organism, “that was responsible both for the condition in these beers and for their flavour”. Claussen disclosed that in his experiments this organism “produces a slow [secondary] fermentation in wort or in beer fermented with ordinary brewer’s yeast” in the course of which “a considerable amount of acid is formed, accompanied by ethereal substances, the taste and flavour of which cannot fail to attract the attention of any connoisseur by their striking resemblance to the flavour of stored English beers”. He noted that the idea of a specific secondary yeast was not new, but the reason why to date it had not been found was because of the assumption that it would be a species of Saccharomyces. He had found that this was not the case. It was a different yeast altogether; a small, ovoid organism with a pointed end, “a non-sporulating budding fungus, belonging to the group Torula”, which he had for the first time isolated from a sample of English stock ale, and which because of its connection with the British brewing industry he had named Brettanomyces. He concluded that “judgments passed against the applicability of Hansen’s pure yeast system to English beer brewing by eminent English brewing chemists were essentially sound” and that “the real truth is that Jørgensen is completely mistaken”.

English brewers who had failed with pure yeast had done so because of the scrupulous measures they had taken to exclude adventitious contamination with Brettanomyces. Some of those who had succeeded had done so because of less than adequate precautions in this matter, or because they only produced ‘running ales’ which received condition due to continued primary fermentation with Saccharomyces. He noted that Jørgensen’s successes had all been achieved with this latter type of beer. True secondary fermentation required for stock ales only occurred after months of storage in cask.

Claussen’s paper can now been seen as decisive in essentially ending what had become something of a sterile argument. In essence he had said nothing new, but what he had done was produce evidence rather than conjecture. He had shown by experiment that two entirely different yeasts were required to produce the unique English stock ale. On the other hand, so long as sufficient fermentable matter remained in the beer when it was run to cask, only one species of yeast was required to make the lighter quickly processed running beers which had been successfully produced both in England and abroad. Morris’s failure even with the latter had been, as Morris suspected, due to the unusually good attenuation of Burton brewed beer.

Why Claussen had seen this so clearly where others had not, is perhaps because he approached the subject without pre-conceived prejudices. Some English brewers had shown considerable confusion between continued primary fermentation and true secondary fermentation; whereas Jørgensen can perhaps be seen as blinded by dogma.

Too late for stock ales
The truth of Claussen’s solution was quickly accepted by the English brewers – the Brewing Trade Review, the official organ of the Brewers’ Society, noting with some glee in its report on Claussen’s paper that “English brewers have not been so stupidly conservative after all”. In the extensive discussion which followed his paper brewers who had obtained success with pure yeast confirmed that this was only obtained with running beers and not stock ales. Even Hansen himself looked favourably on Claussen’s work to judge from the comments he made when giving a lecture at the opening of the new bacteriological laboratories at Heriot-Watt College in 1905. In reality, however, Claussen’s work had little practical effect, for the stock ales which required his Brettanomyces had now all but disappeared from the scene.

William Waters Butler, the scientifically orientated chairman of Mitchells & Butlers, noted in the discussion of Claussen’s paper that only Burton beer was really stock beer and that even in the Burton breweries it had all but been replaced by lighter beers. Certainly, no instance is known of Claussen’s patented process involving production of stock beers by fermentation with Saccharomyces followed by repitching with Brettanomyces, ever being taken up in England. There was, however, at least one attempt further afield. Clausen himself left Denmark to work in the United States for a few years in 1905 and Holger Ludwig Schiönnning, who was an assistant of Hansen’s in the Carlsberg Laboratory, took up his work and made his own isolates of Brettanomyces from English stock ale and Irish stout (Figure 2).

A paper giving the results of his essentially taxonomic study of the organism was read to the Institute of Brewing at the Criterion Restaurant in Piccadilly in October 1908. In it he recorded that the Kalinkin Brewery in St Petersburg had used two yeasts to produce English-style stock beers. Indeed Hans Seyferft of the Russian brewery had already claimed priority over Claussen in a paper published shortly after the latter’s work was made public, in which he announced that he had isolated a “Torula” from English beer in 1889 which produced the typical taste of stock ale.

Another who may have had a priority claim but never aired it was James Wilson Tullo, a Guinness chemist who in a confidential company report of 1899 described the isolation and characteristics of two types of “secondary yeast” from stout which seem to fit the description of what was to become Brettanomyces, but this was not made public.
until over 60 years later. Schöningen himself isolated two different species of Brettanomyces which he described in some detail, noting how “…they carry the fermentation further, being able to multiply and further ferment the sugar residue of the beer, and accordingly as the amount of alcohol and carbonic acid gas thus increases, acids are formed at the same time, which combine with the alcohol to form esters, imparting to the beer the characteristic English taste and aroma”. During the discussion of the paper Hansen was quoted as having said that he was “…forced to the conclusion that under the present conditions of English brewing for the production of stock ales of the present character, a single-cell yeast alone was not sufficient…”. Hansen died in 1909 and Schöningen left in the same year to join the Danish beer taxation service. Work on Brettanomyces at Carlsberg ceased.

Pure yeast and running ales

But if stock ales could not be produced by pure culture, all the evidence now indicated that running ales, made to be drunk within a month after minimal conditioning, could. At least one English brewing scientist acted upon the message and realised the possibilities that running ales, made to be drunk within a month after minimal conditioning, could. At least one English brewing scientist acted upon the message and realised the possibilities. Even then the move was far from being a general one. To this day some local and regional English brewers use an undefined mixed culture with generally good results.

Charringtons, introduced true pure culture using a highly flocculent yeast in the production of a heavily primed draught mild ale. But, it was not until the early 1960s that the UK brewers turned to pure yeast in any numbers as a means of systemising production and increasing product consistency. Even then the move was far from being a general one. To this day some local and regional English brewers use an undefined mixed culture with generally good results.

The reasons for rejection

Why were English brewers so slow to take up pure culture? One answer is that it was an example of English conservative brewing attitudes. The true position is however rather more complex. We have seen how the special character of the true English ales, the stock ales, could in fact not be produced by single pure culture. The confusion caused by this fact and the effect it had upon the otherwise positive attitudes of George Harris Morris and Horace Brown was significant. When pure yeast was first introduced in the 1880s Burton was still the centre of brewing science. That two of its most famous practitioners had failed must have influenced the many country brewers who had not the expertise to tackle the matter themselves. Even when Clausen demonstrated decisively the reason for these failures it had little impact.

As we have noted, by then stock ales sold in such small quantities as to not be worth the bother. Siau’s 1906 paper and the earlier experiences of a handful of other brewers had demonstrated that it was perfectly possible to produce primed running ales using a single strain of yeast, but where was the gain? What was the payback for the investment required and the chance taken? The early years of the 20th century saw a decline in the beer trade in Britain, followed by a World War and economic depression; hardly conditions to inspire innovation in a conservative industry. Based on wide experience of both ale and lager brewing, Herbert Lloyd Hind (Figure 4) in his famous textbook Brewing Science and Practice first published in 1940, considered that “Pure yeast does not appear to be so essential in top fermentation breweries as it has proved to be to maintain regularity of fermentation in lager breweries….In many top fermentation breweries, the same yeast is maintained in use for many years without any of those signs of degeneration or infection that set in much more rapidly with bottom yeast…” This doctrine of if it isn’t broken don’t fix it undoubtedly carried the day amongst British brewers.

Another factor was the difficulty in selecting an appropriate single strain to use. By common consent, because of the higher fermentation temperatures employed, the flavour of ales is generally more reliant upon yeast activity than is the flavour of lagers. Further, the evidence of genetic fingerprinting of modern ale and lager yeasts shows a much greater heterogeneity in the former. This is not surprising when one considers that lager
yeasts originate in a narrow region of Bohemia/Bavaria, whereas ale yeasts have a much more widespread origin and hence gene pool. Selecting a single strain of ale yeast with the required flocculation and attenuation characteristics to yield a beer which also matched the flavour produced from the many diverse yeasts existing in a typical top fermentation brewery culture was thus no easy matter, as brewing technologists discovered in the 1960s.

At least one national ale brewer still uses a ‘pure mixed culture’ derived in the mid 1960s from the then brewery stock culture which combines two separately propagated single strains combined at pitching to ensure the acquired attenuation and characteristic flavour of their product is attained. And, just as Hansen and Jørgensen said would be the case, the proportions of these cultures drift with time requiring frequent replacement of the culture and occasional problems with the beer.

**Brettanomyces today**

So what became of Brettanomyces? The great reforming and combative brewery microbiologist John Lester Shimwell (who wrote under the pen name Brettanomyces for the Brewers’ Journal) reviewed its status in 1940 thus “…at one time an organism indispensable to British breweries for stock-ale production, it has now taken on the role of ‘undesirable ferment’ in running beers by causing frets and ‘wild yeast’ trouble and wreaks its vengeance on the brewing community that once spurned its assistance…the frets pass off in a few weeks, leaving an aromatic vinous flavour, but this, of course, does not suit modern conditions”.

And, as far as British brewers are concerned, so Brettanomyces remains. It has become an increasingly rarely found spoilage organism in beer, causing occasional off-flavours and over conditioning in casks. As Brian Gilliland of Guinness noted in 1961, by which time quickly produced and consumed beers had gained virtual hegemony in the British Isles, “…they grow very slowly… they would not have time to produce significant change in flavour…”.

Brettanomyces has also turned up as an occasional contaminant in soft drinks, weissbier, pilsner, and more frequently in wine. In the latter, attempts have recently been made by some wine writers to have the flavours produced by Brettanomyces – usually described as ‘wet dog/horse blanket’ in this context – to be viewed in a more positive light as something that adds to the complexity of some red wines.

But it is in the production of lactic and gueuze, the special Belgian beers obtained by spontaneous fermentation, that Brettanomyces continues to wield its major influence. The organism was detected in lactic in the 1920s and the extensive studies of Professor Verachtert and his colleagues at the Catholic University of Leuven from the 1970s onward have shown the crucial part played by Brettanomyces in the complex microflora of these beers. After some 6 months, well after the main fermentation is complete, Brettanomyces species start to grow in lactic causing a further slow fermentation and “the appearance of special flavours”. The additional fermentation is possible because Brettanomyces species excrete the enzyme - glucosidase which is not found in brewing strains of Saccharomyces cerevisiae. The enzyme nibles away at the chain ends of residual dextrins releasing free glucose. This activity explains the long observed limited, but significant, extra fermentation of 1-2°Sacch, by Brettanomyces so important for condition in stock beers.

Accompanying this secondary fermentation in lactic, Verachtert detected the production of high levels of acetic and lactic acid and massive amounts of ethyl acetate and ethyl lactate (10-20x flavour threshold) accounting for the estery/ethereal quality of beers associated with Brettanomyces fermentations.

To what extent lactic resembles old English stock ale and porter is a moot point. There is nobody alive today who has ever tasted authentic samples of the latter beers from their heyday. From contemporary descriptions lambics and old stock beers have a vinous, estery, solvent like character in common, but with a pH of around the 3.3 mark, lambic must surely be much more acidic and harsh. Indeed, even in an age when richness of flavour was more common, it is hard to imagine that a beer with all the extreme features of lactic would ever have met with the wide acceptance enjoyed by porter and stock ale in the 18th and 19th centuries. It is significant that the high hop rate in these English beers would have kept bacterial activity in check, to a much greater extent than lambics which use aged hops. The precise species of Brettanomyces isolated from lambic and stock ale also differ and have been reported to produce different levels of flavourosome by-products.

The strains of Brettanomyces that facilitate lactic production arise from the prevailing wild flora present in the brewery. A more controlled entrance is practiced in the Abbaye Notre-Dame d’Orval Brewery for its famous Trappist beer, Orval (Figure 6). This beer is produced by a primary fermentation with a pure strain of Saccharomyces followed by transfer to conditioning tanks and re-pitching with a mixed culture which includes a species of Brettanomyces. The secondary fermentation continues over a period of three weeks at 15°C with further maturation in bottle. Neils Hjelte Clausen would undoubtedly have approved of this method of production.

Indeed there is a case for Orval being the closest extant relative of the deceased English stock ales – it is even dry hopped. An even more ambitious use of pure culture Brettanomyces has recently been introduced by the US craft brewer Arthur Tomme, who’s ‘Cuvee de Tomme’ is an 11% ABV alcohol beer which is fermented over a period of nine months with a strain of Saccharomyces cerevisiae and three Brettanomyces species. We may perhaps see further developments along similar lines in the future as free-thinking brewers search for diversity of flavour in their products. Thus, Brettanomyces, the ‘British Yeast’, may now be spurned in the country which gave it its name, but species of the genus live on in pockets elsewhere where two (or more) yeasts are regarded as better than one in producing beers of unusual character.