What's your barley?

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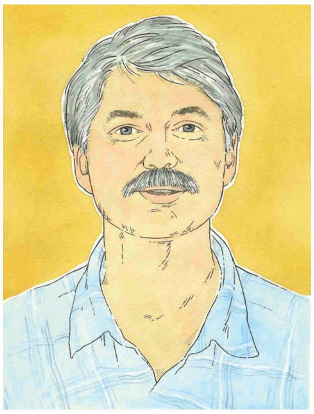

Illustration by Sophie Allsopp

Dr Patrick Hayes argues that barley varieties should not be pre-judged

With all due respect to alternative beer styles and users of adjuncts, barley is the base of beer. According to the Reinheitsgebot, a beer consists of barley, hops, water, and yeast. Of course yeast wasn't "legalised" until it was discovered – just another example of politics preceding science. Discovery continues: 200 years later the taps are open on a deeper understanding of barley genetics. Complementary projects in Europe and the US (ww.barley-cap.org) are characterising thousands of genetic differences in thousands of barley strains. The results of these investigations are already shaking fundamental assumptions about what makes good barley.

Good barley for beer comes from just the right combination of genetics and environment. The best malting barley variety will malt like a rock if it is grown improperly. A feed variety, even if pampered, will tax the maltster's skill and patience. To further complicate things, there is no single configuration of genes that defines a good malting variety. Good barley is very much in the eye of the beholder. Alas, cataracts of tradition and prejudice cloud many a brewing eye.

Tradition has deep roots. Over 10,000 years ago early agriculturalists (and brewers) picked some of the right combinations of genes that balanced starch composition and enzyme activity. Since then winning combinations have been picked with increasing skill, creating today's catalogue barley varieties. Most plant breeders in the major malting barley regions of the world have tended to stick with their own unique gene combinations. These "signatures" represent alternative genetic paths to the same brewing goal. The odds in the breeding game improved with the advent of biotechnology and molecular breeding tools.

Perhaps the most familiar (and controversial) application of these tools is the creation of genetically modified organisms (GMOs). For a host of reasons there are no GMO barley varieties in commercial production.

Suffice it to say that the tools of biotechnology can also be used for capitalising on naturally occurring genetic variation – the differences in DNA sequence between barley varieties that also differ for traits of interest. This information can be used to make decisions regarding conservation of genetic resources, design of breeding programmes and variety maintenance.

Take two examples: growth habit and spike (ear) type. Barley varieties are classified as "winter types" if they are planted in the autumn or "spring types" if they are planted in the spring. "Facultative types" can be planted in any season. Seasonal growth habit is determined – in large part – by vernalization (*Vrn*) genes. Two-row and six-row refer to the number of fertile florets on each axis of the barley spike. Two-row varieties have a single row of seeds on each side of the ear whereas six-rows have three rows of seeds. The principal determinant is the *Vrs1* gene.

Most brewers, maltsters, and knowledgeable consumers will tell you that spring barley is the best malting barley. Winters and facultatives are dismissed as setting the floor price for cheap malt exports. Likewise, some brewers view the prospect of using six-row malt as an act on par with eating human flesh. In other quarters, and significant quarters at that six-row malt is esteemed for the "crisp" flavour it imparts to some incredibly successful American beers.

Set aside these preconceptions about growth habit and ear type and follow the path of genetic analysis. The ancestral form of the *Vrs1* gene leads to two-row. Six-row barleys arose from various mutations in the 900 base pairs of DNA of *Vrs1* that led to loss of gene function. The causal difference between a six-row and a two-row strain could be as simple as substituting one letter of the genetic code. *VrnH2* represses *VrnH1*, preventing the plant from transitioning from a vegetative to a reproductive state until a low temperature requirement is satisfied.

The ancestral form is winter habit; spring types were selected in Northern Europe and Asia based on deletion of the *VrnH2* gene, or deletion of the recognition site of the repressor in *VrnH1*. Facultative types (which lack *VrnH2* but have a competent binding site in *VrnH1*) were favoured in North Africa and the Iberian peninsula. Subsequently, spring types were introduced to the Americas, Oceania, and interbred with local winter and facultative types in Asia. The causal differences between growth habit types are as simple as deletions of sections of the genetic code.

European barley dogma

The origin of brewing traditions in Europe led to the dogma that good (European-style) beer was made from good (European-style) barley which happened to be mostly two-row and spring habit. Undeniably, winters and springs, and two-rows vs. six-rows, do have different quality profiles. But these are not due to differences in *Vrs1*, *VrnH1* or *VrnH2*. Due to the vagaries of history, preference, and chance undesirable quality attributes are more often present in winter and facultative types. And chances are that any given pair of two-row or six-row varieties will have contrasting quality profiles. A host of genes besides *Vrs1* and the *Vrn* genes differ in structure and function, and it is these genes that are determinants of malting and brewing traits.

Thanks to AGOUEB and the Barley CAP, barley breeders will be discovering these genes and determining how differences in sequence lead to differences in performance. Barley users – please don't pre-judge a variety by its kernel number or its growth habit. Instead, let genetics guide your choice and consider performance, availability, and consistency. Cheers! By the way, what's the barley in your glass?