

► physiological, or ‘phenolic,’ ripeness. This means that polyphenolic compounds such as tannins and anthocyanins in the fruit’s skin never undergo natural modifications to smooth out their astringency. Because grapes should be harvested only at phenolic ripeness, growers are then forced to correct problems in the winery — for low acidities, for instance, they might add tartaric acid — which can lead to lower-quality wines.

Wine is, in any case, complex. Jancis Robinson and co-authors’ authoritative *Wine Grapes* (Allen Lane, 2012) describes 1,368 commercially used grape varieties, each with its own characteristics. These range from Cabernet Sauvignon, which can make big, strong, tannic red wines, to Riesling, known for producing delicate, floral, expressive white wines. Determining the vineyards in which each variety will perform well hinges largely on climatic factors and soils: changes in subsoil composition over small distances can have a huge impact on the characteristics of the final wine. The myriad possible interactions of grape variety, climate, growing season and soils means that the array of wines on the market is bewildering — CellarTracker,

a leading database of enthusiast-generated wine-tasting notes, lists more than 1.4 million different wines.

The expansion of viticulture into previously unplanted regions has taught producers much about this interplay of factors. Growers in new regions have had to learn about the influence of different climates on the way grapevines grow, much as they are now having to adapt to climate change. Vineyard prospecting has occurred mainly in the Southern Hemisphere — Australia, New Zealand, Chile and South Africa. Here, intrepid producers have sought out cooler climates, in a bid to emulate the classic fine wines of Europe. For example, some are keenly seeking places where Pinot Noir, the delicate red grape behind elegant Burgundies, might thrive.

Lupin breeder John Gladstones, for instance, sparked a revolution in Western Australia — now home to some of the

“Wine is proving to be a canary in the coal mine for climate change.”

country’s best Cabernet Sauvignon-based reds — by trawling weather and geological data in the 1960s. Gladstones identified the Margaret River area three hours’ drive from Perth as having a Bordeaux-like climate and soils for quality wine growing. Four pioneer wineries duly began to plant vines. And in Chile, new cool-climate vineyards such as those of the Leyda, Elqui and Limari valleys, most of which were established during the past 10 years, are already making interesting wines.

Today’s ideal growing conditions are at the mercy of tomorrow’s climate change, however. Records in Burgundy stretching back to the medieval era show that warm periods similar to that of the 1990s occurred in the 1380s, 1420s, 1520s and 1630s, each time followed by cooler periods. But as Jones and his team in Oregon found, the second half of the twentieth century witnessed a unique trend, with an average rise of 1.26°C in growing-season temperatures across the world’s wine regions. And there has been no sign of cooling since, with 2003 the hottest year since these records began.

For some places, that trend has been a

Vintage scientists

Nature uncorks five tales of researchers who plunged into the heady science of viticulture.

Physicist Richard Feynman said that “if we look at a glass of wine closely enough we see the entire Universe”. It is the stuff of physics, chemistry, geology, psychology and the ferment of life itself. Indeed, viticulture, oenology and wine have long fascinated scientists, from Alexander Fleming and Louis Pasteur to Galileo Galilei, who described wine as “sunlight, held together by water”. Vineyards and wineries are, after all, laboratories in which the fruit of the grapevine *Vitis vinifera* is biochemically transformed, by sunlight, rain, soils, precision, judgement, time and technology, into a potentially sublime elixir. So, here we raise a glass to some of the adventurous scientists — including a Nobel-prizewinning astrophysicist, a group of engineers and a neuroscientist — who, with exactitude and flair, have made waves in the wine world.

Maipenrai, Canberra District, Australia

One of the starriest viticulturalists has to be astrophysicist Brian Schmidt, who runs the 1.1-hectare Maipenrai vineyard near Canberra. Schmidt’s work, observing type Ia supernovae at distances of more than 5 billion light years (1,533 megaparsecs), helped to prove the accelerating expansion of the Universe — and led to a share in the 2011 Nobel Prize in Physics. His plot, planted 12 years before that win with six Pinot Noir clones, now produces some 3,000 bottles of Maipenrai wine a year. Schmidt’s sold-out 2009 vintage had, in his own words, “lovely aromas of plums mixed with forest floor”, a “rich, slightly savoury palate” and — not unlike the astrophysicist’s ever-expanding findings on the day job — “a long life ahead of it, gaining complexity”.



Lethbridge, Geelong, Australia

For 10 years, neuroscientist Ray Nadeson worked on the pain-relieving properties of neurosteroids at Monash University in East Victoria, Australia. In 2003, he left to focus on wine. With partner and former medical researcher Maree Collis and pharmaceutical executive Adrian Thomas, Nadeson has created a 3,000-case winery in Geelong. Lethbridge produces organic, biodynamic wines with a European accent, from varieties including Pinot Noir, Sangiovese and Chardonnay. Nadeson constructed the naturally ventilated buildings of the winery itself from straw bales. Lethbridge’s 2008 Mietta Pinot Noir, according to wine writer Jamie



Goode, has a “taut, fine, spicy, aromatic nose” and a “rich, concentrated, fine-grained palate ... with good acidity and beautiful focus”.





on 7 February, when temperatures of 47°C led to bush fires that killed 173 people. The damage to the region's wine industry caused by fires, smoke taint of grapes and loss of wine quality was estimated at some AU\$368 million.

In some cases, the careful matching of grape variety to vineyard site may have to be reconsidered. This is not a simple solution: grape vines take at least 3 years to produce a crop, and only begin producing peak-quality grapes after 10 or 15 years. And, in most European regions, growers are allowed to plant only authorized varieties.

Now there is a wind from the east, too. China is becoming a leading consumer of wine — and is already the world's eighth-biggest producer. Will parched Europeans, Australians, Americans and Chileans be drinking Great Wall Wine from Hebei a decade down the pike? The warming wine world is watching with interest. ■

Jamie Goode is the author of The Science of Wine and publisher of www.wineanorak.com. e-mail: jamie@wineanorak.com

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boon. For instance, English wine, once a curiosity, is now being taken seriously: as of 2011, there were 419 vineyards, 124 wineries and 1,384 hectares of vines planted. Famed German winegrower Helmut Dönnhoff feels that the degree rise in average temperatures since 1988 has also been kind to German vignerons, saying that the “acidity is lower and the grapes are riper, so the quality of wines has improved”. In the past, German Rieslings from cooler vintages often struggled to attain ripeness, and ended up with searing levels of acidity.

Climate change isn't a simple story, however. A study published in 2010 showed that the climate in California's Napa Valley, which is strongly influenced by air currents from the Pacific, may even be getting cooler.

But it is Jones' predictions for the coming decades that have winegrowers worried. These suggest an average increase in growing-season temperature of 2.04°C between 2000 and 2049, with the largest predicted change in southern Portugal (2.85°C) and the lowest in South Africa (0.88°C). For many, this could be disastrous. Water availability for irrigation is also a concern.

Rising temperatures also bring an increased frequency of extreme weather events, and climate unpredictability. A vintage can be ruined by hail, frost or rain at the wrong time. In Victoria, Australia, shortly before harvest in early February 2009, three days of unprecedented high temperatures (43–45°C) were followed by ‘Black Saturday’

Ridge, Santa Cruz Mountains, California

One of California's most famous wineries, Ridge was launched in 1959 when four scientists at the Stanford Research Institute (SRI) reopened the nineteenth-century Monte Bello winery. Those four were engineer Howard Zeidler; David Bennion, who worked with magnetic systems; Charles Rosen, long-time head of SRI's Robotics Division; and pioneering computer engineer Hewitt Crane, who had collaborated with John von Neumann at the Institute for Advanced Study in Princeton, New Jersey. Bennion made the wines until 1969, when philosopher Paul Draper took over. In the 1970s, Ridge showed the world the depth and complexity possible in Californian Cabernet Sauvignon. The 2009 Monte Bello — the winery's flagship wine — is characterized by Draper as having a “blackberry, red currant, wet stone” nose and a richly textured palate with “minerality, elegant chalky structure and firm acidity”.



Domaine de Vens-le-Haut, Savoie, France

Georges Siegenthaler is on a mission to develop micro-cuvées — limited-production, exceptional wines, made as if in a laboratory. After a career as a biochemist at the University of Geneva's faculty of medicine, Siegenthaler established Domaine de Vens-le-Haut (DVH) in France's Rhône-Alpes region of Savoie in 2002. His watchword is that good wine is made in the vineyard, not the cellar. So although he is serious about alternative methods of fermentation and flavours, ‘clean’ viticulture is his passion. In particular, he and his team are working on alternative treatments for common vine mildews; the conventional one, copper sulphate, accumulates in soil in doses that are toxic to wildlife. Siegenthaler notes that the DVH Mondeuse noire, the great red varietal of the region, is dark ruby in colour “with black berry fruits ... and spicy notes”, a dense structure and “gentle tannins in the finish”.



Domodimonti Società Agricola, Le Marche, Italy

Organic chemist Francesco Bellini — who helped to develop the first compound anti-HIV drug to be made commercially, Eпивir (3TC) — is a self-made man. A mid-1960s migrant to Canada from the Marche region of Italy, he has since authored or co-authored more than two dozen patents. After setting up pharmaceuticals company BioChem Pharma, Bellini began to build Domodimonti Società Agricola, a winery in Montefiore dell'Aso, Marche, in 2004. Bellini sees wine-making as the most ancient form of biochemistry. His ‘natural wines’ are based on sustainable practice, such as hand-picking the grapes and banning additives that enhance mouth-feel or colour. Domodimonti's 2008 Il Messia, made from Montepulciano and Merlot, is a deep ruby red with real biochemical verve — fruity, “powerful and fleshy”, as the winery puts it, with “empyreumatic notes and anise”.



Research by Jamie Goode, wine writer