Vintage 2030 and beyond: Producing quality wines in warmer times

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The authors summarise the main messages delivered during last year's symposium 'Vintage 2030 and beyond – producing quality wines in warmer times', held in Melbourne and jointly hosted by the Australian Wine Research Institute (AWRI) and Wine Victoria. The symposium presented climate projections for Australia's key wine-producing regions and their implications, and discussed methods for adapting to these challenges.

INTRODUCTION

Australia's primary producers have always dealt with the risks associated with producing food or fibre in very variable climates. However, for grape and wine producers recent observations of warming temperatures, shifts in grapevine phenology, compression of vintage, wetter vintages and increased incidence and severity of heatwaves are hard to ignore. The wine industry will need to understand the likely effects of a changing climate and take steps now to adapt to this new future.

To address the climate challenges faced by the wine industry, the Australian Wine Research Institute (AWRI) and Wine Victoria hosted a symposium 'Vintage 2030 and beyond – producing quality wines in warmer times' midway through 2013 at the University of Melbourne. The day was attended by 90 people, mostly from the Victorian wine sector. The symposium brought together researchers and industry to discuss the latest original research and thinking on projections of climates for key wine-producing regions across Australia and their implications. The symposium then discussed novel ways the wine industry is adapting to these challenges both now and into the future.

This article attempts to summarise the major messages from the day. The authors of this article do not in any way claim ownership of the research and original opinions presented at the event but instead have attempted to summarise their findings in a succinct way for the benefit of the broader Australian wine sector. The symposium was skilfully moderated by Professor Snow Barlow, climate change researcher and vigneron from the University of Melbourne and convener of the Primary Industries Adaptation Research Network.

FUTURE CHALLENGES IN 2030 AND BEYOND

Professor Will Steffen, from the Australian National University (ANU) Climate Change Institute and the recently dismantled Climate Commission, began the symposium with a very articulate and authoritative summary of the Climate Commission's recent report 'The critical decade 2013: climate change science risks and responses'. Steffen gave a compelling summary of recent global and national trends in climate statistics, including global mean temperatures, arctic sea ice, heatwaves, bushfires, extreme rainfall and flooding, and provided future climate projections based on a range of emission models and climate policy interventions.

Few delegates were left with any doubts about the compelling evidence

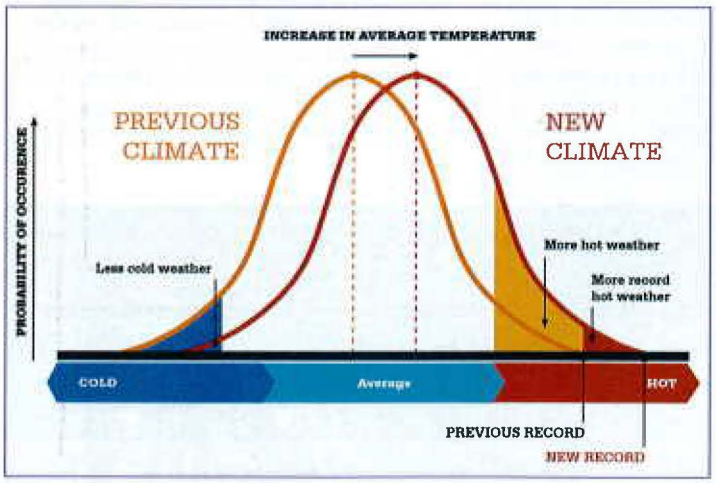

Figure 1. Diagrammatic representation of the shifting climate, showing increased incidence and severity of hot weather and heatwaves (sourced and modified from IPCC 2007).

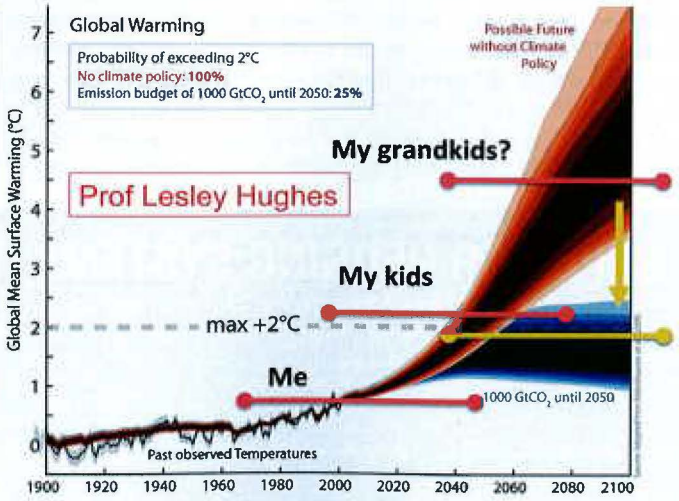

Figure 2. Putting increases in global mean temperatures (°C) into perspective with the impact of differing emission models and Government climate policies on future generations. (Developed by Professor Lesley Hughes of Macquarie University and the Climate Commission)

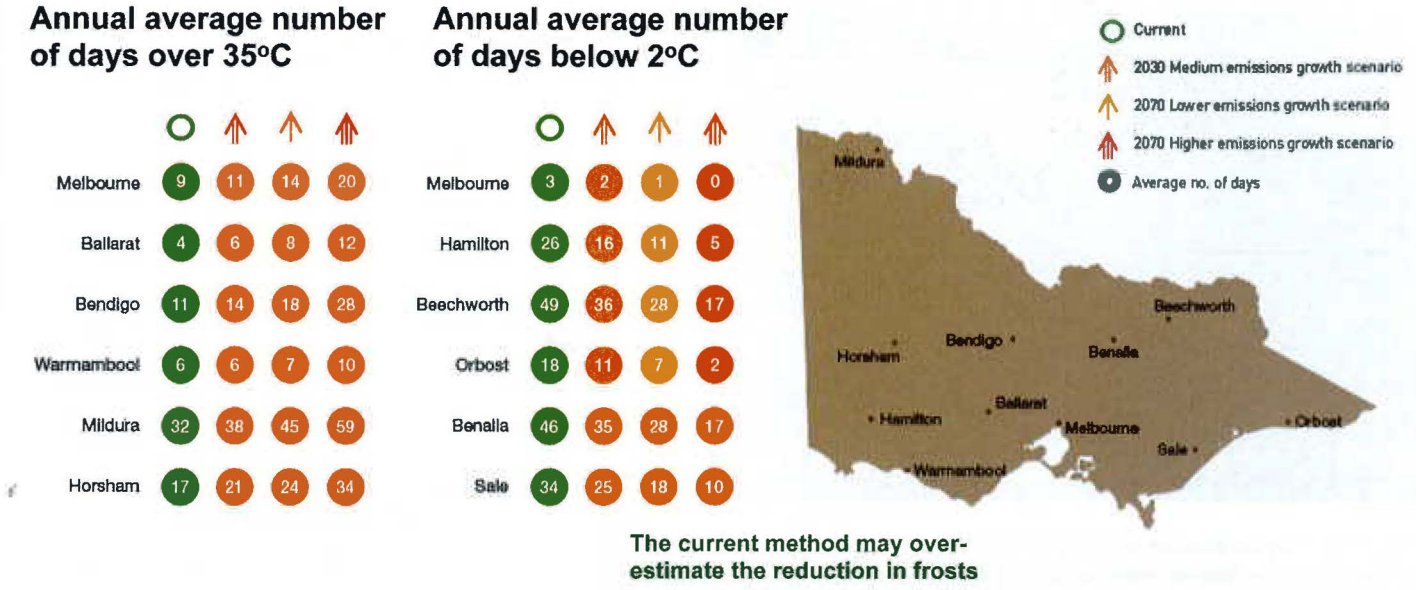

Figure 3. The average number of days over 35°C and average days below 2°C in key regions of Victoria currently (green), in 2030 (medium emissions scenario, orange), 2070 (low emissions scenario, yellow) and 2070 (high emissions scenario, red).

of climate change occurring at a global level and the need for governments around the globe to act sooner rather than later.

Dr Penny Whetton, from CSIRO Marine and Atmospheric Research, presented an update on climate projections for key wine-growing regions in 2030 and beyond. Whetton was in the process of completing a climate projections project for Australia's natural resource management regions and was able to provide up-to-date projections out to 2099. Key messages were the likelihood of a 0.6-1.5°C mean temperature increase by 2030 (mid emissions scenario), 1.0-2.5°C increase by 2070 (low emissions scenario) and 2.0-5.0°C increase by 2070 (high emissions scenario) for most grapegrowing areas across southern Australia. These changes would influence the suitability of growing particular varieties in particular climates. Varieties that are extremely sensitive to climate, such as Pinot Noir for premium/ultra premium wine production, would have their areas of production limited significantly within Australia under these scenarios.

Whetton provided some interesting modelling data on rainfall projections in south eastern Australia. The models tend to predict drier winter and spring periods, but increased rainfall and more intense rainfall periods in the summer months. This may result in wetter ripening and vintage periods, with increased incidences and likelihood of flooding. This will prove more challenging for quality grape and wine production with more fungal pressure during this critical time in the season.

Dr Peter Hayman, from the South Australian Research and Development Institute (SARDI), introduced the concept of 'tipping points', which are defined as the critical points at which strong non linearities appear in the relationship between a system's attributes and its drivers. Once a tipping point threshold is crossed, the change to a new state is typically rapid and might be irreversible. Hayman said tipping points were hard to pinpoint for the Australian wine sector as some regions had benefited from improvements in temperature and growing conditions while others were challenged. The challenge will be how long some regions will be able to adapt before needing to transform to another cooler region to produce grapes and wine more sustainably and profitably or make significant changes in varieties.

Dr Victor Sadras, from the South Australian Research and Development Institute (SARDI), reported on a recently completed Grape and Wine Research and Development Corporation (GWRDC) project looking into the effects of elevated temperature on wine production and quality. Sadras examined the effects of artificially imposed elevated temperatures on vine phenology, yield, berry and wine attributes on Barossa Valley Shiraz between 2009 and 2012.

He examined the direct effect of temperature on vines and wines with an infield side-by-side experimental comparison of treatments involving different temperatures using vines with undervine/

Figure 4. Polycarbonate chambers capable of increasing temperature in Shiraz vines at SARDI Research Station, Nuriootpa, South Australia.

bunchzone polycarbonate chambers capable of achieving an average difference from the control of T_{max} (0.9-2.2 °C) and T_{min} (0.1-0.8 °C).

Sadras showed evidence of nonlinearity of thermal effects on grapevine phenology, which may be explained by two complementary factors. First, temperature-driven shifts of sensitive events (e.g., onset of sugar accumulation in berries) moved the timing of subsequent events into cooler conditions, hence dampening warming effects. Secondly, thermal effects on phenology seemed to be modulated by the interplay between resource-driven growth and temperature-driven development. An enhanced thermal effect on berry ripening associated with a high leaf-area-to-fruit ratio supports this thinking. Measured shifts in maturity were smaller than expected from reported time series analysis. Sadras concluded that thermal sensitivities from time series (6 to 9 days per °C) over-estimate thermal effects on grapevine maturity observed in these experiments (~3 days per °C).

Sadras and colleagues concluded that early maturity associated with higher temperature (and related factors including higher radiation and higher vapour pressure deficit) is primarily driven by the early onset of ripening under a wide range of production systems in south-eastern Australia. Viticultural practices aimed at delaying maturity to counteract the effect of high temperature, high radiation and high vapour pressure deficit are more likely to be successful if they are targeted prior to the onset of ripening.

Robert Paul, from Vintager Winemaking Services, tried to help symposium delegates understand what all this climate change information might mean for the production of premium wine styles. Paul gave a balanced presentation, concluding that it may not be all bad news. In fact, climate change may lead to a more reliable climate in some regions with potentially better harvests, and open up opportunities for new styles and varieties within regions. However, Paul did acknowledge that for many it would mean earlier ripening, compressed harvest periods, an increased need for irrigation, potential increased frost risk and different pest and disease pressures. Also, if regions do get hotter we are likely to encounter fruit with lower total acidity (especially malic acid), lack of nitrogen in musts, fewer flavour precursors, higher potassium levels at pressing and higher sugar levels in must and juice.

Paul discussed the possible adaptation dilemmas to be faced in the future, such as the increased need for canopy to cover and protect fruit from heatwaves, leading to an increase in the pest and disease risk in wetter summers that may become more frequent. Paul also discussed challenges faced in grape production in Central

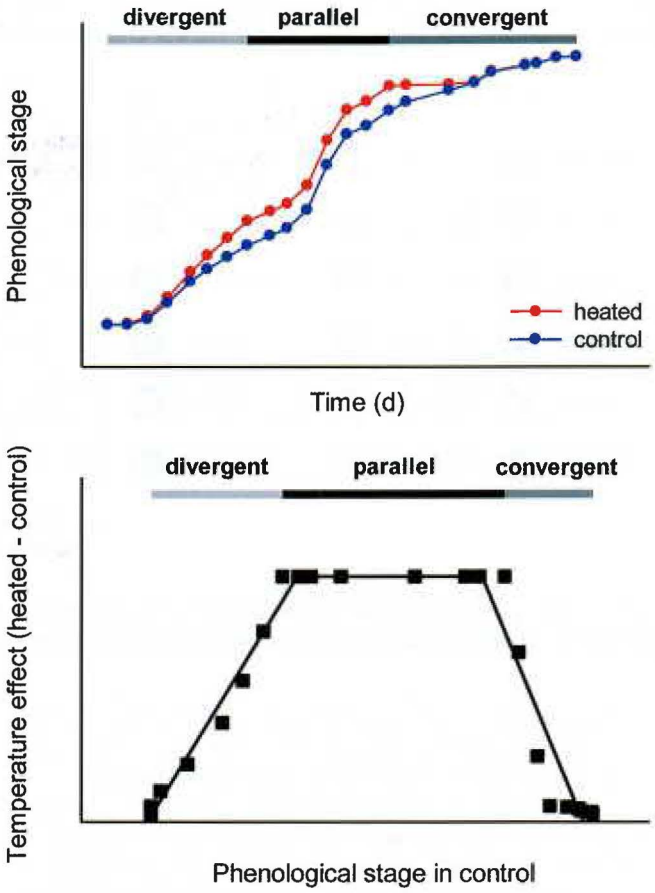

Figure 5. Explaining in arbitrary terms the non-linear thermal effects on grapevine phenology, in which thermal time is taken into consideration. Data shows heated treatments had advanced rates of phenological development prior to veraison, similar rates of development during veraison (lag period) and slower rates of development post-versaison.

Anatolia, Turkey, where mean monthly maximum temperatures are 42.0 °C, 45.0 °C, 44.8 °C and 42.0°C in June, July, August and September, respectively. The mean July temperature is 31.2 °C and the mean annual rainfall is just over 100mm. Growers have adapted to this climate by choosing winegrape cultivars such as Emir, Boğazkere and Öküzgözü that are able to survive and produce grapes in this climate.

Figure 6. Emir vineyard in Cappadocia, Central Anatolia, Turkey (photo courtesy Robert Paul).

Adapting to climate change now and beyond 2030

Dr Michael McCarthy, from SARDI, discussed the management of vines during heatwaves to maintain quality. The South Australian Regional Office of the Bureau of Meteorology defines a heatwave as either five consecutive days with maximum daily temperatures above 35°C, or three consecutive days with maximum daily temperatures above 40°C. But this definition can vary across other parts of Australia, and the effects will depend on how high temperatures are above the long-term average maximum temperature and for how long, as well as where and how winegrape varieties are grown. To be in a position to manage heatwaves, it is critical to ensure that irrigation infrastructure is well maintained and fully functioning, soil moisture monitoring equipment is operating correctly and plans are in place for a power failure. It's also very important in any adaptation strategy to identify susceptible grape varieties and/or high value blocks along with particular problem areas (e.g., shallow soils) and know the current soil water status and buffering capacity of each vineyard block.

Immediately prior to the onset of a forecast heatwave, McCarthy suggested managing vines in the following manner:

- apply irrigation and refill as much of the rootzone as possible to field capacity
- if a deficit irrigation strategy is being used, cease immediately and resupply irrigation
- consider applying a sunscreen spray, e.g., Surround™, however, check with your winery before application to ensure that these products are approved for use
- reconsider any planned leaf removal or canopy manipulation strategy (e.g., foliage wires) that may lead to increased direct bunch/berry exposure.

During a heatwave, irrigation should be applied to maintain soil moisture at a level that enables vines to recover their turgor overnight in preparation for the next hot day. If using overhead irrigation, it should be applied at night to avoid foliage burn. After the heatwave has passed, irrigation is still important to replace lost soil moisture and decrease soil temperature. Growers should also monitor for pests and diseases that may have exploited damaged berries.

Andrew Weeks, from the CCW Cooperative in the Riverland, was unable to attend the symposium, but provided a presentation that highlighted some trial work undertaken in the Riverland using Particle Film Technology (PFT), in particular the use of kaolin-based products such as Surround™. Weeks highlighted recent work conducted by the AWRI showing no residues or effects on fermentation in wine from the use of kaolin-based products, giving many wine companies confidence in allowing their use as sunscreen protection products in the vineyard.

Heat damage can cost winegrape growers in terms of both yield and quality, and some varieties are certainly more susceptible than others. There is also an increased concern about the depletion of acid levels in fruit, depletion of colour, formation of off-flavours and yield loss. In many cases simply adding irrigation water is not enough to prevent canopy and fruit damage from heatwaves.

Weeks trialled Surround™ on Shiraz and Muscat Gordo Blanco and demonstrated reductions in leaf and fruit temperatures, improvement in yields and encouraging financial returns within the Riverland region. It appears that small reductions in canopy temperature from PFT use may mean alot at or near the point of where tissue temperatures can be potentially lethal. However, PFT technology should not be treated as an alternative to supplying adequate irrigation water, rather it should be used in conjunction

Figure 7. Example of Surround™ applied to Shiraz in the Riverland.

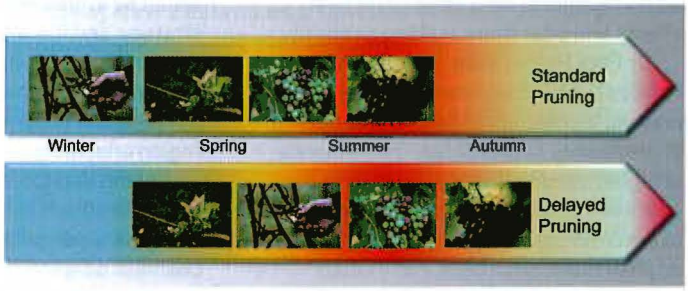

Figure 8. Using delayed pruning in order to delay harvest and move ripening into a cooler part of the season.

Figure 9. A comparison of Shiraz development based on either pruning on 26 May or 22 September.

with irrigation to help ameliorate heat effects and offer more buffering capacity.

Dr Paul Petrie, from Treasury Wine Estates (TWE), discussed using delayed pruning techniques to delay maturation in grapevines to counteract the influence of higher temperatures accelerating maturation. This technique could be used to decompress vintage in some regions, or push maturation back into a cooler ripening period. Between 1993 and 2012, TWE has observed vintage in McLaren Vale getting approximately 2.1 and 1.4 days earlier per year for Cabernet Sauvignon and Chardonnay, respectively. This, coupled with a more compressed vintage for both varieties, creates peak demands on harvesting and crushing facilities. Delaying maturity to a cooler part of the season may lead to an improvement in grape and wine quality, improved harvest logistics, capturing of harvest at an optimal time, better use of key capital equipment (harvesters, crushers, etc) and a reduced risk of exposure to extreme events such as heatwaves. Delayed pruning is a technique that has been used for years to manipulate budburst and manage exposure to frost risk in early budburst varieties. Petrie was aiming to examine the use of delayed pruning to manipulate harvest date.

He examined five pruning date treatments on Shiraz grown in McLaren Vale: 26 May (early normal), 4 August (late normal), 5 September (budburst), 22 September, 18 October. No pre-pruning was conducted on these vines. The technique did demonstrate that delayed pruning could delay ripening to 14.5 Baume. It also showed that the later-pruned treatments resulted in a greater decrease in yield and pruning weight relative to the control treatments (pruned 26 May). TWE is looking to implement this delayed pruning strategy in a range of commercial blocks in Wrattonbully (Cabernet Sauvignon) and Barossa (Shiraz). It should be noted that this would be implemented as part of an overall strategy, and it is unlikely that it would be done in the same vineyard every season, but in rotation with other vineyards it could offer the potential to spread out vintage within a region effectively.

Roland Wahlquist, chief executive of Brown Brothers Milawa Vineyard Pty Ltd, gave a compelling presentation on business adaptation to climate change. Wahlquist discussed what Brown Brothers had observed about climate, its 'tipping point' and when the company started to take climate change seriously and take an integrated approach to adapting the business for the future.

Brown Brothers started to notice key issues emerge from 2001 onwards, with vineyard water supply becoming less reliable, vintages getting earlier and more compressed and higher alcohol contents in wine. However, the biggest change was smoke, and smoke taint. Smoke taint was unheard of prior to the 2003 vintage. Brown Brothers threw out a lot of grapes and wine in 2003, and again in 2007, and limited amounts in 2009.

In 2008, Graeme Anderson, from the Department of Environment and Primary Industries Victoria (DEPI), was asked to present about climate change to the board and senior management team at Brown Brothers. Anderson presented all sorts of scary charts, including global average temperatures from 1850 to 2007 and temperature predictions for the rest of the century. This convinced Brown Brothers that its recent experiences were just a taste of what was to come. For Brown Brothers, this was the management team's 'tipping point'. It convinced the company that this was a shift, not just a couple of hot years, and that as a company it needed to accept climate change, and plan for it in the future. Brown Brothers worked on a 20-year planning horizon assuming a two degree increase in temperature across all vineyards.

Wahlquist gave a very inspiring presentation to the industry members who attended and summarised by indicating that planning horizons are long, so start now! Look for the opportunities. Adaptability will win and this might be where the silver lining lies for Australia. We have a very responsive wine industry, not constrained by the tradition and regulation of much of Europe. We can change, while much of the Old World either cannot, or will not change. If we change more rapidly than the Old World, we will create opportunities for the Australian wine industry as a whole.

OPPORTUNITIES FOR THE AUSTRALIAN WINE SECTOR IN 2030 AND BEYOND

Dr Richard Smart summarised the day by looking at opportunities for the Australian wine sector in 2030 and beyond. Smart indicated that the Australian wine

Figure 10. Smoke taint is an emerging risk to grape and wine production.

industry needed a makeover. He said it was sliding into furthering a reputation as a second rate bulk wine-producing nation, to the detriment of genuine fine wine production and export opportunities. He also indicated that much of Australia's wine production was from varieties grown 'out of place'.

Smart indicated that if the climate were to shift 2°C, much of Australia's area of production would have MJTs higher than any other current winegrape growing region in the world. Only significant table grape production occurs in regions that have an MJT above 26°C. He challenged the Australian industry to tackle this issue and develop some longer-term strategies to ensure Australia has the right 'real estate' to be able to produce the wines that the rest of the world will demand. Smart discussed opportunities for changing grape varieties or moving further south, but implored the industry to not think just about climate change, but to embrace climate choice.

CONCLUSIONS

The 'Vintage 2030 and Beyond' symposium assembled some of the brightest thinkers from around the world in climate change and adaptation to climate challenges. This symposium created moments of clarity for many in the industry, but most importantly, it highlighted the opportunities that industry needs to embrace if it is to move forward in a positive and sustainable way.

Presentations from the symposium are available for download from: http://www.awri.com.au/industry_support/nodes/victoria/vintage-2030-and-beyond/

Please note that some presenters have modified their presentations due to the pending release of peer-reviewed scientific papers and reports to funding bodies.

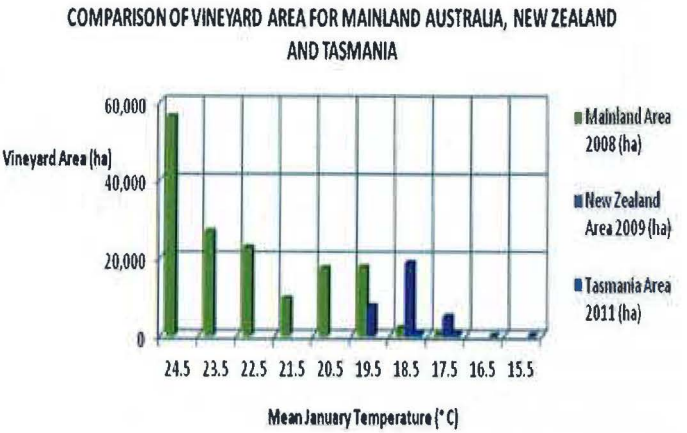

Figure 11. Australia's vineyard production area compared to that of New Zealand as a function of mean January temperature for 2008 planting data.

ACKNOWLEDGEMENTS

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