Future prospects of the grape industry

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Grape is the most valuable horticultural crop in the world. Therefore, it is no surprise that its genome (variety Pinot Noir) was the first amongst fruit crops to be sequenced. Countries all over the world produce grapes and the import/export of grape-products extends over borders, oceans and continents. Unfortunately, this multi-billion dollar industry is now being threatened by a series of unforeseen political and environmental events[1]. First, native grape habitat is being compromised in all areas of its range worldwide. Farming expansion and population explosion have eradicated vast expanses of habitat. In addition, critical germplasm collections have been hampered by financial decisions in certain regions, while political volatility has restricted access to various habitats. Secondly, and may be the most critical event is the onset of global warming[2] and the looming consequences of warmer climate on the grape industry.

There are certain species of *Vitis* grapes in Asia, which are known to have potential cold and disease tolerance characters. However, access to the germplasm is limited, especially in China where the government is hesitant to release the grape germplasm, which may play a vital role in grape crop improvement. Apart from human interference, nature is also affecting the development of the grape industry. Wine grapes are the best agricultural measure of climate change because of their extraordinary sensitivity to weather and meticulous data that have been maintained concerning the long-lived vines. Rising temperatures in the coming years will affect flowering period and shorten the growing season[2]. Consequently, a total shift in grape cropping calendar will adversely affect the quality of the end-product. Some or maybe all the grape varieties in a region may no longer be suitable for the production of balanced wine, due to elevated temperature leading to an earlier harvest. In order to adapt to the changing climate, a complete geographical shift, namely relocation of existing varieties may have to be implemented. Selecting varieties suitable for changing environment should become an integral part of any vineyard establishment strategy.

Total warming will have a greater effect in the northern hemisphere compared to the southern hemisphere[3]. Temperature increase of 1–2°C in Europe during winter and 3–4°C during summer will make life almost impossible in central Spain, one of the leading three grape producers in the world. In addition, rainfall distribution over the year will be upset, which will contribute to an increase in floods and subsequently, erosion. With an unexpected water-deficit, the initial vegetation period would shift by 1–2 months.

The impact of the projected greenhouse gas-induced climate change will vary from region to region. *Vitis vinifera*, the dominant cultivar in the world (FAO Statistical Service), widely regarded as having the highest quality for fresh and dried fruit and wine production, makes up about 98% of the planted acreage[4]. The cultivar, however, possesses few of the resistance genes needed to defend against a host of biotic and abiotic stresses that confront viticulture around the world. With the onset of global warming, scientists expect these stresses to multiply. Climatic change is also sending new insects and diseases. Hot and humid weather will be the proper breeding ground for new bacterial and fungal diseases, which may find a host in grapes, in areas where they were non-existent earlier.

The pest *Hyalestes obsoletus* (a vector for Bois Noir phytoplasma disease) has been attributed to the effects of climate change in southern Germany[5]. Fanleaf degeneration is the world's most serious grape viral disease[6]. Fanleaf is caused by grapevine fanleaf virus (GFLV) and spreads through the soil by the feeding of the dagger nematode, *Xiphinema index*. This disease causes a slow vine decline, but is considered serious because GFLV interrupts normal berry set and can eliminate fruit harvests. Analysis of the recently published genome of Pinot Noir might reveal genes or sets of genes which should help remediate this problem. Specific genes involved in fanleaf disease resistance could be identified and transferred into regionally adapted cultivars. So could be the case in Asia, another centre of origin for the *Vitis* species, where crown gall disease, caused by the bacterium *Agrobacterium tumefaciens*, has been causing severe economic damages to growers in the region for decades[6]. This bacterium is capable of causing tumours, or 'galls', in virtually all plant species, except the monocots (grasses). The disease is particularly destructive as these galls interfere with water and nutrient flow in the plants. Another bacterial disease of economic importance is the Pierce Disease (PD), a lethal disease of grapevine, caused by the bacterium *Xylella fastidiosa*. PD is known from North America through Central America and has been reported from some parts of northwestern South America. In Florida and other southeastern states, PD has completely precluded commercial production of European grape varieties. Climate change will have a tremendous impact on the industry as a whole and grape growers will need to adapt themselves to this.

The industry may need to breed varieties suitable to warmer climates, or bank on *Vitis rotundofilia* native to southeastern US and others known for their adaptation to hot and humid conditions[7], such as those grown in southern Spain or northern Africa. *V. rotundifolia* also known as muscadine grapes, however, lacks the necessary market quality of European grapes[7]. Muscadine has a thick leathery skin, numerous seeds, intense aroma and unstable pigments for wine production. These characteristics will limit its market acceptability, but its disease resistance can be harnessed in response to rise in temperature. The latter will also trigger an increase in demand for irrigation water in most regions. An increase in carbon dioxide means an increase in the rate of photosynthesis[2]. Water accessibility will also play a major role in the future of the grape industry[2]. The grape industry is particularly susceptible to global warming because of its reliance on unique terroirs, which are strongly climate-related[2]. Therefore, land suitable for growing grapes might be cut by 10% in the next few years. By 2050, the reduction might be as much as 44% (high-range warming)[3].

The complete genome sequence of the first grape variety, Pinot Noir, signals the dawn of a new era with exciting prospects.

Predictably, a vast collection of genes involved in flavour formation in fruits has been discovered[8]. New combinations of genes may lead to the development of new flavours. However, flavour formation in grapes is known to be directly linked to its growing conditions and environment. Use of available genes to yield better pest resistance might be an easier attainable goal. Diseases, such as anthracnose, mildew and PD have handicapped the industry for decades. Discovering the gene/s or gene products involved in grape disease resistance could help breeding programmes all over the world achieve their goals in a shorter period of time. The genome sequencing of Pinot Noir should put the grape community a bit closer to achieving this goal.

Global warming has accelerated faster than anticipated. This has forced sugar levels, and consequently alcohol levels to become higher in the wines. Some producers are adding acidic compounds to their wines to prevent them from becoming too sweet and undrinkable. Growers in Spain, Italy and southern France are buying land at higher terrains for future vineyards. Southern England will probably benefit from planet warming. The British wine industry is re-emerging for the first time in the 500 years since a minor ice age cooled Europe.

Finally, here are some possible remedies. As shown in the genome sequencing of Pinot Noir, research is under way to address some of the ills facing the grape industry. In view of the recent alarms on global climate change, the southern states might be called in to play a major role in the future of the grape industry. Eventually, they will house the shift to new geographical cultivation. And this can only be achieved through intensive research and development efforts toward germplasm acquisition and distribution. In addition, to correct deficiencies, new tools have to be developed to evaluate local, regional and national needs. The above needs can only be achieved by encouraging and developing interactions between breeders and grape enthusiasts all over the world.

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Should endemic and threatened freshwater ornamental fishes of Kerala part of the Western Ghats biodiversity hotspot be captive bred for international trade?

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The highly endemic stream fishes of the Kerala part of the Western Ghats (WG) are now an important component of the global ornamental fish trade. Currently, 114 ornamental species from the Kerala part of the WG are being exported[1], having increased from just ten species at the beginning of the decade[2]. These native ornamentals are in great demand in international markets, and some species like, *Puntius denisonii* command exorbitant prices[3]. Our analysis based on regional conservation assessment[4] revealed that out of 114 exported species, 11 are critically endangered (CR) and 24 are endangered (EN). Further, 44 fish species in the export list[1] are strictly endemic to the WG eco-region and not found anywhere else in the world. Even though there are only 13 full-time active exporters of ornamental fishes from India[5], the stock sizes of many native ornamentals of the WG have declined significantly due to indiscriminate exploitation[2]. Some CR species found in the trade (*Osteochilus longidorsalis*, *Pterocryptis wyanaadensis* and *Horaglanis krishnaii*) have shown a population decline of 99% in the last two decades[2].

The fishery for ornamentals in the streams of Kerala is an open-access one, devoid of any quotas or access restrictions[6]. No regulation on either catch or effort is in place, nor is there any policy directed towards native ornamental fisheries. Lack of regulations is in part because native ornamentals are thought to be a free commodity which can be collected from nature. In the absence of any realistic initiatives in fisheries management and/or conservation, captive breeding is widely considered to be the only panacea for sustainable ornamental fish trade by acting as a supply-side policy for relieving pressure on wild collection.

The Species Survival Commission (SSC) of the IUCN[7] has astutely pointed out that 'captive breeding programs involving species at risk should be conducted primarily for the benefit of the species and that, acquisition of animals for such programs "should not" encourage commercial ventures or trade'. However, this is in total contrast to the current state of affairs in the WG region, where captive breeding is seen as an important economic instrument to generate foreign exchange. Un-