Grape mapping populations reveal genetic variation in bloom and fruit development

by Tim Martinson, Al Kovaleski, and Bruce Reisch

On June 29, I photographed clusters from Bruce Reisch's three *VitisG*en mapping populations. Parents are Cornell hybrid cultivar Horizon (with perfect flowers), Illinois 547-1 (a male vine), *Vitis cinerea* (late blooming male vine) and *Vitis rupestris* (early blooming, a female vine*).* Note that 'Horizon' and *V. rupestris* had pea-sized berries and *V. cinerea* had not yet started to bloom. Illinois 547-1 blooms earlier than *V. cinerea* and later than *V. rupestris*, but produces no fruit.

Mapping population #1: *Vitis rupestris* x Horizon (planted in 2010). Progeny of this cross bloomed early and fruit on these vines were uniformly at the 'pea-sized' berry stage.
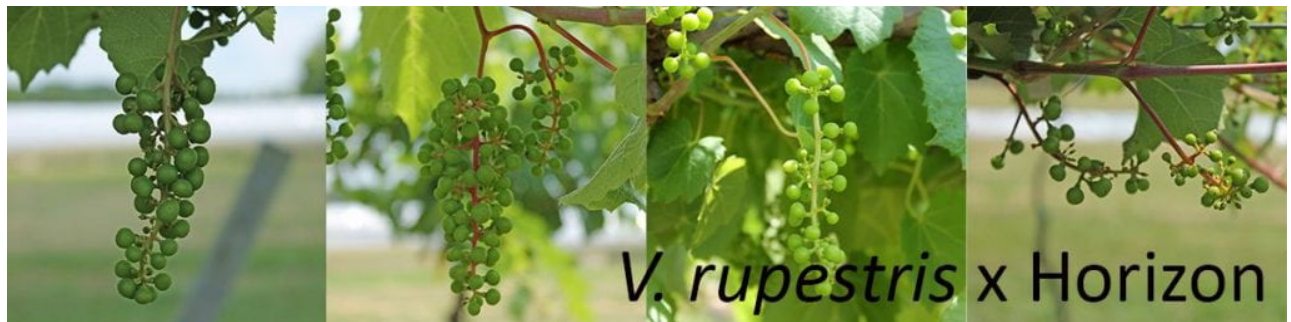
Mapping population #2: Horizon x *Vitis cinerea* (planted in 2011). Progeny of this cross exhibited delayed bloom and cluster development -clusters were at prebloom to early fruit set, generally earlier blooming than the *V. cinerea* parent.

Horizon x *V. cinerea*

Mapping population #3: Horizon x Illinois 547-1 was established in 1990 and 1998. Illinois 547-1 is the progeny of two wild parents used in mapping populations 1 and 2, *Vitis cinerea* and *Vitis rupestris*. Fruit development on the ~150 siblings ranged from bloom to 'pea-sized' berries. This family of sibling vines flowered over a long period of time, from early June to early July.

Horizon x Illinois 547-1

 I went back and collected more clusters of both the parents and the progeny on July 6.

The parents: By July 6, the rachises of the male flowers (Ill. 547-1 and *V. cinerea*) were starting to wither away. The female *V. rupestris* B38 and the 'perfect-flowered' cultivar Horizon had fully-formed clusters with 'pea-sized' fruit.

Horizon | Illinois 547-1 | Vitis rupestris B38 | Vitis cinerea B9
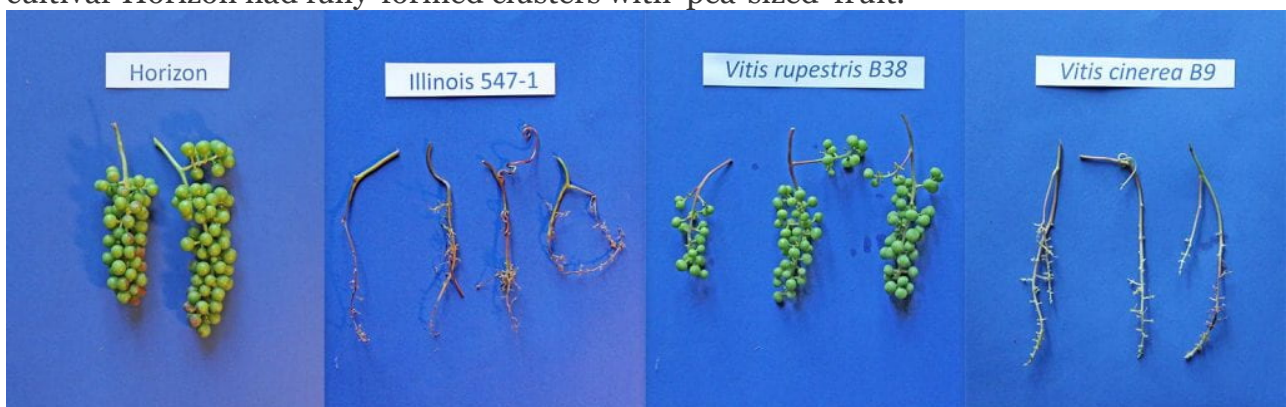
The progeny from three mapping populations: On July 6, I selected clusters from 5 siblings of the *V. rupestris x* Horizon population (left, pea-sized berries), the

Horizon x Ill. 547-1 population (center, a range of sizes and male inflorescences) and the Horizon x *V. cinerea* population (right, flowering to BB-sized berries).

The three mapping populations illustrate clear differences in the timing of bloom and subsequent fruit development. Horizon crossed with *V. rupestris* showed advanced bloom and fruit development phenology, while Horizon crossed with *V. cinerea* showed delayed bloom and fruit development. The Horizon x Ill. 547-1 population (with both *V. cinerea* and *V. rupestris* grandparents) exhibited a whole range of bloom and berry development phenotypes.

Tracking bloom progression: Students from the Cornell AgriTech summer scholar program (Abe Steinberger and Hannah Levengood) and former graduate student Al Kovaleski collected observations every few days on the three mapping populations. They recorded floral development on 171 *V. rupestris* x Horizon, 314 Horizon x Ill. 547-1 and 141 Horizon x *V. cinerea* vines, using the well-known "Eichhorn-Lorenz" (E-L) grapevine phenology index. Dr. Al Kovaleski plotted curves derived from these observations from Stage 18, when floral caps start changing color prior to bloom, to Stage 26, when 100% of the flowers are open. The bloom progression is plotted against cumulative growing degree-days (GDD).
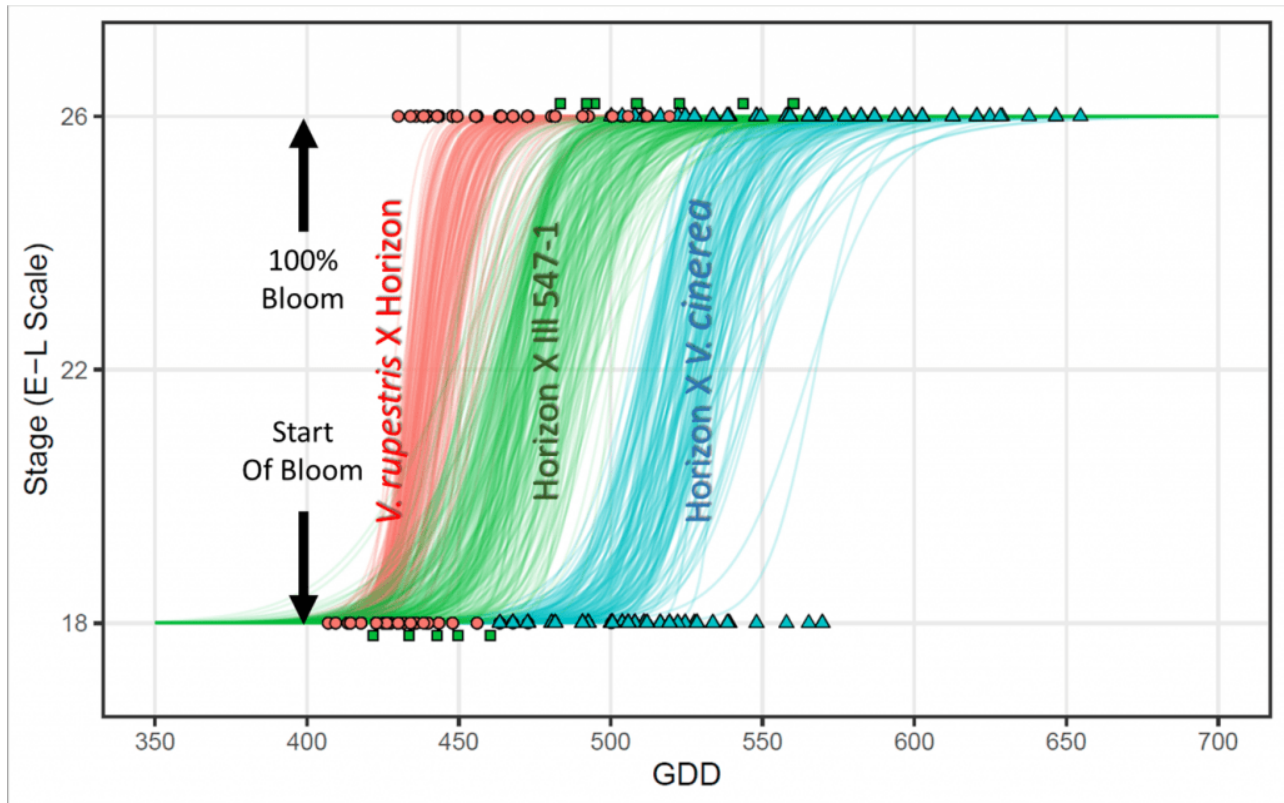
The individual lines show the segregation of these F1 siblings both within each mapping population and clear differences between the three mapping populations. The *V. rupestris x* Horizon vines bloom early and fast (with 50% bloom occurring over 25 GDD or approximately 1-2 d), the Horizon x *V. cinerea* vines bloom late, and over a more extended time period, and the Horizon x Ill. 547-1 siblings are right in the middle. Based on 2-3 years of flowering time data in these populations, the *Vitis*Gen2 project is developing information on the locations in the grape genome that are responsible for controlling flowering time. Note that Ill. 547-1 is itself a hybrid of two wild vines: *V. cinerea* and *V. rupestris*, while "Horizon" is a commercial variety with 'Seyval blanc' and 'Schuyler' in its background.

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