THE “Dark Matter”
OF DIRT

THERE’S STILL MUCH TO BE LEARNED REGARDING
THE ROLE OF BACTERIA IN THE VINEYARD

by Deborah Parker Wong

WITH MILLIONS OF UNKNOWN species existing in a ton of soil, biologist Edward Osborne Wilson has called bacteria “the dark matter of the biological world.” While our knowledge of the roles known bacteria play in the vineyard enables us to make delicious wine, the unknown far exceeds the understood when it comes to analyzing these soil microbiomes.

According to biochemist Paco Cifuentes, who has compared studies from hundreds of vineyards, there’s a distinct kingdom of organisms found only in soils farmed sustainably with organic fertilizers. When evaluating the health of a vineyard, the presence of these organisms becomes a marker for sustainability and diversity. “In a conventionally-farmed vineyard, you’ll find on average 500–700 different types of microorganisms,” says Cifuentes. “In sites that are farmed sustainably, we find anywhere from 1,000–1,200 microorganisms, the majority of which are bacteria.” This promotes an environment of checks and balances where beneficial organisms can effectively suppress harmful organisms and help prevent disease.

That vast array of potentially present microorganisms includes “a dozen or so very distinctive organisms that never show up in sites that are farmed conventionally,” Cifuentes adds, but the role they play in the flavor and quality of finished wine is a puzzle that’s slowly being pieced together.

Cifuentes imports a portfolio of organic and Biodynamic wines from several Spanish regions under the banner Whole Wine Trade, and says he sees less skepticism among producers there who want to understand their soils the same way they understand their grape varieties and rootstocks. “There’s a mentality of growing both grapes and microbes in the vineyard, and an awareness that keeping the soil healthy is important part of the job,” Cifuentes explains. This approach marks the distinction between winemakers who want the same organoleptic characteristics from every vintage—and are, in effect, making wine in the winery—from those whose goal is to “remove the noise from the wine” and express both vintage and terroir.

Although studies have shown a correlation between certain soils and flavors in wine, the fact that compounds found in grapes don’t mimic those found in vineyard soils has sent researchers like Dr. Ignacio Belda of Biome Makers, Inc., back to the lab in pursuit of answers. Belda is researching microbial terroir with WineSeq, a DNA sequencing and machine learning–based technology, to evaluate the microbiome in vineyard soil. The ultimate goal is to identify specific chemical compounds that influence finished wine through fermentation.

Belda says microorganisms exist that act along the fermentation cycle, modifying existing compounds in juice and must; they can also add other characteristics, some of
which could include expressions of mineral-ity. The definition of minerality continues to be a moving target, as only a handful of compounds are known to contribute mineral flavors in wine. Cifuentes and Belda use a modified spider graph to chart the organo-leptic properties of wine and have correlated the presence of Saccharomyces bovans, a yeast with increased mineral expression. “The mystery is in the bugs,” said Cifuentes. “We just don’t know what they’re doing. It’s very likely they are dropping a lot of compounds we haven’t yet been able to isolate.”

During the fermentation process, a succession of different groups of bacteria and yeast interact and then expire. The resulting flavors in the wine are a direct result of the diversity, length, and conditions of the fermentation. “The more bugs you have to begin with, the more potential you’ll have for diverse chemical compounds in the finished wine,” says Cifuentes before pointing out that winemaking practices can promote or suppress that diversity (for example, allowing malo lactic fermentation to occur naturally in red wines as the cellar grows warmer in the early months of spring, versus an inoculated malolactic fermentation that takes place alongside or immediately after the primary fermentation).

Citing a producer in Spain who lets malo-lactic fermentation (MLF) occur naturally in his red wines, Cifuentes says the practice results in a significantly different flavor profile—one that has more terpenes and more mineral expression, as well as a velvety texture that doesn’t require oak aging or the use of sulfur. These desirable characteristics are attributed to a thermo-resistant strain of lactobacillus and a host of other bacteria that can act in colder conditions over a longer period of time. “The organoleptic properties of these wines are judged to be far superior to wines that have been put through MLF immediately after primary fermentation,” Cifuentes adds.

With all of the marketing around native yeast fermentations, having a better understanding of what yeasts other than Saccharomyces cerevisiae bring to the flavor profile of finished wine is key. By analyzing the sensory contributions of non-Saccha-romyces yeast through DNA sequencing, Belda has found that native yeast fermentations contribute increased complexity—a winemaker who uses native fermentation can attest to this—and help stabilize wine.

At the University of Milan, Italian researchers are shedding new light on the role yeasts play in the vineyard. Yeast strains found on wild grapes, most notably Meyerozyma guilliermondii, have potential for use as a biocontrol in combating molds like Botrytis cinerea and sour rot. Field trials are underway to confirm what properties, if any, these wild yeasts strains contribute to fermentation, as well as how effective they are in maintaining checks and balances in the vineyard.