

The Archaeology of Wine Production in Roman and Pre-Roman Italy

EMLYN DODD

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Supplementary Online Appendix

The world of vinicultural archaeology has expanded exponentially over the past two decades, adding novel discoveries, methodologies, theories, and new archaeological evidence. Despite this, focused regional or site-specific approaches and syntheses dominate scholarship. This article provides an alternate, macroperspective via a comprehensive update and overview of the archaeological evidence for the entire Italian peninsula. When considered as a whole, the sheer quantity of evidence is simply a starting point for future research directions. New data from pre-Roman Italy might suggest localized indigenous winemaking experimentation, contrasting with traditionally dominant east–west colonial diffusionist models. Detailed cataloguing and interpretation of Roman wineries demonstrate that two dominant press types were present simultaneously. Along with these syntheses, previously unpublished evidence is analyzed for the first time, including conspicuous, lavish, and theatrical wine production at the Villa dei Quintili just outside Rome.¹

INTRODUCTION

“There are two liquids that are especially agreeable to the human body, wine inside and oil outside” (Plin., *HN* 14.29.150). Wine permeated and enveloped Roman culture. It was both a daily drink and reserved for special occasions, played a key role in trade and the economy, and was found in medicinal, religious, domestic, and commercial contexts. Since antiquity, Roman winemaking and viticulture have been interpreted through historical sources, which tend to be scattered, incomplete, and biased, and, to an extent, comparative ethnography.² Indeed, preindustrial equipment and practice often retain ancient characteristics of the same region and thus provide a valuable proxy

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²Goodchild 2013, 198; Brun 2020, 3.

to fill gaps left by texts, art, and archaeology.³ Increasing attention on Roman agriculture over recent decades, buoyed by improvements in technology and a growing methodological skill set, has, however, created a vast archaeological database that now plays a crucial role in confirming, tweaking, or refuting historic interpretation. In particular, “a revolution in scientific techniques over the past forty years has made it possible to re-examine and, in many cases, re-write the history of wine.”⁴

This article provides an updated and comprehensive overview of how such evidence illuminates production of the dominant beverage in Italian later prehistoric and historic antiquity—wine. Discussion is mostly restricted to the Italian peninsula (fig. 1), drawing comparative evidence from Sicily, Sardinia, and across the Mediterranean, and extending from later prehistory and the Bronze Age through to late antiquity, ca. 600 CE.⁵ These temporal and geographical confines allow observation of winemaking and wine use for both domestic and export markets, through periods of prosperity and decline, on various scales, and for a range of sociocultural groups, strata, and purposes.⁶ By taking a macroperspective and examining the entire Italian peninsula, this article fills a critical gap in current scholarship, which is often localized or regional.⁷

³ Frankel 2016, 550. On the benefits of ethnography to the study of ancient wine, see Dodd 2020, 6–7.

⁴ McGovern 2013, 234.

⁵ On defining late antiquity, see Lavan et al. 2008, xviii; Rossiter 2008, 94; Dodd 2020, viii.

⁶ Roman winemaking in Italy experienced peaks and troughs, dependent on a range of factors. Examples include the eruption of Mount Vesuvius in 79 CE, which reportedly destroyed many Campanian vineyards and caused what was called a “wine famine” in Rome, and, in the following centuries, the proliferation of viticulture in Hispania and Gaul that instigated shifts in the Mediterranean wine trade and perhaps a decline in local Italian production for commercial markets. The latter is particularly visible through the amphora evidence, though recent work suggests Italian viticulture continued to a greater extent than previously thought, albeit on a smaller scale and with different purpose (Arthur and Williams 1992; De Sena 2005, 136; Rossiter 2008; Volpe 2009, 381; Marzano 2013).

⁷ A general lacuna that is exemplified by the comparative lack of discussion regarding archaeological evidence for ancient wine production in Italy in the seminal volume by Amouretti and Brun (1993).

Evidence in the following pages is supplemented by contemporary ancient texts, including by authors from the Italian peninsula itself. Major ancient agricultural treatises include Cato’s pioneering *De agricultura* (second century BCE), Varro’s *De re rusticae* (37 BCE), Columella’s *De re rustica* (first century CE), and Palladius’ *Opus agriculturae* (late fourth or fifth century CE). Pliny the Elder (first century CE) provides one of the most comprehensive accounts of ancient viticulture and winemaking, devoting book 14 in his *Naturalis historia* to the subject. Many of these Republican- and Imperial-period texts used, or were influenced by, the earlier writing of Mago the Carthaginian (date uncertain), whose agricultural text is lost but clearly devoted notable space to viticulture and wine production (evident through fragments found in later texts). For late antiquity in Italy, Zeno of Verona in the mid fourth (*Tractatus* 2.27.2), Symmachus in the fourth to fifth (*Ep.* 3.23.1), Cassiodorus in the mid sixth (*Expositio Psalmorum VIII*), and Pope Gregory in the sixth century (*Dialogi* 9) provide glimpses into the contemporary winemaking process, which appears largely reflective of earlier sources. Although later, and outside the chronology of this article, the Byzantine Greek farming manual *Geoponika* (10th century CE), provides an equally useful and thorough discussion of viticulture, directly citing and drawing much of its material from earlier Greek and Roman sources.

Archaeological evidence for ancient viticulture and winemaking generally falls into five broad categories: remains of grapes, vines, or vineyard arrangements, including irrigation and hydrological systems; tools (e.g., sickles for pruning) used in agricultural processes; components of wine presses; architectural structures (e.g., vats, treading floors, or specially designed cellar areas); and metal, ceramic, and (very rarely) organic evidence for the fermentation, storage, transport, and serving of wine. These categories largely align with the sequence of the following pages, discussing evidence from cultivation and harvest, through processing and production, to fermentation and storage. The obvious lacuna, and an acknowledged limitation of the forthcoming discussion, is amphoras and various other transport *mechanica* of wine (including barrels and *cullei*, large sacks made from entire animal skins, mostly used for overland transport on carts). We focus here on the theme of production, however, and not distribution.



FIG. 1. Map of regions of Italy referred to in the text; labels in capitals indicate ancient regions; labels in title case are modern region names (map by E. Dodd with base GIS and hillshade data from the EEA and Esri).

PRE-ROMAN INFLUENCES IN ITALY

Discoveries over the past 20 years, spurred by organic residue, archaeometric, paleoenvironmental, and DNA analyses, have solidified theories regarding the origins of wine and the grapevine.⁸ Despite its omni-

presence, wine did not originate in Italy or in Roman culture, but more likely in the mountainous regions of Lebanon/anti-Lebanon, the Taurus, Caucasus, and

⁸Organic residue analysis is a method that scientifically tests preserved organic residues from archaeological contexts, often on ceramic or plaster artifacts that aided absorption, to detect the presence of chemical signatures that can indicate or suggest certain products once in contact with that surface (McGovern 2009; McGovern and Hall 2015; McGovern et al. 2021). Paleo-environmental analysis (also paleoecology) aims to reconstruct the biological, chemical, and physical nature of the past environment. In the study of ancient viticulture, this can include archaeo-

botanical study of types of grapevine pollen, phytoliths, seeds/pips/pedicles, peels and skins, and woods and charcoals, as well as geoarchaeological study of soils and sediments. Recent ancient DNA (aDNA) studies have made progress in tracing grape and vine genealogies between contemporary and ancient varieties, particularly in northwestern Italy (Vouillamoz et al. 2007b; Raimondi et al. 2020) including tracing Pliny the Elder's *Raetica* varietal (Vouillamoz et al. 2007a), but also more broadly (see esp. Vouillamoz et al. 2003; Vouillamoz and Grando 2006) and using grape seed morphometrics (Terral et al. 2010).

Zagros.⁹ Early Neolithic villages like Hajji Firuz Tepe in the Zagros Mountains of modern Iran or Shulaveri Gora in Georgia, perhaps as early as 6000 BCE, are among the potential sites for early experimentation and successful fermentation of wine, with vine domestication of the Eurasian grape (*Vitis vinifera* ssp. *vinifera*) perhaps also occurring first in this general region.¹⁰ Evidence from as early as ca. 7000 BCE for a mixed wine drink has also been found in early Neolithic China.¹¹

Wild grapevines (*Vitis vinifera* ssp. *sylvestris*) were, however, present in Italy and exploited in various forms since the Mesolithic; evidence of wild grapevines and grape consumption was found at the Epi-Gravettian and Mesolithic sites of Grotta del Romito (Calabria), Grotta dell'Uzzo (Sicily), and Torre Canne (Apulia).¹² Wild grapes already had a long history in Italy: fossilized traces of grapevine ancestors from ca. 50 Ma have been located near Verona and Vicenza in North Italy (fig. 2).¹³ New evidence suggests, albeit often circumstantially, the beginnings of early cultivation in the Bronze Age.¹⁴ Certain parts of Italy, diachronically differentiated in north and south, experienced agricultural transformation earlier than most of the western Mediterranean at the start of the first millennium BCE.¹⁵

It remains uncertain whether localized cultivation or domestication occurred as early as the Neolithic in southern Italy, with cultivation increasingly likely from the Final Bronze Age (ca. 1200–1000 BCE), based on the remains of pruned vines in a rubbish pit at Santa

Maria Capua Vetere in Campania.¹⁶ Pollen analysis revealed potential evidence for early grapevine exploitation ca. 2000 BCE in the Massaciuccoli Basin (Tuscany), along with pips from Bronze Age contexts near Modena and observation of domesticated traits via morphometric and molecular analyses in north Tuscany.¹⁷ Similar trends are perhaps also visible in increasing preference for, and exploitation of, grapevine over cornelian cherry in the Terramare culture around Ferrara from the Middle to Late Bronze Age, ca. 1400–1170 BCE.¹⁸ Near Aquileia, at Friulian Canale Anfora, grape pips from a context dating before 1500 BCE were found along with the fragment of a *Vitis* vine branch, and the Terramare sites of Santa Rosa di Poviglio and Montale yielded notable quantities of *Vitis* pollen and seeds.¹⁹ Middle and Late Bronze Age evidence for potential grapevine cultivation also comes from Etruria, at San Lorenzo a Greve, Livorno-Stagno, Chiusi, and Tarquinia.²⁰ Similarly, indigenous activity is seen at Bergamo via pollen and pips from coring, which suggests that concentrated grapevine exploitation (noted as “cultivation” by Pini et al.) was practiced at least by the 10th to eighth centuries BCE, up to four centuries earlier than Etruscan trade reached the southern Alpine fringe in the sixth century.²¹ The potential role of foreign influence in what appears archaeobotanically to be local cultivation,

⁹Brun 2004b, 37–39; McGovern 2013; Mercuri et al. 2021, 13; Harutyunyan and Malfeito-Ferreira 2022. Forni (2007, 69) provides an excellent overview of grapevine origins, diffusion, and domestication, though now slightly outdated regarding Italy.

¹⁰McGovern 2011, 185–86; Arroyo García and Revilla 2013.

¹¹McGovern et al. 2004.

¹²Other Neolithic human settlement contexts with wild grape seeds in north-central Italy include Cava Barbieri a Pienza, Podere Casanuova, Pontedera, Monte Cetona, La Marmotta, San Marco di Gubbio, Rivalentella, and Monte Covolo (Mariotti Lippi et al. 2012, 120–21; Komar 2020, 35).

¹³Brun 2004b, 81; Grassi et al. 2006, 837; Marvelli et al. 2013, 155, 159; De Lorenzis et al. 2020, 23. There is also Neolithic evidence in Tuscany; see Aranguren et al. 2007, 88–89.

¹⁴Ciacchi et al. 2007, 19–20, 72–73; Di Pasquale and Russo Ermolli 2010; Pecci et al. 2017a; Motta and Beydler 2020, 403; Mercuri et al. 2021, 13–16; Trentacoste and Lodwick forthcoming. For an overview of the historic distribution and contemporary status of the wild grapevine, see Arroyo García and Revilla 2013.

¹⁵Pérez-Jordà et al. 2021, 17–18.

¹⁶Gismondi et al. 2016; Lentjes and Semerari 2016, 6. Unequivocal proof of horticultural cultivation requires more than pruned vines, which shows the beginnings of control but could equally be related to the exploitation of wild grapevines (similarly noted by Komar 2020, 35–36). Domestication, on the other hand, implies both selection of the hermaphroditic Eurasian vine and perpetuation of a clone through horticultural techniques. The evidence for these practices, even if accidental, is limited at present (P. McGovern, pers. comm. 2021). Some grape seeds dated to the Neolithic from the area of Bari might present intermediate morphological characteristics, between wild and domesticated (Costantini and Costantini Biasini 1999, 178). Conclusive statements and claims to early domestication and cultivation in Italy should be regarded with caution at present (cf. Komar 2021, 245–47). Future studies in aDNA might prove promising (Firmati et al. 2021, 99) via ongoing genetic analyses in the Albegna Valley (Grosseto), indicating tentative evidence for the accumulation of “foreign” (perhaps Calabrian, Sicilian, or Greek) germplasm and a secondary domestication site in the Etruscan era.

¹⁷Menozzi et al. 2002; Aranguren and Perazzi 2007; Cardarelli et al. 2015.

¹⁸Mercuri et al. 2006; Cardarelli et al. 2015.

¹⁹Mercuri et al. 2006; 2021; Pecci et al. 2021, 106, 110.

²⁰Delpino 2007, 134.

²¹Pini et al. 2021, 541–42.



FIG. 2. Map of major sites mentioned in the text with pre-Roman or Roman cultivation evidence (map by E. Dodd with base GIS and hillshade data from the EEA and Esri).

by introduction of an already selected vine, should also be acknowledged.²² This new data extends our understanding of early grapevine exploitation in Italy, but more controlled scientific analysis and evidence are needed to test theories of cultivation and, particularly, domestication.²³

²² Komar 2020, 36–37.

²³ The importance of sample protocols, and the potential for contamination leading to inaccurate results, must be stressed, along with the (often subconscious) temptation to overemphasize evidence for early cultivation and domestication in lieu of appropriately wide-ranging and rigorous data sets. Indeed, results are only as good as the samples tested, which are ideally

Despite this evidence, uses of the grape and vine are many, and it is difficult to determine a clear relationship between early cultivation, if it occurred, and winemaking. Recent evidence does, however, raise suggestions that Bronze Age, and perhaps Neolithic, Italian cultures may have experimented with grapes (whether wild, cultivated, or domesticated) and fermentation at some point; this may have been accidental or deliberate, and quantities were probably

well-excavated, well-dated, well-preserved, and uncontaminated since deposition (e.g., by ground water) or postexcavation (e.g., in the lab or storage facility by improper handling). I am grateful for discussion with P. McGovern on this topic.

limited.²⁴ After all, Italy, the Aegean, and the broader Mediterranean were at times in contact with one another, and it is unsurprising that knowledge of vine cultivation and winemaking might be transferred.²⁵ This is supported in the Middle and Late Bronze Age on peninsular Italy by the presence of cups, strainers, bowls, kraters, and other vessels (sometimes in Mycenaean and more often in local forms) relevant to wine production and consumption.²⁶ Residue analysis, using GC-MS (gas chromatography mass spectrometry), on Terramare culture ceramic samples from Pilastrini di Bondeno (ca. 1500–1300 BCE) and Canale Anfora detected tartaric acid, perhaps indicating wine, along with sulfur, used to waterproof ceramic containers and stabilize and preserve wines.²⁷ One large-mouthed bowl has an estimated capacity of 35–40 liters and, hence, probably too much for single-use consumption.²⁸ Is this evidence of early bulk wine storage and possibly mass consumption? Or was it used in the fermentation process, like the later, much larger dolium?

²⁴Brun 2020, 7; Pecci et al. 2020. At Monte Kronio (Sicily), organic residues on pottery from the fourth millennium BCE indicate the presence of tartaric acid and perhaps some degree of grape juice fermentation (Tanasi et al. 2017, 142–47).

²⁵Brun 2004b, 80–81, 159; Lentjes and Semerari 2016, 1–3; Komar 2020, 38–39. See Cardarelli et al. 2015 for increasing traffic, including trade of ceramics and bronze objects, between Italy and the Aegean in the 14th–12th centuries BCE. Archaeobotanical material from Late Bronze Age Calabria suggests a peak in grapevine exploitation, beyond domestic need, and shortly after, a decline to household levels by the end of the Bronze Age, perhaps linked to the disruption of trade routes with the Mycenaean world (Lentjes 2016). Winemaking was certainly occurring by this time on both mainland Greece and Crete (Brun 2004b, 70–80). McGovern and Hall (2015) show that wine and drinking vessels were present on the Late Bronze Age Uluburun ship, along with goods from the western Mediterranean, northern Europe, sub-Saharan Africa, and the Near East. This glimpse into Canaanite trade highlights possibilities for wine, vine, and knowledge transfer by seafaring Near Eastern cultures directly to Italy in the Bronze Age.

²⁶Cardarelli et al. 2015; Lentjes and Semerari 2016, 3. There may be earlier transmission of wine or viticultural knowledge between Canaanite or Levantine cultures and local populations on Sicily and its minor islands, e.g., Canaanite-type storage jars are present as early as the Early Bronze Age at Monte Grande (Tanasi 2020, 174).

²⁷Pecci et al. 2017a, 54. Some analyses even showed small traces of animal fats, perhaps illustrating multipurpose use of cups, a similar practice to the Greek inclusion of grated cheese in wine, or that wine was mixed with meat broths, possibly precursors to the later Etruscan grog (infra nn. 41–43; see also Pecci et al. 2021, 110).

²⁸Pecci et al. 2021, 110.

It is likely that vines were exploited from the Early Bronze Age on Sardinia, given the notable quantities of carbonized grape pips and charred *Vitis vinifera* wood, and indications that wine was consumed before the arrival of Phoenicians.²⁹ Similarly, evidence of so-called “cultivated” grapevines from the Aeolian island of Salina as well as Vivara, near Ischia, illuminate a degree of Middle Bronze Age (ca. 1500–1400 BCE) expertise in viticulture.³⁰ With the current evidence, it is difficult to determine how early cultivation, in the strictest sense, began in locations like Sardinia, Salina, and Vivara; what is clear is that grapevines, perhaps wild ones, were exploited much earlier than has been traditionally thought. This was also not a linear trend across Italy. Archaeological and archaeobotanical evidence suggests highly localized uptake, in flux with regional and interregional sociopolitical and economic events, and variable diachronically from site to site, often with centuries between.

The slow movement of wine production both westward and within Italy is most visible archaeologically as early as the 10th or ninth century BCE via two streams of development: first, established local exploitation and possible vinicultural activity in places where the native grapevine thrived (e.g., pressed grape residues at 10th- to ninth-century Longola di Poggiomarino on the River Sarno in Campania, and Villanovan Gran Carro in Lazio);³¹ and second, an influx of maritime Phoenician contact with native populations.³² Phoenician knowledge and influence

²⁹Depalmas et al. 2020. The authors use grape pip morphometrics to confirm that “vine cultivation was a fundamental agricultural activity of Sardinia since the Early Bronze Age,” along with botanical and biochemical data to highlight that wine was consumed before the arrival of the Phoenicians. Bartoloni (2017, 330) concludes that grapevine cultivation was introduced on Sardinia as early as the 13th century BCE, perhaps by Mycenaean sailors, but no evidence or paleobotanical scientific data is cited to illuminate what is defined as “cultivation.”

³⁰Martinelli et al. 2021, 39; Brun (2004b, 81) cites evidence of grape seeds from Portella (Salina) and notes that, given its volcanic geology and physical isolation, vines may have been deliberately transported here by boat and planted rather than occurring in the wild. The degree to which this indicates cultivation, rather than exploitation and the beginnings of control, remains debated. Martinelli et al. (2021, 37) suggest that Early Bronze Age (2200–1700 BCE) remains of *Vitis vinifera* at Filo Braccio on the Aeolian island of Filicudi indicate the island’s role in grapevine diffusion in the Tyrrhenian region.

³¹Cicirelli et al. 2008; Lentjes and Semerari 2016, 7; del Mastro et al. 2021.

³²An askoide pitcher from Telavè, Sardinia, shows residual

are observed through similarities in amphora and flask shapes and the transfer of technologies like metalworking, glassmaking, and ivory carving.³³ The intersection of these two streams can perhaps be seen at Cumae, where early indigenous burials, dating from the late 10th to eighth centuries BCE, provide clear evidence for the consumption of wine before the arrival of Greek colonists.³⁴ This included a range of ceramic and impasto beverage sets with cups, askoi, amphoras, and biconical jugs for storage and drinking. Grape pips and residues with chemical indicators for fermented grape juice (of mostly red but also white grapes) were also identified within these vessels. While the authors argue that this indicates the production of local wine, the published evidence so far is insufficient to make such a claim, in comparison to Longola di Poggiomarino, and could equally indicate local consumption of wine sourced from Italy or abroad.

Growing evidence for grapevine cultivation across the Italian peninsula supplements these observations and perhaps links it to the transfer of new vinicultural technical knowledge and cultivars.³⁵ Indeed, Phoenician and earlier Canaanite cultures in the Levant long possessed considerable viticultural technical skill—knowledge that was communicated across their maritime trading network, from the Near East to North Africa, coastal Mediterranean Spain and France, Sicily, Sardinia, the Aeolian Islands, and Etruria.³⁶ Even though the vine also grew wild in Mediterranean coastal Spain and France, recent analyses suggest that, perhaps unlike Italy, cultivation did not commence until Phoenician, Greek, and Etruscan influence from the 10th century BCE, with no evidence for earlier

progressive exploitation of local wild fruits and possible vinicultural activity.³⁷ This additional external impetus, by way of technical and practical knowledge, is hypothesized to have energized already developing Italian viticulture. Local Italian (Villanovan and Etruscan) aristocracies soon adopted and adapted eastern Mediterranean behaviors and established hierarchical drinking customs, equipment, and self-representation.³⁸ Through this, wine and the vine would have accentuated social divisions and perhaps strengthened claims to property rights, given the long gestation period before the vines bore fruit.³⁹

Slightly later, Greek colonial movements further transmitted, embedded or re-embedded, and intensified viticulture across southern Italy. Those who settled in this region named it Oenotria (Antiochos, *FGrHist* 3.555) due to favorable conditions for grapevines.⁴⁰ Greek colonizers may also have transmitted mixed wine beverages, like that made from Pramnian wine, honey, and barley, topped with cheese, and akin to the *kykeon* of Homer (*Il.* 11.638–41; *Od.* 10.234; *Hom. Hymn Dem.* 210). Cheese graters found in elite tombs at Pithekoussai on the island of Ischia, near Naples, point in this direction.⁴¹ Mixed beverages, including Etruscan and Greek grogs, might at times have acted as precursors to a more pure grape wine.⁴² Though the line between pure grape wine and grog is sometimes blurry, many later Roman grape wines were labeled the former despite frequently including added flavors (the Romans also made many different types of nongrape, or “artificial,” wines).⁴³ The extent

traces of wine and has been radiocarbon dated to ca. 1000 BCE (Marvelli et al. 2013, 160).

³³McGovern 2011, 187–88; 2013, 240; McGovern et al. 2013, 10147. Typical Phoenician-style flasks were found in large quantities in the necropoleis of Etruria, with demand for these vessels from the ninth century BCE large enough that they began to be imitated locally (Bartoloni 2017, 329).

³⁴Del Mastro et al. 2017; 2021.

³⁵Trentacoste and Lodwick forthcoming.

³⁶Marvelli et al. 2013, 156 fig. 1; McGovern 2013, 239; McGovern et al. 2013. Ceramic flasks, similar in form to a modern hip flask, from Philistine and Phoenician cultures were found along with local Nuragic ceramic vessels on Sardinia, Mozia (Sicily), and the Lipari Islands, as well as farther east and west on Crete, at Carthage, and El Carambolo, Cadiz, and Huelva on the Iberian peninsula (Bartoloni 2017, 329). These ports of trade clearly acted as melting pots for the transmission of knowledge of wine production and drinking across cultures.

³⁷Pérez-Jordà et al. 2021.

³⁸Brun 2004b, 172; Motta and Beydler 2020, 410.

³⁹See Lentjes and Semerari 2016, 1–2; Riva 2017, 253.

⁴⁰Brun 2003, 87; 2004b, 159; Komar 2020, 58.

⁴¹McGovern 2009, 187–92; 2011, 187–88; 2013, 240.

⁴²Further chemical analyses should be carried out in search of additives in pre–Iron Age beverages, rather than limiting focus and scholarship to just purely grape wine. Evidence already exists for the presence of rosemary, basil, thyme, and pine resin in Etruscan wines (see McGovern et al. 2013).

⁴³Curtis 2001, 376. Pliny (*HN* 14.19) lists a range of non-grape wines, which he calls “artificial,” including those made from millet, date, fig, carob, pear, apple, pomegranate, mulberries, pine nuts, cornel, radish, asparagus, oregano, parsley, mint, rue, thyme, rose flower, wormwood, hyssop, and wood or berries of the cedar, cypress, laurel, juniper, terebinth, or lentisk, along with a range of more obscure herbs and plants. In many cases, it is unclear whether he means that wine itself is made from the fruit or plant, or whether it is simply added to create an alternate version of grape wine (also, on grog, supra n. 42; on additives, infra nn. 199, 200).

to which this differentiation occurred in pre-Roman Italian periods is difficult to determine, made more so by the lack of contemporary written sources.

At Cumae, there are Corinthian A amphoras and metal vessels for drinking in tombs Pontecagnano 926 (seventh century BCE) and Artiaco 104 (late eighth century BCE), which have been suggested to indicate high quality (and expensive) wine buried with the elite.⁴⁴ Rock-cut treading basins on Ischia, perhaps from the Bronze and Early Iron Ages, provide direct evidence of viticultural production.⁴⁵ One example, from Punta Chiarito on the south coast of Ischia and dated to the sixth century BCE, has all the trappings of a fully developed winery: a rock-cut stone basin and, inside the adjacent hut, pithoi, amphoras (local and imported from Corinth and Etruria), billhooks and tools for vine pruning and harvest, and fermentation facilities.⁴⁶ Genomic sequencing of grapevine material also supports links, in the context of Greek colonization, between Greece and first southern Italy, then later central Italy and France.⁴⁷

Recent research has opened the possibility of a third influence on Italian viticulture as early as the Late Bronze Age: a northern overland route via the Danube and Po rivers.⁴⁸ There is, however, less archaeological evidence of connections between Anatolia, one of the posited birthplaces of wine, and the Danube route than one might expect to see.⁴⁹

Archaeobotanical evidence of grapevine cultivation across Italy, likely associated with winemaking, accelerates through the ninth to seventh centuries BCE of the Iron Age.⁵⁰ In the north, coring under the modern hilltop town of Bergamo in 10th- to eighth-century layers identified *Vitis* pollen and grape pips (ca. 830 BCE) in large enough quantities to suggest some sort of concentrated viticultural exploitation.⁵¹ By at least the seventh century BCE, local Italic cultures, notably the Etruscans, had mastered viticulture. Tombs in

Etruria and Latium (e.g., Vulci and Decima) are filled with amphoras that perhaps contained local wine, and vessels in Etruria and the Faliscan region possess religious inscriptions inviting the bearer to drink.⁵² Grape seeds, bronze basins, and *olle d'impasto* from the seventh century were also found in graves I and K in the Roman Forum.⁵³ This should be compared with the literature, however reliable it may be, which reports that Numa Pompilius (traditionally ca. 715–672 BCE) introduced advanced viticulture to Rome and Lazio, characterized by improvements in cultivation technique.⁵⁴

Larger-scale Etruscan wine production undoubtedly increased throughout the Orientalizing and Archaic periods, often leading to interregional export visible through ceramics and shipwrecks.⁵⁵ Industrial local production of ceramic wine amphoras is attested as early as the seventh century BCE, notably in the Albegna River valley (Grosseto) organized within a commercial system centered around Vulci, and Etruscan amphoras were used to export wine to Sardinia, Gaul, and Iberia in the first half of the sixth and fifth centuries BCE.⁵⁶

The production of Italian wine escalates further during the late sixth to fourth centuries BCE, apparent in the remains of agricultural installations at an Etruscan farm at Podere Tartuchino and at Fontanile del Sambuca, Poggio Tondo, Pian d'Alma, and perhaps also Oliovitolo near Taranto (see fig. 2).⁵⁷ It has been argued that changing modes of agricultural production and distribution in the sixth century altered the symbolism of wine in Etruscan funerary and domestic

⁵² Brun 2004b, 172; Perkins 2012, 414. See Komar (2020, 40–42) for a discussion of Etruscan drinking vessels.

⁵³ Komar 2020, 43.

⁵⁴ Plin., *HN* 14.14; Plut., *Num.* 14.3; see Delpino 2007, 135.

⁵⁵ Perkins 2007, 185; Komar 2020, 53–54; Pérez-Jordà et al. 2021, 23.

⁵⁶ E.g., at Sant'Antonio-Marsiliana d'Albegna (Zifferero et al. 2009); see also Riva 2017, 239, 241; Firmati et al. 2021, 99.

⁵⁷ Perkins and Attolini 1992; Brun 2004b, 172–73; Perkins 2012, 417–18; Riva 2017, 241; Van Oyen 2020, 26–27; Trentacoste and Lodwick forthcoming. The infrastructure at Oliovitolo was previously identified as an olive oil processing center, but the published material culture does not satisfactorily remove the possibility of an association with early viticulture. See Cifani 2015 for sixth-century BCE press installations attributed to olive oil, which could equally be multipurpose for oil and wine throughout the annual agricultural cycle, an argument that remains debated but is perhaps strengthened considering the often biennial nature of olive production.

⁴⁴ Brun 2020, 8–10.

⁴⁵ However, dating these rock-cut structures with accuracy is difficult; see Brun 2020, 8–10.

⁴⁶ Ciacci et al. 2007, 56.

⁴⁷ De Lorenzis et al. 2020.

⁴⁸ Pecci et al. 2020.

⁴⁹ P. McGovern via S.M. Valamoti-Kapetanaki, pers. comm. 2021.

⁵⁰ Marvelli et al. 2013, 160; Aversano et al. 2017, 1; Motta and Beydler 2020, 406.

⁵¹ Pini et al. 2021, 539.

contexts.⁵⁸ Greek grape varieties were also continuously transplanted, and production strengthened, at colonial sites from the early fifth century BCE.⁵⁹ While this supports recent arguments that winemaking was systematized and commercialized by interplay between native and immigrant populations,⁶⁰ we must not underestimate substantial existing local expertise for which we now possess a clearer evidentiary base. Even from earlier periods, ancient DNA (aDNA) evidence suggests that centers of varietal accumulation, which often gave rise to new grapevine varieties, were usually near ports or emporia, along major transport routes (including transalpine valleys), or at urban markets that acted as a nexus for concentration and redistribution of products between city and countryside.⁶¹ Aligned with this, morphometric and DNA analyses on grape seeds from Cetamura in Chianti (Etruria) might illustrate changing cultivation and viticultural strategy at the crucial period of rising Roman cultural dominance (ca. 300 BCE–100 CE); namely, significant changes in vineyard management, including grafting, planting in rows, and regular pruning regimes, rather than selection and introduction of new vine varieties.⁶² Local expertise, combined with Phoenician and Greek influence, entrenched winemaking in what would become Roman culture.

VINE CULTIVATION AND THE HARVEST

The inherent destructive nature of archaeology, along with particularly low survival rates of organic material culture and, until recent decades, a deficient scientific skill set, mean that it is often difficult to see ancient viticulture in the archaeological record. This contrasts with the literature, predominantly Roman agricultural treatises, which provides a rich source of information on the entire cultivation life cycle, including determining areas suitable for vines; preparing fields and soil for vines; laying out the vineyard according to the chosen training and support system (when there was one); propagating, grafting, and planting; watering, caring for, pruning, and maintaining vineyards;

and the harvest, including how many workers, what tools, and the exact activities that occur in the final phase of production in the fields.⁶³

Vine-Growing: Evidence from Excavation

Some of the best archaeological evidence for Roman viticultural activity comes from Pompeii. Over several years, Jashemski and her team uncovered areas inside the city walls that were planted with vines. Perhaps best known is the so-called Foro Boario (II.5).⁶⁴ Other evidence exists at the Caupona of Euxinus (I.6), House of the Ship Europa (I.15), House of the Gladiator (I.20), Garden of the Fugitives (I.21) and Garden of Hercules (II.8), and at Regio II Insula 2 and Insula 7. Due to their burial by volcanic material from Vesuvius in 79 CE, vineyard layouts were remarkably well preserved and, in a similar manner to the human bodies at Pompeii, reconstructed using plaster casts. This allowed researchers to compare archaeological material with descriptions by ancient writers. Soil, topography, drainage, spacing between vines, interplanting of fruit trees, methods of vine training, and use of stakes, trellises, and pathways all agreed to varying extents with descriptions by the Roman agricultural writers.⁶⁵ In effect, long-standing hypothetical reconstruction via literature was ground-truthed.

This initiative was furthered recently by excavations and multidisciplinary scientific study at Via della Resistenza just north of Scafati, 3 km east of ancient Pompeii. Within the pre-eruption Roman paleosol, probably from 79 CE, evidence of plowing, ridging and trenching, and furrowing was discovered in the form of an undulating surface indicating planting rows (fig. 3). In fact, distinctive working markings can be seen caused by a broad hoe. The paleosol was cultivated to a depth of 60 cm, trenches were created on top of approximately 20 cm high ridges with groups of two to three small cavities (vine roots) clustered around one larger cavity for a support stake, and then, after trenches were planted and filled, “additional soil material was taken from the sides to pile up around

⁵⁸ Riva 2017.

⁵⁹ Brun 2004b, 164–66.

⁶⁰ See Thurmond 2017, 22–33.

⁶¹ Firmati et al. 2021.

⁶² Aversano et al. 2017. In this case, sample protocol and dating reliability are crucial to verify the validity and reliability of these conclusions. The likelihood of contamination might increase in contexts like this well.

⁶³ Applicable ancient sources have been summarized above in the introduction; see Dodd 2020, 17–22, for an overview of relevant ancient literature.

⁶⁴ Jashemski 1968; 1973a; 1973b; 1975, 53–63; 1979, 201–33; 1993; Boissinot 2009, 111–13.

⁶⁵ E.g., the various Roman methods of vine training illustrated by Jashemski 1973b, 34 ill. 3. On trellising, here and at the nearby Villa Regina, see Brun 2003, 38.



FIG. 3. Roman vineyard from 79 CE cultivated using ridge and furrow, near Scafati, 3 km east of Pompeii, preserved by the Vesuvius eruption (F. Seiler, SALVE project, DAI Berlin).

ridges and along rows.⁶⁶ The vine cavities vary in size from 15 to 60 mm in diameter, clearly indicating that the Romans grew both young vines and those as old as about 10 years side by side as a method of continually rejuvenating the vineyard. An additional, different method of vine propagation was also identified in the field, though it is not described in published material.⁶⁷ It was theorized that because cultivation took place on the top of ridges, furrows may have served as paths through the field or to channel irrigation water.⁶⁸ About 1 m above the pre-eruption surface, 31 regularly distributed yellowish stains were found in the same location as cavities from the Roman level, possibly due to posteruption decay of the vineyard stakes.⁶⁹ The vineyard was probably trained using a type of pergola in the style of *vitis compluviata* with 1.3 m between each vine. Such data clearly aligns with Jashemski's proposed

viticultural systems and the famous Dionysus fresco from Casa del Centenario at Pompeii, as well as the excavated vineyard from Villa Regina at Boscoreale, suggesting regional homogeneity.

Further traces of ancient viticulture and associated hydrological features have been detected elsewhere across the Italian peninsula through excavation and survey. Vineyard trenches from the sixth to fifth centuries BCE were found near Centocelle, with other early examples at Fontanile del Sambuca in Blera (Lazio), Taranto (Apulia), and Acquarossa and San Giovenale in Etruria (see fig. 2).⁷⁰ Those at Blera are in direct association with vats for production, abundant grape seeds, and Etruscan amphoras, clearly illuminating a distinct scale of early viticultural industry.⁷¹ Whether this implies surplus or export, or is simply local or household production on a larger scale, is difficult to determine: low survival rates of other early production infrastructure does not aid comparative interpretation in this regard. There are also many suggestive parallel trenches throughout necropoleis around Paestum (Campania), though viticultural attribution is not certain.⁷² Farther afield, a range of vineyard trenches are known at Megara Hyblaea (Sicily), worked by farmers with small plots of land and likely post-sixth century BCE.⁷³ An enclosure farm near Luceria (Apulia), perhaps second century BCE in date, also appears to have an adjacent vineyard as part of a mixed economy where a range of agricultural activities occurred, including animal husbandry.⁷⁴

Later trenches, some from the Imperial era, were located at Masseria Martelli and Troia Nord near Lucera (Apulia); Pannaconi near Vibo Valentia (Calabria); Tor di Mezzavia, Osteria delle Capannacce, Ponte di Nona, Casal Bianco and Tor Pagnotta just outside Rome, Musarna, and Pian Conserva at Tolfa (Lazio); and Falciano del Massico (Campania).⁷⁵ Such trenches were often historically interpreted as *canali*, perhaps

⁶⁶ Seiler et al. 2016; quote from Vogel et al. 2016, 162; also the poster presentation "New Evidence of Vine-Growing in the Territory of Pompeii" by Seiler at the Vine-Growing and Wine-making in the Roman World conference held in Rome, 27–29 October 2021. An almost identical situation was visible in profile nearby in the modern cemetery of Scafati during construction works.

⁶⁷ My thanks to M. Robinson, via A. Marzano, for this information.

⁶⁸ Vogel et al. 2016, 167.

⁶⁹ Vogel et al. 2016, 163.

⁷⁰ Volpe 2000; 2004; 2009; Brun 2004b, 177; Boissinot 2009.

⁷¹ Zifferero 2012, 89.

⁷² Boissinot 2009, 109–11.

⁷³ Brun 2004b, 165, 172; Boissinot 2009.

⁷⁴ Rossiter 1978, 5–6.

⁷⁵ Arthur 1991, 76–77; Brun 2004a, 28–29, 32–33; Vallelonga 2007, 228; Boissinot 2009, 106, 108, 114, 118. See Volpe 2009, table 1, for a comprehensive listing of vineyard traces in the Roman *suburbium*. Boissinot (2009, 84) provides a detailed description of different types of agricultural excavation in antiquity and how this is represented in the archaeological record, as well as an illustrated overview of all available evidence in Italy (100 fig. 10).

for drainage, though recent interpretation suggests their use for vine cultivation with trenches dug into the bedrock, often soft tufa, to create rows for planting and root growth. Their dimensions and spacing are highly variable across Italy, with some of the smallest (0.5 m wide) dug into limestone at Magliano (Tuscany).⁷⁶ Perhaps wider spacings were used, along with other techniques like the *arbustum* (see below), in humid, rainy, and foggy regions to allow more air between vines and to mitigate certain climatic effects.⁷⁷ Those concentrated in the *suburbium* of Rome are comprised of parallel trenches dug into soft tufa below the soil, typically 0.8–0.9 m wide with a spacing of 2.5 m between trenches and a relatively square profile (fig. 4).⁷⁸ Narrower trenches with a concave profile are instead identified as channels for water, used for either irrigation or drainage, and closely connected to those for vines.⁷⁹ All except one are dated to the Republican period.⁸⁰ At least in central Italy, it seems that extensions to villa complexes in the first to second centuries CE took precedence over viticulture, with vine trenches built over in preference for other profitable, productive endeavors.⁸¹

Most of these trenches are found to the east of Rome, reflecting the suitability of this region for the vine, as opposed to that on the right bank of the Tiber where almost none are found, though excavation bias must be noted.⁸² It seems that in the Roman Republican period the *suburbium* was characterized by cultivation of the vine, interplanted with other fruits, vegetables, wheat, and legumes, probably for consumption in local towns and the city.⁸³ Indeed,

⁷⁶ Marianelli 2011, 40. Cf. dimensions reported throughout Boissinot (2009) and in several examples in Arthur (1991, 76–77, n. 133).

⁷⁷ Cf. Van Limbergen and De Clercq 2021, 472–73.

⁷⁸ Those near Megara Hyblaea also have a square profile and are similarly interpreted as vine trenches (Boissinot 2009, 88–91).

⁷⁹ Volpe 2009, 371.

⁸⁰ Boissinot 2009, 116–17.

⁸¹ Marzano 2007, 116.

⁸² Volpe 2009, 371. It is interesting to compare this distribution and theory to the, admittedly dubious, *Historia Augusta* reference of the emperor Aurelian buying land for vineyards along the Via Aurelia, west of Rome, in an attempt to revitalize Italy's viticulture and add wine to the *Annona* (SHA, *Aurelian* 48). Cf. also the mapped presses around Rome by Tchernia (in Amouretti and Brun 1993, 284).

⁸³ Boissinot 2009, 115; Volpe 2009, 371–80; Marzano 2013. Little evidence exists for amphoras or other ceramic containers produced near Rome, so it is likely that perishable containers,

methods of interplanted cultivation, including the *arbustum* technique, in which vines are intercropped with other plants and encouraged to climb trees, are well represented in ancient Roman texts and archaeology.⁸⁴ Notably, literary sources from the Republican period make no mention of viticulture around Rome; for example, Varro only mentions the cultivation of fruit, vegetables, poultry, and eggs.⁸⁵ Archaeological evidence, therefore, plays a crucial role to fill lacunae in our understanding of local productive topography.

Vine-Growing: Geophysical Prospection and Environmental Studies

The preservation of ancient viticulture in the fields is comparatively rare, however, and other techniques are often used to ascertain similar data. One such technique is geophysical prospection, which can detect agricultural remains through noninvasive remote survey. Methodologies include ground penetrating radar and magnetometry, which have various levels of success in detecting agricultural and other subsurface features. When vineyard trenches or root holes are revealed through these techniques, usually appearing as regular patterns of parallel lines or neatly arranged circular features, it is possible to measure distance, density, and orientation and compare to data provided by excavated samples or ancient descriptions. While further research will be required to create an effective methodological template targeting vineyards or tree groves, promising results have been achieved at *Lucus Feroniae* and *Musarna* (Lazio), and on the Pontine Plain.⁸⁶ It is, however, often difficult to distinguish ancient vine trenches from medieval or early modern ones without excavation.

Other paleoenvironmental scientific techniques complement these methods, including coring, isotope, and pollen analysis. These reveal diachronic changes in landscape use, crop selection, deforestation, and agricultural intensity related to viticulture, which can then

such as animal skins or *cullei*, were used to transport wine the comparatively short distance from suburbs to the city (Volpe 2009, 379–81; Panella in Volpe 2009, 390; Marzano 2013, 88).

⁸⁴ See, e.g., Plin., *HN* 14.14; Brun 2003, 36; Van Limbergen et al. 2017; Van Limbergen 2019, 117.

⁸⁵ Volpe 2009, 384.

⁸⁶ For *Musarna*, see Boissinot 2009, 120. Similar techniques revealed extensive vineyards in the Crimea region, at *Ortli* and *Mamay-Tyup*, dated ca. 300 BCE based on surface ceramics and ground-truthed through excavation (Smekalova et al. 2016).



FIG. 4. Vineyard (white arrows) and hydrological (blue arrows) trenches found at the Villa della Piscina, Centocelle, that predate the villa, probably from the third or second century BCE (R. Volpe; Sovrintendenza di Roma Capitale).

be linked to broader environmental proxies to analyze connections between, and impacts of, climate and geology.⁸⁷ In northern Italy, archaeobotanical material from more than 100 sites dating from the third century BCE to the sixth century CE suggest that cultivation of the grapevine favored areas of shrubby hedgerows and border trees, interspersed with grasslands and pastures.⁸⁸ There are also indications of grapevine, elm, maple, and hornbeam trees close by, perhaps suggesting use of arbustum cultivation techniques.

Cultivation and the Harvest: Protection, Tools, and Art

Disease and natural disaster were constant threats during the growth and cultivation of a vineyard, and ancient societies possessed few resources to protect against such dangers. Hail, in particular, was feared, and two inscriptions found on stones buried in the fields of Noto and Akra in southern Italy contain appeals of protection to Jupiter and magical entities.⁸⁹

⁸⁷ E.g., see Goodchild 2013, 199; McGovern et al. 2017.

⁸⁸ Marvelli et al. 2013 and discussed further in a paper by S. Marvelli, M. Marchesini, E. Rizzoli, and A.C. Muscogiuri at the Vine-Growing and Winemaking in the Roman World conference, October 2021.

⁸⁹ Brun 2003, 44.

Indeed, religion and wine production were often intertwined, with decorated altars, frescoes, and inscribed prayers to pagan gods (and later Christ) in treading and press areas.⁹⁰ In Italy, this can be seen at the villa Magna in Lazio, and villas N. Popidius Narcissus Maior, Giuliana, della Pisanella, in fondo di Palma, and di Sassole in Campania.⁹¹ At Villa Regina, a particularly beautiful Dionysian fresco is the only decorative element in a corner of the otherwise unembellished press room, located above an altar and overlooking a dolium that collected fresh-pressed grape must.⁹²

Various tools used in cultivation and the harvest, and mentioned in Roman literature, provide a tangible glimpse into the daily life and practice of a vineyard worker. Most importantly, the handheld *falx vinitoria* was a multipurpose curved blade used for pruning and other viticultural activities (together with the

⁹⁰ See Dodd 2020, 110; Feige 2021, 44–45. For ancient agricultural responses to climate and weather generally, see Erdkamp 2021, 423–25.

⁹¹ Pasqui 1897, 469; Fentress and Maiuro 2011, 359; Dodd 2020, 110; Feige 2021, 45.

⁹² De Caro 1994. Must is the mixture of predominantly juice, but also skins, stems, stalks, and seeds, that results from crushing grapes in winemaking.

smaller *falcula* for picking grape bunches).⁹³ The *falx* had a paring edge, pointed projection for gouging and hollowing bark, and a small axe blade attached to the back.⁹⁴ Along with the usual type, like those found at Grotta del Malconsiglio (near Sybaris, Calabria) and Benevento (Campania), a diverse range of sickle- and hook-shaped tools were used across the Roman world for viticultural activities.⁹⁵ Prototypical billhook forms have been found from Early Iron Age contexts in Etruria, testifying longevity in agricultural tool practice in Italy.⁹⁶ Indeed, such tools were common for agricultural work in Italy until recently, and still are in some areas. A modern *falcula*, found in a Sicilian flea market, was used in an experimental archaeological study to recreate Roman wine, and others have noticed that a Roman example from Benevento is identical to that used by contemporary Italian vinedressers.⁹⁷ The introduction of regular pruning and vineyard management, enabled through these tools and associated technologies, represents one of the most important innovations in Roman viticulture, leading to larger berries and better yields.⁹⁸

Representations in mosaic, fresco, and relief also provide an important source, particularly to observe aspects of cultivation and the vintage. Rather than simply a tokenistic creative choice, it is far more likely that they represent the local world and context in which they were situated. A relief on a curved well coping at Villa Albani in Rome (fig. 5) depicts workers carrying baskets of grapes to a shallow basin where they are trod by men steadying one another (so as not to slip), with details of a mechanical lever-and-winch press in the background and a juglet and dolium for fermentation.⁹⁹ A similar harvest and treading repre-

sentation appears on the sarcophagus of Annia Faustina.¹⁰⁰ From Rome (Prati), and now housed in the Centrale Montemartini museum, a late third-century CE sarcophagus with remaining gold leaf illustrates a mythical *vendemmia* festival and the wine production cycle in its entirety from harvest to transport and treading (fig. 6). Here, putti with woven baskets climb ladders to reach grapes from vines trained high into trees—further evidence of the arbustum technique, in which vines were specifically trained to trees, often in rows. The reality of this romanticized illustration is delivered by Pliny the Elder, who describes the reluctance and fear of farmers that were required to climb dangerously high into trees to prune the grapevines (*HN* 14.14). The elaborately decorated treading basin has no outlet or collection structure, emphasizing the fantastical nature of the scene or perhaps suggesting that the grape must underwent initial fermentation on the skins within the basin. To the south, at Minturnae, a mosaic floor in the imperial baths portrays similarly winged cherubs picking grapes from vines, pouring them from baskets into a brick treading basin with must flowing into dolia. Representations like these work in tandem with survey, excavation, scientific, and textual data to provide a well-rounded comprehension of Roman viticulture and viniculture.¹⁰¹

WINEMAKING

Discussion in the following sections is supplemented by the chronological information in the online appendix.¹⁰² It should be noted that in many cases, dating production facilities is inherently difficult, and the dates offered here either indicate general periods of production at a specific site or use and occupation of a site more generally. Excavated sites typically provide the most accurate and reliable chronological data for ancient winemaking.

Treading

Given winemaking's long history, by the Roman period, it was a well-developed technical process with diverse production techniques. Within the Roman world, and certainly by the Early Republican era, people from a range of backgrounds developed these

⁹³ Billiard 1913, 349–52; Brun 2004b, 26; White 2010, 93–97.

⁹⁴ Brown et al. 2001, 753. See illustrations in Billiard 1913, 349; Brun 2003, 41.

⁹⁵ Brun 2004a, 32. E.g., note the range of examples held in the British Museum collection (Manning 1985; Brown et al. 2001, 753). Early examples from the Iron Age and Archaic period have also been recovered (Bartoloni 1987), including very early seventh- to sixth-century BCE examples from Punta Charito (Ischia) perhaps belonging to a Greek settler (Boissinot 2009, 111).

⁹⁶ Delpino 2007, 192, 196.

⁹⁷ White 2010, 185; Indelicato et al. 2017, 323.

⁹⁸ Aversano et al. 2017, 11. Perhaps also recognized by Pliny (*HN* 14.14) through his account of King Numa proactively requiring farmers to prune their vines.

⁹⁹ Villa Albani, Rome; acq. date n/a, doc. Zoëga 1808, pl. xxvi; see also Brun 2003, 211–12.

¹⁰⁰ Billiard 1913, 164.

¹⁰¹ See Dodd (2020, viii) for definition and discussion of the difference between viticulture and viniculture.

¹⁰² Online appendix is available at <https://doi.org/10.1086/719697>.

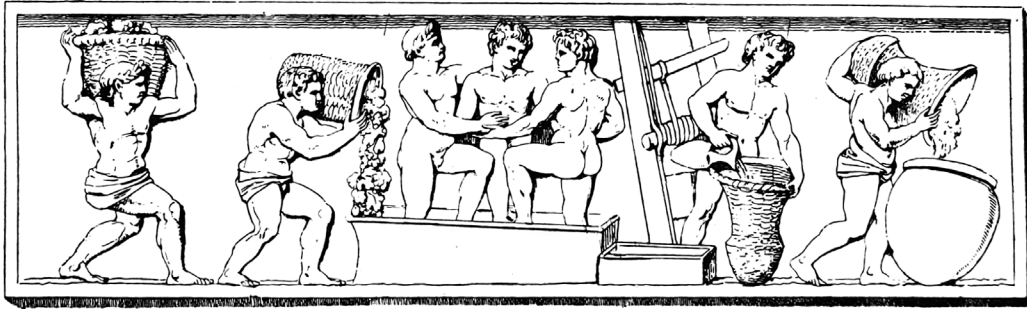


FIG. 5. Drawing of a relief depicting workers carrying grapes, treading in a basin with square collection vat, and decanting wine into portable jars and then a dolium. There is a rare depiction of a lever-and-winch press in the background. Relief in Rome, Villa Albani; acq. date n/a, see n. 99 (after Drachmann 1932, fig. 21).



FIG. 6. Sarcophagus from Prati, Rome, with mythical *vendemmia* (harvest) scene, depicting putti and the sequence of harvesting activities, late third century CE, Luni marble. Rome, Musei Capitolini, Centrale Montemartini, M.C. 839; excav. 1889 (E. Dodd; © Roma, Sovrintendenza Capitolina ai Beni Culturali).

further, creating increasingly diverse quantities, qualities, and types of wine. These developments are apparent already by the third to second century BCE through the writings of Cato (*Agr.* 24, 104–25), which include recipes for making various types of wine, as well as Pliny (throughout book 14 of *Naturalis historia*) and Columella's extensive discussion (*Rust.* 12.27, 12.37–42) of diverse wines in the first century CE. Indeed, the increasing complexity of vinicultural production processes, in time, knowledge, and resources required, naturally led toward the creation of socially stratified products with qualitative differences.¹⁰³

¹⁰³ See Van Oyen 2015, 117; 2020.

This complexity is also seen in processes that were implemented before treading or pressing. Perhaps the most common was to dry grapes, either outside in the sun, in attics over kitchen ovens, or in *fumaria*, to produce specific wines. The process of drying, or raisining, grapes increased sugar levels and created a very sweet wine, sometimes called *passum* in the Roman era but extending back at least to Phoenician and Hittite cultures.¹⁰⁴ The grapes were also boiled, sometimes

¹⁰⁴ See, e.g., the text on the Hittite tablet *KUB* 17.13 col. ii, 5–8. See Dodd 2020, 59–64, for an extensive discussion of *passum*, its production, types of grapes that were used, and related features. In the ancient literature, see, e.g., Ath., *Deipnosophistae* 14.653e; Columella, *Rust.* 12.27, 12.39.3–4; Dioscorides 5.6.4; Galen, *On Good and Bad Juices* 6.800–01; Hes., *Op.* 609–18; Mart., *Epigrams*

in oil, to achieve a similar effect.¹⁰⁵ These sweet wines might find parallels today in the production and taste of *passito* from peninsular Italy and Sicily, particularly the Moscato Passito di Pantelleria, as well as Vinsanto wines from Italy and the Cycladic region of Greece.¹⁰⁶

Once harvested, grapes could be laid in basins or on floors and left to rest for several days, which allowed juices to be naturally extracted by static pressure under their own weight.¹⁰⁷ This process created the highest quality must in the Roman age, called *prototropum*—more desirable with its sweeter and less acidic taste. This should not be confused with the *mustum lixivium* described by Columella (*Rust.* 12.27, 12.41), which is instead must from grapes “barely trod” but not yet pressed. The latter actually involved gently treading grapes, while the former was simply a static release of juices. The degree to which the production of *prototropum* occurred in Italy is difficult to determine without much recognizable infrastructure and architectural remains.¹⁰⁸ We might expect to see shallow, waterproof basins with no collection receptacle, or with a very small collection vat or jar attached, so that grapes could be laid out and small quantities of must collected, as hypothesized at Villa Magna in a quadripartite basin.¹⁰⁹ Those installations with multiple, discrete collection compartments that allow various qualities of grape must to be separated might also be used for this purpose. Such structures have been identified more commonly elsewhere, often in the eastern Mediterranean, and are thought to relate to the initial production of *prototropum* via static pressure.¹¹⁰

13.106; Palladius, *Opus agriculturae* 11.19.1–2; Plin., *HN* 14.81.

¹⁰⁵ Plin., *HN* 14.11; Stat., *Silv.* 4.9.38.

¹⁰⁶ See Dodd 2020, 61, for an extended discussion of modern equivalents.

¹⁰⁷ Dodd 2020, 55.

¹⁰⁸ That Pliny (*HN* 14.85) mentions *prototropum* suggests it was used in Italy and farther east (see also Fentress and Maiuro 2011, 352). Such a technique is still used today, in which vintners pick whole bunches of grapes and lay them in vats for 10 days.

¹⁰⁹ Fentress and Maiuro 2011, 348–53. It is possible that the treading floors and vats commonly found at villas and other installations were used for this purpose, however this would slow down the production cycle considerably. *Palmenti*, or rock-cut basins and vats, could also hypothetically be effectively used for this process. Perhaps, when a cluster of multiple *palmenti* are found, it is possible to theorize various types of must extraction from grapes, and hence qualitative difference in wine, occurring simultaneously (e.g., static pressure and treading and pressing).

¹¹⁰ For potential examples, see Segal et al. 2005, 42; Seligman 2011, 379. Distinguishing between structures designed specifi-

Treading floors (*calcatoria*) or vats are perhaps the quintessential piece of archaeological evidence signifying Roman wine production. Fundamentally unnecessary in the production of olive oil, the presence of a treading floor or basin distinguishes between two industries often otherwise difficult to tell apart. Up to 80% of the grape juice can be extracted by treading, which created the second highest quality wine.¹¹¹ Examples of such floors abound across Italy (fig. 7), from imperial contexts like Villa Magna near Anagni and elite *villae rusticae* around Boscoreale in Campania to those producing on a smaller scale for local demand, like the small treading floor within the walls of Pompeii, at Regio I Insula 20, that flows into a single dolium.¹¹² Other small treading floors exist within the urban fabric of Pompeii, at the House of the Summer Triclinium (II.9.6), the House of Felix and Sabinus (II.1.8–9), and at V.4.6–8 (in rooms located behind a street-side *taberna*) probably producing wine for local demand to be sold at taverns.¹¹³ The latter example, along with its collection dolium and the eight *dolia defossa* in the adjacent room,¹¹⁴ was sampled and tested using GC-MS. Results indicated the presence of tartaric and succinic acids on the treading floor and dolia, suggesting they were used for wine production, and pitch (from Pinaceae) in the dolia in the *cella vinaria* (fermentation and storage cellar), commonly used to coat and waterproof ceramic storage jars.¹¹⁵ An earlier example, dated to the Hellenistic era, but similar in function and scale to those at Pompeii, can be seen at Marta (near Lake Bolsena, Lazio), where

cally for initial collection as opposed to small treading floors and vats for primary fermentation remains very difficult and attributions are largely speculative.

¹¹¹ Thurmond 2017, 25; Dodd 2020, 55.

¹¹² See Dodd 2017.

¹¹³ The last location also has a *cella vinaria*, a fermentation and storage cellar, with eight dolia of various sizes (see Zaccaria Ruggiu et al. 2010).

¹¹⁴ *Dolia defossa* are large ceramic jars (dolia) that are either partially or completely buried in the ground to create stable temperatures and microclimates for goods storage (Cheung 2021a, 69–71; Montana et al. 2021; Cheung et al. 2022).

¹¹⁵ Interestingly, some of the dolia also presented high concentrations of oleic acid, suggesting that they were reused at some point in their use life cycle. These results were presented in a paper by A. Pecci at the Vine-Growing and Winemaking in the Roman World conference, October 2021. For more on this installation, see Brun and Neyme 2008.

two floors of travertine pavers each flow into a square collection vat.¹¹⁶

In 1939, Bastianelli reported *calcatória* at a staggering 50 villas in the territory of Civitavecchia.¹¹⁷ Others of varying size have been located on the Adriatic coastline,¹¹⁸ in Umbria,¹¹⁹ Tuscany,¹²⁰ just outside Rome and in Lazio,¹²¹ Campania,¹²² Calabria,¹²³ and possibly also the tanks and pavements at Villa Russi and Bologna (Emilia-Romagna).¹²⁴ Less certain evidence of *calcatória* has been identified at other sites in central Adriatic Italy,¹²⁵ Campania,¹²⁶ Tuscany,¹²⁷ Lucania,¹²⁸ and Umbria.¹²⁹ Mortared flooring at San

Pietro in Cariano (first–sixth century CE, Valpolicella) was tested using residue analysis with results indicating the presence of wine, perhaps suggesting use as a treading floor.¹³⁰ Many examples of Imperial-era processing facilities for wine, likely with treading floors, exist in ancient Latium.¹³¹ The villas of Volusii, Nocioni, and della Standa at Lucus Feroniae were also possibly equipped with wine producing facilities.¹³² The villa or farmhouse structure at Santa Maria della Strada, Matrice (Molise), has two adjacent rooms, each with at least one collection dolium surrounded by what is likely a waterproof *cocciopesto* treading floor. Grape pips were also found in the paleobotanical study.¹³³ Interestingly, there is little evidence in the far north, around Valpolicella, with only four *calcatória* identified so far.¹³⁴ Rather than concluding that wine was not produced here in the Roman era, this is far more likely an indicator of climate and microregional-specific production practices, where facilities and equipment made from organic materials were used to a greater extent than in central and southern Italian regions.

¹¹⁶Brun 2004b, 173–74. There is possibly another similar structure, albeit poorly recorded, in a building at the seventh km of the Via Appia Antica near Rome (cf. De Franceschini 2005, 2015–17; Feige 2022, 345).

¹¹⁷Marzano 2007, 353.

¹¹⁸Tortoreto Muracche, Colombara di Acqualagna, and perhaps Fontanelle di Monsampolo del Tronto (Van Limbergen 2011, 78; 2019, 113).

¹¹⁹San Giustino at Colle Plinio (Marzano 2007, 110–12, 737).

¹²⁰Settefinestre (Brun 2004a, 38–42; Marzano 2007, 106).

¹²¹Guidonia, Via Nomentana (near S. Alessandro), Via Tiberina and Via Gabina, Villa Magna, Fosso di Montegiardino, Granaraccio near Tivoli (though this is debated and is likely for olive oil), and nearby Nemi (Rossiter 1978, 52; 1981, 348–49; Brun 2004a, 11; De Sena 2005, 144; Marzano 2007, 110; Fentress and Maiuro 2011, 351–52; Feige 2022, LA-28).

¹²²Villas Carmiano/Gragnano at Stabiae, Columbrella, and Somma Vesuviana (Rossiter 1978, 41–45; 1981; Aoyagi et al. 2018, 147–48; Ciafardini 2018). A. Pecci (at the Vine-Growing and Winemaking in the Roman World conference, October 2021) described residue analysis completed on samples from the Villa Columbrella floor, which confirmed the presence of (possibly red) wine.

¹²³Grotta del Malconsiglio and possibly also the tanks and pavements at Pannaconi (Rossiter 1978, 51; 1981, 349; Brun 2004a, 32–33).

¹²⁴Blake 1930, 149–50; Ruggini 1961, 530–33; Ducati 1974, 422–23; Susini 1975; Rossiter 1978, 29–33; Brun 2004a, 48–49. Also, generally, see the catalogues of Rossiter 1981, 360–61; De Sena 2005, 144–47; Feige 2022.

¹²⁵Fermignano San Giacomo Sant' Ippolito di Fano (Van Limbergen 2019, 113).

¹²⁶Santa Maria del Piano and Moscuoso (San Pietro Infine) (Salvatore and Nava 2011, 773–74; Zambardi 2014).

¹²⁷Montelupo (Marzano 2007, 691).

¹²⁸San Giovanni di Ruoti (Rossiter 1981, 349).

¹²⁹At Orticello and perhaps also at Pennavecchia (Marzano 2007, 113, 721, 733). One phase of the villa at Pennavecchia included nine dolia, forming what was interpreted as a *cella vinaria* (Marzano 2007, 721). How and why an attribution to wine, and not oil, production was formed is unclear from the published data. The production of either commodity is theoretically possible with this quantity of dolia and no other conclusive

paleobotanical or chemical evidence.

¹³⁰I am grateful here for discussion with P. Basso and D. Dobrevá at the Vine-Growing and Winemaking in the Roman World conference, October 2021.

¹³¹At the villas of Castel Giubileo, Cinquina, Grottarossa (Saxa Rubra), Monte Canino, Tor Bella Monaca on the Via Gabina, L. Coelius Nicephorus on the Via Aurelia, Via Praenestina at Casal Bertone near Rome, Prima Porta (Cimitero Flaminio), Grotte di Cervara, and at Villa Campetti near Veii (Brun 2004a, 10–11; De Sena 2005, 145–46; Marzano 2007, 493, 505, 521, 631, 643). Phase 2C at Tor Bella Monaca (Site 11) preserves likely evidence of oil production using vats and a press, but the excavators also indicate the possibility of wine production in rooms to the south (Widrig 1980, 127–28). This is noted through “an enclosed and raised basin with an *opus spicatum* floor,” along with ash found in situ and perhaps linked to smoking or heating to alter fermentation (128). The latter process has been hypothesized elsewhere in Italy (cf. infra nn. 197, 198).

¹³²Marzano 2007, 369–72. Attribution of oil or wine production at the Villa dei Volusii remains unclear. Stone fragments might indicate the existence of a mortar, suggesting oil production, and *dolia defossa* might support wine (S. Båse, pers. comm. 2021). The situation at the Villa dei Nocioni is similarly unclear with confusion in publications between the existence of one or two presses and a lack of clarity regarding the location of the press itself (cf. Gazzetti 1992; Marzano 2007). A single vat was found, which in itself does not help to distinguish between wine, oil, or other uses.

¹³³Lloyd 1981, 6; 1984, 2–3. My thanks to E. Pomar and S. Kay for discussions about the structures at Santa Maria della Strada, Matrice.

¹³⁴Again, I thank P. Basso and D. Dobrevá for helpful discussion at the winemaking conference in Rome, October 2021.



FIG. 7. Map of major sites mentioned in the text related to treading floor structures and *palmenti* (map by E. Dodd with base GIS and hillshade data from the EEA and Esri).

In wineries at Posta Crusta (Foggia), San Rocco and Casino Marinelli (Francolise, Campania), and Scalea (Calabria), a raised, round platform in the center of the treading floor allowed trampled skins and stalks to be placed higher.¹³⁵ This encouraged must to flow into the collection vat, reduced pooling liquid, and

¹³⁵Von Blanckenhagen et al. 1965, 59; Frankel 1999, 157. The installation at Posta Crusta was previously attributed as oil-producing (cf. Rossiter 1978, 6; 1981, 356; Lafon 1993; Brun 2004a, 29). However, this is far from certain; it may have been transformed into a winery at a later stage. Preservation of the Phase I villa at San Rocco is poor, so it is unclear whether the raised floor here was for grain threshing or part of a treading process for wine (cf. Cotton and Métraux 1985, 11–26; Frankel 1999, List B, T84).

eased the labor of treading, an innovation that seems to have remained localized in central and southern Italy. Slightly unusual architectural forms also exist, mostly where earlier structures are later transformed into productive spaces. The winery at Villa della Muracciola on the Cassia Nuova presents an apsidal building and adjacent room with *dolia* and a *calcatorium*, perhaps similar to the Villa Subaugusta near Cinecittà (Rome) where an apsidal room was also later converted into a *calcatorium*.¹³⁶ More unusual is an octagonal structure at Asinello, near Viterbo, built over terrain previously

¹³⁶Marzano 2007, 119, 491, 513. Feige (2021, 37) and Purcell (1995, 157–73) suggest theatrical and sensory motives here, like those at Villas Magna and dei Quintili.

planted with vineyards and which housed presses and *dolia*.¹³⁷

Treading floors could be used alone, as at Pompeii, with a mechanical press in the same physical space, like the now-reconstructed Villa dei Misteri press, or with the two processes entirely separate, as at the Late Republican villa at Tortoreto Muracche. At Villa Magna, the sole use of a large treading area on an imperial estate may signify higher-quality production and, when combined with literary evidence, possibly also ritual, theatrical, or performative elements.¹³⁸ Indeed, depictions in mosaic and relief clearly show a lively and celebratory atmosphere around the treading process, like the bas-relief from the Biblioteca Marciana (Venice), which shows two animated men in motion, holding hands as they stomp grapes and use poles for balance, an atmosphere reflected in literary accounts of the *vinalia rustica*.¹³⁹ Art from late antiquity might even emphasize the treading process; for example, the fourth-century CE mosaic from Piazza Armerina (Sicily) as well as the four mosaic scenes from the roughly contemporary Mausoleum of Constantia in Rome (fig. 8) and the many later sarcophagi with fantastical treading depictions. It was treading that produced the initial juice considered purest and of the highest quality (behind the more specialized *prototropum* in some instances). The flow of this “first fruit” and subsequent transformation into wine echoes Christian spiritual belief.¹⁴⁰

Mention must also be made of rock-cut treading areas, or *palmenti*, with adjoining vats, either single or multiple, for collection, decantation, and perhaps fermentation of wine. While these are common on Sicily and Ischia, new research is recognizing and analyzing examples across peninsular Italy at sites like San Biagio a Castel del Piano, San Sepolcro, Monte Amiata, Seggiano, and Vitozza (Tuscany); San Leo (Marche); Allumiere, Tolfa and Manziana near Civitavecchia, and Norchia (Lazio); Serramezzana and Novi Velia (Campania); and Ferruzzano and Bruzzano (Calabria) (see

fig. 7).¹⁴¹ The *palmenti* can be quadrangular or (more rarely) circular in shape, of various sizes and arrangements, and are typically located near water sources, on elevated ground, and with surrounding vineyards, often wild vines.¹⁴² The last feature led Zifferero to suggest that perhaps they were predominantly for processing wild grapes, though without archaeobotanical evidence to confirm, this is very difficult to prove.¹⁴³ Such features generally lack clear dating material and are variously attributed to anytime from the Archaic to pre-industrial eras; however, reinvigorated study using more rigorous scientific methodologies is proving effective and provides more detailed answers regarding topography, structure, chronology, and use. Some *palmenti* on Sicily appear to be pre-imperial in date (perhaps Punic-Hellenistic), abandoned during the imperial era, but reused again from the Byzantine period onward.¹⁴⁴ Though dating is complicated, Brun rightly notes that *palmenti* were likely used throughout antiquity, contemporaneously with larger villa-scale productions, by different people with distinct purposes.¹⁴⁵ Finally, an interesting hybrid feature is seen at Procoio Nuovo (Lazio) where a vat for winemaking is dug into the tuff bedrock accompanied by two adjacent *dolia defossa*.¹⁴⁶

Smaller operations that used portable basins made from organic materials, of which nothing remains in the archaeological record, were likely present throughout antiquity and complicate interpretation.¹⁴⁷ The quantity of treading facilities visible today, therefore,

¹³⁷ Attribution to wine or oil is debated (Brun 2004a, 42; Marzano 2007, 116–18, 645; Feige 2021, 47).

¹³⁸ Fentress and Maiuro 2011. See Purcell 1995, 170, for examples of production as spectacle.

¹³⁹ Billiard 1913, 440; Brun 2003, 55–57. The *vinalia rustica* was a festival to celebrate the opening of the vintage on the 19th of August, before which no must was allowed to be conveyed into the city until various rites were performed (Smith 1875, 1198).

¹⁴⁰ Brun 2003, 201; Rossiter 2008, 98–101.

¹⁴¹ Ciacci et al. 2012, 531–79; see also map in Olcese et al. 2020.

¹⁴² Olcese et al. 2020, 34–35.

¹⁴³ Zifferero 2012, 89.

¹⁴⁴ Olcese et al. 2020, 37–39. Simultaneously, GC-MS testing of the vats indicates that they were used for wine and often waterproofed and lined with pitch and resin (Garnier 2020; Olcese et al. 2020, 40). Results were also able to differentiate between red and white grapes (via the presence or absence of syringic acid), with only one installation restricted to white (Garnier 2020, 44), though this syringic-malvidin method can be problematic. McGovern et al. (2021) also recently highlighted potential flaws in extraction methods. For comparative studies using a range of methodologies in Italy, including an introduction to residue analysis and uses on plasters, ceramics, and flooring to detect wine, oil, *garum*, and other products, see Pecci et al. 2013a; 2013b; 2017a; 2017b; 2018; McGovern and Hall 2015; Pecci 2018; 2020.

¹⁴⁵ Brun 2012, 76.

¹⁴⁶ Marzano 2007, 439.

¹⁴⁷ Rossiter 1981, 348; Van Limbergen 2011, 81; Marzano 2013, 101; Brun 2020.



FIG. 8. Section of mosaic on the northwestern ambulatory vault at the Mausoleum of Constantia (now Santa Costanza) in Rome, fourth century CE. Grapes are harvested by climbing the vines and are lowered in baskets on ropes, then brought to the production facility in carts, and are trod in roofed treading floors with lionhead spouts that convey must into dolia (E. Dodd; courtesy Social Communications Office of the Vicariato di Roma.).

provides a skewed distribution (both socioeconomically and quantitatively) and is certainly considerably fewer than once existed. This is particularly applicable for certain regions (e.g., see above for Valpolicella). Such a biased perception is a major obstacle for future research in this field and can lead to vicious interpretational circles of extrapolating inaccuracy regarding the quantified participation of certain socioeconomic classes in ancient viticulture.¹⁴⁸ Naturally, this also impacts our understanding of the ancient agricultural economy and its scale. Recent projects are attempting to rectify this oversight;¹⁴⁹ indeed, recognition and

¹⁴⁸ One only needs to look at past studies of Roman wine production in Italy (and still today, cf. Feige 2022), which focus emphatically on villas, in part due to archaeological bias and survival rates, and often fail to acknowledge the invisible, admittedly small-scale, production that probably permeated Roman viticulture. Even studies of ceramics and amphoras may not assist greatly in this regard; highly localized, perhaps low-quality production intended for relatively quick consumption may well have been stored in organic containers (e.g., animal skins). When taken in sum, however, the output of this invisible sector could have formed a significant portion of Roman wine production in certain contexts. Domestic, small-scale production like this continues in Italy today, where many families make their own *vino nuovo* or the more modern *vino novello*, drunk just a few months after the harvest.

¹⁴⁹ E.g., see Dodd 2021; 2022; Kelly 2021. Projects like The

acknowledgment of such lacunae is an important step forward in ancient viticultural (and agricultural) scholarship.

Pressing

Harvested grapes could be trod twice before the remaining pomace/marc was placed in baskets made of loosely woven rushes, wound rope, or cloth, or in a wooden box (figs. 9–12) for mechanical pressing (Columella, *Rust.* 12.39.3–4).¹⁵⁰ This mechanical process produced progressively lower qualities of wine; from the first (deemed similar to trodden must), through the second (so-called *mustum tortivum* or *circumsiccium*, often used in medicine), to the third and fourth (Latin: *lora*; Greek: *deuterius*; Hebrew: *tmd*).¹⁵¹ Even lower qualities involved soaking the remaining pomace in water and pressing the rehydrated substance to produce a cheap ‘after-wine’ for workers and the lower classes (Cato, *Agr.* 25.1; Varro, *Rust.* 1.54.3; *Geoponika* 6.13).¹⁵²

Roman Peasant Project are crucial in this rebalancing and already illuminate rural lower classes that were more sophisticated than previously acknowledged (see Bowes 2020).

¹⁵⁰ Dodd 2020, 55.

¹⁵¹ Frankel 1999, 42; Dodd 2020, 56.

¹⁵² Forbes 1956, 132; Frankel 1999, 42–43; Dodd 2020, 56.

The presence of a mechanical press (*torcular* or *torculum*) indicates winemaking for a distinct scale or purpose and is traditionally thought to indicate surplus production and a degree of investment.¹⁵³ Wine can, after all, be made simply by treading grapes with little technological involvement. Yet across the Mediterranean, presses vary greatly in size, complexity, and technology, all of which influence the required expertise, investment, labor, and, subsequently, impact on the product. Press choice is equally influenced by cultural traditions and habits, knowledges, and available resources. The investment needed to purchase presses, also seen below for *cellae vinariae*, contradicts recent arguments that aristocrats, at least in the republic, could not have derived significant wealth from viticulture and that, instead, such investment is the result of wealth derived from other sources.¹⁵⁴ Evidence from, for example, Gaul, Hispania, and perhaps Greece, documenting the progressive expansion of productive villas, might suggest the contrary.¹⁵⁵ Whether driven by agricultural success or outside investment, the diversity of press technology and vast variability in winery scale and infrastructure must reflect a range of socioeconomic strata. The inherent flexibility of viticulture and the winemaking process further enabled this.

Despite such vast possibilities, current archaeological evidence suggests Italy possessed a rather distinct mechanical press tradition throughout antiquity, one that finds echoes in France, Spain, and Istria/Dalmatia but little elsewhere in the Mediterranean. Indeed, press technologies were highly regionalized throughout the ancient Mediterranean. Broad-stroke technological development and uptake rarely occurred, and centuries-old presses were used along with new technologies with choice dependent upon a range of individualized criteria unique to each producer's situation.¹⁵⁶ The architecture and flooring of press rooms in Italy typically uses either *cocciopesto* (waterproof plaster) or *opus spicatum* (herringbone brickwork), or both, with the latter more common among installations in central and northern Italy (though this is by no means a rule). During the Middle Republican era somewhat of a "press revolution" took place, the result of centu-

ries of viticultural evolution and maturation within Italy. This was spurred by favorable socioeconomic conditions and agricultural expansion and is reflected in Cato's text. It is here for the first time that we find colossal lever presses installed in villas, with powerful winches and heavy masonry, of a size not yet seen even in well-established winemaking cultures farther east.¹⁵⁷

In Italy, these presses form two broadly defined types (fig. 13) though there is great variation within these broader groups. Both types can be used for other commodities (e.g., pressing olives for oil), so, unless indicated otherwise, only those with secure viticultural attribution are listed below. Detailed chronologies and geographies also present difficulties when associated with type. Significantly more research dedicated to Italian press architecture is needed to untangle these complications and nuance the often simplistic distinctions that follow here. This will form a crucial future research direction for the field.

Press Type 1. The first type, historically called the platform press, is best illustrated by examples from the elite agricultural villas of Campania, although it now finds similarities in other Italian regions (see fig. 13).¹⁵⁸ It characteristically features a lever-and-drum mechanism directly anchored into the ground, lowered by a winch and handspikes (*sucula*) and pressing over a platform that is often also used for treading. Archaeologically visible are usually two square holes to hold the vertical wooden beams (*stipites*) supporting the winch mechanism, and one hole at the rear end (fulcrum) of the press for an upright (*arbore*).¹⁵⁹

Typical examples in Campania are those at the villas della Pisanella, Regina, and dei Misteri (see fig. 9), at the so-called Stazione and Giuliana farmhouses in Boscoreale, and the villas of C. Olius Ampliatus (southeast Naples) and Prato at Sperlonga (Lazio).¹⁶⁰ A rapidly deteriorating wall painting in the House of the Vettii in Pompeii (VI.15.1) depicts this mechanism.¹⁶¹ Elsewhere in Italy, similar lever-and-drum presses might have existed at Ca' Balduini di sopra, Piano della Monaca, and Tortoreto Case Ozzi in the

¹⁵³Rossiter 1981, 348; Van Limbergen 2011, 81; Lewit 2012, 146; 2020b, 195–96, 213; Marzano 2013, 92–93.

¹⁵⁴Terrenato 2001; Rosenstein 2008.

¹⁵⁵Marzano and Métraux 2018, 488.

¹⁵⁶Lewit and Burton 2019, 106; Lewit 2020a, 314–15, 322; Dodd 2020, 108 n. 804; 2021, 132–33.

¹⁵⁷Brun 2004b, 182.

¹⁵⁸Rossiter 1978, 49–55; 1981; Frankel 1999, 91–93; Baratta 2005, 84–85.

¹⁵⁹Rossiter 1978, 49.

¹⁶⁰Rossiter 1978, 12–14, 18–21; Frankel 1999, List B, T980; Broise and Lafon 2001; Brun 2004a, 14–20; 2004b, 181–83; Cascella and Vecchio 2014; Feige 2022.

¹⁶¹Brun 2003, 212.



FIG. 9. Reconstructed monumental platform press at the Villa dei Misteri, outside Pompeii, with lever-and-drum mechanism and relevant components indicated as mentioned in the text (E. Dodd; courtesy Ministero della Cultura – Parco Archeologico di Pompei).



FIG. 10. Reconstructed press at Regio II Insula 5 at Pompeii, with deteriorated dual collection vats at bottom left. Although it is reconstructed incorrectly, using a winch rather than the more likely screw type, it remains a good example of a Roman press (E. Dodd; courtesy Ministero della Cultura – Parco Archeologico di Pompei).

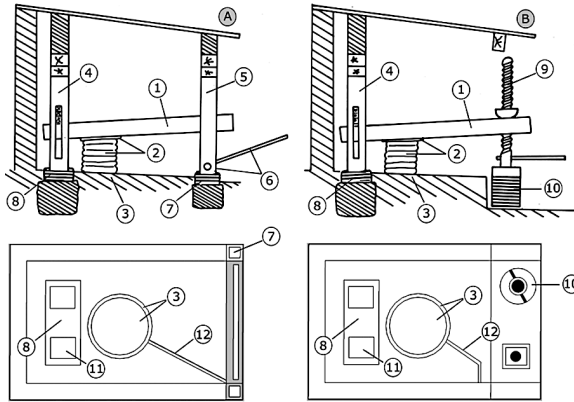


FIG. 11. Diagrams of two varieties of the circular bed press type: A, an anchored lever-and-winch type; B, a hanging lever-and-screw type. 1, *prelum* (wooden beam); 2, *fiscinae* and *orbis* (press baskets and wooden disk); 3, *ara* and *canalis rotunda* (press bed and circular channel); 4, *arbores* (fulcrum-end wooden piers); 5, *stipites* (mechanism-end wooden piers); 6, *vectis* and *sucula* (lever attached to the drum); 7, *silex* (base block for the *stipites*); 8, *lapis pedicinus* or *forum* (base block for the *arbores*); 9, *cochlea* (vertical screw); 10, *arca lapidum* (screw counterweight); 11, *foramina* (*arbore* holes); 12, *canalis* (channel leading to collection vat or *dolium*) (after Van Limbergen 2019, fig. 4).

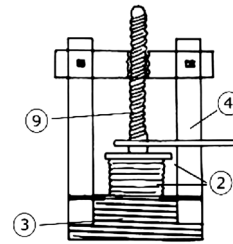


FIG. 12. The direct-pressure screw press: 2, *fiscinae* and *orbis* (press baskets and wooden disk); 3, *ara* and *canalis rotunda* (press bed and circular channel); 4, *arbores* (vertical wooden piers); 9, *cochlea* (vertical screw) (after Van Limbergen 2019, fig. 4).

central Adriatic region of Picenum (from the second century BCE onward); Monte Canino, Capena (Lazio); San Giuliano and Villa di Leonessa (both with *opus spicatum* flooring like installations in northern Italy and at Francolise in Campania), and also probably at Villa d'Agnuli near Mattinata (Apulia); Ciminata near Rossano, with two presses and *opus spicatum* flooring, and Pannaconi near Vibo Valentia (Calabria) (see fig. 13).¹⁶² Press stones suggesting use in lever-and-drum systems are known elsewhere in Lazio (e.g., on the Via Triumphalis at Policlinico Gemelli and at Bovillae) though it is impossible to determine whether these were for wine production.¹⁶³ An excavated villa at Pian della Civita, Artena, has a roughly similar *torcular* and vat with dimensions that might suggest wine production.¹⁶⁴ A villa at Gambarata (Emilia-Romagna) probably produced wine and has a large lever-and-drum counterweight with exterior dovetail mortises and a lateral groove on top—a type very rare in Italy, especially the north, but common in Greece, North Africa, France, and Spain.¹⁶⁵ There is also similar press

evidence at the second-century BCE Villa di Canneto, near Termoli (Campobasso), in a system reminiscent of the Campanian type, and other winepresses of an unidentifiable type at the Villa d'Alba Docilia, Albisola (Liguria), and the villas Fiumana (Emilia-Romagna) and Joannis (Friuli).¹⁶⁶

It was previously thought that this type of press did not survive past the first century CE, yet archaeology now shows it persisted into late antiquity.¹⁶⁷ A second-century CE bas-relief on a sarcophagus fragment in Villa Rondanini in Rome depicts a counterweight with exterior dovetail mortises, frequently used in lever-and-drum presses. A fourth-century CE mosaic at the Roman villa of Piazza Armerina (Sicily) also depicts a lever-and-drum press, reinforcing the notion that newer screw technologies did not completely take over.¹⁶⁸ This contrasts with the eastern Mediterranean,

and for the potential implications this has regarding the transfer of press knowledge between Aegean and western Mediterranean regions. Many installations in Italy possess evidence of only pier bases and press beds; it is possible these once used counterweights like this which are now lost.

¹⁶² Brun 2004a, 36–37, 44, 47.

¹⁶⁷ Lewit 2012, 141; Burton and Lewit 2019, 551; Lewit and Burton 2019, 101.

¹⁶⁸ Sarcophagus relief illustrated in Brun 2003, 209; Baratta 2005, pl. 11, figs. 23, 24. Mosaic illustrated in Brun 2003, 214.

¹⁶² Pallottino 1937, 21; Frankel 1999, List A, site 27-0-1241-00-001; Brun 2004a, 29, 32; 2004b, 184–85; Boissinot 2009, 108; Van Limbergen 2019, 111.

¹⁶³ Brun 2004a, 10.

¹⁶⁴ Marzano 2007, 271–72.

¹⁶⁵ Maldini 2004. See Dodd 2017 for an example at Pompeii



FIG. 13. Map of major sites mentioned in the text related to wine presses and *cellae vinariae*. Square = press type 1; black circle = press type 2; star = uncertain type; white circle = *cella* (map by E. Dodd with base GIS and hillshade data from the EEA and Esri).

where the newer, though not necessarily more efficient, direct-pressure screw presses dominate Late Antique productive contexts.

Some of these platform press types, also found in Campania, used a lever and hanging screw weight, or a screw directly attached to the ground. This can be seen in the now-reconstructed Regio II Insula 5 press at Pompeii (though this is debated, and it is reconstructed, probably inaccurately, with a lever-and-drum mechanism; see fig. 10); at a villa near Sessa Aurunca (suggested to belong to Trajan's daughter, Matidia);

and possibly at the Villa of Publius Fannius Sinistor in Boscoreale.¹⁶⁹

Press Type 2. The second broad type of press in Roman Italy typically features a large pressing area of either *cocciopesto* or, more commonly, *opus spicatum*, delimited by a circular collection channel and often

¹⁶⁹Jashemski 1968; 1973a; 1973b; Rossiter 1978, 33; Rossiter and Haldenby 1989; Brun 2004a, 13–14, 22–23, 27. The latter has also been interpreted as a screw press with wooden box of stones as a weight (Feige 2022, 390–91).

built into a floor structure of the same material (see fig. 11). Rare examples also include flooring of tufa paving or monochrome mosaic, while others have a circular stone press bed or square bed with circular drainage groove.¹⁷⁰ The associated press apparatuses often use a stone pier base with one or two interior, closed mortises (*lapis pedicinus/forum*), the latter previously called the “Tivoli pier base,” to hold the wooden uprights at the fulcrum (*arbores*).¹⁷¹ They have mostly been interpreted as lever-and-screw presses, of which two variations exist, reinforced by in situ counterweight finds.¹⁷² Archaeological data and close comparison to an important passage by Pliny (*HN* 18.74.317), indicate that one variation lifted a mobile stone counterweight (or counterweights, as illustrated in bas-relief on a third-century CE sarcophagus from Aquileia), and the other had a screw attached directly to the ground.¹⁷³ It is also possible that the former lifted a box of stones or stones within a wooden frame, acting as a counterweight, which left little trace in the archaeological record. Screw counterweights appear in a variety of round, cylindrical, and square forms in Italy, using a combination of exterior and interior mortises and sockets. The distribution and chronology of this weight type, called “Samaria” by Frankel, suggests that it developed in Italy with a range of prototypes and subtypes defined.¹⁷⁴ Indeed, screw counterweights are quite common in Italian press mechanisms.¹⁷⁵

The second type is found all over Italy, though there is a notable concentration in the central-northern regions. Archetypal vinicultural examples have been found at Varignano (Liguria), a number around Verona (Veneto) and Trento (Trentino), Settefinestre and Via della Fattoria near Cosa (Tuscany), in the central Adriatic region (Marche),¹⁷⁶ Via Nomentana and at the Villa dei Gordiani (Lazio), and Scalea (Calabria) (see fig. 13).¹⁷⁷ There are also suggestive remains across

the Ager Tiburtinus, stretching northeast of Rome between the Tiber and Aniene rivers, and elsewhere on the peninsula, including Valle Pilella (or Pitella), Prima Porta (Valle Lunga), at Fianello, and also just to the southeast at S. Savino (Poggio Mirteto) though it is uncertain whether wine or oil production occurred at this last facility.¹⁷⁸ Along the eastern slopes of Monte Massico, near Sessa Aurunca in northern Campania, at least five pier base blocks and one screw weight are noted at farm and villa sites ranging from the third or second centuries BCE to at least the second century CE, suggesting that production of the famous Roman Falernian wine utilized this type of press, at least during some of its existence.¹⁷⁹ Recent excavation at the Villa dei Quintili, on the Via Appia Antica just outside Rome, revealed an installation with two such presses, though this remains largely unanalyzed and unpublished, with no counterweights visible when I visited in July 2021.¹⁸⁰ A screw-operated press of similar type likely functioned at a second- to third- century CE winery on the via Gabina just outside Rome, and archaeological evidence of grape seeds and indications of a press at via Cavalotti, Senigallia, suggest possible wine production from the mid second century BCE to the first century CE.¹⁸¹ Finally, some 30 square press beds and counterweights/pier bases have also been found at Verona and Val Belluna, with others in the Ager Tiburtinus and around Collatia, in the Albegna Valley at localities Gabii, Monte Aperto, and Aquilaia.¹⁸² Tanks,

38–43; De Sena 2005, 144; Marzano 2007, 105–6; Van Oyen 2015, 118–19. It remains uncertain whether those at Settefinestre operated by screw or winch. The Republican-era winery at the Villa dei Gordiani had multiple, large collection vats, at least one of which included a sediment depression (De Franceschini 2005, 145–56, figs. 53.7–9). For databases, including less certain vinicultural examples, see Van Limbergen (2011; 2019, 106, 112 n. 69) and Brun (2004a, 34–37).

¹⁷⁸De Sena 2005, 145–46; Marzano 2007, 363, 427, 525. The original excavation report of Valle Pilella leaves the interpretation of wine or oil production open: while the vat size may suggest wine, it is not conclusive (Reggiani 1978).

¹⁷⁹Callot et al. 1986; Arthur 1991; Zannini 2001; Conti 2007; Ciafardini 2018.

¹⁸⁰See Frontoni et al. 2020.

¹⁸¹Brun 2004a, 11; Van Limbergen 2019, 106–8.

¹⁸²Liverani 1987, 126–27; Frankel 1999, List B, T4642; Brun 2004a, 49; De Sena 2005, appx. 1, nos. 19, 34, 36, 54; see also Baratta 2005, 133. I noticed two very well-preserved screw-press counterweights with an interior socket and dual exterior, dove-tail mortises inside the Roman theater at Verona; one of which reuses a first-century BCE monumental public inscription. There

¹⁷⁰It was previously termed the circular bed press (Rossiter 1978, 49–55; 1981; Frankel 1999, 92–93).

¹⁷¹See databases in Van Limbergen 2011; 2019.

¹⁷²Van Limbergen 2019, 112. Some may have used winch mechanisms, as described above and perhaps shown at Varignano (Brun 2004a, 43).

¹⁷³Brun 2003, 215–16; Burton and Lewit 2019.

¹⁷⁴Frankel 1999, 120.

¹⁷⁵Contra Feige 2022.

¹⁷⁶At Chiarino di Recanati, Colombara di Acqualagna, Monte Torto di Osimo, Cupra Marittima San Basso, and Offida San Giovanni (Van Limbergen 2019, 112).

¹⁷⁷Pesce 1936; Rossiter 1978; Liverani 1987; Brun 2004a,

dolia defossa, and *opus spicatum* floors have been recorded at Scrina di Porco as well as across the Picenum (Marche) region at Treia-San Crocifisso and Fossombrone.¹⁸³ It is impossible at present to determine which of these were for wine production.

These wineries using the second type of press group appear from at least the second and certainly first century BCE through to the second century CE, though some undoubtedly continue sporadically through the fourth and fifth centuries.¹⁸⁴ Importantly, and in relation to the first type of press above, the second type is not necessarily a later type, as proposed previously, and clearly possessed a lengthy use-life, though scaling down in size and function perhaps occurred through late antiquity.¹⁸⁵ It is unknown what, if anything, replaced this type from late antiquity onward in Italy, and it is equally likely that a range of press types and wineries persisted, including simple treading on a small scale. Indeed, similarly monumental presses of almost identical type were used in preindustrial Italy.¹⁸⁶

Presses in Roman Italy cannot necessarily be defined specifically by their mechanism, as in other regions; for example, lever-and-screw mechanisms were used in both broadly defined types. Instead, the types here are distinguished by associated architectural design elements: the presence of a raised waterproofed pressing platform (that was also used for treading the grapes) and no press bed, or alternatively, a press bed/base, whether a circular channel built into the floor or a freestanding stone press bed, and the use of stone pier bases (for the *arbores*). There are also facilities that possess a fusion of characteristics (e.g., Grotte di Cervara). While there does seem to be some geographical patterning to the types, this is not as distinct as previously claimed,¹⁸⁷ and we await more focused research.

Earlier Presses. But what of wine presses in earlier periods of Roman and pre-Roman Italy? It is curious that, for example, compared to regions like the Levant and Greece, simpler forms of lever pressing are not better represented in Italian archaeology. This may

are also three identical “Tivoli” pier bases built into the exterior walls at the east end of the cathedral of Santa Maria Matricolare at Verona.

¹⁸³ Van Limbergen 2019, 102–3.

¹⁸⁴ Aligned with evidence of local amphora production and distribution (Van Limbergen 2019, 111, 116).

¹⁸⁵ Cf. Brun 2007, 60–61.

¹⁸⁶ See Dodd 2020, 7.

¹⁸⁷ Cf. Rossiter 1978; Frankel 1999; Feige 2022.

be in part due to archaeological survival rates, material reuse, or lack of recognition. It may also be due to the use of techniques, like the torsion press in Egypt or simply squeezing by hand or foot, that do not leave archaeological traces.¹⁸⁸ Yet the problem remains: there is very little evidence for mechanical vinicultural facilities in pre-Republican and even Early and Middle republican Italy, including methods used before the two presses above.¹⁸⁹

Recent studies on *palmenti* might remedy this lacuna in some locations. Sites from Sicily (e.g., around Monte Cucco in the Alcantara Valley) possess niches that may indicate the existence of small-scale, simple lever presses operated by either human pressure alone or with hanging weights, as seen at other Bronze and Iron Age Mediterranean sites.¹⁹⁰ There is also evidence of a simple lever press, using human pressure alone, on marble coping from a well at the Palazzo Francavilla in Naples dated to the second half of the second century BCE;¹⁹¹ however, it is interpreted as mythological or Dionysiac in nature so its connection to the reality of local winemaking practice remains unclear. Nonetheless, the artist must have been aware of this press style from Italy or abroad. The action depicted is reminiscent of a famous Greek black-figure skyphos, dated

¹⁸⁸ Brun (2007, 58–59) provides thoughts in this respect. The torsion press is well depicted in Egyptian wall paintings and was operated by one or more wooden rods, with grapes wrapped in a fabric bag attached to the rod(s) (e.g., see Frankel 1999, List B, T01001–01005; Brun 2003, 58; Harutyunyan and Malfeito-Ferreira 2022, 4). When the rods were twisted in opposite directions, the fabric bag would compress under the torsion and juice (grape must) was expelled.

¹⁸⁹ Van Limbergen (2019, 111–12) echoes frustrations for Adriatic Italy before the second century BCE and highlights the contrast between vast amphora evidence and a dearth of press remains, as does Riva (2017, 243) for central Italy before the fifth century. One of the best-known examples of early evidence for press technology in Italy, albeit for oil production, is at the Auditorium villa in the *suburbium* of Rome, with the press dated as early as the fifth century BCE and destroyed in the third century BCE (Marzano 2007, 469). This clearly shows that such technology was known and used in these earlier Roman eras, as we should expect given the existence of wine production on a notable scale and intercultural contact and trade.

¹⁹⁰ Olcese et al. 2020, 39. See supra n. 144 for chemical confirmation that these *palmenti* were used for wine production.

¹⁹¹ Brun 2003, 210. Alternatively, Baratta (2005, 52 fig. 14) suggests the first century CE and believes the lever is exerting upward pressure removing a boulder that crushes the grapes, comparing it to a first-century relief on a krater in the Vatican Museums (see fig. 12).

520–510 BCE, which shows a man hanging off a lever press to increase pressure, though here sacks filled with stone weights are also used.¹⁹² Such forms of simple pressing almost certainly existed in earlier periods and probably continued at smaller-scale operations through the Republican and Imperial eras, perhaps for more localized or domestic production (or other noncommercial purposes).

Finally, direct-pressure screw presses were also used in Roman Italy (see fig. 12), though these, too, suffer from low survival rates due to overwhelming use of wooden components and difficulty in identification. It is likely that such mechanisms were preferred in urban environments, where valuable space was limited and could not be given to large lever presses, and within oileries, fulleries, and perfumeries. However, they were almost certainly also used for wine production in Italy; after all, they are included in Pliny's description of wine presses (*HN* 18.74.317). Archaeological remains of these systems exist at Pompeii (for oil or perfume), Luogosano, and Posto (Francolise) in Campania; San Giusto in Apulia (due to absence of weight stones, lever supports, and a lack of space, two adjacent presses have been designated such); San Pietro in Casale, Bologna (in a first-century CE context); and possibly at Treia and Fossombrone on the Adriatic coastline.¹⁹³ South of L'Aquila, in Abruzzo, at least 14 monoliths have mortises and small carved collection holes that are reminiscent of stones used to hold the wooden apparatus of this press type.¹⁹⁴

FERMENTATION AND CELLARING

Once grapes were trod or pressed, must flowed through channels or pipes with varying degrees of complexity, depending on the scale of the installation, into one or more collection structures, typically a vat lined with *cocciopesto* or similar waterproof treatment, or a dolium. In more complex installations, intermediate vats collected must, allowed sediment to settle and primary fermentation to begin, before being ladled, de-

canted, or channeled into a *cella vinaria*, with multiple dolia (*defossa*) for clarification, (often) modification, and fermentation proper.¹⁹⁵

The timing of the initial stages of primary fermentation is difficult to define for antiquity. Ancient authors provide numerous figures, from three to nine days, and a variety of staged and timed processes.¹⁹⁶ Given that the duration is influenced by external and internal factors, particularly in open air facilities, the process was probably highly regionalized and fluctuated depending on regional climatic variability and punctuated weather events across Italy. Recent research in the north of Italy, at Valpolicella, is beginning to show that specific regional practices also extended to cellaring and aging, with excavation revealing artificially heated rooms perhaps used to warm fermentation and storage areas for wine.¹⁹⁷ This practice, which is also described in the ancient literature and included 'smoking' wines, accelerated the aging process and aided the preservation of grape must.¹⁹⁸

Added flavors formed a crucial part of Roman wine production—still to this day in beverages like the Greek *retsina*—with an almost infinite array of herbs, spices, resin, seawater, and honey added, among other things.¹⁹⁹ While the purpose of this was surely sometimes to appeal to a certain taste and create a specific product, the ancient wine production process was unpredictable, with knowledge of stabilizing much less than today. Wines were undoubtedly often quite vinegary, but this could be hidden through additives. Chemical testing plays a crucial role in our ability to detect and specify additives present in ancient wine residue, with a study that detected the presence of

¹⁹⁵ Clarification is the process that removes any suspended insoluble sediments or unwanted solids in the wine. Modification alters the taste or appearance of wine and was frequently done in antiquity by adding, e.g., herbs, spices, honey, seawater, or resin.

¹⁹⁶ See Dodd 2020, 56–59, for a detailed discussion of the evidence and timing of fermentation in antiquity.

¹⁹⁷ Recently discussed by M.S. Busana in a paper at the Vine-Growing and Winemaking in the Roman World conference, October 2021. Columella (*Rust.* 1.6.19) mentions this particularly in *apothecae* (rooms located above heated spaces, including ovens, kitchens, or *caldaria*).

¹⁹⁸ Pliny (*HN* 14.27) mentions various solutions implemented in Alpine regions where wine was aged in barrels in specifically heated rooms, so the cold did not slow down the fermentation process. Martial (*Epigrams* 10.36) suggests that it occurred in Marseille, and hence also Mediterranean regions.

¹⁹⁹ Cf. Columella, *Rust.* 12.27; Palladius, *Opus agriculturae* 11.14–19; Plin., *HN* 14.19.

¹⁹² Boston, Museum of Fine Arts 99.525; see Brun 2003, 199.

¹⁹³ Rossiter 1978, 53 n. 4; Brun 2004a, 31, 49; 2004b, 30–31; Burton and Lewit 2019, 572; Van Limbergen 2019, 118; Lewit 2020b, 210–13; see also Feige 2022. Wedge presses were also present but probably not used for wine (Baratta 2005, 66).

¹⁹⁴ See Rapisarda 2017. Whether these were for wine, oil, or something else is impossible to tell at present; the small collection holes probably rule out wine. The author's suggestion that they relate to the cult of Hercules is highly questionable; they were more likely part of the local agricultural productive landscape.

rosemary, basil, and thyme clearly highlighting future potential.²⁰⁰

The Cella Vinaria

Well-known examples of *cellae vinariae* and fermentation facilities need not be repeated and are listed in various published catalogues and texts.²⁰¹ Less known are a villa storeroom at Casalotti (Via Boccea) with at least eight sunken dolia (there is another villa and *pars rustica* nearby from the second to fourth centuries CE), and at Casilina a pair of *dolia defossa* with channels leading to two large cisterns (about 102,000 liters) along the via Tuscolana in Rome, which probably indicate storage for wine (see fig. 13).²⁰² Excavated since the 1980s, three villas at Cava Ranieri (Terzigno, just north of Pompeii) also have either wine presses or large *cellae vinariae*.²⁰³

Various stages of fermentation existed in antiquity, including primary and secondary malolactic, each with specific requirements and durations and often followed by secondary procedures including clarification and modification via additives.²⁰⁴ Dolia were specifically designed vessels and aided these processes through their materials, morphology, and spatial context.²⁰⁵ Archaeologically, *dolia defossa* (and by extension *cellae vinariae*) can be found in situ in various degrees of preservation (compare the completely intact dolia at Villa Regina (fig. 14) to examples preserved to various heights at Ostia and Vagnari) or robbed out with only circular depressions indicating their size and placement (e.g., at Villa Magna and Vagnari).²⁰⁶ Some have been purposefully removed, broken into

small pieces, and reused as building material (e.g., Settefinestre).²⁰⁷

Channeling from press to storage could occur horizontally, with pipes running between multiple rooms (e.g., Villa dei Misteri and the Regio II Insula 5 *cella* at Pompeii, fig. 15), or vertically, with must flowing through a hole in the floor into collection structures below (e.g., Settefinestre, Villa Subaugusta). Where channeling is not evident, manual decanting probably occurred using ceramic or metal jugs (see fig. 5), or ladles, like examples found at Villa della Pisanella (Cato, *Agr.* 13.2).²⁰⁸ Villa Regina presents a hybrid example, where a short lead pipe channels must from the press room into a single dolium; this was then emptied using ceramic, metal, or wooden containers and transferred into the nearby *cella vinaria* with 18 dolia (see fig. 14).²⁰⁹ The large size of the press room and *cella vinaria*, compared to the single collection dolium, present somewhat of a bottleneck scenario; many rounds of pressing and decanting would be needed in order to fill all 18 dolia. Amphoras were also used as mechanisms to transfer wine to and from dolia at various stages of the production process: this is made clear at Ostia, where numbers inscribed into the necks of dolia record the quantity of amphoras that could be emptied into (or drawn out of) them.²¹⁰ At simple, small-scale installations, like Pompeii insulae I.20, II.1, and II.9, must flowed directly from the treading floor into a single dolium.²¹¹ Some collection vats in Lazio (e.g., Villa Campetti near Veii) and in central Adriatic Italy include access stairs for cleaning and decantation, an architectural feature mirrored in wineries elsewhere in the Mediterranean (e.g., Delos), evidencing the transfer of productive knowledges and styles across the Roman world.²¹²

The location, design, and scale of *cellae vinariae* and fermentation facilities varied across Roman Italy and were largely dependent on climate, socioeconomic status, and purpose. Van Oyen provides an excellent catalogue of those from central Italian contexts, which needs not be repeated here, though the surrounding

²⁰⁰This study used a combination of Fourier-transform infrared spectrometry (FT-IR), GC-MS, ultra high-performance liquid chromatography (HPLC), tandem mass spectrometry (LC-MS-MS), and headspace solid phase micro-extraction (SPME) (see McGovern et al. 2013).

²⁰¹See Rossiter 1978; 1981; Brun 2003; 2004a; 2004b; Baratta 2005; Cheung 2021a; Van Oyen 2020; Feige 2022.

²⁰²Rossiter 1978, 59; De Sena 2005, 144–47. See the illustration of the excavated Casalotti storeroom in Feige 2022, 17, fig. 2.

²⁰³Villa 1 has the largest *cella*, with 42 dolia, while villa 2 has 24 dolia, and villa 6 has a press and cellar (cf. Cicirelli 2000). It appears that the winery areas were created or expanded following the earthquake of 62 CE, a trend also apparent at Pompeii.

²⁰⁴See Dodd 2020, 56–59, 115–16; Van Limbergen 2020.

²⁰⁵Cheung 2021a, 69–70; Cheung et al. 2022.

²⁰⁶Fentress and Maiuro 2011; Cheung 2021a; 2021b; Carroll 2022, 7.

²⁰⁷Celuzza 1985.

²⁰⁸Pasqui 1897, 482.

²⁰⁹De Caro 1994. The villa of C. Olius Ampliatus is similar (cf. Cascella and Vecchio 2014).

²¹⁰Van Oyen 2020, 143. See also the relief from Ostia in Augenti 2016, 74.

²¹¹Dodd 2017.

²¹²Baratta 2005, 113; Van Limbergen 2019, 109–10; Dodd 2020, 75–103.



FIG. 14. The well-preserved *cella vinaria* at Villa Regina, Boscoreale, with 18 dolia and double-layer ceramic lids (E. Dodd; courtesy Ministero della Cultura – Parco Archeologico di Pompei).

context and environment is often unclear and would aid further interpretation.²¹³ Rows of sunken fermentation dolia were housed in the (semi-)open air across Campania, with its favorable climate, and this seems to be replicated farther south in Apulia, as seen at Vagnari.²¹⁴ Double-layer ceramic locking lids were used as protection against the elements and to ensure a stable fermentation environment, still clearly visible at Villa Regina (see fig. 14).²¹⁵ A second-century CE funerary relief from Liverpool suggests that slatted wooden lids could also cover dolia.²¹⁶ At Villa Magna, and perhaps Villa Regina, the interpretation of postholes implies that a wooden structure and shade cloth (*velarium*) could be put up over the dolia in hotter months.²¹⁷ Farther north, in Etruria, the dolia were located in-

side large storage structures.²¹⁸ Partly burying dolia and using in-ground vats compounded stability and microenvironmental control.

Regarding villa contexts from the Late Republic onward, compelling arguments can be made for the dramatic scale and placement of *cellae vinariae* acting as agents of monumentalizing architecture and conspicuous production.²¹⁹ Indeed, there is a notable increase in size from around the first century BCE.²²⁰ Some storage areas, like those at the villas of Settefinestre (Tuscany) and San Giustino (Colle Plinio, Umbria), formed elongated rectangles, which creates both an imposing perspective but also implies longer term storage for wines in less accessible locations and perhaps qualitative and economic differences.²²¹ The practice of storage, of which fermentation forms an initial transformative phase, thus allowed people to not only complete processes and keep a surplus but also to “articulate their place in a social web, their

²¹³ Van Oyen 2020, 192–94.

²¹⁴ Montana et al. 2021, 2; Carroll 2022, 5. It seems unlikely this was a phenomenon restricted to the Vesuvian region (contra Feige 2022) but was instead dictated by microtopography, weather, and climate.

²¹⁵ On this system, see Cheung 2021a, 71.

²¹⁶ Angelicoussis 2009.

²¹⁷ De Caro 1994; Fentress and Maiuro 2011, 347. Interestingly, at the presumably warmer site of Vagnari (Apulia) there is no evidence of postholes to support such an awning or canopy (Carroll 2022, 5).

²¹⁸ Brun 2003, 79. Various called sheds or hangars. For an excellent discussion of winery storage facilities in Italy, see Van Oyen 2015. There are also covered *cellae* in the south, e.g., in Basilicata (Feige 2022, table 6).

²¹⁹ Van Oyen 2015, 119.

²²⁰ Van Oyen 2020, 37.

²²¹ Van Oyen 2020, 51–52.



FIG. 15. The small *cella vinaria* at Regio II Insula 5 at Pompeii, with 10 dolia (two are unseen in the foreground). A plastered, shallow gutter with a tile awning, at left, distributed must from the press in the adjacent room with narrow lead pipes connecting each dolium to the gutter (E. Dodd; courtesy Ministero della Cultura – Parco Archeologico di Pompei).

membership of society [and] their very social being.”²²² It should be noted that although cellaring and fermentation facilities in Roman Italy grew large and certainly produced surplus, they never came close, in number or capacity, to the largest examples in coastal Gaul or Catalonia. There, *cellae vinariae* regularly reached 200 dolia in size, with larger examples, like the villa of Els Tolegassos as early as the late second century BCE, containing up to 400. It is suggested that this is in part due to differential pressures in land ownership between Italy and the northwest Mediterranean: in the latter, larger contiguous estates were easier to form and maintain.²²³ Such a vast difference between the two regions also suggests a different vinicultural model: the larger scale required inherently more complex production, storage, and distribution logistics.

One’s ability to commission the manufacture and installation of tens or hundreds of dolia along with

mechanical presses and specialized equipment—expensive and logistically difficult products requiring substantial knowledge and expertise²²⁴—evidences significant wealth and investment in winemaking. The highest point of this investment is production on imperial estates, like Vagnari, where dolia in what has been interpreted as a second-century CE *cella vinaria* were not produced at local kilns but were imported from either the Tiber Valley near Rome or the Liris-Garigliano Valley near Minturnae at great cost.²²⁵ Their value is demonstrated by frequent evidence of dolia repair

²²⁴ See Curtis 2016; Cheung 2021b. Dolia were too large to be thrown on a standard potter’s wheel and required skilled potters to coil-build them on a turntable with large quantities of coarse architectural-grade clay, a time consuming and laborious process that prevented mass production on the same scale as other pottery (Carroll 2022, 9; Cheung et al. 2022, 799).

²²⁵ Montana et al. 2021, 12–13. Although Carroll (2022, 19) recently argued that this might reflect the imperial administration moving equipment from one property in the emperor’s possession to another and, thus, kept cash within the *patrimonium*.

²²² Van Oyen 2020, 10.

²²³ Van Oyen 2020, 74–79.

and reuse across facilities in Italy, especially in later eras, as well as architectural recycling. Nine of 16 excavated dolia (total *cella* size estimated at 64 dolia) from the third- to fourth-century CE winery at Somma Vesuviana bear the stamps of three different makers from the first century CE, some known at Olbia/Terranova and Herculaneum.²²⁶ The same is true at the Villa dei Quintili, where at least one first-century CE stamped dolium is used in the mid to late third-century facility (fig. 16). Residue analysis from a shop at Pompeii (I.12.8) indicates that dolia originally for wine might also have been reused in the production and storage of *garum*, a type of fermented fish sauce.²²⁷ Maintenance, repair, and reuse in the ancient vinicultural world occurred not just across generations but over many centuries, and it was not confined within the bounds of a single commodity.

Performative and conspicuous production occurred at the Villa dei Quintili in a slightly different sense from that at Villa Magna.²²⁸ Here, must flowed from a *calcatorium* and two presses (via a settling tank) into the *cella vinaria* and dolia through a series of marble-faced *canali* and a facade with fountains in a quasi-nymphaeum-like arrangement (see fig. 16). Three luxurious rooms paved in multicolored *opus sectile* surround the *cella* and may have enabled residents and guests of the emperor to watch the spectacle of production. Even the treading floor is partially clad in red breccia marble. Indeed, the *cella vinaria* itself is a luxurious space commensurate with the broader context of the Villa dei Quintili, not in terms of scale but in architectural quality, where raised walkways separate rows of dolia (also at Villa Magna) and afford winemakers, or casual viewers, a pleasurable and opulent experience generally unheard of in *pars rustica*.²²⁹ At the other end of the spectrum, small installations, with no sign of *dolia defossa*, likely completed initial fermentation in

the primary collection vat and decanted must relatively quickly into portable amphoras for secondary fermentation and aging—a system used commonly in Greece and across the eastern Mediterranean.

Features like dolia and *cocciopesto*-lined (or even brick, mosaic, lead, or tile) vats, along with counterweights and material culture that indicates pressing, therefore, are key archaeological indicators of vinicultural activity. As with other archaeological evidence, great interpretational care must be taken; similar, sometimes indistinguishable, features were also used within oileries, fulleries, aquaculture, and other agricultural endeavors. Similarly, organic structures that leave little archaeological trace, like wooden tubs, were almost certainly used in collection and fermentation at various times and locations throughout antiquity.

CONCLUSION

Vinicultural archaeology is a field experiencing exponential growth and intensified study, which is simultaneously expanding and fine-tuning interpretations. We now know that wine production continued to flourish in Italy through the fourth and fifth centuries CE, and even subsequently into the Middle Ages, with comparatively ancient press technologies used along with traditional modes of land exploitation, villas, and intensive production.²³⁰ This does not necessarily appear to be a spatially restricted phenomenon; it occurred from east to west and north to south, though there is a notable concentration running from northern Tuscany down to Calabria (see figs. 2, 7, 9). This distribution could well be influenced by excavation, research, and preservation bias, and I suspect future research will reveal broader coverage across the peninsula.

The so-called “Villa of Augustus” at Somma Vesuviana exemplifies the long-lasting Roman vinicultural model, which reused infrastructure, adapting to a variety of contexts: multiple presses, large vats, channels, and possibly up to 64 dolia were installed in the late third to mid fourth century CE, within an earlier second-century villa structure.²³¹ Not only does such a large scale clearly illuminate that industrial wine production continued, at least in the Vesuvian region, but also that construction quality and infrastructure remained high. Production here continued well into

²²⁶ Aoyagi et al. 2018, 150–51 n. 48.

²²⁷ Alternatively, it is also possible that wine was used to add flavor to a certain type of *garum* (Pecci et al. 2018).

²²⁸ Cf. Fentress and Maiuro 2011 for Villa Magna. See Feige (2021) for discussion of decorative features in Roman vinicultural and oleicultural productive spaces in Italy, including the concept of ritually organized agro-theater for the elite.

²²⁹ Cf. Settefinestre, where there is often only 25 cm in which to maneuver between dolia (Van Oyen 2020, 51). *Pars rustica* were the working parts of the farm buildings, as opposed to the *pars urbana* (residential quarters) and *pars fructuaria* (storage and barn buildings) (Marzano 2007, 85–101; Shipley et al. 2008, 927–28).

²³⁰ Rossiter 2008, 115–16; Marzano 2021, 522.

²³¹ Aoyagi et al. 2018, 150–51.



FIG. 16. Winery at the Villa dei Quintili, with fountain-like distribution system connecting the large collection vat (at top) to *dolia defossa* in the *cella vinaria* below. The preserved circular channel of a press bed is visible in the top right-hand corner (S. Castellani; Appia Antica Archaeological Park Archive).

the fifth century CE, juxtaposing literary sources that describe farms in Campania as *agri deserti* before the 472 CE eruption (cf. *Cod. Theod.* 11.28). Despite the capital moving north, this was not a phenomenon restricted to central-northern Italy. Villas of a monumental scale, though not always associated with wine production, were also built throughout Apulia and Lucania in the fourth and fifth centuries.²³² Recent research has, however, cautioned that certain socio-economic classes were probably better suited to adaptation, whether caused by human agency or changing climate; archaeologically, large villas might indicate continued Late Antique production, but this was probably not true in all contexts.²³³ The *longue durée* history of wine production in ancient Italy is a diverse story, specific to local geographic, climatic, socio-economic, and sociopolitical environments.

It is not until the sixth century CE that a notable drop-off in large-scale viniculture is visible in the Italian archaeological record, though it certainly continued at a smaller scale for local and domestic use. In time, our understanding of these archaeologically invisible periods may be further enlightened through new foci and archaeometric methods. This extends to the invisible labor force—skilled, unskilled, free, and enslaved—that in many cases drove the ancient wine industry but remain overlooked, understudied, and deserving of future research. It is also my hope that scholarship’s long-standing fixation on industrial-scale export production and our constant search for “big” facilities and yields will give way. Rather than trying in vain to fill gaps in the archaeology that are simply not there, we must realize that production occurred on an always contextualized and wide-ranging spectrum and was often medium to small-scale. Our understanding of Roman wine production in Italy will, inevitably, continue to evolve.

Throughout the Roman period in Italy “agriculture remained the only respectable way of investing capital

²³² Gualtieri 2018, 169.

²³³ See Marzano 2021.

for a member of the upper classes,” with country villas often taking center stage in literary works portraying the Roman upper-class ideology of profit.²³⁴ The structures themselves held complex ideological and economic dimensions, which evolved and shifted, not just diachronically as Marzano highlights, but also spatially, socioculturally, and socioeconomically.²³⁵ Wineries and associated viticultural production facilities played into this, either simply for subsistence and profit or, as we have seen, for monumentalizing conspicuous production.

Archaeometric techniques, including geophysical prospection and paleoenvironmental, archaeobotanical, chemical, and other scientific analyses, will play increasingly crucial roles into the future, along with traditional methods of survey and excavation as well as ethnography. A highly multidisciplinary framework—already being pursued by viticultural archaeologists—presents the most holistic and high-resolution methodology for future studies.²³⁶ It must also acknowledge and work around the limitations of individual techniques.²³⁷ By using the full spectrum of analytical methodologies available, we will begin to understand the multilayered and multiscalar network of human and natural components that interacted to create unique wine landscapes and territorial diversity across fields, production facilities, and sites of consumption.²³⁸ Comprehending this “paleo-terroir” will form a crucial future research direction.

²³⁴ Marzano 2007, 225–26.

²³⁵ See Marzano 2007, 232.

²³⁶ In a similar vein to that proposed by McGovern and Hall (2015) regarding organic residue analysis in biomolecular archaeology: focus should be given to obtaining relevant and uncontaminated samples from the best preserved and dated contexts, but also to the incorporation of related data from other fields such as botany, zoology, geology, and others.

²³⁷ E.g., paleoenvironmental testing might detect grapevine pollen and indicate concentrated local vine exploitation, but unless accompanied by organic residue analysis that indicates the presence of fermented grape juice, it is difficult to draw conclusions regarding the production of wine above and beyond the exploitation and cultivation of vines. Similarly, current residue testing methodologies can detect chemical signatures that indicate the presence of wine, but we are still not yet advanced enough to confidently distinguish this from vinegar—a product with a similar organic makeup and chemical identifiers—so results can be misinterpreted.

²³⁸ I am grateful for discussions with D. Van Limbergen on this matter.

Much could have been added to this article, particularly in relation to the identification, organization, and conditions of laborers at the wineries, as well as amphoras and ceramic material, transport and storage in *cullei*, barrels, and other organic materials. Nor have I touched on types of vines, wines, or the innumerable facets of their use and purposes (social, economic, cultural, religious, medicinal, to name a few). The preceding discussion does, however, illuminate how archaeology has expanded and honed our understanding of ancient wine production across peninsular Italy. Much of this applies to other Mediterranean regions as well. Traditionally accepted theories have been questioned (e.g., an exclusive Phoenician or Greek colonial introduction of wine to Italy), on the basis of new data and interpretation. When observed from a macro perspective, the vast quantity of data now available to the viticultural archaeologist begins to shed light on the diverse, inherently contextualized, and multiscalar nature of wine production in antiquity, balancing elite bias, and bringing new forms of evidence into focus.

Emlyn Dodd
British School at Rome
Rome, Italy
emlyn.dodd@mq.edu.au

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