



Methods in Ancient Wine Archaeology

SCIENTIFIC APPROACHES IN ROMAN CONTEXTS

Edited by Emlyn Dodd & Dimitri Van Limbergen

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ABBREVIATIONS

Where applicable, abbreviations are given in accordance with the *Oxford Classical Dictionary*, 4th edn (E. Eidinow, ed.), Oxford: Oxford University Press.

Ancient Sources

Ath., <i>Deip.</i>	Athenaeus, <i>Deipnosophistae</i>
Cassiod., <i>Var.</i>	Cassiodorus, <i>Variae</i>
Cato, <i>Agr.</i>	Cato, <i>De Re Rustica/De Agricultura</i>
Columella, <i>Rust.</i>	Columella, <i>De Re Rustica</i>
Hero, <i>Mech.</i>	Hero of Alexandria, <i>Mechanica</i>
Herodotus, <i>Hist.</i>	Herodotus, <i>Histories</i>
Hes., <i>Op.</i>	Hesiod, <i>Opera et Dies (Works and Days)</i>
Hes., <i>Theog.</i>	Hesiod, <i>Theogonia</i>
Just., <i>Epit.</i>	Justinus, <i>Epitome</i> (of Trogus)
Martial, <i>Ep.</i>	Martial, <i>Epigrams</i>
Palladius, <i>Op. Agr.</i>	Palladius, <i>Opus Agriculturae</i>
Paus.	Pausanias
Pliny, <i>HN</i>	Pliny the Elder, <i>Historia Naturalis (Natural History)</i>
SHA, <i>Prob.</i>	Scriptores Historiae Augustae, <i>Probus</i>
Strabo, <i>Geog.</i>	Strabo, <i>Geography</i>
Suet., <i>Aug.</i>	Suetonius, <i>Divus Augustus</i>
Symm., <i>Ep.</i>	Symmachus, <i>Epistulae</i>
Tac., <i>Agr.</i>	Tacitus, <i>Agricola</i>
Theoc., <i>Id.</i>	Theocritus, <i>Idylls</i>
Theophr., <i>Caus. pl.</i>	Theophrastus, <i>De causis plantarum</i>
Theophr., <i>Hist. pl.</i>	Theophrastus, <i>Historia plantarum</i>
Varro, <i>Rust.</i>	Varro, <i>De Re Rustica</i>
Virgil, <i>Aen.</i>	Virgil, <i>Aeneid</i>

Abbreviations

Virgil, <i>Ecl.</i>	Virgil, <i>Eclogues</i>
Virgil, G.	Virgil, <i>Georgics</i>
Vit., <i>De arch.</i>	Vitruvius, <i>De architectura</i>

Miscellaneous

GPR	Ground-Penetrating Radar
hl	hectolitre (100 metric litres)
iug.	iugerum / iugera
ORA	Organic Residue Analysis

CHAPTER 2

ANCIENT VINICULTURE: A MULTIDISCIPLINARY HOLISTIC PERSPECTIVE

*Patrick E. McGovern*¹

Abstract

With ever-improving archaeological and scientific techniques and methodologies over the past half century, our understanding of ancient Roman viniculture has greatly advanced. A multidisciplinary holistic approach has proved essential in developing working hypotheses and testing them. This approach is illustrated by a review of how viticulture, winemaking, and the ‘wine culture’ moved from the Near East to the western Mediterranean where they were consolidated under the Roman empire. Organic Residue Analysis, a representative scientific approach, is also reviewed. Technological comparisons between East and West (e.g. stomping vats, winepresses, fermentation in pottery jars, finishing processes and additives) show the conservative character of Roman viniculture, which was spread throughout the empire. Rome’s influence lasted for centuries until the present. Experimental archaeology enables us to reimagine what Roman wine tasted like by testing the many variables involved in its production and pointing the way forward for future investigation of ancient viniculture.

Introduction

Before the advent of scientific archaeology,² our knowledge of Near Eastern and Roman viniculture was largely limited to texts written by classical authors.³ Those writers in turn depended on Greek and Phoenician sources, especially the agricultural compendium by the third to second century BCE Punic author, Mago the Carthaginian. His twenty-eight

¹I thank Emlyn Dodd, Dimitri Van Limbergen and Maria Stella Busana for their invitation to present a keynote address at the conference in Rome, as well as the Belgian, British and Dutch institutes for their support. I learned much in the process of being brought up-to-speed on ancient Roman viniculture in my quest to understand its past and advance its future investigation. I also benefited greatly from my colleagues worldwide, whose knowledge and assistance have been invaluable over the years.

²McGovern 1995, 2019a.

³cf. White 1970a.

books in Punic (Phoenician) detailed many Levantine vinicultural techniques, such as raisined wine, that were adopted by the Romans. Scholars also culled ancient artwork, especially Greek vase paintings (Figure 2.1) and Etruscan and Roman frescos, for information on viniculture. Egyptian tomb frescos and reliefs (Figure 2.2) could be compared. Because they were produced as much as 3,000 years earlier, they showed how Roman viniculture likely was ultimately rooted in Levantine technology, as was the earlier Egyptian industry.

Artefacts and ecofacts (e.g. grape seeds) might provide other relevant data. Their usefulness, however, was undermined by their general lack of archaeological context and dating. Stratigraphic excavation was not yet practiced, and the art market was not regulated. A relic could well have an uncertain history in its use and how it was conserved. Traditional Italian winemaking, which had likely resisted change since Roman times, provided another avenue for understanding ancient viniculture. The drawback was



Figure 2.1 Dionysus sailing the Mediterranean, after he has miraculously grown a grapevine up his ship's mast and transformed his attackers into dolphins, by Exekias inside a *kylix* of the mid-sixth century BCE. Courtesy of the Staatliche Antiksammlungen und Glyptothek, Munich, no. 8729.



Figure 2.2 Winemaking scene from the Theban tomb of the scribe Nakht, c. 1400 BCE. Courtesy of The Metropolitan Museum of Art, Rogers Fund, 1915 [15.5.19e].

discerning the differences between past and present. Together, texts, artwork, artefacts/ecofacts and ethnography provided a first approximation to ancient Roman viniculture. But a more scientific methodology was needed to prevent inaccuracies.

To start with, it should be appreciated that archaeological science is a historical ('soft') science, like geology and cosmology.⁴ Unlike the 'hard' sciences (e.g. chemistry and physics), experiments cannot be repeated in the laboratory. Past events are unique, and they are preserved to a limited degree. We infer a working hypothesis from the available data, assuming regularities in nature and human culture. Consequences, if the hypothesis is true, are then deduced and tested and credibility grows with repeated confirmation and ever-increasing levels of probability.

Scientific archaeology is extremely multidisciplinary, drawing upon the hard and soft sciences as well as the humanities. Attention needs to be given to all the available evidence, to interpret it in the most meaningful and holistic way possible. Ancient viniculture, so central to so many cultures, offers the prospect of achieving this goal as few other human activities can.

Principal scientific disciplines

The following approaches are essential in reconstructing ancient viniculture for a specific region and time period:

1. **Precise dating** of the pertinent archaeological contexts and artefacts/ecofacts, especially by radiocarbon determinations.

⁴See McGovern and Hall 2015.

Methods in Ancient Wine Archaeology

2. Comprehensive **surveying** for ancient vineyards and winemaking facilities by geophysical prospection (e.g. magnetometry and ground-penetrating radar), drones and satellite imagery. Follow-up with test excavations and analyses of recovered materials.
3. Reconstruction of the **ancient environment, climate, biome and microbiome** by excavation and coring, followed by geological, archaeobotanical, archaeozoological, and physicochemical analyses (e.g. soil pH). Apply modern precipitation levels and temperatures as proxy measurements.
4. **Landscape archaeology** to establish relationships between ancient vinicultural features within their physical setting throughout the year, including soil composition, altitude, sun exposure, water availability, humidity, and wind direction and velocity.
5. **Site excavation** by the best stratigraphic archaeological methods available, with special attention to geomorphology, pedology and hydrology. Vinicultural samples for scientific analyses handled with gloves, avoiding contaminants (e.g. plasticizers) and properly stored.
6. **Taphonomy** of vinicultural remains, inorganic and organic, assessed by analyses and known physicochemical properties. Soil samples collected from the same contexts are essential as controls. Careful observation of archaeological contexts for other sources of degradation and disturbance (e.g. insects).
7. **Archaeobotany and archaeozoology**, using standard techniques and flotation of macro-remains, ideally coupled with high-power microscopic observations (e.g. starch, pollen and phytoliths).
8. **Molecular Archaeology:**
 - a. **Organic Residue Analysis (ORA)** of putative wine vessels and installations by applying many chemical techniques to identify biomarkers ('finger-print' compounds) that derive from the original natural products.
 - b. **DNA analyses** to determine the genetic sequences of the wild Eurasian species (*Vitis vinifera* ssp. *sylvestris*) and its domesticated varieties (*Vitis vinifera* ssp. *vinifera*). Also sequence and identify other microorganisms in the soil that are important in wine fermentation (e.g. yeast) along with any additives (other fruits, herbs and natural products) mixed with the wine.
 - c. **Inorganic analyses** of putative wine vessels and artefacts made of pottery, metal, glass/faience, etc. by microscopic examination, chemical analyses (e.g. instrumental neutron activation analysis (NAA), petrography, etc.), to determine their contributions to the detection of grape/wine and vinicultural processes within the archaeological and environmental context (including soil).
9. **Experimental archaeology** employed as proxy for laboratory replication of results to support a hypothesis, based on the available archaeological, botanical, textual, artistic, ethnographic and other scientific evidence. Numerous interacting variables are tested for their effects on ancient vineyard design, winemaking process and wine flavour.

Many of these approaches are applied to specific case studies in the following chapters of this book. When taken together, a holistic, albeit still partial, picture of the beginnings and subsequent development of Roman viniculture can be seen to be emerging. In no small measure, the integration of multidisciplinary techniques accounts for this signal achievement. Much is still left to do, and many more scientifically excavated sites are needed to firm up working hypotheses and round out the picture. Because of the limited archaeological and scientific database that is available to work from, controversies about interpretations and the best methods to use will continue to persist.

Organic residue analysis

One key example of how the application of any scientific technique to ancient vinicultural hypotheses needs to be constantly assessed and refined is provided by an evaluation of recent developments in my principal area of expertise: ORA.

ORA is one of the most promising tools in our scientific repertoire, with great potential in reconstructing ancient viniculture across regions. This discipline has played a pivotal role in the larger field of biomolecular archaeology to identify ancient grape and wine remains. Great strides forward have been made in the use of chemical biomarkers to identify wine, additives and preservatives, as well as methods to elucidate how wine was processed and aged, perhaps even whether it went through gradual fermentation or was intentionally heated and smoked to speed up this process.

Progress over the past several decades has been especially impressive for the Italian peninsula and the emergence and consolidation of Rome and its empire. Pompeii and Herculaneum, whose inorganic remains were preserved *in situ* under volcanic debris, were informative but only up to a point. Organic compounds of archaeobotanical remains were incinerated, but the physical forms of fruits (e.g. grapes) were retained. Artistic evidence, such as frescos, showed how wine was served in home and tavern, and how it was important and integrated into the social, religious and economic life of the city. There are few archaeological sites that have contributed so much from so many perspectives to a detailed understanding of ancient Roman vinicultural expertise and wine culture. Yet, there was much more to know that only better-preserved organic materials from other archaeological sites, together with modern surveying and excavation methods, could reveal. Archaeologists in collaboration with scientific specialists have shown just how much information can be gleaned to illuminate how vineyards were laid out, what specific types of winepresses were employed, what grape cultivars might have been cultivated, and how the grape must was vinified in *dolia defossa* and specially designed cellaring facilities.⁵

⁵Dodd 2022a.

As part of a holistic multidisciplinary approach, ORA has been increasingly used to analyse contemporaneous organic remains from excavated sites in the central and western Mediterranean.⁶ However, the results are only as good as the samples to be tested, which are ideally well-provenanced, well-dated, well-preserved, and were not contaminated after their deposition (e.g. by ground water) or post-excavation in the lab or storage facility (e.g. by human handling without gloves or conservation materials). Specific chemical extraction and analytical methods must also be scrutinized for their data precision and accuracy and overall effectiveness in solving important archaeological and historical questions.

Findings should not be accepted at face value and presented as assured results until they have been critically evaluated. For example, chemical evidence has been used to bolster theories of Bronze Age cultivation of the native wild Eurasian grape vine in the western Mediterranean, advocating its possible domestication at that time in contrast to traditionally dominant ‘East to West’ diffusionist models in which the Eurasian grape was domesticated in a unique event in the mountainous Near East at an earlier period. While there is increasing evidence that the grape was exploited in pre-Roman Italy (especially, in native ‘grogs’), there is yet insufficient evidence to argue for extensive cultivation in the Italian peninsula, let alone domestication (i.e. planting and exploitation of the hermaphroditic vine cloned by vegetative horticultural methods) before the arrival of the Iron Age Phoenicians and Greeks. Late Bronze Age interactions with Canaanites and Mycenaeans also appear to have had a comparatively minimal impact, at least as regards the introduction of the domesticated vine. The much earlier domestication in the Near East represents a truly revolutionary process, yet unparalleled for the Eurasian grapevine across its broad geographic range from the Iberian Peninsula to central Asia or among the many other species of *Vitis* worldwide.

Very recently, the chemical evidence for ancient Mediterranean and Near Eastern viniculture, including ancient Italian and Roman investigations, has come under serious scrutiny and scepticism.⁷ The critics are generally tied to what might be denoted as the ‘Gas Chromatographic-Mass Spectrometric (GC-MS) lipid school’ of ORA, based on the primary use of one chemical technique.⁸ As already pointed out, however, the very limited archaeological evidence for ancient grape or wine should be assessed from a broader scientific and historical perspective, otherwise we run the risk of becoming overly dismissive of data that are crucial to developing plausible working hypotheses. Such scepticism might then be extended out into the secondary literature, as has already begun to occur in this instance,⁹ which might impede the long-term development of the field.¹⁰ It is useful here, therefore, to contrast a variety of ORA techniques to judge how

⁶Indeed, Pecci describes many of these in Chapter 5 of the present volume.

⁷cf. Drieu et al. 2020, 2021; Briggs et al. 2021; Whelton et al. 2021.

⁸Evershed 2008.

⁹cf. Craig 2021.

¹⁰This has happened in the past with other applications of the natural and social sciences to archaeology (e.g. radiocarbon dating before it was put on a firmer basis by tree-ring calibration).

the discipline might best proceed into the future in carrying out analyses of ancient wine and grape remains.

First and foremost, absolute chemical certainty should not – and cannot – be the goal, especially when based on a single chemical technique. The shortcomings of such an approach have been laid out previously.¹¹ The upshot of this critique is that a careful weighing of the available evidence from multiple disciplines is required, combining and balancing natural scientific and socio-cultural approaches. Working hypotheses can then be induced and tested deductively.

As regards ORA's role in this process, special note should be given to how tartaric acid (TarA) is analysed, since it is the characteristic organic acid of wine, occurring in large amounts only in the Eurasian grapes of the Near East and Mediterranean regions. Of course, it cannot be used exclusively as a biomarker to detect wine, since it occurs to a limited extent in other natural products of the region such as the pomegranate (c. eighteen times less than the Eurasian grape) and is also produced in small amounts by soil microorganisms. Due regard also needs to be given to whether a specific natural product with higher amounts of the acid, such as baobab fruit from Africa, *Viburnum* fruit from the Russian plain¹² or hawthorn fruit from east Asia, might have been imported into the region in the period under investigation.

The possibility has been raised recently that small organic acids, such as TarA, are particularly susceptible to being degraded or contaminated by environmental factors as opposed to small lipid compounds, such as palmitic and stearic fatty acids.¹³ In fact, the latter are less soluble in water than small organic acids. But what might be gained by less groundwater leaching and contamination of fatty acids is negatively offset by the weaker binding properties of palmitic and stearic acids (pKa's of 4.75) in a pottery matrix, the usual material of the vessels being tested by ORA, as compared to the enhanced ionic binding to the aluminosilicate structure of clay by a stronger acid like tartaric (pKa 2.98 at 25°C for its first acidic function; note that pKa is a measure of the dissociation of a proton from an acid compound in aqueous solution). The amphiphilic nature of fatty acids also subjects them to movement in both hydrophilic and lipophilic materials, such as soils and especially in poorly provenanced and mixed archaeological contexts.

It should also be noted that the analysis of precipitated tartrate salts, including potassium bitartrate and calcium tartrate, at the bottom interiors of pottery vessels offers excellent prospects of detecting TarA as they are better protected from environmental factors and usually comprise larger amounts of the acid.¹⁴ If the ancient pottery vessel being tested once contained a liquid, this effect will be further enhanced by the absorption of TarA into the pottery matrix where conversion to the insoluble salt can also occur.

¹¹McGovern and Hall 2015 contra Evershed 2008; Roffet-Salque et al. 2013.

¹²Drieu et al. 2020.

¹³Whelton et al. 2021.

¹⁴Calcium tartrate, which often forms in the calcareous geological regimes of the Near East and Mediterranean, has a solubility of only 100 mg/L in water at 20°C – markedly less from that of the acid (1.3 kg/L) and much more comparable to the solubility of palmitic acid (7.2 mg/L).

Especially in dry climates and in well-defined and protected archaeological contexts such as a tomb or well-sealed floor of a building, TarA in a wine vessel will then be better absorbed, bound by ionic forces to the pottery matrix, retained, and preserved over time than will palmitic and stearic acids. A similar argument can be made for the accumulation and preservation of malate and other organic acid salts.

Moreover, if the sample to be tested comes from a narrow-mouthed pottery vessel or, even better, one that was stoppered at some time during its history – as was almost always the case for storage and transport containers like *amphorae* – then the prospects of retention of TarA are further improved.¹⁵ Note, however, that associated archaeological evidence is usually required to make the case for this working hypothesis, such as the excavation of the stoppers in the immediate vicinity of the tested whole vessels and ascertaining that the stoppers have identical diameters to the mouths of the vessels. If possible, it is also advisable to test any visible deposits on the interiors of vessels that might represent wine residues. Careful visual inspection and low-power microscopic examination should be standard practice.

Since the goal of any ORA investigation is to obtain reliable results that bear meaningfully on important cultural, technological and/or historical developments, the all-important starting point should be a careful assessment of the archaeological context of the proposed samples to be tested for their potential in developing and testing working hypotheses.¹⁶ The specific archaeological contexts that the samples came from – whether intact tomb, *in situ* primary settlement feature, or a secondary or tertiary disturbed context such as a refuse pit or building refurbishing – need to be fully detailed and published. Non-primary archaeological contexts are especially problematic, and they should be excluded from any ORA study.

Unfortunately, many GC-MS lipid studies come up short by either not providing such information or not clearly articulating their archaeological rationale for their choice of samples.¹⁷ Because these studies can be based on poorly provenanced sherds and rarely include whole vessels, one cannot independently judge how meaningful the samples are and to what extent supposed biomarkers have been contaminated and/or degraded by groundwater, soil chemistry, microbial activity and other factors. Although most of these studies involve large assemblages of samples, it is then difficult to evaluate the statistical significance of the data in testing and corroborating a working hypothesis.

Soil samples collected near the pottery vessels to be tested, which are contemporaneous with the latter, are the most effective way to monitor the loss and/or gain by groundwater movement, contamination, and/or degradation of the biomarker compounds, especially for longer time spans. Instead of contemporaneous soil samples as the most effective proxy, one study opts for an absolute amount of extracted residue – 5 µg lipid per gram

¹⁵For examples of unfired raw-clay stoppered vessels that tested positive for TarA from sites throughout the ancient Near Eastern and Mediterranean worlds and dating back to the early Neolithic period, see McGovern 2019a with references to published technical articles.

¹⁶McGovern and Hall 2015.

¹⁷E.g. Drieu et al. 2021.

potsherd – ‘for a valid interpretation.’¹⁸ But such a relatively small amount is no guarantee of this, as already discussed.¹⁹ Much higher amounts, combined with contemporaneous soil controls, are best and should be emphasized.

As our recent critique has also made clear,²⁰ Drieu et al. (2020) wrongly assumed that the ancient samples extracted by the Lamuela-Raventós group were done with potassium hydroxide (KOH) before testing for TarA/tartrate.²¹ In fact, the Lamuela-Raventós group used only 0.1 per cent formic acid in water/methanol (80:20 vol/vol) in their extractions, which was adequate for detecting TarA/tartrate if well-preserved in sufficient amounts. If KOH had been part of their extraction, it would certainly precipitate out the nearly insoluble potassium bitartrate, which explains the < 0.1 per cent recovery yield when a pure tartaric acid standard was run.²² Secondly and separately, the Lamuela-Raventós group did extract their samples using an alkaline KOH fusion reaction, to analyse for syringic acid derived from the red pigment, malvidin. The mistake of using KOH in the initial extraction has been made elsewhere and continues to be employed.²³

Previous studies give the misleading impression that the full range of published extraction methods were evaluated by Drieu et al. (2020), and only that of Garnier and Valamoti proved to be adequate.²⁴ Whelton et al. state that ‘the difficulties and pitfalls in attempting the detection of wine through ORA of specific “biomarkers” have recently been comprehensively reviewed and discussed in Drieu et al.’ (p. 4). They have, however, overstated their case, since the latter study did not evaluate the specific extraction method used in conjunction with the now state-of-the-art method employing liquid chromatography high resolution Orbitrap mass spectrometry (LC-HRMS) or tandem LC-MS/MS.²⁵ The best extraction method for detecting TarA by this technique was determined to be an ammonium hydroxide solution in water/methanol, followed by ultra-purification protocols. Associated control soils from the specified archaeological contexts went through the same procedure. This approach, which was apparently not available for testing by the GC-MS lipid group, is currently the most sensitive and accurate chemical method for the detection of TarA/tartrate.

Tandem LC-MS/MS was the method of choice in analysing early Neolithic wine from Georgia in the South Caucasus.²⁶ It represents a model study of the superior capabilities of this method in which a multidisciplinary approach incorporating ORA is integrated with other pertinent archaeological, archaeobotanical, climatic and scientific data. This is

¹⁸Whelton et al. 2021: 9.

¹⁹Indeed, the arbitrariness of the cut-off point has been revealed by scholars who advocate a much lower limit of only >1 µg/g of pottery (cf. Drieu et al. 2020). Reduced further to >0.1 µg/g in Briggs et al. 2021.

²⁰McGovern et al. 2021.

²¹Beginning with Guasch-Jané et al. 2004.

²²cf. Drieu et al. 2020.

²³cf. Pecci, Cau and Garnier 2013; Pecci et al. 2020; Drieu et al. 2021; Briggs et al. 2021.

²⁴Whelton et al. 2021.

²⁵cf. McGovern, Mirzoi and Hall 2009; McGovern et al. 2013, 2017.

²⁶McGovern et al. 2017.

not to say that the Garnier-Valamoti extraction method, which avoids using KOH and is well-tailored to GC-MS, cannot be equally effective in identifying ancient grape products, especially wine, at sites throughout Italy and elsewhere, thereby shedding important new light on vinicultural development over millennia.

A more recent paper additionally claims to have discovered a ‘robust analytical approach’ for identifying ancient Eurasian grape (*Vitis vinifera*) products, including wine, ‘with a high degree of confidence’.²⁷ It argues that if a pottery sherd recovered from the soil of an ancient archaeological site has a tartaric acid (TarA) content exceeding 35 per cent compared to the sum of its malic acid (MA) and TarA, its original vessel contents very likely derive from grape; if less than 35 per cent, the likelihood is nil. In advance of a more detailed critique, the following points should be considered:

1. The MA content of fully matured wild *Vitis* species generally exceeds that of TarA, often by as much as three times.²⁸ Wild and modern domesticated varieties from the 2022 vintage in Georgia are now being analysed to test that likelihood for *Vitis vinifera*. If true, the cut-off point for the TarA percentage will be considerably decreased, certainly below 35 per cent.
2. To enable consumption, humans would have been motivated to lower the MA content, a quantitatively variable genetic trait, by clonal selection. The composition of the wild grape was adapted to birds, which can tolerate higher acid contents than humans.²⁹ Depending upon the historical course of viticultural practice, a cut-off above 35 per cent for the TarA percentage might apply to recent European cultivars but not to ancient cultivars on Sicily or elsewhere.³⁰ The latter probably have considerably lower MA contents than ancient ones.
3. The validity of the TarA–MA ratio likely also depends greatly on the specific grape cultivar, its altitude, whether the grapes were harvested prior to or at full maturation, groundwater movement and/or contamination, soil type and pH, the microbiome (e.g. MA is generally more susceptible to attack by microorganisms than TarA), possible malolactic fermentation whether accidental or intentional, dilution effects due to an increase in size of the domesticated grape, and the relative initial absorption and retention of both acids into the pottery matrix over time.

Such factors, taken together and especially for the distant past, could result in widely varying relative percentages of TarA to MA, essentially invalidating any exact cut-off point.

²⁷Drieu et al. 2021.

²⁸Kliewer 1967; Burzynski-Chang et al. 2019.

²⁹Waterhouse, Sacks and Jeffery 2016; Schneider and Troxell 2018.

³⁰Drieu et al. 2021.

Beginning and spread of viniculture and ‘wine culture’

The preceding review of ORA, as applied to ancient viniculture, highlights how careful appraisals of other archaeological, botanical, historical, textual, artistic, ethnographic and scientific approaches, following a similarly rigorous approach, are needed to advance the field. In what follows, I concentrate on the most basic hypothesis of all: how was viniculture as a holistic entity first established on Roman territory? An understanding of its beginnings will serve as a reference point from which to judge how conservative Roman winemaking might have been or whether it improvised and improved upon the technology. An assessment can also be made of its influence elsewhere as the empire expanded.

To answer this fundamental question, we begin in the Near East. Briefly stated, my working hypothesis posits that the wild Eurasian grapevine (*Vitis vinifera* ssp. *sylvestris*) was first taken into cultivation and domesticated at a single time and place in the mountainous Near East. On current evidence, the general area can be delimited to the mountainous South Caucasus and nearby regions of the eastern Taurus and northwestern Zagros Mountains.³¹

We now know that grape domestication occurred at least by c. 6000 BCE during the early Neolithic period. Illustrative of the holistic multidisciplinary approach advocated here, an international project arrived at this conclusion by integrating the results from multiple scientific disciplines, including archaeological excavation, spatial analysis, radiocarbon dating, archaeobotany (low-power microscopy, and starch and pollen studies), biomolecular archaeology (ORA and DNA analysis), ancient climatic reconstruction (from which the Winkler Index for viable winemaking could be calculated) and artefactual studies.³² Because the domesticated grape (*V. vinifera* ssp. *vinifera*) is hermaphroditic (i.e. male and female sexual organs occur together in the flowers of the same plant unlike the wild species in which male and female are separate plants), it is more easily pollinated. Consequently, it produces more fruit for larger-scale and more efficient wine production.

From these beginnings, a ‘wine culture’ was eventually consolidated in the mountainous Near East. Such a culture, as exemplified by ancient and modern Georgia in the Caucasus and Mediterranean Italy, is one in which wine becomes the centre of human activities from birth to death, for rites of passage, religious celebrations and offerings, economic activity, political negotiations, feasts with song, dance, and other entertainment like the Roman *convivium*, or simply an everyday meal, possibly accentuated with toasting. Once established, wine culture can be hypothesized to have gradually radiated out in time and space to become a dominant socio-economic, religious, artistic and medical force throughout the Near East and Mediterranean region. This development entailed transplanting the domesticated grapevine and the adoption of vinicultural techniques by other peoples, often with the advice of those who were already adept winemakers.

³¹See McGovern 2019a, especially the updated Afterword, which should be consulted for more detailed discussion and bibliography on this topic and others, addressed below.

³²McGovern, et al. 2017.

For our purposes in tracking the course of wine culture from ‘East to West’ across the Mediterranean, its arrival in the northern Levant represents a crucial point of departure. Likely adopted there by at least 5000 BCE, it took longer to reach the southern Levant where the wild vine did not grow. Beginning around 4000 BCE, the Jordan Valley and environs were planted with the domesticated vine and began producing wine. Later in the fourth millennium BCE, the probable ancestors of the historic Bronze Age Canaanites of the southern Levant started exporting wine to nearby Egypt, which was also devoid of grapes. Most remarkable is the tomb of the Dynasty 0 pharaoh Scorpion I at Abydos on the middle Nile River, which was stocked for eternity with some 700 jars (4,500 litres) of wine as early as c. 3150 BCE. This finding, too, was based on biomolecular archaeological and archaeobotanical evidence.³³

However, since an Egyptian winemaking industry was yet to be established, from where did the jars and their wine come? Clues to their origin were their unusual shapes, decorations and manufacturing details, which were not local to Egypt. The best parallels came from sites in the Jordan Valley, near the Dead Sea, and in the vicinity of Gaza along the Mediterranean, the closest settled area in the southern Levant to Egypt. Since stylistic comparisons can be misleading, an inorganic chemical technique was applied: NAA. By measuring as many as thirty-five chemical elements, especially the rare earths, and applying powerful statistical techniques, it was shown to a 99 per cent probability that the wine jars from the Scorpion I tomb were made of the same clays as those found in the Jordan Valley, the Hill Country of the West Bank and Transjordan, and the Gaza region.³⁴

Correspondence between the stylistic and chemical findings could hardly be coincidental. At this time – the Early Bronze Age I in the southern Levant – most pottery is argued to have been locally produced in small workshops, as was further corroborated by the NAA evidence for the exploitation of local Levantine clay beds. The most parsimonious and straight-forward conclusion was suggested: where the pottery was made was most likely near where the wine inside the jars was made.

With the pharaohs perhaps setting the precedent of importing wine from Canaan, a native Egyptian industry was established in the Nile Delta *de novo* by Dynasty 1, c. 3000 BCE. Canaanite winemakers thus likely played a major role in overseeing and advising on vinicultural decisions and techniques. The advanced stage of Canaanite technology is evident from Egyptian tomb frescos and reliefs (Figure 2.2), the earliest known depictions in the world, which began to be produced in the third millennium BCE. We see how the vines were deliberately trained on trellises and pergolas, to protect the grapes from the potentially damaging sun and for easier cultivation and harvesting. Small treading facilities, well attested throughout the Levant,³⁵ are shown with red grape must gushing

³³McGovern, Mirzoiian, and Hall 2009; McGovern 2022.

³⁴McGovern 2001.

³⁵Frankel 1999; Fischer-Genz 2016; Orsingher, et al. 2020.

from spouts. Stoppered *amphorae*, which evolved from the Canaanite Jar³⁶ to become the container *par excellence* for ageing and transporting wine, are also illustrated. They bear detailed hieroglyphic wine labels noting the year of the pharaoh and the winery's location, akin to the information provided by the later *dipinti* on Roman *amphorae*.

With this success behind them, the Canaanites from their city-states along the Levantine coast – Byblos, Tyre and Sidon – became superb shipbuilders and seafaring entrepreneurs. In their state-of-the-art 'Byblos ships' made of cedar of Lebanon, they ventured ever farther out into the Mediterranean. According to my working hypothesis, they applied a similar formula wherever they went: import wine and other luxury goods, entice the rulers with the wine culture by presenting them with specialty wine sets, and establish a native vinicultural industry by transplanting the domesticated Eurasian grapevine and establishing a wine industry.

Canaanite seafaring prowess is exemplified by the fourteenth century BCE Uluburun shipwreck, which thus far is the earliest one found in the Mediterranean and has been convincingly argued by its excavators to be a Canaanite ship.³⁷ Scientific testing demonstrated that the vast majority of the approximately 150 *amphorae* on board contained a terebinth-tree resinated wine.³⁸ Several jars were filled only with the resin, to use as a sealant or for adding more to the wine as a preservative on its journey. Similar ships were probably already travelling to the nearest island, Cyprus, by the mid-third millennium BCE, moving on to Crete by around 2200 BCE, and to the Greek Mainland probably shortly thereafter.³⁹

During the early first millennium BCE, the Phoenicians ventured farther into the western Mediterranean where they founded colonies in Africa, on strategic islands including Malta, Sicily and Sardinia, and along the Spanish coast, even out into the Atlantic to Huelva, near Cádiz.⁴⁰ Archaeological remains illustrate that they likely promoted wine culture to local cultures, as they did in Egypt, and fostered the production of wine locally. Widespread Phoenician, and later Greek, activity gave rise to new domesticated grape varieties due to the secondary crossing of the Near Eastern grapevine with local wild grapevines. In the wake of Phoenician trade and colonization, native fermented beverages, especially mixed fermented beverages ('grogs'), such as the Greek *kykeon*, with their numerous ingredients, were marginalized, modified, and displaced by grape wine.⁴¹

Probably by the tenth to ninth centuries BCE, when their influence was already felt in Spain,⁴² the Phoenicians might well have made contact with people in Etruria in central Italy. Archaeology shows the adoption of many eastern Mediterranean technologies,

³⁶McGovern 2019a: 110.

³⁷See McGovern and Hall 2015 with references to published reports.

³⁸McGovern and Hall 2015.

³⁹Hadjisavvas 2020.

⁴⁰Botto 2013.

⁴¹McGovern 2009.

⁴²cf. Ramón 2010; Botto 2013; Peña Cervantes 2020.

including glassmaking, metalworking, shipbuilding, ivory carving, Royal Purple dyeing, and preeminently wine consumption in special drinking sets and production.⁴³ These developments followed probable native exploitation of wild grapevines already growing on the peninsula and making a fermented beverage perhaps as early as the Bronze Age (c. 1500–1400 BCE), possibly stimulated by contacts with traders from the Aegean region.⁴⁴ The Etruscans can be hypothesized to have carried this tradition a step further by drawing upon Phoenician expertise in viniculture.

A prime piece of evidence for this working hypothesis, in my opinion, is that the Etruscan *amphora*, which was eventually adapted by the Etruscans as their container for exporting wine to southern France,⁴⁵ is more closely modelled after the Phoenician *amphora* than the Greek one, represented by Massiote and Greek types of the same period (Figure 2.3). While problematic to confirm, similarities in container styles, especially in the early stages of their adoption, might well imply similar contents – in this instance, wine. A comparable case can be made for the Phoenician *amphora* and its culture having influenced the development of the *amphora* and winemaking in their Iberian colonies. The pivotal role of Mago the Carthaginian in providing a foundation for later Roman texts might provide further evidence of this influence.

From Etruria, wine culture passed over into the Roman world, with added Greek elements which increasingly penetrated northwards from *Oenotria* (and Magna Graecia more broadly) at the southern tip of the Italian peninsula.

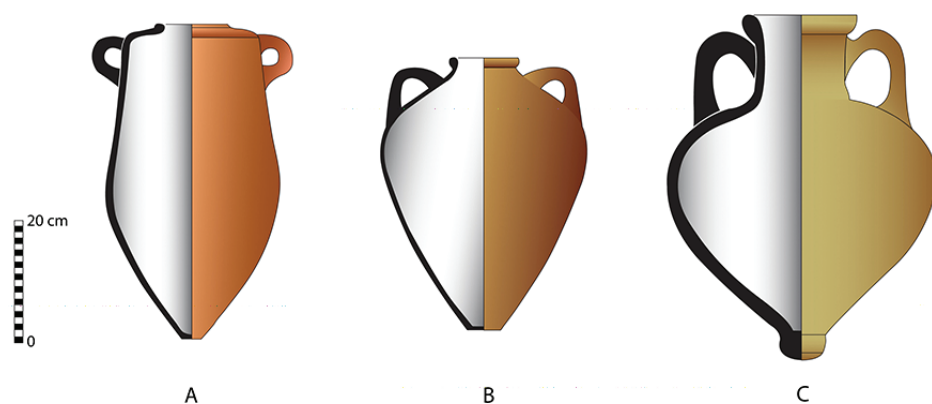


Figure 2.3 Early *amphora* types from the western Mediterranean: (A) Phoenician type A-PUN, c. 700–600 BCE; (B) Etruscan type A-ETR 4, c. 626–575 BCE; (C) Massaliote type A-MAS 1, c. 550–475 BCE. Drawings courtesy of B. P. Luley.

⁴³Del Mastro et al. 2017, 2021.

⁴⁴Dodd 2022a: 446–50.

⁴⁵McGovern et al. 2013.

Technological comparisons between the East and West

Specific technological features of the Roman winemaking industry support this general hypothesis that viniculture flowed from ‘East to West’. If we examine the Roman vinicultural *chaîne opératoire*, it is remarkable how similar some treading vats, trellising methods, vinification techniques, and wine additives are to those in the East at much earlier periods (cf. Figure 2.4). The Levant had hillside stomping platforms with settling basins perhaps from prehistoric times; Rome had *palmenti*, which span a long prior history.⁴⁶ The Near East had buried vinification jars at Chalcolithic Areni in Armenia⁴⁷ and Bronze Age Byblos in Lebanon;⁴⁸ Rome had similarly subterranean *dolia defossa*. In both regions, again beginning earlier in the East, grapevines were variously grown up trees as was their natural habit, supported on linear trellises and pergolas above ground (Figure 2.4), trained to run along the ground, or pruned into low bushes.⁴⁹ Tools that originated in the East (e.g. the pruning hook) were likely carried on ships as trade goods⁵⁰ and adopted in Etruria and Rome.⁵¹ Herbal and tree resin ingredients, which were



Figure 2.4 Black-figured vase by the Athenian Amasis Painter (sixth century BCE), recovered from the Etruscan site of Vulci, Italy. It is the earliest depiction in the Greek world of the vinicultural *chaîne opératoire*. Photograph by P. Neckermann, courtesy of the Martin von Wagner Museum, University of Würzburg (redrawn by B. P. Luley).

⁴⁶Dodd 2022a.

⁴⁷Areshian et al. 2012.

⁴⁸Brun 2004a: 59.

⁴⁹White 1970a: Figure 2.

⁵⁰Delpino 2012: Figure 7.

⁵¹Zifferero 2012; De Grummond 2018.

chemically identified in wine vessels throughout the Near East beginning in the Neolithic period, were also regularly added by vintners to later Roman and Greek wines (cf. Pliny, *HN* 14.19, Columella, *Rust.* 12.27; Palladius, *Op. Agr.* 11.14–19).

By contrast, the differences that exist between the vinicultural technologies, East and West, are relatively minor. For example, while the archaeological remains of facilities show that Roman winemakers, especially in Italy, perhaps carried out their primary fermentation in open-air collection vats, probably followed soon after by continuing the process in partially or fully underground *dolia* so as to free up the collection vat,⁵² the Levantine custom was generally to do these operations sequentially in multiple tanks and smaller *amphorae* and jars, such as *pithoi*, fully above ground (Figure 2.2). Both regions, however, completed their secondary fermentations and ageing in above-ground pottery vessels or those slightly embedded into a surface. The minor differences remain to be explained. The Roman (Italian) method was rarely adopted in the Levant, except at King Herod's winter palace whose *dolia* were probably imported from a pottery workshop in Italy.⁵³

Additives that went into the wine, which were very important in pharmacopoeias both East and West, also varied only slightly, depending mainly on access to local and imported herbs, spices and tree resins. Diluting wine with water, however, was less common in the East where peoples preferred it neat.⁵⁴ Adding seawater to wine, as a form of 'amelioration', was the mark of the best Greek imported sweet whites from the Aegean, especially from Kos (Pliny, *HN* 14.9). The practice probably came via Greek colonization in Italy, since the sweet Levantine wines, which were accorded high praise by classical authors (e.g. Byblite: Hes., *Op.* 589; Euripides, *Ion* 1177; Theoc., *Id.* 14.15; Archestratus of Gela, fr. 59.5; Ath., *Deip.* 1.29B), were not described by them as having been similarly treated.

While the origins and diachronic distribution patterns of mechanical winepresses remain difficult to untangle, they may again point to the Near East; for example, the lever-and-fulcrum concept was already used in Egypt as early as the third millennium BCE for an irrigation device, the *shaduf*, as depicted in Old Kingdom artwork. The ancient Egyptians, and presumably the Canaanites, also had sack winepresses for extracting the maximum amount of juice from the grapes from an early time. Textile sacks were stretched between two poles by teams of as many as eight men and a more mechanical version was constructed within wooden frames, which was operated by several men rotating a stick to twist the sack.⁵⁵ It is likely depicted in one of the earliest hieroglyphs of the First Dynasty, appropriately designating a vine, vineyard, or wine.⁵⁶

The earliest winepress that combined the lever-and-fulcrum and the sack concepts was the lever-and-weights type, numerous examples of which were excavated at third

⁵²Dodd 2020a, 2022a.

⁵³Porat et al. 2018.

⁵⁴McGovern 2019a: 235.

⁵⁵James 1995: Figures 13.6–13.10.

⁵⁶James 1995: 200–1, Figure 13.3, Hieroglyph A.

millennium BCE Ugarit in the northern Levantine. Based on current evidence, Brun argues for their exclusive use for olive oil extraction, but Zamora makes a reasonable case for concomitant extraction of grape juice.⁵⁷ The lever-and-weights winepress was definitely well established by the second millennium BCE throughout the Levant, and this type continued in use for millennia until the present.⁵⁸

Such advances provided a foundation for other winepress types described by the Roman authors and whose features are corroborated by excavated archaeological remains and artwork. They included the lever-and-drum (or winch), lever-and-screw, and the single and double direct-screw sub-types, among others.⁵⁹ Although their origins are uncertain,⁶⁰ they might well have been developed in the central or western Mediterranean where they are best represented. The increasing use of the lever-and-screw and the direct-screw types in the East from the fourth century CE might also suggest that these types were first developed in the West and later adopted in the East.⁶¹

Many other steps in the *chaîne opératoire* might be similarly explored from the perspective of the East–West hypothesis. Among many topics worthy of investigation are the specific origins of wine grapes across regions with a focus on white varieties which are said to have been especially appreciated by the Romans,⁶² vineyard layouts, irrigation methods, pruning and grafting of the vines, plant rotation and fertilizing, tools such as large funnels and hoes, and the inception and development of *passito* wine (*passum* in Latin) made from raisins for which Mago the Carthaginian first provided a recipe. One's success in pursuing other relevant topics is sometimes limited by the available evidence. For example, ancient vineyards in the Near East surprisingly have yet to be located for any period. Even where Roman imperial activity is well-documented (e.g. Herodium), the location of the vineyards associated with the winemaking facility are unknown. Surveys and mapping by satellite and aerial reconnaissance, geophysical prospection and excavation are needed, along the lines of model studies carried out in Sicily, the Crimea and around Pompeii.⁶³

Conclusion and the future

My goal in this review of ancient viniculture from a scientific perspective has been multifold. I have articulated a working hypothesis of how this highly consequential technology and its associated wine culture probably arose in the Near East and spread

⁵⁷Brun 2004a: 50–8; Zamora 2000.

⁵⁸Lewit and Burton 2019.

⁵⁹Brun 2003, 2004a, 2004b; Frankel 2020.

⁶⁰cf. Lewit 2020.

⁶¹Lewit and Burton 2019.

⁶²Tchernia 1990: 65; Komar 2020.

⁶³Sicily: Boissinot 2009; Crimea: Smekalova et al. 2016; Pompeii: Jashemski 1979, 1993. See also the contribution by Seiler in the present volume.

westward across the Mediterranean to Rome. There it blossomed and lay the foundation for winemaking, not just elsewhere in the empire but around the world in the centuries to come, up until today. I stress that this hypothesis is by no means ‘proven’. Rather, a multidisciplinary holistic approach, suitable for resolving and testing important questions for a historical science such as archaeology, should lead the way in directing future research. The challenge is to bring to bear the most appropriate and advanced methodologies in the natural and social sciences in concert with those of the humanities.

I believe that the primary ‘East to West’ hypothesis has thus far been borne out. Rome received its vinicultural knowledge and expertise, together with the transplanted domesticated Eurasian grape, ultimately from the Levant and region of the fertile crescent. For ‘Roman’ viniculture specifically, the main channel for the adoption of related technology was the Phoenicians via the Etruscans who, in turn, passed it on to the Romans. Greece played a later auxiliary, albeit crucial, role in the process. Roman farmers, winemakers, artisans, engineers, and other craftspeople (e.g., potters and metalworkers) undoubtedly made their own contributions to various stages in the process (whether through irrigation, crop husbandry or mechanical pressing methods), but they do not presently appear to have contributed any advance that was revolutionary and might have had far-reaching effects on the long-standing practice of viniculture.

Any influence going from West to East from the empire as it expanded was comparatively minimal. Local viticulture and winemaking in the Levant and further east continued along the same indigenous lines that it had followed for millennia. Some improvements were no doubt made as a result of new developments in the central and western Mediterranean, such as better cultivation techniques and more diverse pressing operations, but those were at the margins, either too difficult to discern in the archaeological record or requiring more investigation. Only when a ruler such as Herod the Great deliberately imitated Roman practice and custom by probably importing *dolia* made in Italy or using preferred botanicals from there or elsewhere can one say that a more extensive transfer of technology might have occurred.

Much more remains to be done. For example, experimental archaeology, as a proxy for laboratory replication of results to support a hypothesis, can be employed to evaluate the numerous, interacting variables that might be proposed for an ancient vineyard design, winemaking apparatus, or finishing process.⁶⁴ Depending on the success or failure of the replicative experiment, a working hypothesis can be gradually refined.⁶⁵ The experimental archaeology approach to ancient winemaking can take many forms. For example, you might integrate the available archaeological and scientific evidence for viniculture from a specific region and period with an ancient recipe for a specific wine according to contemporaneous texts and artwork. This is what Jean-Pierre Brun and André Tchernia, the archaeologists, and Hervé Durand, the vintner, did at the Mas des

⁶⁴E.g. Indelicato 2020a, 2020b; Harutyunyan and Malfeito-Ferreira 2022; Harutyunyan et al. 2022. Also see the contribution of Harutyunyan et al. in this volume.

⁶⁵See McGovern 2017a regarding mixed fermented beverage recreations, including grape wine.

Tourelles winery, along the southern Rhone River at Beaucaire, where a Gallo-Roman pottery workshop and winery once stood next to a vineyard.⁶⁶

They based their approach on their extensive ancient vinicultural knowledge and on detailed recipes of the Roman writer Columella (4 BCE–c. 70 CE). A massive wine press and Roman cellar were reconstructed following Brun's recommendations, and Roman *dolia* and *amphorae* made according to Tchernia's specifications. Durand chose to grow a recently hybridized grape, Villard Blanc, in ancient Roman fashion on pergolas, single-poles and trees. The grapes were stomped and pressed, juice collected in open concrete vats, and then transferred to and fermented in pitch-lined *dolia*, partly buried in the ground. The finishing touches were to add fenugreek, *defrutum* syrup (grape juice boiled down to half its volume), seawater and lime, with quince, iris, lilac, and other ingredients experimented with in later vintages. The final product, named Turriculae, was aged in *amphorae* in the cellar.

I did a tasting of Turriculae with Tchernia and Durand in October 2002 and was duly impressed by the deep yellow colour and its sherry-like nutty quality, accented by herbs, such as the fenugreek with its own sherry-like caramelized character. In addition to their later experiments, they might also have tried basil, thyme and/or rosemary which were chemically detected in early Etruscan wine.⁶⁷ Roman wine, with its many additives, represents the apotheosis of this approach. The assumption of such experimental recreations of an ancient wine is that human senses and the 'mind-altering' experience caused by alcohol have remained largely constant over thousands of years despite changes in individual and societal tastes. That's a reasonable expectation, even for Palaeolithic hominins with brain structures probably similar to our own.⁶⁸

Ideally, any tasting component of a re-created beverage should be coupled with scientific measurements. Besides compiling the judgements of the best vintners and sommeliers, their assessments need to be calibrated with Electronic-Nose GC-MS in which the taster provides descriptors of the volatile aromatics as they come off the chromatograph and then go into the spectrometer for chemical identification. Much of what we call taste is gleaned from our olfactory sense and similarities and differences for human and machine may turn out to be quite revealing. For example, knowing a wine's colour ahead of time can severely prejudice your evaluation of it, even for the expert taster.⁶⁹ Once the different taste variables have been described and identified from one another as much as possible, they can be correlated with the available archaeological, textual, artistic and other scientific data to help in their interpretation and refine additional experiments. Thus, a holistic multidisciplinary scientific approach, again, comes to the fore.

An important investigation still to be done is to compare the olfactory properties of wines vinified for long periods on their lees of skins, seeds and stems in underground

⁶⁶Tchernia and Brun 1999.

⁶⁷McGovern et al. 2013; note the re-creation of an Etruscan 'grog' in McGovern 2017a.

⁶⁸McGovern 2009: 7–8, 23; McGovern 2019c.

⁶⁹Castrioto-Scanderberg et al. 2005.

pottery jars, like the Georgian *qvevri*, with those made in oak barrels.⁷⁰ Both Old and New World winemakers have begun avidly experimenting with fermentation above or below ground in pottery replicas of ancient vessels, sometimes importing them from Georgia and sometimes producing them out of local clays and in keeping with distinctive indigenous styles.⁷¹

From a chemical vantage point, wine made and aged in oak, especially toasted barrels, can be expected to be more resinous in character. Using oak in winemaking is a kind of nod to ancient, resinated wines. Woody flavours and aromas are imparted by lactones, produced from the lipids in oak. Its tannins readily hydrolyse to form acetal, which may yield a pleasing but vegetal taste. When heat is applied to the wood, its lignins break down into compounds such as vanillin and other phenolic aldehydes, which are often lamented in over-oaked wine. Oak's high carbohydrate content is converted into caramelization products by heating. By contrast, pottery and other ceramics as inorganic materials are relatively neutral chemically. But they can contribute a different range of flavours and aromas from those of oak, owing to the porosity and ionic structure of specific tempered clays with metal ions that undergo oxidation-reduction, polymerization and enzymatic reactions, many of which are yet to be characterized. Stainless steel and most other metals have little or no effect on the final product.

Anyone who has tasted an *amphora* or *qvevri* wine will have been struck by how unusual its flavours and aromas are compared to the standard wines made according to Western 'industrial' standards. They are worlds apart. You might be captivated by the new or nauseated by the old method. Yeast and grape variety can add to your confusion, especially if the cultivar is not one of the twenty-five or so varieties, usually of French derivation, that are most commonly planted. If the yeast and other microorganisms have taken up residence in the pottery pores and cannot be easily washed out between fermentations, then they may contribute their own blend of indigenous flavours (and perhaps off flavours) to the mix.

Because of the millennia-long development of viticulture in the East, which then spread westwards, we now have 5,000 or more grape cultivars, with their seemingly infinite varietal range of tastes. They all ultimately derive from the Eurasian species (*Vitis vinifera*) of the mountainous Near East transplanted or crossed again and again as the wine culture moved from 'East to West,' and then spread out to the rest of the world. While our understanding of these developments is still limited, our increasing ability to deploy archaeological, historical and scientific techniques, based on a holistic multidisciplinary approach, promises to fill in the gaps in our knowledge. This volume represents a major step forward in that direction.

⁷⁰cf. Grigalashvili and Khomasuridze 2021.

⁷¹Barisashvili 2017; Glonti and Glonti 2013.

BIBLIOGRAPHY

- Acconcia, V. and A. Piergrossi (2021), 'L'archeologia del vino nella penisola italiana e nelle grandi isole del Tirreno tra il neolitico e la romanizzazione: tematiche, dati e approcci possibili', *Bollettino di Archeologia online*, 12 (1–2): 183–230.
- Accorsi C. A., M. Bandini Mazzanti, L. Forlani, N. Giordani, M. Marchesini, S. Marvelli and G. Bosi (1998), 'Archaeobotany of the Cogmento hiding well (Modena; Northern Italy; 34 m a.s.l.; 44°40'N 10°55'E; Late Roman – Modern Age)', in *1st International Congress on 'Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin'*, November 27–December 2 1995, 1537–54, Catania.
- Agostinelli, C. and U. Lund, (2017), 'R package "circular": Circular Statistics (version 0.4-93). Available online: <https://cran.r-project.org/web/packages/circular/citation.html> (accessed 21 February 2022).
- Ahmed, M. A. M. (2019), *Rural Settlement and Economic Activity: Olive Oil, Wine and Amphorae Production on the Tarhuna Plateau During the Roman Period*, Society for Libyan Studies Open Access Monograph 1, Oxford: Oxbow Books.
- Aimar, F., P. Gullino and M. Devecchi (2021), 'Towards Reconstructing Rural Landscapes: A Case Study of Italian Mongardino.' *Journal of Rural Studies* 88: 446–61.
- Akerman, J. R., ed. (2009), *The Imperial Map: Cartography and the Mastery of Empire*, Chicago: University of Chicago Press.
- Akkemik, Ü., H. Caner, G. A. Conyers, M. J. Dillon, N. Karlioğlu, N. K. Rauh and L. O. Theller (2012), 'The Archaeology of Deforestation in South Coastal Turkey', *International Journal of Sustainable Development and World Ecology* 1 (1): 1–11.
- Alba, V., C. Bergamini, M. Gasparro, F. Mazzone, S. Roccotelli, D. Antonacci and A. R. Caputo, eds (2015), *Il Progetto Basivin SUD: Recupero e valorizzazione delle principali varietà locali e dei vitigni autoctoni minori in Basilicata*, Bari: Mario Adda Editore.
- Albert, R. M., R. Shahak-Gross, D. Cabanes, A. Gilboa, S. Lev-Yadun, M. Portillo et al. (2008), 'Phytolith-rich Layers from the Late Bronze and Iron Ages at Tel Dor (Israel): Mode of Formation and Archaeological Significance.' *Journal of Archaeological Science* 35 (1): 57–75.
- Al-Gaadi, K. (2012), 'Employing Electromagnetic Induction Techniques for the Assessment of Soil Compaction', *Am. J. Agric. Biol. Sci.* 4: 425–34.
- Allegrezza, V. (2017), 'Torcular e gli olivi nel Lazio settentrionale: nuove evidenze', *Rivista di Storia dell'Agricoltura*, 57 (1): 3–24.
- Allevato E., M. Buonincontri, A. Pecci, M. A. Cau, M. Vairo, M. Yoneda, G. F. De Simone, C. Angelelli, S. Matsuyama, K. Takeuchi and G. Di Pasquale (2012), 'Persistence of the Cultural Landscape in Campania (Southern Italy) Before the AD 472 Vesuvius Eruption: Archaeoenvironmental Data', *Journal of Archaeological Science* 39 (2): 399–406.
- Amouretti, M.-C. and J.-P. Brun, eds (1993), *La production du vin et de l'huile en Méditerranée*, BCH Supp. XXVI, Athens: École Française d'Athènes.
- Andersen, S. T. (1970), 'The Relative Pollen Productivity and Representation of North European Trees, and Correction Factors for Tree Pollen Spectra', *Dan Geologiske Undersogelse II* 96: 1–99.
- Andreev, A. A., P. E. Tarasov, F. A. Romanenko, and L. D. Sulerzhitsky (1997), 'Younger Dryas pollen records from Sverdrup Island (Kara Sea)', *Quat. Int.*, 41/2, 135–9.

Bibliography

- Andrieu-Ponel, V., P. Ponel, A. J. T. Jull, J.-L. de Bealieu, H. Bruneton and P. Leveau (2000), 'Towards the Reconstruction of Holocene Vegetation History of Lowert Provence: Two New Pollen Profiles from Marais des Baux', *Vegetation History and Archaeobotany* 9: 71–84.
- Angourakis, A., V. Martínez Ferreras, A. Torrano and J. M. Gurt Esparraguera (2018), 'Presenting Multivariate Statistical Protocols in R Using Roman Wine Amphorae Productions in Catalonia, Spain', *Journal of Archaeological Science* 93: 150–65.
- Antonini, E. and M. Marchesini (2017), 'La piantata e la viticoltura: persistenza nel paesaggio moderno', in L. Malnati, S. Pellegrini, F. Piccinini and C. Stefani (eds), *Mutina splendidissima: la città romana e la sua eredità*, Catalogo della Mostra, Modena 2017–18, 290–3, Rome: De Luca Editori d'Arte.
- Areshian G. E., B. Gasparian, P. S. Avetisyan and R. Pinhasi (2012), 'The Chalcolithic of the Near East and South-Eastern Europe: Discoveries and New Perspectives from the Cave Complex Areni-1, Armenia', *Antiquity* 86: 115–30.
- Armstrong, K. L. and T. Kalayci (2015), 'Images of the Past: Magnetic Prospection in Archaeology', in A. Sarris (ed.), *Best Practices of Geoinformatic Technologies for the Mapping of Archaeolandscape*, 1–12, Oxford: Archaeopress.
- Arobba D., R. Caramiello and G. P. Martino (1999), 'Analisi paleobotaniche di resine dal relitto navale romano del Golfo Dianese', *Rivista di Studi Liguri* 63–4: 339–55.
- Arobba D., R. Caramiello and G. P. Martino (2005), 'Il contributo delle analisi archeobotaniche per la storia del paesaggio agrario della città romana di Albintimilium (Ventimiglia)', *Rivista di Studi Liguri* 70: 283–306.
- Arobba D., F. Bulgarelli and R. Caramiello (2010), 'Preliminary Study on Carpological Remains of Food Resources from a Roman Well at Vada Sabatia', in C. Delhon, I. Théry-Parisot and S. Thiébault (eds), *Des Hommes et des Plantes: Exploitation du milieu et gestion des ressources végétales de la préhistoire à nos jours, XXX rencontres internationales d'archéologie et d'histoire d'Antibes*, 123–7. Antibes: Editions APDCA.
- Arobba D., F. Bulgarelli, C. Siniscalco and R. Caramiello (2013), 'Roman Landscape and Agriculture on the Ligurian Coast through Macro and Microremains from a Vada Sabatia Well (Vado Ligure, Italy)', *Environmental Archaeology* 18 (2): 114–31.
- Arobba D., F. Bulgarelli, F. Camin, R. Caramiello, R. Larcher and L. Martinelli (2014), 'Paleobotanical, Chemical and Physical Investigation of the Content of an Ancient Wine Amphora from the Northern Tyrrhenian Sea in Italy', *Journal of Archaeological Science* 45: 226–33.
- Arriaga-Varela, E. J. and T. Takahashi (2019), 'Automatic Georeferencing of Heterogeneous Historic and Illustrated Maps', in *Abstracts of the International Cartographic Association 1, 29th International Cartographic Conference (ICC 2019), 15–20 July 2019, Tokyo, Japan*, 1–2.
- Arroyo García, R. A. and E. Revilla (2013), 'The Current Status of Wild Grapevine Populations (*Vitis vinifera* ssp *sylvestris*) in the Mediterranean Basin', in D. Poljuha and B. Sladonja (eds), *The Mediterranean Genetic Code: Grapevine and Olive*, 51–72. London: Intech Open.
- Aspinall, A., C. Gaffney and A. Schmidt (2008), *Magnetometry for Archaeologists*, Lanham: AltaMira.
- Atherden, M., J. Hall and J. C. Wright (1993), 'A Pollen Diagram from the Northeast Peloponnese, Greece: Implications for Vegetation History and Archaeology', *The Holocene* 3 (4): 351–6.
- Atkins, R. and I. Meadows (forthcoming), *Neolithic Pits, Pit Alignments and Iron Age to Roman Settlements at Wollaston Quarry Northamptonshire*, Museum of London Publications.
- Auriemma, R. and V. Degrassi (2015), 'Flussi di circolazione e redistribuzione in Adriatico tra tarda Repubblica e Impero: anfore da contesti terrestri subacquee', in *AdriAtlas et l'histoire de l'espace adriatique du VIe s. a.C. au VIIIe s. p.C.: actes du colloque international de Rome (4–6 novembre 2013)*, 453–78, Bordeaux.
- Aversano, R., B. Basile, M. P. Buonincontri, F. Carucci, D. Carputo, L. Frusciante and G. Di Pasquale (2017), 'Dating the Beginning of the Roman Viticultural Model in the Western Mediterranean: The Case Study of Chianti (Central Italy)', *PLoS ONE* 12 (11): e0186298. <https://doi.org/10.1371/journal.pone.0186298>.

- Ayalon, E., R. Frankel and A. Kloner, eds (2009), *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*, Oxford: BAR Publishing.
- Aydinoğlu, Ü. and A. K. Şenol, eds (2010). *Olive Oil and Wine Production in Anatolia During Antiquity: Symposium Proceedings 06–08 November 2008, Mersin, Turkey*, Istanbul: Research Centre of Cilician Archaeology, KAAM.
- Bacchetta, A. (2003), *Edilizia Rurale Romana. Materiali e tecniche costruttive nella Pianura Padana (II sec. a.C. – IV sec. d.C.)*, Firenze: All'Insegna del Giglio.
- Bacilieri, R., L. Bouby, I. Figueiral, C. Shaal, J.-F. Terral, C. Breton, S. Picq, A. Weber and A. Schlumbaum (2017), 'Potential of Combining Morphometry and Ancient DNA Information to Investigate Grapevine Domestication', *Vegetation History and Archaeobotany*, 26 (3): 345–56.
- Bacilieri, R., T. Lacombe, L. Le Cunff, M. Di Vecchi-Staraz, J.-P. Genna and B. Péros (2013), 'Genetic Structure in Cultivated Grapevines Is Linked to Geography and Human Selection', *BMC Plant Biology*, 13: 25.
- Badiali, F. (2009), 'Dagli acini d'uva alla ricostruzione del paesaggio: l'esempio dell'ecomuseo della collina e del vino di castello di Serravalle (Bologna)', *Bollettino Associazione Italiana Cartografia*, 136–7: 81–92.
- Badiali, F. (2012), *Metodologia e ricerche sperimentali sull'evoluzione del paesaggio in contesti 'naturali' (Montese e Castello di Serravalle, Appennino emiliano) e urbani (Oradea, Romania)*, Scuola di Dottorato in ESS: Environment Resources and Cultural Heritage, XXIV (2009–12), Università degli studi di Modena e Reggio Emilia.
- Bakels, C. (2020), 'Pollen and archaeology', in A. G. Henry (ed.), *Handbook for the Analysis of Micro-particles in Archaeological Samples*, 203–24, Cham: Springer.
- Baker, A., G. Mariethoz, L. Comas-Bru, A. Hartmann, S. Frisia, A. Borsato, P. C. Treble and A. Asrat (2021), 'The Properties of Annually Laminated Stalagmites: A Global Synthesis', *Reviews of Geophysics*, 59 (2): e2020RG000722.
- Balmelle, C. and J.-P. Brun (2005), 'La vigne et le vin dans la mosaïque romaine et byzantine', in H. Morlier (ed.), *La Mosaïque gréco-romaine IX*, 899–921, Rome.
- Bandinelli, R. and G. Di Collalto (1997), 'La presenza del vitigno Ansonica in Toscana', in *Ansonica: La riscoperta di un antico vitigno*, Atti del Convegno Nazionale, Isola del Giglio 1996, 23–35, Firenze: Regione Toscana.
- Bandini Mazzanti, M., C. A. Accorsi, R. Curina, A. Cattini and M. Marchesini (1995), 'Carpological Remains from a Pit Fill at the Roman Villa (1st–4th Century AD) of Casteldebole (Bologna–Emilia Romagna, North Italy)', *Giornale Botanico Italiano*, 129 (2): 222.
- Baratta, G. (1994a), 'Circa Alpes ligneis vasis condunt circulisque cingunt', *Archeologia Classica*, 46: 233–60.
- Baratta, G. (1994b), 'Bolli su botti', in *Epigrafia della produzione e della distribuzione: Actes de la VIIe Rencontre franco-italienne sur l'épigraphie du monde romain (CEFR 193)*, 555–65, Rome.
- Baratta, G. (1997), 'Le botti: dati e questioni', in *Techniques et économie antiques et médiévales: le temps de l'innovation, Colloque international C.N.R.S. Aix-en-Provence 21–23 Mai 1996*, 109–12, Paris.
- Baratta, G. (2001), 'Un'alternativa all'anfora: la botte', in J. Maldonado Rosso (ed.), *Actas del I simposio de la Asociación Internacional de Historia y Civilización de la Vid y del Vino*, Vol. I, 149–55, El Puerto de Santa Maria.
- Baratta, G. (2005), 'La cupa nell'ambito femminile: dalla caupona al locus?', in F. Cenerini and A. Buonopane (eds), *Donna e vita cittadina nella documentazione epigrafica: Epigrafia e antichità* 23, 95–108, Faenza.
- Barisashvili, G. (2017), *Making Wine in Qvevri*, Tbilisi: Biological Farming Association.
- Barker, P. (1998), *Techniques of Archaeological Excavation*, 3rd edn, London and New York: Routledge.

Bibliography

- Barnabei, F. (1901), *La villa pompeiana di P. Fannio Sinistore scoperta presso Boscoreale*, Rome: Tipografia della R. Accademia dei Lincei.
- Barzanò, A. (2018), 'La crisi del III secolo', in C. Bearzot and A. Barzanò (eds), *Istituzioni di storia antica: Dalla preistoria all'espansione araba, 279–90*, Rome.
- Basso, P., G. Falezza, M. Migliavacca and F. Saggioro (forthcoming), *Veronensium mensa: Food and Wine in Ancient Verona*, Roma: Quasar.
- Baxter, M. J. (2008), 'Mathematics, Statistics and Archaeometry: The Past 50 Years or So', *Archaeometry* 50 (6): 968–82.
- Beaurredon, J. (1887), *La Culture de la Vigne dans l'Antiquité*, Imprimerie Dax: Labèque.
- Bellelli, V. (2018), 'Ischia, le anfore etrusche di Nocera e il vino amineo', *La Parola del Passato* 73 (2): 359–429.
- Bellin, D. and G. Bolognesi (forthcoming), 'Analisi morfometriche e genetiche sui vinaccioli', in P. Basso, G. Falezza, M. Migliavacca and F. Saggioro (eds), *Veronensium mensa: Food and Wine in Ancient Verona*, Roma: Quasar.
- Benčić G. (2006), 'L'origine di Torre: dalla torre all'abitato', in D. L. Ratković (ed.), *Torre, Fratta, Abrega: Patrimonio culturale*, 275–98, Poreč.
- Benoit, M. F. (1954), 'Amphores et céramique de l'épave de Marseille', *Gallia* 12 (1): 35–51.
- Benoit, M. F. (1958), 'Typologie et épigraphie amphoriques: Les marques de Sestius', *Rivista di Studi Liguri* 23: 247–86.
- Benoit, M. F. (1961), *Fouilles sous-marines: L'épave du Grand Congloué à Marseille*, Gallia Supp. 14, Paris.
- Berger, J. F. and C. Jung (1996), 'Fonction, Evolution et "Taphonomie" des parcellaires en moyen vallée du Rhône: Un exemple d'approche intégrée en archéomorphologie et en géoarchéologie', in G. Chouquer (ed.), *Les formes du paysage: Vol. 2. Archéologie des parcellaires*, 95–112, Paris: Éditions Errance.
- Bernigaud, N., A. Bondeau, J. Guiot, F. Bertonecello, M.-J. Ouriachi, L. Bouby, P. Leveau, L. Bernard and D. Isoardi (forthcoming), 'The Impact of Climate Change on the Agriculture and the Economy of Southern Gaul: New Perspectives of Agent-Based Modeling', *PLoS ONE*.
- Bernigaud, N., A. Bondeau and J. Guiot (2021), 'Understanding the Development of Viticulture in Roman Gaul during and after the Roman Climate Optimum: The Contribution of Spatial Analysis and Agro-Ecosystem Modelling', *Journal of Archaeological Science: Reports* 38: 103099.
- Bernal Casasola, D. (2015), 'What Contents Do We Characterize in Roman Amphorae? Methodological and Archaeological Thoughts on a Trending Topic', in C. Oliveira, R. Morais and A. Morillo (eds), *Archaeoanalytics: Chromatography and DNA analysis in archaeology. International Symposium*, 61–83, Porto: University of Porto.
- Bertolazzi, R. and V. Guidorizzi (2017), 'Regio X – Venetia et Histria. Arilica – Sirmio (I.G.M. 47, II, NE; 48, III, NE, NO, IV, SO)', in M. L. Lazzarini (ed.), *Supplementa Italica: Nuova Serie*, Vol. 29, 309–72, Rome: Quasar.
- Bevan, A. (2014), 'Mediterranean Containerization', *Current Anthropology* 55 (4): 387–418.
- Bezczky T. (1998), *The Laecanius Amphora Stamps and the Villas of Brijuni*, Wien: Österreichische Akademie der Wissenschaften, Philosophisch-historische Klasse, Denkschriften, 261 Band.
- Bielefeld, D. (1997), *Stadtrömische Eroten-Sarkophage*, ASR V, Teil 2, Fasz. 2.
- Biggs, M. (1999), 'Putting the State on the Map: Cartography, Territory and European State Formation', *Comparative Studies in Society and History* 41 (2): 374–405.
- Bignami, F., R. Sciarra, S. Carniel and R. Santoleri (2007), 'Variability of Adriatic Sea Coastal Turbid Waters from SeaWiFS Imagery', *Journal of Geophysical Research: Oceans* 112 (C3).
- Billiard, R. (1913), *La Vigne dans l'Antiquité*, Lyon: Librairie H. Lardanchet.
- Birley, A. R. (1991), 'Vindolanda: New Writing-tablets 1986–9', in V. Maxfield and M. J. Dobson (eds), *Roman Frontier Studies 1989: Proceedings of the XVth International Congress of Roman Frontier Studies (Exeter)*, 16–20, Exeter.

- Bitella, G., R. Rossi, A. Loperte, A. Satriani, V. Lapenna, M. Perniola and M. Amato (2015), 'Geophysical Techniques for Plant, Soil and Root Research Related to Sustainability', in A. Vastola (ed.), *The Sustainability of Agro-Food and Natural Resource Systems in the Mediterranean Basin*, 353–72, New York: Springer.
- Boissinot, P. (1998), 'Les vignobles antiques du midi de la France', Poster at *Geoarchaeology of the Landscapes of Classical Antiquity Conference*, Ghent, 23–4 October.
- Boissinot, P. (2009), 'Les vignobles des environs de Mégara Hyblaea et les traces de la viticulture italienne durant l'Antiquité', *MEFRA* 121 (1): 83–132.
- Boissinot, P. and J.-E. Brochier (1998), 'Pour une archéologie du champ', in G. Chouquer (ed.), *Les formes des paysages*, 35–56, Paris: Éditions Errance.
- Boldrin, A., S. Carniel, M. Giani, M. Marin, F. Bernardi Aubry, A. Campanelli, F. Grilli and A. Russo (2009), 'Effects of Bora Wind on Physical and Biogeochemical Properties of Stratified Waters in the Northern Adriatic', *Journal of Geophysical Research* 114 (C8).
- Bolla, M. (2008), 'Le Iscrizioni dal Teatro Romano di Verona', in P. Basso, A. Buonopane, A. Cavarzere and S. Pesavento Mattioli (eds), *Est enim ille flos Italiae: Vita Economica e Sociale nella Cisalpina Romana*, 77–101, Verona: Qui Edit.
- Bondeau, A., P. C. Smith, Z. Zaehle, S. Schaphoff, W. Lucht, W. Cramer, D. Gerten, H. Lotze-Campen, C. Müller, M. Reichstein and B. Smith (2007), 'Modelling the Role of Agriculture for the 20th Century Global Terrestrial Carbon Balance', *Global Change Biology*, 13: 67–706.
- Bonhomme, V., S. Picq, C. Gaucherel and J. Claude (2014), 'Momocs: Outline Analysis Using R', *Journal of Statistical Software*, 56: 1–24.
- Bonhomme, V., S. Picq, S. Ivorra, A. Evin, T. Pastor, R. Bacilieri, T. Lacombe, I. Figuierail, J.-F. Terral and L. Bouby (2020), 'Eco-evo-devo Implications and Archaeobiological Perspectives of Trait Covariance in Fruits of Wild and Domesticated Grapevines', *PLoS ONE* 15 (11): e0239863. <https://doi.org/10.1371/journal.pone.0239863>.
- Bonhomme, V., J.-F. Terral, V. Zech-Matterne, S. Ivorra, T. Lacombe, G. Deborde, P. Kuchler, B. Limier, T. Pastor, P. Rollet and L. Bouby (2021), 'Seed Morphology Uncovers 1500 Years of Vine Agrobiodiversity before the Advent of the Champagne Wine', *Scientific Reports* 11: 1–14.
- Borgna E., S. Corazza, M. Marchesini, A. Pecci and G. Petrucci (2022), 'Fire Installations at the Bronze Age Site of Ca' Baredi Near Aquileia: An Interdisciplinary Insight into Subsistence and Social Practices', *Journal of Archaeological Science: Reports*, 46: 103648.
- Borgongino, M. (1999), 'Le culture extraurbane', in A. Ciarallo and E. de Carolis (eds), *Homo faber: Natura, scienza e tecnica nell'antica Pompei*, 89–91, Milano: Electa.
- Bosi, G., A. M. Mercuri, M. B. Mazzanti, A. Florenzano, M. C. Montecchi, P. Torri, D. Labate and R. Rinaldi (2015a), 'The Evolution of Roman Urban Environments through the Archaeobotanical Remains in Modena – Northern Italy', *Journal of Archaeological Science*, 53: 19–31.
- Bosi, G., A. Benatti, R. Rinaldi, D. Dallai, C. Santini, M. Carbognani, M. Tomaselli and M. B. Mazzanti (2015b), 'The Memory of Water: Archaeobotanical Evidence of Wetland Plants from Modena (Emilia Romagna, Northern Italy) and Palaeoecological Remarks', *Plant Biosystems*, 149: 144–53.
- Bosi, G., M. B. Mazzanti, M. C. Montecchi, P. Torri and R. Rinaldi (2017), 'The Life of a Roman Colony in Northern Italy: Ethnobotanical Information from Archaeobotanical Analysis', *Quaternary International*, 460: 135–56.
- Bosi, G. and M. Marchesini (2017), 'Reperti archeobotanici di vite a Mutina', in L. Malnati, S. Pellegrini, F. Piccinini and C. Stefani (eds), *Mutina splendidissima: La città romana e la sua eredità*, 288–9, Rome: De Luca Editori d'Arte.
- Bosi, G., E. Castiglioni, R. Rinaldi, M. Mazzanti, M. Marchesini and M. Rottoli (2020), 'Archaeobotanical Evidences of Food Plants in Northern Italy during the Roman Age', *Vegetation History and Archaeobotany*, 29 (6): 681–97.

Bibliography

- Bosi, G., D. Labate, R. Rinaldi, M. C. Montecchi, M. Mazzanti, P. Torri, F. M. Riso and A. M. Mercuri (2019), 'A Survey of the Late Roman Period (3rd–6th century AD): Pollen, NPPs and Seeds/Fruits for Reconstructing Environmental and Cultural Changes after the Floods in Northern Italy', *Quaternary International*, 499: 3–23.
- Bottema, S. (1999), 'Landscape Archaeology and Reconstruction of the Mediterranean Environment based on Palynology', in P. Leveau, F. Trément, K. Walsh and G. Barker (eds), *Environmental Reconstruction in Mediterranean Landscape Archaeology*, The Archaeology of Mediterranean Landscapes 2, 9–16, Oxford: Oxbow Books.
- Bottema, S., G. Entjes-Nieborg and W. Van Zeist, eds (1990), *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, Rotterdam: A. A. Balkema.
- Bottema, S. and A. Sarpaki (2003), 'Environmental Change in Crete: A 9000-year Record of Holocene Vegetation History and the Effect of the Santorini Eruption', *The Holocene* 13 (5): 733–49.
- Bottema, S. and H. Woldring (1990), 'Anthropogenic Indicators in the Pollen Record of the Eastern Mediterranean', in S. Bottema, G. Entjes-Nieborg and W. Van Zeist (eds), *Man's Role in the Shaping of the Mediterranean Landscape*, 231–64, Rotterdam: Balkema.
- Botto M. (2013), 'The Phoenicians and the Spread of Wine in the Central West Mediterranean', in S. Celestino Pérez and J. Blázquez Pérez (eds), *Patrimonio Cultural de la Vid y el Vino*, 103–31, Madrid: UAM.
- Bouby, L., I. Figueiral, A. Bouchette, N. Rovira, S. Ivorra, T. Lacombe, T. Pastor, S. Picq, P. Marinval and J.-F. Terral (2013), 'Bioarchaeological Insights into the Process of Domestication of Grapevine (*Vitis vinifera* L.) during Roman Times in Southern France', *PLoS ONE*. <https://doi.org/10.1371/journal.pone.0063195>
- Bouby, L. and P. Marinval (2001), 'La vigne et le début de la viticulture en France: apports de l'archéobotanique', *Gallia*, 58: 13–28.
- Bouby, L., P. Marinval and J. Terral (2014), 'From Secondary to Speculative Production? The Protohistory History of Viticulture in Southern France', in A. Chevalier, E. Marinova and L. Pena-Chocarro (eds), *Plants and People: Choices and Diversity through Time*, 175–210, Oxford: Oxbow.
- Bouby, L., N. Wales, M. Jalabadze, N. Rusishvili, V. Bonhomme, J. Ramos-Madriral, A. Evin, S. Ivorra, T. Lacombe, C. Pagnoux, E. Boaretto, M. T. P. Gilbert, R. Bacilieri, D. Lordkipanidze and D. Maghradze (2021), 'Tracking the History of Grapevine Cultivation in Georgia by Combining Geometric Morphometrics and Ancient DNA', *Vegetation History and Archaeobotany*, 30 (1): 63–76.
- Boudreau L. (1894), *Études d'histoire générale: Histoire de l'alimentation*, Paris.
- Boulay, T. (2018), 'Tastes of Wine: Sensorial Wine Analysis in Ancient Greece', in K. C. Rudolph (ed.), *Taste and the Ancient Senses*, 197–211, New York: Routledge.
- Bouvier, M. (2000), 'Recherches sur les gouts de vins antiques', *Pallas*, 53: 115–34.
- Bowman, A. and A. Wilson, eds (2009), *Quantifying the Roman Economy: Methods and Problems*, Oxford: OUP.
- Bowman, A. K. and A. Wilson, eds (2013), *The Roman Agricultural Economy: Organization, Investment, and Production*, 1st edn, Oxford: OUP.
- Braconi, P. (2012), 'In vineis arbustisque: Il concetto di vigneto in età romana', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della Vite e del Vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 291–306, Borgo San Lorenzo: Edizioni All'Insegna del Giglio.
- Brandaglia, M. (1997), 'Le origini e la viticoltura dell'Ansonica dell'Isola del Giglio', in *Ansonica: La riscoperta di un antico vitigno*, Atti del Convegno Nazionale, Isola del Giglio 1996, 36–60, Firenze: Regione Toscana.
- Brandaglia, M. (2001), *Il vitigno Ansonica: Dalla ricerca delle antiche colture allo stato attuale della viticoltura sull'Isola del Giglio*, Grosseto: Provincia di Grosseto.

- Braudel, F. (1949), *La Méditerranée et le monde méditerranéen à l'époque de Philippe II*, Paris: Armand Colin.
- Breitenbach, S. F. M., K. Rehfeld, B. Goswami, J. U. L. Baldini, H. E. Ridley, D. J. Kennett, K. M. Prufer, V. V. Aquino, Y. Asmeron, V. J. Polyak, H. Cheng, J. Kurths and N. Marwan (2012), 'Constructing Proxy-Record Age Models (COPRA)', *Climate of the Past*, 8 (5): 1765–79.
- Brewer, S., J. Guiot and D. Barboni (2013), 'Pollen Methods and Studies: Use of Pollen as Climate Proxies', in S. A. Elias and C. J. Mock (eds), *Encyclopedia of Quaternary Science*, 2nd edn, 805–15, Elsevier.
- Briggs L., S. Demesticha, S. Katzev, H. W. Swiny, O. E. Craig and L. Drieu (2021), 'There's More to a Vessel than Meets the Eye: Organic Residue Analysis of "Wine" Containers from Shipwrecks and Settlements of Ancient Cyprus (4th–1st century BCE)', *Archaeometry*, 64 (3): 779–97.
- Broadhead, W. (2007), 'Colonization, Land Distribution, and Veteran Settlement', in P. Erdkamp (ed.), *A Companion to the Roman Army*, 148–63, Oxford & Carlton: Blackwell Publishing Ltd. Malden.
- Broecker, W. S., E. A. Olson and P. C. Orr (1960), 'Radiocarbon Measurements and Annual Rings in Cave Formations', *Nature*, 185: 93–4.
- Broise, H. and V. Jolivet (1995), 'Bonification agraire et viticulture antiques autour du site de Musarna (Viterbe)', in L. Quilici and S. Quilici Gigli (eds), *Interventi di Bonifica Agraria nell'Italia Romana*, Atlante tematico di topografia antica 4, 107–16, Rome: L'Erma di Bretschneider.
- Broise, H. and V. Jolivet (1996), 'Musarna (Viterbe): le site étrusco-romain', *MEFRA*, 108 (1): 455–60.
- Broodbank, C. (2013), *The Making of the Middle Sea: A History of the Mediterranean from the Beginning to the Emergence of the Classical World*, London: Thames and Hudson.
- Brown, A. G. and I. Meadows (2000), 'Roman Vineyards in Britain: Finds from the Nene Valley and New Research', *Antiquity*, 74: 491–2.
- Brown, A. G., I. Meadows, S. D. Turner and D. Mattingley (2001), 'Roman Vineyards in Britain: Stratigraphic and Palynological Data from Wollaston in the Nene Valley, England', *Antiquity*, 75: 745–57.
- Brown, A. G., K. Walsh, D. Fallu, S. Cuchiarro, P. Tarolli, P. Zhao, B. Pears, K. van Oost, L. Snape, A. Lang, R. M. Albert, I. G. Alsos and C. Waddington (2021a), 'Ending the Cinderella Status of Terraces and Lynchets in Europe: The Geomorphology of Agricultural Terraces and Implications for Ecosystem Services and Climate Adaptation', *Geomorphology*, 379: 107579.
- Brown, A. G., K. Walsh, D. Fallu, S. Cuchiarro and P. Tarolli (2021b), 'European Agricultural Terraces and Lynchets: From Archaeological Theory to Heritage Management', *World Archaeology*, 52: 566–88.
- Brown, A. G., T. Fonville, M. van Hardenbroek, G. Cavers, A. Crone, F. McCormick, E. Murray, H. Mackay, N. Whitehouse, A. Henderson, P. Barratt, K. Head, I. G. Alsos and D. Pirrie (2022), 'New Integrated Molecular Approaches for Understanding Lake Settlements in NW Europe', *Antiquity* 96 (389): 1179–99.
- Brown, J. (2010), 'A Possible Roman Vineyard on Land off Tavistock Avenue, Ampthill, Bedfordshire', *Northamptonshire Archaeology Report* 10/132.
- Brun, J.-P. (1986), *L'Oléiculture Antique en Provence: Les Huileries du département du Var*, Paris: CNRS.
- Brun J.-P. (1993), 'La discrimination entre les installations oléicoles et vinicoles', in M.-C. Amouretti and J. P. Brun (eds), *La production du vin et de l'huile en Méditerranée*, BCH Supp. XXVI, 511–38, Athens and Paris: École Française d'Athènes.
- Brun, J.-P. (1997), 'Production de l'huile et du vin en Lusitanie romaine', *Conimbriga*, 36: 45–72.
- Brun, J.-P. (2001), 'La viticulture antique en Provence', in J.-P. Brun and F. Laubenheimer (eds), *La viticulture en Gaule*, 69–89, Paris: CNRS.

Bibliography

- Brun, J.-P. (2003), *Le vin et l'huile dans la Méditerranée antique: Viticulture, oleiculture et proceeds de transformation*, Paris: Éditions Errance.
- Brun, J.-P. (2004a), *Archéologie du vin et de l'huile de la préhistoire à l'époque hellénistique*, Paris: Editions Errance.
- Brun, J.-P. (2004b), *Archéologie du vin et de l'huile dans l'Empire romain*, Paris: Editions Errance.
- Brun, J.-P. (2005), *Archéologie du vin et de l'huile en Gaule romaine*, Paris: Editions Errance.
- Brun, J.-P., N. Garnier and G. Olcese, eds (2020), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some new data from Italy – International Congress of Classical Archaeology – Panel 3.5, Proceedings of the 19th International Congress of Classical Archaeology* (Cologne-Bonn 22–6 May 2018), Heidelberg: Propylaeum.
- Brun, J.-P. and K. J. Gilles (2001), 'La viticultura Antique en Rhénanie', *La viticulture en Gaule, Gallia*, 58: 165–79.
- Brun, J.-P. and F. Laubenheimer, eds (2001), *La viticulture en Gaule*, Paris: CNRS.
- Brun, J.-P. and Cl. Pommerpuy (1992), 'La nécropole de Bucy-le-Long (Picardie), Le fond du Petit Marais', *Association Française pour l'Étude de l'Âge du Fer (AFEAF): Bulletin Intérieur*, 10: 17–18.
- Brun, J.-P., M. Poux and M.-L. Hervé-Monteil (2011), *La vigne et le vin dans les Trois Gaules*, Paris: CNRS.
- Brun, J.-P., M. Poux and A. Tchernia, eds (2004), *Le Vin: Nectar des Dieux, Génie des Homme*, Gollion.
- Buffat, L., C. Pellecuer, S. Mauné and H. Pomarèdes (2001), 'La viticulture antique en Languedoc-Roussillon', in J.-P. Brun and F. Laubenheimer (eds), *La viticulture en Gaule*, 91–111, Paris: CNRS.
- Bucelli, P. and D. I. Costantini (2009), 'Wine Grape and Vine Zoning', in E. A. C. Costantini (ed.), *Manual of Methods for Soil and Land Evaluation*, 353–400, Enfield: Science Publishers.
- Buchi, E. (1996), 'La vitivinicultura cisalpina in età romana', in G. Forni and A. Scienza (eds), *2500 anni di cultura della vite nell'ambito alpino e cisalpino*, 373–89, Trento: Istituto Trentino del Vino.
- Buchi, E. (1987), 'Porta Leoni e la Fondazione di Verona Romana', *Museum Patavinum*, 5: 13–45.
- Büntgen, Ü., V. S. Myglan, F. Charpentier Ljunqvist, M. McCormick, N. Di Cosmo, M. Sigl, J. Jungclaus, S. Wagner, P. J. Krusic, J. Esper, J. O. Kaplan, M. A. C. de Van, J. Lutherbacher, L. Wacker, W. Tegel, A. V. Kirdyanov (2016), 'Cooling and Societal Change during the Late Antique Little Ice Age from 536 to around 660 AD', *Nature Geoscience*, 9: 231–36.
- Burzynski-Chang E. A., E. J. Brown, N. Reshef and G. L. Sacks (2019), 'Malate Content in Wild *Vitis* Spp. Demonstrates a Range of Behaviors during Berry Maturation', *American Journal of Enology and Viticulture*. <https://doi.10.5344/ajev.2019.19015>
- Busana, M. S. (2002). *Architetture rurali nella Venetia romana*, Rome: L'Erma di Bretschneider.
- Busana, M. S. (2003), 'La produzione vinaria dalle fonti archeologiche nella Valpolicella di età romana', *Annuario Storico della Valpolicella* 19: 117–32.
- Busana, M. S. (forthcoming), 'Wine Production in the Roman West: The Role of Artificial Heating', in D. Van Limbergen, E. Dodd and M. S. Busana (eds), *Vine-Growing and Winemaking in the Roman World*, Leuven: Peeters.
- Busana, M. S., C. D'Inca and S. Forti (2009), 'Olio e pesce in epoca romana nell'alto e medio Adriatico', in S. Pesavento Mattioli and M.-B. Carre (eds), *Olio e Pesce in Epoca Romana: Produzione e Commercio nelle Regioni dell'Alto Adriatico: Atti del Convegno (Padova 16 febbraio 2007)*, 35–79, Rome: Quasar.
- Butorac, L., K. Hančević, K. Lukšić, Z. S. Kvorc, M. Leko, E. Maul and G. Zdunić (2018), 'Assessment of Wild Grapevine (*Vitis vinifera* ssp. *sylvestris*) Chlorotypes and Accompanying Woody Species in the Eastern Adriatic Region' *PLoS ONE*, 13 (6): e0199495.
- Buxeda i Garrigós, J., M. A. Cau Ontiveros and V. Kilikoglou (2003), 'Chemical Variability in Clays and Pottery from a Traditional Cooking Pot Production Village: Testing Assumptions in Pereruela', *Archaeometry*, 45: 1–17.

- Cabanes, D. (2020), 'Phytolith Analysis in Paleoecology and Archaeology', in A. G. Henry (ed.), *Handbook for the Analysis of Micro-Particles in Archaeological Samples*, 255–88, Cham: Springer.
- Caillaud, C. (2018), 'Vinalia, fête du vin et de la cuisine antiques', *Territoires du vin*, 8: <https://preo.u-bourgogne.fr/territoiresduvin/index.php?id=1339#toc>
- Calamita, G., A. Perrone, L. Brocca, B. Onorati and S. Manfreda (2015), 'Field Test of a Multi-Frequency Electromagnetic Induction Sensor for Soil Moisture Monitoring in Southern Italy Test Sites', *J. Hydrol.* 529 (1): 316–29.
- Callender, M. H. (1965), *Roman Amphorae*, London: Oxford University Press.
- Calzolari, M. (2008), *Città dell'Aemilia: Mutina: le fonti letterarie di Modena romana*, Modena: G.s.B.M.
- Campana, S. (2016), 'Sensing Ruralscapes: Third-Wave Archaeological Survey in the Mediterranean Area', in M. Forte and S. Campana (eds), *Digital Methods and Remote Sensing in Archaeology: Quantitative Methods in the Humanities and Social Sciences*, 113–45, Cham: Springer.
- Campanile, T. (1922), 'Negrar di Valpolicella: Avanzi di una villa romana con magnifici mosaici', *Notizie degli Scavi di Antichità*: 347–61.
- Campbell, J. B. (1995), 'Sharing Out Land: Two Passages in the "Corpus Agrimensorum Romanorum"', *The Classical Quarterly*, 45: 540–6.
- Campbell, J. B. (1996), 'Shaping the Rural Environment: Surveyors in Ancient Rome', *Journal of Roman Studies*, 86: 74–99.
- Campbell, J. B. (2000), *The Writings of the Roman Land Surveyors: Introduction, Text, Translation and Commentary*, Journal of Roman Studies Monograph 9, London: Society for the Promotion of Roman Studies.
- Campbell, J. B. (2006), 'Surveyors, Topography, and Definition of Landholding, in Ancient Rome', in D. Conso, A. Gonzales, J. Y. Guillaumin (eds), *Les vocabulaires techniques des arpenteurs romains: Actes du Colloque International (Besançon 2002)*, 540–46, Besançon: Presses universitaires de Franche-Comté, Institut des Sciences et Techniques de l'Antiquité.
- Carandini, A. (1989), 'L'economia italica fra Repubblica e Medio Impero considerata dal punto di vista di una merce: il vino', in *Amphores Romaines et Histoire Économique: Dix ans de recherche*, 505–21, Rome.
- Carandini, A. and A. Ricci, eds (1985), *Settefinestre una villa schiavistica nell'Etruria romana*, Modena: Panini.
- Carbonneau, A. and R. Rotunno (2000), 'Reconstitution du vignoble de Pompéi', *Pallas*, 53: 135–40.
- Cardarelli, A., G. Bosi, R. Rinaldi, M. Uccesu and G. Bacchetta (2015), 'Vino o non vino? Nuovi dati sui vinaccioli della Terramara di Montale (Modena) tra la fine della media età del Bronzo e il Bronzo Recente', in *Preistoria del cibo: 50ma Riunione Scientifica dell'Istituto Italiano di preistoria e Protostoria*, 1–9, Rome: Istituto Italiano di Preistoria.
- Cardell, M. F., A. Amengual and R. Romero (2019), 'Future Effects of Climate Change on the Suitability of Wine Grape Production across Europe', *Regional Environmental Change*, 19 (3): 1–12.
- Carmenati, R., G. Fiorentino and R. Perna (2019), 'The Roman Villa of Villamagna (Urbisaglia (Macerata), Italy): Pilot Archaeobotany Analysis', in G. Fiorentino (ed), *Book of Abstracts of 18th International Workgroup for Palaeoethnobotany Conference* (Lecce, 3rd–8th June 2019), 169, Lecce.
- Carrato, C. (2017a), *Le dolium en Gaule Narbonnaise (Ier s. av. J.-C. – IIIe s. ap. J.-C.): Contribution à l'histoire socio-économique de la Méditerranée nord-occidentale*, Ausonius Éditions, Collection Mémoires 46, Bordeaux.
- Carrato, C. (2017b), 'Dynamique de la production vinicole en Gaule Narbonnaise à l'époque romaine à partir des capacités de stockage (I^{er} s. av. J.-C. – V^e s. ap. J.-C.)', in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some New Data from Italy: Panel 3.5*, 159–66, Heidelberg: Propylaeum.

Bibliography

- Carrato, C., V. M. Ferreras, J.-M. Dautriam and M. Bois (2019), 'The Biggest Opus doliare Production in Narbonese Gaul Revealed by Archaeometry (first to second centuries A.D.)', *ArcheoSciences, revue d'Archéométrie*, 43 (1): 69–82.
- Carrato, C., A. Ichkhakh, M. Kbiri Alaoui, E. Rocca, M.-P. Ruas, M. Alilou, V. Mathieu, S. Sanz-Laliberté, N. Garnier and J.-B. Pineau (2020), 'Recent Discovery of an Urban Winery in Rirha (Sidi Slimane, Morocco), 2nd–3rd Century CE', in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some New Data from Italy: Panel 3.5*, 167–75, Heidelberg: Propylaeum.
- Carre M.-B., V. Kovačić and F. Tassaux (2011), *L'Istrie et la mer: La côte du Parentin dans l'Antiquité*, Bordeaux: Ausonius Mémoires 25.
- Carre, M.-B. and S. Pesavento Mattioli (2003), 'Anfore e Commerci nell'Adriatico', in F. Lenzi (ed.), *L'archeologia dell'Adriatico dalla Preistoria al Medioevo*, 268–85, Firenze: All'insegna del Giglio.
- Carre, M.-B., S. Pesavento Mattioli and P. Monsieur (2014), 'Transport Amphorae Lamboglia 2 and Dressel 6A: Italy and/or Dalmatia? Some Clarifications', *Journal of Roman Archaeology*, 27: 417–28.
- Carreras, C. (2014), 'Nuevas tendencias y datos sobre la demografía romana en la Península Ibérica', *Boletín del Seminario de Estudios de Arte y Arqueología*, 80: 53–82.
- Carroll, M. (2022), 'Viticulture, Opus Doliare, and the Patrimonium Caesaris at the Roman Imperial Estate at Vagnari (Puglia)', *Journal of Roman Archaeology*, 35 (1): 1–26.
- Carruthers, W. J. and K. L. Hunter Dowse (2019), 'A Review of Macroscopic Plant Remains from the Midland Counties', *Research Report Series*, 47/2019, Historic England.
- Cartaxo-Pinto, S., G. H. C. Paulo, B. R. Jackes, V. Gonçalves-Esteves and C. B. F. Mendonça (2022), 'A Palynological Perspective on the Tribe Viteae of the Grape Family (Vitaceae)', *Grana*, 61: 27–44.
- Carver, E. (2001), *The Visibility of Imported Wine and Its Associated Accoutrements in Later Iron Age Britain*, British Archaeological Reports.
- Castagnoli, F. (1984), 'Sulle più antiche divisioni agrarie romane', *Accademia Nazionale Lincei: Rendiconti classe scienze morali, storiche e filologiche*, 39: 7–17.
- Castagnoli, F. (1993), *Topografia antica: Un metodo di studio*, Vol. 2, Rome: Istituto Poligrafico e Zecca dello Stato.
- Castelletti, L., E. Castiglioni, M. Cottini and M. Rottoli (1996), 'Analisi paleobotaniche', in P. Melli (ed.), *La città ritrovata: Archeologia urbana a Genova 1984–1994*, 263–9, Genova: Tormena Editore.
- Castelletti, L., E. Castiglioni, M. Cottini and A. Di Vora (1998), 'Analisi morfometrica dei vinaccioli di vite (*Vitis vinifera* L.) provenienti da scavi archeologici', *Atti UISPP XIII*, 11–24, Forlì.
- Castiglione d'Orcia 2011 = Biagini, B., ed. (2011), *Origini della viticoltura*, Atti del Convegno, Castiglione d'Orcia 2010, Podere Forte: Tipografia Castiglione d'Orcia.
- Castiglioni, E. and M. Rottoli (1994), 'Resti vegetali: carboni, semi e frutti. Ricostruzione dell'ambiente naturale e coltivato', in E. Cavada (ed.), *Archeologia a Mezzacorona: Documenti per la storia del popolamento rustico di età romana nell'area atesina*, 205–31, Trento.
- Castrioto-Scanderberg, A., G. E. Hagberg, A. Cerasa, G. Committeri, G. Galati, F. Patria, S. Pitzalis, C. Caltagirone and R. Frackowiak (2005), 'The Appreciation of Wine by Sommeliers: A Functional Magnetic Resonance Study of Sensory Integration', *Neuroimage*, 25: 570–8.
- Cau, M. Á., V. Martínez, A. Pecci, C. Mas and L. Fantuzzi (2018), 'Archaeometric Analysis for Provenance and Content of Roman Amphorae from the Site of Sa Mesquida (Mallorca, Spain)', *Mediterranean Archaeology and Archaeometry*, 18: 2–105.
- Cavaliere Manasse, G. (1998), 'Banchi d'Anfore Romane a Verona: Nota Topografica', in S. Pesavento Mattioli (ed.), *Bonifiche e Drenaggi con Anfore in Epoca Romana: Aspetti Tecnici e Topografici*, 185–96, Modena: Franco Cosimo Panini.

- Chabal, L. (2005), 'Charbons de bois et bois gorgé d'eau des puits antiques: des jardins de Lattara aux forêts du delta du Lez', *Lattara*, 18: 221–34.
- Cheng, H., H. Zhang, C. Spötl, J. Baker, A. Sinha, H. Li, M. Bartolomé, A. Moreno, G. Kathayat, J. Zhao, X. Dong, Y. Li, Y. Ning, X. Jia, B. Zong, Y. A. Brahim, C. Pérez-Mejías, Y. Cai, V. F. Novello, F. W. Cruz, J. P. Severinghaus, Z. An and R. L. Edwards (2020), 'Timing and Structure of the Younger Dryas Event and its Underlying Climate Dynamics', *Proceedings of the National Academy of Sciences*, 117 (38): 23408–17.
- Cheung, C. (2021a), 'Precious Pots: Making and Repairing Dolia', in H. Hochscheid and B. Russell (eds), *The Value of Making: Theory and Practice in Ancient Craft Production*, 171–88, Turnhout: Brepols.
- Cheung, C. (2021b), 'Managing Food Storage in the Roman Empire', *Quaternary International*, 597: 63–75.
- Chevalier, M., B. A. S. Davis, O. Heiri, H. Seppä, B. M. Chase, K. Gajewski, T. Lacourse, R. J. Telford, W. Finsinger, J. Guiot, N. Kühl, S. Y. Maezumi, J. R. Tipton, V. A. Carter, T. Brussel, L. N. Phelps, A. Dawson, M. Zanon, F. Vallé, C. Nolan, A. Mauri, A. de Vernal, K. Izumi, L. Holmström, J. Marsicek, S. Goring, P. S. Sommer, M. Chaput and D. Kupriyanov (2020), 'Pollen-based Climate Reconstruction Techniques for Late Quaternary Studies', *Earth-Science Reviews* 210: 103384.
- Chouquer, G. (1983), 'La genèse des paysages du Centre-Est de la Gaule: Polymorphisme et production d'une identité rurale', *Dialogues d'histoire ancienne*, 9: 113–39.
- Chouquer, G., M. Clavel-Lévêque, F. Favory and J. P. Vallat (1987), *Structures agraires en Italie Centro-méridionale: Cadastres et paysage ruraux*, Rome: Collection de l'École Française de Rome.
- Chouquer, G. and F. Favory (1979), 'Contribution a la recherche des cadastres antiques', *Annales Littéraires de l'Université de Besançon: Centre de Recherches Spécialisées d'Histoire Ancienne. Equipe de Recherche Associée au CNRS*, Vol. 31, Paris.
- Chouquer, G., and F. Favory (1991), *Les paysages de l'Antiquité: Terres et cadastres de l'Occident romain*, Paris: Éditions Errance Paris.
- Chouquer, G. and F. Favory (2001), *L'arpentage Romain: histoire des textes, droit, techniques*, Paris: Éditions Errance, Paris.
- Ciacci, A. and M. Giannace, eds (2012), *Senarum Vineae: Il paesaggio urbano di Siena. Forme di recupero e valorizzazione dei vitigni storici*, Siena: Nuova Immagine Editrice.
- Ciacci, A., P. Rendini and A. Zifferero, eds (2012), *Archeologia della Vite e del Vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, Borgo San Lorenzo: Edizioni All'Insegna del Giglio.
- Ciacci, A. and A. Zifferero, eds (2005), *VINUM: Un progetto per il riconoscimento della vite silvestre nel paesaggio archeologico della Toscana e del Lazio settentrionale*, Siena: Ci.Vin.
- Ciacci, A. and A. Zifferero (2007a), 'Il "Progetto VINUM": prime considerazioni conclusive', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della Vite e del Vino in Etruria: Atti del Convegno Internazionale di Studi, Scansano 2005*, 249–72, Siena: Ci.Vin.
- Ciacci, A. and A. Zifferero (2007b), 'Progetto VINUM: prospettive di ricerca in area popoloniese', in L. Botarelli, M. Coccoluto and M. C. Mileti (eds), *Materiali per Popolonia* 6, 397–419, Pisa: Edizioni ETS.
- Cianferoni, R., Z. Ciuffoletti and L. Rombai (2002), *Storia dell'Agricoltura Italiana. L'Età Contemporanea: Dalle 'rivoluzioni agronomiche' alle trasformazioni del Novecento*, Florence: Edizioni Polistampa.
- Ciarallo, A. and E. de Carolis, eds (1999), *Homo faber: Natura, scienza e tecnica nell'antica Pompeii*, Milan: Electa.
- Cipriano, S. (2009), 'Le Anfore Olearie Dressel 6b', in S. Pesavento Mattioli and M.-B. Carre (eds), *Olio e Pesce in Epoca Romana: Produzione e Commercio nelle Regioni dell'Alto Adriatico: Atti del Convegno (Padova 16 febbraio 2007)*, 178, Rome.

Bibliography

- Cipriano, S. and S. Mazzochin (2002), 'Analisi di alcune serie bollate di anfore Dressel 6B (AP. PVL Cri, FLAV. FONTAN/FONTANI, L. IVNI. PAETINI, L. TRE. OPTATI)', *AquilNost*, 73: 305–40.
- Ciurletti, G. (1996), 'La viticoltura nel Trentino Alto Adige fra preistoria ed età romana: Contributi archeologici', in G. Forni and A. Scienza (eds), *2500 anni di cultura della vite nell'ambito Alpino e Cisalpino*, 441–74, Trento: Istituto Trentino del Vino.
- Clark, A. (1996), *Seeing Beneath the Soil: prospecting methods in archaeology*, London: Routledge.
- Clarke, J. R., S. De Caro and A. Lagi (2015), 'Oplontis e le sue ville', in P. G. Guzzo and G. Tagliamonte (eds), *Città vesuviane: Antichità e fortuna. Il suburbio e l'agro di Pompei, Ercolano, Oplontis e Stabiae*, 142–55, Roma: Treccani.
- Clarke, J. and I. Meadows (2014), 'Archaeological evaluation and open area at Appleby Lodge, Wellingborough, Northamptonshire', *MOLA Northampton Report*, 14/126.
- Clavel-Lévêque, M. (1983), *Cadastres et espace rural: Approches et réalités antiques*, Paris: Éditions du CNRS.
- Clavel-Lévêque, M., D. Conso and A. Gonzales (1996), *Hygin l'arpenteur: L'établissement des limites*, Naples: Jovene.
- Clavel-Lévêque, M. and A. Orejas, eds (2002), *Atlas historique des cadastres d'Europe*, Vol. II, Luxemburg.
- Clavel-Lévêque, M. and A. Vignot, eds (1998), *Atlas historique des cadastres d'Europe*, Vol. I, Bruxelles.
- Coles, J. (1981), *Archeologia Sperimentale*, Milano: Longanesi.
- Columbu, A., V. Chiarini, C. Spötl, S. Benazzi, J. Hellstrom, H. Cheng and J. D. Waele (2020), 'Speleothem Record Attests to Stable Environmental Conditions during Neanderthal-Modern Human Turnover in Southern Italy', *Nature Ecology & Evolution*, 4 (9): 1188–95.
- Comas-Bru, L., K. Rehfeld, C. Roesch, S. Amirnezhad-Mozhdehi, S. P. Harrison, K. Atsawawanunt, S. M. Ahmad, Y. A. Brahim, A. Baker, M. Bosomworth, S. F. M. Breitenbach, Y. Burstyn, A. Columbu, M. Deininger, A. Demény, B. Dixon, J. Fohlmeister, I. G. Hatvani, J. Hu, N. Kaushal, Z. Kern, I. Labuhn, F. A. Lechleitner, A. Lorrey, B. Martrat, V. F. Novello, J. Oster, C. Pérez-Mejías, D. Scholz, N. Scroxton, N. Sinha, B. M. Ward, S. Warken, H. Zhang and SISAL Working Group members (2020), 'SISALv2: A Comprehensive Speleothem Isotope Database with Multiple Age-Depth Models', *Earth Syst. Sci. Data*, 12 (4): 2579–2606.
- Conca Messina, S. A., S. Le Bras, P. Tedeschi and M. Vaquero Piñeiro (2019), *A History of Wine in Europe, 19th to 20th Centuries*, Vol. I, Cham: Palgrave Macmillan.
- Conca Messina, S. A., S. Le Bras, P. Tedeschi and M. Vaquero Piñeiro (2020), *A History of Wine in Europe, 19th to 20th Centuries*, Vol. II, Cham: Palgrave Macmillan.
- Condamin, J. F., F. Formenti, M. O. Metais, M. Michel and P. Blond (1976), 'The Application of Gas Chromatography to the Tracing of Oil in Ancient Amphorae', *Archaeometry*, 18 (2): 195–201.
- Conso, D., A. Gonzales and J. Y. Guillaumin, eds (2005), *Les vocabulaires techniques des arpenteurs romains: Actes du Colloque International (Besançon 2002)*, Besançon: Presses universitaires de Franche-Comté, Institut des Sciences et Techniques de l'Antiquité.
- Contreras, D. A., A. Bondeau, J. Guiot, A. Kirman, E. Hiriart, L. Bernard, R. Suarez and M. Fader (2019), 'From Paleoclimate Variables to Prehistoric Agriculture: Using a Process-Based Agro-Ecosystem Model to Simulate the Impacts of Holocene Climate Change on Potential Agricultural Productivity in Provence, France', *Quaternary International*, 501 (Part B): 303–16.
- Contreras, D. A., E. Hiriart, A. Bondeau, A. Kirman, J. Guiot, L. Bernard, R. Suarez, S. Van Der Leeuw (2018), 'Regional Paleoclimates and Local Consequences: Integrating GIS Analysis of Diachronic Settlement Patterns and Process-Based Agroecosystem Modeling of Potential Agricultural Productivity in Provence (France)', *PLoS ONE*, 13 (12): e0207622.
- Conyers, L. (2012), *Ground-Penetrating Radar for Archaeology*, Plymouth: AltaMira Press.
- Conyers, L. B., E. G. Ernenwein, M. Grealy and K. M. Lowe (2008), 'Electromagnetic Conductivity Mapping for Site Prediction in Meandering River Floodplains', *Archaeological Prospection*, 15: 81–91.

- Corsi, C. and F. Vermeulen (2007), 'Digital vs. Historical Cartography for Studying Archaeological Sites: A Case Study from Corsica', in *Proceedings of the 11th Workshop 'Archäologie und Computer: Kulturelles Erbe und Neue Technologien', Wien 18–20 Oktober 2006*, 1–19, Wien: Stadtarchäologie.
- Cosgrove, D. (1992), 'Mapping New Worlds: Culture and Cartography in Sixteenth-Century Venice', *Imago Mundi*, 44: 65–89.
- Costantini, L. and L. Costantini Biasini (1999), 'La viticoltura della Grecia alla Magna Grecia: La documentazione archeobotanica', in O. Failla and G. Forni (eds), *Alle radici della civiltà del vino in Sicilia*, 169–92, Menfi: Cantine Settesoli.
- Costantini, E. A. C., P. Bucelli and S. Priori (2012), 'Quaternary Landscape History Determines the Soil Functional Characters of Terroir', *Quaternary International*, 265: 63–73.
- Costantini, E. A. C., R. Lorenzetti and G. Malorgio (2016), 'A Multivariate Approach for the Study of Environmental Drivers of Wine Economic Structure', *Land Use Policy*, 57: 53–63.
- Cottica, D., M. Marchesini, S. Marvelli, M. Novello and P. Ventura (2017), 'Per uno studio integrato di uomo e ambiente ad Aquileia: alcune riflessioni a partire da recenti indagini archeologiche', *Rivista di Archeologia*, 41: 99–123, Tav. XIV–XVI.
- Craig, O. E. (2021), 'Prehistoric Fermentation, Delayed-Return Economies, and the Adoption of Pottery Technology', *Current Anthropology*, 62, Suppl. 24. <https://doi.org/10.1086/716610>
- Craig, O., H. Saul and C. Spiteri (2020), 'Residue Analysis', in M. Richards and K. Britton (eds), *Archaeological Science: An Introduction*, 70–98, Cambridge: CUP.
- Cremonini, S., D. Labate and R. Curina (2013), 'The Late-Antiquity Environmental Crisis in Emilia Region (Po River Plain, Northern Italy): Geoarchaeological Evidence and Paleoclimatic Considerations', *Quaternary International*, 316: 162–78.
- Crovetto C., M. Ferrari, C. Peretto, L. Longo and F. Vianello (1994), 'The Carinated Denticulates from the Paleolithic Site of Isernia La Pineta (Molise, Central Italy): Tools or Flaking Waste? The Results of The 1993 Lithic Experiments', *Human Evolution*, 9 (3): 175–207.
- Curtel, G. (1903), *La Vigne et la Vin chez les Romains*, Paris: Masson et Cie.
- Curtis, R. I. (2001), *Ancient Food Technology*, Leiden: Brill.
- Curtis, R. I. (2008), 'Food Processing and Preparation', in J. P. Oléson (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World*, 369–92, Oxford: Oxford University Press.
- Dalmasso, G. (1941), *La Viticoltura ai Tempi dell'Impero Romano*, Rome: Libreria Editrice Aseq.
- Dark, P. (2000), *The Environment of Britain in the First Millennium AD*, Bristol: Bristol Classical Press.
- Day, J. (1932), 'Agriculture in the Life of Pompeii', *YaleClSt*, 3: 165–208.
- Davis, M. B. (1963), 'On the Theory of Pollen Analysis', *AmJSci*, 261: 897–912.
- De Caro, S. (1994), *La villa rustica in località Villa Regina a Boscoreale*, Rome: Bretschneider.
- De Carolis, E., M. R. Senatore and A. Ciarallo (2012), 'Rinvenimento di resti di viti e di un palo di sostegno al di sotto dei depositi dell'eruzione del 79 d.C.', *RStPomp*, 23: 140–2.
- de Grummond, N. T. (2018), 'Grape Pips from Etruscan and Roman Cetamura del Chianti: On Stratigraphy, Literary Sources and Pruning Hooks', *Etruscan Studies*, 21: 27–57.
- de Ligt, L. (2012), *Peasants, Citizens and Soldiers: Studies in the Demographic History of Roman Italy 225 BC–AD 100*, Cambridge: Cambridge University Press.
- De Lorenzis, G., F. Mercati, C. Bergamini, M. F. Cardone, A. Lupini, A. Mauceri, A. R. Caputo, L. Abbate, M. G. Barbagallo, D. Antonacci, F. Sunseri and L. Brancadoro (2019), 'SNP Genotyping Elucidates the Genetic Diversity of Magna Graecia Grapevine Germplasm and Its Historical Origin and Dissemination', *BMC Plant Biology*, 19 (7): 1–15.
- De Lorenzis, G., F. Mercati, C. Bergamini, M. F. Cardone, M. G. Barbagallo, F. Sunseri, L. Brancadoro, A. Scienza and O. Failla (2020), 'Genomic Tools to Reconstruct the Grapevine Domestication and Evolution in the Western Mediterranean Basin' in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some New Data from Italy*, 23–5, Heidelberg: Propylaeum.

Bibliography

- De Neef, W. (2020), 'A Crossroads in the Central Potenza Valley: Non-Invasive Research into Settlement (Dis-)Continuity at Monte Franco (Pollenza, Marche, Italy)', in F. Boschi, E. Giorgi and F. Vermeulen (eds), *Picenum and the Ager Gallicus at the Dawn of the Roman Conquest: Landscape Archaeology and Material Culture*, 131–44, Oxford: Archaeopress.
- De Sena, E. (2005), 'An Assessment of Wine and Oil Production in Rome's Hinterland: Ceramic, Literary, Art Historical and Modern Evidence', in B. Frizell and A. Klynne (eds), *Roman Villas Around the Urbs: Interaction with Landscape and Environment. Proceedings of a Conference at the Swedish Institute in Rome, September 17–18, 2004*, 135–49, Rome: Swedish Institute in Rome.
- De Simone, G. F. (2017), 'The Agricultural Economy of Pompeii: Surplus and Dependence', in M. Flohr and A. Wilson (eds), *The Economy of Pompeii*, 23–51, Oxford: Oxford University Press.
- De Smedt, Ph., P. Garwood, H. Chapman, K. Deforce, J. De Grave, D. Hanssens and D. Vandenberghe (2021), 'Identifying Elusive Prehistoric Land Use by Integrating Electromagnetic and Invasive Survey Approaches', *ArcheoSciences*, 45 (1): 231–3.
- De Smedt, P., T. Saey, A. Lehouck, B. Stichelbaut, E. Meerschman, M. Monirul Islam, E. Van De Vijver and M. Van Meirvenne (2013), 'Exploring the Potential of Multi-receiver EMI Survey for Geoarchaeological Prospection: A 90 ha Dataset', *Geoderma*, 199: 30–6.
- De' Spagnolis, M. (1989), 'Il ritrovamento di località Tre Ponti di Scafati e la via extraurbana Pompei-Sarno', *RStPomp*, 3: 41–52.
- De' Spagnolis, M. (1991–2), 'Ville rustiche a Scafati', *RStPomp*, 5: 67–88.
- De' Spagnolis, M. (1995), 'Osservazioni sulle fasi edilizie di alcune ville rustiche di Scafati, suburbio orientale di Pompei, seppellite dalla eruzione del 79 d.C.', in *Archäologie und Seismologie: La regione vesuviana dal 62 al 79 d.C. Problemi archeologici e sismologici. Colloquium, Boscoreale 26–27 November 1993*, 93–102, München.
- De' Spagnolis, M. (2002), *La villa N. Popidi Narcissi Maioris in Scafati suburbio orientale di Pompei*, *Studia Archaeologica* 119, Roma: L'Erma di Bretschneider.
- De Stefani, S. (1887), 'Negrar di Valpolicella', *Notizie degli Scavi di Antichità*: 431–2.
- de Vivo, F. (2003), 'Historical Justifications of Venetian Power in the Adriatic', *Journal of the History of Ideas*, 64 (2): 159–76.
- De Vogüé, M. (1865–77), *Syrie Centrale: Architecture Civile et Religieuse du Ier au VIIe Siècle*, Paris: J. Baudry Libraire-Éditeur.
- Dechandol, H., M.-P. Feuillet, T. Odier (1983), 'Donzère (Drôme): le grand domaine viticole du Molard', *Histoire et Archéologie, les dossiers*, 78: 167–207.
- Deiana, R., G. Leucci and R. Martorana, eds (2018), *New Perspectives on Geophysics for Archaeology*, Special Issue: Surveys in Geophysics 39.6.
- Del Lungo, S. (2016), 'Centro terziario di domesticazione: la topografia antica e la genetica in Enotria, dalle Siriche alla multivarietà viticola della Lucania', in V. Alba, C. Bergamini, M. Gasparro, F. Mazzone, S. Roccotelli, D. Antonacci and A. R. Caputo (eds), *Basivin_SUD: La ricerca del germoplasma viticolo in Basilicata*, 37–86, Bari: Mario Adda Editore.
- Del Lungo, S. (2017), 'Third Center of Domestication: Interaction between Genetics and Archaeological Sciences in Lands Devoted to Biodiversity of Grapevine Varieties', *Journal of Horticulture*, 4 (1): 194.
- Del Mastro, B., P. Munzi, J.-P. Brun, H. Duday and N. Garnier (2021), 'Vino per gli Opikoi: L'Esempio delle Tombe Preelleniche di Cuma', in D. Frère, B. del Mastro, P. Munzi and C. Pouzadoux (eds), *Manger, Boire, se Parfumer pour l'Éternité: Rituels Alimentaires et Odorants en Italie et en Gaule du IXe siècle avant au Ier siècle après J.-C.*, 165–89, Napoli: Centre Jean Bérard.
- Del Mastro, B., P. Munzi, J.-P. Brun and N. Garnier (2017), 'Wine Before the Greeks: The Contribution of the Organic Chemistry Analyses', in *3rd IMEKO International Conference on Metrology for Archaeology and Cultural Heritage, Lecce (October 23–25, 2017)*, 1–6, Lecce: HAL.

- Del Zan, F. (2004), 'Grecia', in F. Del Zan, O. Failla and A. Scienza (eds), *La vite e l'uomo: Dal rompicapo delle origini al salvataggio delle reliquie. Evidenze storico-ampelografiche per ripercorrere il viaggio della vite da Oriente alle soglie dell'Occidente*, 531–658, Gorizia: ERSA.
- Della Corte, M. (1921a), 'Altra villa rustica, scavata dal Sig. Cav. Carlo Rossi-Filangieri nel Fondo di Raffaele Brancaccio, nella stessa Contrada Civita-Giuliana (Comune di Boscoreale), nei mesi da Gennaio a Marzo 1904', *NSc*, 18: 423–6.
- Della Corte, M. (1921b), 'Villa rustica, Esplorata dal Sig. Cav. Carlo Rossi-Filangieri nel Fondo di Antonio Prisco, in Contrada Civita-Giuliana (Comune Di Boscoreale), nei mesi da Febbraio a Luglio dell'anno 1903', *NSc*, 18: 415–23.
- Della Corte, M. (1923), 'Villa rustica esplorata dal Sig. Giacomo Matrone in un Fondo di sua proprietà, posto immediatamente ad occidente della via vicinale che attraversa, in direzione Nord-Sud, la Contrada Messigno, in comune di Gragnano', *NSc*, 20: 271–4.
- Delpino, F. (2007), 'Viticoltura, produzione e consumo del vino nell'Etruria protostorica', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della vite e del vino in Etruria*, 133–46, Siena: Ci.Vin.
- Delpino, F. (2012), 'Viticoltura, produzione e consumo del vino nell'Etruria protostorica', in A. Ciacci, P. Rendini, and A. Zifferero (eds), *Archeologia della vite e del vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 189–99, Borgo San Lorenzo: All'Insegna del Giglio.
- Demesticha, S. (2015), *Per Terram, Per Mare: Seaborne Trade and the Distribution of Roman Amphorae in the Mediterranean*, Uppsala: Åströms Förlag.
- Depalmas, A., C. Loi, N. Garnier and A. Pecci (2020), 'Wine in Sardinia: New Archaeological Data and Research Methodology', in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some new data from Italy: Panel 3.5*, *Archaeology and Economy in the Ancient World* 9, 61–71, Heidelberg: Propylaeum.
- Desbat, A. (1997), 'Le tonneau antique: questions techniques et problème d'origine', in D. Garcia and D. Meeks (eds), *Techniques et économie antiques et médiévales: le temps de l'innovation, colloque international (C.N.R.S.), Aix-e,-Provence 21–23 mai 1996*, 113–20, Paris: Éditions Errance.
- Desmarchelier, J. M., J. C. Hellstrom, M. McCulloch (2006), 'Rapid Trace Element Analysis of Speleothems by ELA-ICP-MS', *Chemical Geology*, 231 (1–2): 102–17.
- Di Castri, F., D. W. Godall and R. L. Specht, eds (1981), *Ecosystems of the World II: Mediterranean Type Shrublands*, Amsterdam: Elsevier Scientific Publishing.
- Di Filippo Balestrazzi, E. (2004), *Vino e coltura del vino nell'area orientale della Venetia: Dalla vite al vino. Antropologia e storia di una cultura enologica nell'angolo più orientale della Pianura Veneta*, 9, Fondazione 'Antonio Colluto'.
- Di Pasquale, G., ed. (2010), *Vinum Nostrum: Arte, Scienza e Miti del Vino nelle Civiltà del Mediterraneo Antico*, Firenze: Giunti Editore.
- Di Pasquale, G., A. Migliozi, E. Allevato and M. Marotta (2012), 'Italian Cultural Landscapes, A Little Known Resource: The Study Case of the Alberata Aversana, A Vineyard 2500 Years Old', in A. Ferrari (ed.), *5th International Congress 'Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin'. Istanbul 22–25 November 2011*, 322–6, Roma: Valmar.
- Di Vecchi Staraz, M., R. Bandinelli, M. Boselli, P. This, J.-M. Boursiquot, V. Laucou, T. Lacombe and D. Varès (2007), 'Genetic Structuring and Parentage Analysis for Evolutionary Studies in Grapevine: Kin Group and Origins of the Cultivar Sangiovese Revealed', *Journal of the American Society for Horticultural Science*, 132 (4): 514–24.
- Diederich, S. (2005), 'Das römische Agrarhandbuch als Medium der Selbstdarstellung', in T. Fögen (ed.), *Antike Fachtexte: Ancient Technical Texts*, 271–88, Berlin and New York: De Gruyter.
- Dilke, O. A. W. (1971), *The Roman Land Surveyors: An Introduction to the Agrimensores*, Newton Abbot: David and Charles.

Bibliography

- Ding, W., Q. Xu and E. Tarasov (2017), 'Examining Bias in Pollen-based Quantitative Climate Reconstructions Induced by Human Impact on Vegetation', *Climate of the Past*, 13 (9): 1285–1300.
- Dion, R. (1959), *Histoire de la Vigne et du Vin en France*, Paris: Flammarion.
- Dodd, E. (2017), 'Pressing Issues: A New Discovery in the Vineyard of Region I.20, Pompeii', *Archeologia Classica*, 68: 577–88.
- Dodd, E. (2020a), *Roman and Late Antique Wine Production in the Eastern Mediterranean: A Comparative Archaeological Study at Antiochia ad Cragum (Turkey) and Delos (Greece)*, Oxford: Archaeopress.
- Dodd, E. (2020b), 'Late Roman Viticulture in Rough Cilicia: An Unusual Wine Press at Antiochia ad Cragum', *Journal of Roman Archaeology*, 33: 467–82.
- Dodd, E. (2020c), 'Population Decline and Viticultural Industry: Societal Transformation on Late Antique Delos (Greece)', in D. Van Limbergen, S. Maréchal and W. De Clercq (eds), *The Resilience of the Roman Empire: regional case studies on the relationship between population and food resources*, 109–28, Oxford: BAR.
- Dodd, E. (2022a), 'The Archaeology of Wine Production in Roman and Pre-Roman Italy', *American Journal of Archaeology*, 126 (3): 443–80. <https://doi.org/10.1086/719697>
- Dodd, E. (2022b), 'Wine, Oil, and Knowledge Networks across the Graeco-Roman Cyclades: New Data from Paros and Naxos in 2021', *Mediterranean Archaeology*, 34/5: 155–67.
- Dodd, E. (2022c), 'Wine, Oil, and Knowledge Networks across the Graeco-Roman Cyclades (Greece)', *Papers of the British School at Rome*, 90: 352–5.
- Dodd, E., G. Galli and R. Frontoni (2023), 'The Spectacle of Production: A Roman Imperial Winery at the Villa of the Quintilii, Rome', *Antiquity* 97 (392): 436–53.
- Donahue, J. F. (2015), *Food and Drink in Antiquity: Readings from the Graeco-Roman World: A Sourcebook*, London: Bloomsbury.
- Donahue, J. F. (2017), *The Roman Community at Table during the Principate (New and Expanded Edition)*, Ann Arbor: University of Michigan Press.
- Donev, D. and R. Willett (2017), 'Book Review of An Urban Geography of the Roman World, 100 BC to AD 300', *American Journal of Archaeology*, 121 (4). <https://doi.org/10.3764/ajonline1214>. Donev
- Dong, Y. et al. (2023), 'Dual Domestications and Origin of Traits in Grapevine Evolution', *Science* 379: 892–901.
- Doolittle, J. A. and E. C. Brevik (2014), 'The Use of Electromagnetic Induction Techniques in Soils Studies', *Geoderma*, 223: 33–45.
- Doorenbosch, M. (2013), *Ancestral Healths*, Leiden: Sidestone Press.
- Dougherty, P. H. (2012), 'Introduction to the Geographical Study of Viticulture and Wine Production', in P. H. Dougherty (ed.), *The Geography of Wine: Regions, Terroir and Techniques*, 3–36, Dordrecht: Springer.
- Dressel, H. (1899), *Corpus Inscriptionum Latinorum* XV, Pars 1, Berlin.
- Drieu L., P. Orecchioni, C. Capelli, A. Meo, J. Lundy, V. Sacco, L. Arcifa, A. Molinari, M. Carver and O. E. Craig (2021), 'Chemical Evidence for the Persistence of Wine Production and Trade in Early Medieval Islamic Sicily', *The Proceedings of the National Academy of Sciences USA*, 118 (10): e2017983118.
- Drieu L., M. Rageot, N. Wales, B. Stern, J. Lundy, M. Zerrer, I. Gaffney, M. Bondetti, C. Spiteri, J. Thomas-Oates and O. E. Craig (2020), 'Is It Possible to Identify Ancient Wine Production Using Biomolecular Approaches?', *STAR: Science & Technology of Archaeological Research*, 6: 16–29.
- Drysdale, R. N., C. Spötl, J. C. Hellstrom and D. A. Richards (2012), 'New Advances in the Dating of Speleothems: An Introduction', *Quaternary Geochronology*, 14: 1–4.
- Dunbabin, K. M. D. (2003), *The Roman Banquet: Images of Conviviality*, Cambridge: Cambridge University Press.
- Duncan-Jones, R. (1974), *The Economy of the Roman Empire: Quantitative Studies*, Cambridge.

- Dzierzbicka, D. (2018), *OINOS: Production and import of wine in Graeco-Roman Egypt*, Warsaw: University of Warsaw.
- EEA (2012), *EEA Catchments and Rivers Network System ECRINS v1.1: Rationales, Building and Improving for Widening Uses to Water Accounts and WISE Applications*, Luxembourg.
- Ehmig, U. (2003), *Der Römischen Amphoren aus Mainz*, Frankfurter Archäologische Schriften 4, Möhnesee: Bibliopolis.
- Erdtman, G. (1952), *Pollen Morphology and Plant Taxonomy: Angiosperms (An Introduction to Palynology I)*, Stockholm: Almqvist and Wiksell.
- Eterovich, F. H. and C. Spalatin, eds (1964), *Croatia: Land, People, Culture*, Vol. 1, Toronto: University of Toronto Press.
- Eterovich, F. H. and C. Spalatin, eds (1970), *Croatia: Land, People, Culture*, Vol. 2, Toronto: University of Toronto Press.
- Evershed, R. (1993), 'Biomolecular Archaeology and Lipids', *World Archaeology*, 25 (1): 74–93.
- Evershed, R. P. (2008), 'Organic Residue Analysis in Archaeology: The Archaeological Biomarker Revolution', *Archaeometry*, 50 (6): 895–924.
- Fabbrini, L. (2003), *I vigneti sperimentali in Toscana*, Firenze: ARSIA.
- Fabre, G., M. Mayer and I. Rodà (1984), *Inscriptions Romaines de Catalogne, I (sauf Barcino)*, Paris: Universitat Autònoma de Barcelona.
- Fabrini, G. M. (2000), 'L'area del tempio-criptoportico ad Urbs Salvia: Risultati preliminari delle campagne di scavo 1995–1999', *Picus*, 20: 113–58.
- Fader, M., W. von Bloh, S. Shi and W. Cramer (2015), 'Modelling Mediterranean agro-Ecosystems by Including Agricultural Trees in the LPJmL model', *Geosci. Model. Dev.*, 8: 3545–61.
- Failla, O. (2014), 'Il vitigno: significato, origine e variabilità', in G. Forni, G. Kezich and A. Scienza (eds), *Le frontiere nascoste della cultura del vino*, Atti del Seminario Permanente di Etnografia Alpina, SPEA 14, *Annali di San Michele*, 25: 115–38.
- Fairchild, I. J. and A. Baker (2012), *Speleothem Science: From Process to Past Environments*, Chichester: Wiley-Blackwell.
- Faraji, M., A. Borsato, S. Frisia, J. C. Hellstrom, A. Lorrey, A. Hartland, A. Greig and D. P. Matthey (2021), 'Accurate Dating of Stalagmites from Low Seasonal Contrast Tropical Pacific Climate using Sr 2D Maps, Fabrics and Annual Hydrological Cycles', *Scientific Reports*, 11: 2178.
- Fassbinder, J. W. E. (2016), 'Magnetometry for Archaeology', in A. S. Gilbert (ed.), *Encyclopedia of Geoarchaeology*, 499–513, Dordrecht: Springer.
- Favretto, A. (2012), 'Georeferencing Historical Cartography: A Quality-Control Method', *Cartographica: The International Journal for Geographic Information and Geovisualization*, 47 (3): 161–7.
- Feier, I., A. Migala, M. Pietruszka and M. Jackowski (2019), 'Roman Wine in Babaricum: Preliminary Studies on Ancient Wine Recreation', *Heritage*, 2: 331–8.
- Feige, M. (2021), 'Decorative Features and Social Practices in Spaces for Agricultural Production in Roman Villas', in A. Haug and M. T. Lauritsen (eds), *Principles of Decoration in the Roman World*, 33–52, Berlin: De Gruyter.
- Feige, M. (2022), *Landwirtschaftliche Produktionsanlagen römischer Villen im republikanischen und kaiserzeitlichen Italien*, Berlin: De Gruyter.
- Ferdière, A. (1988), *Les Campagnes en Gaule Romaine*, Paris: Errance.
- Figueiral, I., L. Bouby, L. Buffat, H. Petitot and J.-F. Terral (2010), 'Archaeobotany, Vine Growing and Wine Producing in Roman Southern France: The Site of Gasquinoy (Béziers, Hérault)', *Journal of Archaeological Science*, 37 (1): 139–49.
- Finley, M. I. (1975), *The Ancient Economy*, London: Chatto and Windus.
- Finné, M., M. Bar-Matthews, K. Holmgren, H. S. Sundqvist, I. Liakopoulos and Q. Zhang (2014), 'Speleothem Evidence for Late Holocene Climate Variability and Floods in Southern Greece', *Quaternary Research*, 81 (2): 213–27.
- Fiorentino, G. and F. Solinas (2006), 'Carboni e carporesti dal palazzo di Monastiraki', in A. Kanta and M. Marazzi (eds), *Monastiraki I, Missione Monastiraki: Campagne 2002/2004*, 123–40, Naples: Suor Orsola Benincasa nell'Università.

Bibliography

- Firenze 2006 = *Il Sangiovese vitigno tipico e internazionale: identità e peculiarità. Atti del Secondo Simposio Internazionale (Firenze 2004)*, Firenze: ARSIA.
- Firmati, M. (2012), 'I comprensori indagati nel 2005: la valle dell'Albegna', in A. Ciacci, P. Rendini and A. Zifferero, (eds), *Archeologia della Vite e del Vino in Toscana e nel Lazio. Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 517–30, Borgo San Lorenzo: All'Insegna del Giglio.
- Firmati, M., ed. (2013), *Scansano. Guida al territorio e al Museo Archeologico e della Vite e del Vino*, Siena: Nuova Immagine Editrice.
- Firmati, M., A. Zifferero and V. Zorzi. (2021), 'Il Vinum in Maremma', *Archeo: Attualità del Passato*, 439: 98–105.
- Firmati, M., A. Zifferero, V. Zorzi and G. Ferrari Melillo (2015), 'Scansano (GR). Progetto ArcheoVino: l'impianto del vigneto sperimentale etrusco-romano', *Notiziario della Soprintendenza per i Beni Archeologici della Toscana*, 11: 497–501.
- Fischer-Genz, B. (2016), 'Ancient Wine and Oil Presses from the Bekaa Valley', *Journal of Eastern Mediterranean Archaeology & Heritage Studies*, 4: 57–71.
- Flandrin, J. L. and M. Montanari, eds (1997), *Storia dell'alimentazione*, Rome: Laterza.
- Forbes, H. (1993), 'Ethnoarchaeology and the Place of the Olive in the Economy of the Southern Argolid, Greece', in M.-C. Amouretti and J.-P. Brun (eds), *La Production du Vin et de l'Huile en Méditerranée*, BCH Supp. XXVI, 213–26, Athens.
- Forbes, R. J. (1955), *Studies in Ancient Technology III*, Leiden: Brill.
- Formenti, F., A. Hesnard and A. Tchernia (1978), 'Note sur le contenu d'une amphore Lamboglia 2 de l'épave de la Madrague de Giens', *Archaeonautica*, 2: 95–100.
- Fornacelli, C., A. Palmieri and S. Rojo Muñoz (2022), 'Le vie del bucchero', *Archeo: Attualità del Passato*, 447: 20–1.
- Forni, G. (1996), 'Genesi e diffusione della viti-vinicoltura dal Mediterraneo orientale alla Cisalpina: aspetti ecologici, culturali, linguistici e tecnologici', in G. Forni, A. Scienza (eds), *2500 anni di cultura della vite nell'ambito alpino e cisalpino*, 19–183, Trento: Istituto Trentino del Vino.
- Forni, G. (1999), 'La tecnologia e l'economia vitivinicola della Magna Grecia e della Sicilia antica', in O. Failla and G. Forni (eds), *Alle radici della civiltà del vino in Sicilia*, 131–67, Menfi: Cantine Settesoli.
- Forni, G. (2012a), 'La matrice euromediterranea della nostra viticoltura: La prospettiva pluridisciplinare', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della Vite e del Vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 93–118, Borgo San Lorenzo: All'Insegna del Giglio.
- Forni, G. (2012b), 'The Origin of "Old World" viticulture', in D. Maghradze, L. Rustioni, J. Turok, A. Scienza and O. Failla (eds), *Caucasus and Northern Black Sea Region Ampelography*, 27–38, Vitis.
- Foxhall, L. (2007), *Olive Cultivation in Ancient Greece: Seeking the Ancient Economy*, Oxford: OUP.
- Fraga, H. (2019), *Viticulture and Winemaking Under Climate Change*, Basel, Beijing, Wuhan, Barcelona, Belgrade: MDPI.
- Frankel, R. (1999), *Wine and Oil Production in Antiquity in Israel and Other Mediterranean Countries*, Sheffield: Sheffield Academic Press.
- Frankel R. (2020), 'Olive and Olive Oil in the Eastern Mediterranean: From Antiquity to the Pre-Industrial Age', in I. Anagnostakis and E. Balta (eds), *Olive and Olive Oil in the Eastern Mediterranean: From Antiquity to the Pre-Industrial Age*, 117–44, Athens: Piraeus Bank Group Cultural Foundation (PIOP) and the Institute of Historical Research (IHR) of the National Hellenic Research Foundation (NHRF).
- Franzoni, L. (1990), *La Valpolicella nell'Età Romana*, Verona: Centro di Documentazione per la storia della Valpolicella.

- Fredlund, G. G. and L. L. Tieszen (1997), 'Calibrating Grass Phytolith Assemblages in Climatic Terms: Application to Late Pleistocene Assemblages from Kansas and Nebraska', *Palaeogeography Palaeoclimatology Palaeoecology*, 136 (1–4): 199–211.
- Fuks, D., G. Bar-Oz, Y. Tepper and E. Weiss (2020), 'The Rise and Fall of Viticulture in the Late Antique Negev Highlands Reconstructed from Archaeobotanical and Ceramic Data', *PNAS*, 117 (33): 19780–91.
- Fyfe, R. M., J.-L. de Bealieu, H. Binney, R. H. W. Bradshaw, S. Brewer, A. Le Flao, W. Finsinger, M.-J. Gaillard, T. Giesecke, G. Gil-Romera, E. C. Grimm, B. Huntley, P. Kunes, N. Kühl, M. Leydet, A. F. Lotter, P. E. Tarasov and S. Tonkov (2009), 'The European Pollen Database: Past Efforts and Current Activities', *Vegetation History and Archaeobotany*, 18: 417–24.
- Gaffney, C. and J. Gater (2003), *Revealing the Buried Past: Geophysics for Archaeologists*, Stroud: Tempus.
- Gaffney, V. L. and B. Kirigin, eds (2006), *The Adriatic Islands Project: The Archaeological Heritage of Vis, Biševo, Svetac, Palagruža and Šolta*, BAR International Series 1492, Oxford: BAR.
- Gaffney, V. L., B. Kirigin, M. Petric and N. Vujnovic, eds (1997), *The Adriatic Islands Project: Contact, Commerce and Colonialism, 6000 BC–AD 600*, BAR International Series 660, Oxford: BAR.
- Gaillard, M. J., S. Sugita, M. J. Bunting, R. Middleton, A. Broström, C. Caseldine, T. Giesecke, S. E. V. Hellman, S. Hicks, K. Hjelle, C. Langdon, A.-B. Nielsen, A. Poska, H. von Stedingk, S. Veski and POLLANDCAL members (2008), 'The Use of Modelling and Simulation Approach in Reconstructing Past Landscapes from Fossil Pollen Data: A Review and Results from the POLLANDCAL Network', *Vegetation History and Archaeobotany*, 17: 419–43.
- Gallo, D., M. Ciminale, H. Becker and N. Masini (2009), 'Remote Sensing Techniques for Reconstructing a Vast Neolithic Settlement in Southern Italy', *JAS*, 36: 43–50.
- Galtier, G. (1960), *Le vignoble du Languedoc méditerranéen et du Roussillon*, Montpellier: Thèse Paris.
- Garcés-Pastor, S., S. Lavergne, E. Coissac, Y. Lammers, O. W. Wangenstein, J.-P. Theurillat, C. Schwörer, A. G. Brown, W. Tinner, F. Rey, O. Heiri, M. Heer, A. Rützel, K. Walsh, P. D. Heintzman, T. Goslar and I. G. Alsos (2022), 'High Resolution Ancient Sedimentary DNA Shows That Alpine Plant Diversity is Associated with Human Land Use and Climate Change', *Nat. Comms.*, 13 (6559).
- García Armendáriz, J. I. (1995), *Agronomía y tradición clásica. Columela en España*, Sevilla: Universidad de Cádiz y Sevilla.
- García, J.-P., S. Chevrier, A. Dufraisse, M. Foucher and R. Steinmann (2010), 'Le vignoble gallo-romain de Gevrey-Chambertin "Au-dessus-de Bergis", Côte-d'Or (Ier–Ile s. ap. J.-C.): Modes de plantation et de conduite de vignes antiques en Bourgogne', *Revue archéologique de l'Est*, 59 (2): 505–37.
- García Sanz, O. (1991), 'Ad summam ubertatem vini', *Gerión*, 3: 219–22.
- Garnier, N. (2003), 'Structural Analysis of Organic Materials Preserved in Ancient Results: New Results from Chromatography and Mass Spectrometry Analyses', unpublished PhD thesis, Paris: Université Pierre et Marie Curie (Paris VI).
- Garnier, N. (2007), 'Analyse de résidus organiques conservés dans des amphores: un état de la question', in M. Bonifay and J. C. Trégliá (eds), *LRCW 2 Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean: Archaeology and Archaeometry*, BAR International Series 1662, 39–49, Oxford: Archaeopress.
- Garnier, N. (2015), 'Methodologies d'analyse chimique organique en archéologie', in C. Oliveira, R. Morais and A. Morillo (eds), *Archaeoanalytics: Chromatography and DNA analysis in archaeology. International Symposium*, 13–39, Porto: University of Porto.
- Garnier, N. (forthcoming), 'Elaborazione e consumo di cibi e bevande attraverso il prisma delle analisi organiche dei contenuti invisibili', in P. Basso, G. Falezza, M. Migliavacca and F. Saggioro (eds), *Veronensium mensa: Food and Wine in Ancient Verona*, Rome: Quasar.
- Garnier, N., P. Richardin, V. Cheynier and M. Regert (2003), 'Characterization of Thermally Assisted Hydrolysis and Methylation Products of Polyphenols from Modern and

Bibliography

- Archaeological Vine Derivatives Using Gas Chromatography-Mass Spectrometry', *Analytica Chimica Acta*, 493 (2): 137–57.
- Garnier, N., T. Silvino and D. Bernal Casasola (2011), 'The Identification of the Content of Amphorae: Oils, Salsamenta and Pitch', in *French Society for the Study of Archaeological Ceramics from Gallia, Proceedings of the Congress SFEACAG (Arles, June 2011)*, 397–416, Arles.
- Garnier, N. and A. Pecci (2021), 'Amphorae and Residue Analysis: Application to the Determination of the Content of Amphorae', in M. Bonifay, D. Bernal, A. Pecci and V. Leich (eds), *Roman Amphora Contents: Reflecting on the Maritime Trade of Foodstuffs in Antiquity*, 113–26, Oxford: Archaeopress.
- Garnier, N. and S. M. Valamoti (2016), 'Prehistoric Wine Making at Dikili Tash (Northern Greece): Integrating Residue Analysis and Archaeobotany', *JAS*, 74: 195–206.
- Gauthier, E. and M. Joly (2003), 'Nouvelles données sur la culture de la vigne dans l'est de la Gaule (Bourgogne/Franche-Comté)', in F. Favory and A. Vigot (eds), *Actualité de la recherche en histoire et archéologie agraires, Actes du colloque AGER V, Besançon 19–20 septembre 2000*, 191–208, Besançon: Presses Universitaires Franc-Comtoises.
- Giannichedda, E. (2006), *Uomini e cose*, Bari: Edipuglia.
- Giannitrapani, E., L. Simone and S. Tinè, eds (1990), *Interpretazione funzionale dei 'fondi di capanna' di età preistorica: Atti del seminario di archeologia sperimentale, Milano, 29–30 aprile 1989*, Genova.
- Giardino, C. (2012), 'L'Archeologia sperimentale e la preistoria: un contributo alla conoscenza del passato', *Conimbriga*, 51: 5–33.
- Giguet-Covex, C., J. Pansu, F. Arnaud, P.-J. Rey, C. Griggo, L. Gielly, I. Domaizon, E. Coissac, F. David, P. Choler, J. Poulenard and P. Taberlet (2014), 'Long Livestock Farming History and Human Landscape Shaping Revealed by Lake Sediment DNA', *Nature Communications*, 5 (3211).
- Giguet-Covex, C., G. F. Ficotola, K. Walsh, J. Poulenard, M. Bajard, L. Fouinat, P. Sabatier, L. Gielly, E. Messenger, A. L. Develle, F. David, P. Taberlet, E. Brisset, F. Guiter, R. Sinet and F. Arnaud (2019), 'New Insights on Lake Sediment DNA from the Catchment: Importance of Taphonomic and Analytical Issues on the Record Quality', *Scientific Reports*, 9 (14676).
- Gilles, K.-J. (1995), *Neuere Forschungen zum roemischen Weinbau an Mosel und Rhein, Schriftenreihe des Rheinischen Landesmuseums Trier 11*, Trier: Rheinisches Landesmuseum.
- Ginori, L. (1978), *Cabrei in Toscana: Raccolte di Mappe, Prospetti e Vedute*, Pistoia: Cassa di Risparmio.
- Gismondi, A., G. Di Marco, F. Martini, L. Sarti, M. Crespan, C. Martínez-Labarga, O. Rickards and A. Canini (2016), 'Grapevine Carpological Remains Revealed the Existence of a Neolithic Domesticated Vitis vinifera L. Specimen Containing Ancient DNA Partially Preserved in Modern Ecotypes', *JAS*, 69: 75–84.
- Gladstones, J. (2011), *Wine, Terroir and Climate Change*, Mile End: Wakefield Press.
- Glicksman, K. (2005), 'Internal and external trade in the Roman province of Dalmatia', *Opvsvla Archaeologica*, 29 (1): 189–230.
- Glicksman, K. (2007), 'Olive and Vine Cultivation in the Roman Province of Dalmatia', *Histria Antiqua*, 15: 43–50.
- Glonti, T. and Z. Glonti (2013), *The Remarkable Qvevri Wine (Why Is the Qvevri Wine Better than One Made without It?)*, Tbilisi: Qvevri Foundation.
- Gnirs, A. (1915), 'Forschungen über antiken Villenbau in Südistrien, I. Die Grabung in der antiken Villenanlage von Val Catena, II. Eine villa rustica am strand der Bucht Olmo grande', *Jahreshefte des Österreichischen archäologischen Instituts*, 18: 99–163.
- Godino, Y., Lebole C. and G. Di Gangi (2020), 'Fornire la pratica che sostiene la teoria: una riflessione sull'Archeologia Sperimentale', *Archeologie Sperimentali: Temi, Metodi, Ricerche*, 1: 1–27.

- Goodchild, H. (2009), 'Modelling the Productive Landscape of the Middle Tiber Valley', in F. Coarelli and H. Patterson (eds), *Mercator placidissimus: the Tiber Valley in Antiquity: New Research in the Upper and Middle River Valley: Rome, 27–28 February 2004*, 769–96, Roma.
- Goodchild, H. (2013), 'Agriculture and the Environment of Republican Italy', in J. DeRose Evans (ed.), *A Companion to the Archaeology of the Roman Republic*, 198–213, Oxford: Wiley-Blackwell.
- Goodchild, H. (2019), 'De Agri Cultura Experientia: From Modern Agronomy to Roman Economic Analysis', in J. Remesal Rodríguez, V. Revilla Calvo, D.-J. Martín-Arroyo Sánchez and A. Martín I Oliveras (eds), *Productive Landscapes and Trade Networks in the Roman Empire*, 155–78, Barcelona: University of Barcelona.
- Goodman, D. and S. Piro (2013), *GPR Remote Sensing in Archaeology*, Geotechnologies and the Environment 9, New York: Springer.
- Goode, J. (2006), *The Science of Wine: From Vine to Glass*, Berkeley: University of California Press.
- Grace, V. (1979), *Amphoras and the Ancient Wine Trade*, Princeton.
- Grassi, F. and G. De Lorenzis (2021), 'Back to the Origins: Background and Perspective of Grapevine Domestication', *Int J Mol Sci*, 22 (9): 4518.
- Grasso, A. M. and G. Fiorentino (2012), 'Archeologia e storia della vite e del vino nel Medioevo italiano: Il contributo dell'archeobotanica e di nuove metodologie di analisi integrate per la caratterizzazione varietale applicate ai contesti archeologici della Puglia meridionale', in F. Redi and A. Forgione (eds), *VI Congresso Nazionale di Archeologia Medievale (L'Aquila, 12–15.9.2012)*, 688–92, Firenze: All'Insegna del Giglio.
- Grave, P. and L. Kealhofer (1999), 'Assessing Bioturbation in Archaeological Sediments using Soil Morphology and Phytolith Analysis', *JAS*, 26: 1239–48.
- Greig, J. (2015), 'Pollen', in M. Atkinson and S. J. Preston Heybridge (eds), *A Late Iron Age and Roman Settlement: Excavations at Elms Farm 1993–5*, *Internet Archaeology*, 40, <http://dx.doi.org/10.11141/ia.40.1.greig>
- Grigalashvili, Z. A. and M. B. Khomasuridze (2021), 'Impact of Oak Barrel and Its Alternatives on Sensory Characteristics and Phenolic Compounds of Qvevri Wine', *Georgian Engineering News*, 92: 159–66.
- Grisso, R., M. M. Alley, D. Holshouser and W. Thomason (2009), *Precision Farming Tools: Soil Electrical Conductivity*, Petersburg: Virginia Polytechnic Institute and State University.
- Guasch-Jané, M. R. (2019), 'Grape Archaeology and Ancient DNA Sequencing', in D. Cantu and M. Andrew Walker (eds), *The Grape Genome*, 57–75, Cham: Springer.
- Guasch-Jané, M. R., M. Iberno-Gómez, C. Andrés-Lacueva, O. Jáuregui, R. M. and Lamuela-Raventós (2004), 'Liquid Chromatography with Mass Spectrometry in Tandem Mode Applied for the Identification of Wine Markers in Residues from Ancient Egyptian Vessels', *Analytical Chemistry*, 76: 1672–77.
- Guasch-Jané, M. R., C. Andrés-Lacueva, O. Jáuregui and R. M. Lamuela-Raventós (2006), 'First Evidence for White Wine in Ancient Egypt from Tutankhamun's Tomb', *Journal of Archaeological Science*, 33: 1075–80.
- Guido, M. A., M. Mariotti Lippi, B. I. Menozzi, S. Placerani and C. Montanari (2004), 'Il paesaggio vegetale montano della Liguria centro-occidentale nell'età del Ferro: area del Monte Beigua (Savona)', in R. C. De Marinis and G. Spadea (eds), *I Liguri*, 91–5, Milano: Skira.
- Guiot, J. and D. Kaniewski (2015), 'The Mediterranean Basin and Southern Europe in a warmer world: what can we learn from the past?', *Frontiers in Earth Science*, 3: 28.
- Guiot, J., N. Bernigaud, A. Bondeau, L. Bouby and W. Cramer (2023), 'Viticulture Extension in Response to Global Climate Change Drivers – Lessons from the Past and Future Projections', *Climate of the Past*, 19 (6): 1219–44.
- Hadjisavvas, S. (2020), *Archaeology of Wine in Cyprus*, Nicosia: Napaphos.
- Hanson, J. W. (2016), *Cities database (OXREP databases). Version 1.0*, accessed here: <http://oxrep.classics.ox.ac.uk/databases/cities/>. DOI: <https://doi.org/10.5287/bodleian:eqapevAn8>

Bibliography

- Harper, K. and M. McCormick (2019), 'Reconstructing the Roman Climate', in W. Scheidel (ed.), *The Science of Roman History: Biology, Climate, and the Future of the Past*, 11–52, Princeton: Princeton University Press.
- Harrison, A., U. Rajala, S. Stoddart, R. E. Witcher and E. Zubrow (2004), 'The Enhancement of the South Etruria Survey: Phase 1', in H. Patterson (ed.), *Bridging the Tiber: Approaches to Regional Archaeology in the Middle Tiber Valley*, 29–35, London: British School at Rome.
- Harutyunyan, M. and M. Malfeito-Ferreira (2022), 'Historical and Heritage Sustainability for the Revival of Ancient Wine-Making Techniques and Wine Styles', *Beverages*, 8 (1): 10.
- Harutyunyan, M., R. Viana, J. Granja-Soares, M. Martins, H. Ribeiro and M. Malfeito-Ferreira (2022), 'Adaptation of Ancient Techniques to Recreate "Wines" and "Beverages" using Withered Grapes of Muscat of Alexandria', *Fermentation*, 8 (2): 85.
- Harutyunyan, M., R. Viana, J. Granja-Soares, A. Asryan, J. C. Marques and M. Malfeito-Ferreira (2023), 'Consumer Acceptance of Sweet Wines and Piquettes Obtained by the Adaptation of Ancient Winemaking Techniques ("AWT")', *Journal of Sensory Studies*, 38 (3), e12823.
- Harvey, S. M. (2010), 'Iron Tools from a Roman Villa at Boscoreale, Italy, in the Field Museum and the Kelsey Museum of Archaeology', *AJA*, 114: 697–714.
- Hegyí, A., D. Diaconescu, P. Urdea, A. Sarris, M. Pisz and A. Onaca (2021), 'Using Geophysics to Characterize a Prehistoric Burial Mound in Romania', *Remote Sensing*, 13: 842.
- Hendy, C. H. (1971), 'The Isotopic Geochemistry of Speleothems in the Calculation of the Effects of Different Modes of Formation on Isotopic Composition of Speleothems and their Applicability as Palaeoclimatic Indicators', *Geochimica Cosmochimica Acta*, 35: 801–24.
- Hendy, C. H. and A. T. Wilson (1968), 'Palaeoclimate Data from Speleothems', *Nature*, 219: 48–51.
- Heron, C. and A. M. Pollard (1987), 'The analysis of natural resinous materials from amphorae', in *Science and Archaeology*, Glasgow, Oxford: British Archaeological Reports.
- Hine, H. M. (2011), '"Discite . . . Agricolae": Modes of instruction in Latin Prose Agricultural Writing from Cato to Pliny the Elder', *CQ*, 61: 624–54.
- Hirschfeld, Y. (1983), 'Ancient Wine Presses in the Park of Aijalon', *Israel Exploration Journal*, 33 (3–4): 207–18.
- Hjelle, K. L., I. K. Mehl, S. Sugita and G. L. Andersen (2015), 'From Pollen Percentage to Vegetation Cover: Evaluation of the Landscape Reconstruction Algorithm in Western Norway', *Journal of Quaternary Science*, 30 (4): 312–24.
- Hodges, R. (2010), 'Adriatic Sea Trade in a European Perspective', *Scottish Archaeological Journal*, 32 (2): 95–119.
- Hoffelink, A. and F. Vermeulen (2021), 'Ubi sunt macella? The Contribution of Non-Invasive Archaeological Survey to the Identification and Study of Roman Food Markets', *Oxford Journal of Archaeology*, 40: 105–33.
- Holloway, B. (2019), 'Archaeological Trial-Trenching Evaluation: Land North of Elmstead Road, Colchester, Essex, CAT Project Ref.: 14/02h, NGR: TM 0221 2442', Colchester and Ipswich Museum accession code: 2014.19.
- Horden, P. and N. Purcell (2000), *The Corrupting Sea: A Study of Mediterranean History*, Oxford: Wiley.
- Hudson, N. F. (2010), 'Changing Places: The Archaeology of the Roman Convivium', *American Journal of Archaeology*, 114 (4): 663–95.
- Iglesias, J. (1979), *El fogatge de 1553*, Barcelona: Fundació Salvador Vives Casajuana.
- Imazio, S. and M. Labra (2005), 'I marcatori molecolari e il loro impiego nello studio della domesticazione della vite, attraverso il confronto con la vite selvatica', A. Ciacchi, A. Zifferero (eds), *VINUM: Un progetto per il riconoscimento della vite silvestre nel paesaggio archeologico della Toscana e del Lazio settentrionale*, 57–66, Siena: Ci.Vin.
- Indelicato, M. (2017), 'Coltivare la vite, produrre il vino: un approccio sperimentale e multidisciplinare allo studio della viticoltura della Sicilia romana', unpublished tesi di Specializzazione in Archeologia Classica, Università degli Studi di Catania.

- Indelicato, M. (2020a), 'Archeologia Sperimentale e alimentazione: il panorama italiano', *Archeologie Sperimentali: Temi, Metodi, Ricerche*, 1: 36–55.
- Indelicato, M. (2020b), 'Columella's Wine: a Roman Enology Experiment', *EXARC*, 1: 1–8.
- Indelicato, M., D. Malfitana and G. Cacciaguerra (2017), 'The Archaeology of Wine in Italy: A Sicilian Experiment', in R. Alonso, J. Baena and D. Canales (eds), *Playing with the Time: Experimental Archaeology and the Study of the Past*, 321–8, Madrid: Universidad Autónoma de Madrid.
- Inserra, F., A. Pecci, M. Á. Cau Ontiveros and J. Roig Buxó (2015), 'Organic Residue Analysis of Late Antique Pottery from Plaça Major-Horts de Can Torras (Castellar del Vallés, Catalonia, Spain)', *Periodico di Mineralogia*, 84 (1): 123–38.
- Jackson, R. S. (2008), *Wine Science: Principles and Applications*, London: Academic Press.
- James, T. G. H. (1995), 'The Earliest History of Wine and Its Importance in Ancient Egypt', in P. E. McGovern, S. J. Fleming and S. Katz (eds), *The Origins and Ancient History of Wine*, 197–213, New York: Gordon and Breach.
- Jashemski, W. (1968), 'Excavations in the "Foro Boario" at Pompeii: A Preliminary Report', *AJA*, 72: 69–73.
- Jashemski, W. (1973), 'The Discovery of a Large Vineyard at Pompeii: University of Maryland Excavation, 1970', *AJA*, 77: 27–41.
- Jashemski, W. (1979), *The Gardens of Pompeii, Herculaneum and the Villas Destroyed by Vesuvius*, Vol. 1, New Rochelle: Caratzas.
- Jashemski, W. (1993), *The Gardens of Pompeii: Herculaneum and the Villas Destroyed by Vesuvius*, Vol. 2: Appendices, New York: Caratzas.
- Jerković, I., Z. Marijanović, M. Gugić and M. Roje (2011), 'Chemical Profile of the Organics Residue from Ancient Amphora found in the Adriatic Sea Determined by Direct GC and GC-MS Analysis', *Molecules*, 16: 7936–48.
- Jochum, K. P., D. Scholz, B. Stoll, U. Weis, S. A. Wilson, Q. Yang, A. Schwalb, N. Börner, D. E. Jacob and M. O. Andreae (2012), 'Accurate Trace Element Analysis of Speleothems and Biogenic Calcium Carbonates by LA-ICP-MS', *Chemical Geology*, 318–19: 31–44.
- Johnson, H. and J. Robinson (2019), *The World Atlas of Wine*, 8th edn, London: Octopusbooks.
- Jones, D. W. (2014), *Economic Theory and the Ancient Mediterranean*, Malden: Wiley-Blackwell.
- Jones, G. V. (2007), 'Climate Change: Observations, Projections and General Implications for Viticulture and Wine Production', in *Climate and Viticulture Congress, Zaragoza, April 10–14, 2007/8th International Symposium Innovations in Enology, Stuttgart April 20–23, 2007*, 1–13, accessed here: <https://www.infowine.com/intranet/libretti/libretto4594-01-1.pdf>
- Jones, G. V. and R. Davis (2000), 'Climate Influences on Grapevine Phenology, Grape Composition and Wine Production and Quality for Bordeaux, France', *Am J Enol Vitic* 51 (3): 249–61.
- Jones, G. V., É. Duchêne, D. Tomasi, J. Yuste, O. Braslavská, H. Schuktz, C. Martínez, S. Boso, F. Langellier, C. Perruchot and G. Guimberteau (2005), 'Changes in European Winegrape Phenology and Relationships with Climate', in *XIV International GESCO Viticulture Congress, Geisenheim, Germany, 23–27 August, 2005*, 54–61.
- Jones, G., R. Reid and A. Vilks (2012), 'Climate, Grapes and Wine: Structure and Suitability in a Variable and Changing Climate', in P. H. Dougherty (ed.), *The Geography of Wine: Regions, Terroir and Techniques*, 109–33, Dordrecht: Springer.
- Jones, G. and L. B. Webb (2010), 'Climate Change, Viticulture and Wine: Challenges and Opportunities', *Journal of Wine Research*, 21 (2): 103–6.
- Jongman, W. (1988), *The Economy and Society of Pompeii*, Dutch Monographs on Ancient History and Archaeology 4, Amsterdam: Gieben.
- Jouanna, J. (2012), 'Wine and Medicine in Ancient Greece', in P. van der Eijk (ed.), *Greek Medicine from Hippocrates to Galen: Selected Papers*, Studies in Ancient Medicine 40, 173–93, Boston: Brill.

Bibliography

- Joyce, J. (2019), 'Modelling Agricultural Strategies in the Dutch Roman Limes via Agent-Based Modelling (ROMFARMS)', in P. Verhagen, J. Joyce and M. R. Groenhuijzen (eds), *Finding the Limits of the Limes: Modelling Demography, Economy and Transport on the Edge of the Roman Empire*, 109–27, Cham: Springer.
- Jung, C., H. Pomarède, M. Compan, I. Figueiral, S. Martin, O. Ginouvez and C. Tardy (2013), 'Pratiques culturelles et système agraire gallo-romain: L'exemple de la vallée de l'Hérault et du Biterrois (Hérault)', *RAN*, 46: 159–77.
- Kaal, J., F. Criado-Boado, M. Costa-Casis, J. A. López-Sáez, L. López-Merino, T. Mighall, Y. Carrión, N. S. Sánchez and A. M. Cortizas (2013), 'Prehistoric Land Use at an Archaeological Hot-Spot (the Rock Art Park of Campo Lameiro, NW Spain) Inferred from Charcoal, Synanthropic Pollen and Non-Pollen Palynomorph Proxies', *Journal of Archaeological Science*, 40: 1518–27.
- Kaniewski, D., N. Marriner C. Morhange, D. Rius M.-B. Carre S. Faivre and E. Van Campo (2018), 'Croatia's Mid-Late Holocene (5200–3200 BP) Coastal Vegetation Shaped by Human Societies', *Quaternary Science Reviews*, 200: 334–50.
- Kaplan, J. O., I. C. Prentice and N. Buchman (2002), 'The Stable Carbon Isotope Composition of the Terrestrial Biosphere: Modelling at Scales from the Leaf to the Globe', *Global Biogeochemical Cycles*, 16 (4): 8–11.
- Karaman, L. (1930), *Iz kolijevke hrvatske prošlosti*, Zagreb: Matica hrvatska.
- Karlioğlu, N., H. Caner, N. K. Rauh, Ü. Akkemik and N. Kose (2014), 'Palynological Evidence for Human Occupation in Western Rough Cilicia (Antalya, Gazipaşa)', *ANMED 2014–12 (News of Archaeology from Anatolia's Mediterranean Areas)*, 158–62, Antalya: Suna and Inan Kirac Research Institute on Mediterranean Civilizations.
- Karlioğlu, N., H. Caner, N. K. Rauh, U. Akkemik and E. M. Connor (2016), 'Palynological Evidence for Human Occupation in Western Rough Cilicia (Southwest Turkey)', *Quaternary International*, 401: 109–22.
- Kay, J. E., C. Deser, A. Phillips, A. Mai, C. Hannay, G. Strand, J. M. Arblaster, S. C. Bates, G. Danabasoglu, J. Edwards, M. Holland, P. Kushner, J. F. Lamarque, D. Lawrence, K. Lindsay, A. Middleton, E. Munoz, R. Neale, K. Oleson, L. Polvani and M. Vertenstein (2014), 'The Community Earth System Model (CESM) Large Ensemble Project: A Community Resource for Studying Climate Change in the Presence of Internal Climate Variability', *Bull. Am. Meteorol. Soc.*, 96 (8): 1333–49.
- Kimura, P., G. Okamoto and K. Hitano (1998), 'The Mode of Pollination and Stigma Receptivity in *Vitis Coignetiae* Pulliat', *American Journal of Enology and Viticulture*, 49: 1–5.
- Kliwer, W. M. (1967), 'Concentration of Tartrates, Malates, Glucose and Fructose in the Fruits of the Genus *Vitis*', *American Journal of Enology and Viticulture*, 18: 87–96.
- Kolendo, J. (1980), *L'agricoltura nell'Italia romana: tecniche agrarie e progresso economico dalla tarda repubblica al principato*, Rome: Editori Riuniti.
- Kolendo, J. (1985), 'Le attività agricole degli abitanti di Pompei e gli attrezzi agricoli ritrovati all'interno della città', *Opus*, 4: 111–24.
- Komar, P. (2016), 'Wine from Cyprus and Cilicia: Taste and Trade', *Electrum*, 23: 155–85.
- Komar, P. (2020), 'In Vino Sanitas: Medical Qualities of Greek Wines', *Mélanges de l'Ecole Française de Rome*, 132: 429–47.
- Komar, P. (2021), 'Wine Imports and Economic Growth in Rome Between the Late Republic and Early Empire', *Historia*, 70 (4): 437–62.
- Kvavadze, E., M. Chichinadze and I. Martkoplshvili (2010), 'The Pollen Production and Yield in Vineyard of Kakheti According to the Results of Pollen Monitoring', in *33rd World Congress of Vine and Wine*, Georgian National Museum.
- Labate, D. (2010), 'Il popolamento in età romana della collina modenese: l'insediamento e gli impianti produttivi', in F. Guandalini and D. Labate (eds), *Insediamento di Montegibbio: una ricerca interdisciplinare per l'archeologia: Atti del convegno, Sassuolo (Modena), 7 febbraio 2009*, 21–30, Borgo S. Lorenzo: All'Insegna del Giglio.

- Labra, M., O. Failla, T. Fossati, S. Castiglione, A. Scienza and F. Sala (1999), 'Phylogenetic Analysis of Grapevine cv. Ansonica Growing on the Island of Giglio, Italy, by AFLP and SSR Markers', *Vitis*, 38: 161–6.
- Lagóstena, L. (1996), *Alfarería romana en la Bahía de Cádiz*, Cádiz: Universidad de Cádiz.
- Lagóstena, L. (2016), 'El Lacus Ligustinus como agente de articulación urbana y conectividad territorial: De las riberas de Hasta Regia a Carissa Aurelia y el acceso a la serranía', *Studia Historica*, 34: 63–86.
- Lagóstena, L. (2021), 'Estructura de la ocupación rural romana en las campiñas Hastenses y Gaditanas: aportación de la exploración GPR a su conocimiento', in V. Mayoral Herrera, I. Grau Mira and J. P. Bellón Ruiz (eds), *Arqueología y sociedad de los espacios agrarios: en busca de la gente invisible en la materialidad del paisaje*, 109–17, Mérida: Mytra.
- Lagóstena, L. and J. Molina (2019), 'La figlina como ámbito de investigación cuantitativa de la economía romana: Aportación y potencial de la exploración georradar', in V. Revilla Calvo, A. Aguilera Martín, L. Pons Pujol and M. García Sánchez (eds), *Ex Baetica Romam: Homenaje a José Remesal Rodríguez*, Col·lecció Homenatges 58, 923–46, Barcelona: University of Barcelona.
- Lagóstena, L. and P. Trapero (2019), 'La localización de los viñedos de Marco Columela: literatura agronómica y análisis GIS en el interfluvio Guadalquivir-Guadalete', in J. Remesal, V. Revilla, D. J. Martín-Arroyo and A. Martín i Oliveras (eds), *Paisajes productivos y redes comerciales en el imperio romano*, Instrumenta 65, 89–114, Barcelona.
- Lake, M. (2020), 'Spatial Agent-Based Modelling', in M. Gillings, P. Hacıgüzeller and G. Lock (eds), *Archaeological Spatial Analysis: A Methodological Guide*, 247–72, New York: Routledge.
- Lamboglia, N. (1950), *Gli Scavi di Albintimilium e la cronologia della ceramica romana I (campagne di scavo 1938–1940)*, Bordighera: Istituto Internazionale di Studi Liguri.
- Lamboglia, N. (1952), 'La nave romana di Albegna', *Rivista di Studi Liguri*, 28: 131–2.
- Lamboglia, N. (1955), 'Sulla cronologia delle anfore romane di età repubblicana', *Rivista di Studi Liguri*, 31: 241–70.
- Landa, V., Y. Shapira, M. David, A. Karasik, E. Weiss, Y. Reuveni and E. Drori (2021), 'Accurate Classification of Fresh and Charred Grape Seeds to the Varietal Level, Using Machine Learning Based Classification Method', *Scientific Reports*, 11 (13577).
- Lasfargues, J. (1985), 'Informations archéologiques: Rhône-Alpes', *Gallia*, 43: 542–3.
- Lavee, S. (2000), 'Grapevine (*Vitis Vinifera*) Growth and Performance in Warm Climates', in A. Erez (ed.), *Temperate Fruit Crops in Warm Climates*, 343–66, Dordrecht: Springer.
- Laville, P. (1990), 'Le terroir, un concept indispensable à l'élaboration et à la protection des appellations d'origine comme à la gestation des vignobles: le cas de la France', *Bulletin de l'OIV*, 63: 217–41.
- Lechterback, J. and C. E. Jensen (2020), 'Exploring the Potential of Palynology in Archaeological Contexts: Proceedings of the Session Held at the 24th Annual Meeting of the European Association of Archaeologists in Barcelona 2018', *Vegetation History and Archaeobotany*, 29: 111–12.
- Leckebusch, J. (2003), 'Ground-Penetrating Radar: A Modern Three-Dimensional Prospection Method', *Archaeological Prospection*, 10: 213–41.
- Lee, A. (2022), 'People of Roman Lincoln – Marcus Aurelius Lunaris. The Collection Art and Archaeology in Lincolnshire', accessed at: <https://www.thecollectionmuseum.com/?/blog/view/people-of-roman-lincoln-marcus-aurelius-lunaris> Last accessed 8/11/2022
- Leidwanger, J. (2020), *Roman Seas: A Maritime Archaeology of the Eastern Mediterranean*, Oxford: Oxford University Press.
- Lelli, E. (2010), *L'agricoltura Antica: I Geoponica di Cassiano Basso*, Soveria Mannelli: Rubbettino Editore.
- Lentjes, D. (2016), *Planting the Seeds of Change: Landscape and Land Use in First Millennium BC Southeast Italy*, Amsterdam: Amsterdam University Press.
- Lentjes, D. and G. S. Semerari (2016), 'Big Debates over Small Fruits: Wine and Oil Production in Protohistoric Southern Italy (ca. 1350–750 BC)', *BABesch*, 91: 1–16.

Bibliography

- Leveau, Ph. and J. C. Golvin (1979), 'L'amphithéâtre et le théâtre-amphithéâtre de Cherchel: Monuments à spectacles et histoire urbaine à Caesarea de Maurétanie', *MÉFRA*, 91 (2): 817–43.
- Leveau, Ph. (2011), 'Entre faits archéologiques et concepts: la recherche sur les agglomérations protohistoriques et gallo-romaines', in *Les Rutènes: Du peuple à la cité*, Supp. Aquitania 25, 591–603, Bordeaux: Aquitania.
- Lewis, Ch. and T. Short (1879), *A Latin Dictionary*, London: Clarendon Press.
- Lewit, T. (2020), 'Invention, Tinkering, or Transfer? Innovation in Oil and Wine Presses in the Roman Empire', in P. Erdkamp, K. Verboven, A. Zuiderhoek (eds), *Capital, Investment, and Innovation in the Roman World*, 307–53, Oxford: OUP.
- Lewit, T. and P. Burton (2019), 'Wine and Oil Presses in the Roman to Late Antique Near East and Mediterranean: Balancing Textual and Archaeological Evidence', in A. Squitieri and D. Eitam (eds), *Stone Tools in the Ancient Near East and Egypt: Ground Stone Tools, Rock-Cut Installations and Stone Vessels from Prehistory to Late Antiquity*, 97–110, Oxford: Archaeopress.
- Li, X. J., A. Bevan, M. Martínón-Torres, T. Rehren, W. Cao, Y. Xia and K. Zhao (2014), 'Crossbows and Imperial Craft Organisation: The Bronze Triggers of China's Terracotta Army', *Antiquity*, 88 (339): 126–40.
- Lindhagen, A. (2009), 'The Transport Amphoras Lamboglia 2 and Dressel 6A: A Central Dalmatian Origin?', *Journal of Roman Archaeology*, 22: 83–108.
- Lindhagen, A. (2013), 'The Freedman Milieus at Delos and Naron: New Perspectives on the Lamboglia 2 Wine Trade', in A.-L. Schallin (ed.), *Perspectives on Ancient Greece: Papers in celebration of the 60th anniversary of the Swedish Institute at Athens*, 231–50, Stockholm: Paul Astroms.
- Lindhagen, A. (2020), 'A Central Dalmatian Origin of the Adriatic Wine Amphorae? New Evidence from Xrf-analyses', in I. Kamenjarin and M. Ugarkovic (eds), *Exploring the Neighborhood: The Role of Ceramics in Understanding Place in the Hellenistic World, Proceedings of the 3rd conference of IARPotHP, Kastela, June 2017, 1st–4th*, 343–52, Wien: Phoibos Verlag.
- Linford, N. (2006), 'The Application of Geophysical Methods to Archaeological Prospection', *Reports on Progress in Physics*, 69: 2205–57.
- Lipovac Vrkljan, G. (2009), 'L'officina ceramica di Crikvenica', in S. Pesavento Mattioli and M.-B. Carre (eds), *Olio e pesce in epoca romana: Produzione e commercio nelle regioni dell'alto Adriatico, Atti del Convegno (Padova, 16 febbraio 2007)*, 309–14, Rome: Quasar.
- Lipovac Vrkljan, G., I. Radic Rossi and A. Konestra, eds (2017), *AdriAmphorae: Amphorae as a resource for the reconstruction of economic development in the Adriatic region in Antiquity: local production, Proceedings of the workshop, Zagreb 21st April 2016*, Zagreb: Institut za Arheologiju.
- Lipovac Vrkljan, G. and A. Konestra, eds (2019), *Pottery Production, Landscape and Economy of Roman Dalmatia*, Oxford: Archaeopress.
- Lissarague, F. (1989), *L'immaginario del simposio Greco*, Roma; Bari: Editori Laterza.
- Liverani, P. (1987), 'Termini muti di centuriazione o contrappesi di torchi?', *MÉFRA*, 99: 111–27.
- Liverani, P. (1988), 'Resti di torchi di tradizione romana in Valpolicella', *Annuario storico della Valpolicella*, 6: 53–62.
- Lodwick, L. and E. Rowan (2022), 'Archaeobotanical Research in Classical Archaeology', *American Journal of Archaeology*, 126 (4): 593–623.
- López Amador, J. J. and J. A. Ruiz Gil (2007), 'Arqueología de la vid y el vino en El Puerto de Santa María', *Revista de Historia del Puerto*, 38: 11–36.
- López Amador, J. J. and J. A. Antonio Ruiz Gil (2005), 'Arqueología de la repoblación Alfonsí: Pocito Chico en La Laguna del Gallo de El Puerto de Santa María (Cádiz, España)', *Revista de Historia de El Puerto*, 35: 11–51.
- Lyne, M. (2006), *Roman Wight*, Isle of Wight History Centre, accessed here: <https://www.iwhistory.org.uk/resourceassessment/iow%20Roman.pdf>

- Macias-Fauria, M. and K. J. Willis (2013), 'Landscape Planning for the Future: Using Fossil Records to Independently Validate Bioclimatic Envelope Models for Economically Valuable Tree Species in Europe', *Global Ecology and Biogeography*, 22 (3): 318–33.
- Madrigal, J., A. K. W. Runge, L. Bouby, T. Lacombe, J. A. Samaniego, A.-F. Adam-Bondon, I. Figueiral, C. Hallavant, J. M. Martinez-Zapater, C. Schaal, R. Töpfer, B. Patersen, T. Sicheritz-Pontén, P. This, R. Bacilieri, M. Gilbert and N. Whales (2019), 'Palaeogenomic Insights into the Origins of French Grapevine Diversity', *Nature Plants*, 5: 595–603.
- Maggi, P. and Y. Marion (2011), 'Le produzioni di anfore e di terra sigillata a Loron e la loro diffusione', in G. Lipovac Vrkljan, I. Radić Rossi and B. Siljeg (eds), *Officine per la produzione di ceramica e vetro in epoca romana: Produzione e commercio nella regione adriatica. Atti del convegno (Crikvenica, 23–24 ottobre 2008)*, 175–87, Crikvenica.
- Magri, D. and L. Sadori (1999), 'Late Pleistocene and Holocene Pollen Stratigraphy at Lago di Vico, Central Italy', *Vegetation History and Archaeobotany*, 8: 247–60.
- Magris, G., I. Jurman, A. Fornasiero, E. Paparelli, R. Schwöpe, F. Marroni, G. di Gaspero and M. Morgante (2021), 'The Genomes of 204 Vitis Vinifera Accessions Reveal the Origin of European Wine Grapes', *Nature Communications*, 12: 7240.
- Malaguti, C., M. Marchesini, L. Casagrande, V. Cobianchi, I. Gobbo, S. Marvelli, L. Mura and E. Rizzoli (2011), 'Il pozzo di Badia Polesine (Rovigo): Archeologia e tecnica dei pozzi per acqua dalla pre-protostoria all'età moderna' in, S. Cipriano and E. Pettenò (eds), *Archeologia e tecnica dei pozzi per acqua dalla pre-protostoria all'età moderna*, Antichità Altoadriatiche LXX, 85–114, Rome: Quasar.
- Malavolti, F. (1948), 'Rapporti tra alluvioni ed antichi insediamenti umani nella pianura emiliana', *Emilia Preromana*, 1: 79–86.
- Malheiro, A. C., J. A. Santos, H. Fraga and J. G. Pinto (2010), 'Climate Change Scenarios Applied to Viticultural Zoning in Europe', *Climate Research*, 43: 163–77.
- Manataki, M., A. Sarris, J. C. Donati, C. Cuenca and T. Kalayci (2015), 'GPR: Theory and Practice in Archaeological Prospection', in A. Sarris (ed.), *Best Practices of Geoinformatic Technologies for the Mapping of Archaeolandscape*, 13–24, Oxford: Archaeopress.
- Manca, R., L. Pagliantini, E. Pecchioni, A. P. Santo, F. Cambi, L. Chiarantini, A. Corretti, P. Costagliola, A. Orlando and M. Benvenuti (2016), 'The Island of Elba (Tuscany, Italy) at the Crossroads of Ancient Trade Routes: An Archaeometric Investigation of Dolia Defossa from the Archaeological Site of San Giovanni', *Miner Petrol*, 110: 693–711.
- Mangafa, M. and K. Kotsakis (1996), 'A New Method for the Identification of Wild and Cultivated Charred Grape Seeds', *Journal Archaeological Science*, 23: 409–18.
- Mange, M. and T. Bezeczky (2006), 'Petrography and Provenance of Laecanius Amphorae from Istria, Northern Adriatic Region, Croatia', *Geoarchaeology*, 21 (5): 429–60.
- Manning, J. G. (2018), *The Open Sea: The Economic Life of the Ancient Mediterranean World from the Iron Age to the Rise of Rome*, Princeton and Oxford: Princeton University Press.
- Manzi, L. (1883), *La Viticoltura e l'Enologia presso I Romani*, Rome: Quasar.
- Manzoni, L. (1965), 'Esame istologico dei reperti di fusti di vite a Torcello', *Memorie di Biogeografia Adriatica*, 6: 147–56.
- Marcello, A. (1965), 'Testimonianze di una antica ortofrutticoltura nell'isola di Torcello', *Memorie di Biogeografia Adriatica*, 6: 111–45.
- Marchesini, M. (1998), *Il paesaggio vegetale nella pianura Bolognese in età romana sulla base di analisi archeopalinologiche ed archeocarpologiche*, PhD thesis, Università degli Studi di Firenze.
- Marchesini, M. and L. Forlani (2002), 'I legni del pozzo di Cognento (Modena) dal periodo tardo romano all'età moderna', *Archeologia dell'Emilia Romagna*, 3: 229–42.
- Marchesini, M., L. Forlani and N. Giordani (1998), 'Reperti antraco/xilologici del pozzo di Rubiera (53 m s.l.m., Reggio Emilia-Nord Italia): età tardo antica; fine VI-metà VII sec. d.C.' in *Studi in ricordo di Daria Bertolani Marchetti: Atti della Giornata di Studi, Formigine, 18 maggio 1996*, 375–83.

Bibliography

- Marchesini, M. and S. Marvelli (2010), 'Ricostruzione del paesaggio vegetale e antropico nelle aree centuriate dell'Emilia Romagna attraverso le indagini archeobotaniche: Sistemi e opere di assetto agrario tra età romana primo medioevo', *Agri Centuriati: An International Journal of Landscape Archaeology*, 6: 313–23.
- Marchesini, M. and S. Marvelli (2017), 'Paesaggio vegetale e agricoltura nella pianura padana in età romana', in E. Lo Cascio and M. Maiuro (eds), *Popolazione e risorse nell'Italia del nord dalla romanizzazione ai longobardi*, 289–304, Roma; Bari: Edipuglia.
- Marchesini, M., S. Marvelli and E. Rizzoli (2021), 'La diffusione della viticoltura nell'età del bronzo in Italia', in I. Damiani, A. Cazzella and V. Copat (eds), *Studi di Preistoria e Protostoria – 6, Preistoria del cibo: L'alimentazione nella preistoria e nella protostoria*, 535–42, Firenze.
- Marchesini, M., A. C. Muscogiuri, E. Rizzoli and S. Marvelli (forthcoming), 'Paesaggio e alimentazione: il contributo delle analisi archeobotaniche', in P. Basso, G. Falezza, M. Migliavacca and F. Saggioro (eds), *Veronensium mensa: Food and Wine in Ancient Verona*, Rome: Quasar.
- Marcone, A. (1997), *Storia dell'agricoltura romana*, Rome: Nuova Italia Scientifiche.
- Marengo, S. M. (2002), 'Laterizi con marchio C. HER. DIOG', in G. Paci (ed.), *Antiqua Frustula, Macerata*, 116, no. 17, Pollenza: Tipografia S. Giuseppe.
- Marescalchi, A. and G. Dalmaso (1931), *Storia della Vite e del Vino in Italia*, Milan: Editrice Unione Italiana Vini.
- Marinval, P., D. Maréchal and D. Labadie (2002), 'Arbres fruitiers et cultures jardinées gallo-romains à Longueil-Sainte-Marie (Oise)', *Gallia*, 59: 253–71.
- Mariotti Lippi, M., M. Guido, B. I. Menozzi, C. Bellini and C. Montanari (2007), 'The Massaciuccoli Holocene Pollen Sequence and the Vegetation History of the Coastal Plains by the Mar Ligure (Tuscany and Liguria, Italy)', *Vegetation History and Archaeobotany*, 16 (4): 267–77.
- Mariotti Lippi, M., M. Mori Secci and C. Bellini (2012), 'L'archeobotanica e lo studio della vite nella preistoria della Toscana', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della vite e del vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 119–24, Borgo San Lorenzo: All'Insegna del Giglio.
- Mariottini, V. and F. Salvadori (2012), 'Archeologia dell'alimentazione, dallo scavo open air allo studio dei reperti mobili, riflessioni metodologiche', in Redi F. and A. Forgione (eds), *VI Congresso Nazionale di Archeologia Medievale: Atti del convegno, L'Aquila, 12–15 settembre 2002*, 69–72, Firenze.
- Marlière, E. (2001), 'Le tonneau en Gaule romaine', *Gallia*, 58: 181–201.
- Marlière, E. (2002), *Loutre et le tonneau dans l'Occident romain*, Montagnac: Editions Mergol.
- Marlière, E. and J. Costa (2005), 'Tonneaux et amphores a Vindolanda: contribution à la connaissance de l'approvisionnement des troupes stationnées sur le mur d'Hadrien (II)', in A. Birley and J. Blacke (eds), *Vindolanda: The Excavations of 2003–2004*, 214–36, Durham: Vindolanda Trust.
- Marret, F., J. O'Keefe, P. Osterloff, M. Pound and L. Shumilovskikh, eds (2021), *Applications of Non-Pollen Palynomorphs: From Palaeoenvironmental Reconstructions to Biostratigraphy*, Geological Society Special Publication 511, London: Geological Society of London.
- Marsh, E. J. and J. R. Ferguson (2010), 'Introduction', in J. R. Ferguson (ed.), *Designing Experimental Research in Archaeology: Examining Technology Through Production and Use*, 1–12, Boulder: University of Colorado.
- Marston, J. M., C. Warinner and J. D'Alpoim Guedes (2014), *Method and Theory in Paleoethnobotany*, Boulder: University of Colorado.
- Martín, R. (1971), *Recherches sur les agronomes latins et leurs conceptions économiques et sociales*, Paris: Société d'édition les belles lettres.
- Martín i Oliveras, A. (2013), 'The CELLA VINARIA Project and Archaeological Park (Teià, Maresme, Barcelona): A Great Experimental Archaeology Laboratory', in F. W. F. Foulds (ed.), *Experimental Archaeology and Theory: Recent Approaches to Archaeological Hypotheses*, 67–100, Oxford: Oxbow Books.

- Martín i Oliveras, A. (2015a), 'Arqueología del Vino en Época Romana: Teoría económica, lógica productiva y comercial aplicada al envasado, la expedición, el transporte y la distribución de ánforas vinarias del nordeste peninsular (s. I a.C.-I d.C.)', in V. Martínez Ferreras (ed.), *La difusión Comercial de las Ánforas Vinarias de Hispania Citerior Tarraconensis (s.I aC-I dC)*, Roman Archaeology 4, 19–38, Oxford: Archaeopress.
- Martín i Oliveras, A. (2015b), *Arqueologia del vi a l'època romana. Del cultiu al consum: Marc teòric i epistemològic*, Premi d'Arqueologia Memorial Josep Barberà i Farràs (12a edició), Barcelona: Societat Catalana d'Arqueologia.
- Martín i Oliveras, A. (2016), 'Aspectos transversales de lógica económica, productiva y comercial aplicada al envasado, la expedición, el transporte y la distribución de ánforas vinarias del nordeste peninsular (siglos I a.C. - III d.C.): Algunas reflexiones', in R. Járrega and P. Berni (eds), *Amphorae ex Hispania: paisajes de producción y consumo. Actas del III Congreso de la SECAH-Sociedad de Estudios de Cerámica Antigua-Ex Officina Hispana, celebrado en Tarragona el 10–13 de diciembre de 2014*, 34–54, Tarragona: Institut Català d'Arqueologia Clàssica.
- Martín i Oliveras, A. and F. Bayés (2009), 'Cella Vinaria de Vallmora (Teià-Maresme-Barcelona): Estudi per la reconstrucció de dues premses romanes', in M. Prevosti and A. Martín i Oliveras (eds), *El vi tarraconense i laietà: ahir i avui, Actes del Simposium, Tarragona-Teià 2007*, 215–48, Tarragona: Institut Català d'Arqueologia.
- Martín i Oliveras, A., D. Martín-Arroyo Sánchez and V. Revilla Calvo (2017), 'The Wine Economy in Roman Hispania: Archaeological Data and Modellization', in J. Remesal Rodríguez (ed.), *The Roman Economy: New Perspectives*, 189–237, Barcelona: University of Barcelona.
- Martín i Oliveras, A. and B. Parés (2020), 'Modelización 3D de un *dolium* romano a partir de técnicas combinadas de metrología dimensional y fotogrametría digital', in V. Revilla, A. Aguilera, L.L. Pons and M. García (eds), *Ex Baetica Romam': homenaje a José Remesal Rodríguez*, 947–74, Barcelona: Universitat de Barcelona.
- Martín i Oliveras, A. and V. Revilla (2019), 'The Economy of Laetanian Wine: A Conceptual Framework to Analyse an Intensive/Specialized Winegrowing Production System and Trade (First Century BC to Third Century AD)', in P. Verhagen, J. Joyce and M. Groenhuijzen (eds), *Finding the Limits of the Limes*, 129–63, Cham: Springer.
- Martín i Oliveras, A. and V. Revilla (2020), 'Quantifying Laetanian Roman Wine Production Function (1st century BC–3rd century AD): A Microeconomic Approach to Calculating Vineyard's Crop and Winemaking Processing Facilities Yields', in A. Marzano (ed.), *Archaeology and Economy in the Ancient World 17: Villas, Peasant Agriculture, and the Roman Rural Economy. Proceedings of the 19th International Congress of Classical Archaeology, Panel 3.15*, 89–112, Cologne–Bonn: Propylaeum.
- Martín i Oliveras, A., V. Revilla, C. Carreras and J. Remesal (2020), 'Viticulture and Demography in the Laetanian Region (Hispania Citerior Tarraconensis), 1st c. BC – 3rd c. AD', in D. Van Limbergen, S. Maréchal and W. De Clercq (eds), *The Resilience of the Roman Empire: Regional Case Studies on the Relationship between Population and Food Resources*, BAR International Series 3000, 47–69, Oxford: BAR.
- Martín-Arroyo, D. and J. Remesal (2018), 'Modelado GIS de la agricultura romana en un marco colonial teórico. Vegetación de ribera y viticultura en Hasta Regia', *SPAL*, 27 (1): 211–35.
- Mathieu, J. R. (2002), 'Introduction', in J. R. Mathieu (ed.), *Experimental Archaeology: Replicating Past Objects, Behaviours and Processes*, 1–12, Oxford: Archaeopress.
- Maune, S. (2003), 'La villa gallo-romaine de "Vareilles" à Paulhan (Hérault; fouille de l'autoroute A75). Un centre domanial du Haut-Empire spécialisé dans la viticulture?', *Revue archéologique de Picardie*, 1 (1): 309–37.
- Marvelli, S. (1999), 'Testimonianze archeobotaniche: Reperti di vite in Emilia-Romagna', in M. Marchesini, S. Marvelli and P. Pancaldi (eds), *La vite maritata: Storia, cultura, coltivazione, ecologia della piantata nella pianura padana*, 35–50, San Giovanni in Persiceto: Comune di S. Giovanni in Persiceto.

Bibliography

- Marvelli, S., S. De Siena, E. Rizzoli and M. Marchesini (2013), 'The Origin of Grapevine Cultivation in Italy: The Archaeobotanical Evidence', *Annali di Botanica*, 3: 155–63.
- Marzano, A. (2007), *Roman Villas in Central Italy: A Social and Economic History*, Boston: Brill.
- Marzano, A. (2013), 'Agricultural Production in the Hinterland of Rome: Wine and Olive Oil', in A. Bowman and A. Wilson (eds), *The Roman Agricultural Economy: Organisation, Investment, and Production*, 85–106, Oxford: Oxford University Press.
- Matijašić, R. (1993), 'Oil and Wine Production in Istria and Dalmatia in Classical Antiquity and the Early Middle Ages', in M.-C. Amouretti and J.-P. Brun (eds), *La production du vin et de l'huile en Méditerranée*, 247–61, BCH Supp. XXVI, Athens: École Française d'Athènes.
- Matijašić, R. (1998), *Gospodarstvo antičke Istre*, Pula: Zavičajna naklada 'Zakan Juri'.
- Matijašić, R. and F. Tassaux (2000), 'Liber et Silvanus', in C. Delplace and F. Tassaux (eds), *Les cultes polythéistes dans l'Adriatique romaine*, 65–117, Bordeaux: Ausonius Éditions.
- Matijašić, R. (2007), 'O Nalazu Kasniantičkih Tijesaka u Poreču', *Opuscula Archaeologica*, 31: 265–81.
- Matijašić, R. (2012), 'Le Città Romane Dell'Istria: Nuovi Particolari', in G. de Marinis, G. M. Fabrini, G. Paci, R. Perna and M. Silvestrini (eds), *I processi formativi ed evolutivi della città in area adriatica*, BAR International Series 2419, 445–52, Oxford: BAR.
- Mazzetti, G. (1892), 'Per lo scavo di un nuovo pozzo in Modena: Cenno intorno alla fauna e alla flora del sottosuolo di Modena', in *Atti della Società dei Naturalisti di Modena*, 59–73, Modena.
- McCormick, M., U. Büntgen, M. A. Cane, E. R. Cook, K. Harper, P. J. Huybers, T. Litt, S. W. Manning, P. A. Mayewski, A. F. M. More, K. Nicolussi and W. Tegel (2012), 'Climate Change During and After the Roman Empire: Reconstructing the Past from Scientific and Historical Evidence', *Journal of Interdisciplinary History*, 43 (2): 169–220.
- McDermott, F. (2004), 'Palaeo-climate Reconstruction from Stable Isotope Variations in Speleothems: A Review', *Quaternary Science Reviews*, 23: 901–18.
- McDermott, F., H. Schwarcz and P. J. Rowe, (2005), 'Isotopes in Speleothems', in M. J. Leng (ed.), *Isotopes in Paleoenvironmental Research*, 186–226, Dordrecht: Springer.
- McGovern, P. E. (1995), 'Science in Archaeology: A Review', *American Journal of Archaeology*, 99: 79–142.
- McGovern, P. E. and H. M. Rudolph (1996), 'The Analytical and Archaeological Challenge of Detecting Ancient Wine: Two Case Studies from the Ancient Near East', in P. E. McGovern, S. J. Fleming and S. H. Katz (eds), *The Origins and Ancient History of Wine*, 57–67, New York.
- McGovern, P. E. (2001), 'The Origins of the Tomb U-j Syro-Palestinian Type Jars as Determined by Neutron Activation Analysis', in U. Hartung (ed.), *Umm El-Qaab II: Importkeramik aus dem Friedhof U in Abydos (Umm el-Qaab) und die Beziehungen Ägyptens zu Vorderasien im 4. Jahrtausend v. Chr.*, Archäologische Veröffentlichungen 92, 407–16, Mainz: P. von Zabern.
- McGovern, P. E. (2003), *Ancient Wine: The Search for The Origins of Viniculture*, Princeton: Princeton University Press.
- McGovern, P. E. (2004), *L'archeologo e l'uva*, Rome: Carocci.
- McGovern, P. E. (2009), *Uncorking the Past: The Quest for Wine, Beer, and Other Alcoholic Beverages*, Berkeley: University of California.
- McGovern, P. E. (2011), 'Two Luxury Items of the Canaanites and Phoenicians: Royal Purple and Wine', in *Forum II: Ligue des cités Cananéennes, Phéniciennes et Puniques*, 30 October 2009, 184–90, Beirut: Fondation Tyr.
- McGovern, P. E. (2013), 'From East to West: The Ancient Near Eastern "Wine Culture" Travels Land and Sea', in S. Perez and J. Perez (eds), *Patrimonio Cultural de la Vid y el Vino: Vine and Wine Cultural Heritage*, 233–41, Madrid: Universidad Autónoma de Madrid.
- McGovern, P. E. (2017a), *Ancient Brews Rediscovered and Re-created*, New York: W.W. Norton.
- McGovern, P. E. (2019a), *Ancient Wine: The Search for the Origins of Viniculture* (with updated Afterword), Princeton: Princeton University Press.

- McGovern, P. E. (2019c), 'Uncorking the Past: Alcoholic Fermentation as Humankind's First Biotechnology', in K. Hockings and R. I. M. Dunbar (eds), *Alcohol and Humans: A Long and Social Affair*, 81–92, Oxford: Oxford University Press.
- McGovern, P. E. (2022), 'Vessel Contents as Revealed by Organic Residue Analysis: The Scorpion I Tomb as a Case Study', in R. David (ed.), *Concise Manual for Ceramic Studies / الفخار لدراسات موجز دليل from the Nile Valley to the Middle East*, 109–13, Paris: Soleb.
- McGovern, P. E., M. P. Callahan, G. R. Hall, W. C. Petersen, D. Cavalieri, D. L. Hartl, O. Jáuregui and R. M. Lamuela-Raventós (2021), 'A Response to Léa Drieu et al., 2020, "Is it possible to identify ancient wine production using biomolecular approaches?"' *STAR: Science & Technology of Archaeological Research*, 7: 43–48.
- McGovern, P. E. and G. R. Hall (2015), 'Charting a Future Course for Organic Residue Analysis in Archaeology', *Journal of Archaeological Method and Theory*, 23: 592–622.
- McGovern, P. E., M. Jalabadze, S. Batiuk, M. P. Callahan, K. E. Smith, G. R. Hall, E. Kvavadze, D. Maghradze, N. Rusishvili, L. Bouby, O. Failla, G. Cola, L. Mariani, E. Boaretto, R. Bacilieri, P. This, N. Wales and D. Lordkipanidze (2017), 'Early Neolithic Wine of Georgia in the South Caucasus', *The Proceedings of the National Academy of Sciences USA*, 114: E10309–E10318.
- McGovern, P. E., B. P. Luley, N. Rovira, A. Mirzoian, M. P. Callahan, K. E. Smith, G. R. Hall, T. Davidson and J. M. Henkin (2013), 'Beginning of Viniculture in France', *The Proceedings of the National Academy of Sciences USA*, 110: 10147–52.
- McGovern, P. E., A. Mirzoian and G. R. Hall (2009), 'Ancient Egyptian Herbal Wines', *The Proceedings of the National Academy of Sciences USA*, 106: 7361–6.
- McGovern, P. E., S. J. Fleming and S. H. Katz, eds (1996), *The Origins and Ancient History of Wine*, Amsterdam: Routledge.
- McGovern, P. E., J. Zhang, J. Tang, Z. Zhang, G. R. Hall, R. A. Moreau, A. Nuñez, E. D. Butrym, M. P. Richards, C. S. Wang, G. Cheng, Z. Zhao and C. Wang (2004), 'Fermented Beverages of Pre- and Proto-Historic China', *Proceedings of the National Academy of Sciences USA*, 101: 17593–8.
- McLean, A. and X. Rubio-Campillo (2022), 'Beyond Least Cost Paths: Circuit Theory, Maritime Mobility and Patterns of Urbanism in the Roman Adriatic', *Journal of Archaeological Science*, 138: 105534. <https://doi.org/10.1016/j.jas.2021.105534>.
- Meadows, I. (1996), 'Wollaston: The Nene Valley, a British Moselle?', *Current Archaeology*, 150: 212–15.
- Menotti, E. M. (1999), *Archeologia dal territorio mantovano*, Catalogo della mostra, Mantova.
- Menozi, B. I., A. Fichera, M. A. Guido, M. Mariotti Lippi, C. Montanari, G. Zanchetta, F. P. Bonadonna and F. Garbari (2002), 'Lineamenti paleoambientali del bacino del Lago di Massaciuccoli (Toscana nord-occidentale)', *Atti della Società Toscana di Scienze Naturali Serie B*, 109: 177–87.
- Mentzer, S. M., D. G. Romano and M. E. Voyatzis (2017), 'Micromorphological Contributions to the Study of Ritual Behavior at the Ash Altar to Zeus on Mt. Lykaion, Greece', *Archaeological Anthropological Sciences*, 9: 1017–43.
- Mercati, F., G. De Lorenzis, A. Mauceri, M. Zerbo, L. Brancadoro, C. D'Onofrio, C. Morcia, M. G. Barbagallo, C. Bignami, M. Gardiman, L. de Palma, P. Ruffa, V. Novello, M. Crespan and F. Sunseri (2021), 'Integrated Bayesian Approaches Shed Light on the Dissemination Routes of the Eurasian Grapevine Germplasm', *Frontiers in Plant Science*, 5, August 2021.
- Mercuri, A. M. (2014), 'Genesis and Evolution of the Cultural Landscape in Central Mediterranean: The "Where, When and How" Through the Palynological Approach', *Landscape Ecology*, 29: 1799–1810.
- Mercuri, A. M., C. A. Accorsi, M. Bandini Mazzanti, G. Bosi, A. Cardarelli, D. Labate, M. Marchesini and G. T. Grandi (2006), 'Economy and Environment of Bronze Age Settlements – Terramaras – in the Po Plain (Northern Italy): First Results of the Archaeobotanical Research at the Terramara di Montale', *Vegetation History and Archaeobotany*, 16: 43–60.

Bibliography

- Mercuri, A. M., C. A. Accorsi, M. Bandini Mazzanti, P. Bigi, G. Bottazzi, G. Bosi, M. Marchesini, M. C. Montecchi and D. Pedini (2009), 'From the "Treasure of Domagnano" to the Archaeobotany of a Roman and Gothic Settlement in the Republic of San Marino', in J.-P. Morel and A. M. Mercuri (eds), *Plants and Culture: Seeds of the Cultural Heritage of Europe*, 69–91, Bari: Edipuglia.
- Mercuri, A. M., P. Torri, A. Florenzano, E. Clò, M. Mariotti Lippi, E. Sgarbi and C. Bignami (2021), 'Sharing the Agrarian Knowledge with Archaeology: First Evidence of the Dimorphism of Vitis Pollen from the Middle Bronze Age of N Italy (Terramara Santa Rosa di Poviglio)', *Sustainability*, 13 (4): 2287.
- Mezquiriz, M. Á. (2004), 'La producción de vino en época romana a través de los hallazgos en territorio navarro', *Trabajos de Arqueología de Navarra*, 17: 133–60.
- Middleton, R. and M. J. Bunting (2004), 'Mosaic v1.1: Landscape Scenario Creation Software for Simulation of Pollen Dispersal and Deposition', *Review of Palaeobotany and Palynology*, 132: 61–6.
- Middleton, W. D., L. Barba, A. Pecci, J. H. Burton, A. Ortiz, L. Salvini and R. Rodriguez-Suárez (2010), 'The Study of Archaeological Floors: Methodological Proposal for the Analysis of Anthropogenic Residues by Spot Tests, ICP-OES, and GC-MS', *Journal of Archaeological Method and Theory*, 17: 183–208.
- Milanesi, C., F. Antonucci, P. Menesatti, C. Costa, C. Faleri and M. Cresti (2011), 'Morphology and Molecular Analysis of Ancient Grape Seeds', *Interdisciplinaria Archaeologica*, 2: 95–100.
- Mille, P. and Ph. Rollet (2020), 'Étude de trois grands tonneaux mis au jour à Reims/Durocortorum (Marne): le savoir-faire des tonneliers antique', *Gallia: Archéologie de la France antique*, 77 (2): 123–55.
- Miniero, P. (1991–2), 'Stabiae. Attività dell'ufficio Scavi 1991', *RStPom*, 5: 221–8.
- Montana, G., L. Randazzo, D. Barca and M. Carroll (2021), 'Archaeometric Analysis of Building Materials and Dolia Defossa from the Roman Imperial Estate of Vagnari', *Journal of Archaeological Science: Reports*, 38: 103057.
- Moore, P. D., J. A. Webb and M. E. Collinson (1991), *Pollen Analysis*, 2nd edn, London: Blackwell Scientific.
- Mori Secci, M. (2005), 'Archeobotanica della vite', in A. Ciacchi and A. Zifferero (eds), *VINUM: Un progetto per il riconoscimento della vite silvestre nel paesaggio archeologico della Toscana e del Lazio settentrionale*, 67–74, Siena: Ci.Vin.
- Moricca, C., L. Bouby, V. Bonhomme, S. Ivorra, G. Pérez-Jordà, L. Nigro, F. Spagnoli, L. Peña-Chocarro, P. Van Dommelen and L. Sadori (2021), 'Grapes and Vines of the Phoenicians: Morphometric Analyses of Pips from Modern Varieties and Iron Age Archaeological Sites in the Western Mediterranean', *Journal of Archaeological Science: Reports*, 37: 102991.
- Morris, D. (2017), *The Naked Ape: A Zoologist's Study of the Human Animal*, first published 1967, London: Jonathan Cape Publishing.
- Motta, L. and K. Beydler (2020), 'Agriculture in Iron Age and Archaic Italy', in D. Hollander and T. Howe (eds), *A Companion to Ancient Agriculture*, 399–415, Hoboken: John Wiley & Sons.
- Mulholland, S. C. and G. Rapp Jr (1992), 'Phytolith Systematics: An Introduction', in G. Rapp Jr. and S. C. Mulholland (eds), *Phytolith Systematics: Emerging Issues*, 1–14, New York: Plenum Press.
- Musti, D. (2005), *Il Simposio nel suo sviluppo storico*, Roma; Bari: Laterza.
- Myles, S., A. R. Boyko, C. L. Owens, P. J. Brown, F. Grassi, M. K. Aradhya, B. Prins, A. Reynolds, J. M. Chia, D. Ware, C. D. Bustamante and E. S. Buckler (2011), 'Genetic Structure and Domestication History of the Grape', *PNAS*, 108: 3530–5.
- Naqinezhad, A., R. Ramezani, M. Djamali, A. Schnitzler and C. Arnold (2018), 'Wild Grapevine (*Vitis vinifera* subsp. *Sylvestris*) in the Hyrcanian Relict Forests of Northern Iran: An Overview of Current Taxonomy, Ecology and Paleorecords', *Journal of Forestry Research*, 29: 1757–68.

- Naso, A. (2012), 'Sui primi contatti dell'Etruria con il mondo greco', in A. Mandolesi and M. Sannibale (eds), *Etruschi: L'ideale eroico e il vino lucente* (Catalogo della Mostra, Asti 2012), 48–55, Milan: Electa.
- Naveh, Z. and J. Dan (1973), 'The Human Degradation of Mediterranean Landscapes in Israel', in F. Di Castri and H. A. Mooney (eds), *Mediterranean Type Ecosystems*, 373–90, Berlin: Springer.
- Nencini, P. (2009), *Ubbriachezza e sobrietà nel mondo antico: Alle radici del bere moderno*, Milano: GEM Edizioni.
- Nesbitt, A., S. Dorling and A. Lovett (2018), 'A Suitability Model for Viticulture in England and Wales: Opportunities for Investment, Sector Growth and Increased Climate Resilience', *Journal of Land Use Science*, 13 (4): 414–38.
- Notarstefano, F. (2012), *Ceramica e alimentazione: L'analisi chimica dei residui organici nelle ceramiche applicata ai contesti archeologici*, Quaderno 10, Bari: B.A.C.T.
- Nowak, A. (2018), 'Symmetry Park, Bicester', *Oxfordshire Archaeological Recording Action; Phase 2*, Report No. MK 141/18.
- Odiot, T. (1984), 'Un grand domaine viticole à Donzère (Drôme)', in *Archéologie en Rhône-Alpes: Protohistoire et monde galloromaine: dix ans de recherches. Catalogue de l'exposition* (Lyon 1983–1984), 28–9, Lyon.
- OPEL IV (2002), *Onomasticon Provinciarum Europae Latinarum (OPEL) 4*, Quadrata-Zures, Wien: Forschungsgesellschaft Wiener Stadtarchäologie.
- Orengo, H. A., F. C. Conesa, A. Garcia-Molsosa, A. Lobo, A. S. Green, M. Madella and C. A. Petrie (2020), 'Automated Detection of Archaeological Mounds using Machine-Learning Classification of Multisensor and Multitemporal Satellite Data', *Proceedings of the National Academy of Sciences*, 117 (31): 18240–50.
- Orfila, M., A. Rodríguez-Antón, E. Chávez-Álvarez, A. C. González-García and J. A. Belmonte (2020), 'Determinación de orientaciones de ciudades romanas por medio de la "varatio" / Orientation layout of Roman towns by using the "varatio"', *Archivo Español de Arqueología*, 93: 127–46.
- Orrù, M., O. Grillo, G. Lovicu, G. Venora and G. Bachetta (2013), 'Morphological Characterization of Vitis vinifera L. Seeds by Image Analysis and Comparison with Archaeological Remains', *Vegetation History and Archaeobotany*, 22: 231–42.
- Orsingher, A., S. Amicone, J. Kamlah, H. Sader H. and C. Berthold (2020), 'Phoenician Lime for Phoenician Wine: Iron Age Plaster from a Wine Press at Tell el-Burak, Lebanon', *Antiquity*, 94: 1224–44.
- Paci, G. (2009), 'Una Nuova Testimonianza sul Consumo di Olive Picene in Ambito Renano', *Picus*, 29: 179–86.
- Paci, G. and R. Perna (2016), 'Una villa romana nel territorio di Pollentia-Urbs Salvia: note preliminari sulle indagini archeologiche condotte presso Villamagna (Urbsaglia-MC)', *The Journal of Fasti Online*, 371: 1–14.
- Pagnoux, C., L. Bouby, S. Ivorra, C. Petit, S.-M. Valamoti and J.-F. Terral (2015), 'Inferring the Ancient Grapevine (Vitis Vinifera L.) Agrobiodiversity in Greece by a Comparative Shape Analysis of Archaeological and Modern Seeds', *Vegetation History and Archaeobotany*, 24: 75–84.
- Pagnoux, C., L. Bouby, S.-M. Valamoti, V. Bonhomme, S. Ivorra, E. Gkatzogia, A. Karathanou, D. Kotsachristou, H. Kroll and J.-F. Terral (2021), 'Local Domestication or Diffusion? Insights into Viticulture in Greece from Neolithic to Archaic Times, using Geometric Morphometric Analyses of Archaeological Grape Seeds', *Journal of Archaeological Science*, 125: 105263.
- Palet, J. M. (1997), *Estudi territorial del Pla de Barcelona. Estructuració i evolució del territori entre l'època iberoromana i l'altmedieval segles II-I aC. / X-XI dC.*, Estudis i Memòries d'Arqueologia de Barcelona 1, Barcelona.
- Palet, J. M., Fiz, J. I. and H. A. Orengo (2009), 'Centuriació i estructuració del l'ager de la colònia Barcino: anàlisi arqueomorfològica i modelació del paisatge', *Quaderns d'Història i Arqueologia de la Ciutat de Barcelona*, 5: 103–26.

Bibliography

- Palet, J. M., Orenco H. A. and S. Riera (2010), 'Centuriación del territorio y modelación del paisaje en los llanos litorales de Barcino (Barcelona) y Tarraco (Tarragona): Una investigación interdisciplinar a través de la integración de datos arqueomorfológicos y paleoambientales', *Agri Centuriati: An International Journal of Landscape Archaeology*, 7: 113–29.
- Palet, J. M., Orenco H. A. and S. Riera (2011), 'Centuriación del territorio y modelación del paisaje en los llanos litorales de Barcino y Tarraco: Una investigación interdisciplinar a través de la integración de datos arqueomorfológicos y paleoambientales', in P. L. Dall'aglio and G. Rosada (eds), *Sistemi Centuriali e Opere di Assetto Agrario tra Età Romana e primo Medioevo: Atti del convegno borgoricco (Padova)-Lugo (Ravenna) 10–12 Settembre 2009*, 113–29, Pisa: Fabrizio Serra.
- Palet, J. M., M. J. Ortega and C. Miró (2021), 'The Territory of Roman Barcino: Methodological Advances Applied to the Study of a Centuriated Landscape', in M. Prevosti and J. Guitart (eds), *Proceedings of the 1st TIR-FOR Symposium: From Territory Studies to Digital Cartography*, 173–88, Barcelona.
- Panella, C. (1989), 'Le anfore italiche del II sec. d.C.', in *Amphores romaines et histoire économique: dix ans de recherche: Actes du Colloque de Sienne (22–24 mai 1986)*, 139–78, Rome: École Française de Rome.
- Parducci, L., K. Bennett, G. F. Ficetola, I. G. Alsos, Y. Suyama, J. Wood and M. Winther Pedersen (2017), 'Ancient Plant DNA in Lake Sediments', *New Phytologist*, 214: 924–42.
- Parker, A. J. (1990), 'The Wines of Roman Italy', *JRA*, 3: 325–31.
- Parker, A. J. (1992a), *Ancient Shipwrecks of the Mediterranean and the Roman Provinces*, Oxford: BAR.
- Parker, A. J. (1992b), 'Cargoes, Containers and Stowage: The Ancient Mediterranean', *IJNA*, 21: 89–100.
- Parker, A. J. (1996), 'Sea Transport and Trade in the Ancient Mediterranean', in E. E. Rice (ed.), *The Sea and History*, 97–109, Stroud: Sutton.
- Parker, R. M. (2008), *Wine Buyers Guide*, 7th edn, New York: Simon and Schuster.
- Parsons, R. W. and I. C. Prentice (1981), 'Statistical Approaches to R-values and the Pollen Vegetation Relationship', *Rev Palaeobot Palynol*, 32: 127–52.
- Pasqui, A. (1897), 'La villa pompeiana della Pissanella presso Boscoreale', *MonAL*, 7: 397–554.
- Pasquinucci, M. and S. Menchelli (2017), 'Rural, Urban and Suburban Communities and their Economic Interconnectivity in Coastal North Etruria (2nd Century BC–2nd Century AD)', in T. de Haas and G. Tol (eds), *The Economic Integration of Roman Italy*, 322–41, London: Brill.
- Peacock, D. P. S. and D. F. Williams (1986), *Amphorae and the Roman Economy: An Introductory Guide*, London: Longman.
- Pearsall, D. M. and D. R. Piperno, eds (1993), *Current Research in Phytolith Analysis: Applications in Archaeology and Paleocology*, MASCA Research Papers in Science and Archaeology, Vol. 10, Philadelphia: University of Pennsylvania.
- Pecci, A. (2005), 'Per una definizione funzionale degli spazi e delle ceramiche all'interno degli insediamenti in corso di scavo: un progetto archeometrico', unpublished PhD thesis in Medieval Archaeology, University of Siena.
- Pecci, A. (2007), 'Potenzialità delle analisi chimiche applicate all'archeologia dei consumi alimentari: un bilancio delle conoscenze', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della vite e del vino in Etruria*, 123–31, Siena: Ci.Vin.
- Pecci, A. (2009), 'Analisi funzionali della ceramica e alimentazione medievale', *Archeologia Medievale*, 36: 21–42.
- Pecci, A. (2013), 'Almost Ten Years of Plasters Residue Analysis in Italy: Activity Areas and the Function of Structures', *Periodico di Mineralogia*, 82 (3): 393–410.
- Pecci, A. (2016), 'Appendice: Analisi dei residui in tre dolia rinvenuti nella UT 88', in G. Cordiano (ed.), *Carta archeologica del litorale ionico aspromontano*, 163–6, Pisa: Edizioni Ets.

- Pecci, A. (2018), 'Analisi dei residui organici nelle ceramiche: Contenuti, rivestimenti, uso e funzione', in M. Giorgio (ed.), *Storie [di] Ceramiche 4: Ceramiche e Archeometria*, 13–20, Firenze: All'Insegna del Giglio.
- Pecci, A. (2018–19), 'La Producción y consumo de vino a través del análisis de residuos químicos en materiales arqueológicos', *Tribuna d'Arqueologia*, 1130–7781: 322–33.
- Pecci, A. (2019), 'The Life Cycle of Wine: Examples from the Bronze Age to the Middle Ages on the Italian Peninsula', in P. Stockhammer and J. Fries-Knoblach (eds), *Was Trankt die Frühen Kelten? Bedeutungen und Funktionen mediterraner Importe im früheisenzeitlichen Mitteleuropa (BEFIM 1)*, 203–9, Leiden: Sidestone Press.
- Pecci, A., E. Borgna, S. Mileto, E. Dalla Longa, G. Bosi, A. Florenzano, A. M. Mercuri, S. Corazza, M. Marchesini and M. Vidale (2020), 'Wine Consumption in Bronze Age Italy: Combining Organic Residue Analysis, Botanical Data and Ceramic Variability', *Journal of Archaeological Science*, 123: 105256.
- Pecci, A. and M. Á. Cau (2010), 'Análisis de residuos orgánicos en ánforas. El problema de la resina y del aceite', in J. M. Blázquez and J. Remesal J. (eds), *Estudios sobre el Monte Testaccio (Roma) V*, Instrumenta 35, 593–600, Barcelona: Universitat de Barcelona.
- Pecci, A., M. Á. Cau and N. Garnier (2013), 'Identifying Wine and Oil Production: Analysis of Residues from Roman and Late Antique Plastered Vats', *Journal of Archaeological Science*, 40 (12): 4491–8.
- Pecci, A., J. Clarke, M. Thomas, J. Muslin, I. van der Graaff, L. Toniolo, D. Miriello, G. M. Crisci, M. Buonincontri and G. Di Pasquale (2017), 'Use and Reuse of Amphorae. Wine Residues in Dressel 2–4 Amphorae from Oplontis Villa B (Torre Annunziata, Italy)', *Journal of Archaeological Science: Reports*, 12: 515–21.
- Pecci, A., A. Contino, S. Mileto, L. Toniolo and P. Reynolds (2021b), 'Anfore africane antiche a Pompei: uso e riuso in base all'analisi dei contenuti', *Rivista di Studi Pompeiani*, 32: 87–102.
- Pecci, A., S. Domínguez-Bella, M. Buonincontri, D. Miriello, R. De Luca, G. Di Pasquale, D. Cottica and D. Bernal-Casasola (2018), 'Combining Residue Analysis of Floors and Ceramics for the Study of Activity Areas at the Garum Shop at Pompeii', *Archaeological and Anthropological Sciences*, 10: 485–502.
- Pecci, A. and G. Giorgi (forthcoming), 'L'analisi chimica dei pavimenti e dei contenitori per derrate della cosiddetta Casa delle Anfore – UT 161', in A. Zifferero (ed.), *Materiali per Marsiliana d'Albegna 3. Ricerche nell'area suburbana*.
- Pecci, A., G. Giorgi, L. Salvini and M. Á. Cau Ontiveros (2013), 'Identifying Wine Markers in Ceramics and Plasters Using Gas Chromatography–Mass Spectrometry: Experimental and Archaeological Materials', *JAS*, 40: 109–15.
- Pecci, A., P. Reynolds, S. Mileto, J. M. Vargas Girón and D. Bernal-Casasola (2021a), 'Production and Transport of Goods in the Roman Period: Residue Analysis and Wine Derivatives in Late Republican Baetican Ovoid Amphorae', *Environmental Archaeology*, 1–13. <https://doi.org/10.1080/14614103.2020.1867291>
- Pecci, A., L. Salvini, E. Cirelli and A. Augenti (2010), 'Castor Oil at Classe (Ravenna, Italy): Residue Analysis of some Late Roman Amphorae coming from the Port', in S. Menchelli, S. Santoro, M. Pasquinucci and G. Guiducci (eds), *LRCW3: Late Roman Coarse Wares, Cooking Wares and Amphorae in the Mediterranean. Archaeology and Archaeometry*, 617–22, BAR International Series 2185, Oxford: BAR.
- Pecci, A., M. Vidale, S. Mileto, S. Bergamini and M. Cupitò (2021), 'Il primo bicchiere non si scorda mai', *Archeo: Attualità del Passato*, 439: 106–11.
- Peña Cervantes, Y. (2010), *Torcularia: la producción de vino y aceite en Hispania*, Documenta 14, Tarragona: ICAC.
- Peña Cervantes, Y. (2020), 'Wine Making in the Iberian Peninsula During the Roman Period: Archaeology, Archaeobotany and Biochemical Analysis', in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of*

Bibliography

- Amphorae: Some New Data from Italy. Panel 3.5, Archaeology and Economy in the Ancient World 9*, 73–81, Heidelberg: Propylaeum.
- Peña Cervantes, Y. (2023), *De tornos y tornillos: Tecnologías de prensado de la uva y la aceituna en el mundo romano y tardoantiguo*, Granada: Comares.
- Pereira, P. and T. Silvino (2015), 'Chemical Analysis about Roman Wine on the Douro valley – The Site of Prazo (Freixo de Numao, Portugal)', in C. Oliveira, R. Morais and A. Morillo (eds), *Archaeoanalytics: Chromatography and DNA Analysis in Archaeology. International Symposium*, 187–91, Porto: University of Porto.
- Perez-Arantegui, J., J. A. Paz Peralta and E. Ortiz Palomar (1996), 'Analysis of Products Contained in Two Roman Glass Unguentaria from the Colony of Salsa (Spain)', *JAS*, 23: 649–55.
- Pérez-Jordà, G., N. Alonso, N. Rovira, I. Figueiral, D. López-Reyes, P. Marinval, E. Montes, L. Peña-Chocarro, R. Pinaud-Querrac'h, J. Ros, M. Tarongi, M. Tillier and L. Bouby (2021), 'The Emergence of Arboriculture in the 1st Millennium BC along the Mediterranean's "Far West"', *Agronomy*, 11 (5): 1–32.
- Perna, R. (2006), *Urbs Salvia: Forma e Urbanistica*, Rome: L'Erma di Bretschneider.
- Perret, M. (1997), 'Polymorphisme des génotypes sauvages et cultivés de *Vitis vinifera* L. détecté à l'aide de marqueurs RAPD', *Bulletin de la société Neuchâteloise des sciences naturelles*, 120: 45–54.
- Pesavento Mattioli, S. (2003), 'Produzione e commercio del vino: un percorso di ricerca nella Valpolicella di età romana', *Annuario Storico della Valpolicella*, 19: 103–16.
- Pesavento Mattioli, S. and M. Mongardi (2018), 'Anfore Vinarie dalla Cisalpina in età augustea: un aggiornamento su alcune serie bollate', in M. Cavalieri and C. Boschetti (eds), *MVLTA PER AEQUORA. Il polisemico significato della moderna ricerca archeologica: Omaggio a Sara Santoro*, 321–45, Louvain: Presses universitaires de Louvain.
- Pfunter, L. (2017), 'Review of An Urban Geography of the Roman World, 100 BC to AD 300. Archaeopress Roman Archaeology, 18', *Bryn Mawr Classical Review*, 2017.05.12.
- Pignatti, S. (2017–19), *Flora d'Italia*, I–IV, Bologna: Edagricole Calderini.
- Pini, R., C. Ravazzi, R. Comolli, R. Perego, L. Castellano, C. Croci, M. De Amicis, D. A. El Khair, G. Furlanetto and D. Marsetti (2021), 'Life on a Hilltop: Vegetation History, Plant Husbandry and Pastoralism at the Dawn of Bergamo-Bergomum (Northern Italy, 15th to 7th century BC)', *Vegetation History and Archaeobotany*, 30: 525–53.
- Piperno, D. R. (1988), *Phytolith Analysis: An Archaeological and Geological Perspective*, San Diego: Academic Press.
- Piperno, D. R. (2006a), *Phytoliths: A comprehensive guide for archaeologists and paleoecologists*, Lanham: AltaMira Press.
- Piperno, D. R. (2006b), *Phytolith Analysis in Archaeology and Environmental History*, Walnut Grove: AltaMira Press.
- Pinto, G., C. Poni and U. Tucci, eds (2002), *Storia dell'Agricoltura Italiana: Il Medioevo e l'Età Moderna*, Firenze: Edizioni Polistampa.
- Poglajen, S. and T. Zerjal (2007), 'The Potential of Slovenian Istria for Roman Viticulture and Oleoculture', *Histria Antiqua*, 15: 267–80.
- Pollard, A. M. and C. Heron (2008), *Archaeological Chemistry*, Cambridge: Royal Society of Chemistry Publishing.
- Porat, R., Y. Kalman, R. Chachy, S. Terem, R. Bar-Natan, E. Weiss, A. Ecker, T. Ben-Gedalya and E. Drori (2018), 'Herod's Royal Winery and Wine Storage Facility in the Outer Structure of the Mountain Palace-Fortress at Herodium Antiquities', *Qadmoniot*, 156: 106–14.
- Poux, M. (2011), 'Le "vin du Triumvir" à Lyon: Témoignages archéologiques et littéraires d'une production de vin sur le territoire colonial de Lugdunum', *Gallia*, 68 (1): 13–91.
- Poux, M., J.-P. Brun and M.-L. Hervé-Monteil, eds (2011), 'La Vigne et le Vin dans les Trois Gaules', *Gallia*, 68: 1–285.
- Prentice, I. C. (1985), 'Pollen Representation, Source Area, and Basin Size: Toward a Unified Theory of Pollen Analysis', *Quatern Res*, 23: 76–86.

- Prentice, I. C. and R. W. Parsons (1983), 'Maximum Likelihood Linear Calibration of Pollen Spectra in Terms of Forest Composition', *Biometrics*, 39: 1051–7.
- Preston, D., Pearman, D. A. and A. R. Hall (2004), 'Archaeophytes in Britain', *Botanical Journal of the Linnean Society*, 145: 257–94.
- Pullen, J., J. D. Doyle, T. Haack, C. Dorman, R. P. Signell and C. M. Lee (2007), 'Bora Event Variability and the Role of Air-Sea Feedback', *Journal of Geophysical Research*, 112: C03S18.
- Punt, W., A. Marks and P. P. Hoen (2003), 'VITACEAE', *Review of Palaeobotany and Palynology*, 123: 67–70.
- Purcell, N. (1985), 'Wine and Wealth in Ancient Italy', *JRS*, 75: 1–19.
- Purcell, N. (1990), 'Review of: Jongman, the Economy and Society of Pompeii', *The Classical Review*, 40: 111–16.
- Py, M. (1985), 'Les amphores étrusques de Gaule meridionale', in M. Cristofani (ed.), *Il commercio etrusco arcaico: Atti dell'Incontro di Studio, Roma 1983*, 73–94, Rome: Consiglio Nazionale delle Ricerche.
- Raimondi, S., G. Tumino, P. Ruffa, P. Boccacci, G. Gambino and A. Schneider (2020), 'DNA-Based Genealogy Reconstruction of Nebbiolo, Barbera and Other Ancient Grapevine Cultivars from Northwestern Italy', *Scientific Reports*, 10: 1–16.
- Ramón, J. (2010), 'La cerámica fenicia del mediterráneo extremooccidental y del Atlántico (s. VIII – 1R. 1/3 del VI AC)', in L. Nigro (ed.), *Problemas y perspectivas actuales: Motya and the Phoenician Ceramic Repertoire between the Levant and the West 9th–6th Century BC*, 211–53, Rome: Missione Archeologica a Mozia.
- Ramos-Madrigal, J., A. K. Wiborg Runge, L. Bouby, T. Lacombe, J. A. Samaniego Castruita, A.-F. Adam-Blondon, I. Rigueiral, C. Hallavant, J. M. Martínez-Zapater, C. Schaal, R. Töpfer, B. Petersen, T. Sicheritz-Pontén, P. This, R. Bacilieri, M. T. P. Gilbert and N. Wales (2019), 'Paleogenomic Insights into the Origins of French Grapevine Diversity', *Nature Plants*, 5: 595–603.
- Rapp, G. and S. C. Mulholland, eds (1992), *Phytolith Systematics: Emerging Issues*. New York: Plenum.
- Rauh, N. K. (2006), 'The Archaeology of Deforestation in Ancient Rough Cilicia', *ANMED 2006–4 (News of Archaeology from Anatolia's Mediterranean Areas)*, 83–4, Antalya: Suna & Inan Kirac Research Institute on Mediterranean Civilizations.
- Rauh, N. K. (2008), 'The Rough Cilicia Archaeological Survey Project: Paleo-Environmental Research of the 2007 Season', *ANMED 2008–6 (News of Archaeology from Anatolia's Mediterranean Areas)*, 117–19, Antalya: Suna & Inan Kirac Research Institute on Mediterranean Civilizations.
- Rauh, N. K. (2012), 'Dağlık Kilikiya Yüksek Arazi Arkeoloji Araştırması: 2011 Yılı Raporu, 30', *Araştırma Sonuçları Toplantısı*, 30 (2): 223–34.
- Rauh, N. K., M. J. Dillon, C. Dore, R. M. Rothaus and M. Korsholm (2006), 'Viticulture, Oleoculture, and Economic Development in Roman Rough Cilicia', *Münster Beiträge für Antike Handelsgeschichte*, 25: 49–98.
- Ravegnani, G. (2004), *I Bizantini in Italia*, Bologna: Il Mulino.
- Ravenna 2007 = D. Vitali, ed. (2007), *Le fornaci e le anfore di Albinia: Primi dati su produzioni e scambi dalla costa tirrenica al mondo gallico*, *Atti del Seminario Internazionale, Ravenna 2006*, Bologna: Università di Bologna.
- Reill, D. K. (2012), *Nationalists Who Feared the Nation: Adriatic Multi-Nationalism in Habsburg Dalmatia, Trieste, and Venice*, Stanford: Stanford University Press.
- Remola, J. A., J. Lozano, I. Ruisanchez, M. S. Larrechi, F. X. Rius and J. Zupan (1996), 'New Chemometric Tools to Study the Origin of Amphorae Produced in the Roman Empire', *Trend Anal. Chem.*, 15: 137.
- Revilla Calvo, V. (1995), *Producción cerámica, viticultura y propiedad rural en Hispania Tarraconensis (Siglos I a.C. – III d.C.)*, Barcelona: L'Estiquirot-Barcelona.

Bibliography

- Reynolds, J. M. (2011), *An Introduction to Applied and Environmental Geophysics*, 2nd edn, Oxford: Wiley-Blackwell.
- Ribechini, E., F. Modugno, M. P. Colombini and R. P. Evershed (2008a), 'Gas Chromatographic and Mass Spectrometric Investigations of Organic Residues from Roman Glass Unguentaria', *Journal of Chromatography A*, 1182: 158–69.
- Ribechini, E., F. Modugno, C. Baraldi, P. Baraldi and M. P. Colombini (2008b), 'An Integrated Analytical Approach for Characterizing an Organic Residue from an Archaeological Glass Bottle Recovered in Pompeii', *Talanta*, 74 (4): 555–61.
- Rice, P. (1987), *Pottery Analysis*, First Edition, Chicago: University of Chicago Press.
- Rice, C. (2016), 'Mercantile Specialization and Trading Communities: Economic Strategies in Roman Maritime Trade', in A. Wilson and M. Flohr (eds), *Urban Craftsmen and Traders in the Roman World*, 97–114, Oxford: OUP.
- Rinaldi, F. (2003), 'Motivi geometrici e temi figurati nelle pavimentazioni musive della villa romana di Negrar', in A. Buonopane and A. Brugnoli (eds), *La Valpolicella in età romana: Atti del II Convegno (Verona, 11.5.2002)*, 133–60, Verona: Centro di Documentazione per la storia della Valpolicella.
- Rinaldi, R., M. Bandini Mazzanti and G. Bosi (2013), 'Archaeobotany in Urban Sites: The Case of Mutina', *Annali di Botanica*, 3: 217–30.
- Roaf, M. (1992), *Atlante della Mesopotamia e dell'Antico Vicino Oriente*, Milan: De Agostini.
- Robinson, J. (2015), *The Oxford Companion to Wine*, 4th edn, Oxford: Oxford University Press.
- Roffet-Salque, M., P. I. Bogucki, J. Pyzel, I. Sobkowiak-Tabaka, R. Grygiel, M. Szymt and R. P. Evershed (2013), 'Earliest Evidence for Cheese Making in the Sixth Millennium B.C. in Northern Europe', *Nature* 493: 522–5.
- Rojo Muñoz, S. (2021), 'Il vino etrusco: una concorrenza tra grand crus?', *Archeo: Attualità del Passato*, 439: 20–2.
- Romanowska, I., C. D. Wren and S. A. Crabtree (2021), *Agent-Based Modelling for Archaeology: Simulating the Complexity of Societies*, Santa Fe: The Santa Fe Institute Press.
- Romanus, K., J. Baeten, J. Poblome, S. Accardo, P. Degryse, P. Jacobs, D. De Vos and M. Waelkens (2009), 'Wine and Olive Oil Permeation in Pitched and Non-Pitched Ceramics: Relation with Results from Archaeological Amphorae from Sagalassos, Turkey', *JAS*, 36 (3): 900–9.
- Rosada, G. and J. Turchetto (2008), 'La questione dell'assetto agrario e dello sfruttamento delle risorse nella Val Belluna romana', in P. Basso, A. Buonopane, A. Cavarzere and S. P. Mattioli (eds), *Est enim ille flos Italiae: Vita economica e sociale nella Cisalpina Romana, Atti delle Giornate di Studi in onore di Ezio Buchi (Verona, 30 novembre–1 dicembre 2006)*, 501–19, Verona: QuiEdit.
- Rosen, A. M. (1999), 'Phytolith Analysis in Near Eastern Archaeology', in S. Pike and S. Gitin (eds), *The Practical Impact of Science on Aegean and Near Eastern Archaeology*, 86–92, London: Archetype Press.
- Rosen, A. M. (2008), 'Phytolith Analysis', in D. M. Pearsall (ed.), *Encyclopedia of Archaeology*, 1818–22, New York: Academic Press.
- Rossiter, J. J. (1981), 'Wine and Oil Processing at Roman Farms in Italy', *Phoenix*, 35: 345–61.
- Rossiter, J. J. (1998), 'Pressing Issues: Wine and Oil Production', *Journal of Roman Archaeology*, 11: 597–602.
- Rostovtzeff, M. I. (1957), *The Social and Economic History of the Roman Empire*, 2nd edn, edited by P. M. Fraser, Oxford: Clarendon Press.
- Roth-Congés, A. (1996), 'Modalités pratiques d'implantation de cadastres romains: quelques aspects', in *MEFRA* 108, 299–422.
- Rotshild-Boros, M. C. (1981), 'The Determination of Amphora Contents', in G. Barker and R. Hodges (eds), *Archaeology and Italian Society*, BAR International Series 102, 79–89, Oxford: Archaeopress.
- Rottoli, M. and E. Castiglioni (2011), 'Plant Offering from Roman Cremations in Northern Italy: A Review', *Vegetation History and Archaeobotany*, 20: 495–506.

- Roushannafas, T., A. Bogaard and M. Charles (2022), 'Geometric Morphometrics Sheds New Light on the Identification and Domestication Status of "New Glume Wheat" at Neolithic Çatalhöyük', *Journal of Archaeological Science*, 142: 105599.
- Rousse, C., D. Munda, G. Benčić, O. Bourgeon, P. Maggi, V. Dumas, K. Bartolić, E. Botte and F. Welc (2020), 'Loron / Santa Marina (Tar-Vabriga, Poreč, Croatie). La villa de Santa Marina. Campagne 2019', *Chronique des activités archéologiques de l'École française de Rome*, <https://doi.org/10.4000/cefr.4862>
- Rousse, C., G. Benčić, D. Munda, N. Garnier, K. Bartolić Sirotić, V. Dumas, N. Basuau and P. Maggi (2022), 'La villa de Santa Marina (Tar Vabriga – Torre Abrega, Croatie)', *Bulletin archéologique des Écoles françaises à l'étranger*, <https://doi.org/10.4000/baefe.5098>
- Rowlett, L. M. and D. M. Pearsall (1993), 'Archaeological Age Determinations derived from Opal Phytoliths by Thermoluminescence', in D. M. Pearsall and D. R. Piperno (eds), *Current Research in Phytolith Analysis: Applications in Archaeology and Paleoecology*, MASCA Research Papers in Science and Archaeology 10, 25–30, Philadelphia: University of Pennsylvania.
- Rubio-Campillo, X. (2016), 'Model Selection in Historical Research Using Approximate Bayesian Computation', *PLOS ONE*, 11 (1): e0146491.
- Rubio-Campillo, X., M. Coto-Sarmiento, J. Pérez-Gonzalez and J. Remesal Rodríguez (2017), 'Bayesian Analysis and Free Market Trade within the Roman Empire', *Antiquity*, 91 (359): 1241–52.
- Ruffing, K., J. Renger and A. Gutsfeld (2002), 'Wein', in *Der Neue Pauly* 12/2, 424–36, Stuttgart: Brill.
- Ruiz, M., I. Rondán, J. Catalán, L. Lagóstena and J. Remesal (2021), 'Lectura de Arva desde la investigación no invasiva de la urbs y el suburbium', in *Congreso Internacional Small Town: Una realidad urbana en la Hispania romana*, Alicante.
- Ruiz Gil, J. A., L. Lagóstena, J. Pérez Marrero, D. Martín, P. Trapero and J. Catalán (2019), 'Villae y Figlinae a orillas del Lacus Ligustinus. Análisis GIS y prospección geofísica en el territorium ribereño de Hasta Regia', in J. Remesal, V. Revilla, D. J. Martín-Arroyo and A. Martín i Oliveras (eds), *Paisajes productivos y redes comerciales en el imperio romano*, Instrumenta 65, 115–38, Barcelona: Universitat de Barcelona.
- Ruiz Hernández, M. (2021), 'Densidad del vino', *La Rioja* 25, 11 June. Available online: <https://www.larioja.com/opinion/densidad-vino-20210611214244-nt.html> (accessed 30 April 2022).
- Rylatt, K. (2004), *Report on a Programme of Archaeological Trial Trenching: Lincoln Eastern Bypass, Lincolnshire*, Lincoln: Pre-Construct Archaeology.
- Saltini, A. (1979), *Storia delle scienze agrarie: venticinque secoli di pensiero agronomico*, Bologna: Edagricole.
- Salviat, F. and A. Tchernia (2013), *Vins, Vignerons et Buveurs de l'Antiquité*, Rome: L'Erma Di Bretschneider.
- San Quirico d'Orcia 2010 = G. Barbieri, A. Ciacci and A. Zifferero (eds), *Eleiva Oleum Olio. Le origini dell'olivicultura in Toscana: nuovi percorsi di ricerca tra archeologia, botanica e biologia molecolare*, *Atti della Giornata di Studi, San Quirico d'Orcia 2007*, San Quirico d'Orcia: Edizioni Don Chisciotte.
- Sands, R. and E. Marlière (2020), 'Produce, Repair, Reuse, Adapt, and Recycle: The Multiple Biographies of a Roman Barrel', *European Journal of Archaeology*, 23 (3): 356–80.
- Santangeli Valenzani R. and R. Volpe (2012), 'Paesaggi agrari della viticoltura a Roma e nel suburbio', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della vite e del vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 61–70, Borgo San Lorenzo: All'Insegna del Giglio.
- Santos, J. A., A. C. Malheiro, J. G. Pinto and G. V. Jones (2012), 'Macroclimate and Viticultural Zoning in Europe: Observed Trends and Atmospheric Forcing', *Climate Research*, 51: 89–103.
- Sarpaki, A. (2012), 'Revisiting the Visibility of the Grape, Grape-Products, By-Products and Some Insights of Its Organization from the Prehistoric Aegean, as Guided by New Evidence from Monastiraki, Crete', *IASNA*, 3: 211–20.

Bibliography

- Scali, M., A. Zifferero and R. Vignani (2018), 'Distribution and Characterization of the *Vitis vinifera* L. subsp. *sylvestris* in Southern Tuscany', *Recent Patents on Biotechnology*, 12: 208–20.
- Scansano 2007 = A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della Vite e del Vino in Etruria: Atti del Convegno Internazionale di Studi, Scansano 2005*, Siena: Ci.Vin.
- Scheidel, W. (1992), 'Neuen Wein in leere Schläuche: Jongman's Pompeii, Modelle und die kampanische Landwirtschaft', *Athenaeum*, 80: 207–13.
- Schmidt, A. (2009), 'Electric and Magnetic Methods in Archaeological Prospection', in S. Campana and S. Piro (eds), *Seeing the Unseen: Geophysics and Landscape Archaeology*, 67–81, London: Routledge.
- Schmitt, A. (1998), 'Amphorae from Lyons: Petrographic and Chemical Arguments', *Archaeometry*, 40: 293–310.
- Schneider, V. and S. Troxell (2018), *Acidity Management in Must and Wine*, San Francisco: Board and Bench.
- Scholz, D. and D. L. Hoffmann (2011), 'StalAge – An Algorithm Designed for Construction of Speleothem Age Models', *Quaternary Geochronology*, 6 (3–4): 369–82.
- Scienza, A. (2004), 'Il terzo anello: storia di un viaggio', in F. Del Zan, O. Failla and A. Scienza (eds), *La vite e l'uomo: Dal rompicapo delle origini al salvataggio delle reliquie. Evidenze storico-ampelografiche per ripercorrere il viaggio della vite da Oriente alle soglie dell'Occidente*, 99–148, Gorizia: ERSA.
- Scienza, A., ed. (2006), *Vitigni tradizionali ed antichi italiani: La storia, il paesaggio, la ricerca*, Siena: Ci.Vin.
- Scienza, A. (2010), 'L'origine dei vitigni coltivati: una storia interdisciplinare della cultura europea', in G. Di Pasquale (ed.), *Vinum nostrum: Arte, scienza e miti del vino nelle civiltà del Mediterraneo antico*, Catalogo della Mostra, Firenze 2010, 23–41, Firenze: Giunti Editore.
- Scienza, A. and O. Failla (1996), 'La circolazione dei vitigni in ambito padano-veneto ed atesino: le fonti storico-letterarie e l'approccio biologico-molecolare', in G. Forni and A. Scienza (eds), *2500 anni di cultura della vite nell'ambito alpino e cisalpino*, 185–268, Trento: Istituto Trentino del Vino.
- Scienza, A. and O. Failla (2016), 'La circolazione varietale della vite nel Mediterraneo: lo stato della ricerca', *Rivista di Storia dell'Agricoltura*, 56 (1–2): 31–48.
- Scienza, A. and S. Imazio (2018), *La stirpe del vino*, Milan: Sperling and Kupfer.
- Scollar, A., A. Tabbagh, A. Hesse and I. Herzog (1990), *Archaeological Prospecting and Remote Sensing*, Cambridge: Cambridge University Press.
- Seiler, F. (2023), 'Der Fluss Sarno: Schnittstelle in der Entwicklung der Küstenregion Pompejis zwischen Umweltbedingungen und Siedlungsdynamiken', *Archäologischer Anzeiger*, 2: 1–37. doi: 10.34780/78ah-0gx3.
- Seiler, F., M. Märker, P. Kastenmeier, S. Vogel, D. Esposito, U. Heussner, M. Boni, G. Balassone, G. Di Maio and M. Joachimski (2011), 'Interdisciplinary Approach on the Reconstruction of the Ancient Cultural Landscape of the Sarno River Plain Before the Eruption of Somma-Vesuvius A. D. 79', in H.-R. Bork, H. Meller and R. Gerlach (eds), *Umweltarchäologie – Naturkatastrophen und Umweltwandel im archäologischen Befund: 3. Mitteldeutscher Archäologentag vom 07. bis 09. Oktober 2010*, 145–54, Halle (Saale): Landesmuseum für Vorgeschichte.
- Seiler, F., S. Vogel and D. Esposito (2019), 'Ancient Rural Settlement and Land Use in the Sarno River Plain (Campania, Italy): Predictive Models and Quantitative Analyses', in J. R. Rodríguez, V. Revilla Calvo, D. J. Martín-Arroyo Sánchez and A. Martín i Oliveras (eds), *Productive Landscapes and Trade Networks in the Roman Empire*, 179–99, Barcelona: Universitat de Barcelona Edicions.
- Senatore, F. (1998), '"Ager Pompeianus": viticoltura e territorio nella piana del Sarno nel I secolo d.C.', in F. Senatore (ed.), *Pompei il Sarno e la Penisola Sorrentina: Atti del primo ciclo di conferenze di geologia, storia e archeologia. Pompei, aprile-giugno 1997*, 135–66, Rome: Bardi Editore.

- Senior, L. M. and D. P. Birnie (1995), 'Accurately Estimating Vessel Volume from Profile Illustrations', *American Antiquity*, 60: 319–34.
- Sereni, E. (1964), 'Per la storia delle più antiche tecniche e della nomenclatura della vite e del vino in Italia', *Atti e Memorie dell'Accademia Toscana di Scienze e Lettere La Colombaria*, 29: 75–204.
- Sereni, E. (1987), *Storia del paesaggio agrario italiano*, Roma; Bari: Editori Laterza.
- Shumilovskikh, L. S. and B. van Geel (2020), 'Non-Pollen Palynomorphs', in A. G. Henry (ed.), *Handbook for the Analysis of Micro-Particles in Archaeological Samples*, 65–94, Cham: Springer.
- Shumilovskikh, L. S., E. S. Shumilovskikh, F. Schlütz and B. van Geel (2022), 'NPP-ID - Non-Pollen Palynomorphs Image Database as a Research and Educational Platform', *Vegetation History and Archaeobotany*, 31: 323–8.
- Singleton, V. L. (1996), 'An Enologist's Commentary on Ancient Wines', in P. E. McGovern, S. J. Fleming and S. H. Katz (eds), *The Origins and Ancient History of Wine*, 67–77, New York: Gordon and Breach.
- Slovenec, D., I. Sondi and B. Crnkovic (1991), 'Mineraloske karakteristike amfora s područja srednjeg Jadrana', *Geoloski Vjesnik*, 44: 129–37.
- Smekalova, T. N., B. W. Bevan, A. V. Chudin and A. S. Garipov (2016), 'The Discovery of an Ancient Greek Vineyard', *Archaeological Prospection*, 23: 15–26.
- Smith, W. and C. Anthon (1854), *A New Classical Dictionary of Greek and Roman Biography, Mythology and Geography, Partly Based Upon the Dictionary of Greek and Roman Biography and Mythology*, New York: Harper and Brothers.
- Smith, H. and G. Jones (1990), 'Experiments on the Effects of Charring on Cultivated Grape Seeds', *JAS*, 17: 317–27.
- Smith, W., W. Wayte and G. E. Marindin, eds (1890), *A Dictionary of Greek and Roman Antiquities*, London: John Murray.
- Sondi, I. and D. Slovenic (2003), 'The Mineralogical Characteristics of the Lamboglia 2 Roman-Age Amphorae from the Central Adriatic (Croatia)', *Archaeometry*, 45: 251–62.
- Sourisseau, J.-C. (2011), 'La diffusion des vins grecs d'Occident du VIII^e au IV^e s. av. J.-C., sources écrites et documents archéologiques', in M. Lombardo, A. Siciliano and A. Alessio (eds), *La vigna di Dioniso: vite, vino e culti in Magna Grecia. Atti del Quarantanovesimo Convegno di Studi sulla Magna Grecia (Taranto 2009)*, 143–52, Taranto: Istituto per la Storia e l'Archeologia della Magna Grecia.
- Spallanzani, L. (1798), *Travels in the Two Sicilies and Some Parts of the Apennines*, Eng. trans. by G. G. Robinson and J. Robinson, London: Paternoster-Row.
- Spötl, C. and D. Matthey, (2012), 'Scientific Drilling of Speleothems – A Technical Note', *Int. J. Speleology*, 41: 29–34.
- Šprem, K. (2021), 'All Aboard! Quarries and Transport in Roman Istria', *Proceedings from the 7th Scientific Conference Methodology and Archaeometry*, 67–85, Zagreb: University of Zagreb.
- Stanić, Z., ed. (1999), *The Archaeological Heritage of the Island of Brač, Croatia: The Adriatic Islands Project Contact, Commerce and Colonialism: 6000 BC–AD 600*, Oxford: Archaeopress.
- Steinhübel, L. (2013), 'Palynological Analysis of a Pompeian Excavation Site in Scafati, Italy, to Reconstruct Vegetation During Roman Times', unpublished thesis, Faculty of Biology and Psychology Georg-August-University Göttingen, Göttingen.
- Stevenson, A. C. and P. D. Moore (1988), 'Studies in the Vegetational History of S.W. Spain IV. Palynological investigations of a valley mire at El Acebron, Huelva', *Journal of Biogeography*, 15 (2): 339–61.
- Stromberg, C. A. E. (2002), 'The Origin and Spread of Grass-Dominated Ecosystems in the Late Tertiary of North America: Preliminary Results Concerning the Evolution of Hypsodonty', *Palaeogeography Palaeoclimatology Palaeoecology*, 177 (1–2): 59–75.
- Stromberg, C. A. E. (2004), 'Using Phytolith Assemblages to Reconstruct the Origin and Spread of Grass-Dominated Habitats in the Great Plains of North America during the Late Eocene to Early Miocene', *Palaeogeography Palaeoclimatology Palaeoecology*, 207 (3–4): 239–75.

Bibliography

- Stubert, L., A. Martín i Oliveras, M. Märker, H. Schernthanner and S. Vogel (2020), 'Viticulture in the Laetanian Region (Spain) during the Roman Period: Predictive Modelling and Geomatic Analysis', *Geosciences*, 10 (6): 206.
- Stummer, A. (1911), 'Zur Urgeschichte der Reben und des Weinbaues', *Mitteilungen der Anthropologischen Gesellschaft in Wien*, 41: 283–96.
- Sugita, S. (1994), 'Pollen Representation of Vegetation in Quaternary Sediments: Theory and Method in Patchy Vegetation', *J Ecol*, 82: 881–97.
- Tang, P., F. Chen, A. Jiang, W. Zhou, H. Wang, G. Leucci, L. de Giorgi, M. Sileo, R. Luo, R. Lasaponara and N. Masini (2018), 'Multi-Frequency Electromagnetic Induction Survey for Archaeological Prospection: Approach and Results in Han Hangu Pass and Xishan Yang in China', *Surveys in Geophysics*, 39: 1285–1302.
- Tassaux, F. (2005), 'Patrimoines sénatoriaux de la Decima Regio', *Cahiers du Centre Gustave Glotz*, 26: 139–64.
- Tassaux, F., R. Matijašić and V. Kovačić (2001), *Loron (Croatie): Un grand centre de production d'amphores à huile istriennes (Ier-IVe s. P.C.)*, Mémoires 6, Bordeaux: Institut Ausonius.
- Tchernia, A. (1968–1970), 'Premiers résultats des fouilles de juin 1968 sur l'épave de Planier', *EtCl*, 3: 51–82.
- Tchernia, A. (1969), 'Recherches archéologiques sous-marines', *Gallia*, 27: 465–99.
- Tchernia, A. (1986), *Le vin de l'Italie romaine: Essai d'histoire économique d'après les amphores*, Bibliothèque des Écoles Françaises d'Athènes et de Rome 261, Rome: De Boccard.
- Tchernia, A. (1990), 'La vinification des Romains', in G. Garrier (ed.), *Le Vin des Historiens: Actes du Ier Symposium Vin et Histoire, 19–21 mai 1989*, 65–74, Suze-la-Rousse: Université du Vin.
- Tchernia, A. (1998), 'Archéologie expérimentale et goût du vin romain', in *El Vi a l'antiguitat: economia, producció i comerç al Mediterrani occidental: II Colloqui Internacional d'Arqueologia Romana, actes (Barcelona 6–9 de maig de 1998)*, 503–9, Badalona: Museu de Badalona.
- Tchernia, A. (2013), 'Les dimensions de quelques vignobles Romains', in F. Salviat and A. Tchernia (eds), *Vins, Vignerons et Buveurs de l'Antiquité*, 153–66, Rome: L'Erma di Bretschneider.
- Tchernia, A. and J.-P. Brun (1999), *Le vin romain antique*, Grenoble: Glénat.
- Terral, J.-F. (2002), 'Quantitative Anatomical Criteria for Discriminating Wild Grapevine (*Vitis vinifera* ssp. *sylvestris*) from Cultivated Vines (*Vitis vinifera* ssp. *vinifera*)', in S. Thiébaud (ed.), *Charcoal Analysis: Methodological Approaches, Paleoecological Results and Wood Uses*, BAR International Series 1063, 59–64, Oxford: BAR.
- Terral, J.-F., E. Tabard, L. Bouby, S. Ivorra, T. Pastor, I. Figueiral, S. Picq, J. B. Chevance, C. Jung, L. Fabre, C. Tardy, M. Compan, R. Bacilieri and T. Lacombe (2010), 'Evolution and History of Grapevine (*Vitis vinifera*) under Domestication: New Morphometric Perspectives to Understand Seed Domestication Syndrome and Reveal Origins of Ancient European Cultivars', *Annals of Botany*, 105: 443–55.
- Terrenato N. and J. A. Becker, eds (2012), *Roman Republican Villas: Architecture, Context, and Ideology*, University of Michigan Press, Papers and Monographs of the American Academy in Rome.
- Thomas, R. and A. Wilson (1994), 'Water Supply for Roman Farms in Latium and South Etruria', *Papers of the British School at Rome*, 62: 139–96.
- Thurmond, D. L. (2017), *From Vines to Wines in Classical Rome: A Handbook of Viticulture and Oenology in Rome and the Roman West*, Leiden: Brill.
- Tirone, L. (1970), 'Le vigne dans l'exploitation agricole in Italie', *Méditerranée*, 1 (4): 339–62.
- Tobler, W. R. (1979), 'Cellular Geography', in S. Gale and G. Olsson (eds), *Philosophy in Geography*, 379–86, Dordrecht: Springer.
- Tol, G., T. De Haas, J. Sevink, M. Schepers, B. Ullrich and W. De Neef (2020), '"There is More than Meets the Eye": Developing an Integrated Archaeological Approach to Reconstruct Human-Environment Dynamics in the Pontine Marshes (Lazio, Central Italy)', *Geoarchaeology*, 36 (1): 109–29.

- Toniolo, L. and A. Pecci (2020), 'Il ciclo di vita del vino: Casi studio dall'area Vesuviana', in J.-P. Brun, N. Garnier and G. Olcese (eds), *A. Making Wine in Western-Mediterranean. B. Production and the Trade of Amphorae: Some New Data from Italy, Panel 3.5*, 131–42, Heidelberg: Propylaeum.
- Tosi, G. (1983–4), 'La villa romana di Negrar di Valpolicella', *Annuario Storico della Valpolicella*, 2: 91–102.
- Toupet, C. and P. Lemaître (2003a), 'Une plantation de vignes gallo-romaine, dans le Nord de la Gaule, à Bruyères-sur-Oise (Val d'Oise)', *Actualité de la Recherche en Histoire et Archéologie agraires: Actes du Colloque international AGER V, Septembre 2000*, Annales Littéraires 764, Série 'Environnement, Sociétés et Archéologie' 5, 209–23, Besançon: Presses Universitaires Franc-Comtoise.
- Toupet, C. and P. Lemaître (2003b), 'Vignobles et modes d'exploitation viticoles antiques dans le Nord de la Gaule: L'exemple de Bruyères-sur-Oise (Val-d'Oise): une relecture', *Revue archéologique de Picardie*, 1–2: 209–26.
- Trapero Fernández, P. (2016), 'Roman Viticulture Analysis based on Latin Agronomists and the Application of a Geographic Information System in Lower Guadalquivir', *Virtual Archaeology Review*, 7 (14): 53–60.
- Trapero Fernández, P. (2018), 'Ways to Make History and Archaeology with Non-Invasive Techniques: The Application of GIS, RPA and GPR in Hasta Regia Roman City', in M. J. Mosquera and M. L. Almoraima Gil (eds), *Conserving Cultural Heritage*, 129–31, London: CRC Press.
- Trapero Fernández, P. (2021a), 'Condicionantes para el cultivo de la vid en época romana a través de Columela y los SIG', *Revista de Estudios Andaluces*, 41: 25–46.
- Trapero Fernández, P. (2021b), *La viticultura romana en el estuario del Guadalquivir: Las practicas de cultivo, producción distribución y modelado SIG en la colonia Hasta Regia*, BAR International Series 3022, Oxford: BAR.
- Trentacoste, A. and L. Lodwick (2023), 'Agriculture and Animal Husbandry in First-Millennium BC Italy: Towards an Agroecology of the Roman Expansion', in D.-E. Padilla Peralta, S. Bernard and L. Mignone (eds), *New Approaches to Middle Republican Rome and Italy*, Cambridge: Cambridge University Press.
- Trevizam, M. (2013), *Prosa Técnica: Catão, Varrão, Vitruvius e Columela*, Campinas: Editora da Uni.
- Trocchi, T., M. Marchesini, S. Marvelli and L. Lambertini, eds (2014), *La villa nel pozzo: Un insediamento rustico romano a Sant'Agata Bolognese*, San Giovanni in Persiceto: Museo Archeologico Ambientale.
- Trojsi, G. (2017), 'Villa romana di Cottanello: Indagini archeometriche su alcuni campioni di Dolia e di ceramiche comuni', in P. Pensabene and C. Sfameni (eds), *Villa romana di Cottanello: Ricerche 2010–2016*, 28–292, Bari: Edipuglia.
- Tsartsidou, G., S. Lev-Yadun, R. M. Albert, A. Miller Rosen, N. Efstratiou and S. Weiner (2007), 'The Phytolith Archaeological Record: Strengths and Weaknesses Evaluated Based on a Quantitative Modern Reference Collection from Greece', *JAS*, 34 (8): 1262–75.
- Turner, S. D. and A. G. Brown (2004), 'Vitis Pollen Dispersal in and from Organic Vineyards I: Pollen Trap Data', *Review of Palaeobotany and Palynology*, 129: 117–32.
- Turner, P. and G. L. Greasy (2003), 'Terroir: Competing Definitions and Applications', *Australian and New Zealand Wine Industry Journal*, 18 (6): 48–55.
- Tyree, E. L. (1994), 'Phytolith Analysis of Olive Oil and Wine Sediments for Possible Identification in Archaeology', *Canadian Journal of Botany*, 72: 499–504.
- Valamoti, S. M. (1998), 'Η εκμετάλλευση της αμπέλου στο χώρο της μακεδονίας και της ?ρης κατά τη ?εολιθική και την πρώιμη εποχή του ?αλκού (The Exploitation of the Grapevine in Macedonia and Thrace during the Neolithic and the Early Bronze Age)', in *Αμπελοοινική Ιστορία στο Χώρο της Μακεδονίας και της Θράκης (History of Viticulture and Wine in Macedonia and Thrace)*, 137–49, Athens: ETBA.

Bibliography

- Valamoti, S. M. (2004), *Plants and People in Late Neolithic and Bronze Age Northern Greece: An Archaeobotanical Investigation*, BAR International Series 1258, Oxford: Archaeopress.
- Valamoti, S. M. (2009), *Η Αρχαιοβοτανική Έρευνα της Διατροφής στην Προϊστορική Ελλάδα (An Archaeobotanical Investigation of Prehistoric Diet in Greece)*, Thessaloniki: University Studio Press.
- Valamoti, S. M. (2015), 'Harvesting the "wild"? Exploring the Context of Fruit and Nuts Exploitation at Neolithic Dikili Tash, with Special Reference to Wine', *Vegetation History and Archaeobotany*, 24: 35–46.
- Valamoti, S. M., M. Mangafa, H. Koukouli-Chrysanthaki and D. Malamidou (2007), 'Grape-Pressings from Northern Greece: The Earliest Wine in the Aegean?', *Antiquity*, 81: 54–61.
- Valamoti, S. M., P. Darcque, C. Koukouli-Chrysanthaki, D. Malamidou and Z. Tsirtsoni (2015), 'An Archaeobotanical Investigation of Prehistoric Grape Vine Exploitation and Wine Making in Northern Greece: Recent Finds from Dikili Tash', in A. Diler, K. Senol and Ü. Aydinoglu (eds), *Olive Oil and Wine Production in Eastern Mediterranean during Antiquity: International Symposium Proceedings 17–19 November 2011, Urla, Turkey*, 125–39, Izmir: Ege Üniversitesi.
- Valamoti, S. M., E. Gkatzogia, I. Hristova and E. Marinova (2018), 'Iron Age Cultural Interactions, Plant Subsistence and Land Use in SE Europe Inferred from Archaeobotanical Evidence of Greece and Bulgaria', in S. Gimatzidis, M. Pieniazek and S. Mangalağlı-Votruba (eds), *Archaeology Across Frontiers and Borderlands: Fragmentation and Connectivity in the North Aegean and the Central Balkans from Bronze to Iron Age*, Oriental and European Archaeology 9, 269–90, Wien: Institute for Oriental and European Archaeology.
- Valamoti, S. M., C. Pagnoux, M. Ntinou, L. Bouby, V. Bonhomme and J. F. Terral (2020), 'More than Meets the Eye: New Archaeobotanical Evidence on Bronze Age Viticulture and Wine Making in the Peloponnese, Greece', *Vegetation History and Archaeobotany*, 29: 35–50.
- Valdambri, C., A. Pecci and L. Salvini (2007), 'Ceramiche da mensa e da dispensa da alcuni siti della provincia di Grosseto: rapporto contenuto/contenitore', in *Atti del Convegno Internazionale della ceramica: La ceramica da fuoco e da dispensa nel basso medioevo e nella prima età moderna (secoli XI–XVI)*, Savona, 26–27 maggio 2006, 120–8, Firenze: All'Insegna del Giglio.
- Vallelonga, F. and A. Zifferero (2010), 'Archeologia dell'olivo e dell'olio nel Lazio settentrionale', in G. Barbieri, A. Ciacci and A. Zifferero (eds), *Eleiva Oleum Olio: Le origini dell'olivicoltura in Toscana: nuovi percorsi di ricerca tra archeologia, botanica e biologia molecolare*, *Atti della Giornata di Studi, San Quirico d'Orcia 2007*, 49–70, San Quirico d'Orcia: Edizioni Don Chisciotte.
- Van der Mersch, C. (1996), 'Vigne, vin et économie dans l'Italie du Sud grecque à l'époque archaïque', *Ostraka*, 1: 155–85.
- Van der Veen, M., A. Livarda and A. Hill (2008), 'New Plant Foods in Roman Britain – Dispersal and Social Access', *Environmental Archaeology*, 13: 11–36.
- van Joolen, E. (2003), 'Archaeological Land Evaluation: A Reconstruction of the Suitability of Ancient Landscapes for Various Land Uses in Italy Focused on the First Millennium BC', unpublished PhD thesis, University of Groningen.
- Van Leeuwen, C. and P. Darriet (2016), 'The Impact of Climate Change on Viticulture and Wine Quality', *Journal of Wine Economics*, 11 (1): 150–67.
- Van Limbergen, D. (2011), 'Vinum Picenum and Oliva Picena: Wine and Oil Presses in Central Adriatic Italy between the Late Republic and the Early Empire: Evidence and Problems', *BABesch*, 86: 71–94.
- Van Limbergen, D. (2015), 'Pots, Presses, People and Land: The Role of Overseas Export and Local Consumption Demand in the Development of Viticulture and Oleoculture in Central Adriatic Italy (250 BC – AD 200)', unpublished PhD thesis, Ghent University.
- Van Limbergen, D. (2016), 'A Note on Olives and Olive Oil from Picenum (Marche, Northern Abruzzo): An Obscured Food Product Within the Economy of Central Adriatic Italy in Roman Times?', *PICUS*, 36: 171–82.

- Van Limbergen, D. (2017), 'Changing Perspectives on Roller Presses in Northern Syria', *Syria*, 94: 307–23.
- Van Limbergen, D. (2018), 'The Central Adriatic Wine Trade of Italy Revisited: The Central Adriatic Wine Trade of Italy', *Oxford Journal of Archaeology*, 37 (2): 201–26.
- Van Limbergen, D. (2019), 'Vinum Picenum and Oliva Picena II: Further Thoughts on Wine and Oil Presses in Central Adriatic Italy', *BABesch*, 94: 1–31.
- Van Limbergen, D. (2020a), 'Wine, Greek and Roman', in T. Whitmarsh and N. Morley (eds), *The Oxford Classical Dictionary*, Oxford: Oxford University Press.
- Van Limbergen, D. (2020b), 'Growing grapes in populous landscapes: demography, food, land and vine agroforestry in central Adriatic Italy', in D. Van Limbergen, S. Maréchal and W. De Clercq (eds), *The Resilience of the Roman Empire: Regional case studies on the relationship between population and food resources* (BAR IntSeries 3000), Oxford: BAR Publishing: 73–111.
- Van Limbergen, D. (2022), 'Debating the Yield Potential of Vineyards in Roman Italy', *Revue Belge de Philologie et d'Histoire*, 100: 69–110.
- Van Limbergen, D. and W. De Clercq (2021), 'Viticulture as a Climate Proxy for the Roman World? Global Warming as a Comparative Framework for Interpreting the Ancient Source Material in Italy and the West (ca. 200 BC–200 AD)', in P. Erdkamp, J. G. Manning and K. Verboven (eds), *Climate Change and Ancient Societies in Europe and the Near East: Diversity in Collapse and Resilience*, 443–84, London: Palgrave Macmillan.
- Van Limbergen, D. and P. Komar (forthcoming), 'Making Wine in Big Clay Jars: Comparative Perspectives on Roman Winemaking', *Antiquity*.
- Van Limbergen, D., P. Monsieur and F. Vermeulen (2017), 'The Role of Overseas Export and Local Consumption Demand in the Development of Viticulture in Central-Adriatic Italy (200BC–AD150): The Case of the Ager Potentinus and the Wider Potenza Valley', in T. de Haas and G. Tol (eds), *The Economic Integration of Roman Italy: Rural Communities in a Globalizing World*, 342–66, Leiden: Brill.
- Van Limbergen, D. and F. Vermeulen (2021), 'A Method for Estimating Roman Population Sizes from Urban Survey Contexts: An Application in Central Adriatic Italy', in K. Verboven (ed.), *Complexity Economics: Building a New Approach to Ancient Economic History*, 203–49, Cham: Palgrave Macmillan.
- Van Pool, T. L. and R. D. Leonard (2011), *Quantitative Analysis in Archaeology*, London: Blackwell.
- Van Valkenburgh, P. and J. A. Dufton (2020), 'Big Archaeology: Horizons and Blindspots', *Journal of Field Archaeology*, 45: S1–S7.
- Vaschalde, C., C. Rousse, B. Brossier and G. Benčić (2021), 'Production and Management of Fuel for the Imperial Ceramic Workshop of Loron (Croatia): An Archaeological and Anthracological Approach', in D. Van Limbergen and D. Taelman (eds), *The Exploitation of Raw Materials in the Roman World: A Closer Look at Producer-Resource Dynamics, Panel 4.4, Archaeology and Economy in the Ancient World – Proceedings of the 19th International Congress of Classical Archaeology (Cologne/Bonn 2018, Band 27)*, 31–45, Heidelberg, Propylaeum.
- Vaschalde, C., M. Tillier, N. Rovira, F. Guibal, D. Kaniewski, C. De Bruxelles, M.-B. Carre, C. Rousse, G. Benčić, V. Kovačić and D. Munda (forthcoming), 'Landscape, Resources Management and Vegetal Economy in the Parentium Area (Croatia) between the Imperial Period and the Beginning of the Middle Ages. First Results of Archaeobotanical Investigation', in I. Borzić et al. (eds), *Transformations of Adriatic Europe (Ile - IXe s. A.D.). Proceeding of the international Conference (Zadar 2016)*, Oxford: Archaeopress.
- Venable, W. N. and B. D. Ripley (2002), *Modern Applied Statistics with S*, 4th edn, New York: Springer.
- Verdonck, L., A. Launaro and F. Vermeulen (2020), 'Ground-Penetrating Radar Survey at Falerii Novi: A New Approach to the Study of Roman Cities', *Antiquity*, 94: 705–23.

Bibliography

- Verhagen, P. (2008), 'Testing Archaeological Predictive Models: A Rough Guide', in A. Posluschny, K. Lambers and I. Herzog (eds), *Layers of Perception: Proceedings of the 35th International Conference on Computer Applications and Quantitative Methods in Archaeology (CAA)*, Berlin, 2.-6. April 2007, 285–91, Bonn: Koll.
- Verhagen, P., M. Kleijn and J. Joyce (2021), 'Different Models, Different Outcomes? A Comparison of Approaches to Land Use Modeling in the Dutch Limes', *Heritage*, 4: 2081–104.
- Verhagen, P. and T. G. Whitley (2020), 'Predictive Spatial Modelling', in M. Gillings, P. Hacigüzeller and G. Lock (eds), *Archaeological Spatial Analysis: A Methodological Guide*, 231–46, Oxon and New York: Routledge.
- Verheyden, S. (2004), 'Trace Elements in Speleothems: A Short Review of the State of the Art', *Int. J. Speleol.*, 33 (1/4): 95–101.
- Vermeulen, F., G.-J. Burgers, S. Keay and C. Corsi, eds (2012), *Urban Landscape Survey in Italy and the Mediterranean*, Oxford: Oxbow Books.
- Vermeulen, F., D. Van Limbergen, P. Monsieur and D. Taelman, eds (2017), *The Potenza Valley Survey (Marche, Italy): Settlement Dynamics and Material Culture in an Adriatic Valley between Iron Age and Late Antiquity*, Academia Belgica Studia Archaeologica 1, Rome: Fondazione Dià Cultura.
- Vidal, J. M. and D. M. Corredor (2018), 'The Roman Amphorae Average Capacity (AC)', *Oxford Journal of Archaeology*, 37 (3): 299–311.
- Vidale, M. (2000), 's.v. *Archeologia sperimentale*', in R. Francovich and D. Manacorda (eds), *Dizionario di Archeologia: Temi, concetti e metodi*, 280–2, Bari; Roma: Editori Laterza.
- Vignani, R., E. Paolucci, M. Scali, J. Bigliazzi, M. Cresti and V. Zorzi (2012), 'Il "Progetto ArcheoVino": caratteri e genoma della vite silvestre in Maremma', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della Vite e del Vino in Toscana e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 653–62, Borgo San Lorenzo: All'Insegna del Giglio.
- Vita-Finzi, C., E. Higgs, D. Sturdy, J. Harriss, A. Legge and H. Tippet (1970), 'Prehistoric Economy in the Mount Carmel Area of Palestine: Site Catchment Analysis', *Proceedings of the Prehistoric Society*, 36: 1–37.
- Vitali, D., ed. (2007), *Le fornaci e le anfore di Albinia: Primi dati su produzione e scambi della costa tirrenica al mondo gallico*, Bologna: Dip. Arceo.
- Vogel, S. and M. Märker, M. (2012), 'Comparison of Pre-AD 79 Roman Paleosols in Two Contrasting Paleo-Topographical Situations Around Pompeii (Italy)', *Geografia Fisica e Dinamica Quaternaria*, 35: 199–209.
- Vogel, S. and M. Märker (2014), 'Analysis of Post-Burial Soil Developments of Pre-AD 79 Roman Paleosols Near Pompeii (Italy)', *Open Journal of Soil Science*, 4 (10): 337–56.
- Vogel, S., M. Märker, D. Esposito and F. Seiler (2016a), 'The Ancient Rural Settlement Structure in the Hinterland of Pompeii Inferred from Spatial Analysis and Predictive Modeling of Villae Rusticae', *Geoarchaeology*, 31 (2): 121–39.
- Vogel, S., M. Märker, I. Rellini, P. Hoelzmann, S. Wulf, M. Robinson, L. Steinhübel, G. Di Maio, C. Imperatore, P. Kastenmeier, L. Liebmann, D. Esposito and F. Seiler (2016b), 'From a Stratigraphic Sequence to a Landscape Evolution Model: Late Pleistocene and Holocene Volcanism, Soil Formation and Land Use in the Shade of Mount Vesuvius (Italy)', *Quaternary International*, 394: 155–79.
- Vogel, S., M. Märker and F. Seiler (2011), 'Revised Modelling of the Post-AD 79 Volcanic Deposits of Somma-Vesuvius to Reconstruct the Pre-AD 79 Topography of the Sarno River Plain (Italy)', *Geologica Carpathica*, 62 (1): 5–16.
- Volpe, R. (2009), 'Vino, vigneti ed anfore in Roma repubblicana', in V. Jolivet (ed.), *Suburbium II: Il suburbio di Roma dalla fine dell'età monarchica alla nascita del sistema delle ville, V–II secolo a.C.*, 369–92, Rome: École française de Rome.
- Vouillamoz, J. F. and S. Grando (2006), 'Genealogy of Wine Grape Cultivars: "Pinot" Is Related to "Syrah"', *Heredity*, 97: 102–10.

- Vouillamoz, J. F., A. Monaco, L. Costantini, M. Stefanini, A. Scienza and M. S. Grando (2007a), 'The Parentage of "Sangiovese": The Most Important Italian Wine Grape', *Vitis*, 46: 19–22.
- Vouillamoz, J. F., A. Schneider and M. S. Grando (2007b), 'Microsatellite Analysis of Alpine Grape Cultivars (*Vitis vinifera* L.): Alleged Descendants of Pliny the Elder's *Raetica* are Genetically Related', *Genet Resour Crop Evol*, 54: 1095–1104.
- Vouillamoz, J. F., A. Monaco, L. Costantini, J. Zambanini, M. Stefanini, A. Scienza, M. S. Grando (2008), 'Il Sangiovese è per metà figlio del Calabrese di Montenuovo', *L'Informatore Agrario*, 5: 59–62.
- Wales, N., C. Caroe, M. Sandoval-Velasco, C. Gamba, R. Barnett, J. A. Samaniego, J. R. Madrigal, L. Orlando, M. Thomas and P. Gilbert (2015), 'New Insights on Single-Stranded Versus Double-Stranded DNA Library Preparation for Ancient DNA', *Biotechniques*, 59: 368–71.
- Wales, N., J. R. Madrigal, E. Cappellini, A. C. Baez, J. A. S. Castruita, J. A. Romero-Navarro, C. Caroe, M. C. Ávila-Arcos, F. Peñaloza, J. V. Moreno-Mayar, B. Gasparyan, D. Zardaryan, T. Bagoyan, A. Smith, R. Pinhasi, G. Bosi, G. Fiorentino, A. M. Grasso, A. Celant, G. Bar-Oz, Y. Tepper, A. Hall, S. Scalabrini, M. Miculan, M. Morgante, G. Di Gaspero and M. T. P. Gilbert (2016), 'The Limits and Potential of Paleogenomic Techniques for Reconstructing Grapevine Domestication', *Journal of Archaeological Science*, 72: 57–70.
- Waliszewski, T. (2014), *Elaion: Olive oil production in Roman and Byzantine Syria-Palestine*, PAM Monograph 6, Warsaw: Warsaw University Press.
- Ward-Perkins, J. B. (1962), 'Etruscan Towns, Roman Roads and Medieval Villages: The Historical Geography of Southern Etruria', *The Geographical Journal*, 128 (4): 389–404.
- Waterhouse, A. L., G. L. Sacks and D. W. Jeffery (2016), *Understanding Wine Chemistry*, Hoboken: Wiley.
- Webb, D. A. (1968), 'Vitaceae', in T. G. Tutin, V. H. Heywood, N. A. Burges, D. M. Moore, D. H. Valentine, S. M. Walters D. A. Webb (eds), *Flora Europaea* 2, 246–47, Cambridge: Cambridge University Press.
- Webster, D., H. Webster and D. F. Petch (1967), 'A Possible Vineyard of the Romano-British Period at North Thoresby, Lincolnshire', *Lincolnshire History and Archaeology*, 2: 55–61.
- Welc, F., G. Lipovac Vrkljan, A. Konestra and T. Rosic (2017), 'Remote Sensing of a Roman Pottery Workshop: Report on a Geophysical Survey Carried out in Crikvenica (Ancient Ad Turres, Croatia)', *Studia Quaternaria*, 34 (2): 119–30.
- Welc, F., A. Konestra, A. Dugonjic, P. Andrioc Gracanin, K. Rabiega and B. Nowacki (2019), 'Multidisciplinary Insights into Late Roman Rural Settlement on the Northeastern Adriatic Coast of Croatia: Island of Rab Case Study', *Polish Archaeology in the Mediterranean*, 28 (2): 433–54.
- Welc, F., C. Rousse and G. Bencic (2020), 'Results of Geophysical Scanning of a Roman Senatorial Villa in the Santa Marina Bay (Croatia, Istria) using the Amplitude Data Comparison Method (ADCM)', *Studia Quaternaria*, 37 (2): 79–90.
- Wendt, K. A., X. Li and R. Lawrence Edwards (2021), 'Uranium–Thorium Dating of Speleothems', *Elements*, 17 (2): 87–92.
- Whelton, H. L., S. Hammann, L. J. E. Cramp, J. Dunne, M. Roffet-Salque and R. P. Evershed (2021), 'A Call for Caution in the Analysis of Lipids and other Small Biomolecules from Archaeological Contexts', *Journal of Archaeological Science*, 132: 105397.
- White, K. D. (1967), *Agricultural Implements of the Roman World*, Cambridge: Cambridge University Press.
- White, K. D. (1970a), *Roman Farming*, London: Thames & Hudson Ltd.
- White, K. D. (1970b), *A Bibliography of Roman Agriculture*, Reading: University of Reading.
- White, K. D. (1975), *Farm Equipment of the Roman World*, Cambridge: Cambridge University Press.
- Willcox G. (1999), 'Archaeobotanical Significance of Growing Near Eastern Progenitors of Domestic Plants at Jalès, France', in P. Anderson (ed.), *Prehistory of Agriculture*, Monograph 40, 103–17, Los Angeles: University of California.
- Wilkes, J. J. (1969), *Dalmatia*, Harvard: Harvard University Press.

Bibliography

- Wilkins, B. and B. Roberts (2003), *Land to the South of the A120, Takerley, Essex (Barkers Tank Site)*, Archaeological Excavation Interim Site Narrative. Hertfordshire Archaeological Trust, Report No. 1301.
- Williams, D. (1977), 'A Consideration of the Sub-Fossil Remains of *Vitis vinifera* L. as Evidence for Viticulture in Roman Britain', *Britannia*, 8: 327–34.
- Wilson, A. (2009), 'Approaches to Quantifying Roman Trade', in A. K. Bowman and A. I. Wilson (eds), *Quantifying the Roman Economy: Methods and Problems*, 213–49, Oxford: Oxford University Press.
- Wilson, A. (2011), 'Developments in Mediterranean Shipping and Maritime Trade from the Hellenistic Period for AD 1000', in D. Robinson and A. Wilson (eds), *Maritime Archaeology and Ancient Trade in the Mediterranean*, 33–60, Oxford: Oxford University Press.
- Wilson, A. (2014), 'Quantifying Roman Economic Performance by Means of Proxies: Pitfalls and Potential', in F. de Callatay (ed.), *Quantifying the Greco-Roman Economy and Beyond*, 147–67, Bari: Edipuglia.
- Wiltshire, P. E. J. (1997), 'Evidence for the Environment and Economy: The Easterton Brook Channel. Palynological Analysis of the Palaeochannel Sediments', in P. Williams and R. Newman (eds), *Market Lavington, Wiltshire: An Anglo-Saxon cemetery and settlement. Excavations at Grove Farm 1986–90*, Wessex Archaeology Report No. 19, 121–37, Wessex Archaeology.
- Winkler, A. J., J. A. Cook, W. M. Kliever and L. A. Lider (1992), *General Viticulture*, 2nd edn, Berkeley: University of California Press.
- Wiseman, T. P. (1987), *Roman Studies: Literary and Historical*, Liverpool: Francis Cairns.
- Wiseman, R., E. Brewer, R. Luxford, J. Losh, R. Fosberry, M. Roberts, C. Jackson-Slater and A. Boulton (2020), *Roman Planting Trenches in the East of England: Archaeology on Furlough*, Cambridge: Cambridge Archaeological Unit.
- Witcher, R. (2013), 'On Rome's Ecological Contribution to British Flora and Fauna: Landscape, Legacy and Identity', *Landscape History*, 34: 5–26.
- Witcher, R. (2016), 'Agricultural Production in Roman Italy', in A. E. Cooley (ed.), *A Companion to Roman Italy*, 459–82, Chichester: Wiley-Blackwell.
- Won, I. J., D. Keiswetter, D. Hanson, E. Novikova and T. Hall (1997), 'GEM 3: A Monostatic Broadband Electromagnetic Induction Sensor', *J. Environ. Eng. Geophys.*, 2 (1): 53–64.
- Wong, C. J. and D. O. Brecker (2015), 'Advancements in the Use of Speleothems as Climate Archives', *Quat. Sci. Rev.*, 127: 1–18.
- Woodfield, C. and C. Johnson (1989), 'A Roman Site at Stanton Low, on the Great Ouse, Buckinghamshire. Excavated by Margaret Jones, 1957–58', *Archaeological Journal*, 146, 135–278.
- Woodworth, M., D. Bernal, M. Bonifay, N. B. Garnier, S. Keay, A. Pecci, J. Poblome, M. Pollard, F. Richez and A. Wilson (2015), 'The Content of African Keay 25/Africana Amphorae: Initial Results of the CORONAM Project', in C. Oliveira, R. Morais and A. Morillo (eds), *Archaeoanalytics. Chromatography and DNA analysis in archaeology: International Symposium*, 41–57, Porto: University of Porto.
- Wynn, J. C. (1986), 'A Review of Geophysical Methods Used in Archaeology', *Geoarchaeology: An International Journal*, 1 (3): 245–57.
- Zamora, J.-A. (2000), *La Vid y el Vino en Ugarit*, Madrid: Consejo Superior de Investigaciones Científicas.
- Zech-Matterne, V. and L. Bouby (2011), 'Viticulture et viniculture dans le nord du bassin parisien d'après les données archéobotaniques', *Gallia*, 68 (1): 257–62.
- Zevi, F. (1966), 'Appunti sulle anfore romane. I – la tavola tipologica del Dressel', *AC*, 18: 208–47.
- Zifferero, A. (2012), 'Parchi per l'archeologia e il paesaggio: Uno sviluppo possibile per Archeo-Vino', in A. Ciacci, P. Rendini and A. Zifferero (eds), *Archeologia della vite e del vino in Toscana*

- e nel Lazio: Dalle tecniche dell'indagine archeologica alle prospettive della biologia molecolare*, 683–704, Borgo San Lorenzo: All'Insegna del Giglio.
- Zifferero, A. (2016), 'Archeologia e circolazione varietale: prospettive di ricerca e valorizzazione del paesaggio agrario in Italia centrale', *Rivista di Storia dell'Agricoltura*, 56 (1-2): 13–30.
- Zifferero, A. (2017a), 'Le attività artigianali nel territorio vulcente: la Valle dell'Albegna e Marsiliana', *Scienze dell'Antichità*, 23 (2): 311–29.
- Zifferero, A. (2017b), 'Il paesaggio del vino a Mutina: circolazione varietale, produzione e consumo', in L. Malnati, S. Pellegrini, F. Piccinini and C. Stefani (eds), *Mutina splendidissima: la città romana e la sua eredità*, Catalogo della Mostra, Modena 2017–18, 275–84, Rome: De Luca Editori d'Arte.
- Zifferero, A. (2021), 'Produzione e consumo del vino in Etruria nel periodo orientalizzante: metodi di analisi e prospettive di ricerca', *Mediterranea*, Supplementi 1: 479–500.
- Zlateva, B. and M. Rangelov (2015), 'Chemical Analysis of Organic Residues Found in Hellenistic Time Amphorae from SE Bulgaria', *Journal of Applied Spectroscopy*, 82: 221–7.
- Zohary, D. and M. Hopf (2000), *Domestication of Plants in the Old World*, 3rd edn, New York.
- Zohary, M. (1973), *Geobotanical Foundations of the Middle East*, Stuttgart: G. Fischer.

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