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Archaeology and Economy in the Ancient World

17

Villas, Peasant Agriculture, and the Roman Rural Economy

Panel 3.15

Annalisa Marzano (Ed.)

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Volume 17: Villas, Peasant Agriculture,
and the Roman Rural Economy

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Edited by

Martin Bentz and Michael Heinzelmann

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PREFACE

On behalf of the 'Associazione Internazionale di Archaeologica Classica (AIAC)' the 19th International Congress for Classical Archaeology took place in Cologne and Bonn from 22 to 26 May 2018. It was jointly organized by the two Archaeological Institutes of the Universities of Cologne and Bonn, and the primary theme of the congress was 'Archaeology and Economy in the Ancient World'. In fact, economic aspects permeate all areas of public and private life in ancient societies, whether in urban development, religion, art, housing, or in death.

Research on ancient economies has long played a significant role in ancient history. Increasingly in the last decades, awareness has grown in archaeology that the material culture of ancient societies offers excellent opportunities for studying the structure, performance, and dynamics of ancient economic systems and economic processes. Therefore, the main objective of this congress was to understand economy as a central element of classical societies and to analyze its interaction with ecological, political, social, religious, and cultural factors. The theme of the congress was addressed to all disciplines that deal with the Greco-Roman civilization and their neighbouring cultures from the Aegean Bronze Age to the end of Late Antiquity.

The participation of more than 1.200 scholars from more than 40 countries demonstrates the great response to the topic of the congress. Altogether, more than 900 papers in 128 panels were presented, as were more than 110 posters. The publication of the congress is in two stages: larger panels are initially presented as independent volumes, such as this publication. Finally, at the end of the editing process, all contributions will be published in a joint conference volume.

We would like to take this opportunity to thank all participants and helpers of the congress who made it such a great success. Its realization would not have been possible without the generous support of many institutions, whom we would like to thank once again: the Universities of Bonn and Cologne, the Archaeological Society of Cologne, the Archaeology Foundation of Cologne, the Gerda Henkel Foundation, the Fritz Thyssen Foundation, the Sal. Oppenheim Foundation, the German Research Foundation (DFG), the German Academic Exchange Service (DAAD), the Romano-Germanic Museum Cologne and the LVR-LandesMuseum Bonn. Finally, our thanks go to all colleagues and panel organizers who were involved in the editing and printing process.

Bonn/Cologne, in August 2019

Martin Bentz & Michael Heinzelmann

Villas, Peasant Agriculture, and the Roman Rural Economy: An Introduction

Annalisa Marzano

The Roman villa can be defined as the unit of agricultural exploitation that combined a working farm with well-appointed residential quarters. Such villas were characteristic element of the Roman world, just as much as urban baths, amphitheatres, and monumental architecture. The appearance and spread of villas, both in various regions of Roman Italy and abroad, have been linked to various historical phenomena: Rome's territorial expansion, the establishment of colonial settlements, as well as the readiness and desire of indigenous elites to participate in forms of Roman life. In other words, the villa lies at the centre of the discourse on 'Romanization' or on acculturation, depending on what aspect of the phenomenon one wishes to emphasise. In addition to studies focussing on the architectural typology of villas and their visual and sculptural decoration, villas themselves have been the object of a vast number of works investigating the Roman economy and society. This is because the Roman villa has not been understood simply as the result of the diffusion of specific architectural forms, building techniques, and visual vocabulary. At the same time, it also exemplifies a particular type of agricultural production, which is centred on the use of slave labour.

Past scholarship on villas has approached the subject from a range of perspectives. Marxist-inspired interpretations claimed that slave labour was the basis for the Roman villa, and that this was the unit denoting a particular type of agricultural exploitation and 'mode of production'. Other studies aimed at understanding how settlement hierarchy and modes of landownership changed over time. In all of these approaches, archaeological evidence (from excavations and field surveys) has been central to the debate. As is well known, the traditional historiographical interpretation of the socio-political changes that Rome underwent during the Republic viewed the influx of booty and slaves brought by Roman imperialism as the main driver of the diffusion of villas. Thus, the spread of large villas in Republican Italy has been interpreted as a phenomenon that displaced small and medium landowners from the land. As a result, it contributed to Rome's socio-political problems and the ultimate crisis experienced by Republican institutions from the time of the Gracchi onwards. Recent studies, however, have in fact stressed that large villas and farms were not at variance with each other. Alessandro Launaro's research in Italy has shown that the number of villas and farms in a given territory grew or diminished at the same rates. Therefore, we cannot automatically consider the appearance of large villas as a sign that small farmers had been displaced.[1] Within peninsular Italy, there are only very limited exceptions to this.

The productivity of peasant farmers and the degree of competition they had within economic markets have also been the subject of important recent investigations

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and reassessments. Geoffrey Kron has repeatedly argued that Roman agriculture in general achieved very high levels of productivity thanks to things like their reliance on manuring and crop rotation. Following this argument, peasant farmers, far from being simply ousted by big landlords, actually managed to be competitive in the market. His positive appraisal of Roman agriculture appears to have been confirmed by the results of the 'Excavating the Roman Peasant Project'. The investigation of a number of small rural sites in southern Tuscany together with the associated paleo-environmental data suggest that the peasant farmers who lived there practiced ley farming. The project also showed that these peasants were connected to the wider regional economy.[2]

In the light of these relatively recent studies and re-evaluations of the Roman rural economy,[3] the triple-panel 'Villas, Peasant Agriculture, and the Roman Rural Economy' was organized at the Bonn/Cologne 19th International Congress of Classical Archaeology. It aimed at offering a more organic evaluation of how the 'villa economy' and the 'peasant economy' operated, and to what degree, if any, the two were integrated. One question at the core of the papers presented in the panel was whether and how villas and small and medium farms were part of two productive and distributive systems which supported each other. This could occur for instance, by giving access to agricultural processing facilities present on large estates, or by growing complementary crops. Another issue investigated was to what extent the picture emerging from provincial territories compares with the situation in Roman Italy. Addressing this aspect seemed particularly timely considering the advancement of research concerning Roman rural Italy, and because many studies in provincial archaeology / history still take for granted the direct transfer of Italian models to the provinces.

The papers delivered at the conference, of which a good selection is included in this volume, therefore have focussed not only on Roman Italy, but also on key provincial territories, such as the Iberian Peninsula, Roman Britain, and the Balkans. This diverse geographic overview has offered some surprising results. The data presented for Roman Britain and for a portion of the territory of Hispania *citerior* (corresponding to modern coastal Catalonia) invites us to radically reconsider the idea that the 'villa' was a ready toolkit exported to various territories. Instead, it was the villas, that is rural settlements of a certain size, that were always the centre of market-oriented agricultural production.

The first paper by Werner Tietz takes a text-based approach to explore the fundamental issue of the type of manpower employed in villas. Slavery was an important component of Roman society, but large-scale agricultural exploitation cannot be reduced to the exclusive use of slave labour. Tietz's discussion reminds us of the role played by seasonal labourers and by the small farmers who could work on the large estates at given times of the year.

From Roman Italy, the paper by Maria Stella Busana and Claudia Florin on Roman Cisalpine Gaul presents the analysis of 203 rural sites dating from the 2nd century BC to the 5th century AD. Although there are some differences in the types of settlement

between east and west Cisalpine Gaul, the data discussed by Busana and Florin suggest that small and medium farms and villas formed part of a single productive system until the end of the 2nd century AD. Smaller sites disappeared only with the wider changes that occurred in the second part of the 2nd century AD / early 3rd century AD.

The results of the Podere Marzuolo project by Astrid Van Oyen et al. are presented in this volume in the form of an extended abstract. They highlight the difficulty in relying on firm typological distinctions between villas and farms, or between villas and peasant economies. Excavations at Podere Marzuolo have uncovered a rural site where large-scale investment in construction took place in the Augustan period. The site has many features normally associated with villa economies, and yet its layout, physical appearance, and material assemblages are not those of a villa.

Four papers in this volume discuss the provincial territories: two focus on *Hispania citerior* (Alvarez Tortosa and Olesti), one on *Pannonia inferior* and *Moesia superior* (Ilić), and one on Roman Britain (Lodwick).

Juan Francisco Álvarez Tortosa examines the northwest of *Hispania citerior* between the 2nd century BC and the 2nd century AD, with a particular focus on commercial viticulture, which formed the main part of the local economy. His PhD work tackled a huge dataset comprising 1,380 rural sites and elaborated a complex classification system to systematize the wealth of data. The paper presented here offers two main points for reflection. First, the start of commercial viticulture in Laeetania, a region which was a great exporter of wine in the imperial period, was not in the context of villas/farms; rather it was through the indigenous proto-farms and administrative centres that played a role in the military organization of Rome during the conquest. Second, when a great boom in rural settlements and viticulture occurred in the Augustan period, various types of connections can be identified among the different types of rural settlements (villas, farms, kiln centres, etc.). Small farms provided amphorae to bottle the wine of large villas, kilns supplied different kinds of sites, and so forth. In other words, we have a complex pattern of integration and collaboration, suggesting that villas and smaller farms were all part of the same system and complemented each other.

Oriol Olesti discusses the wine production of the *ager Barcinonensis,* the territory of the Augustan colony of Barcino (mod. Barcelona). This paper focuses on the relationship between colonial foundations and rural production centres, which entailed a reorganization of land division. When compared with the abundant epigraphic record for the Roman period, the study of toponyms attested in the region's medieval documentation suggests that a number of the medieval names of *fundi* refer to the original Roman landlords of the *ager Barcinonensis*. This documentation shows a strict correlation between the main families documented in the cities (particularly in Barcino) and the known rural estates, where wine production for export took place. However, in a number of cases the epigraphic evidence and the medieval toponyms also show that freedmen owned the estates and/or *figlinae*. This demonstrates the phenomenon of social mobility well attested in other parts of the Roman world.

Olivera Ilić's paper discusses the transformations that occurred in the territories of *Moesia inferior* and *Pannonia superior* during the Roman period. It brings to the fore another form of rural settlement less known archaeologically, but on which much has been written by experts of Roman law and institutions: the *vici*. In the region Ilić discusses, the *vici* resulted from the settlement of veterans and were important production units in supplying the urban centres before the appearance of agricultural villa estates in the same areas. However, these two very fertile provinces had a very low level of urbanization and we do not see the same dynamics and complex social exchanges between city and countryside that characterized other more urbanized provinces.

Lisa Lodwick's paper brings us to the northmost of the Roman provinces: Britain. Her study focuses on grain-drying ovens, which were widely distributed in Roman Britain from the 2nd century AD onwards at a range of site types. These structures can be used to quantify cereal production. The preliminary results of Lodwick's study place farms and farmsteads in a different light: not only were innovative forms of grain-drying ovens attested at both farms and villas, but clusters of this type of ovens have been recorded at farmsteads in proximity to the road network. This shows that technological innovation was not something that occurred only at one type of sites (e.g. innovation at the large villas required considerable capital, such as for water mills), but also at smaller settlements. While archaeology cannot tell us who the owners of these farmsteads were (they could have been part of larger landholdings), their proximity to the road network suggests two things. First, that the clustering of grain-drying ovens addressed specific cereal processing needs in an area that experienced high amounts of road traffic (e.g. cereals needed at inns and/or road stations; the relationship with military settlements should also be considered). Second, it may also indicate that the movement of people along the road network helped the diffusion of new grain-drying oven designs and technical knowledge.

This selection of the papers delivered at the Cologne/Bonn conference closes with a longer contribution by Antoni Martín i Olivera and Víctor Revilla Calvo. Their study combines data and methods for calculating grape and wine yields from modern viticulture with the information contained in the Latin agricultural treatises. As a result, they propose a new method for quantifying ancient wine production. They take as their case study the Laeetania region of *Hispania citerior*, and in this respect their paper supplements the ones by Alvarez Tortosa and Olesti. The methods and the formulas they use are not exclusive to this region and can, with some adjustments, be deployed to other regions of the Roman world. It is a serious attempt to quantify ancient wine production, which, as we know, was one of the most important market-oriented agricultural productions in antiquity. Once refined further, their approach can produce more accurate results than estimating the potential wine production of an estate from the size of the *lacus* and/or the number and dimension of the containers for the must to ferment. This has important consequences for the study of regional economies.

Acknowledgments

The panel 'Villas, Peasant Agriculture, and the Roman Rural Economy' presented at the 19th International Congress of Classical Archaeology in Cologne/Bonn was sponsored by the international research project 'Structural Determinants of Economic Performance in the Roman World',[4] based at the University of Ghent. I am very grateful for their financial support and I thank the project leaders, Koenraad Verboven and Paul Erdkamp.

I also wish to acknowledge the support of the Leverhulme Trust: the topic of this panel is related to my current project funded by a Leverhulme Major Research Fellowship. The period of research leave this entails has allowed me to organize this panel, participate in the conference, and edit this volume.

Finally, I wish to thank the discussants, Alessandro Launaro and Marco Maiuro, and all the speakers for their participation, in particular those who decided to publish a version of their research in this venue.

Notes

[1] Launaro 2011.

[2] Bowes 2017.

[3] For recent thought-provoking studies on rural communities, see the papers in Tol – de Haas 2017.

[4] <http://www.sdep.ugent.be/> (06.03.2019).

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Bowes 2017

K. D. Bowes, Peasant agricultural strategies in southern Tuscany: convertible agriculture and the importance of pasture, in: de Haas – Tol 2017, 170–199.

Launaro 2011

A. Launaro, Peasants and Slaves: The Rural Population of Roman Italy (200 BC to AD 100) (Camebridge 2011).

de Haas – Tol 2017

T. C. A. de Haas – G. W. Tol, The Economic Integration of Roman Italy: Rural Communities in a Globalizing World (Boston 2017).

Temporary Workforce in the Roman Villa

Werner Tietz

This paper is dedicated to evaluating the exchange of workforce between villas and surrounding 'subsistence' farms in Roman Italy and beyond. The latter economic model often suffered from a lack of arable land, but had a surplus of workers. The former had need for considerable additional workers during the harvest and other peak seasons.[1] Ideally, these two types of farms would complement each other. Villas could avoid keeping a permanent workforce without enough work to do, while smallholders could earn cash money or could be granted access to facilities which demanded investment in capital they lacked, such as wine presses or storage units close to markets.

The crucial question is how well this model of workforce exchange worked in reality to build a circle of exchange in the Roman countryside. Possible obstacles lay on both sides of the bargain. The smallholders could lack the necessary infrastructure to get to the next villa within a reasonable time, could be occupied harvesting the same kind of crops on their own land, or simply could not care enough, (either due to lack of information or indifference towards the possibilities offered by earning cash money). The villas, on the other hand, could profit from more suitable sources of workforce, especially slaves of the same owners but from different estates, unoccupied at the time. Additionally, they may be unwilling to employ workers from surrounding areas for political reasons, or focused on conspicuous consumption in the form of slaves.

Looking at the ancient economy, scholars over the last 150 years have often found that it lacks a certain kind of entrepreneurial spirit. Over 1000 years the means of agricultural production and processing seemed to have hardly changed. Still potent are the suggestions advanced by Moses Finley and others that the ancient landowners, in particular the Roman elite, lacked a real sense for rational thinking when it came to terms of investment and return. It has often been claimed that the Roman elite could rely on a permanent stream of slaves from successful wars to provide cheap labour for their huge estates. Furthermore, it was proposed that Roman large landlords had no incentive to heighten returns from their land by technology, a rational division of labour, or even sophisticated bookkeeping.[2] The classical works cited to support this approach ranged from the writings of Cicero to Tacitus; these authors are almost exclusively members of the elite and, one could argue, not really connected to the actual day-to-day-business on their estates. Most importantly, however, is the often-neglected point that they wrote with an agenda of their own. This agenda often encompassed criticism of elite behaviour and was not meant to be a description of the real world.

The idea of the prevalence of slaves over free landowners in ancient Rome goes back to well-known texts such as this famous passage from Plutarch:

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"But his brother Gaius, in a certain pamphlet, has written that as Tiberius was passing through Tuscany on his way to Numantia, and observed the dearth of inhabitants in the country, and that those who tilled its soil or tended its flocks there were imported barbarian slaves, he then first conceived the public policy which was the cause of countless ills to the two brothers. However, the energy and ambition of Tiberius were most of all kindled by the people themselves, who posted writings on porticoes, house-walls, and monuments, calling upon him to recover for the poor the public land."[3]

In this text, greedy landowners seem to stand against the poor *plebs rustica*, depriving them of their land and replacing them with slaves (i.e. not even keeping them on as tenants). The moralising quality of texts such as this has often been overlooked. Finley notes: "Clearly the exploitation of agricultural labour was intense, of tied peasants and dependent labour in the eastern and some other conquered territories, primarily of slaves and of the marginal free men who took small tenancies in the classical heartland."[4] This fits well with other ancient texts, from Cicero to Vergil to Plutarch. Mostly, the contrast is made between slaves working for absentee landlords, and free farmers who are either landowners or tenants barely getting by.[5]

While the concerns of the landowning elite make up most of this evidence, a great part of the actual work was probably done by neither of those groups but by free labourers who were temporarily employed, mostly on mid- or small-sized villas. These also made up a great portion of the labour on bigger estates.

A quick calculation suffices to show that slaves were a profitable means of production only when there was work all year round, a piece of knowledge clearly shown by Columella.[6] According to him, an able adult slave cost about 6,000 to 8,000 sesterces, and at the same time a landowner paid his free day labourers about four sesterces a day.[7] Even if one takes the low price of 6,000 sesterces and optimistically assumes that this slave would work full-time for 30 years, one could employ a free labourer for the price the slave had cost for 42 days each year – more than enough to cover all the labour-intensive periods on a farm, like ploughing or harvest seasons. However, slaves also needed food, drink, and housing, and by no means would remain healthy at all times. All things considered, the costs for a slave might have amounted to close to 20,000 sesterces over 30 years, adding up to 5,000 days of work (i.e. almost half a year every year).[8] This, of course, would have been a convincing argument for any Roman farmer to use just a minimal staff of slaves together with a supplementary force of seasonally employed free labour, provided that there was a sufficient quantity available.[9]

The most successful villas thus probably operated in areas of mixed economic character, where villas and smallholders existed side by side.[10] Slaves were usually valued by their agricultural owners. As everywhere in the Roman economy, there were different degrees of skill and levels of responsibility in Roman agriculture, with the two going hand-in-hand.[11] Whenever ancient writers discuss investing in slaves, they do not forget to mention a good education and a system of rewards, including the possibility, if not to be freed, to live almost like free-born people.

We find slaves in all kinds of services and trades, where they usually make up the well-educated and higher-ranking part of the personnel. In potters' workshops and brickyards, for example, they are attested as supervisors of free workers. Knowledge counted more than legal status, especially from the perspective of the slave owner. The same seems to be true for the rural economy. Personal legal status often seemed too abstract a concept to govern the daily operations on a Roman villa. Varro explicitly suggests having literate slaves as foremen, who should even be entitled to rebuke and strike the free staff whenever they deemed it necessary. Furthermore, they should be rewarded and assigned little plots of land or a small flock for their own use in order to have them develop strong ties with the estate.[12] This model, born out of necessity and generations of practice, became a space with its own legal setting. For example, the shepherds in the 2nd century A.D. novel *Daphnis and Chloe* are slaves, but the readers are told about that only just before the end, when they need the permission of their owner to get married.[13] Until that point, they and many other characters acted as if they were completely free. A novel may seem a little far from reality, but according to each and every one of our agricultural writers, one had to take good care of the slaves. Often this might be the result of a humanitarian rather than a utilitarian motivation, but this is exactly the point. *Servi quasi coloni* (i.e. slaves acting as quasi-independent tenants) were a ubiquitous phenomenon.[14]

A great part of recent scholarship, though, trusts rather in conspicuous consumption than in rationality as a prime motif for Roman elite behaviour. Losses might have been taken in order to attain higher goals in aristocratic competition. Slaves might have been an excellent means for that, and they are presented as such in some passages of Roman literature.[15] These passages, though, should not be seen as accurate representations of reality, but rather as a conscious exaggeration for the sake of social and moral criticism.

Farms of 10 *iugera* of land or less were not capable of comfortably sustaining a family, but this size is what was given to retiring Roman soldiers and is often mentioned in our texts.[16] So, where would the rest of the necessary funds for those families have come from? The 'primitivist' view in ancient economic history supposes the ruthless exploitation of the arable land, destroying the last resources of those families. It needs to be taken into account, though, that the Roman economy lasted for over 500 years basically within the same set of principles, so a constant loss of land does not seem to be the right solution for the problem of surplus workforce.

It remains to consider huge wanderings of labour from small farms to bigger villas as well as into nearby towns. Hired temporary workers were a ubiquitous phenomenon in the Roman world.[17] In towns we find temporary labour, too, but we can rarely distinguish whether the free workers came in from the countryside or were actually part of the *plebs urbana*.[18] It has been shown that there was no clear social or economic division between Roman towns and the surrounding countryside.[19] This clearly also applies to the frequent exchange of temporary workers, whether a city-based entrepreneur was

looking for someone to fill in with the packing of pottery, or a rural landlord came to town in search of harvest labour, as described in the Gospel of Matthew.[20]

Our sources abound with documentation of temporary work in the Roman countryside, and those were not only the infamous *obaerati*, people working off their debts, who are mentioned by Varro in Asia Minor, Egypt, and Illyricum.[21] The dozens of papyri from Egypt that stipulate seasonal work might be considered an exception. Yet, Cato and others give their readers a whole set of examples and models for such contracts for basically every kind of harvest where time was a critical issue; large forces of labour were a necessity over short periods of time.[22] Pliny the Younger, certainly one of the wealthiest senators of his time, takes his urban slaves with him when harvest is due and puts this in the centre of one of his letters.[23] This must have been considered extraordinary, and Pliny might well be fishing for compliments here, showing himself off as a frugal owner who avoids hiring extra labour, the usual way of supplying the extra workforce needed for harvest and other peak seasons. This behaviour points to a temporarily huge demand for labour meeting the unwillingness of the Roman elite to supply it from their own staff. Untrained free workers filled in. In another letter, Pliny deplores the lack of good tenants for his land and reacts by sending guards for the fields and slaves as supervisors.[24] This happened in Roman Italy, where purportedly masses of slaves laboured in the fields, as Gaius Gracchus had already written 200 years earlier!

In regions where huge estates were the dominant feature, the supply of free labour from nearby farms certainly had its limits. To supply it anyway, there were companies with huge working gangs. These companies had long-term contracts with the landowners, and the gangs worked their way through Italy, North Africa (where slaves were always rare),[25] Egypt, Mesopotamia, and certainly several other regions for which we lack testimony.[26] The famous harvester's epitaph from Mactar shows the protagonist as part of such a gang,[27] but there were also small enterprises that specialized in certain activities during harvest season, such as the correct preparation and working of the oil presses.[28]

These specialists probably were the exception. Our evidence rather points towards a *plebs rustica* that hired out their readiness to work, and not with special skills. A graffito from Pompeii ridicules a man for having worked as waiter, potter, saltfish-maker, baker, farmer and many other jobs.[29] Those certainly were odd jobs for an unskilled worker.

Of course, due to the nature of our archaeological and textual sources, quantification is a problem also when it comes to estimating the contribution of free labour to the economy of the Roman villa. But it seems that especially on mid-sized farms they were the unrivalled model for every farmer who had his wits together. It is probable that slaves usually figured as rather independent agents of their owners, often blurring the lines of civil and legal status. The flourishing cities of Roman imperial times attest to a flourishing rural economy. This is best imaginable by suggesting an efficient exchange of temporary labour.

These conclusions might affect our view towards the remains of Roman farms and rural estates. In the surviving archaeological evidence, there are very few examples of Roman villas where we can be sure that they had slave quarters. It is often assumed that compact structures around an inner courtyard, like the ones at Lucus Feroniae, Boscotrecase, Settefinestre, and some others, were used to house slaves.[30] Very rarely do we actually find them equipped with shackles, guard rooms, or other clear indications for the legal status of the occupants.[31] Mere trust issues, on the other hand, might have come up when the landowner's own slaves were concerned, and perhaps especially when landowners had to hire an additional temporary workforce they did not necessarily know from previous enterprises. Rooms used as living quarters other than those for the landowner or his steward (especially on farms smaller than the large senatorial or imperial estates, but also other kinds of farms), should be considered as a multiple-use structure, occasionally providing housing for free labour.

Notes

[1] Varro rust. 1, 17; Shaw 2013, 13–23.

[2] For this whole discussion, see the summary in Pleket 1990, 32–53; Greene 2000.

[3] Plut. TG 8, 7; cf. Plut. TG 9. For Gaius Gracchus as a writer of pamphlets and thus fabricating his own legend see also Cic. div. 2, 62.

[4] Finley 1985, 103; cf. Pleket 1990, 99–102.

[5] See the summary in Bringmann 1985, 8–16.

[6] Columella's postulate of eight slaves working fifty hectares of arable land (2, 12) has been shown to cover just a little less than the amount of work required year-round, but nothing more: Bringmann 1985, 16; Spurr 1986, 136–140.

[7] Colum. 3, 3, 8; cf. Hor. epist. 2, 2, 1–5 and Plin. nat. 10, 84; NT Matth. 20, 1–5.

[8] For a detailed calculation, see Tietz 2015, 290–291.

[9] Rathbone 1981.

[10] Cato agr. 13; Varro rust. 1, 17, 2.

[11] See, e.g., the list in White 1970, 332–376.

[12] Varro rust. 1, 17, 4–5.

[13] Longus 3, 31; 'marriage' among slaves and other 'liberties' conceded to them prove this point, that reality often superseded legal status: White 1970, 351–359; 411. Similarly, a freedman in Petronius claims to have been a slave for 40 years, with no-one knowing his real status: Petron. 57, 9.

[14] Pleket 1990, 100–102 with note 130; Tietz 2015, 292–294.

[15] Petron. 47, 12–13. 53, 2–10. 57, 7; Brunt 1975; Pleket 1990, 100.

[16] See the compilation in White 1970, 345–347.

[17] Cic. off. 1, 150; White 1970, 347–350.

[18] CIL IV 10150.

[19] Goodman 2007.

[20] NT Matth. 20, 1–5.
[21] Varro rust. 1, 17.
[22] Cato agr. 64–67. 114–115. 153–154; Longus 2, 2; Shaw 2013, 31–33.
[23] Plin. epist. 9, 20, 2: *Ipse cum maxime vindemias graciles quidem, uberiores tamen quam exspectaveram colligo, si colligere est non numquam decerpere uvam, torculum invisere, gustare de lacu mustum, obrepere urbanis, qui nunc rusticis praesunt meque notariis et lectoribus reliquerunt.*
[24] Plin. epist. 9, 37, 2–4.
[25] Lepelley 2006, 102.
[26] Suet. Vesp. 1, 4; Rufinus Hist. Mon. 18; Shaw 2013, 72–79.
[27] CIL VIII 11824.
[28] P. Oxy. 1631.
[29] CIL IV 10150.
[30] See the compilation in Andrews – Privitera 2016, 136–237.
[31] For a critique of the interpretation of the slave-quarters at Settefinestre and Lucus Feroniae, see Marzano 2007, 125–153.

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Planning and Investment in a Peasant Landscape: the Site of Podere Marzuolo (Tuscany, Italy)

Astrid Van Oyen – Gijs Tol – Rhodora G. Vennarucci

The site of Podere Marzuolo (Grosseto, Tuscany) highlights the precariousness of making firm typological distinctions between villa and peasant economies in Roman Italy. Situated c. 35 km away from the coast and from the nearest urban settlement of Roselle, Marzuolo finds itself in a fragmented Tuscan topography, which is populated by sites associated with small-scale peasant activity. Marzuolo exhibits many features traditionally ascribed to villa economies. The site, which covers c. 2–3 ha, was carefully planned and experienced a sudden, large-scale investment in construction in the early to mid-Augustan period. This included a central building in *opus quasi-reticulatum* masonry, and a material assemblage testifying to supra-regional connections (e.g., amphorae). However, neither the layout of the site nor its material signature conform to the image of a traditional *villa rustica*. Instead, recent excavations by the Marzuolo Archaeological Project (2016–2017) have revealed a purpose-built and multi-craft community, geared towards production and distribution. In particular, Marzuolo produced *terra sigillata* pottery, the emblematic fine ware of the Roman empire, in both an experimental phase (final quarter of the 1st century BC) and a later, standardized phase (mid-1st century AD). In addition, there is firm evidence of blacksmithing on site, as well as indications of carpentry and other crafts.[1]

As a site without type – and thus without disciplinary history – Marzuolo throws into relief questions about the nature and drivers of the Roman rural economy, and about the agencies at stake in Roman history. Investment at Marzuolo concerned not only infrastructure but also human capital, a much-overlooked factor in the Roman rural economy. While the extent of elite investment in agriculture and rural production more generally has been a long-standing concern, Marzuolo urges us to ask whether such models leave space for experimentation and innovation. Did large landowners invest in sites other than villas and activities other than agriculture, perhaps on a more modest scale than the elite-run brick manufactories or mines? Were they interested in developing new productions and new techniques? To what extent did they depend on the labour, and the skills, of smallholders? Or, alternatively, could peasants innovate? Was bottom-up innovation a viable option in the Roman rural economy? In short, where did risk taking reside in the Roman rural economy? Based on the current evidence, Marzuolo cannot conclusively answer these questions. However, its data refuse to comply with existing explanatory narratives, and encourage the development of more nuanced models of the Roman rural economy together with the consideration of more diverse agencies.

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Economy and Production Systems in Roman Cisalpine Gaul: Some Data on Farms and *Villae*

Maria Stella Busana – Claudia Forin

Aims and Methods

In the past years, part of Claudia Forin's PhD project carried out a systematic census of isolated extra-urban sites (from the 2nd century BC to the 5th century AD) excavated in Roman northern Italy.[1] The data come from published documentation that is supplemented whenever possible by archival data. We analysed more than two hundred sites that offer a representative picture of the sparse settlements in this area. The data were stored in a database that featured several sections, including the environmental and topographical context, the buildings in general, and individual rooms. The database is linked to a GIS, with the aim of undertaking a distributional analysis and to connect the dataset with environmental and topographical data. The 203 sites are distributed throughout the entire study-area, with the greatest concentration in the plain. The collected data were studied both from architectural and functional perspectives in order to understand the cultural models (local or external) and the economic role. When possible, we attempted to give a socio-economic assessment of the owners.

C.F., M.S.B.

Data Analysis

The analysis of many different aspects has led to the definition of six principal settlement types, distinguished on the basis of the criteria summarised in the table (figs. 1–2):

- Geographical and topographical setting
- Dimensions (smallest possible overall area occupied by site)
- Ground plan and architectural characteristics
- Specialised zones (residential and productive)
- Decorative elements (both fixed and portable) and infrastructure (such as baths and heated rooms)
- Productive equipment and indicators of production (fixed and movable)
- Construction materials and building techniques

It was possible to suggest an interpretation for 138 out of 203 sites. The first major split is between farms (Types A and B) and villas (Types C, D and E): the fundamental differentiating element is the scale, both in terms of architectural form and economic capacity. The analysis identified a total of 25 farms of different sizes, situated in inland rural areas, particularly in the western and eastern parts of the study-area.

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	Settlement type	Geographical and topographical setting	Dimensions	Ground plan and architectural characteristics	Specialised zones	Decorative elements and infrastructures	Productive equipment and indicators of production	Construction materials and building techniques	N° Sites
Type A	**Small farms**	Rural setting (plain)	130 to 230 sq.m.	Small compact building with no internal court	No (multifunctional spaces)	-	-	Local materials in the substructures and walls in perishable materials	10
Type B	**Medium farms**	Rural setting (plain and hills)	>350 to >480 sq.m.	Different buildings or main building with additional annexes	Domestic and artisanal activities in specific spaces	Small decorative elements	Artisanal activities in specific spaces or in courtyards	Local materials in the substructures and walls in perishable materials	15
Type C.1	**Villas with residential and productive areas**	Rural setting (plain, hills and lagoon)	>750 to 3.000 sq.m.	Building organized around a central courtyard; different buildings; terraces; annexes	Clearly differentiated areas	Quite pleasant living areas (baths and heating plant)	Modest productive facilities	Local materials in the substructures and walls in perishable materials; buttresses	74
Type C.2	**Villas with residential and productive areas**	Rural setting (plain, hills and coasts)	>3.000 to 7.700 sq.m.	Building organized around a central courtyard or more courtyards; terraces; annexes	Clearly differentiated areas	Pleasant living areas (baths and heating plant); adoption of central italic models	Well-developed productive areas	Local materials in the substructures and walls in perishable materials; buttresses; no-local materials	
Type D.1	**Representation villas**	Rural hilly setting; suburban villas	>2.700 to 4.000 sq.m.	Compact building employing *basis villae* and terracing	Residential spaces	High quality decorative equipment; baths and heating plant; adoption of central italic models	No evidence	Local materials in the substructures and walls in perishable materials; no-local materials	27
Type D.2	**Representation villas** (including Late antiquity villas)	Coastal and suburban setting (including rural positions)	Until 18.000 sq.m.	Compact building employing *basis villae* and terracing or linear building with scenographic front	Residential and representative spaces	High quality decorative equipment; baths and heating plant; adoption of central italic models	No evidence	Local materials in the substructures and walls in perishable materials; no-local materials	
Type E	**Villas-*mansiones***	Rural and coastal setting; close to road network	> 620 to 7.700 sq.m.	Building organized around a central courtyard or more courtyards	Differentiated areas	Quite pleasant living areas (baths and heating plant)	Productive facilities	Local materials in the substructures and walls in perishable materials; buttresses	8
Type F	**Specialised productive centres**	Rural setting, close to waterways and transit routes, not far fron cities	Smallest overall area occupied: 4000, 2500 sq.m.	Different buildings	Minimal or absent residential quarters; well-developed productive areas	-	Production in the external areas or in specialised spaces	Local materials in the substructures and walls in perishable materials; buttresses	4

Fig. 1: Table of settlement types.

Modest dimensions (130–230 m^2) characterise Type A farms and they tend to have fairly simple architecture (fig. 3). A total of 10 have been identified. We can imagine that the small farms met the needs of a single-family group, given the presence of only a few rooms and one hearth. However, it is not possible to say whether the inhabitants worked a small *fundus* of their own or whether a larger villa employed them as workers. It is also possible that these buildings were only used seasonally. Such farms must have been very widespread, but they are not very visible on the ground and may also have been built-over by later villas.

Type B farms (15 cases identified) are larger and complex structures, with a main building (350–480 m^2) and additional annexes, sometimes delimited by enclosures. This type of farm has traces of both domestic and artisanal activities, carried out in specific spaces or in courtyards. The farm's economy was based on the processing of agricultural and husbandry products, indicated by the presence of storerooms and stables, such as at the Rosta (Turin)[2] and Roncade-Ca' Tron (Treviso)[3] sites (fig. 4). It should be noted that many of these sites lie within a 15 km radius from urban centres or near terrestrial and fluvial communication routes.[4] These farms seem to have provided for the needs of their occupants plus a small surplus destined for rural or urban markets. The connection to markets, even though limited, is probably the key-factor favouring the longer habitation of these sites in comparison to smaller farms.

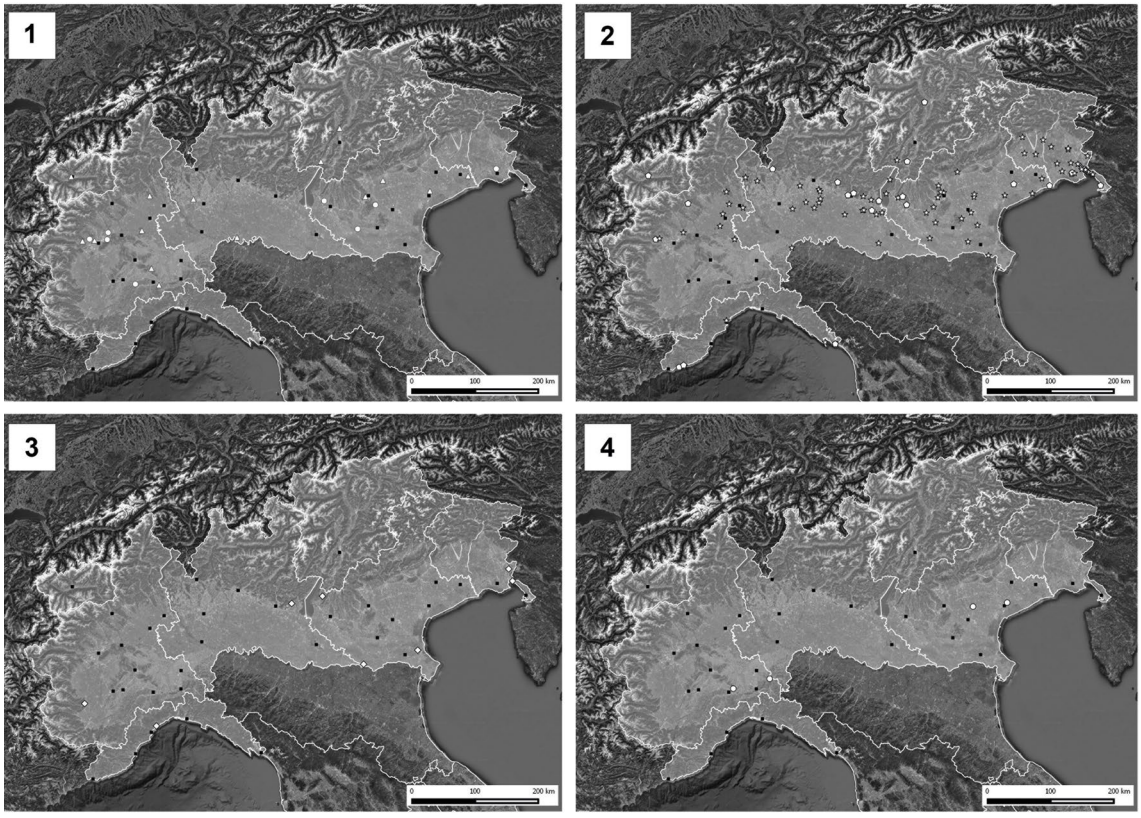

Fig. 2: Distributional maps of the sites attributed to the six settlement types. The black squares represent the main ancient urban centres. 1) Type A farms (circle) and B (triangle) – 2) Type C villas (star) and D (pentagon) – 3) Type E *villae-mansiones* (diamond); 4) Type F production centres (circle).

The *villa*[5] is the typical unit of rural settlement in northern Italy and is found everywhere, particularly on hills and plains. There are a variety of types differentiated according to their scale and main function.

The Type C villas (74 complexes) feature the presence of clearly differentiated areas between residential and productive activities. The smallest villas (Type C.1) present pleasant living areas, with baths and heating systems, and have relatively modest productive facilities. These are linked to an agricultural-pastoral system, which indicates a more market-focused role in comparison to the farms. Some villas (the Type C.2) are larger, better built, and decorated, and they display urban models and non-local building materials. Furthermore, productive activities are very well-developed in this group, with the presence of wine production (like at Costigliole Saluzzo, Cuneo),[6] cereal processing (Villabartolomea-Venezia Nuova, Verona),[7] or sheep-farming facilities (Vicenza-Dal Molin)[8] (fig. 5). Sometimes, there is the clear adoption of Central Italic models, both in terms of residential architecture (the *atrium* type) and of productive aspects (presence

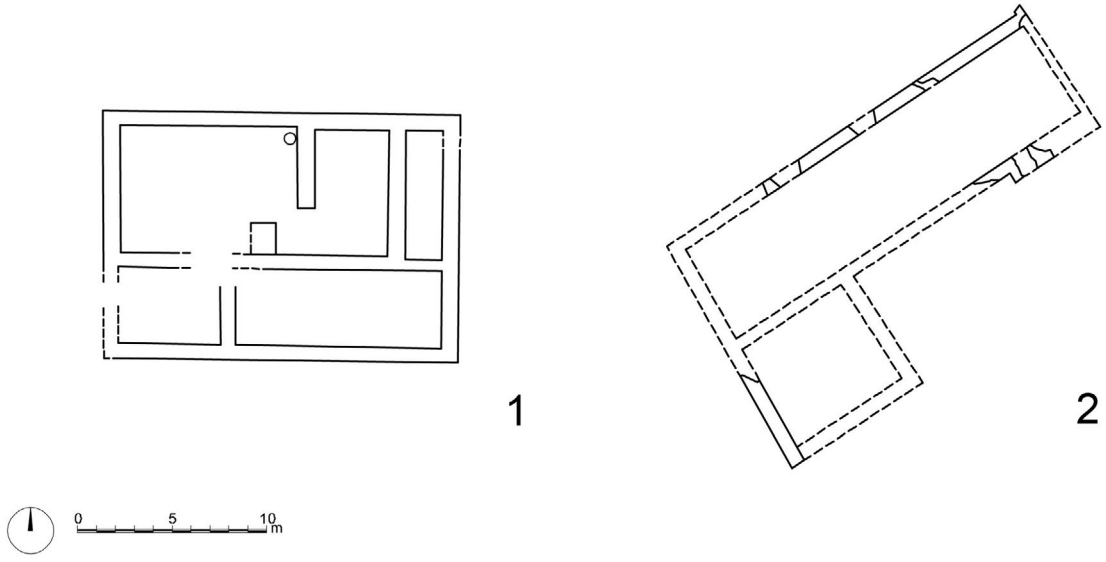

Fig. 3: 1) S. Pietro in Cariano, Archi di Castelrotto (Verona). 1st–2nd century AD – 2) Pianezza (Turin). Roman era. Plans of Type A farms.

of *torcularia*). A notable example is the famous maritime villa of Varignano,[9] in the territory of the colony of Luna, which was founded in 177 BC.

The Type D villa (27 sites are known) can be seen as a proclamation of its owners' status. Two sub-groups exist for this category, based on their dimensions and architecture. Most of these villas show good-quality construction techniques, the use of *basis villae* and artificial terracing, together with high-quality décor and architectural apparatus (Type D.1). No evidence of production activities was found, but this could be due to the limits of the excavations. The recorded complexes were always located in commanding positions: on the hills, as in the case of the Almese villa (Turin),[10] or along sea- and lake-shores. The same status claims can be seen in the suburban villas, which are located in proximity to the city. Despite this, they still offer tranquillity and privacy, while surely also representing excellent investments for the members of the higher social classes.[11] Some costal villas, especially the ones located on the shores of Lake Garda, stand out for their exceptional architectural and decorative elements (Type D.2). Examples of this type come from the so-called Grotte di Catullo villa, in Sirmione (Verona),[12] and the Toscolano Maderno villa, which is attributed to the Nonii Arii, a prominent family of Brixia (mod. Brescia).[13] Considering that Verona and Brescia were not *coloniae*, these villas provide evidence of the so-called "self-Romanisation" phenomenon. This group of villas (Type D.2) that proclaimed the social status of the owner also includes some villas that underwent major reconstruction in Late Antiquity. At least four sites fall within this category, and were linked to the new centres of power in Milan and Aquileia. These sites are very large and show a high

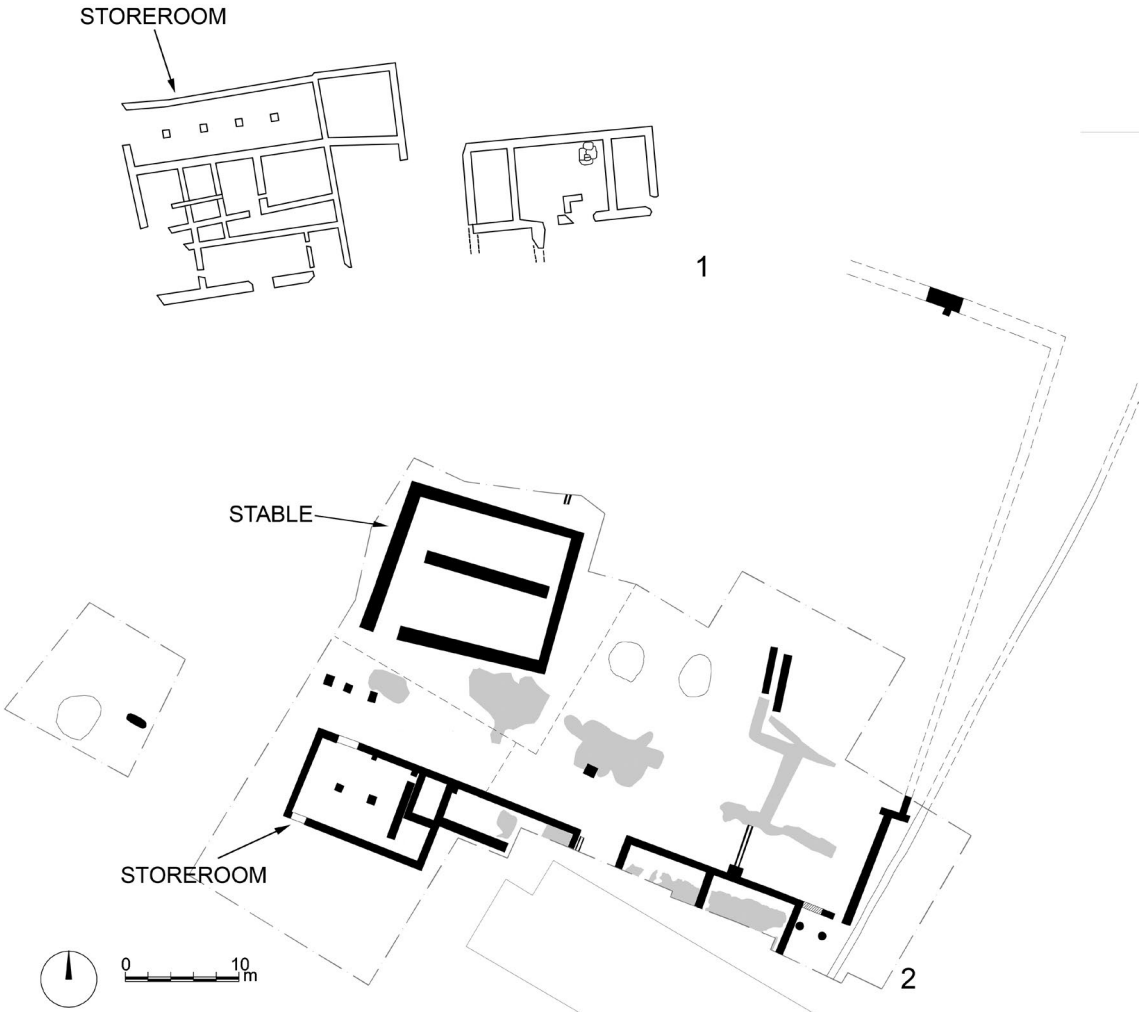

Fig. 4: 1) Rosta (Turin). 1st–4th century AD – 2) Roncade, Ca' Tron – sito A (Treviso). 1st–5th century AD. Plans of Type B farms.

degree of complexity in their architecture and decorative elements.[14] The most striking cases are Palazzo Pignano (Cremona) and Desenzano-Borgo Regio (Brescia), where one can fully appreciate the updated architectural scheme (the pavilion villa type) and the use of a common artistic language attested throughout the Empire.[15]

A further type of villa (Type E) consists of structures that seem to have had a dual purpose as both unit of production and inn,[16] as mentioned in sources such as Varro[17] and Columella.[18] The eight complexes identified as villas-*mansiones* feature good-quality lodgings and services that are separated from the living quarters of the villa itself. Such complexes also were in close proximity to the road network. Excavations at Albisòla Superiore (Savona) have revealed the most interesting villa-*mansio* (fig. 6); it is located close to the *Via Iulia Augusta*, between Genua

Fig. 5: Vicenza, Dal Molin: plan of the complex.

and Albingaunum. This site is commonly identified with Alba Docilia,[19] mentioned (without an illustration) in the *Tabula Peutingeriana*. This complex has all the characteristics of a big farm: the living quarters and baths lie to the southwest, while to the north and northwest we find storage rooms and production facilities all arranged around a courtyard.[20]

A sixth category (Type F) comprises only four examples, and is tentatively proposed for sites that were specialised production centres.[21] Large size and an absence of residential quarters characterise this type, which often were located close to waterways and to other transit routes and not too far from the city (i.e. in strategic areas for the supply of resources). An example is the Roncade-Ca' Tron complex (Altinum area, near the northern Venice Lagoon), which specialised in the rearing of sheep (fig. 7).[22] It remains an aim for future work on this type of villa to assess how they were managed and to what extent such complexes can be considered autonomous or as part of larger landholdings.

C.F.

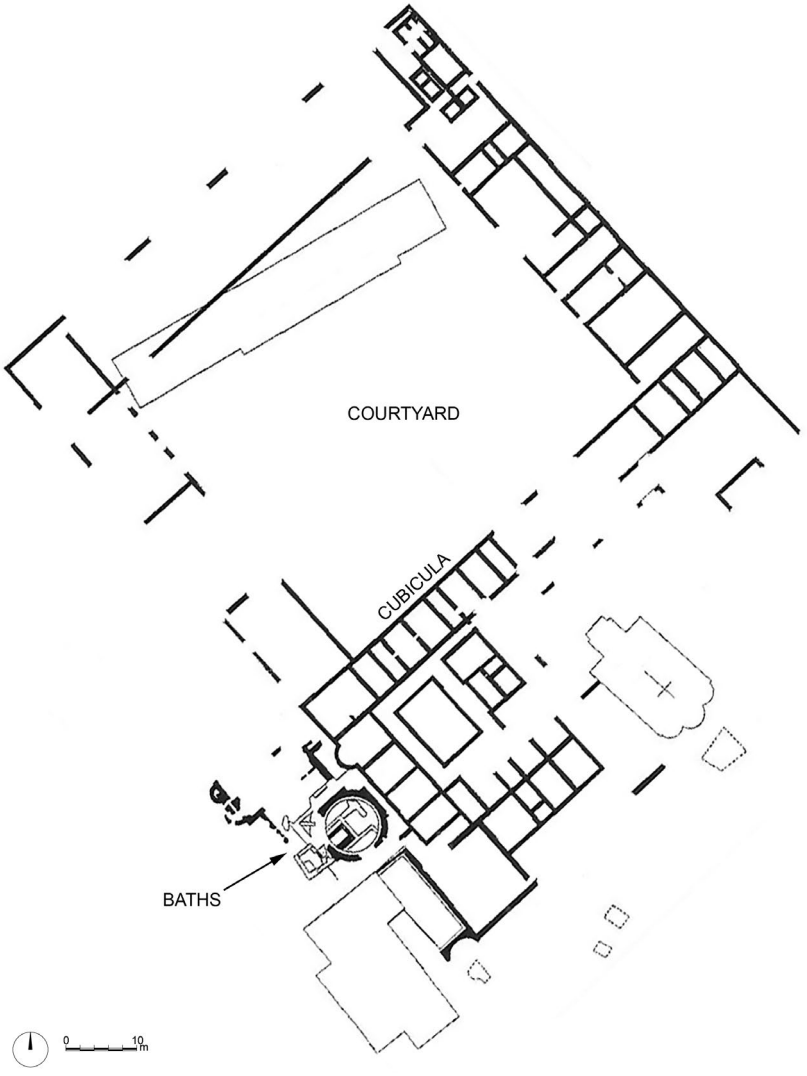

Fig. 6: Albisola Superiore (Savona): plan of the complex.

Historical and Social Aspects

The graph (fig. 8) shows the evolution over time of the different site types. This graph should be treated with considerable caution given the great variety in the quality of the documentary evidence, and in the dating criteria and the excavation methods employed. It should be emphasized that artefacts have rarely been studied systematically.

With the exception of Aquileia and Luna, *coloniae* founded in 181 and 177 BC respectively, northern Italy became part of the Roman state during the 1st century BC.

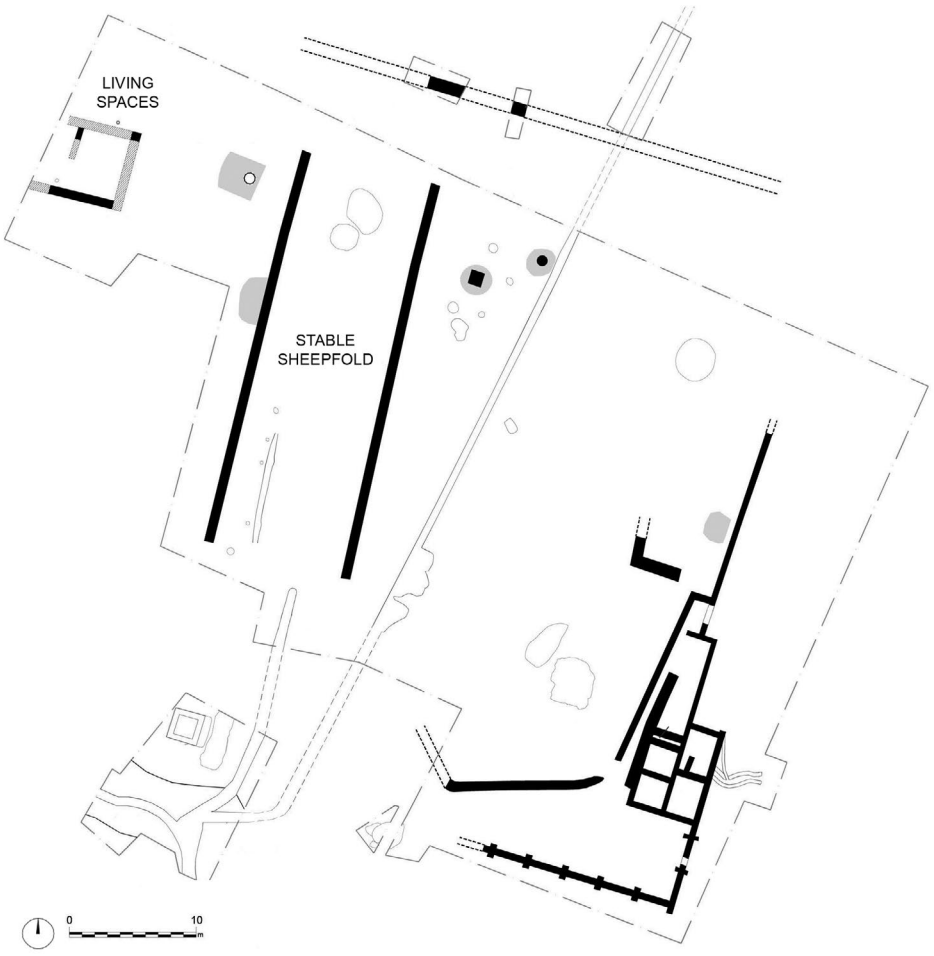

Fig. 7: Roncade, Ca' Tron – site M (Treviso): plan of the complex.

Both the farms and the first villas appeared during the Romanisation phase (2nd–1st centuries BC). In the 1st century BC, the archaeological evidence reveals the co-existence of farms (Types A and B), *villae* (Types C and E), some villas as symbols of social status (Type D), and the first productive centres (Type F). The distribution of these is strongly linked to the process of Romanisation. From the middle of the 1st century BC to the end of the 1st century AD there was a constant growth. The peak in AD 100 shows the success of the villa model.

Between the end of the 1st century AD and the mid-2nd century AD we see the first abandonments, particularly of farms, with the almost total disappearance of the smaller ones (Type A) from the 3rd century onwards. The more complex settlements (Types C and D) were able to resist better, but we still see a reversal in the earlier growth trend and, a real decline particularly for the Type C villas. These sites disappeared by the 5th and 6th centuries, bringing about the gradual depopulation of the countryside.

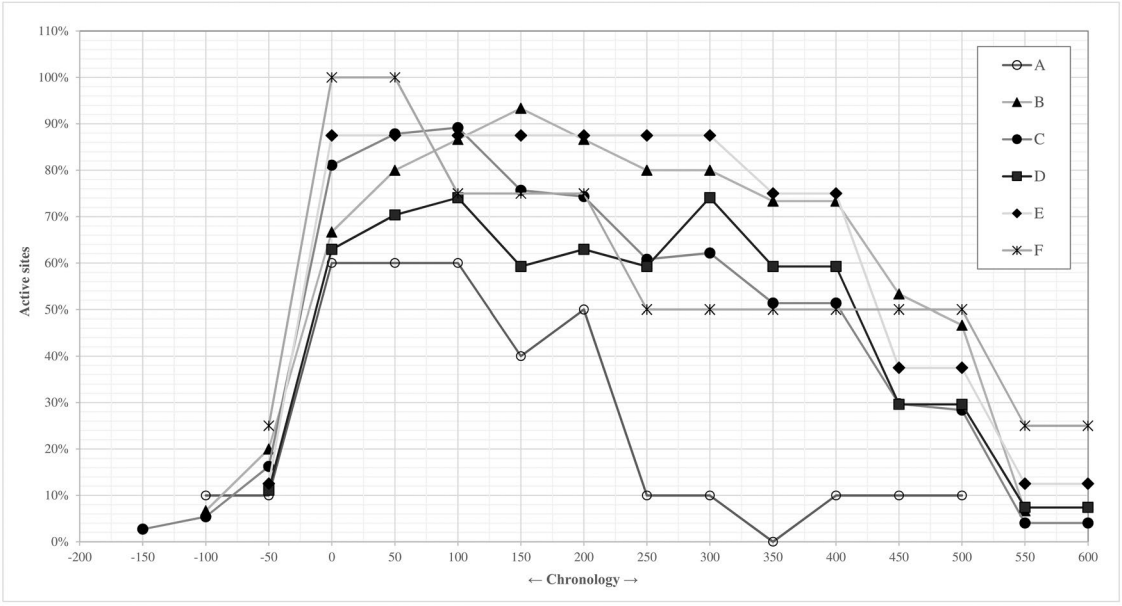

Fig. 8: Chronological trends per settlement types. The ratio of active sites is calculated on the basis of the total number of interpreted sites per each type.

It can be inferred, with due caution, that, until the end of the 2nd century AD, small and medium farms and *villae* formed part of a single productive system, perhaps complementary to each other. The signs of the crisis that troubled Italy in the late 2nd and early 3rd centuries AD – a changing economy and the merging of landholdings into ever-larger units – may have permitted the survival of the larger, more structured entities (*villae*). However, this also may have brought about the end of the smaller ones. We see this phenomenon particularly in the eastern areas, where major restructuring and transformations of their productive facilities helped large villas to survive. At the same time, the quality of their living areas greatly declined.

At this point we stop to consider a fundamental aspect: the problem of ownership and management. Given the sample of excavated sites, at the height of the villa's success in the 1st century AD, the most impressive and complex sites are concentrated heavily in *Regio X*. This result fits well with the socio-economic analysis by Marco Maiuro,[23] who noted that the documented presence of imperial property is very different between east and west. This is suggested by the near total absence of relevant epigraphy in the west. There also seems to be no documents attesting to investment by non-local senators in *Regio IX* or *XI*.

The strategic role of the north-east, where financial interest appears to have been focused, depended on the position of the *Regio X* near provinces with stationed legions. It was also supported by Aquileia's role as a point of contact between the Adriatic-Aegean regions and the Transalpine one since Republican times. Productive villas,

mostly from the Augustan era onwards, perhaps were the source of supplies for the provincial areas in which the army was stationed.[24]

The analysis shows the complex nature of settlement in the area as well as the difficulty of defining a "typology of settlements", even when focussing on the main role of the complex. This work represents a first step towards understanding the organization of extra-urban areas in Roman times, including the so-called "small towns". A continuation of this project should involve wide-ranging research agendas, including surveys and a systematic study of artefacts, something that until now has seldom happened in northern Italy.

M.S.B.

Notes

[1] Forin 2017.

[2] Brecciaroli Taborelli 1993.

[3] Busana et al. 2012, 130–135.

[4] There are eight farms located near urban centres (within 15 km). In three other cases, the farms were further away but still near a road or river path. In two cases, the complexes were located near presumed second-tier agglomerations.

[5] For a critical analysis of the terminology used in the sources: Carandini 1989, 107–108; Gros 2001, 265–267.

[6] Elia – Meirano 2012.

[7] Busana 2002, 368–377, with previous bibliography.

[8] Gamba et al. 2012.

[9] Gervasini – Landi 2002.

[10] Barello 2014.

[11] Adams 2006, 9–24. The distance of the residences from the city is commensurate to the size of the city itself. For example, the villas of the suburb of Rome are located within a radius of 30–40 km from the city, while the villas of the suburb of Pompeii are known to lie at a distance of 4–5 km.

[12] Roffia 2013, 129–135.

[13] Roffia 2015; Roffia – Simonotti 2015.

[14] Romizzi 2003, 74.

[15] Romizzi 2003, 74; Romizzi 2006, 38; Sfameni 2006; on the empire-wide use of common architectural and decorative schemes, see Marzano and Métraux 2018.

[16] Basso – Zanini 2016; Basso 2010, 156–157.

[17] Varro rust. 1, 2, 23.

[18] Colum. 1, 5–6.

[19] Tinè Bertocchi 1978.

[20] Bulgarelli 2001, 743–752.

[21] An important comparison for this type of complex comes from the provinces in particular from the

coastal territory of Catalonia, where several examples of settlements have been documented, mostly specializing in wine production: Revilla Calvo 2008, 112–113; Revilla Calvo 2010, 36–38; see also Alvarez Tortosa in this volume.

[22] Busana et al. 2012, 135–139.

[23] Maiuro 2012.

[24] Similar considerations have been proposed for the eastern sector of the *Regio VIII*, where the *classis praetoria* was assigned to *Classis*, a town close to *Ravenna* at the end of the 1st century BC. In the Augustan age, numerous production complexes were built or rebuilt here: Scagliarini Corlàita 1989, 33.

Image Credits

Fig. 1: C. Forin. – Fig. 2: C. Forin; DTM by Google Maps. – Fig. 3: Drawing by C. Forin after (1) Busana 2002, p. 342, fig. 140 (2) Barello 2004, tav. LVIIa. – Fig. 4: Drawing by C. Forin after (1) Brecciaroli Taborelli 1993, tav. CXV (2) Busana et. al. 2012, p. 146, fig. 17. – Fig. 5: Gamba et al. 2012. – Fig. 6: Bulgarelli 2001, p. 744, fig. 1. – Fig. 7: Busana et. al. 2012, p. 147, fig. 18. – Fig. 8: C. Forin.

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Production Models in Roman Commercial Agriculture: the Northwest of *Hispania Citerior* Between the 2nd Century BC and the 2nd Century AD

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From the very origins of modern historical research, specialized, market-oriented agricultural production is one of the aspects of the Roman economy that has greatly interested scholars. Especially studies focused on the specialized production of oil and wine (and the containers used for their transport) have allowed researchers to deepen our knowledge of medium- and long-distance trade.

Scholarship has established a direct and indissoluble relationship between this kind of productive activity (specialized commercial agriculture) and a specific type of rural unit: the *villa rustica*. This relationship has its origin in the confluence between the information transmitted by classical sources[1] and by a type of archaeology that we could qualify as 'romantic-philological.[2] With this term I refer to a very specific type of archaeology, whose ultimate intention is to use fieldwork to corroborate a series of *a priori* ideas derived from the literary sources. This approach marked the excavations developed by the team led by A. Carandini at the Settefinestre *villa*.[3] Their results gave rise to the elaboration of a model, known as the '*villa* system', which in essence assumes that all the specialized and market-oriented agricultural production in the Roman world was carried out through *villae rusticae*. These centres shared a series of common characteristics indicated in the classical sources and supposedly confirmed by the Settefinestre excavation: 1) a concentration of its means of production; 2) wine and oil as the major commercial crops; 3) the use of slave manpower.

This model acquired the rank of paradigm, extending to the entire Roman world. In this way, the results of a particular case were applied to the general, without considering possible regional variants within the vast territories dominated by Rome. At the same time, the definition of another model occurred, which was opposed to the previous one: the 'peasant economy'. This category indicated subsistence farmers with little capacity to generate surplus for trade; these would have been small- and medium-sized farms where the use of free manpower prevailed.[4] We are therefore faced with a theoretical construct in which all agricultural production in the Roman world can be placed in either one or the other of these two categories. However, this juxtaposition between the '*villa* system' and the 'peasant economy' does not stand up to scrutiny when compared to the archaeological evidence that has emerged in the last decades from different areas of the Roman world. In fact, they suggest a more complex scenario that necessarily invites a reconsideration of the existing paradigms.

My research stemmed from the realization that Roman agricultural production needed to be defined more closely to the reality revealed by both the historical and archaeological sources. To this end, I selected a region of the Roman world that was

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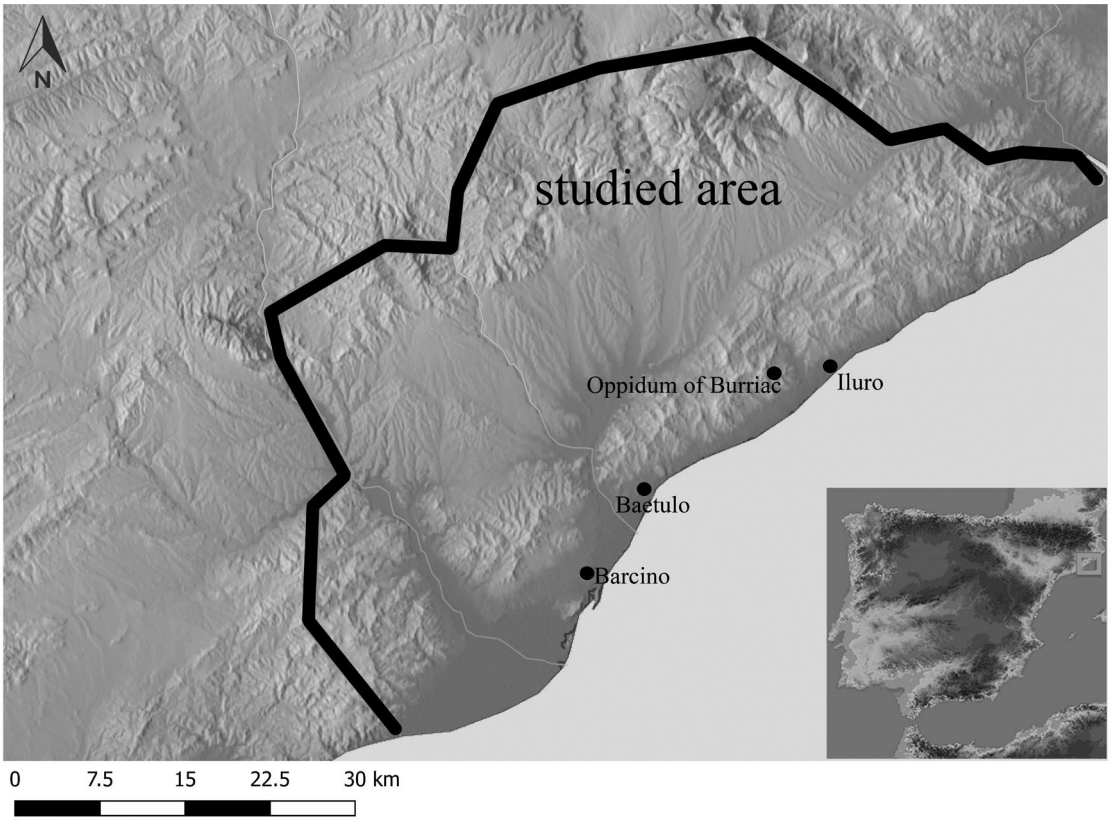

Fig. 1: The study area.

characterized by its large participation in the wider trade of its agricultural produce and that also had a high level of archaeological documentation. In order to have a feasible framework, I chose to focus exclusively on the production of wine. Based on these premises, the chosen region was *Hispania citerior* and, within it, the area where the production and export of wine is best attested: the coastal strip of the current province of Barcelona, which corresponds to the old Iberian region of Laeetania (fig. 1).[5]

The next step was to carry out the classification and analysis of all 1,380 documented rural sites for the period between the introduction of commercial wine production (the end of the 2nd century BC) until the crisis of this activity (the end of the 2nd century AD). Finally, based on the data generated, I proceeded to analyse the different forms or sub-models adopted in the agricultural production. I have distinguished up to 26 possible ways of organizing the cycle of wine production for the market, divided into cultivation, transformation, and packaging (fig. 2). The type of production represented by the two paradigmatic models ('*villa* system' and 'peasant economy') do fall within this set of sub-models but, instead of being the only possible options, they are part of a much wider range. According to their characteristics, these 26 sub-models are assigned to five large groups. The autonomous (type 1), the dependent (type 2), and the

SUB-MODEL TYPE 1 (AUTONOMOUS)					
MADE FROM *VILLAE RUSTICAE*			MADE FROM FACTORIES		
ONE PRODUCER		VARIOUS PRODUCERS	ONE PRODUCER		VARIOUS PRODUCERS
WITHOUT EXTERNAL CENTERS	WITH EXTERNAL CENTERS	WITH EXTERNAL CENTERS	WITHOUT EXTERNAL CENTERS	WITH EXTERNAL CENTERS	WITH EXTERNAL CENTERS
-SUB-MODEL 1.1.1.1	-SUB-MODEL 1.1.1.2.1 -SUB-MODEL 1.1.1.2.2 -SUB-MODEL 1.1.1.2.3	-SUB-MODEL 1.1.2.2.1 -SUB-MODEL 1.1.2.2.1 -SUB-MODEL 1.1.2.2.1	-SUB-MODEL 1.2.1.1	-SUB-MODEL 1.2.1.2.1 -SUB-MODEL 1.2.1.2.2 -SUB-MODEL 1.2.1.2.3	-SUB-MODEL 1.2.2.2.1 -SUB-MODEL 1.2.2.2.2 -SUB-MODEL 1.2.2.2.3

SUB-MODEL TYPE 2 (DEPENDENT)			
MADE FROM *VILLAE RUSTICAE*		MADE FROM FACTORIES	
ONE PRODUCER	VARIOUS PRODUCERS	ONE PRODUCER	VARIOUS PRODUCERS
-SUB-MODEL 2.1.1.1 -SUB-MODEL 2.1.1.2 -SUB-MODEL 2.1.1.3	-SUB-MODEL 2.1.2.1 -SUB-MODEL 2.1.2.2	-SUB-MODEL 2.2.1	-SUB-MODEL 2.2.2

SUB-MODEL TYPE 3 (URBAN)		
EXTERNAL TRANSFORMATION	EXTERNAL PACKAGING	AUTONOMOUS
-SUB-MODEL 3.1	-SUB-MODEL 3.2	-SUB-MODEL 3.3

SUB-MODEL TYPE 4 (SMALL LANDOWNERS)
-SUB-MODEL 4

SUB-MODEL TYPE 5 (WITHOUT COMMERCIAL ORIENTATION)
-SUB-MODEL 5

Fig. 2: The various sub-models of production.

urban (type 3) are all generated from specialized centres. Despite not being made from specialized centres, the sub-model of small landowners (type 4) also has a commercial orientation like the three previous groups. Type 5 lacks commercial orientation and meets the characteristics of the 'peasant economy' model. The same thing happens with the '*villa* system', represented by one of the type 1 sub-models.[6]

The first evidence for commercial production of wine in my studied area goes back to the last quarter of the 2nd century BC. It is limited to a few fragments of local imitations of wine amphorae of the Greco-Italic and Dressel 1 types, which were concentrated in the Cabrera valley (Cabrera de Mar, Barcelona; fig. 3).[7] This area was a real focus of indigenous power before the Roman conquest: it was the location of the *oppidum* of Burriac, the political, economic, and religious headquarters of Iberian Laeetania.[8] Rome chose a nearby location to establish its first settlement in the region, the proto-urban centre of Ca l'Arnau-Can Mateu.[9] During the first years of the conquest, prior to the founding of the first cities, the *oppidum* of Burriac and Ca l'Arnau-Can Mateu shared control of the region.[10] Evidence for Roman influence has been documented in the indigenous *oppidum* with the use of *tegulae* and *dolia.*[11] There are even some interesting elements of hybridization, such as the construction of the *oppidum* gate in *opus quadratum* accompanied by a rite of indigenous origin.[12] In this period, one of the most important buildings of the *oppidum* became a *cella vinaria.* It is a warehouse equipped with large, locally made terracotta containers, which are however smaller (0.9–1.10 m in diameter) than the usual Roman *dolia.*[13] A stone from a possible press

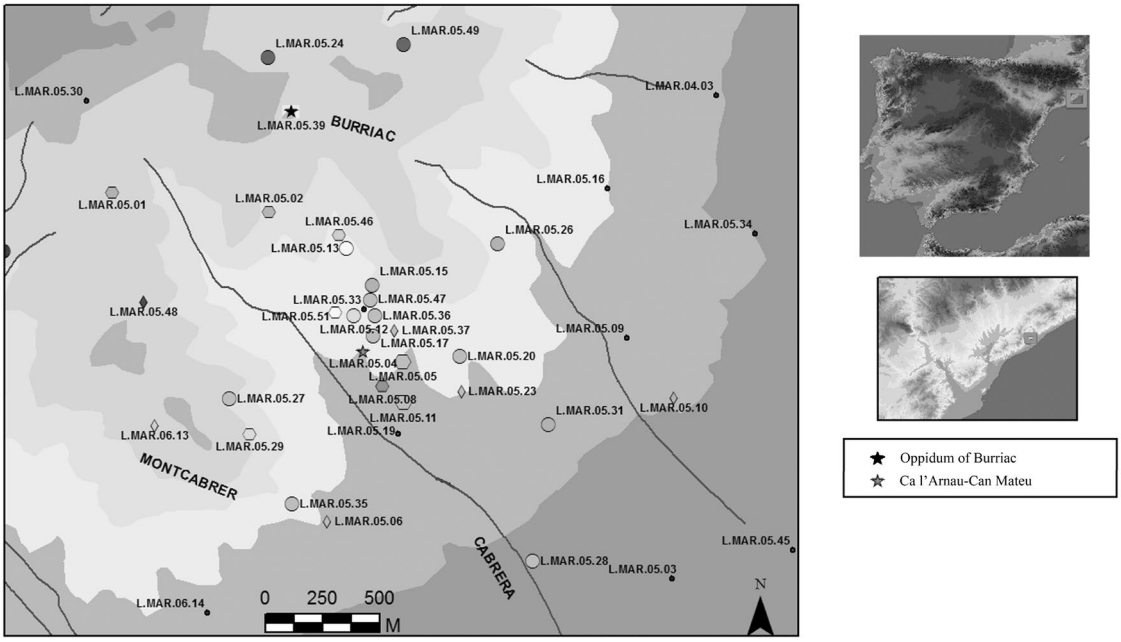

Fig. 3: Settlements in the Cabrera Valley at the end of the 2nd century BC.

was also documented (fig. 4).[14] It is more than probable that these represent the origins of local wine production. To this day, the kiln has not yet been located, but an artisanal area was identified in the partially excavated proto-city of Ca l'Arnau-Can Mateu.[15] Possibly, pottery and wine amphorae were made here. What is clear, however, is that the first production of wine for trade is to be found at the epicentre of the political, economic, and administrative power of the region after the conquest of Rome. This is a moment when production cannot be related in any way to the *villae rusticae* (fig. 5a), since these are not documented in the region before the Augustan Age.[16] Rather, market-oriented wine production was first introduced in a context linked to power. When Rome removed the management of grain from the control of the local oligarchies, this must have produced a fracture in the complex patronage networks based on the redistribution of prestige goods. Among these, wine was obtained in exchange for cereals. Faced with this situation, the conquerors allowed, and even encouraged the local production of wine in order to benefit from the collaboratively-minded local elites.[17]

The first, but modest, growth in wine production occurred only in the first two thirds of the 1st century BC, when this production activity expanded from the Cabrera Valley to other neighbouring areas. In particular this reached the cities of Baetulo and Iluro, which were founded in this period.[18] With Iluro's foundation, the proto-urban complex of Ca l'Arnau-Can Mateu was replaced by a kiln. The new city assumed the functions provisionally performed by the axis formed by Ca l'Arnau-Can Mateu and the *oppidum* of Burriac. However, it seems that this did not mean the interruption of viticulture here.

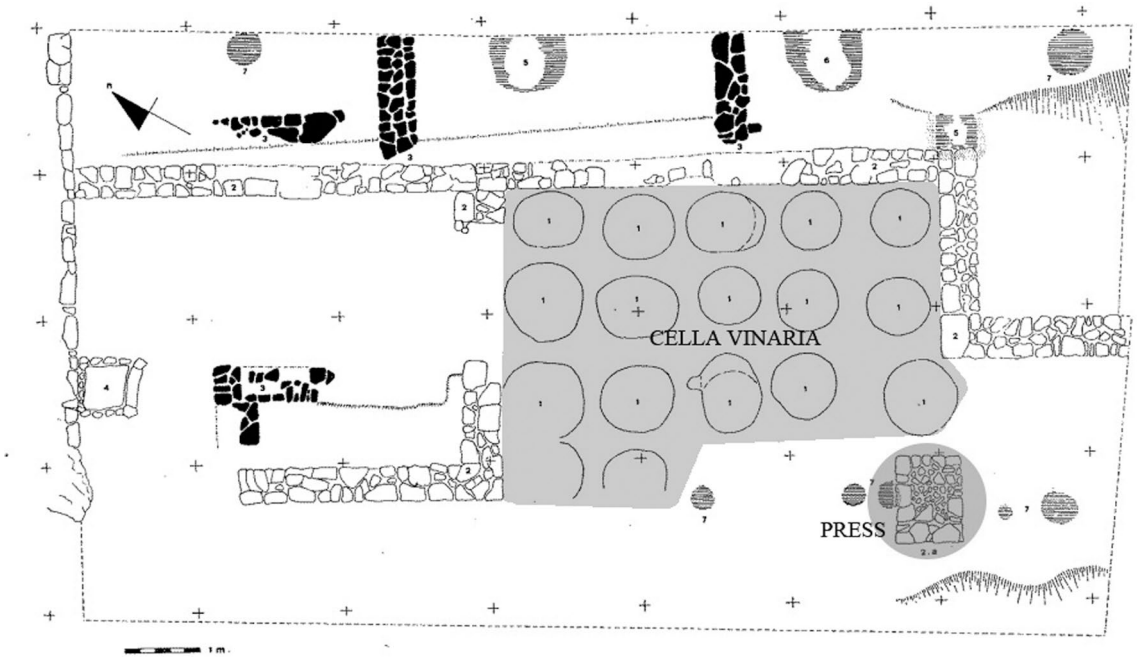

Fig. 4: Burrriac, *oppidum*: the wine warehouse.

There are no signs that point to the abandonment of the *oppidum* warehouse, so it is possible that it continued with its activity.[19] This is especially probable, considering that Ca l'Arnau-Can Mateu was transformed into a kiln that made Dressel 1 wine amphorae in this period,[20] and that no other production centre has been identified in this area.

Similarly, there are indications that allow us to link the new cities with the commercial production of wine. At Iluro, archaeological layers linked to wine production were identified from the early phase of the Roman settlement.[21] The kiln at Forns de la Riera de Sant Simó, which manufactured Dressel 1, may have supplied the amphorae.[22] In the case of Baetulo, the indications of its participation in viticulture and wine trade are more subtle. They are reduced to fragments of local Dressel 1 amphorae found in a garbage dump outside the city walls that date to this period.[23] Given that winemaking facilities are known within Baetulo as early as the Augustan period,[24] it is likely that this activity had already been developed in the area.[25] The three cases documented for this period (the *oppidum* of Burriac, Baetulo, and Iluro) have the same common denominator: wine production is linked to urban centres. In addition, all of them structure the activity in a similar way, and require the intervention of an external centre to be able to complete all phases of the process (fig. 5 b).

When it comes to the commercial viticulture and wine production of this region, the real point occurred in the last third of the 1st century BC. There was a profound territorial reorganization during the Augustan era, as evidenced by the appearance of a

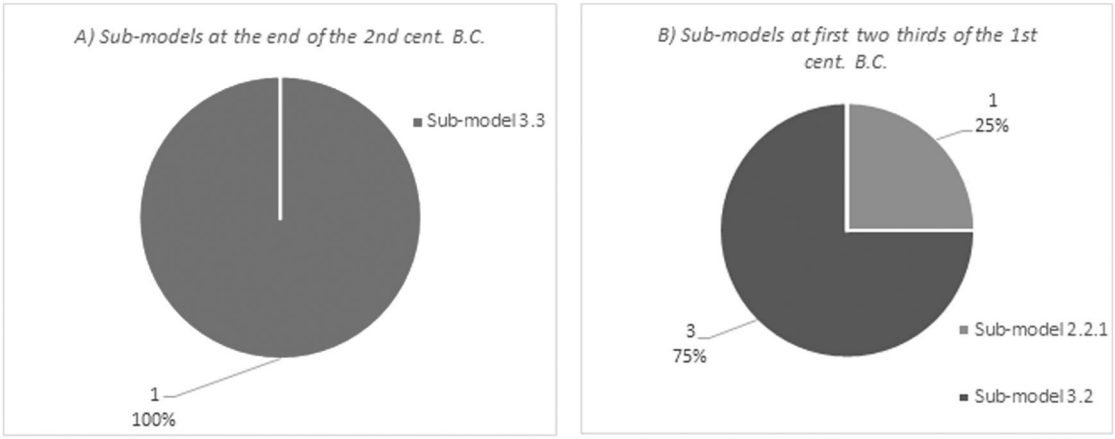

Fig. 5: Sub-models identifying different operational systems at the end of the 2nd century BC (A) and in the first two thirds of the 1st century BC (B).

new urban centre, Barcino, although this reorganization also affected existing cities and their territories. It meant the definitive disappearance of the territorial scheme of pre-Roman times and the introduction of new types of specialized production centres, such as the *villae rusticae*. It is possible to speak of a flourishing of commercial viticulture, with an unusual increase in the number of centres involved in this.[26] The sub-models of production linked to the urban world that had worked in the previous periods maintained their presence and even increased it with the incorporation of Barcino. But its weight in the total of sub-models identified for this period is diluted compared to the appearance of other sub-models that are generated around the new *rural* centres. Within the sub-models whose production is centred on *villae rusticae,* we find examples of centralized and autonomous *villae* (such as Santa Rita) that therefore fulfil the model of the 'villa system'.[27] But we also find other *villae*, such as at Santa Anna,[28] Les Piques,[29] or Cal Ros de les Cabres,[30] which have full autonomy at the production level, but show the participation of auxiliary centres. Production sub-models where no *villae* participated also existed, like the kiln of Ca l'Arnau-Can Mateu. In the previous period, the kiln was associated with the *oppidum* of Burriac, but after the abandonment of this *oppidum* in the Augustan era it was connected to the artisanal settlement of La Peirota. Thus, it shows a different type of organization of production that can be placed in a separate sub-model.[31] The Casc Antic de Sant Boi complex has a similar pattern, with the proviso that no centre for agricultural processing has been identified.[32] However, we know that there must have been several, since its material record reveals the participation of more than one producer. At times, kilns appear in well-connected areas such as river valleys, but far from other specialized centres. This is, for example, the case of Sant Sebastià and Can Matavens.[33] They could have provided amphorae to more than one producer. Given that there are no known specialized centres in their vicinity, I proposed that these kilns made wine amphorae for small, non-specialized producers.

These examples serve to illustrate the enormous diversity of modes of operation, and hence of sub-models, registered for this period. They also show that the presence of *villae rusticae* was not necessary during the initial phases of commercial viticulture in my study area; in fact, villas were not essential even after commercial viticulture had emerged. My analysis of the available data shows that the proportion of *villae rusticae* within the sub-models group does not exceed 19% of the total (fig. 6a).

The following period (covering the first two thirds of the 1st century AD) continues the same principles established in the Augustan period. The number of centres dedicated to specialized production increase in this period, reaching its zenith. These production centres continue to fall within a wide variety of sub-models. Among some of the most significant cases for this period we can single out the site at El Morè. It was a large workshop that lacked any *pars urbana*. It had full productive autonomy, although it could count on some subsidiary centres; in addition to packaging its own wine, it could do the same for other producers. It represents perhaps the clearest case of an autonomous model generated from a workshop.[34]

On the other hand, El Roser functioned according to the same model, but instead its epicentre was a *villa rustica*.[35] It was capable of carrying out the different phases of production by itself, but despite this, the possible participation of more than one producer is posited. I have also identified centres that had remained outside of specialized production until this period, like Vinya d'en Manel.[36] This site seems to have become a *villa rustica* in the mid-1st century AD. Its facilities categorise it as an autonomous and centralized *villa*, which shows the characteristics predicted by the '*villa* system'. As for the earlier period, a wide diversification of productive sub-models can be seen. Centralized and autonomous *villae* increase slightly, and are, in fact, the most represented settlement type. However, they are far from being the prevalent unit of agricultural exploitation one would expect according to the current idea of the development of Roman agriculture. According to this historical reconstruction, all wine production destined for trade would have taken place within the 'villa system', that is, through centralized and autonomous *villae* (fig. 6b).

The tendency for the sustained increase of centres related to the specialized production of wine stopped in the last third of the 1st century AD. From this moment, and throughout the following century, a perceptible decline can be seen from the disappearance of several of the amphora types used in previous periods (e.g. Oberaden 74 and Pascual 1), accompanied by the reduced presence of the most abundant type, the Dressel 2–4. This process coincides chronologically with the incorporation of other provinces, specifically *Gallia Narbonensis*, into commercial viticulture. Its wine was transported in Gauloise 4 amphorae, a type imitated by some kilns of *Hispania citerior*. However, its incidence was low compared to the flourishing experienced in previous periods. As an example of the most significant changes registered throughout this period, one can look at the site of Can Farrerons. This site was a workshop focussing on the production and packaging of wine for commerce, but after its kiln and its productive facilities ceased

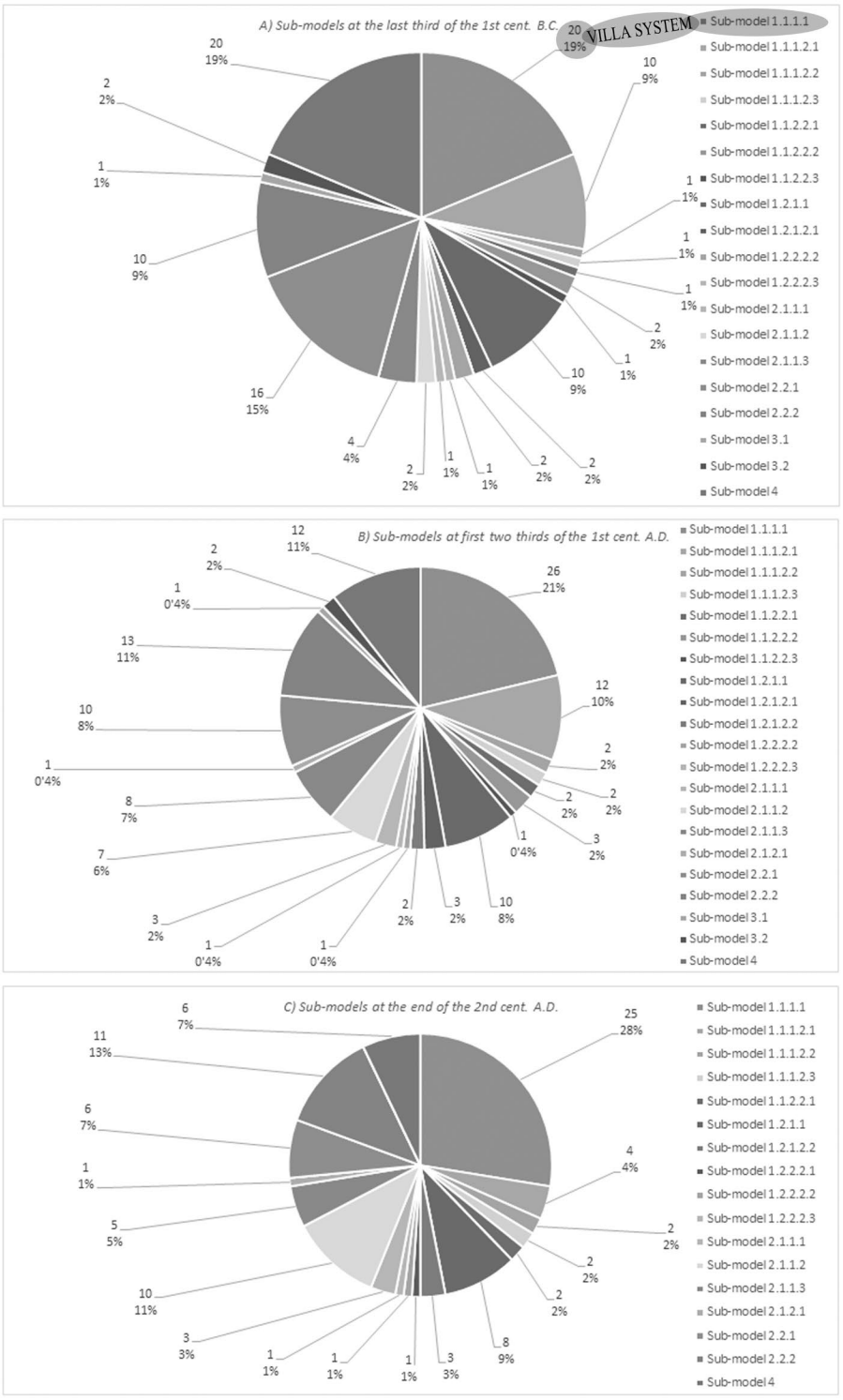

Fig. 6: Sub-models identifying different operational systems in the last third of the 1st century BC (A), first two thirds of the 1st century AD (B), and at the end of the 2nd century AD (C).

to operate in the second half of the 1st century AD, it became a luxurious residence, with no evidence for viticulture.[37] Another site noted in previous periods as part of the production organization of Ca l'Arnau-Can Mateu and La Peirota was disarticulated in the same period due to the abandonment of both sites.[38] The incorporation of new production centres into the system also took place, although to a lesser extent.[39] The general decrease in specialized wine production seems to have caused an expansion of the sub-model based on centralized and autonomous *villae*. This shows a greater representation in this period, which is not the result of a significant increase in the number of known cases (fig. 6c).

In light of these results, it can be said that, at least in my study area, it is possible to approach the specialized production of wine in a more complex way. The weight of centralized and autonomous *villae rusticae* in the total production is particularly interesting. Not only does it show that there was specialized wine production prior to the introduction of *villae rusticae* in the region, but also that their participation in this activity, while important, was far from being hegemonic.

Notes

[1] Cato agr. 2, 1–6; 5, 2; 6, 4; 7, 1–5. 65–68; Varro rust. 1, 2, 14; 1, 16, 5; 1, 17, 1; 1, 18; 1, 22, 6; 1, 36; 3,2,1-10; Columella 1, 2, 2; 1, 6; 1, 9.

[2] Molina Vidal 2013, 136.

[3] Carandini 1985.

[4] Álvarez Tortosa 2017, 698–699.

[5] Álvarez Tortosa, 22–29.

[6] Álvarez Tortosa, 86–98.

[7] López Mullor – Martín Menéndez 2008, 691; Járrega Domínguez – Prevosti Monclús 2010, 470–471.

[8] Coll Monteagudo – Cazorla Carrera 1998; García Roselló – Zamora Moreno 2006, 230; Zamora Moreno 2007, 289. 312; Álvarez Tortosa 2017, 106–115.

[9] Martín Menéndez 2002; 2004, 393–396; Martín Menéndez – García Roselló 2007, 70; Pera Isern et al. 2016, 193–198.

[10] Olesti Vila 2000, 66.

[11] Zamora Moreno 2007, 52, 126–127. 210–211.

[12] Pera Isern et al. 2016, 195–196.

[13] Zamora Moreno 2007, 100.

[14] Barberà Farràs – Pascual Guasch 1980, 227.

[15] Pera Isern et al. 2016, 194.

[16] Olesti Vila 1997, 83–90.

[17] Álvarez Tortosa 2017, 114–115.

[18] Jiménez Fernández 2002, 65–66; García Roselló et al. 2000, 41–42.

[19] Álvarez Tortosa 2017, 164.

[20] Martín Menéndez 2004, 378.
[21] Parra Ale – Acedo Rodríguez 2002, 3–4.
[22] Olesti Vila 1995, 456–457; Revilla Calvo 1995, 258.
[23] Comas Solà 1998, 221.
[24] Beltrán de Heredia Bercero – Comas Solà 2009, 162.
[25] A kiln very close to this city, at Línia 2 Pep Ventura-Badalona Centre is known, see Antequera Devesa et al. 2010, 280–286.
[26] Álvarez Tortosa 2017, 171–179.
[27] Járrega Domínguez – Berni Millet 2014, 394–396.
[28] Ruestes Bitrià 2002, 388–390.
[29] Ruestes Bitrià 2002, 220–221.
[30] Martínez Ferreras 2014, 184. 193–194.
[31] Ruestes Bitrià 2002, 643–644; Álvarez Tortosa 2017, 196–197.
[32] Martínez Ferreras 2014, 53–57.
[33] Ruestes Bitrià 2002, 387; Olesti Vila 1995, 445.
[34] Tremoleda Trilla 2008, 121–122.
[35] López Mullor-Fierro Macía 1985, 203–205.
[36] Oller Guzmán 2012, 265–266.
[37] Coll Monteagudo et al. 2016, 136.
[38] Martín Menéndez 2004, 395–396; Martín Oliveras 2004, 622.
[39] E.g. the site at Santa Maria de les Feixes, which was a villa equipped with a kiln that produced Gauloise 4 amphorae: Oller Guzmán 2012, 88–89.

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Fig. 1–3. 5–6: by the author. – Fig. 4: by the author after Barberà Farràs – Pascual Guasch 1980, 227 fig. 10.

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Villae, Fundi, Peasant Agriculture and Wine Production in the *Ager Barcinonensis*

Oriol Olesti

Any historical community establishes relationships with its environment, generating a particular historical landscape. Such a landscape may be called "social", since it is the result of the dialectical relationship between a community (in this case, a Roman *civitas*) and their territory. Traditionally, the so-called *villa* system has been considered the essence of the Roman rural landscape; in such a reconstruction, this type of settlement was considered the backbone of the territory. In fact, the *villae* were just part of this landscape, and other elements, such as the structure of landownership, the existence of workshops and modest farms, and the network of roads and resources, affected the particular social landscape. This phenomenon can be properly evaluated only with a holistic approach that takes into account cities, their territory, *villae*, farms, elites, peasants, producers, amphorae, markets, commerce, and consumption.[1]

In this paper, I discuss the case study of the *Ager Barcinonensis* (*Hispania Tarraconensis*), the territory including the Roman colony of Barcino. I also include several neighbouring cities of the region of Laeetania,[2] such as Iluro, Baetulo, Egara, and Aquae Calidae. Modern Layetania includes the regions of Barcelonés, Maresme, Vallès, and Baix Llobregat (fig. 1).[3]

Villas and the Start of the Laietanian Wine Production

The diffusion of *villae*, with their recognizable social and architectural characteristics, started in Laeetania from the Augustan period onwards. This development needs to be connected to start of the Layetanian wine production in the area and to the region's juridical and historical changes.

In fact, there are few examples of *villae* in north-east *Hispania citerior* dating back to the middle of the 1st century BC. These should be connected with the presence of some Roman urban foundations, such as Gerunda or Emporion.[4] Only when the first urban elites of these two Pompeian-Caesarean foundations formed do we see the appearance in the territory of some rural settlements. These displayed architectural features that we readily associate with a "*villa*" (courtyards, residential rooms with a certain level of décor, bath suites with hypocausts).

This is not the case in the Layetanian region and in Barcino. From the mid-1st century BC, there was an important increase of wine-producing centres and amphora workshops in this region,[5] which occupied some key areas, like the lowlands of the Llobregat River or the Maresme coast. These new production centres were not in relation to any *villae*. At some sites (e.g. Sant Boi de Llobregat, Torre Llauder) it is possible to observe the

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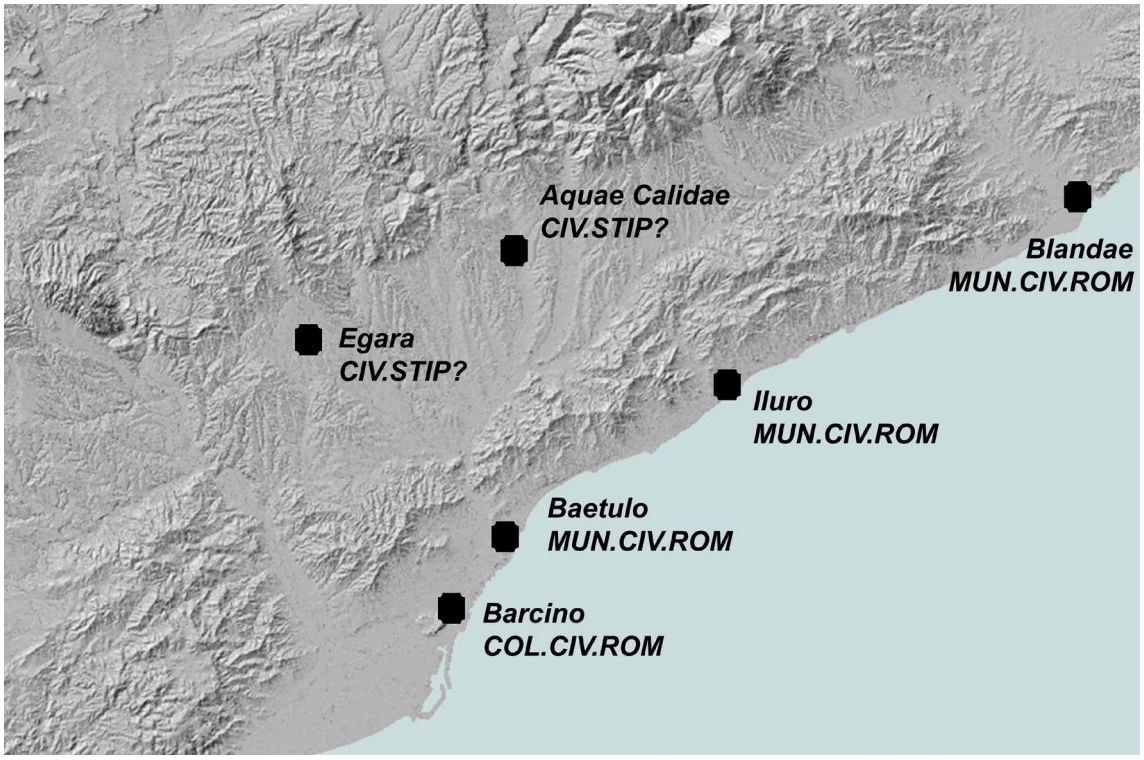

Fig. 1: Roman cities in the Laeetania region (pre-Flavian period).

stratigraphic superposition of the *villa* over the amphora kiln structures; in other words, the diffusion of wine production predated the presence of *villae*.[6]

The growth of the Layetanian wine production was the result of a previous phenomenon, which included the integration and Romanisation of local communities, as well as the activity of some Italian families, probably acting as agents or traders.[7] This initial production was not developed within the frame of the *villa*, but other forms of settlements, including Romano-Iberian farms and proto-industrial ateliers.

A turning point in the evolution of the Layetanian territory was the foundation of the colony of Barcino in 15–10 BC.[8] This *deductio* took place in the coastal territory south of the Baetulo River and impacted the previous communities of the area, probably belonging to the *civitas* of Baetulo. We do not know the exact extension of the *ager* of the new colony, but in addition to the coastal area it is likely that inland zones were also impacted.[9]

Augustan activity in Laeetania was not limited to the foundation of Barcino: in the same period Baetulo and Iluro acquired the status of Roman *municipia*. The new civic status had important consequences for the territory. First of these was the creation of local elites, whether colonial or municipal. Second was the deployment of the Roman legal landownership structure, which implied a real *dominium* over the land. Both of these developments explain the emergence of the *villa* as the main type of rural

settlement pursued by these elites, and the inversion in one of the most profitable production: the **Layetanian** wine.[10]

The Territorial Model: *Civitas* (*urbs*/*ager*)

As mentioned, the legal consolidation of the 'urban model' in Laeetania in the Augustan age implies the genesis of local / colonial elites, together with the emergence of the *villa* in the landscape. In fact, however, the key piece of the Roman territorial structure was the *fundus* or *praedium*, the rural property, a direct consequence of *dominium*. These *fundi* were the 'core' of the *census*, the inventory of the citizens and their properties; the *census*, in turn, was the base for the political, social, and economic life of the city.

The *fundi* were delimited and assigned at the moment of the foundation of the new city. In the case of a colony like Barcino, this possibly followed the centuriation system (*ager divisus et adsignatus*). In other cases, the system of the *ager arcifinius* was followed, in which natural boundaries or former land division markers where used for the delimitation of the properties. The land was then organized according to the respective form of ownership (*dominium*), which was declared by *professio* at the *census*, as is well known from documents such as the *tabula* of Velleia[11].

Is it possible to identify these changes at the archaeological level? How can we analyse the landownership structure? Can the mapping of *villae* represent the 'social landscape' of the Layetanian region?

The Consolidation of the *dominium*

From the juridical point of view, the promotion of these cities (and their rural territories) to Roman rights presupposes the establishment of the *dominium ex iure Quiritum* as well as and the full property rights on their estates. The land precariously possessed by landowners (*possessio*) was transformed in *dominium*, and for the first time it was included in a real *census* (the colonial *census* in Barcino, and municipal *census* in Baetulo, Iluro, and Aquae Calidae). From the agrimensorial point of view, it is possible that the elaboration of the new *forma* (i.e. the mapping of these properties), was combined with a new delimitation or marking of the boundaries of these estates. Further definition of boundaries is sure in the case of Barcino, where the colonists' new plots had to be marked in the fields, perhaps by using the *centuriatio* system.

Two interesting documents from the Laeetanian region refer to this process. The first is a property boundary excavated on a slope near Iluro, which was set up with the upper part of seven Pascual 1 amphorae placed upside down in a ditch (fig. 2).[12] This kind of property boundary was also identified at Sept Fonts, Baeterrae (Béziers), and was easily connected with the procedure indicated by Siculus Flaccus[13] as a way to delimitate neighbouring

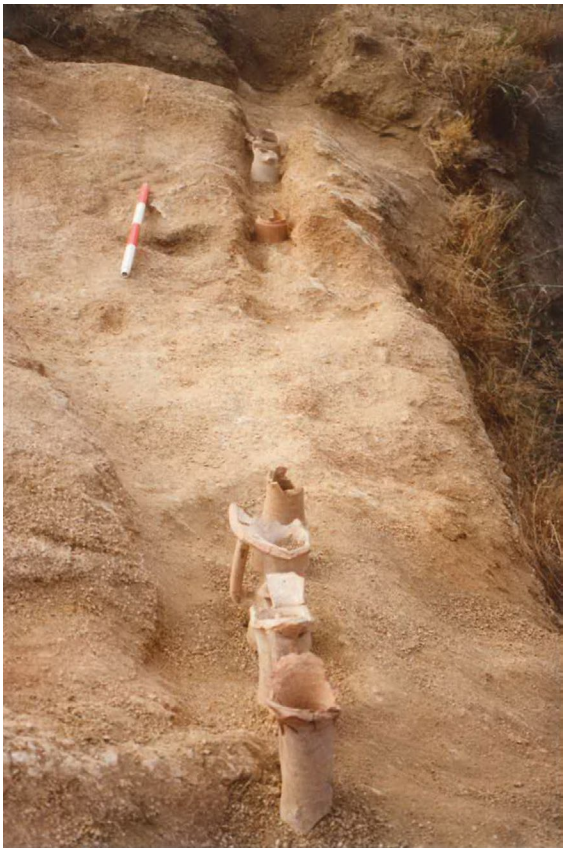

Fig. 2: Property boundary, Can Soleret (Iluro).

estates. The Augustan chronology of both property boundaries has to be connected with the implementation, at that time, of the *dominium* in their *civitates*.

The second document is a *terminus augustalis* found in Montornés that also dates to the Augustan period and delimits the boundary of two unknown cities, maybe Baetulo or Barcino.[14] This *terminus* is one of the markers pertaining to the procedure of delimitation of the *civitas* perimeter (*depalatio*) that had to be carried out when the community started to use Roman law.[15]

The Origin of Colonial *fundi*: Towards a Landownership Map?

What about the *fundi*? Attempting to study forms of landownership in the Roman period through archaeological evidence is often considered a fanciful aim. Field survey studies and diachronic analyses of settlement patterns on the basis of archaeological databases (e.g. the distribution of *villae*), have permitted only a general approach to this question. This type of data cannot provide specific information on the type of

ownership. Amphorae and ceramic epigraphy may give more specific information, but they lack a firm territorial connection. In this context, place names and landscape morphology preserved in the early-medieval documentation are important sources. Toponyms ending in *-anum* or *-ana* are especially useful since they derive from Latin adjectival forms denoting the name, and are derived from the owner's name of *praedia* and *fundi*.[16] Their use is, however, not straightforward, particularly in the case of place names identified in medieval or modern documentation. Place names are difficult to date, and etymologies are also prone to error. Sometimes minor changes in the location associated with a particular toponym may have occurred. However, the voluminous documentation of the 9th-11th centuries offers a good approach to landscape morphology of this period. Of course, a chronological jump from the early Middle Ages to the Roman period needs to be justified critically. Despite some doubts amongst researchers, the information gleaned from toponyms has been very useful when combined with field surveys and archaeological investigations. The study of Veleia's territory is a good example of this methodology.[17]

The origin of the name of the *fundi* is clear in Roman law: it was derived from the first owner's name, the person who first registered the property in the *census*. In the case of Barcino, this was when the Augustan *deductio* occurred. The name of the first owner was used chiefly for fiscal and administrative purposes, with the aim of maintaining control over that land despite changes in ownership: it was referred to as the *vocabulum fundi*.[18] Any *fundus* or *praedium* could be transferred into other hands over time, via marriage, inheritance, purchase, or sale. However, the original name of the *fundus* was retained while the *census* and ownership system remained in function. Therefore, despite some logical changes, these names would have survived until the start of late antiquity, when the taxation model changed dramatically.

In sum, it is believed that the names of *fundi* from the medieval documentation of the *Ager Barcinonensis* refer to the original proprietors of the Roman estates. These names survived during late antiquity and the medieval period due to the continuity in the agricultural exploitation of the territory. Even if not for all estates, the names of at least the main ones were preserved as toponyms, since they were useful indicators for defining and articulating the medieval landscape.

The *fundi* of the *Ager Barcinonensis*

Recent studies have shown the potential for such a method applied to the *ager Barcinonensis*.[19] This area has an important number of medieval toponyms related to Roman names, generally identified in the early-medieval landscape as *locus*, *terminus*, or *territorium* (fig. 3; fig. 4). These place names were identified in the most important medieval archives of the region (e.g. ACB, SCC, and the CODOLCAT database), and later we located them on maps. Most of the names documented in this way also appear

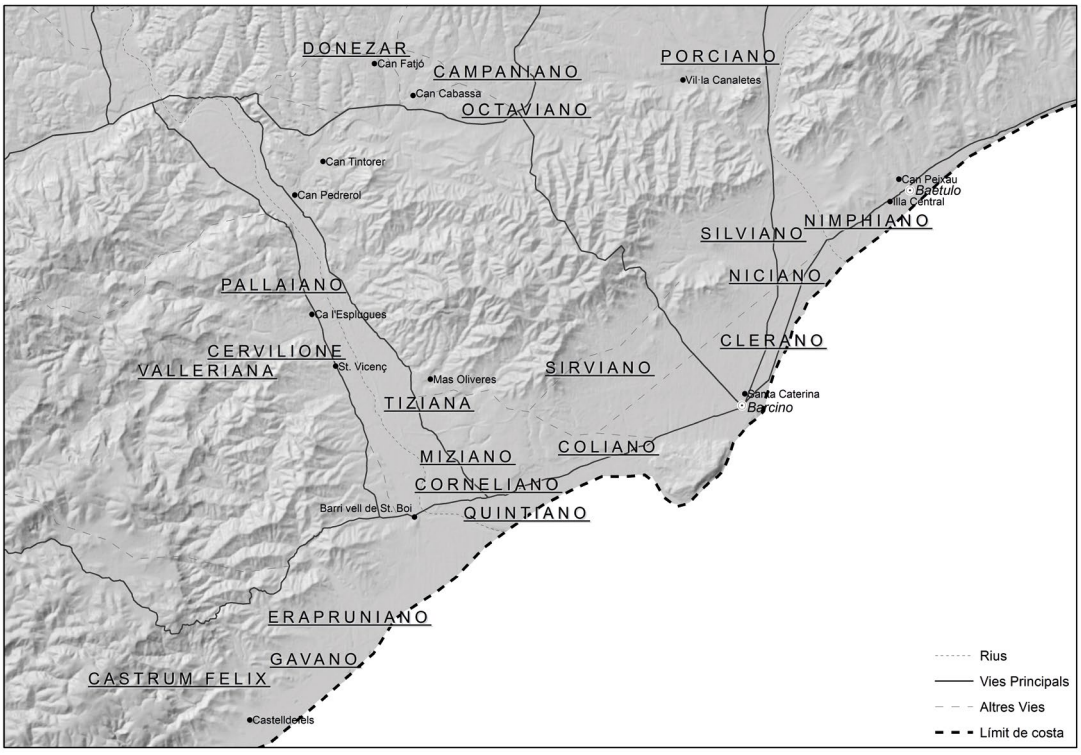

Fig. 3: Roman *fundi* in the *Ager Barcinonensis*: southern sector.

in Roman monumental or funerary epigraphy, confirming that the families owning the estates were present in the cities. These were mostly wealthy families, whose members were local magistrates engaged in euergetism, and who reached the equestrian, or even senatorial class.

However, this was only the first step of the research. As the Layetania region has undergone many transformations, we have a rich archaeological heritage in most areas and an impressive number of Roman sites excavated, especially in the last 25 years. Not only do we have an important overview of Roman settlements (e.g. *villae*, farms, pottery kilns), but also an intense documentation of the *gentes* present in the territory, preserved in the names on amphorae, *dolia*, or brick stamps. All this information was combined into a single map, trying to connect the *fundi* (preserved in the medieval toponyms), the Roman sites, and the *nomina* of the *gentes* documented from the *instrumentum domesticum* and stamps.

Below I briefly give some examples of *fundi* identified in this research. To start, there is the *gens Minicia*, that seems to be connected to the medieval place-name *Miziano* (CSC 382, 1002), and has two senators amongst its members identified in *Barcino* (IRC IV 30-32). An excavated Roman site close to *Miziano* recently produced the stamp *MIN. CEL* (a possible *Minicius Celsius*). The stamp came from a discarded local wine amphora, which confirms the presence of this *gens* in the area.

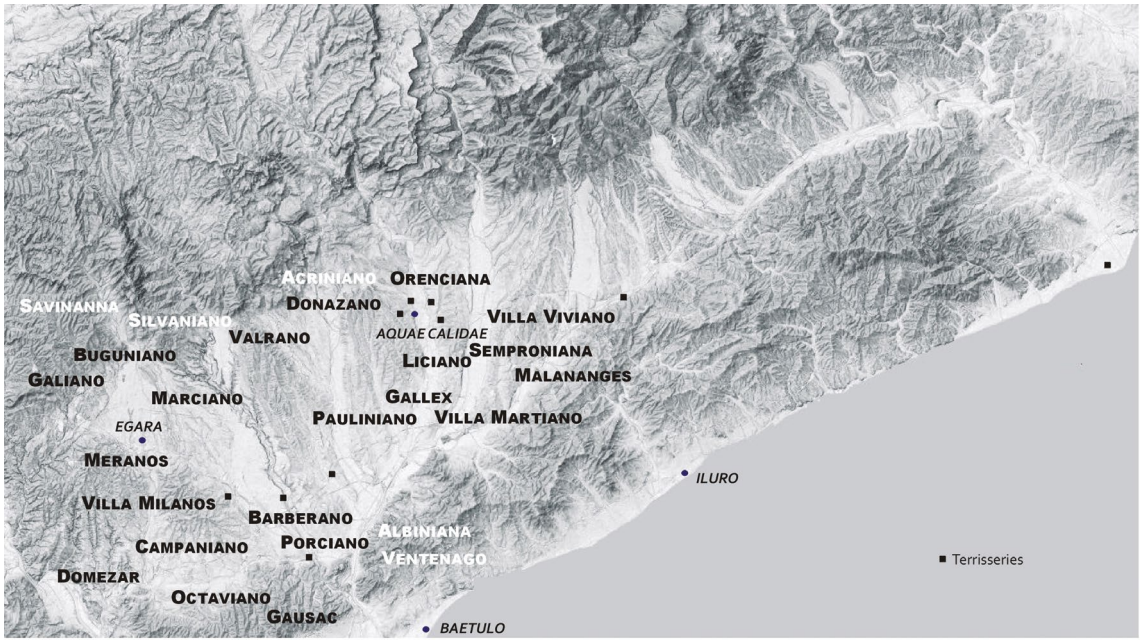

Fig. 4: Roman *fundi* in the *Ager Barcinonensis*: northern sector.

Porciano is a toponym in Montcada (SCC 128, 220, 237, 288), and there is a Roman site in the area that produces amphorae (Can Canaletes). It should be the original *fundus* of the *gens Porcia*, well documented in *Barcino* with nine members, one of which dates to the Augustan period (IRC-IV, 173). But it is also interesting to point out that a workshop of the *gens* has been documented in Baetulo following the course of the *Baetulo* river. It produced Pascual 1 amphorae, as shown by the presence at the site of the stamp *M.POR.FIG* (*Figlina).*

Another example concerns the *gens Licinia*, identified in the place-names *Liciano subteriore* (SCC 233, 989) and *Lizano superiore* (SCC 383, 1002), modern Lliçà (Vallès Oriental).[20] Close to Lliçà there is a magnificent Roman *villa* that has been connected with the senator L. Licinius Sura and his freedman, L. Licinius Secundus, honoured in Barcino.[21] In the area, several *L. Licini* are documented by *dolia* and amphorae stamps.

However, not all the names of the *fundi* came from the owner's *nomen*. We know from the literary sources also of the use of *cognomina* as *vocabulum fundi*. We have an interesting example from our region: *Pauliniano* (CSC 516, 103), modern Polinyà (Vallès Oriental), is a place-name derived from the *cognomen* Paullinus. In the area of *Pauliniano* we have the site of Can Bodada, an early-imperial farm where a *tegula* was found bearing the stamp: *[TEG]ULA PAULI EX FUN(do) [---]PERIANO* (IRC V 139). It is possible to connect this *Paulus*, probably a freedman that produced tiles, with the existence of his *fundus,* or perhaps his *officina,* in the surroundings. It is possible to identify the existence of a *figlina* belonging to one owner in the literary and epigraphic sources, while the property belonged to another person.[22] However, what is striking in this case is the existence in Barcino of a Roman inscription, in which a M. Paullus

Fig. 5: Roman *fundi* connected to wine production.

Paullinus honoured L. Licinius Secundus as *amicus* (IRC IV 98). *Liciniano* and *Pauliniano* are two properties very close to each other, at a distance of 4 km, and their owners were probably neighbours and *amici*.

Conclusions

As a brief conclusion, some of the preliminary results of our research can be summarized. The two maps reproduced in figs. 3 and 4 (the South and North of Layetania) show the localization of the identified Roman place names preserved in the early-medieval documentation. Out of a total of 50 *fundi* documented, 30 appear in the epigraphic records of the region, confirming the relationship between urban elites and *fundi*. There is an evident correlation between the main families documented in the cities (particularly in the colony of Barcino) and the *fundi* documented in Laeetania.

Out of the 30 *fundi* confirmed by epigraphic evidence, 13 were owned by *gentes* documented through the amphora or *dolia* stamps identified in the area as wine producers (fig. 5). Archaeological evidence for wine production is present in at least 20 of the other *fundi* documented. The connection between urban elites, *fundi*, and wine production is not in any doubt.

From the epigraphy related to production (e.g. stamps on amphorae, *dolia*, tiles, lead *signacula*, etc.), it is possible to identify a significant number of slaves and freedmen involved in the production of wine. Some were in the group of owners, in some cases as owners of *figlinae* (e.g. *O.GAVIDIENI*, *O. IULI ANTER*); in other cases they were the owners of *fundi* (e.g. see the toponyms *Nymphiano, Primiliano,* or the estate of *Synecdemus*).[23]

It can also be suggested that there was a significant level of mobility of craftsmen (probably individuals of freed status) all over the Layetanian region, as suggested by the presence of exactly the same stamps on amphorae and *dolia* produced at different workshops and kilns (e.g. *C. IULIUS LAETI*, *ACAS*, *HILARI*, *AEMULI*, *L.LICINIUS CHRESIMUS*). In many of these cases, we suppose that they were *institores*, probably acting on behalf of the main *gentes* of the region. Some of them, following a typical path in social advancement for individuals of freed status, became *Seviri augustales*, positions that are well documented in the epigraphy of the colony.

Notes

[1] Olesti – Carreras 2013; Olesti 2016.

[2] Plin. nat. 3, 3, 4.

[3] Several researchers are working in this area; for a recent overview: Revilla et al. 2008; Jarrega – Berni 2016.

[4] Palahí 2010.

[5] Producing Tarraconense 1 and, mainly Pascual 1 amphorae.

[6] Olesti 1998.

[7] Olesti 2016. Some of the foreign agents come from the *Narbo Martius* area. Perhaps not by chance, at the same time Cicero (Cic. rep. 3, 9, 15) mentioned the prohibition against planting new vines and olive trees in Transalpine Gaul.

[8] Ravotto – Rodà 2017

[9] Scholars frequently forget that *Barcino* was not only a Roman colony, but also had fiscal *immunitas*, (Dig. 50, 15, 8). Compared to other provincial cities, the agricultural land and produce of the *Barcinonensis inmunes* (as in IRC IV, 62) had a lower taxation level and, logically, more surplus. This was probably also an important feature of this "social landscape".

[10] The *villae* documented in Laeetania were just part of a larger rural settlement system. In some regions, like inland Layetania, just 10 out of 35 excavated rural settlements were *villae*. The rest were mid- or small-sized farms and workshops (Olle 2015, 407). A similar percentage can be observed also in the Maresme area (Revilla et al. 2013).

[11] CIL XI 1147.

[12] Clavel-Léveque – Olesti 2009.

[13] Thulin 1913, 105–106.

[14] IRC I 200 suppl., Vallés, Layetania.

[15] From Loupian, near Beziers in the south of France, two interesting private boundary stones are known. Dating to the first half of 1st century AD (probably the Augustan period), they mention private roads (*iter privato* and *iter privato prekario*; Bermond et al. 2017). Both inscriptions could be connected with the same historical process: the delimitation, for the first time, of the private properties (and in this case, also the adjacent roads) as well as the moment of the juridical promotion of the city.
[16] Calzolari 1997; Olesti 2005.
[17] Calzolari 1997; Braconi 2003.
[18] Several examples from the *Digest* indicate the obligation to preserve the original owners' name that was linked to the *professio*, the declaration of landownership for taxation purposes (Dig. 50, 15, 4). The limited number of Roman *nomina* caused frequent confusion between homonymous *fundi* and owners: Siculus Flaccus (Thulin 1913, 126. 267) mentions a *controversia de modo* between two owners with the same name laying claim to the same plot of land. Therefore, when Hyginius Gromaticus (L.7-8) gives an example of how to declare the *fundi concessi* in the fiscal registry (*forma*), he quotes the case of a *fundus Seianus* given to L. Manilius. A similar case is reported by Varro, who also names a *fundus Seianus* (Varro rust. 3, 2, 7–8). Another paradigmatic case concerns the *Tabula* of Veleia, frequently attesting to large and medium landlords who owned diverse *fundi* and/or *praedia*. Most of these properties keep their original names and were not referred to by the name of the current owners (CIL XI 1147). Other examples may be documented in the gromatic maps, in which there are remarkable examples of estates that kept their original names despites changes in ownership, e.g. the *Dominius Faustiniani* (La. 185) belonging to a Publius Scipio or the *Dominius Manilianus* owned by the colony Iulia Constantia.
[19] Olesti 2005; Olesti – Carreras 2013.
[20] Berni et al. 2005.
[21] Mayer 1996.
[22] Verboven 2002.
[23] Olesti – Carreras 2013.

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Fig. 1. 3–5: by author. – Fig. 2: copyrigth Atics S.L. 1994.

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The Organisation of Cereal Production in *Britannia*: Grain-drying Ovens as Evidence for Agricultural Integration

Lisa Lodwick

Introduction

Cereal production in Roman Britain has been marginal to empire-wide discussions of the Roman agricultural economy. Rural modes of production and the integration of the agricultural economy have received research focus in the Mediterranean world, informed by the ancient sources, extensive rural survey data, and, more recently, an increase in excavations, especially of non-villa sites.[1] Away from the Mediterranean, agriculture was also a key aspect of the economies of the north-western provinces. Whilst previous models have downplayed the levels of economic production along the frontiers, decades of excavation in this region, combined with the recent synthesis of projects such as the RurLand project in north-east Gaul and the Roman Rural Settlement Project (RRSP) in Britain, have mustered large quantities of excavation data to portray the economic complexity of these regions.[2]

The main areas of production in the economy of Roman Britain can be identified as cereals (wheat and barley), animals (cattle, sheep, pig) and their secondary products (leather, wool), iron, lead, precious metals, salt, bricks, pottery, and timber/charcoal. The economy is considered to have been structured in three sectors: the imperial economy, the provincial economy, and the extra-provincial economy.[3] There is good evidence that the majority of rural settlements were involved in cereal production, with widespread evidence for consumption, traceable through a number of site based (ovens, granaries), artefactual (querns, tools), and archaeobotanical evidence.[4] Furthermore, in the 4th century AD, Zosimus and Ammianus Marcellinus describe the supply of grain to the garrisons on the German Limes, indicating the potential for the large-scale production of cereals in Roman Britain.[5]

In terms of addressing how the production of cereals was organised, a long focus has been on the study of villa sites, especially in the third quarter of the 20th century, with attempts to model the economic basis of several villa estates at Bignor Villa and Barton Court Farm. Analyses were based on estimates of estate size, modern day crop yields, production numbers from agronomic writers, calculations of building size, and environmental archaeology.[6] Such approaches were summarised in Villa Economies by Branigan and Miles.[7] The long-standing notion of the villa as a rural farming estate was disrupted in 1990 when Millett reformulated the villas as a social phenomenon.[8] Since then, the focus of discourse on Roman Britain has shifted towards the study of identity, local agency, and material culture,[9] with the study of the rural agricultural economy receiving limited attention.

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The RRSP (2012-2017) produced a database of excavated rural settlements in Roman Britain, containing 2627 excavated rural settlements, and analysed this data to identify key patterns in rural settlement and economy.[10] Contrary to earlier studies focused on villas, the project has shown unequivocally that the rural landscape of Roman Britain was dominated by farms, with settlement form and chronological patterns varying regionally. However, the question of how the rural economy was articulated remains open.[11] For instance, while regional variations in cereal crops have been established, generally speaking, all sites were growing the same range of cereal crops. We have some understanding of cultivation practices and crop processing, but are unable to propose quantitative levels of production and thus infer the movement of crops between settlements.[12]

The difficulty of undertaking quantitative studies of cereals has been acknowledged elsewhere, with Bowman and Wilson writing that: "Recent decades have seen considerable intensification of quantified studies of various aspects of Mediterranean agriculture, particularly olive oil and wine, whereas the third member of the triad has proved generally more intractable."[13] In reference to Roman Britain, Gerrard has commented that there is an "absence of meaningful statistical data" on food production.[14] There are several options for quantifying past cereal production including: extrapolating yields from modern land use and ancient sources, calculating arable pasture ratios in insect assemblages, using the densities of charred cereal remains, and from archaeological finds of querns and mill stones.[15] However these evidence forms are limited by their uneven distribution across archaeological sites, and their representation of different stages of cereal production. An alternative form of evidence, which can inform upon the scale of production and the integration of different settlement types within the economy, is a particular type of agricultural processing structure known as the corn-drying or grain-drying oven.

Corn-Drying or Grain-Drying Ovens

The corn-drying or grain-drying oven (*Getreidedarre/Structures de sechage et de fumage*) is well known in Roman Britain but absent from many discussions of the Roman agricultural economy and agricultural processing.[16] The structure consists of a stoking hole and fire place, a subterranean flue overlain by a drying floor to hold cereals, and, in some cases, the remains of a superstructure. Construction materials include flint, limestone, brick, clay, and wattle and daub. A range of oven structures has been recorded, which have been grouped into single and multiple flue forms (Fig. 1a–b).[17]

These structures are archaeologically easily identifiable as the flues survive well, but are only revealed through excavation (Fig. 2). In Britain, grain-drying

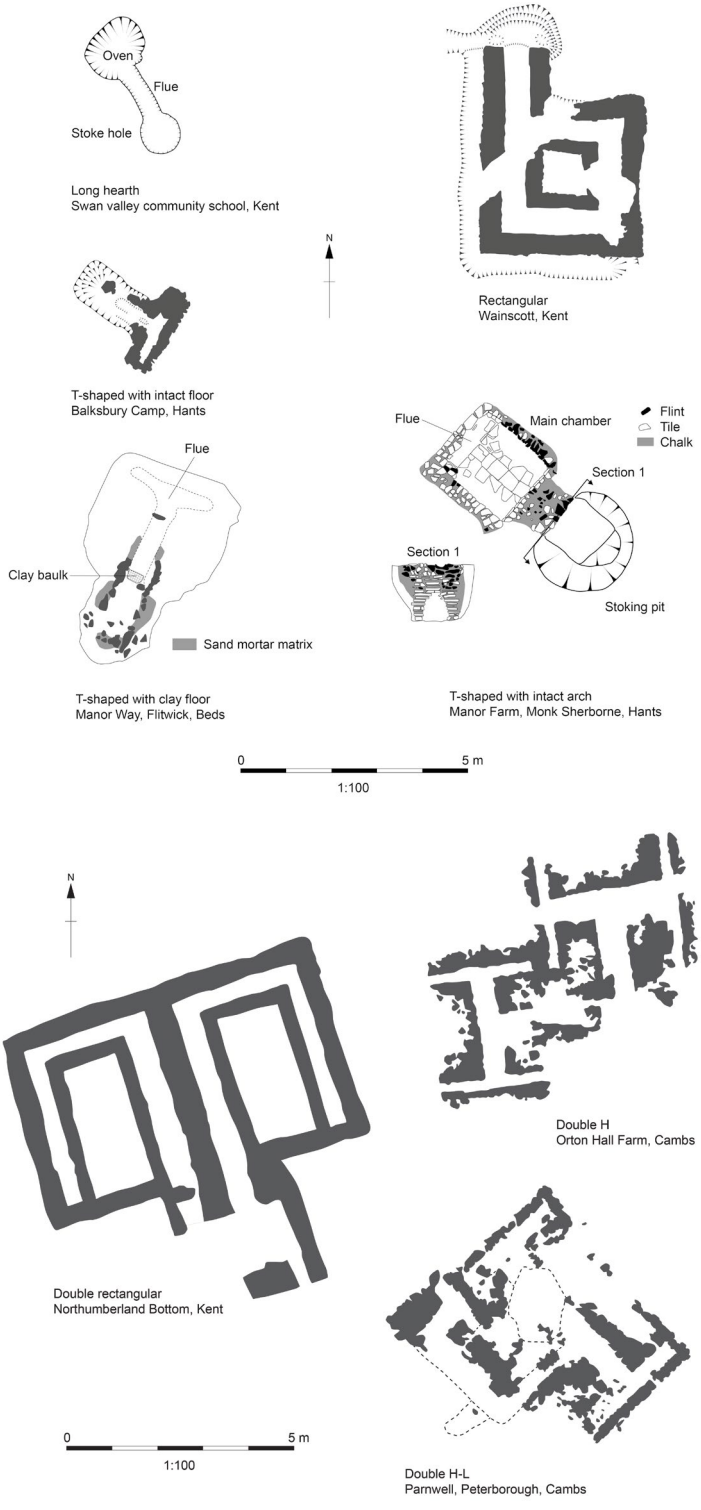

Fig. 1a–b: Plans of grain-drying ovens

Fig. 2: Grain-drying oven from Marnel Park, Popley.

ovens are often the most characteristic aspect of rural settlements where we may normally find limited architecture. Antiquarian excavations of such structures identified them as hypocausts or subways, but the structures were first defined archaeologically as a grain oven by Gowland in 1912, based on examples from the villa at Hambleden in the Thames Valley.[18] Writing in the late 1970s, Morris was able to compile a catalogue of 60 examples of grain-drying ovens, and a decade later, Van der Veen provided an overview of archaeobotanical evidence for their use.[19] The function of these structures has been debated over the last few decades, and is still unclear.[20] Some ovens were clearly used in brewing, to parch germinated grain in order to arrest the germination process so that this material could be turned into malt. Alternatively, the ovens could be used to parch cereals in preparation for de-husking or milling, or prior to storage. Early studies identified grain-drying as the main function based on the recovery of charred cereal grains from flues. Following the experiments at Butser Farm in the late 1970s, malting was also considered as a possible function.[21] At some sites it has been possible to distinguish these functions. For instance, at Northfleet

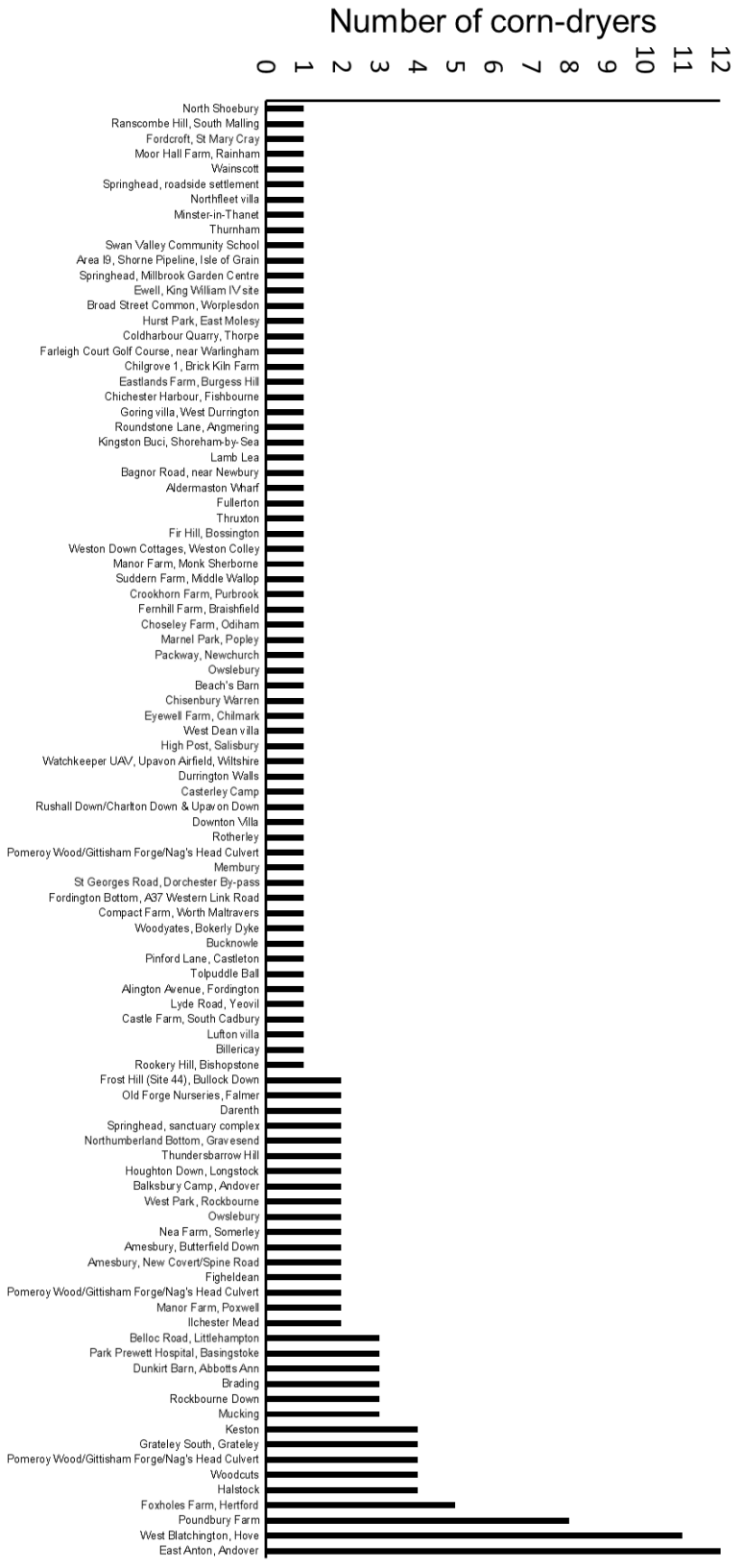

Fig. 3: Bar chart showing the number of grain-drying ovens at individual sites in the south. Bibliographic information on each site can be found in the RRSP online database (Allen et al. 2018).

villa in Kent in south-east Britain, a rectangular oven was located adjacent to a malting cistern, and archaeobotanical samples were full of charred germinated cereals and detached cereal sprouts.[22]

Beyond the specific function, the motivations behind the widespread construction of these ovens has also been debated. Construction has been linked to climatic shifts, with Applebaum linking the proliferation of grain-drying ovens with wetter periods of climate and the export of cereals. However, the dating of many of these structures to the 2nd century AD invalidates links with the climatic shifts of the late antique period.[23] Morris interpreted them as indicators of capital investment and large-scale production, which continues to be the consensus. Most recently, Gerrard has suggested that the insertion of drying ovens within high status buildings in the 4th century indicates the need for social elites to supervise production.[24]

The origin of these structures appears to lie in the 2nd century AD. Ovens recorded at Iron Age settlements in Britain are very different in character. At Danebury hillfort in south-central Britain, ovens consisted of a simple undivided ceramic chamber, whereby the fire would be raked-out before the bread was baked.[25] Grain-drying ovens are much more substantial in nature, often with mortared stonework, are larger in size, and, crucially, have a drying floor.

The location where this innovation in the use of heated air to dry or parch cereals first took place is unclear. Grain-drying ovens also appear at villas in Gaul, Germania Inferior, Germania Superior and Raetia, such as at Weitersbach and Dietikon.[26] The only previous overview by Van Ossel identified 29 such structures in northern France dated to the 3rd–5th centuries AD. Whilst currently no 1st- or 2nd-century AD structures are known of, there is early evidence for large-scale malting from a mid-1st century AD structure in Xanten identified as a brewery, and a similar find in early-Roman Zurich;[27] malting may therefore be the source of grain-drying oven development. In Britain, the earliest evidence for large-scale malting is currently dated to the 2nd century, with examples such as Northfleet villa, and farmsteads at Whitelands Farm and Weedon Hill.[28] Evidence from the 1st-century AD consists of a structure associated with malting through archaeobotanical finds at Nonnington, Kent, and written accounts relating to beer production on the Bloomberg tablets from Roman London.[29] Malting for beer production is occasionally evidenced in Iron-Age western Europe,[30] but the only evidence in Britain is artefactual, in the form of tankards first occurring in the Late Iron Age period.[31]

Hence, there is currently a separation between the earliest evidence for malting and the earliest evidence for distinct grain-drying structures. This suggests either there was a lag time between the practice of malting and the construction of grain-drying ovens, or that grain-drying ovens originate from a separate need to dry or parch cereals. Whilst the development and function of grain-drying ovens requires further exploration, these structures can be used as a quantifiable proxy for cereal production, in similar ways that olive- and wine- presses have been utilised in the Mediterranean world.

Patterns across *Britannia*

A recent review has summarised the distribution of grain-drying ovens across Britannia on the basis of the RRSP database.[32] Grain-drying ovens have been recorded at 358 excavated rural settlements in most areas of Roman Britain, indicating a wide region engaged in large-scale cereal production, but are very rare in Wales, the south-west and the north-west.[33] In terms of the chronological distribution, few grain-dryers date to the second half of the 1st century AD, with the only distinctive T-shaped structure at Springhead in Kent. However, the numbers peak in the 2nd century AD in the east, 3rd century AD in the north-east and central belt, and 4th century AD in the south. In terms of their socio-economic distribution, grain-dryers are most common in each region at nucleated settlements: roadside settlements in the central belt and east, villages in the south, and complex farmsteads in the north-east. Grain-drying ovens also occur in urban centres in the late 4th and 5th century AD, such as Silchester and Verulamium.[34]

Grain-Drying Ovens in the South

Such a broad review enables us to identify regions of large-scale processing, but does not provide a quantitative assessment of how much cereal production these structures indicate, and how this varied between settlement types. A preliminary case study region of the south is presented here to illustrate initial patterns in these structures. The south region was defined by the RRSP as a region mainly of upland chalk landscape, stretching from Kent to Somerset, which encompasses several towns including Calleva Atrebatum, Londinium, and Venta Belgarum. Settlement pattern in this area was a mix of villas, farmsteads, and some roadside settlements.[35] Building from the work of the RRSP, this study has returned to the primary archaeological reports for additional detail on grain-drying structures. 97 sites are included here which are part of the RRSP database, are located in the south, and have a grain-drying oven present.

Firstly, we can consider the number of grain-drying ovens recorded at individual sites. Figure 3 indicates that most sites only have one or two grain-drying ovens, with 54 sites having a single drying structure, and 13 sites having two drying structures. However, there are several rural sites with large numbers of T-shaped ovens. One example comes from East Anton, Hampshire, a roadside settlement close to the junction between the roads leading to *Calleva Atrebatum*, *Venta Belgarum*, and *Corinium*. The majority of activity at the sites was dated to c. AD 240–400, including the construction of at least 12 mainly T-shaped ovens amongst an area of field systems of 1.6 ha. Similar rural agglomerations of drying-ovens have been excavated at: a farmstead at Poundbury Farm, Dorset, where eight grain-drying ovens were recorded consisting of a mix of simple, T-shaped and rectangular ovens dating to the mid-late Roman period; an unenclosed farmstead at Foxholes Farm, Hertfordshire, where five grain-dryers were

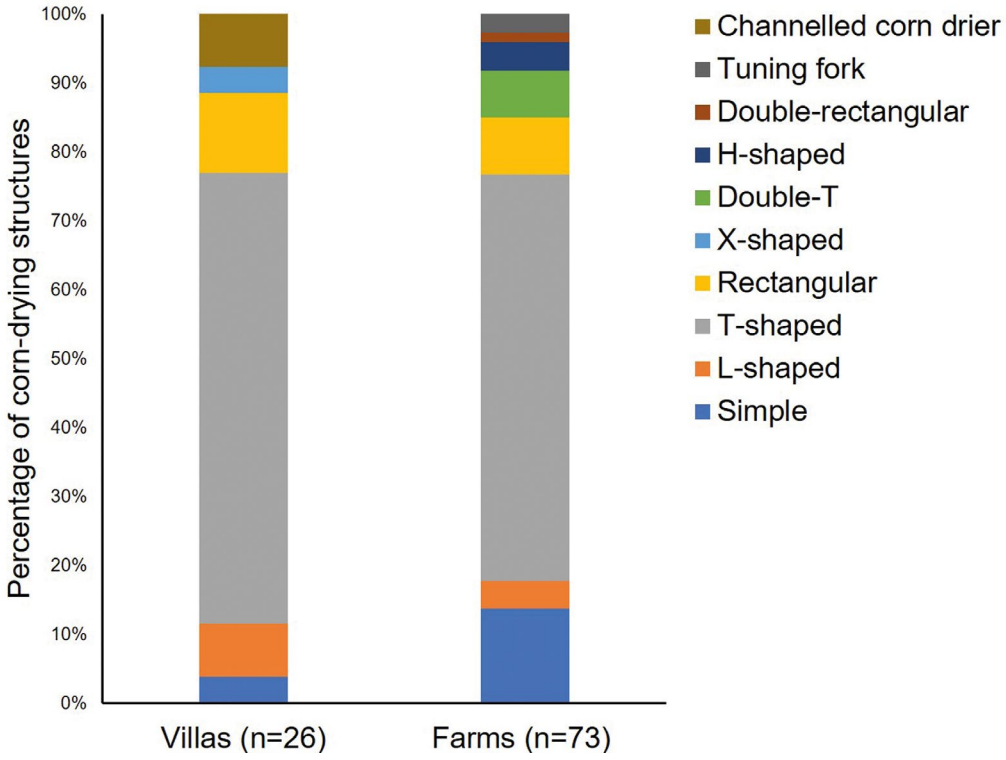

Fig. 4: Bar chart showing the proportion of grain-drying ovens at farmsteads and villas in the south.

recorded dating to the 4th century AD; and at a farmstead at West Blatchington, Hove, where 11 structures were found that dated to the mid-2nd and 3rd century AD.[36] Hence, there is an emerging pattern of sites with large numbers of ovens, and hence cereal-processing capacity in the countryside. To what extent this pattern is the product of excavation bias is unclear. Many excavations are often too small to characterise rural settlement form and villa excavations have focused on the central residential buildings themselves rather than the surrounding area.[37] Sites with grain-drying ovens may well have been connected to larger estates, but we cannot presume unitary land holdings around a villa.[38]

A range of grain-dryer forms are found at villas and farms, ranging from single flues to multi-flues. Comparing the proportion of grain-dryer types recorded at site types across the South (Fig. 4), overall a similar proportion of single flues (simple, L-shaped, T-shaped) are present at both site types, making up just under 80% of structures. Within the range of dryer types, a slightly wider range is found at farmsteads, consisting of rectangular, double-T, H-shaped, double-rectangular, and tuning-fork structures. Rectangular structures were also found at villas, with the addition of channelled grain-driers and an x-shaped structure at Fullerton villa.

Hence, villas are not the centres of diversity in grain-dryer forms. In fact, some forms are only present at rural farmsteads. For instance, a tuning-fork structure was recorded at Manor Farm, Poxwell, Dorset, and at Compact Farm, Worth Maltravers, Dorset. Beyond the South, this grain-dryer structure is also found at a farmstead at Hinkley Point, Somerset, but also appears also at Yewden villa in the Central Belt region.[39] Other rare structures have been found at farmsteads, for instance a triangular oven at Broughton Manor Farm, Buckinghamshire and around 10 km away at a farmstead at Windmill Hill, Buckinghamshire.[40] Experiments in grain-dryer form were most likely a way to increase the surface area of the drying floor and to enable a larger heated area with one fire setting, meaning a more efficient use of fuel and labour. Ethnographic observations have shown that constant observation of drying ovens is needed to ensure that the grain does not catch fire, which did happen at Grateley villa, Hampshire.[41]

It has been suggested that villas were the centres of processing and storage of cereals in the rural landscape in the third and fourth centuries. The preliminary results of this study on grain-dryers contrast with this suggestion, indicating the importance of other settlement forms in both the quantity and diversity of grain-dryer forms.[42] However, it is unclear whether farmsteads and villas within a region were distinct economic entities. As previously argued by Taylor, there is an overlap in the distribution of grain-dryers and villas indicating landscapes of agricultural investment,[43] but the extent to which different settlements forms were economically integrated within these landscapes requires further research.

Conclusions

Grain-drying ovens are overlooked agricultural structures that have the potential to provide quantifiable insights into cereal production and the integration of the rural agricultural economy in Britannia and beyond. A recent review of the national evidence for rural settlement has indicated that grain-drying ovens are widely distributed from the 2nd century AD onwards and occur at a range of site types. This preliminary analysis indicates that further insights can be made by considering the number and form of grain-drying ovens. A key conclusion of this initial analysis is that a-typical clusters of grain-drying ovens occur at farmsteads across the south, often lying close to the road network. Furthermore, innovative forms of grain-drying ovens have been recorded at rural farms and villas, indicating the adoption of technological innovations linked to increased agricultural-processing capacity. In order to illuminate the process and spread of innovation and technology the evidence from rural Roman Britain must be integrated with that from the continent. Furthermore, in order to utilise grain-drying ovens as a proxy for cereal production, detailed consideration of the function, processing capacity, and seasonality of use is required, and these topics will be subjects of future study.

Acknowledgments

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Notes

[1] De Haas – Tol 2017; Erdkamp et al. 2015.
[2] Whittaker 1994. – RurLand project: Reddé 2017.
[3] Mattingly 2007, 491–502.
[4] Lodwick 2017, 12.
[5] Zos. 3, 5, 2; Amm. 28, 2, 3.
[6] Applebaum 1975.
[7] Jones 1984; Branigan – Miles 1989.
[8] Millett 1990; Taylor 2011.
[9] See contributions in Millett et al. 2016.
[10] Database: Allen et al 2018. Publications: Smith et al. 2016; Allen et al. 2017; Smith et al. 2018.
[11] Fulford 2017.
[12] Allen – Lodwick 2017, 173–177.
[13] Bowman – Wilson 2013a, 3.
[14] Gerrard 2013, 97.
[15] Yields: Shaw 2015, 19. Arable/Pastoral ratios in insect assemblages: Robinson 1983. Densities of charred plant remains: Lodwick 2017. Mill stones: Shaffrey 2015.
[16] Absent from White 1970; Bowman – Wilson 2013b; Thurmond 2006.
[17] Lodwick 2017.
[18] Hypocausts: Collingwood 1930. Subways: Cocks 1921; Corder 1940.
[19] Morris 1979.
[20] Van der Veen 1989.
[21] Goodchild 1943; Reynolds – Langley 1979.
[22] Andrews et al. 2011, 224–226.
[23] Lodwick 2017.
[24] Climate change: Applebaum 1958, 81. Social control: Gerrard 2013, 255–259. Large-scale production: Morris 1979; Van der Veen 2016.
[25] Cunliffe – Poole 1991, 145–151.
[26] Weitersbach: Wightman 1970, 142. 185. Dietikon: Ebnöther – Béarat 1995.
[27] Van Ossel 1992; Bridger 2017.
[28] Lodwick 2017, 62–66.
[29] Helm – Carruthers 2011; Tomlin 2016.
[30] Stika 2011.
[31] Horn 2015.

[32] Lodwick 2017.
[33] See Lodwick 2017, 55–61 for a review of grain-drying ovens in Roman Britain.
[34] Morris 1979, 20.
[35] Allen 2016.
[36] East Anton: Firth 2011. Poundbury Farm: Dinwiddy – Bradley 2011. Foxholes Farm: Partridge 1989. West Blatchington: Norris – Burstow 1950, 1952. Note: site classified as a farm on the RRSP database but multi-roomed aisled building in use in the 3rd century AD.
[37] Allen – Smith 2016, 19–20.
[38] Todd 1989.
[39] Manor Farm: Hurst – Wacher 1986. Compact Farm: Graham et al. 2002. Hinkley Point: Saunders 2010. Yewden: Eyers 2011.
[40] Atkins et al. 2014; Mynard 1987. Villa sites: Morris 1979, 97–98.
[41] Fenton 1978, 387; Campbell 2008.
[42] Fulford 2017.
[43] Taylor 2011, 190.

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Roman Rural Settlements in the Provinces of *Pannonia Inferior* and *Moesia Superior*

Olivera Ilić

The Pannonian area and the northern parts of modern Serbia belong to a wider geographical area that can be designated as the Middle and Lower Danube Valley. Over centuries, the Danube and the Sava rivers have connected this region with Central Europe and Italy to the west, and the eastern parts of the Balkans and the Black Sea to the east. The valleys of the Morava and Vardar rivers offered a connecting channel with the Mediterranean world.

After the conquest of this territory in the process of Roman expansion in the 1st century AD and the establishment of Roman administration in the newly-created provinces, organised urbanisation emerged, alongside autochthonous rural settlements, which continued to exist for some time.

According to investigations conducted so far, this process developed more intensively in the Pannonia region than was the case in the barely accessible mountainous and hilly areas of the Central Balkans (fig. 1). The new organisation of the Roman state resulted in the establishment of new types of rural settlements: the *vici* (table 1). Such settlements, which to a great extent resulted from the settlement of veterans, were important production units. These played a part in supplying the urban centres before the establishment of agricultural estates of the *villa rustica* type.

Investigations in the Srem region (the south-eastern portion of *Pannonia Inferior*) have revealed that early Roman settlements dating to the 1st and 2nd centuries AD were situated in the same areas where building complexes classified as 'villas' later were constructed, or in their immediate vicinity. The sites of Beocin-Dumbovo, Hrtkovci, and Sasinci are examples of this evolution.

A boundary marker uncovered in the area of the village of Beocin-Dumbovo bears an inscription about the assignment of land of the *Iosista* village to a Titus Claudius Priscus, the prefect of the *ala I civium Romanorum* in the second half of the 1st century AD. This evidence suggests an early Romanisation of the area.[1] The inhabitants in this settlement lived in elliptical pit houses that had rectangular open hearths (fig. 2). In addition to traditional local pottery (consisting of rough handmade pots), fragments of *terra sigillata* and Italic glass were also found. Ceramic spindle whorls and flint tools indicate that an indigenous economic system continued to exist.

Typological and stratigraphic analyses of the housing structures and the finds, particularly of pottery, point to the parallel existence of the indigenous population, with their protohistoric socio-economic structure, and the Italic Roman soldiers.[2] In this still inadequately documented symbiosis, we can assume that two opposite socio-economic categories were the fundamental components in the formation of the *vicus* at Dumbovo-Beocin.

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SITE	LOCATION	PROVINCE	CENTURY
Dumbovo, Beocin, Srem	Roman *limes*. Later, a villa was built near the *vicus*	*Pannonia Inferior*	1st–2nd century
Kudos, Sasinci; Srem	Main road between *Sirmium* and *Singidunum*. Later, a villa was built near the *vicus*	*Pannonia Inferior*	1st–2ndcentury
Kuzmine, Srem	Main road between *Sirmium* and *Singidunum*	*Pannonia Inferior*	1st–2ndcentury
Malo Kuvalovo, Krnjesevci; Srem	Main road between *Sirmium* and *Singidunum*	*Pannonia Inferior*	1st century
Vranj, Hrtkovci, Srem	Left bank of the Sava. Later, a villa was near the *vicus*	*Pannonia Inferior*	1st–2nd century
Prhovo, Srem	Main road between *Sirmium* and *Singidunum*	*Pannonia Inferior*	1st–2nd century
Bube, near Belgrade	Vicinity of *Singidunum*	*Moesia Superior*	1st–2nd century

Table 1: Roman *vici* in the provinces of *Pannonia Inferior* and *Moesia Superior*.

Usually, the main economic activity of the inhabitants of a *vicus* was agriculture and animal farming; the latter is confirmed by faunal remains of domestic and wild animal species recovered at the site of Dumbovo-Beocin. The animal bones studied (634 bone finds), belonged to both phases, with the older horizon represented by the *vicus*, and the later settlement embodied by the *villa rustica*.[3] For both chronological periods the bones of domestic animals represent the majority when compared to those of wild animals. Faunal taxa included: domestic cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), pigs (*Sus domesticus*), horses (*Equus caballus*), dogs (*Canis familiaris*), and chicken (*Gallus gallus*). The wild animal bones consisted of remains of red deer (*Cervus elaphus*) and greylag goose (*Anser anser*). Fish such as carp, pike, and catfish were also represented.

Analysis of bone material from this site shows that domestic ox was the most common species (34.3%), followed by pig (24.8%) and sheep/goat (18.9%). Wild animals make up only 1.4% of the total. These numbers clearly represent the way

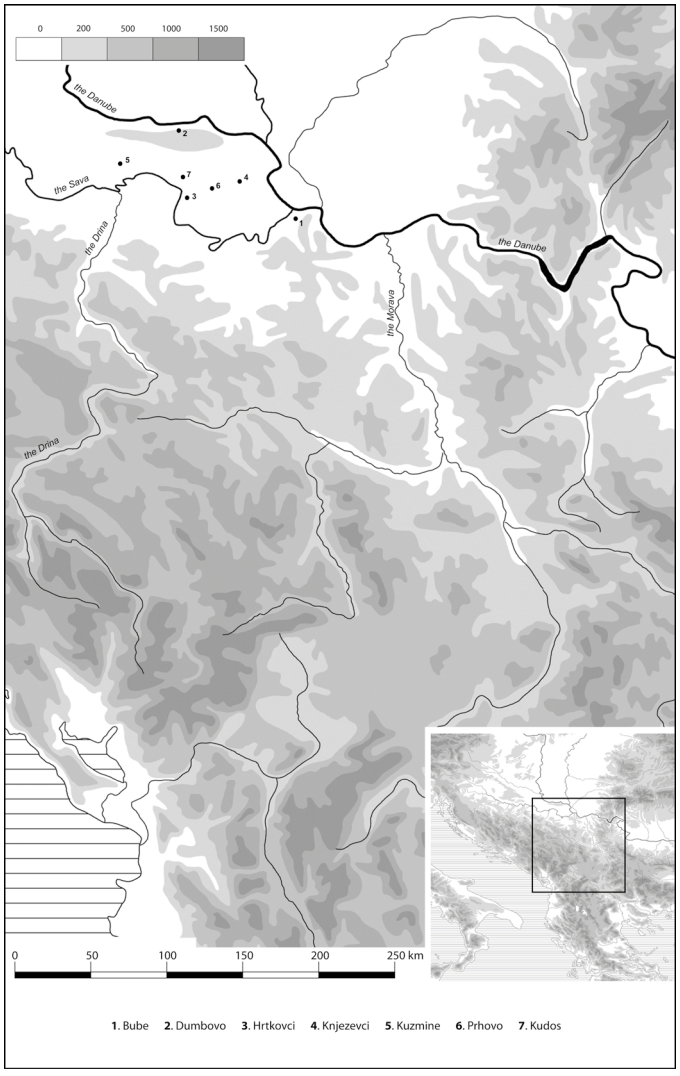

Fig. 1: Roman *vici* in the provinces of *Pannonia Inferior* and *Moesia Superior*.

of life of the inhabitants in the Roman rural settlement, which was primarily based on domestic animal breeding rather than on hunting. Most of the animals were used for food, except for the horse, that served as work animal, and the dog, whose function was as guardian or pet.

Besides farming and cattle breeding, forest exploitation and various kinds of handicrafts (e.g. pottery, leather and wool processing, crafts associated with wood–working) also contributed to the economic activity of the *vicus* in Dumbovo. We suppose that the processing of raw materials was, at first, limited only to satisfying the needs of the inhabitants and their immediate neighbours. However, at a later point they reached more distant areas via trade routes, thus becoming a segment

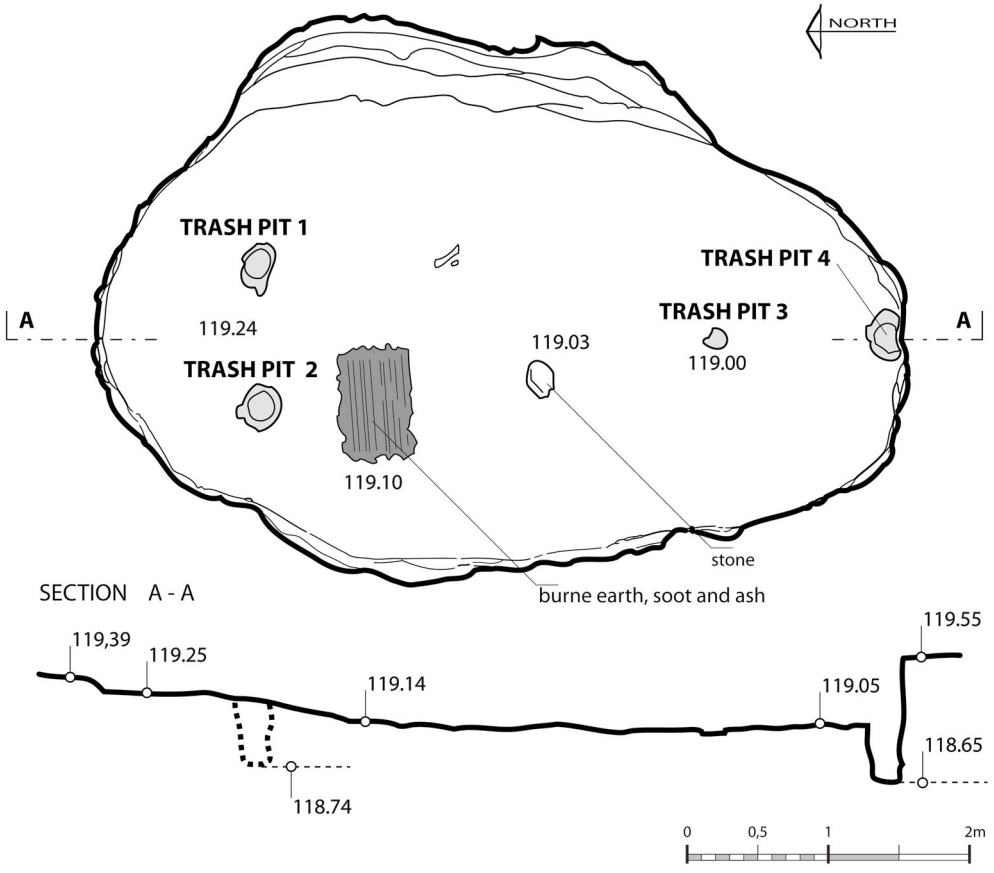

Fig. 2: Beocin, Dumbovo: plan and cross–section of Hut 2.

of the economic life of the province. This was the time of the reorganisation of the frontier defensive system and when auxiliary troops were deployed on the Danube banks. Archaeological investigations have revealed that after the abandonment of the pit houses and the disappearance of that type of settlement, a rather small country estate – a villa rustica with watchtower – was established in the valley in the 4th century AD.

Although villas are recorded in relatively large numbers, they have not been systematically investigated so far in the provinces of Lower Pannonia and Upper Moesia. We can speak of the typology of those structures only on the basis of examples from the neighbouring regions, primarily Pannonia. This is thanks to the great expert on the architecture of Roman villas, Edith Thomas, who made an overview of villas in Roman Pannonia, including the territory of present–day Vojvodina.[4] Unfortunately, given that most of the villas in the Central Balkans are insufficiently investigated, a typological classification of those structures, as well as their size, could not be precisely established.

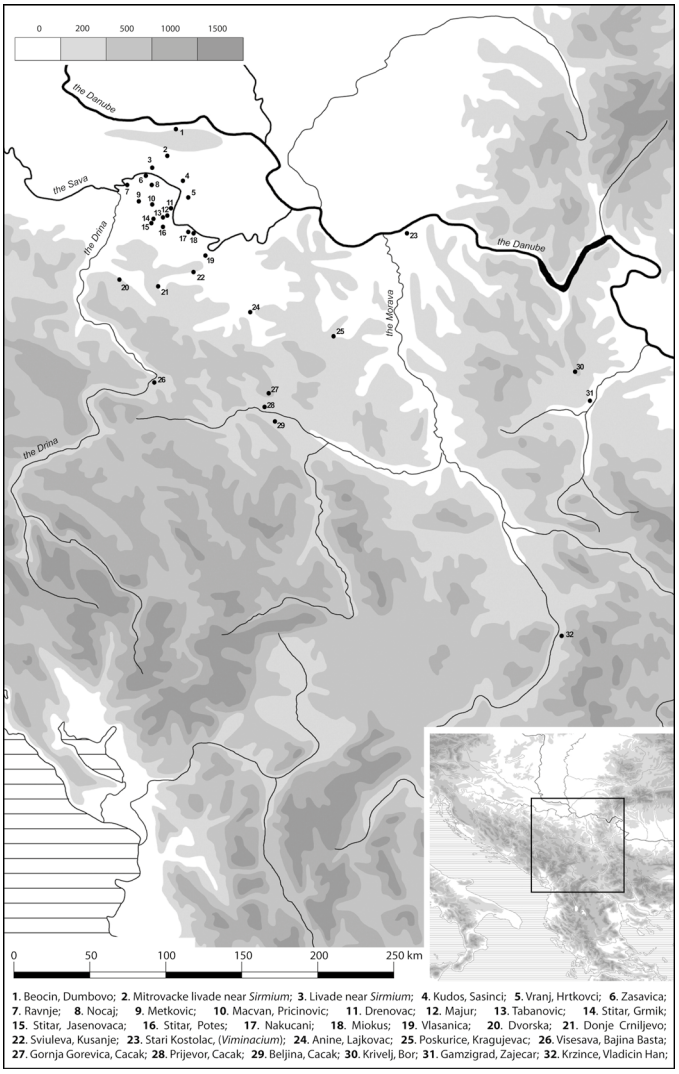

Fig. 3: Roman *villae rusticae* in the provinces of *Pannonia Inferior* and *Moesia Superior*.

Region of *Sirmium* and *Bassianae*

A significant number of villas have been recorded or partially investigated in the course of field surveys and rescue excavations within the wider urban territory of the ancient cities of *Sirmium* and *Bassiane* (fig. 3). The wider territories of both these cities are characterised by typical Pannonian plains, which are interrupted partially by the southern slopes of the Fruska Gora Mountain (*Alma Mons*). This area is traversed by the Sava and Danube and is rich in smaller waterways. It was especially convenient for establishing small rural settlements: *vici* as well as agricultural estates, the *villae rusticae*. A certain number of these villas were built in the territory or immediate vicinity of the

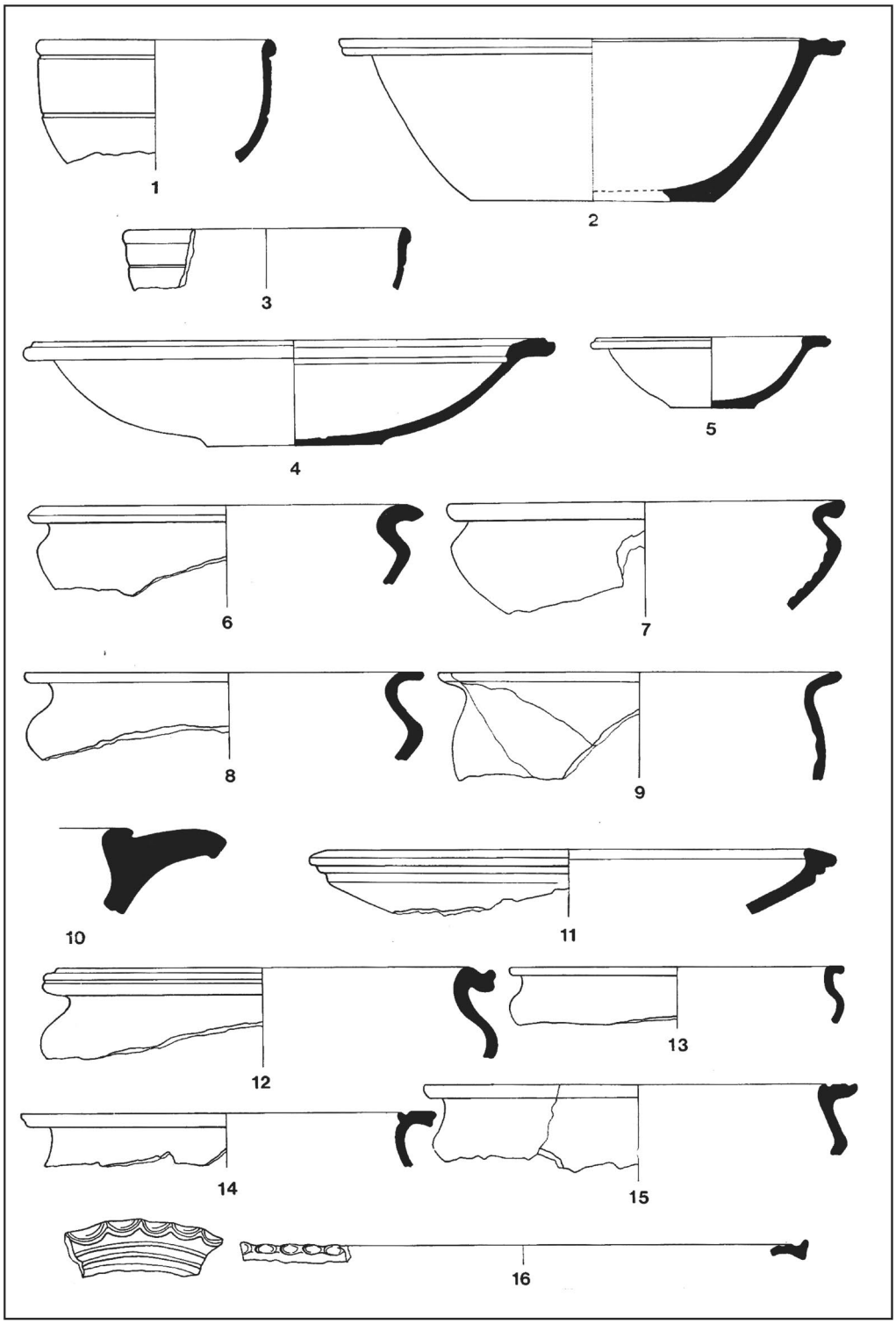

Fig. 4: Beocin, Dumbovo: Roman provincial terracotta bowls.

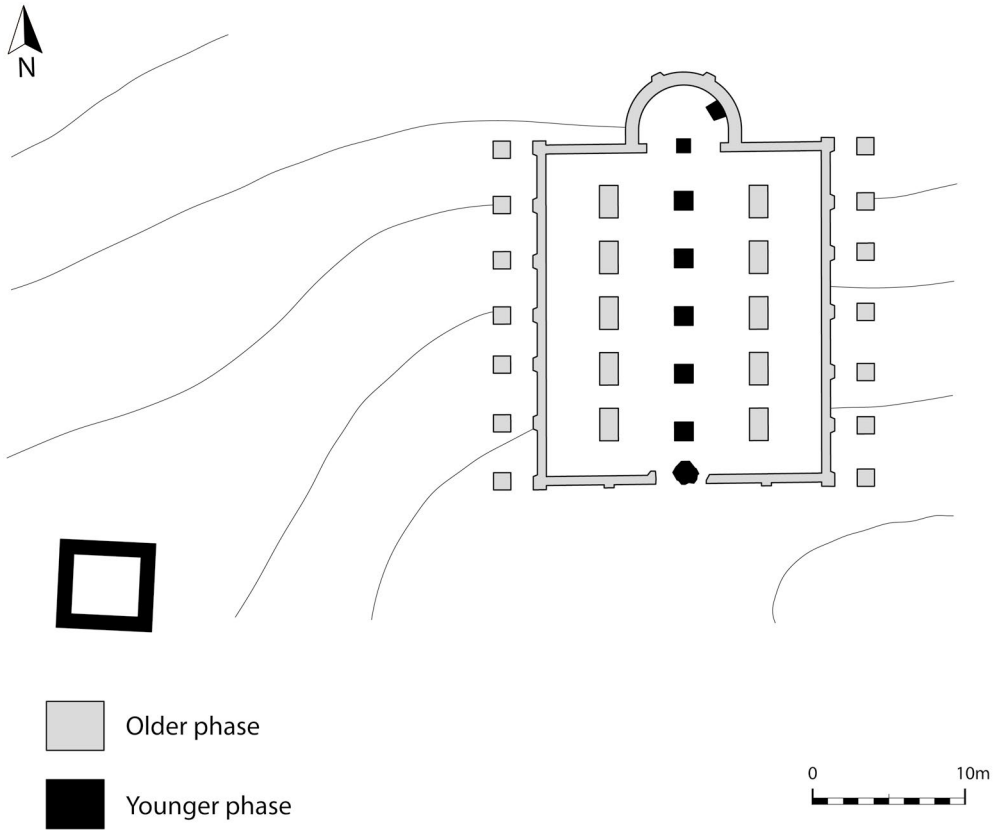

Fig. 5: Kudos, Sasinci: Basilica and watchtower of the *villa rustica* complex.

early Roman settlements starting in the 1st and 2nd centuries AD. The villa at Beocin-Dumbovo was built in the 4th century in the valley along the stream, while a watchtower stood on the slope of the hill. The villa had three building units devoted to residential and production functions. The rectangular shaped *speculum* or watchtower protected the residents of the villa and prevented the enemy from passing through the valley into the interior of the province. Archaeological finds, especially Roman provincial pottery forms typical of the 4th century, were found in large numbers (fig. 4). We could say that the villa in Beocin-Dumbovo was not simply a private economic unit that satisfied the needs of the owner and the inhabitants of the estate. Erected in the close vicinity of the *castra* of *Bonnonia* and *Cusum*, its agricultural activities and crafts ensured the development of economy and trade. This was of great importance for the supply of the military and the frontier population, and thus contributed to the security of the border.

Archaeological material and coins from the site of Sasinci suggest two phases of habitation: a rural village (a *vicus)* from the time of the Flavians, and a *villa rustica* dating to the 3rd and 4th centuries (fig. 5). In the area of the Hrtkovci village, besides the partially explored villa of Vranj (fig. 6), five more villas have been recorded on the basis of surface finds that consist of building rubble and other archaeological material.[5]

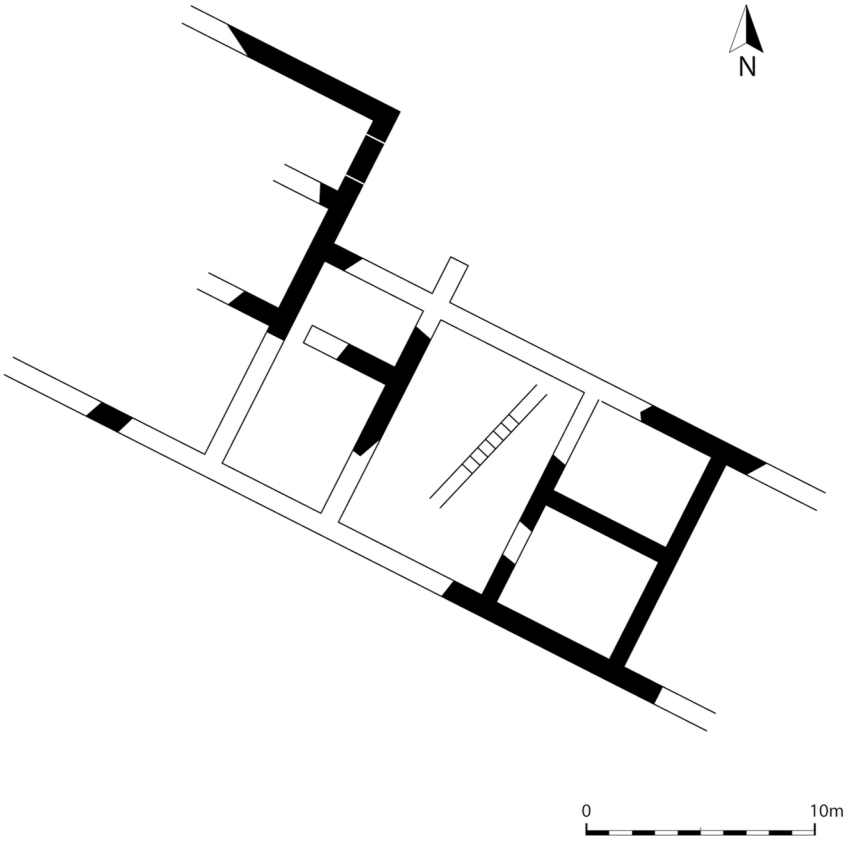

Fig. 6: Vranj, Hrtkovci: Plan of the partially investigated walls of the *villa rustica*.

Remains of a brick-built hypocaust indicate that the Vranj villa had an under–floor heating system. A rather large quantity of fresco fragments, comprising vegetal and geometric motifs, was found in one of the rooms of the villa. The structures of these villas were positioned on the foundations of earlier buildings of the 1st and 2nd centuries AD, a characteristic of most of the villas of Pannonia so far investigated.

The Region of Macva and the Drina Valley

The region of modern northwestern Serbia is of exceptional importance for studying Roman villas in the area of the Central Balkans. Thanks to the partial archaeological excavations conducted during the last decades, new light has been shed on the ancient topography of the region. This is the area where three Roman provinces bordered each other: *Pannonia Inferior*, *Dalmatia* and *Moesia Superior*. Much of the mountainous region of the Drina valley owed its development to mining and forest exploitation, whereas Macva developed as a result of being a region suitable to intensive agricultural

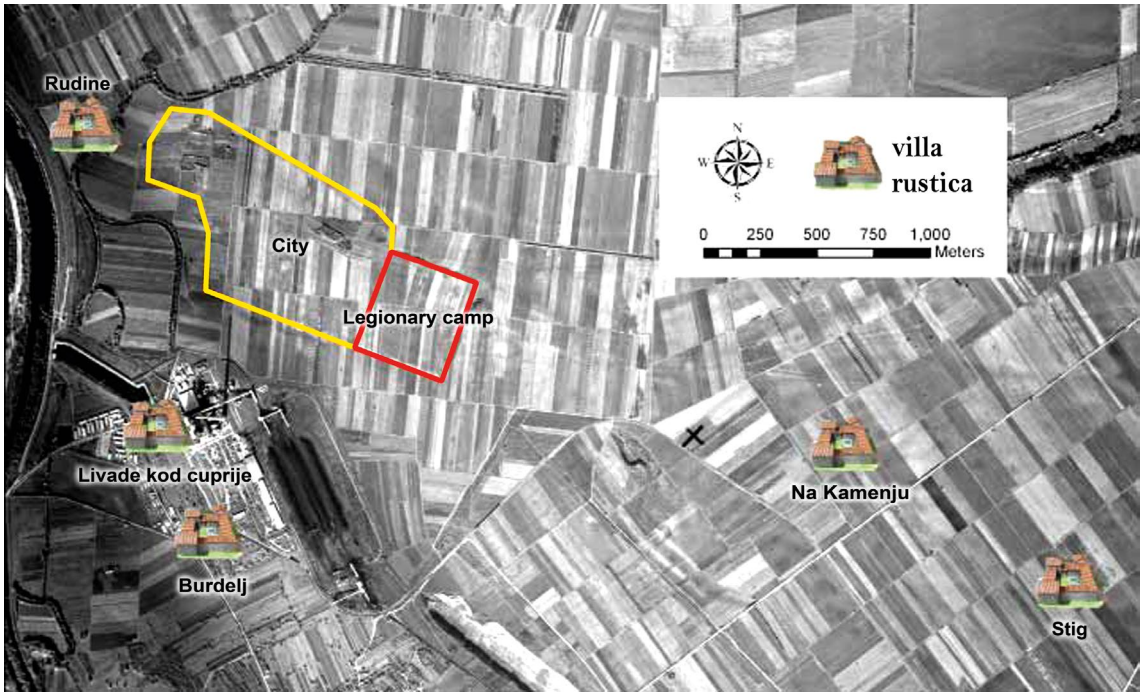

Fig. 7: Stari Kostolac (*Viminacium*): Roman villas in the vicinity of the city.

exploitation. This entire area abounded in agricultural estates. The region towards the Sava River was particularly densely populated; such population concentration is understandable considering the fertility of the land, together with the fact that the area gravitated towards the great urban centre of *Sirmium*. In general, considering the distribution of villas and settlements, the impression is that they were mostly located in immediate proximity to rivers; to the left and right of the rivers were open areas for cultivation. Undoubtedly, certain communication routes also had a significant impact on the location of the villas. Currently, this region is the most thoroughly investigated area in the territory of *Moesia Superior* as far as Roman villas are concerned. Here, it is most probable that a seasonal labour force was employed. Such a conclusion is also suggested by an archaeological survey of the sites in Stitar, where, in addition to the main residential building for the owner, there are smaller structures or huts. Hired workers may have resided in these. Such a system of hired labour is also suggested by the well-known large monetary hoard from Svileuva, in the vicinity of a villa at Kusanje.[6] The hoard contained coins from the period of Gordian III to Carinus. We can assume, judging by the large amount of money in the Kusanje hoard, that this was an agricultural estate of considerable size.

We attempted to establish the chronology of the villas based on the surface finds (e. g. pottery, coins) and the coin hoards. We hypothesise that the development of agriculture started in these areas in the middle of the 1st century AD, and was followed in the 2nd

Fig. 8: Stari Kostolac (*Viminacium*): Roman villa at Nad Klepeckom.

and 3rd centuries by a larger degree of immigration and development of agriculture, primarily farming. In this context we should mention the villa at Bela Crkva, which contained the remains of ancient structures and a hoard consisting of silver jewellery, vessels, and coins.[7] Coins from that hoard span the period from Nero to Commodus, so we could classify the villa as one of the earliest, with its date of construction assumed to be in the mid-2nd century AD.[8] Most of the other villas recorded in the region of Macva date from the middle of the 3rd to the end of the 4th century.[9] It can be safely assumed that all these villas were connected by a road network.

Viminacium and its Surroundings

Very little is known about villas in the vicinity of *Viminacium*, the capital of *Moesia Superior*, particularly taking into account the importance and position of this city in the Roman Empire. In the course of decade-long investigations at *Viminacium*, villas have not been adequately studied and presented to the academic audience, despite being very important for the study of the economy of the provincial capital. When the city had the status of *municipium* (117 AD), its territory encompassed a larger part of the plain in the lower course of the Mlava River (mod. Stig plain). After acquiring the status of *colonia* (239 AD), *Viminacium* expanded to include the entire Stig plain and *Pincum* (mod. Veliko

Gradište). The remains of five villas have been discovered at various locations within the city's ager in the course of archaeological investigations at *Viminacium* (fig. 7).

A large villa complex was discovered in 2013 at the site of Nad Klepeckom, several kilometres to the east of *Viminacium*. The research at this villa site has not been completed yet. Currently, the area investigated measures 80 × 31.5 m and features at least 24 rooms, making it the largest villa complex known so far in the surroundings of *Viminacium*. The villa had a central courtyard; the west side housed the service quarters while the residential part was on the east side. Here, remains of the floors and wall heating system have been discovered (fig. 8).

Conclusion

The territories of the Roman provinces of *Pannonia Inferior* and *Moesia Superior* stood out during the entire ancient period as agrarian areas with low levels of urbanization. A few areas could be distinguished for their intensive agriculture, which certainly was the result of favourable natural factors: topography, soil composition, and hydrological and climatic characteristics. One of these primarily agricultural areas is the territory of present-day Srem and Macva, in Pannonia. On the basis of the distribution and location of the recorded sites, Roman settlements appear to have been established in the vicinity of main roads and at locations that made possible the exploitation of natural raw materials as well as the employment of labour from the neighbouring native settlements. According to the archaeological investigations carried out so far, in this region we can see that villas complexes were mostly constructed on the same spot of previous, early-imperial settlements of the 1st and 2nd centuries AD, or in their immediate vicinity (table 2).

Notes

[1] Mirković 1971, 81–82 no. 79, pl. 12,1.

[2] Brukner 1976, 22.

[3] Bökönyi 1976, 49–50.

[4] Thomas' study (Thomas 1964) is still current, even though it was written more than half a century ago.

[5] Dautova Ruševljan 2005, 239–240.

[6] The hoard was discovered in 1916. 11,000 pieces of Roman coins are stored in the National Museum in Belgrade.

[7] The richness of the finds and the Illyrian character of some jewelry pieces confirm the hypothesis that in the 2nd and 3rd centuries there were fewer landowners.

[8] Petrović 1941, 11–23.

[9] Vasić 1985, 128.

SITE	TYPE	PROVINCE	CENTURY
Dumbovo, Beocin	Pannonian villa with a central corridor and watchtower	*(Panonnia Secunda)*	4th century
Mitrovacke Livade, Sirmium	Partially investigated villa complex. It was built in the vicinity of a Roman rural settlement of the 1st/2nd century. Later, a watchtower was built	*Pannonia Inferior (Panonnia Secunda)*	3rd–4th century
Livade, Sirmium	Pannonian villa with a central corridor	*Pannonia Inferior (Panonnia Secunda)*	3rd–4th century
Kudos, Sasinci	The villa complex consisted of a basilical building with apse and a few smaller utilitarian structures. The villa complex included a watchtower	*Pannonia Inferior (Panonnia Secunda)*	3rd–4th century
Vranj, Hrtkovci	Some rooms of the villa have been partially investigated. The complex was built in the vicinity of a Roman rural settlement of the 1st/2nd century	*Pannonia Inferior (Panonnia Secunda)*	3rd–4th century
Zasavica in Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Ravnje, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Nocaj, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Metkovic, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Macvan, Pricinovic, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Drenovac, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	

Table 2: Roman *villae rusticae* in the provinces of *Pannonia Inferior* and *Moesia Superior.*

SITE	TYPE	PROVINCE	CENTURY
Majur, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	3rd century
Tabanovic, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Stitar, Grmik, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda*	
Stitar, Jasenovica, Macva	Villa with projecting towers at the corners (Eckrisalit)	*Pannonia Inferior (Panonnia Secunda)*	4th century
Stitar, Potes, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Nakucani, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	4th century
Miokus, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Vlasanica, Macva	A villa was partially investigated	*Pannonia Inferior (Panonnia Secunda)*	
Dvorska	A villa was partially investigated	*Dalmatia*	3rd century
Donje Crniljevo	A villa was partially investigated	*Dalmatia*	3rd century
Kusanje, Sviuleva	A villa was partially investigated	*Moesia Superior (Moesia Prima)*	3rd century
Viminacium, Nad Klepeckom	Villa with central courtyard and 24 rooms	*Moesia Superior (Moesia Prima)*	3rd century
Viminacium, Livade near Cuprija	Pannonian villa with a rectangular ground plan and central corridor	*Moesia Superior (Moesia Prima)*	4th century

Table 2 (continued)

SITE	TYPE	PROVINCE	CENTURY
Anine, Lajkovac	Six rooms of the villa have been partially explored. It is one of the largest villas known in Serbia.	*Moesia Superior (Moesia Prima)*	4th century
Poskurice, Kragujevac	The villa complex is partially investigated.	*Moesia Superior (Moesia Prima)*	3rd century
Višesava, Bajina Bašta	Villa with portico?	*Dalmatia*	2nd–3rd century
Gornja Gorevnica, Cacak	A building with an apse has only been partially explored ?	*Moesia Superior (Moesia Prima)*	4th century
Prijevor, Cacak	Rectangular residential building with five rooms. The villa complex was only partially investigated	*Moesia Superior (Moesia Prima)*	4th–5th century
Beljina, Cacak	Some rooms of the villa have been partially explored. It is a rather small agricultural estate	*Moesia Superior (Moesia Prima)*	1st phase: 2nd/3rd century; 2nd phase: end of 4th – 1st half of 5th century
Krivelj, Bor	Pannonian villa with a corridor	*Moesia Superior (Dacia Ripensis)*	The end of 3rd to the end of 4th century
Gamzigrad, Zajecar	In the SE section of the imperial palace complex, a villa was partially explored: it has two longitudinal rooms and a portico to the east	*Moesia Superior (Dacia Ripensis)*	3rd century
Krzince, Vladicin Han	A complex villa, only partially explored. A passage between the rooms is linked in with a portico	*Dacia Mediterranea*	4th century

Table 2 (continued)

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Fig. 1: by author. – Fig. 2: after Brukner 1976, pl. 4, with modifications. – Fig. 3: by author. – Fig. 4: after Brukner 1976, T.X., with modifications. – Fig. 5: after O. Brukner, native settlements, in: Z. Vaja, Arheološka istraživanja duž autoputa kroz Srem (Novi Sad 1995), pl. 2, with modifications. – Fig. 6: after Dautova Ruševljan 2005, fig. 2. – Fig. 7: Documentation of the Institute of Archaeology SASA, Belgrade. – Fig. 8: Documentation of the Institute of Archaeology SASA, Belgrade. – Table 1–2: by author.

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Quantifying Roman Laeetanian Wine Production (1st Century BC – 3rd Century AD): A Microeconomic Approach to Calculating Vineyard's Crop and Winemaking Processing Facilities Yields

Antoni Martín i Oliveras – Víctor Revilla Calvo

in qua terra iugerum unum denos et quinos
denos culleos fert vini, quot quaedam Italia regiones? [1]
Varro rust. 1, 2, 7

pressura una culleos XX implere debet. hic est pes iustus.
ad totidem culleos et lacus XX iugeribus unum sufficit torculum[2]
Plin. nat. 18, 317

Introduction

Viticulture played an important role in the economy of the coastal Mediterranean part of Hispania Citerior Tarraconensis between the 1st century BC and the 3rd century AD. The vineyards, wineries, and pottery workshops are usually found clustered in specific areas, such as the Laeetanian region in the north-eastern part of the Iberian Peninsula.

Their spatial and temporal distributions have been interpreted previously as a proof of the existence of an intensive and specialized winemaking economy that is associated with large-scale production and trade of wine in bulk, and that targeted predominantly overseas markets.[3]

Despite the significance of winegrowing in this territory and its relative important role in the empire-wide economy, the processes involved in the production, trade, and consumption of Laeetanian wine and their evolution over time have not been quantified using formal and empirical economic models and econometrical methods.

Here we present a first approach to a microeconomic explanatory data analysis of ancient wine production, paying particular attention to a vineyard's crops and the yields from winemaking processing facilities; values and data employed come from the Latin written sources, the archaeological record, experimentation, and ethnographic or modern viticulture data.

The main goal of this paper is to explain the different processes and factors involved in this supply chain and production function, to quantify the main values

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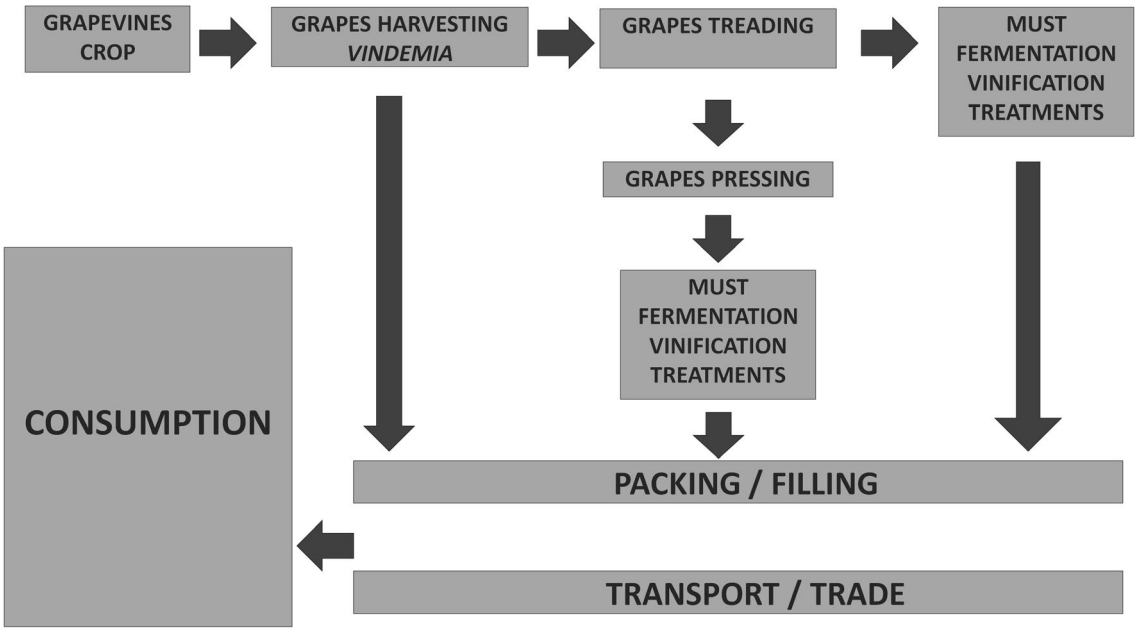

Fig. 1: Flow scheme of Roman viticulture supply chain and winegrowing production function.

and economic ratios and apply them in further geospatial econometrics models. This will assess *ab origine* the changing dynamics of the Laeetanian wine production system in a timeline dataset.

Roman Viticulture Supply Chain and Winegrowing Production Function

A supply chain is a system of resources and processes involved in the production and trade of goods or services from supplier to customer. Viticulture's supply chain involves both the production process and trade activities from its inception to its delivery to the end customer or consumer (fig. 1). The production function is the global system that characterizes a productive activity. The factors of production constitute the inputs of the economic system. A specific technology combines these inputs (e.g. raw materials, labour, machinery, tools, facilities, etc.) to obtain an optimal performance. The outputs are the finished products, the goods or services resulting from the productive activity.[4] In any type of socioeconomic organization, the production of goods and services may be in the hands of the state or in the hands of private producers. The Roman winegrowing production process is not alien to all these factors, conditions and microeconomic variables. It also has its particular production function with its own inputs intervening in the different stages of the productive chain.

Winegrowing Yields Quantification

The analysis of ancient viticulture can be approached in several ways according to different parameters of study. Its quantification is fundamental for the study of agricultural production processes, so we will try to adapt it both to the vineyard crop and to the processes of transformation, production and exploitation, for each of the different stages of viticulture's supply chain.[5] The quantification of winegrowing yields is fundamental for organizing the entire grapevine crop and winemaking production chain. This has several advantages: planning clusters and thinning needs in order to prevent excessive production and consequent poor wine quality; planning the harvest in relation to the timing of grape collection, labour needs, the configuration of the cellar, and conditioning of the equipment.[6] It is also useful for planning purchases and/or grape sales, establishing grape prices and the management of wine stocks, the management of the grape and wine market, planning investments, as well as the development of sales and trade strategies. This multiplicity of potential planning advantages makes the quantification of winegrowing yields one of the major current research topics in modern oenology. It is also one of the most interesting procedures we can use for reconstructing the productive processes of ancient viticulture.

To estimate global winegrowing yields we have to distinguish two main methods:

- Vineyard crop yields: this refers both to the crop yield itself, as regards the productive capacity of the plant, or yield per strain according to different intervening parameters and variables, and the harvesting yield (i.e. the mass of grapes collected prior to pressing, expressed in weight and produced in the whole vineyard, property, area or territory).
- Winemaking processing facilities yields: this calculates the yields from the processes of treading and pressing the grapes, its transformation into must and then into wine, as well as the maximum and average productive capacity of the processing machinery. Thus, we can determine the quantity and capacity of vats needed for collecting, ageing, and storing the wine produced.[7]

Vineyard's Crop Yields Parameters and Variables

Crop yield quantification in vineyards is important for managing vines in order to optimize growth and for controlling fruit quality over the time. If it is possible to forecast the grapevine crop yield then the planning of harvesting operations becomes easy, and optimal vineyard yields and the grape's quality goals can be achieved. Viticulture is much more effective when it is based on an accurate yield estimation. Typically, crop predictions are performed using historical data on vineyard yields, which are based on the grape cultivar, soil conditions, age of the vines, local weather patterns related with biotic and abiotic stresses, and cultural practices used by the grower. These are complimented by measurements taken manually in the field. Agronomic studies have established that a large spatial variability exists for vineyards yields across multiple

regions and depending on growing conditions. Therefore, vineyard yields can display high temporal variability, either regionally or locally. Furthermore, within the same vineyard plot there can occur variability between vines, between clusters of the same vine, and between berries of the same bunch.

There are different ways to estimate potential yields in a vineyard. However, the ones based on the vineyard crop estimation components are the most used at the farm level and are conditioned by different factors that can influence in the final result.[8] These factors are:

a) Vineyard field configuration: this refers to the modulation patterns in the field, the geometry of plantation (plantation frame, vine density, row orientation and training system), and the vine architecture (plantation system, driving system and pruning methods).
   - Modulation patterns in the field: this refers to the extension, the shape of properties and the percentage of field devoted to vineyards. The ancient *agrimensores* distinguished three possibilities of modulation patterns in the fields:[9]
     – *Ager divisus et adsignatus*: this was public land assigned to *coloni* or private individuals by *catastro et centuriato*. The territorial division or cadastre featured land plots of different modules depending on the geomorphology and topography of the territory. The Roman unit of length used for land measurements was the *actus* of 120 *pedes*; the square *actus* measures 14,400 square *pede*s and one *iugerum* equals 2 *actus*. The most common land division consisted in square or rectangular plots of 100 *iugera* (≅ 62.22 ac ≅ 25.18 ha = 251,800 m^2) or 200 *iugera* (≅ 124.45 ac ≅ 50.36 ha = 503,600 m^2) called *centuria,* orthogonally organized and ascribed to a *civitas* or *municipium*.[10] This modulation of 100 or 200 *iugera* is the standard parcel module for a vineyard that we used in our calculations.
     – *Ager per extremitatem mensura comprenhibus*: this is a form of land division which seems to have followed earlier land organization patterns. It is, therefore, a system very common in provincial territories. It appears to refer to land measured only along its external boundaries; the land was normally assigned *in toto* to some pre-established community.
     – *Ager arcifinalis*: this term appears to express the division of a territory in parcels which have arbitrary boundaries not defined by specific measurement, but by natural elements such as mountain ranges, hills, woods, rivers, streams, valleys, marshy areas, maritime shores, etc. (table 1).

   In respect to the special features of the *Laeetana regio*, and considering its particular geospatial configuration, geoeconomic characteristics, and historical evolution over the time, all three possibilities of modulation patterns are represented:
     – *Ager centuriatio et catastro:* this type of land division was present in the hinterland of the colony of Barcino.[11] Perhaps a cadastral division was in place in the Vallès plain territory, where we found important secondary settlements defined as *civitas sine urbe.*[12]

ROMAN UNITS OF LENGHT AND AREA CORRESPONDANCES					
Lenght units			Area units		
digitus (1/16 *pes*)	0.728 in	18.5 mm	-	-	-
palmus (1/4 *pes*)	0.243 ft	74 mm	-	-	-
pes (pattern unit)	0.971 ft	29.6 cm	*Pes quadratus* (pattern unit)	0.94 ft²	0.0876 m²
palmipes (1 ¼ *pes*)	1.214 ft	37.0 cm	*Scrupulum* (100 *pedes quadrati*)	94.3 ft²	8.76 m²
cubitum (1 ½ *pes*)	1.456 ft	44.4 cm	*Actus minimus* (480 *pedes quadrati*)	453 ft²	42.1 m²
gradus (2 ½ *pedes*)	2.427 ft	74 cm	Clima (1/4 *actus quadrati* = 1/8 *iugerum*)	3,390 ft²	315 m²
passus (5 *pedes*)	4.854 ft	1.48 m	*Actus quadratus* (½ *iugera* =30 *actii minimus*)	0.311 a	1292 m²
pertica (10 *pedes*)	9.708 ft	2.96 m	*Iugerum*	0.623 a	2518 m²
actus (120 *pedes*)	116.496 ft	35.5 m	*Haeredium* (2 *iugera*)	1.248 a	5047 m²
stadium (625 *pedes* /125 *passi*)	202.38 yd	185 m	*Centuria* (100 *haeredia* = 200 *iugera*) ½ *centuria* (50 *haeredia*=100 *iugera*)	124.45 a 62.22 a	50.36 ha 25.18 ha
Mille/Milia passi	0,919 mi	1.48 km	*Saltus* (4 *centuriae*)	499 a	201.9 ha

Table 1: Roman units of length and area and their equivalences for measuring the extension of the fields and calculate vineyard's crop yields.

  - *Ager per extremitatem mensura comprenhibus:* this land division may have been used in the central coastal fringe between the Baetulo (Besós) and Arnum (Tordera) rivers, an area with an important pre-Roman settlement. The *ager arcifinalis* could also have been used here.
  - *Ager arcifinalis:* this was probably adopted in the lower course of the *Rubricatum* (Llobregat) River and in the short coastal fringe located between its mouth and the foothills of the Garraf massif.[13]
- Geometry of plantation: this concerns the vine's spatial disposition on the ground. There are different parameters to take into account:
  - Plantation frame: this refers to the vines layout and spacing of the vines in individual vines and rows. Different plantation systems were used in Roman times. One of the most used was the so-called standard frame of 5 *pedes* (≅ 4.85ft = 1,48m) × 4 *pedes* (≅ 3.93ft = 1.20m) = 20 *pedes quadrati* (≅19.5ft2 = 1,78m^2), described by Pliny the Elder.[14] The most common layouts in the fields were rectangular, with vines in groups of two or four, or even in *quincunx* (four vines forming a square and one vine in the centre). We will use these values of a plantation's frame for our vineyard's plant density calculations.
  - Planting density: this refers to the total number of vines present in a given area. From this datum a proportional value or *ratio* of vines/acre or vines/hectare or

vitis/iugera is determined. Both the plantation frame and planting density are determined by the plantation system adopted.

- Row orientation: this refers to the maximum exposure of leaf surface to direct sunlight. This is crucial for grapevine performance in terms of yield, grape composition, and wine quality.[15] When rows are planted in north-south orientation, more leaves are exposed to direct sunlight than in the case of east-west orientation.[16] The row orientation should also take into account the direction of the prevailing summer breezes, since they have an important cooling effect on bunches and leaves.[17]
- Training system*:* this refers to how a vine is cultivated in regards to the aerial configuration of the canopy. There are three main systems of training vines: free (without support), staking (using posts) or trellising. In Laeetanian vineyards the training system was free without any kind of trellising, due to the plantation system and pruning method adopted. This growing method has a great advantage due to the savings in infrastructure costs.

• Vine architecture*:* this refers to the strain configuration, which is determined by different parameters such as:

- Plantation system: the Roman agronomists distinguish two ways of planting a vineyard according to the ploughing system used: eeither in *scrobes* (trenches) or *alveus* (small ditches). The most common plantation system in Laetania consisted in two vines planted on both sides in a rectangular or ovoidal *alveus* of 4 *pedes* (≅ 3.93ft = 1.20m) × 1 *pes* (≅ 0.9701ft = 0.2957m) × 1 *pes* (deep).
- Driving system: this refers to the configuration of the vines' space and their layout on the ground. This is defined by the relationship between the plantation frame and planting density as and in relation to the height of the trunk as well as the pruning system adopted.[18]
- Pruning methods*:* different pruning methods could be used in order to favour and increase the homogeneity of fruiting. This also controlled the strain's growth, adapting it to a specific canopy's shape and improving the productivity and the quality of the grape. The vines are pruned to limit the amount of wood and delay the aging of the strain. According to the number and disposition of the different parts of the vine (trunk, branches, spurs, shoots, and buds), different levels of vine and vineyard productivity can be obtained. The common method adopted by Laeetanian growers was spur pruning, called also "goblet" or open "vase" (see fig. 2).

Laeetanian vineyards adopted a configuration with a free-training and head-driving systems, with trunks between 1.5 *pes* (1.45ft = 44.4cm) and 3 *pedes* (2.90ft = 88.8cm) tall, in an *alveus* planting system and using spur pruning. This offered strong comparative advantages. It allowed for high productivity and lowered labour costs of harvesting in comparison to other competitors such as the Italic producers.[19]

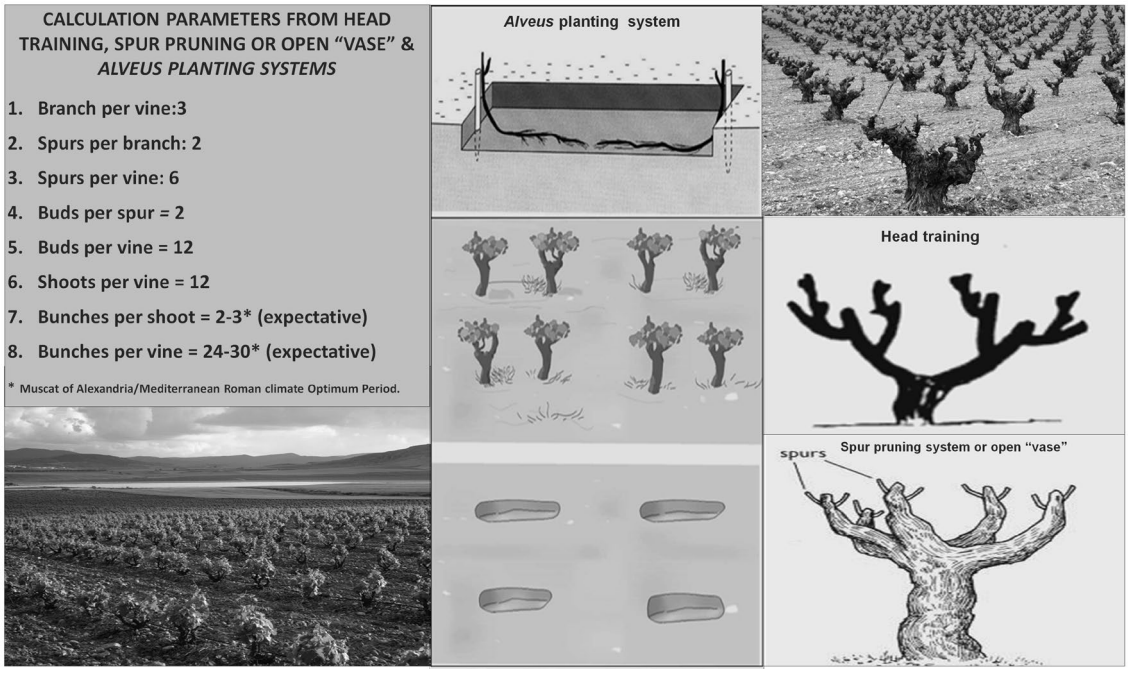

Fig. 2: Calculation parameters from head training, spur, "goblet" or open "vase" pruning, and alveus planting systems in a Laetanian vineyard.

b) Grapevine productivity: this is determined by the growth parameters of the selected vine/grape variety (e.g. vine/grape vigour and production capacity, crop load, crop level, vine balance, ripening process, mass of grapes per cultivar) and the type of canopy management chosen (e.g. trellising, thinning, fertilising and phytosanitary treatments).
   - Vine/grape variety growth parameters*:* this refers to the natural growth characteristics of the plant, clusters, and berries. They can be improved with a good management of the canopy and other care applied to the vine.
     – Vine vigour: this refers to the vine's natural capacity to increase its vegetative growth (shoots and leaf production) and its reproductive development (grapes and berries production) in specific favourable environmental circumstances. This forces the grower to find the correct balance between these two growing parameters.
     – Crop load: determines the ratio between the reproductive development (number of clusters and berries) and the vegetative development (number of exposed photosynthetically active leaves). The crop load ratio allows the grower to determine the optimal amount of fruit that can ripen on a given vine.
     – Crop level: this is analogous to crop yield but it does not imply that the entire crop will be harvestable. Therefore, crop level is a worse yield calculation parameter than crop load.[20]

  - Vine balance: is the point at which the crop load is ideally matched with vine growth. Achieving the correct crop load ratio for a balanced vine can optimize the quality of the fruit and lead to consistent production. The vine balance can vary according to the cultivar, location, training system, management practices, and overall climatic conditions.[21]
  - Ripening process*:* refers to the time period needed for the grapes to achieve the optimal point of equilibrium between sugar and acids. This period is shorter or longer depending if the cultivar ripens early or late.[22]
  - Mass of grapes per cultivar*:* refers to the ratio of the total wheight of the grapes obtained from a single vine or yield per strain and from the whole field.
  - Harvesting yield: this can be counted by plant, row or ground portion (acre, hectare, or *iugerum*).
- Canopy management: this encompasses the practices undertaken by the grower to care for the vines as well as the climatic and soil influence. This allows for an optimal balance between vine growth and its productivity. There are different tasks for the grower:
  - Trellising: it combines the training of vines and the driving actions in the canopy‘s aerial space to achieve the desired arrangement of the strains.
  - Thinning: it refers to the removal of excessive shoots, leaves, or immature grape bunches (green pruning) to ease the burden of the strains and achieve the vine balance.
  - Fertilization: a vineyard needs a regular supply of mineral and organic elements in its soil like nitrogen, phosphorus, and potassium. It is achieved by adding animal manure and mineral fertilizers that promote the healthy growth of the vines and fruits and protect them against diseases.
  - Phytosanitary treatments*:* it refers to the treatments against diseases and parasites. This includes mechanical actions, such as ploughing the soil under the vine rows to fluff and aerate the earth and also eliminate larvae, insects, and weeds that can compete with the vine roots for the soil nutrients: it also includes chemical actions, such as sulphuring the vines against parasites and fungi.

Regarding the grapevine variety productivity calculation parameters for Laeetanian wine, we chose those of the Muscat of Alexandria or Roman Muscat. This is the modern variety closest to the *coccolobis hispana* described by the Roman agronomists for this territory.[23] It is predominantly a white, sweet grape of the 4th epoch (large vegetative cycle of > 185 days), with a tardy maturation period of +55 days that should be harvested later than other similar varieties (between mid-September and mid-October).[24] It is used for wine, as a table grape, and to make raisins. This grape produces sweet and dry elegant wines with a powerful floral flavour.

Spacing Feet (m)		Between Rows									
		3 (0.9)	4 (1.2)	5 (1.5)	6 (1.8)	7 (2.1)	8 (2.4)	9 (2.7)	10 (3.0)	11 (3.4)	12 (3.7)
Between Vines	3 (0.9)	4840	3630	2904	2420	2074	1815	1613	1452	1320	1210
	4 (1.2)	3630	2723	2178	1815	1556	1361	1210	1089	990	908
	5 (1.5)	2904	2178	1742	1452	1245	1089	968	871	792	726
	6 (1.8)	2420	1815	1452	1210	1037	908	807	726	660	605
	7 (2.1)	2074	1556	1245	1037	889	778	691	622	566	519
	8 (2.4)	1815	1361	1089	908	778	681	605	545	495	454
	9 (2.7)	1613	1210	968	807	691	605	538	484	440	403

Table 2: Vines per acre based on planting spacing. Multiply by the conversion value 2.55052 to get vines/hectare.

c) Yield components calculation: there are three main parameters to take into account:
   - Planting density calculation: refers to the ratio of vines to area. It can be expressed as number of vines/acre, vines/hectare or *vitis*/*iugerum*, depending on the surface units used or the measurement system we want to apply.
   - Yield per strain: it refers to the mass of grapes per cultivar in regards to the capacity of the vine to produce a specific wheight of total grapes. This depends on different parameters, which derive from the selected vine/grape variety, the plantation system, the driving and pruning methods adopted, and the canopy management.
   - Harvesting yield: it refers to the total mass of grapes, expressed in weight, produced in the whole vineyard, property, or territory.

   These three parameters are the most used to calculate vineyard crop and grapevine yields in respect to two main productivity values: Maximum and Average (table 5).

Vineyard Crop and Grapevine Yields Calculation

There are two main parameters for calculating the total harvesting yield of a single vineyard, a property or *fundus*, and area or territory (region, province, etc.). These are also used to obtain the corresponding ratio for predicting a potential vineyard crop after considering planting density, cultivar chosen, environmental conditions, and the mass of grapes per cultivar and per field.

a) Vineyard crop yield: the most common way to predict a potential vineyard crop yield is the so-called traditional method. To do this, some data are needed:

   First, the planting density, which equals the total number of vines per acre/hectare/*iugera*. There are modern tables of vineyard planting densities that estimate the vines based on the plantation frame and calculated from the distances between rows and vine spacing (table 2).

	1 m	1,10 m	1,15 m	1,20 m	1,25 m	1,30 m	1,40 m	1,50 m	1,75 m	2 m	2,25 m	2,50 m	2,75 m	3 m
1 m	10.000	9.090	8.695	8.333	8.000	7.692	7.142	6.666	5.714	5.000	4.444	4.000	3.636	3.333
1,10 m		8.264	7.905	7.575	7,272	6.993	6.493	6.060	5.194	4.545	4.040	3.636	3.305	3.030
1,15 m			7.561	7.246	6.956	6.688	6.211	5.797	4.968	4.347	3.864	3.478	3.162	2.898
1,20 m				6.944	6.666	6.410	5.952	5.555	4.761	4.166	3.703	3.333	3.030	2.777
1,25 m					6.400	6.153	5.714	5.333	4.571	4.000	3.555	3.200	2.909	2.666
1,30 m						5.917	5.494	5.128	4.335	3.846	3.418	3.076	2.797	2.564
1,40 m							5.102	4.761	4.081	3.571	3.174	2.857	2.597	2.380
1,50 m								4.444	3.809	3.333	2.962	2.666	2.424	2.222
1,75 m									3.265	2.857	2.539	2.285	2.077	1.904
2 m										2.500	2.222	2.000	1.818	1.666
2,25 m											1.975	1.777	1.616	1.481
2,50 m												1.600	1.454	1.333
2,75 m													1.322	1.212
3 m														1.111

Table 3: Vines per hectare based on planting spacing. Divide by the conversion value 2.55052 to get vines/acre.

The highlighted vine density value in table 2 is associated with common vine spacing in the Laeetanian region in Roman times:

4 *pedes* × 5 *pedes* ≅ 4/5 vines/frame ≅ 2178 vines/acre

A 10 % reduction in vine numbers ought to be considered due to the use of land for margins and roads:[25]

2178 vines/acre × 10 % = 217.8 vines/acre

2178 vines/acre – 217.8 vines/acre ≅ 1960 vines /acre (table 2)

The values of vines highlighted in Table 3 is associated with the common vine spacing in the Laeetanian region in Roman times:

4 *pedes* per 5 *pedes* ≅ 4/5 vines/frame ≅ 5,555 vines/ha.

When considering the 10 % reduction due to the need for roads and margins, we have:

5,555 vines/ha × 10 % = 555 vines/ha

5,555 vines/hectare – 555 vines/hectare ≅ 5,000 vines /ha.

We can transform these values by converting the units of measure:

1 acre ≅ 0,405 ha / 1 hectare ≅ 2.47 acres

1 *iugerum* ≅ 0.620 acres / 1 *iugerum* ≅ 0.2518 ha.

The calculation for both values of surface measurements is:

1,960 vines/acre × 0.620 acres = 1,215.2 *vitis/iugerum*

5,000 vines/hectare × 0.2518 hectare = 1,259 *vitis/iugerum.*

The resulting average value is:

1,960 vines/acre ≅ 5,000 vines/ha ≅ 1,237.1 *vitis/iugerum.*[26]

Then we can calculate the plant density for a vineyard of 100 *iugera* or 200 *iugera*:

1,237.1 *vitis/iugerum* × 100 *iugera* = 123,710 *vitis/½ centuria*

1,237.1 *vitis/iugerum* × 200 *iugera* = 247,420 *vitis/centuria.*

Row width (m)	Number of rows per ha	Number of bearers/ha[1]	Mass of grapes[2] for cultivars with							
			120 g/bunch[3]		150 g/bunch[4]		200 g/bunch[5]		250 g/bunch[6]	
			Per bearer (g)	Per ha (t)	Per bearer (g)	Per ha (t)	Per bearer (g)	Per ha (t)	Per bearer (g)	Per ha (t)
3,0	33	33 000	360	11,8	450	14,9	600	19,8	750	24,8
2,7	37	37 000	360	13,3	450	16,7	600	22,2	750	27,8
2,5	40	40 000	360	14,4	450	18,0	600	24,0	750	30,0
2,2	45	45 000	360	16,2	450	20,3	600	27,0	750	33,8
2,0	50	50 000	360	18,0	450	22,5	600	30,0	750	37,5

[1] With a bearer spacing of 10 cm between bearers
[2] For an average of 3 bunches per spur
[3] E.g. Cabernet Sauvignon, Cabernet franc, Pinot noir
[4] E.g. Merlot, Pinotage
[5] E.g. Crouchen blanc, Morio Muscat, Sauvignon blanc
[6] E.g. Carignan, Colombar, Mourvèdre

Table 4: Mass of grapes for cultivars on different plantation frames and grapevine varieties (footnote 26).

Second, we need the number of clusters per vine to calculate the yield per strain value. This is estimated either based on the buds left at pruning (and therefore, potential shoots/vine) or the typical cluster count/shoot for the grape variety. It can also be estimated in-season by doing cluster counts on selected vines within a block. Often, it is done at both times, particularly in years where winter damage has resulted in significant bud damage, or when early frosts have damaged emerging shoots. (fig. 2)

Third and finally, we need an estimated mass of grapes for cultivars of an average cluster weight. This is taken from historical records (and thus, a grower should keep yearly records). If calculating the potential yield just before harvest, a grower can sample a few clusters and use their average weight as this estimate. The traditional equations also allow us to determine the number of clusters they should leave per vine, if they have a target yield in mind. There are some tables of correspondence between mass of grapes for cultivars and average cluster weights for different grapevine varieties: (table 4)

With all this information, we can calculate the potential yield in tons/acre or in tons/hectare or in *librae/ iugerum* by applying this simple formula:[27] (fig. 3)

b) Grapevine crop yield: this has to adapt to the grapevine variety chosen. For Laeetanian wine, we have used the parameters from Muscat of Alexandria / Roman Muscat variety in a standard vineyard of 100 *iugera*. The calculation parameters have been calculated for both the maximum and average productivity levels: (table 5)
We can convert these values:
1 Roman *libra* ≅ 0.7109 lb /1 Roman *libra* ≅ 0.32245 kg
1 ton (UK) = 2,240 lb / 1 metric ton = 1,000 kg
1 Roman wine *amphora* ≅ 81 Roman *librae.*

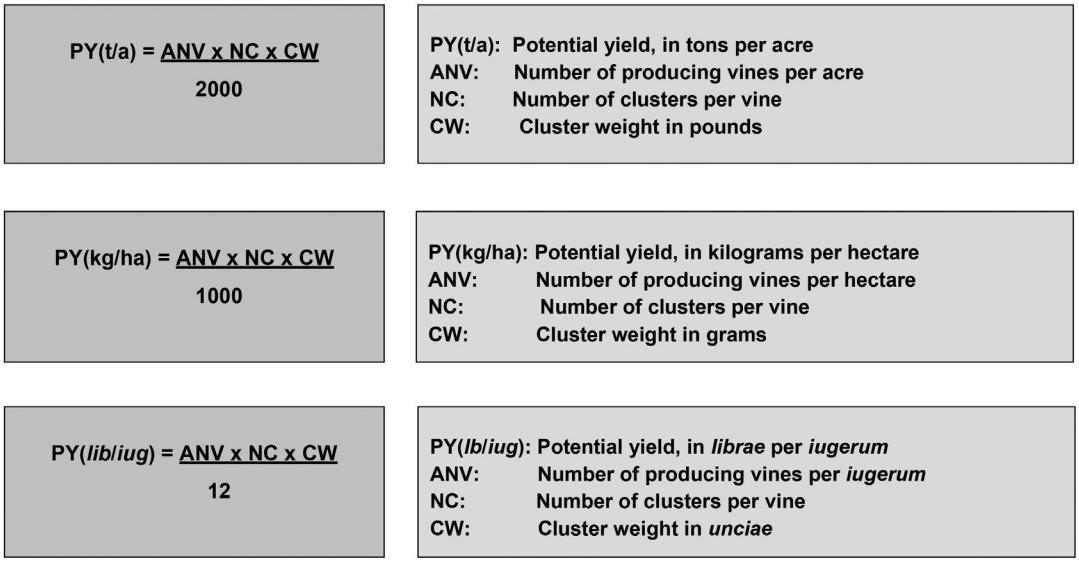

Fig. 3: Formula for calculation of potential yields in different measurement magnitudes.

The calculations for both values of weight and surface are:
1 (mt) = 1000 (kg) = 2,204.62 (lb) /1 ha ≅ 2.47 acres/ 1 *iugerum* ≅ 0. 2518 ha
25.74 mt/ha = 25,740 kg/ha × 2.20462 (lb) = 56,747 (lb) : 2,204 (lb) = 25.74 (t)/ha
25.74 (t) /ha : 2.47 (a) = 10.42 tons/acre
25.74 (mt) × 0.2518 ha = 6.52 (mt)/*iug* = 6522 kg/*iug*: 0.32245 kg/lb = 20,226 *librae*/*iugerum.*

The calculation and conversion of these weight/surface values in volume/surface units of wine are the following:
20,226 *librae/iugerum*: 81 *librae*/*amphorae* ≅ 250 *amphorae* /*iugerum* × 22.5 litres[28] = 5,625 litres/*iug* ≅ 5.62 hl /*iugerum* × ± 4 *iugerum*/ha ≅ 22.5 hl /ha ≅ 494.93 gallons/ha: 2.47 acres/ha = 200.37 gallons/acre = 6.36 wine barrels (UK)/acre[29]
250 *amphorae*/*iugerum* ≅ 10.73 *cullei*/*iugerum*[30] × 100 *iugera* = 1,073 *cullei*/½ *centuria*
250 *amphorae*/*iugerum* ≅ 10.73 *cullei*/*iugerum* × 200 *iugera* = 2,146 *cullei*/*centuria*
This could be the average ratio of a Laeetanian vineyard crop yield obtained in volume of wine produced per field.

Yields, Parameters, and Variables of Winemaking Processing Facilities

There are two methods for quantifying the yields of a processing facility based on the four main winemaking tasks developed: extraction of the juice by treading on the grapes in the *calcatoria* (treading vats); pressing of the pomace in the *torcular* (winepresses); collection of the must in the *lacus* (collecting tanks); and transferal into the *dolia* (large fermentation jars).[31]

MUSCAT OF ALEXANDRIA / ROMAN MUSCAT **GRAPEVINE CROP YIELD COMPONENTS CALCULATION**	
Calculation parameters (maximum)	***Calculation parameters (average)***
1. Vines per ha = 5000	1. Average Vines per ha = 4766
2. Vines per *iugera* = 1259	2. Average Vines per *iugera* = 1200
3. *iugerum* in field = 100	3. *iugerum* in field = 100
4. Bunches per vine ≅ 27 (24-30 bunches)*	4. Average bunches per vine ≅ 27 (24-30 bunches)*
5. Bunches weight = 450 g	5. Average bunches weight = 200 g
6. Berries per bunch ≅ 104	6. Average berries per bunch = 100
7. Berry weight = 4,32 g	7. Average berry weight = 2,00 g
8. Target yield kg per vine = 12.15 (kg)	8. Average yield kg per vine = 5,4 (kg)
9. Target yield tons per ha = 60.75 (mt)	9. Average yield tons per ha = 25.74 (mt)
10. Target yield tons per *iugerum*= 15.18 (mt)	10. Average yield tons per *iugerum*= 6.52 (mt)

Table 5: Grapevines crop yield components calculation at maximum and average productivity levels.

Thus, quantification can focus on two main operations:

a) Treading and pressing yields*:* this tries to calculate the maximum capacity of must processed during the vintage period or *vindemia* both by grape-stomping in treading vats and by pressing the pomace in winepress. This method has several advantages compared to the second one. First, practically all the harvested grapes ought to be treaded and pressed to obtain the must to be fermented into wine.[32] Second, some important values can be derived from the written sources, experimental archaeology, ethnographic data, and modern oenology.[33] Third, estimations can be subjected to mathematical and statistical analysis.[34]
b) Collection and storage yields*:* previous studies have tried to apply this method, which calculates the capacity of production from the data provided by the Latin literary sources regarding the recommended number of *dolia.*[35] It also uses archaeological data pertaining to the number and size of vats and storage structures present in production centres.[36] However, the data from the literary sources are often scarce or contradictory, and the archaeological data are often incomplete. This does not mean that we cannot use this type of calculation if sufficient data are available.[37]

A set of fixed parameters can be established from the data derived from Cato[38] about the three wine-presses necessary for processing the harvest from a 100-*iugera* vineyard (≅ 25 ha ≅ 61.77 acres), and from Pliny's description of the pressing yield capacities according to volume of must processed,[39] as c. 20 *cullei* (≅ 105 hl ≅ 2310 gal = 73 wine barrels (UK)). However, these authors do not specify how many times the presses were operated and, if the value included the volume of must extracted from treading the grapes.

To quantify the temporal variable, an average of the *vindemia* period can be calculated if we compare the values inferred from the Roman agronomists with the data taken from

Concept year	Grapes weight (tm) real	Treading must (hl) real	Pressing must (hl) real	Total must 1/2 day 6h/(hl)	Corresponding *iugera* (≅ 5.25hl)	Corresponding ha (≅ 21hl)
1995*	7,9*	23,5*	23,0*	46,5*	8,9*	2,2*
1996	5,0	16,0	14,0	30,0	5,7	1,4
1997	5,0	19,0	16,0	35,0	6,7	1,7
1998	6,0	15,5	14,0	29,5	5,6	1,4
Average	5.97(t)*/ 5.33(t)	18.5(hl)*/ 16.83(hl)	16.75(hl)*/ 14.66(hl)	35.25(hl)*/ 31.5(hl)	6.72(*iug*)*/ 6.0(*iug*)	1.6(ha)*/ 1.5(ha)

Table 6: Real yield values obtained during the Mas de Tourelles experiment.

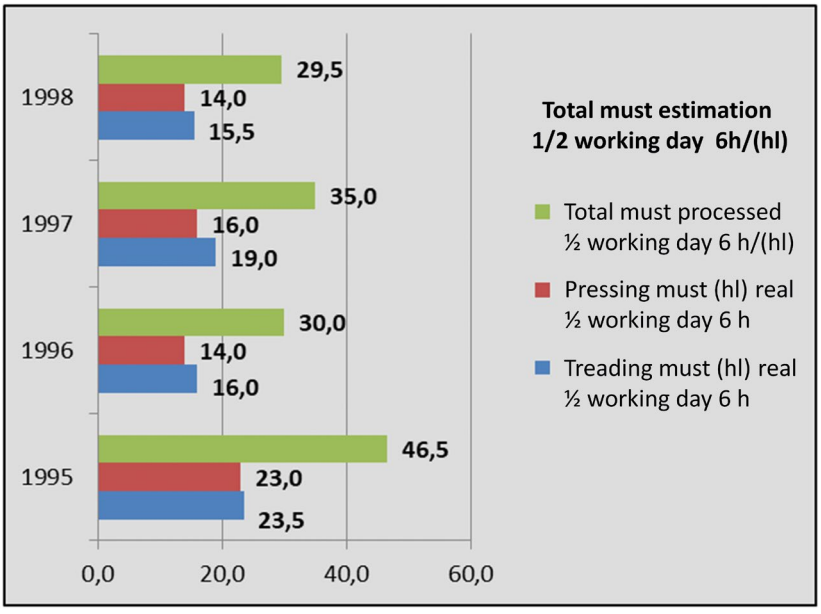

Fig. 4: Real yield values obtained during Mas de Tourelles experiment.

ethnographic and experimental sources. We calculated the maximum and the average pressing capacity of one Catonian press in half of a working day (≅ 6 hours) and a complete working day (≅ 12 hours).[40]

The fixed calculation parameters and variables are:

Vindemia maximum period ≅ 30-44 days.[41]

Vindemia average period of harvesting and processing Muscat of Alexandria grapes ≅ 12–15 days.[42]

Working hours per day: 12 hours of sun (Laeetanian region/Barcelona).[43]

Vineyard extension unit: 1 *iugerum* ≅ 2,518 m^2 = 0.2518 ha ≅ 0.623 acres

Vineyard extension plot: 100 *iugera* ≅ 25.18 ha ≅ 62.3 acres,[44] or 200 *iugera* ≅ 50.36 ha ≅ 124.6 acres[45]

Concept year	Grapes weight (tm) estimation /day	Treading must (hl) estimation/day	Pressing must (hl) estimation/day	Total must estimation 1 day 12h/(hl)	Corresponding *iugera* (≅ 5.25 hl)	Corresponding ha (≅ 21hl)
1995*	15,8*	47,0*	46,0*	93,0*	17,7*	4,4*
1996	10,0	32,0	28,0	60,0	11,4	2,9
1997	10,0	38,0	32,0	70,0	13,3	3,3
1998	12,0	31,0	28,0	59,0	11,2	2,8
Average	11.95(t)*/ 10.6(t)	37(hl)*/ 33.6(hl)	33,5(hl)*/ 29.33(hl)	70.5(hl)*/ 63.0(hl)	17.82(iug)*/ 11.96(iug)	13.14 (ha)*/ 3.00 (ha)

Table 7: Estimate yield values obtained per a working day of 12 hours (our own).

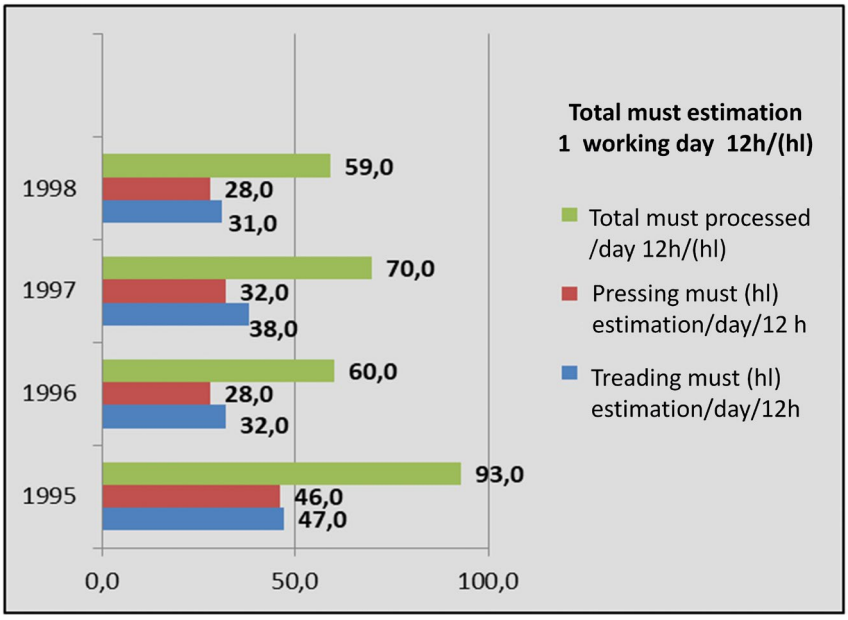

Fig. 5: Estimate yield values obtained per a working day of 12 hours (our own).

Roman liquid volume measure unit: 1 hl = 100 l ≅ 22 gal (UK)
Roman volume unit equivalence: 1 *culleus* ≅ 5.25 hl ≅ 525 l ≅ 115.3 gal (UK)
Average grapes per day (12 h) processed: ≅ 10.6 (mt) ≅ 10.38 (t)
Average grapes per *vindemia* (15 days) processed: ≅159 (mt) ≅ 155.82 (t).[46]

Winemaking Processing Facilities Yields Calculation

Our calculations take into account the data offered by A. Tchernia's and J.-P. Brun's experimental archaeology project carried out from 1995 to 1998 that used reconstructions of Roman processing facilities at Mas de Tourelles (Beaucaire, France). Moreover, we should distinguish both values (e.g. the must yields deriving from the treading process and the must yields deriving from the pressing process)

when trying to obtain a production ratio of the total yield. A series of tables were developed and comparative graphs were developed that allow us to assess the average capacity of yield performance.

First, we calculate the processing yield values obtained for half of a working day (≅ 6 hours) (table 6; fig. 4),[47] followed by the values for a complete working day (≅ 12 hours) (table 7; fig. 5).

It is important to note that 1995 was the first year of the experiment, and that the experimenters themselves considered the second yield value obtained for the grape treading process to be aberrant. In order to adjust the final results, two average values are possible. The first one (total average values with asterisk) is the sum of yields for the whole period (1995–1998). The second ones are obtained from the sum of the yields for the last three years (1996–1998); this period has great coherence in terms of the final results. For the sake of accuracy, we will take the second average values as our point of comparison with our results.

Discussion

It is possible to compare the results of the calculations based on the values given in the text of the agronomists with the results obtained from experimental archaeology:

a) Data derived from the Roman agronomists:[48]
   - Cato[49] gives some information about vineyard crop yield values that have been established by J.-P. Brun in a ratio ≅ 33 hl/ha. From this we can calculate other yield ratio magnitudes: 33 hl/ha = 3,300 l/ha : 0.2518 ha/*iug* ≅ 13,105 l/*iug* : 525 litres/*culleus* ≅ 24.96 *cullei*/*iugerum* × 100 *iugera* = 2,496 *cullei*/*½centuria*; 24.96 *cullei*/*iugerum* × 200 *iugera* = 4,992 *cullei*/*centuria*.[50]

For processing yields, J.-P. Brun established a total target of 750 hl of must processed in a facility with three presses.[51] Supposing a ratio of 250 hl per press and applying Pliny's processing yield ratio per press (20 *cullei* ≅ 105 hl ≅ 2310 gal = 73 wine barrels UK), this results in just three days of work.[52]

- Varro[53] gives an average vineyard crop yield value for Italy between 10-15 *cullei* × *iugerum* ≅ 52.5–78.75 hl ≅ 1184.84–177.26 gal = 38-57 wine barrels UK.[54]
- Pliny (nat. 18, 317), estimates that one press can produce ≅ 20 *cullei* ≅ 105 hl ≅ 2,310 gal = 73 wine barrels UK and can process ≅ 20 *iugera* ≅ 5.0 ha ≅ 12.36 acres, but does not give any temporal reference. Brun also considered that taking Pliny's ratio of 63 hl/ ha (which for Columella thought was good),[55] the total production obtained from 20 ha of vineyard ≅ 80 *iugera* would bee 240 *cullei* ≅ 1,260 hl ≅ 27,716 gal ≅ 880 wine barrels UK. A single Catonian winepress could process this amount in around 12 working days. This means that for a 25-ha vineyard ≅ 100

iugera, producing 1,575 hl ≅ 34,645 gal ≅ 1100 wine barrels UK, a single winepress would take c. 15 days to process the grape.

Interpreting the productive yields values relying only on the Roman agronomists' information is difficult because the data are incomplete and the results obtained are inconsistent. However, it seems that the winemaking facilities were prepared with large harvests in mind and to obtain an optimal ratio of wine productivity.[56]

b) Results obtained by archaeological experimentation:[57]

One of the most important results achieved with the Mas de Tourelles' experiment is the ability to determine the average yield value of the treading and pressing processes per working day. These results can help to answer the question of the temporal variable missing in the written sources. Another important issue not treated in the ancient sources is how to know the must yield obtained in every process of grape treading and pressing. A third important point is to determine whether the yield values given by the Roman agronomists are coherent with the results obtained by experimental archaeology. In regard to both winemaking processes, we have obtained the following yield values according to experimental archaeology: (Table 8)

CALCATORIUM YIELD (Optimal average according to Tchernia & Brun, 1999, 104)		CATONIAN WINE PRESS YIELD (Optimal average according to Tchernia & Brun, 1999, 104)
1. Must per working day (12 h)= 33.6 (hl) ≅ 739.09 gal (UK) ≅ 23.46 wine barrels (UK) ≅ 6.4 *cullei*	+	1. Must per working day (12 h)= 29.3 (hl) ≅ 654.51 gal (UK) ≅ 20.77 wine barrels (UK) ≅ 5.6 *cullei*
2. Must per *vindemia* (10*days)= 336 (hl) ≅ 7391 gal (UK) ≅ 234.63 wine barrels (UK) ≅ 64 *cullei*		2. Must per *vindemia* (10 days*)= 293 (hl) ≅ 6445.09 gal (UK) ≅ 204.60 wine barrels(UK) ≅ 56 *cullei*
*Taking the minimum estimate time value.		*Taking the minimum estimate time value.

Table 8: Optimal average values for processing facilities (treading + pressing) obtained by archaeological experimentation.

It assumes a yield average value of 53% of must production obtained from treading and a yield average value of 47% from pressing.[58] The sum of both values gives a total average ratio per processing facilities:

The total average of must processed / working day is: ≅ 63 hl ≅ 1,385.78 gal ≅ 48 wine barrels (UK) ≅ 12 *cullei* ≅ 280 *amphorae*.[59]

The total average of must processed (treading and pressing) over a 10-day *vindemia* is: ≅ 629 hl ≅ 13,836.06 gal ≅ 439 wine barrels (UK) ≅ 120 *cullei* ≅ 2,700 *amphorae*.

The total average of must processed (treading and pressing) over a 15-day *vindemia*: ≅ 943.5 hl ≅ 20,754.09 gal ≅ 659 wine barrels (UK) ≅ 180 *cullei* ≅ 4,193 *amphorae*.

Since no experimental archaeology project was carried out on the yields of a vineyard's crop, the relevant calculations are theoretical. Nevertheless, some comparative calculations can be done between these values and dataset of yields from winemaking processing facilities that came from the experiment.

Comparing the total average results obtained from the three datasets studied (vineyard crop, Roman agronomist dataset, and experimental archaeology processing yields) is important since it clarifies ideas and gives calculation patterns that can be further applied in the analysis of winegrowing productive capacity yields in other geographic areas.

The correlations between viticulture's productive ratios and the dataset from experimental archaeology allow us to quantify Laeetanian winegrowing yields more accurately: (table 9)

Note that the average ratios ≅ 5.62 hl/*iugerum** per vineyard crop yield and ≅ 5.25 hl/*iugerum* both per Catonian wine press yield and winemaking processing facilities yield ≅ ±10 *cullei* per working day (12h) are either very similar or common in all three of the datasets.[60] Despite the different values resulting from each calculation methodology these results indicate that a statistically correlation exists between them, as shown by the common or similar average ratio obtained for the three yield calculation systems.

VINEYARD CROP YIELD CALCULATION PARAMETERS (OBTAINED)	**Average ratio**
• **Average yield weight per vine = 5.4 (kg)**	
• **Average yield weight per hectare = 25.74 (mt)**	
• **Average yield weight per *iugerum* =6.52 (mt) ≅ 10.73 *cullei/iug*** ≅	**5.62 hl/*iugerum****
• **Average yield per vineyard (100 *iug*) = 1,073 *cullei*½ *centuria***	
• **Average yield per vineyard (200 *iug*) = 2,146 *cullei*/centuria**	

CATONIAN WINE PRESS YIELD CALCULATION PARAMETERS (SUGGESTED)	**Average ratio**
• **Must processed 10 *cullei* /workday= 52.5 hl ≅ 2.5 ha ≅ 10 *iugera*** ≅	**5.25 hl/*iugerum***
• **Total *vindemia* period (+-10 days)= 525 hl ≅ 25 ha ≅ 100 *iugera* ≅ 100 *cullei* ≅ 1 press**	
• **Total *vindemia* period (+-15 days)= 787.5 hl ≅ 37.5 ha ≅ 150 i*ugera*≅150 *cullei* ≅1 press**	

WINEMAKING PROCESSING FACILITIES YIELDS (TREADING + PRESSING) CALCULATION PARAMETERS (EXPERIMENT RESULTS) (Based on Tchernia & Brun, 1999)	**Average ratio**
• **Total must estimation 1 workday (12h) ≅ 63 hl ≅ 3 ha ≅ 12 *iugera*** ≅	**5.25 hl/*iugerum***
• **Total *vindemia* period (+-10 days) ≅ 630 hl ≅ 30 ha ≅ 120 *iugera* ≅ 120 *cullei* ≅ 1 press**	
• **Total *vindemia* period (+-15 days) ≅ 945 hl ≅ 45 ha ≅ 180 *iugera* ≅ 180 *cullei* ≅ 1 press**	

Table 9: Comparative study of different yield calculation methodologies for assesses its correlation.

Conclusions

Changes in rural and urban settlement patterns also reflected a change in agrarian exploitation systems. Winegrowing yield calculations are crucial to the organization of the whole grapevine crop and winemaking production chain. The interaction between the potential vineyards extension and the needs of winemaking production facilities in a given area is a good way to explore the quantification of viticulture yields. To estimate global winegrowing yields we have to distinguish between two main methods:

- Vineyard's crop yield: it refers to the mass of grapes obtained (in weight) both per vine and per harvesting on the area examined.
- Winemaking processing facilities yield: it refers to the productive capacity of the processing facilities for transforming the mass of grapes into volume of must, and, with fermentation, into *cullei* of wine.

These calculations depend on a large number of variables that can affect the results, such us the agroecological environment (geomorphology, soil features, climatology and weather conditions, grape varieties, age of vines, etc.), availability of labour, transport networks, and sociocultural practices.

Comparison between vineyard crop and winemaking facilities yields (treading and pressing) is a key element for achieving this goal. It makes it possible to "reconstruct" viticulture productive units as "types" and to calculate production capacities in absolute terms. It combines the data of modern oenological studies, of the Roman agronomists, the archaeological record, ethnographic sources, and experimental archaeology.

Our explanatory data analysis has focused on obtaining some important ratios that allow us to analyse and model the scope of the Laeetanian Roman wine economy and its specific evolution over the time. This microeconomic approach also allows us to develop further predictive or reconstructive models about the productive and trading systems of the past.

In summary, combining yields' datasets obtained from experimental archaeology with available oenological, ethnographic, and historical yield datasets can be the best way to achieve an optimal knowledge (and one closer to reality) about the productive capacity of winegrowing during the Roman period. Furthermore, it is also possible to apply this method to the study of viticulture or other economic activities in other territories and periods.

Notes

[1] "In which soil does one *iugerum* produce between 10 or 15 *cullei* of wine like in the Italian regions?"(authors' transl.).

[2] "One press ought to fill (one vat of) 20 *cullei*. That is the norm. Thus, one single press should be enough for (pressing) 20 *iugera* (of vineyard) and for filling all the collecting vats (*lacus)* and wineskins (*cullei*)" (authors' transl.).

[3] Martín i Oliveras 2015, Martín i Oliveras – Revilla 2019, with previous bibliography.
[4] Martín i Oliveras 2015, 182.
[5] Amouretti – Brun 1993, 552.
[6] In the case of ancient viticulture, preparing the grape stock containers, cleaning the treading areas (*calcatoria*), greasing the presses (*torcularia*), proofing the must collecting tanks (*lacus*), and re-pitching the earthenware fermentation jars (*dolia*).
[7] Winemaking process in facilities yields are also called Winery's yields. Martín i Oliveras – Revilla 2019.
[8] Clingeleffer et al. 2001
[9] Frontinus "*De agrorum qualitate*" <http://www.thelatinlibrary.com/frontinus/qualitate.shtml> (30.04.2019). See also J. Murray, A Dictionary of Greek and Roman Antiquities (London 1875) s. v. Ager, 29–31. <http://penelope.uchicago.edu/Thayer/E/Roman/Texts/secondary/SMIGRA*/Ager.html> (30.04.2019) ; Castillo 2011, 83–110.
[10] Martín i Oliveras 2015, 44–50.
[11] Palet – Fiz – Orengo 2009.
[12] Oller 2015, 408–410 Map 8–12.
[13] Rivers, streams banks, and flood plains could be important constraints for settlement patterns. Mountains, marshes, and sea shores could be also conditioning factors.
[14] Plin. nat. 17, 20.
[15] Archer 2010.
[16] Champagnol 1984.
[17] Hunter – Volschenk 2008.
[18] Martin i Oliveras 2015, 71.
[19] See Tchernia 1986, 127. The author believes that this cultivation method was imported into the Iberian Peninsula by Punic colonizers and was adopted by the indigenous inhabitants in *Hispania Citerior*, this method improved productivity and lowered the production costs, making the Laetanian wine much more competitive.
[20] Stein et al. 2016, 1056–1057.
[21] Skinkis – Vance 2013.
[22] See Martin i Oliveras 2015, 39 Tab. 1. Maturation periods could be between < 5 and +55 days. Vegetative cycles could be between < 145 days and > 185 days, depending on grape varieties.
[23] Colum. 3, 2, 19; Plin. nat. 14, 29–30. See Miles et al. 2011, fig. 3: the Muscat of Alexandria is one of the most ancient and less hybrid grapevine "mother" varieties in the world.
[24] Depending on the soil typology and microclimatic conditions of the vineyard. Grape variety data come from: <http://www.vitivinicultura.net/moscatel-de-alejandria.html> (30.04.2019). Some scholars also believe that an ancient variety of *balisca* or *bilisca,* the *vitis Apiana,* cited by Pliny (Plin. nat. 14. 24. 81) as "the grapes that attract bees", and the *coccolobis hispana* were the same cultivar: García 1991, 219–221.
[25] Percentage of vines losses value taken from: <http://www.viverosmacaya.com/plantacion/> (30.04.2019).
[26] The average is obtained by adding both total quantities (vines/acres + vines/hectare) and dividing them into two.

[27] The Romans did not use weight measurements but preferred to measure by capacity. Thus a Roman cubic foot (26.26 dm3) was equivalent to a *quadrantal* or *amphora* (28 *sextarii* or 0.547 l) and one Anglo-Saxon gallon (3.785 l) would be more or less equivalent to a Roman *congius* (= 6 *sextarii* or 3.283 l). The *amphora* was equivalent to 81 Roman wine *libras*, one Roman *libra* equals 322.45 gr. which in turn are equal to 1.4 Anglo-Saxon ounces.

[28] Average capacity of Laetanian wine amphora form Pascual 1, see *Amphorae ex Hispania* database: <http://amphorae.icac.cat/amphora/pascual-1-tarraconensis-northern-coastal-area/features> (30.04.2019).

[29] 1 hl = 21.9969248299 gallons (UK) /1 gallon (UK) = 0.0454609 hl /1 barrel (UK) = 31.5 gallons (UK).

[30] 1 *culleus* ≅ 525 l ≅ 115.2639 gallons (UK) = 3.66 wine barrels (UK).

[31] In fact there are three methods if we add the vineyard crop yield calculation and its correlation with capacity units of wine produced.

[32] Except those that were sold as fruit (as grapes or raisins). According to the Food and Agriculture Organization (FAO), approximately 71 % of the world's grape production is used for wine, 27% for fresh consumption as fruit, and 2 % as raisins and juices: <http://www.fao.org/faostat/en/#data> (30.04.2019).

[33] From experimental archaeology we only have the data from the Mas de Tourelles experiment done in 1995–1998: Tchernia – Brun 1999, 102–105.

[34] Estimates are the object of debate among scholars, but have been accepted by most economic historians due to the scarcity of data and the absence of more reliable information: De Sena 2005, 2 note 7.

[35] E.g. Cato agr. 11, 1.

[36] Brun 1993, 307–342; Tchernia 2013, 153–166.

[37] Mainly to be able to contrast them with the results obtained by other quantification methodologies (vineyard crop yields and winemaking processing facilities yields).

[38] Cato agr. 11.

[39] Plin. nat. 18, 317.

[40] The Romans divided the day into twelve *horae* or hours starting at sunrise and ending at sunset. The night was divided into four watches. Sunlight parameters for the months of August/September/October in the Barcelona area are from: <https://meteogram.es/sol/espana/barcelona/> (30.4.2019).

[41] Varro rust. 1, 34, 2; Plin. nat. 18, 319.

[42] Assuming a vineyard of Muscat of Alexandria variety in the Laetanian region's agro-ecological conditions (i.e. soil, slope, weather, temperatures, planting system, head-spur pruning, etc.), with an extension of 100 *iugera* (≅ 62.3 acres ≅ 25.18 ha) and also considering the average temporal values for processing (treading and pressing) as deduced from Pliny's dataset (see discussion section).

[43] Op. cit. note 32.

[44] Cato agr. 10, 1.

[45] Colum. 2, 12.

[46] Average grape values taken from Mas de Tourelles experiment: Tchernia – Brun 1999, 102–105.

[47] Corresponds to the real values obtained in the 6 hours of work / day during the experiment in France.

[48] All data are from Brun 2004, 20.

[49] Cato agr. 11.

[50] These values appear too optimistic.
[51] We have not been able to deduce from where the total processing yield target of 750 hl arises, since if we take the ratio of 33 hl/ha previously established and multiply it per 25 ha (≅ 100 iugera), the result obtained is 825 hl.
[52] We think the temporal ratio of almost three days is deduced by assuming Pliny's processing yield value of 20 *cullei* for one single press in one single working day adding the treading yield as well. In any case, the result obtained is oversized.
[53] Varro rust. 1, 2, 7.
[54] These values are coherent with Pliny's processing yields ratio of 20 *cullei* / *iugerum* but also are oversized.
[55] Colum. 3, 3,1.
[56] Note that we speak of optimal results, not maximal; achieving a good balance between vineyard's crops and processing facilities yields was the main objective pursued by the winegrowers.
[57] All data from Tchernia – Brun 1999, 104–109 and our own study.
[58] Percentages from Tchernia – Brun 1999, 104.
[59] Op. cit. note 25.
[60] Considering the bias resulting from the conversion between weight and volume for liquids values.

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The Roman villa was a defining element of the Roman world and its appearance and spread, both in various regions of Roman Italy and abroad, have been linked to various historical phenomena: Rome's territorial expansion, the establishment of colonial settlements, and the indigenous elites' readiness to participate in forms of Roman life. While traditional historiography has seen the spread of large villas in Republican Italy as a phenomenon that displaced small and medium landowners from the land, and thus contributed to Rome's socio-political problems, recent studies have stressed that large villas and farms were not at variance with each other. The papers gathered in this volume aim at giving a more organic evaluation of how the 'villa economy' and the 'peasant economy' operated, and to what degree, if any, the two were integrated. It does so by addressing two main questions: whether villas and small and medium farms were part of two distinctive productive and distributive systems or not; and to what extent the picture emerging from provincial territories compares with the situation in Roman Italy.

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