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QUANTIFYING THE SUPPLY OF ROMAN WINE AND OLIVE OIL IN FRANCE: AN AORISTIC ANALYSIS OF AMPHORAE ASSEMBLAGES

Summary. *This article analyses the dynamics of Roman olive-oil and wine production and commerce in present-day France from the second half of the second century* BC *to the mid-fourth century* AD*, drawing on a corpus of more than 7000 amphorae recovered from Gallic and Romano-Gallic settlements across the French territory, excluding Alsace. The methodology consists of a quantitative strategy based on aoristic distribution, assessing both regional and chronological trends according to production and settlement chronologies. The results highlight a clear preponderance of Italic wine in Late Republican Gaul, followed by imports from Hispania, before local Gallic wine came to dominate the domestic market and expanded to other provincial contexts. In parallel, the study traces initial Italic olive-oil imports to southern Gaul, subsequently supplanted by the predominance of Hispanic oil and the growing presence of North African products. The article follows these dynamics up to the mid-fourth century* AD*, considering both the impact of the crisis of the third century and the substitution of amphorae by barrels in northern Europe. The statistical methodology applied to this large amphora assemblage allows for a reassessment of production and distribution trends and of the chronological phases of wine and olive-oil supply in Roman Gaul.*

INTRODUCTION

The production, distribution and consumption of foodstuffs were, undoubtedly, among the main economic activities in the Roman economy. Wheat produced in Egypt was consumed in Rome and elsewhere. *Garum* from North Africa was shipped to Germania. Baetican olive oil reached the Eastern Mediterranean. Rome created an integrated pan-Mediterranean food market where certain regions, for example, specialized in agro-fisheries production whose output catered to distant provinces (Horden and Purcell 2000).

Roman consumption archaeology relies almost exclusively on Roman amphorae, used as containers for foodstuffs, as the primary vector to trace these Mediterranean food market dynamics. As a non-perishable item in the archaeological record, amphorae can illuminate perspectives on the

distribution and consumption of agricultural products, with limitations concerning the final stage of the production-consumption pipeline. In the same vein as fine Roman pottery, amphorae have been studied since the nineteenth century (Dressel 1899; Déchelette 1908–14). However, since the second half of the twentieth century, this topic witnessed a renewed interest with the creation of consistent typologies, their respective chronologies and identification of their contents and origins (among others, but not exclusively: Callender 1965; Tchernia 1969; Beltrán 1970; Panella 1973; Grace 1979; Keay 1984; Laubenheimer 1985; Empereur and Picon 1986; Peacock and Williams 1986; Hesnard *et al*. 1989; Bonifay 2004; Keay and Williams 2005).

Recently, there has been a shift towards quantitative and simulation analysis in the Roman economy, especially in pottery studies employing computational techniques (Brughmans and Poblome 2016; Tol 2017; Brughmans and Pecci 2020; Attema *et al*. 2021). Wilson and Brughmans' monograph (*Simulating Roman Economies: Theories, Methods, and Computational Models*) includes a discussion about the utility and applicability of these new approaches, while offering examples of archaeological studies performed using computational methods (Brughmans 2022; Wilson 2022). Along these lines, Franconi *et al*. (2023) and Komar *et al*. (2025) deduced macro-trends of amphorae production, distribution and consumption in Germania and Italy respectively, analysing amphorae assemblages with a methodology based on an aoristic distribution (see next section). The aim and originality of these articles lie in the handling of large assemblages of amphorae (*c*.30,000 each) in a wider region with 80 settlements each. These two large datasets consider chronological information regarding the temporal production of an amphora type, and combine it with the chronology of the settlements where these amphorae assemblages were found.

In this article, the methodology follows that established by Franconi *et al*. (2023) and Komar *et al*. (2025) in Germany and Italy, respectively. Amphora assemblages are employed to examine production and import trends of wine and olive oil across present-day France, excluding Alsace, from *c*.150 BC to the mid-fourth century AD (Figs. 1–3). This study then incorporates a second methodological stage (outlined in the following section) to achieve greater chronological precision.

METHODOLOGY AND DATABASE

The statistical tool employed by Franconi *et al*. (2023) and Komar *et al*. (2025) is the aoristic distribution. Despite the effectiveness of this approach for addressing the chronological and recovery biases often associated with archaeological material, the use of this tool in classical archaeology is uncommon, with only a few precedents for its application (Wilson 2009; 2011; Verhagen *et al*. 2016; Palmisano *et al*. 2017).[1] An aoristic distribution is a probabilistic method that allocates the frequency of archaeological objects within a time range when it is not possible to know the exact date at which certain objects were produced, as is the case for amphorae. It distributes the frequency of amphorae in a dataset uniformly throughout a particular chronological range. In this case, there are two possible ranges: the chronologies of production of each amphora form, and the chronology of the settlements where they were found. Combining the two reduces the effects

[1] Although it has been applied also to other historical and archaeological periods: see Johnson 2003; Crema 2012; Berger *et al*. 2019; Hinz *et al*. 2019; Kleijne 2019.

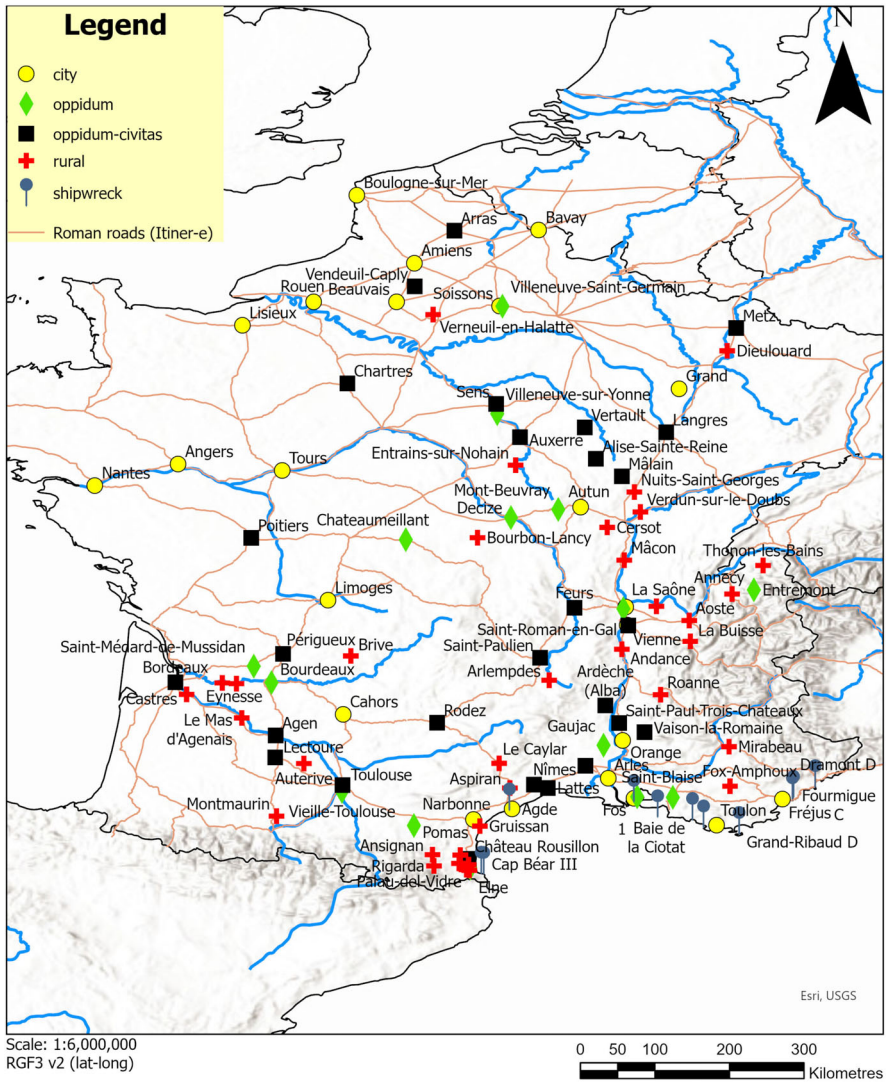

FIGURE 1
Site and site-types encompassed in the database of this study in which amphora(e) were found.

of chronological uncertainties and ambiguities. Moreover, the resulting distribution facilitates quantitative analyses of amphorae production, as well as the distribution and consumption of olive oil and wine. The aoristic distribution is expressed in the equation below; and for this article, the aoristic distributions were programmed in Python using *Visual Studio Code* software.[2]

[2] https://code.visualstudio.com/

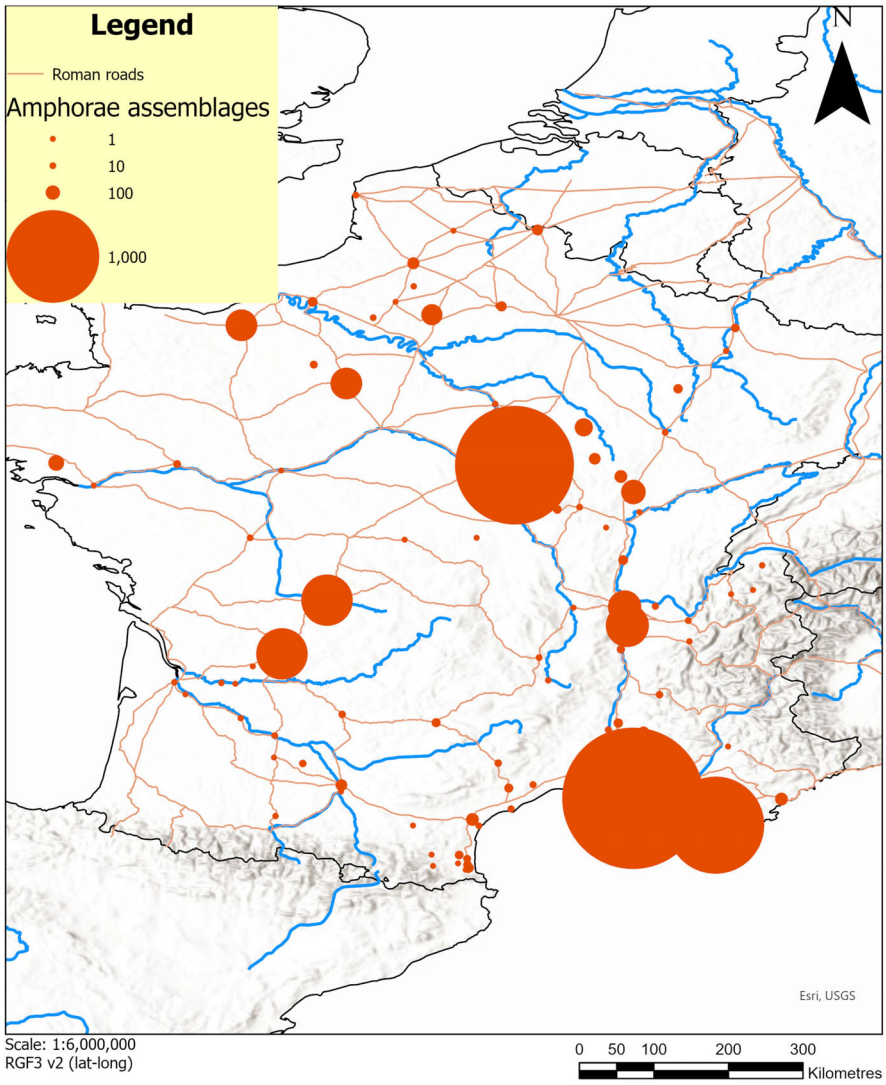

FIGURE 2
Proportional spatial and quantitative representation of amphorae assemblages.

$$P(X) = \Sigma_c \frac{Fc}{\Delta t} \ \ if \ \ X \in (t_{start}, t_{end})$$

P(X) stands for the probability that a particular amphora was deposited in a particular year within its production range or site chronology (depending on the analysis).
F_c is the frequency of amphorae detected, i.e. the number of amphorae of a certain class.
Δt is the chronological range over which an amphora set is distributed. It can be the dates of production of a certain amphora or the chronology of a settlement.

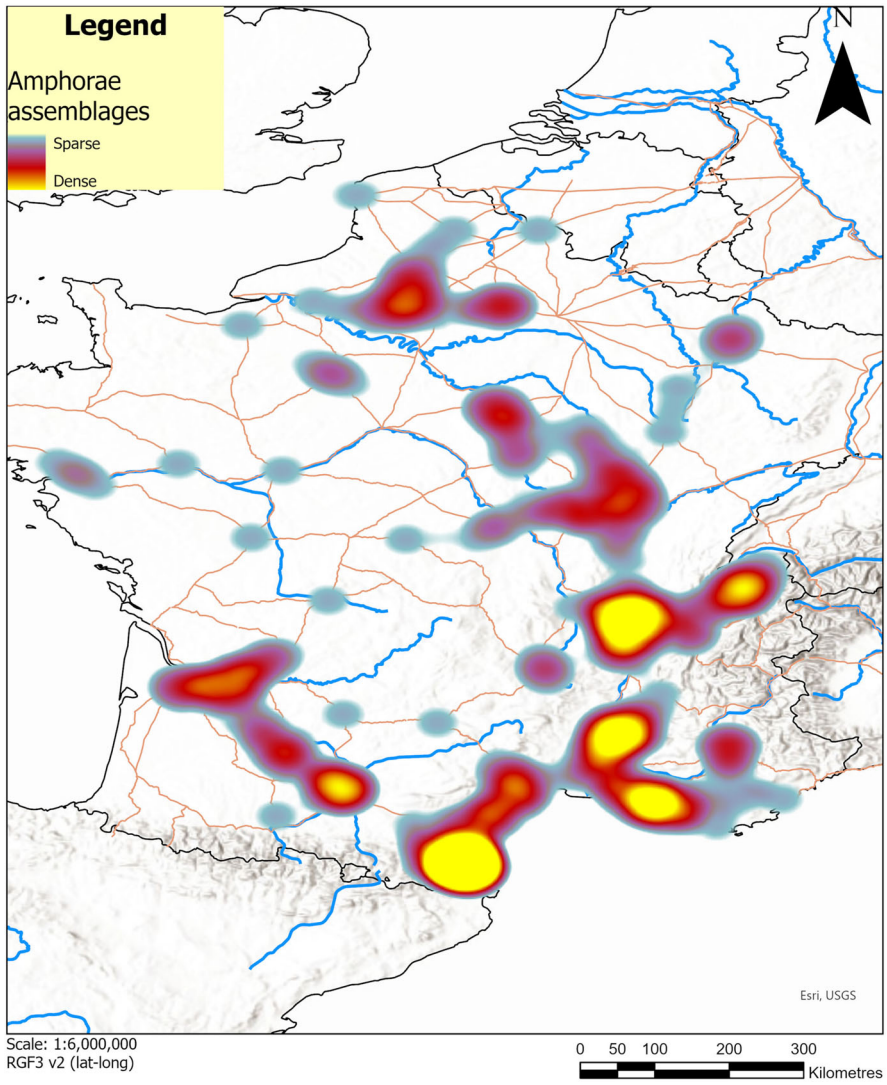

FIGURE 3
Distribution 'heat map' of amphorae assemblages.

Σc is the overall amphorae sum of a certain amphora set.

This process generates an aggregate possibility curve. Thus, the aggregate curve depicts how many amphorae of wine or olive oil of X geographical origin were deposited in a particular year based on site chronology and the dates of amphorae production.

The site chronological approach is especially useful for detecting trends in sites with a relatively short time-span (Franconi *et al.* 2023, 10). Sites with long chronologies add some limitations: they can create artificially extended periods of amphora use, including years before or after a given type was actually produced. In the 'site-date' visualizations shown in the right-hand panels,

'Site Date' refers to a constrained site chronology, i.e. the intersection between each site's occupation range and each amphora form's production range. Amphorae are only allocated to years that fall within this intersection, which reduces (but does not fully eliminate) long plateaus created by long-lived sites. The constrained site-date approach removes impossible extensions beyond production ranges, but does not guarantee a sharp cut-off in all metrics. In type-count plots plateaus are expected because diversity changes in stepwise fashion; even minimal late evidence can keep at least one type present beyond the point where frequency or site-count curves effectively drop to zero.

The great part of the database of this study has been obtained from the CEIPAC Roman Open data site and the CEIPAC CORPUS.[3] Additionally, the database has been expanded and supplemented with further bibliography.[4] The total number of amphorae used in this study is 7076. The CEIPAC database has amphorae with stamps that obviate the need to apply quantitative systems on sherds to calculate the number of potential individual amphorae. Within the CEIPAC database, 20% of the Gallic amphorae have been recovered from shipwrecks found along the coast of Provence (Mouchot 1969; Joncheray 1975; Colls *et al*. 1977; Amar and Liou 1984; Gassend *et al*. 1984; Sciallano and Liou 1985; Colls 1986; Lequément 1987; Hesnard *et al*. 1989; Liou and Gassend 1990; Baudoin *et al*. 1994; Joncheray and Brandon 1997; Sabrina 2008; Long 2012; Fontaine *et al*. 2020; Marty *et al*. 2023).

Even so, amphorae from shipwrecks have been excluded from the aoristic distribution of sites, as it is not possible to identify where these amphorae were being transported to. Another reason to exclude these sunken amphorae from the site count is the relatively short chronology of shipwrecks compared with terrestrial sites. This causes significant distortion in the aoristic distribution, as the short chronology of shipwrecks allocates the distribution of large numbers of amphorae in a small time-frame.

The amphorae analysed here have been found in the current territory of France, part of the former province of Gaul. Amphorae from the *limes* region have been excluded – according to traditional interpretations, these regions received large military supplies from the Roman state for the army encamped there (Whittaker 1994; Remesal 1997). However, more recently this view has shifted, emphasizing the role of non-military and non-state imports of olive oil and wine (Franconi *et al*. 2023). Concerning such military bases, the database does not include strictly-military Roman bases, with the exception of Dieulouard (Scarponna), Soissons and Vendeuil-Caply (Dufour and Piton 1984; Legendre 2014). Amphorae from Alsace are not included, as these amphorae have recently been studied by Franconi *et al*. 2023, using an aoristic distribution. This study only encompasses amphorae containing olive oil and wine, and any amphora whose contents were uncertain were also excluded from the dataset. Of the database, 73% are olive-oil amphorae, with 27% those of wine. Forty-five amphora types have been identified, each with its respective production chronology, i.e. start production year and end production year. In the database generated for this study, each type of amphorae has a geographical origin (the province(s) where that amphora was produced), and a content. Five geographical zones have been used: North Africa, Hispania, Gaul, Italy and the Eastern Mediterranean (mainly amphorae from Chios, Crete and Rhodes).

[3] The CEIPAC (Centro para el Estudio de la Interdependencia Provincial en la Antigüedad Clásica) is a Spanish-European research project that studies Roman commercial inter-provincial relationships through the analysis of amphorae with epigraphic evidence. See https://romanopendata.eu/ and http://ceipac.ub.edu/.

[4] See supplementary bibliography and the complete database here: https://github.com/AlvaroSH2000/Roman-Amphorae-in-France-dataset.

Amphorae were recovered from a total of 105 sites, with another set being recovered from 19 shipwrecks. Shipwrecks apart, this article classifies these sites into four broad groups: rural settlements (from villas to small farms, including non-urban pottery workshops), *oppida*, *oppidum-civitas*, and cities. The class *oppidum-civitas* refers to those Gallic settlements that persisted after the Roman conquest and, subsequently, were developed into a Roman city from the original Gallic *oppidum*. The city category stands for urban agglomerations founded after the Roman conquest. Finally, *oppida* refers to Gallic settlements that progressively vanished after the Roman conquest. The communities inhabiting these settlements were either immediately or gradually displaced and resettled, enslaved or eliminated, in some cases even 50 to 100 years after the conquest. Each site has an initial occupation date and an abandonment date that enables the generation of an aoristic distribution based on the chronology of sites.

WINE ANALYSIS BY REGION

In Fig. 4 are illustrated several approaches undertaken to assess wine production in present-day France (Gallic wine) alongside wine imported from Italy, North Africa and the Eastern Mediterranean. Throughout the discussion, 'type date' refers to distributions based on amphora-type production chronologies, whereas 'constrained site date' refers to distributions based on the overlap between site occupation dates and amphora-type production chronologies. The two most important and reliable Figs. are 4a and 4b, as they present data about amphorae quantities or frequencies. Throughout the discussion, 'type date' refers to distributions based on amphora-type production chronologies, whereas 'constrained site date' refers to distributions based on the overlap between site occupation dates and amphora-type production chronologies. The three principal chronological peaks which emerge from these two figures show Italian amphorae giving way to Hispanic amphorae in the second half of the first century BC. The number of Gallic amphorae rose during the late first century BC and then peaked in the first century AD, experiencing first a decline in the late second century AD, and then a complete collapse *c*.300 AD. The other amphorae assemblages were of minimal importance except for a minor rise of African amphorae during the second century AD.

Figure 4c shows the number of sites at which wine amphorae of a particular geographical origin have been identified and distributed over a time range consisting of the production dates of that set of amphorae (type dates). Fig. 4d does the same while focusing on a chronology derived from the temporal occupation of sites (site dates), with overlapping type chronologies. These figures allow us to gain a sense of the geographical and chronological distribution of amphora classes. Once again, the plots depict an early expansion of Italian amphorae followed by Hispanic ones. This growth of Hispanic amphorae coexisted with the Gallic wine expansion that reached many settlements in the database. This also indicates a clear trend towards wine import replacement in Gaul. Eastern Mediterranean and North African amphorae assemblages are more limited and confined to Languedoc, which will be explained later.

Figure 4e considers the numbers of each wine amphora type (such as the Gaulouise 1, Crétoise 3, Dressel 1A, etc.) by geographical origin and distributes them according to the 'type date' criterion explained above. Figure 4e replicates the same strategy with an aoristic distribution set using type chronologies for production as well, showing the number of different amphora *types* at any one period, rather than the number of amphorae. It shows a variety of amphora types coexisting in the early Empire, with Gallic amphora types being the most abundant, but with the noticeable

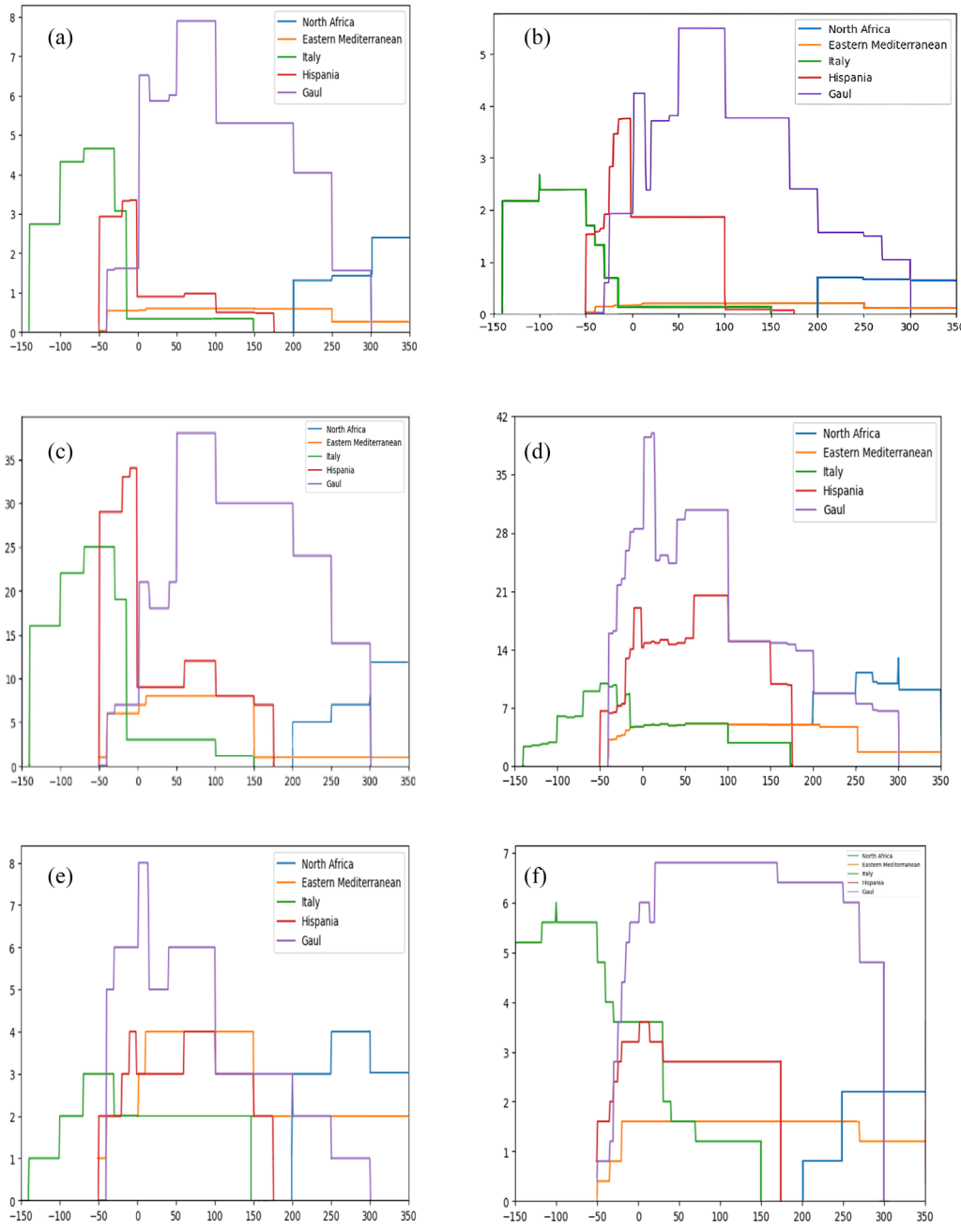

FIGURE 4

a–f. Aoristic distributions of wine amphorae by geographical origin. Panels a, c, and e use amphora-type production dates as the chronological range; panels b, d, and f use constrained site dates, i.e. the overlap between site occupation dates and amphora-type production dates. The three rows show, respectively, amphora frequency (a–b), site count (c–d), and type count (e–f).

presence of a heterogeneous corpus of Eastern Mediterranean and Hispanic amphorae. During the second and third centuries AD, North African typologies appeared, whilst all the other amphorae progressively vanished. Figure 4f distributes the recognized amphora types by site chronology and taking into account overlaps of type chronologies. It offers a similar perspective, but it helps to bring out that during the early Empire the variety of Hispanic amphorae was greater than the Eastern Mediterranean amphorae. This plot also better captures the exponential expansion of Gallic amphora types.

Earlier studies, such as Loughton's (2003) analysis of Republican amphorae in France, have highlighted the penetration of Italian wine via the Rhône corridor during the second and first centuries BC, so providing an essential background to the later dynamics assessed here. Roman wine was introduced into Gaul in the second half of the second century BC, particularly with the conquest of Gallia Narbonensis in 123 BC. Previously, Greek-Massalians and Etruscans had been exporting moderate amounts of wine along the Rhône-Saône axis to Gallic settlements (Dietler 2010). This kind of trade has traditionally been interpreted as an elite exchange involving Gallic princes and, according to diffusionist archaeology principles, it motivated the adoption of some Greek practices, such as the *symposium*, by Gallic elites (Poux 2004). Archaeologically, this is evidenced by the presence of imported Greek *kraters* in Gaul from the fifth century BC onwards.

The construction of the port of *Fossa Marianae*, modern Fos-sur-Mer, by the Romans in 102 BC facilitated the expansion of the Italian wine trade during the second half of the first century BC (Liou and Sciallano 1989). This can be clearly appreciated in Figs. 4a and 4b. The massive production of wine in Roman Italy, aimed at export, rapidly displaced the smaller Massalian productions (Loughton 2003; Launaro 2015). The Romans traded wine for metals, especially copper from the Bragny-sur-Saône region (Bonnamour 1994). Most notably, Romans acquired slaves in Gaul, as reported by Diodorus Siculus, who probably exaggerated when he claimed that one amphora of wine could be exchanged for a slave (Diodorus Siculus, *Bibliotheca Historica* 5, 26). Additionally, in settlements such as Chalon and Glanon, shackles have been recovered (Bonnamour 1994). Agricultural Gallic products, if to a lesser extent, cannot be ruled out as part of this commercial relationship.

The presence of Greco-Italian amphorae – Dressel 1A, Dressel 2–4 Italian, Lamboglia 2, etc. – confirms the major expansion of this economic scheme up until the conquest of Gaul by Caesar in the middle of the first century BC. Campanian and Latium wines accounted for the main imports in the second century BC, whilst wines from Etruria were more prominent in the first century BC. At this point, Figs. 4a–f all reveal a sudden drop in the Italian wine commerce brought about by the end of the social and cultural elements that sustained it: prestige exchanges between Roman merchants and Gallic inter-tribal raiding to obtain slaves to exchange for Italian wine. Furthermore, Loughton (2009) argued that the arrival of Italian wine in Late La Tène Gaul should not be understood solely as a phenomenon restricted to elites or warrior groups. His studies in the Auvergne, particularly at sites such as Le Pâtural, reveal that even rural farmsteads accumulated substantial numbers of amphorae, pointing to a wider social access to imported wine.

The second half of the first century BC witnessed a decline of Italian imports coinciding with the arrival of Hispanic wines from the nearby province of Tarraconensis, trafficked in Tarraconense 1, Dressel 2-4, Catalan and Pascual 1 amphorae, among others (Liou and Sciallano 1989; Py and Buxó 2001; Loughton 2003; Brun 2005; 2011). In the second half of the first century BC, Gallic wine production commenced, in Gallia Narbonensis and the Rhône Valley, as is attested by Gallic wine amphorae such as Galouise 2, 7, Pascual 1 similis and Dressel 2-4 Lyon 2.

After this, Gallic wine production soared, accompanied by new amphorae forms like the Galouise 1, 3 and 4 (Brun 2011; Bernigaud *et al*. 2021). Figures 4c and 4d illustrate the rapid geographical expansion of early Gallic wine production, as evidenced by the widespread distribution of Gallic amphorae across numerous sites from the second half of the first century BC. As highlighted by Rice (2023), Gallia Narbonesis experienced in this period a significant transformation of its landscape. From the first century AD the agricultural settlements there oriented their production to wine (Mauné 2003: Figueiral *et al*. 2010).[5] What emerges is a pattern of progressive growth: these estates expand over time, mirrored by an increase in the number and storage capacity of *dolia* (Carrato 2017). The implication is that production is being scaled up in an accumulative manner, consistent with the logic behind economies of scale – larger planted areas, greater output and sustained investment in the infrastructure required for processing and storage (Rice 2023).

However, the great villas did not operate as purely monocultural units. They also hosted a range of secondary activities – clearly of lesser weight in the overall productive profile – such as pastoral husbandry, wool production, arboriculture and ceramic manufacture. Crucially, however, the archaeological sequence suggests that, as the estates expanded, viticulture increasingly displaced these other activities (Rice 2023). A similar dynamic is invoked for smaller farms discussed in the article. Although these units could not compete directly with the large estates in terms of scale, they nevertheless display a strong tendency towards a specialization in viticulture. To offset their structural disadvantages, they seem to have pursued cooperative solutions in production – most notably through the shared use of presses.

It is important to note that this expansion coincides with the foundation of numerous Roman cities such as Lyon, Arles and Nîmes (among others), where noteworthy amphorae assemblages have been recovered. However, these foundations potentially create some disturbance in the site date plots (Figs. 4b, 4d and 4f). This perturbation is also to be observed in the sudden, confusing and ephemeral short drop observed in Gallic amphorae in Fig. 4b at around 25 AD: this is related to the abandonment of numerous *oppida* during the first half of the first century AD.

The rapid expansion of Gallic wine production, from the late first century BC onwards, depicted in all figures, is further upheld in the study of amphorae distribution in Germania. This study revealed that by the late first century BC, the main wine supplier of the German *limes* was Gaul (Franconi *et al*. 2023). In Italy, Gallic wine similarly ranked second or third among imported wines, depending on the counting method employed (Komar *et al*. 2025). To enable such massive interprovincial exports, Gallic wine had to be being produced on a vast scale already by the first half of the first century BC. This achievement not only cut down the level of imports, but also targeted other provincial markets successfully.

The paleoclimatic evidence is also responsible for the enhanced conditions for the production in Roman France. Bernigaud *et al*. (2023; 2024) investigated the effects of weather conditions on agriculture for Languedoc and Provence: they concluded that the Roman Optimum climate made southern France more humid and warmer, thus increasing its suitability for vineyards and also extending the potential cultivable area northwards.

Undoubtedly, the first century AD witnessed the extension and consolidation of Gallic wines in Roman Gaul, as is depicted in all the Figs. 4a–f. The Narbonne region and the Rhône Valley saw the decisive extension of viticulture, in a process directly linked to the local urban elites (Laubenheimer 1985; Brun 2005). From the first century AD on, the Loire Valley, Burgundy

[5] For example, the villas of Saint-Bézard, Pardigon 3, Molard; the farms at Gasquinoy and Renaussas and the agglomeration at Peyre Plantade (see Rice 2023).

and Bordeaux increasingly developed viticulture, reaching a peak in the second century AD (Laubenheimer and Notet 1986; Woolf 2001; Ferdière 2020). These dynamics led to the supremacy of Gallic wine in Gaul, as shown by the sharp decline of wines from Italic and Hispanic competitors.

Next, it is important to stress how Fig. 4 illustrates a reduction of Gallic wine amphorae in the second half of the second century. At this point, it is interesting to note that it was in this period that the Antonine Plague occurred – which chronologically coincides with the abandonment of several rural settlements in the database – but it is not possible to ascribe to this event alone the cause of the reduction of Gallic wine amphorae. Whatever the case, a clear breakdown is attested in Gallic wine amphorae during third century AD. The Plague of Cyprian, the Military Crisis, the Gallic Empire, and the Alamannic and Frankish invasions of this period may all have severely affected both local productions and imports. Demographic shocks and political instability may have reduced demand and disrupted the coordination required for long-distance exchange, while insecurity and administrative reorganization probably increased the costs and risks of moving bulk commodities. Indeed, during this time, Gallic Roman cities erected palisades or walls, as seen at Auxerre, Dieulolard, and Sens, in response to the Germanic invasions. Others were reduced in size due to the combination of these catastrophic events, e.g. Limoges, Périgueux, Poitiers, etc. (Leman 1990; Bataille *et al*. 1992).

An economic dislocation between provinces also might have played a crucial role for Gallic wine exports, following the broader framework outlined by Rice (2023). The key point here is that the economic success of specialized regional production (such as in Roman Provence) depended on highly integrated systems of supply and demand, and disruptions at any stage – production, transport, market access, or demand – could translate into abrupt changes in what appears in the archaeological record.

Regarding the paleoclimatic data, Bernigaud *et al*. (2024) concluded that the general cooling period in the Late Antiquity may have affected the productivity of vineyards in Southern France, but only from the fourth century AD onwards. This does not seem though sufficient in itself to account for a general and dramatic decrease in wine production.

The decreases evident in all plots from the second century AD onwards should also be linked to the adoption of wooden barrels as a transport medium, a practice that arguably got under way in the late first century BC (Marlière 2002; Wilson 2009). The gradual substitution of amphorae by barrels progressively cut down the utilization of these ceramic containers for local products (Bonnamour 1994). The figures of this article cannot take account for the barrel substitution phenomenon, but it surely will have reduced the scale of amphora usage, thus further complicating interpretation from the late first century AD onwards.

Another lesser trend requiring comment is the presence of late North African wine in Gaul. These productions (in the database shown in the Keay 1A and Keay 1B amphorae) not only emerged in the second century, but also managed to survive the general collapse following the Crisis of the third century. This pattern is parallelled in the export of large amounts of African red slip ware pottery in the Western Mediterranean, all travelling as parts of a larger suite of commodities (Bonifay and Tchernia 2012). Interestingly, this North African wine evident in the plot demonstrates the continued use of amphorae in transporting African wines, at a time when possibly most wine in temperate Europe was carried in barrels. Most of these African amphorae are found on the Provence coast, and their distribution did not reach the upper Rhône as other types did. Finally, Eastern Mediterranean wines first appeared in Gaul from the first century BC. Their import persisted down to the third century AD. Their presence, however, is marginal when compared with other wines, and their distribution is also confined to the Languedoc.

OLIVE-OIL ANALYSIS BY REGION

Figures 5a–f illustrate the consumption dynamics of olive oil in Roman Gaul, categorized by the origins of olive-oil imports from North Africa, Hispania and Italy. Each figure represents a specific aoristic distribution that follows the same criteria explained in the previous section on wine.

The overall dominance of Hispanic olive oil is depicted in Figs. 5a and 5b. The overwhelming presence of Dressel 20 amphorae in the dataset causes the North African and Italian curves to look inconsequential. The main trend here is the massive imports to Gaul of Baetican olive oil from the second half of the first century BC until the middle of the third century AD, when the green line representing them shows a sudden and immediate collapse. The other two curves show a transition from Italian to North African olive oil starting in the first century AD, consolidated in the second century.

A similar pattern is visible in Figs. 5c and 5d. Once again, the quasi-monopoly of Hispanic imports is evident. Nevertheless, it is worth noting that Italian and North African products are found at a similar number of sites, as seen in both figures. Most of these non-Hispanic amphorae are located in Gallia Narbonensis, and their penetration into Roman Gaul via the Rhône axis is far more limited than that of Hispanic olive-oil amphorae (mainly of the Dressel 20 type). This last was exported more to Gaul, Germania and Britannia via the Atlantic coastal route (Rubio *et al*. 2018).

Finally, Figs. 5e and 5f present a scenario in which the olive-oil amphora typologies from Hispania exhibit their greater diversity of forms in contrast to the reduced corpus of Italian and North African typologies (mainly Brindisian amphorae and Dressel 6B for Italic, with Tripolitania 1, Africana 1 Piccolo, and Africana 2B Grande for North African olive oil).[6]

In contrast to the wine trade with Gallic societies, Roman olive oil was not exported in large quantities into Celtic Gaul. Italic olive oil was introduced into Gallia Narbonensis once this province was incorporated into the Republic (Woolf 2001; Leveau 2003). All figures show the Italian olive-oil imports occurring during the late second century BC and the first half of the first century BC. Brindisian amphorae were the main amphorae employed in this trade scheme, containing olive oil produced in the Campanian and Apulian Roman regions (Launaro 2015). Italian olive oil rapidly diminished when the Hispanic took over (Hitchner 2002). However, Figs. 5a–c depict a minor resurgence of Italic olive oil in Roman Gaul, which I believe to be associated with the Adriatic boom, as attested by Dressel 6B amphorae (Limbergen 2016).

It has been qualitatively inferred that Hispanic olive oil flooded Roman Gaul concurrently with wines produced in Tarraconensis (Deniaux 1985; Sayó 2000). Figures 5a–b show a quantitative perspective on the great consumption in Gaul of Baetican olive oil, mainly in Haltern 70 (*defrutum*), Dressel 20, and Dressel 23 types of amphorae. The expansion and dominance of Baetican olive oil in the Western Mediterranean is a well-studied phenomenon, the best visible manifestation of which is the Monte Testaccio in Rome (Blázquez *et al*. 1994; Blázquez and Remesal 1999; Remesal 2018). In this case, as in Germania, Roman Gaul was almost entirely dependent on cheap imports of Hispanic olive oil (Blázquez 1991; Cesteros and Tremmel 2012; Franconi *et al*. 2023). The domination of Baetican olive oil in France is strongly highlighted through this study. Consumption of Hispanic olive oil in Roman France targeted civilian supply, as the legions were encamped in the *limes*. Traditionally, the presence of a fraction of Hispanic amphorae in France has been linked to army distribution chains, with the state supplying military garrisons in

[6] Later North African olive-oil amphorae such as Keay 36b and Keay 60 were excluded, as these amphorae fall outside the chronological scope of this article. Late Roman Amphora 1 Cilician type was excluded for the same reason.

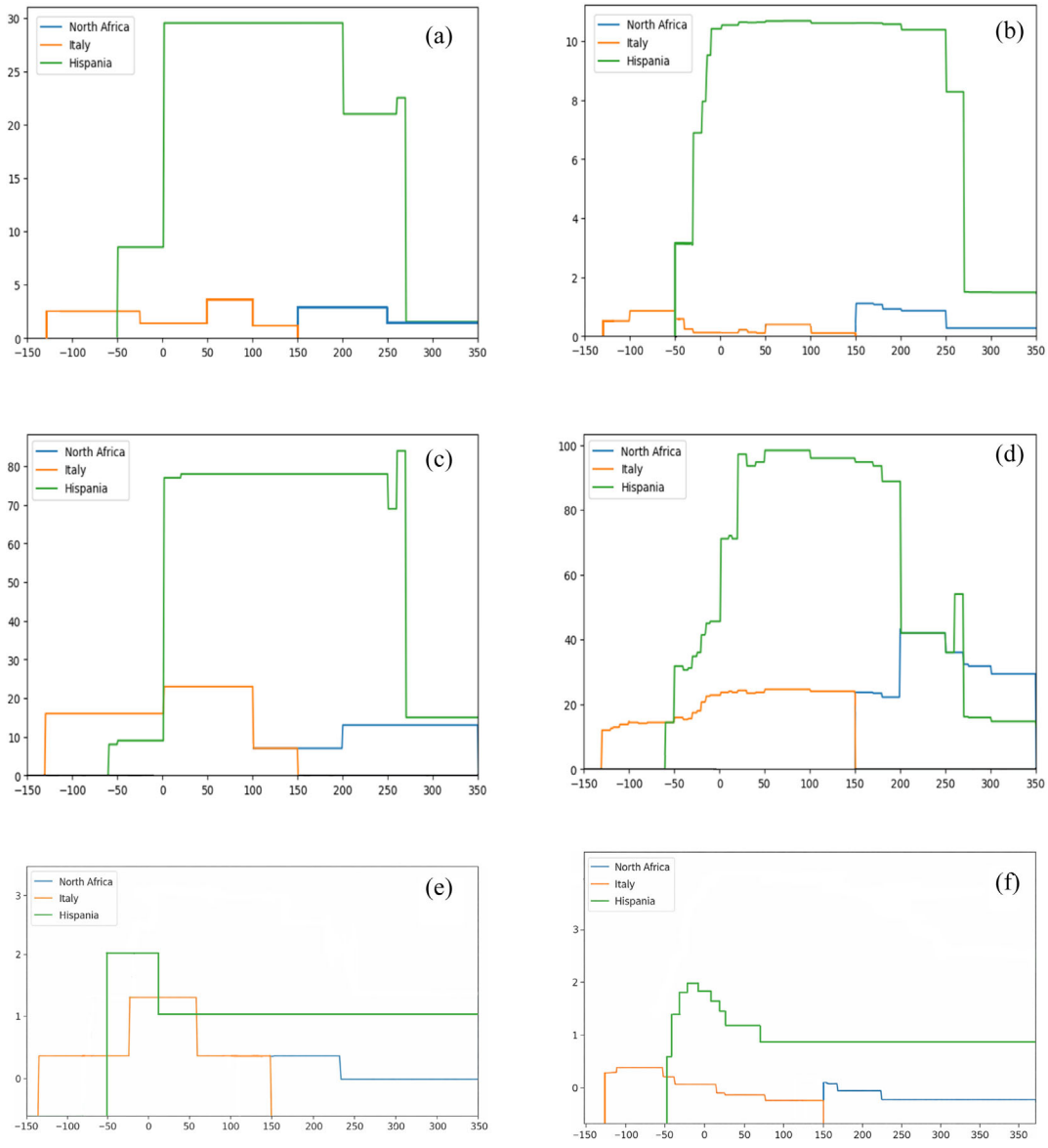

FIGURE 5

a–f. Aoristic distributions of olive-oil amphorae by geographical origin. Panels a, c, and e use amphora-type production dates as the chronological range; panels b, d, and f use constrained site dates, i.e. the overlap between site occupation dates and amphora-type production dates. The three rows show, respectively, amphora frequency (a–b), site count (c–d), and type count (e–f).

Germania (Blázquez and Remesal 1999). More recently, however, scholars have shown that a wider range of non-state agents were active in Baetican olive-oil distribution (Rubio *et al*. 2017) with significant amounts of Mediterranean olive oil reaching the northern provinces for civilian consumption (Franconi *et al*. 2023).

It is notable that by the middle of the third century the import of Hispanic olive oil abruptly came to an end, probably as a result of the aforementioned events that occurred at that time: the Alemannic and Frankish invasions, the military anarchy and the Plague of Cyprian, plus rising transaction costs and risks on the long-distance routes with a reconfiguration of fiscal and transport priorities, and finally a contraction of the purchasing power and demand in the receiving regions. In Rome, at the Monte Testaccio, the cessation of Hispanic olive-oil amphorae coincides with the emergence of the short-lived Gallic Empire between 260 and 274 AD (Blázquez and Remesal 1999; Remesal 2018; Tobar 2023). In fact, the Gallic Empire episode may have disrupted the supply chains of Baetican olive oil right across the Empire, as this period of political turmoil could have brought an end to the state-organized distribution of Baetican olive oil to Rome and other provinces (Wilson 2024, 112). In Figs. 5c–f the quasi-total collapse of Hispanic olive oil in *c*.250–270 AD is something overly exaggerated by the end of the Dressel 20 amphorae, as shown in Figs. 5a–b. From this point onwards, the successor of the olive oil Dressel 20 amphorae – the Dressel 23 – is present in the Gallic archaeological record, albeit in smaller quantities than the Dressel 20, as shown by Figs. 5c–f. These graphs illustrate a decreased, but not entirely interrupted, import trade of Baetican oil to Gaul, highlighting once again the utility of cross-comparison between figures.

Concerning North African olive oil, figures demonstrate that though these imports did increase during the first and the second centuries AD, they were always overshadowed by the omnipresent Hispanic olive oil. Explanations, based on the distribution of African red slip ware (travelling as part of the grain trade) together with the appearance of new North African olive-oil amphora typologies (Bonifay 2004), have stated that North African olive oil benefited from the collapse of their Hispanic competitors in the Western Mediterranean. Although Hispanic producers experienced growing competition from their North African rivals, especially from the second century onwards, it is not possible to assume that, at least in Roman Gaul, North African olive oil swiftly filled the void left by Hispanic imports (Gibbins 2001). While there is little doubt that African imports of olive oil replaced those from Hispania, a degree of caution is necessary, as African production did not equal that of Hispania and anyway suffered a gradual decline in quantity, as expressed in the graphs. The figures in this study show that, at least until 350 AD, African productions underwent a period of stagnation. The studies carried out in Germany and Italy using this same approach concluded that not only did North African olive-oil imports not increase during the Late Empire, but on the contrary that they waned through the fourth and fifth centuries AD (Franconi *et al*. 2023; Komar *et al*. 2025). As the consumption/deposition of olive-oil amphorae does not equate exactly to overall olive-oil consumption, the trends documented here should be read primarily as indicative of changes in the supply of amphora-borne oil to Roman Gaul. It is therefore plausible that part of demand was met through other channels (e.g. alternative containers, local/regional production), although these remain less archaeologically visible.

Assessing Roman-Gallic olive-oil production

The pacification and foundation of Roman colonies in Gallia Narbonensis, such as Arausio (Orange), Nemausus (Nîmes) and Arelate (Arles), triggered Gallic olive-oil production as an

attempt to reduce imports of the same (Woolf 2001; Ferdière 2020). Nevertheless, it is difficult, in quantitative terms, to obtain a figure for Gallic olive-oil agricultural output. There is extensive archaeological evidence in the form of olive-oil presses that corroborate olive-oil production from the late first century BC onwards (Brun 1986; 2020; Hitchner 2002; Marzano 2013).[7] However, some devices thought to be intended for olive oil have been reclassified as wine presses (Brun 2020). Nevertheless, native olive-oil output was insignificant compared to Hispanic and North African productions and was probably never intended to compete with them, being aimed at local consumption (Leveau *et al.* 1991; Leveau 2003). Moreover, we must consider that specializing on wine in France was to the detriment to that of olive oil, that could however be cheaply imported from Hispania (Rice 2023). Lastly, and for the purpose of this article, there were no native Romano-Gallic olive-oil amphorae. It is assumed that the reuse of imported olive-oil amphorae was common in Gallia Narbonensis. This prevents any quantitative research into Roman olive oil using amphorae as proxies, unless a systematic and large-scale petrological and residue examination of Gallic amphorae assemblages was to be conducted (Brughmans and Pecci 2020).

CONCLUSIONS

This article has assessed the macro-trends of wine and olive-oil dynamics in Roman France from the Late Roman Republic to the mid-fourth century AD, successfully integrating a statistical approach and a moderately-sized amphorae assemblage. It has also provided a clear quantitative overview of the use and distribution of amphorae, supplementing other approaches that have relied on qualitative principles.

The most notable trends that have been underscored are the rapid boom experienced in Gallic wine production from the first half of the first century BC to the second century AD, with a notable peak in the first century AD. Wine from Gallia Narbonensis and the Rhône Valley drove out foreign competition (mainly Hispanic wines), and consolidated a dominant position over Roman Gaul, before being exported in vast quantities to other neighbouring provinces.

The olive-oil analysis demonstrates the massive dominance of Baetican olive oil, and the figures provide a clear impression of this phenomenon. They also corroborate the assumed commercial collapse of Hispanic olive oil in the Western Mediterranean as a result of the third century-crisis. North African products succeeded their Hispanic competitors, but failed to match the enormous quantities of exported Hispanic olive oil, as has been traditionally believed from the wide spread of African red slip ware and the development of new African olive-oil amphorae during the Late Empire. Instead, this paper shows that North African olive oil, which may have profited from the absence of Hispanic competitors, was only at the level of a small fraction of the former Baetican production.

The combination of two chronological filters (amphora-type production dates and constrained site dates) with three counting measures (frequency, site count and type count) allows comparison of changes in the volume, spread and diversity of wine- and olive-oil supply over time. Nevertheless, as with any technique, there are some limitations to consider, in addition to those derived from the nature of the database mentioned elsewhere. Barrel usage in temperate Europe

[7] Recently, several Roman villas that were classified as olive-oil production centres in southern France have been reassessed as wine-pressing villas. Such is the case of Saint-Michel à La Garde. See Brun 2020.

gradually distorts the figures for the wine-trade from the first century AD onwards. Equally, other factors must be considered. These include errors in the archaeological recording of amphora sets and the presence of mixed-context records in settlements with long occupation periods. However, and most importantly, the combination of site dates filter with type dates filter reduces significantly these potential biases. Most importantly, the conclusions have been constructed on matching trends present in the graphs for both type dates and site dates.

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