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RESEARCH

Consumption Trends, Trading Patterns and Economic Development in Italy Across Centuries: Data Analysis of Roman Amphorae in a Long-Term Perspective

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Abstract

This paper presents novel insights into the long-term chronological patterns related to the distribution and consumption of amphora-borne foodstuffs in Italy. The study specifically focuses on the consumption of wine, olive oil and fish sauces, which exhibit diverse provenances. Notably, it contributes significantly to our understanding of the Roman economy by utilising an open dataset and a replicable research method. The analysis reveals a pronounced growth pattern during the late Republican to early Imperial period. Importantly, quantitative evidence demonstrates that the diverse consumption pattern observed in the capital city of Rome is less exceptional than previously believed. The study draws upon a substantial dataset comprising 28,851 diagnostic amphora fragments excavated and documented from 28 different urban and rural settlements in the North Adriatic and Central Italy, spanning the period from the 4th c. BCE to the 7th c. CE. The analytical approach employs a probabilistic aoristic method, evenly distributing amphora frequencies across relevant date ranges.

Keywords Amphorae · Rome · Italy · Consumption patterns · Economy

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Introduction

The functioning and performance of the ancient economy have long been one of the key debates in classical studies. After many years of strong reliance on written sources in this matter (Finley, 1973; Hopkins, 1978, 1980, 2002: 190–230), the last two decades have brought a significant turn towards archaeology and the critical quantification of material sources (Saller, 2005: 223–38; De Callataÿ, 2005: 361–372; Friesen & Scheidel, 2009: 61–91; Scheidel, 2009: 46–70; Lo Cascio, 2009: 87–106; Kron, 2014: 123–46; Jongman, 2006: 237–54; id. 2007a, 2007b; 2009; 2014: 169–88; 2017a: 260–8; 2017b). A number of attempts to understand and quantify movements of goods in antiquity, as well as assessing the volume of trade and nature of market relations, have substantially enhanced our understanding of the origins, transport and consumption of many goods (Bowman&Wilson, 2009a, 2009b; Wilson Bowman, 2018; Franconi *et al*., 2023), but there are still many challenges associated with the imperfections of archaeological data, especially regarding how they reflect ancient economic phenomena.

In recent years, a 'big data' revolution has transformed archaeology, leading to the integration of multiple survey datasets and enabling the creation of a robust, systematic body of information. This advancement facilitates the connection of regional datasets to globally relevant themes, such as economic performance, connectivity and integration across time and space (*e.g.* De Haas, 2017; Verhagen *et al*., 2019; Attema *et al*., 2021; Franconi *et al*., 2023). Simultaneously, computer simulations (*e.g.* of pottery distribution; see Brughmans & Poblome, 2016; Brughmans & Pecci, 2020) help to partially address issues of representativeness in preserved and excavated archaeological materials. However, addressing broad, global questions often overlooks finer, local trends. Comparing local and regional trends remains essential to gaining insights into goods exchange at local, regional and inter-regional levels, as well as the underlying factors behind economic efficiency or decline (De Haas, *et al*., 2011; Tol, 2017). This study combines and presents data from various areas in Italy, enabling the observation of broader trading and consumption trends.

The present study focuses on global trends and, by necessity, does not allow for a comprehensive analysis of minor, local patterns. However, some of these smaller shifts are identified, which opens new directions for future research. The Roman amphorae data analysis results presented in this paper make a significant contribution to our understanding of the economy of the Roman world, providing novel insights into trade in amphorae-borne products. We use a large dataset consisting of 28,851 diagnostic amphora fragments excavated and published from urban and rural sites in Central Italy, perform a quantitative data analysis and make the dataset and data analysis code openly available to allow for scrutiny and replication of our published results. Our analysis focuses on identifying long-term chronological patterns in the distribution and consumption of amphora-borne foodstuffs in Italy, with a particular focus on the consumption of wine,

olive oil and fish sauces with diverse provenances. We critically assess the effects of the imperfections and heterogeneity of our dataset by identifying how robust identified data patterns are in light of different dating evidence and site types and by complementing the identification of major trends in the combined dataset with more in-depth analyses of subsets relevant for the study of specific places such as Ostia, Rome and the Bay of Naples, of specific foodstuffs and provenances. Our results provide important case studies of changing Italian supply networks and economic connections across the Mediterranean over a 1000-year period (400 BCE–600 CE), reflecting phenomena including changing tastes and demands among Italian consumers of goods, changing production centres in Italy and the provinces and changing economic interdependencies in the Mediterranean.

Materials and Methods

Data Collection

This study is based on published amphora data from 66 individual archaeological excavation sites representing 28 different settlements in central Tyrrhenian and North Adriatic Italy, dated between the 4th c. BCE and the 7th c. CE.[1] These 66 sites were selected because they were argued to be closed contexts, relatively precisely dated and reliable quantified; amphora frequencies are published for them. In addition, they provided significant numbers of amphorae, meaning at least several dozens of potsherds, while sites with singular containers or their fragments were excluded due to their lack of representativity. Our data collection aimed to include as many sites as possible in the study area, representing both coastal and inland centres situated in the north and south as well as east and west of Italy. The chosen sites represent both urban, harbour and rural contexts, though the former are considerably more represented and they provided higher numbers of pottery sherds.

This paper concentrates on the numbers of diagnostic fragments of transport jars (rims, bases and handles—RBH), which were published for each site, as this is the most commonly used method of calculating pottery sherds, contrary to minimum number of individuals (MNI), maximum number of individuals (MAX) or estimated number of vessels (EVE}, which cannot always be approximated (or as in the case of MAX have only been used by few scholars, *e.g.* Ehmig, 2003). A comparable quantitative data analysis by Franconi *et al.*, (2023, Fig. 4 with description) on amphorae from Germania revealed that using RBH and NMI in most cases provides similar general results, while MAX shows some different trends (because MAX is only used for a handful of sites). In this paper, we will use published RBH frequencies consistently, and results should be interpreted as such. However, these still remain frequencies of diagnostic sherds and are therefore more representative of attested

[1] The dataset used is openly available as part of our Github repository: https://github.com/Tom-Brughmans/Sonata.

typological diversity than of consumption volume. For this reason, we do not merely perform queries of amphora frequencies but equally of typological diversity and the numbers or sites at which they are attested (*i.e.* their distribution).

One possible limitation of this approach is that the trends may not accurately reflect actual consumption capacities for products like wine and olive oil. Given that different types of amphorae varied widely in capacity (*e.g.* Anatolian amphorae held around 6–12 L, while African containers held approximately 80 L), comparing the number of amphora fragments rather than their average capacities could introduce distortions. However, De Sena has shown that the statistical outcomes do not differ significantly. Therefore, whether we consider only the number of diagnostic fragments or estimate the total volume of wine (by multiplying the number of amphorae by their average capacity), the results should remain similar. The data may be biased only for wine from Anatolia and Calabria, as containers from these regions were much smaller than other amphorea (De Sena, 2005, 3). Thus, when interpreting the results, it should be noted that Anatolian and Calabrian products were even less significant in Italy than the amphora curves might suggest.

The database includes 28,851 diagnostic fragments of amphorae from all over the Mediterranean representing 204 individual types. Each entry in our database represents a unique combination of amphora type excavated at a certain site, and its published RBH frequency. Each amphora type is accompanied by a geographic origin (Tyrrhenian, Adriatic, Aegean, Oriental, Cypriot/Cilician, Egyptian, African, Tripolitanian, Lusitanias, Tarraconesian, Baetican, Spanish, Gaulish) as well as the typical 'content', which records its most commonly carried product (wine, olive oil, olives, fish products, alum, unknown). We use the Southampton Roman amphora database (University of Southampton (2014) Roman Amphorae: a digital resource [data-set]. York: Archaeology Data Service [distributor] https://doi.org/https://doi.org/10.5284/1028192) and other, more recent publications, if possible, as a key reference for both origin and typical content. The origin but especially the typical content is not known in all cases, and these are explicitly marked as 'unknown' in the database. To give an impression of the quantitative impact of these unknown contents, we compare data patterns of diverse contents with those of 'unknown' contents. Moreover, a production 'Start date' and 'End date' are recorded for every container form, according to their standard typologies (most following the Southampton Database), which are classified as 'Type dates' in our database (Table 1). Considering that these dates mark when the amphora was produced rather than when it was actually used, they are also accompanied by the 'Start date' and 'End date' of the context where the form was discovered—the so-called Site dates on the graphs we present. Sites are identified by their modern names (and if possible ancient names) as well as their function: urban, harbour/urban, rural and unknown (see a map of sites—Fig. 1 and Table 2). Urban sites clearly predominate in the database, 46 entries, and added to this are nine harbour sites (marked in our database as 'urban/harbour'), predominantly from Ostia, but also from the Adriatic part of Italy. There are also ten rural sites (referred sometimes in the text as villages), which include hinterlands close to ancient urban centres and isolated inland settlements, in the neighbourhood of which no bigger ancient centres were discovered. Among the rural sites, there are two villae classified as *villae rusticae*, which may be associated with Roman aristocrats

Table 1 Description of all fields in the database

Field name	Type	Description
'Amphora_type'	String	Commonly used typologies for Amphora type
'New_type_name'	String	Indicates values in the field 'Amphora_type' that are treated as the same type in the analyses
'Amphora_type_merged'	String	The same as 'Amphora_type' but fields that have a value in 'New_type_name' are updated with that name. Typologies for Amphora type that take into account grouped types from 'New_type_name'
'Provenance'	String	A region where an amphora was produced: 1. Adriatic Italy 2. Baetica 3. Tyrrhenian Italy 4. Gaul 5. Aegean 6. Spain 7. Unknown 8. Aegean/Oriental 9. Africa 10. Pergamon 11. Anatolia 12. Crete 13. Rhodes 14. Cyprus/Cilicia 15. South Italy/EM 16. Lusitania 17. Tarraconesis 18. Africa/Sicily 19. Calabria/Sicilia 20. Orient 21. Palestina 22. Tripolitania 23. Sicilia 24. Italy 25. Italy—Tiber Valley 26. Cilicia 27. Spain/Africa 28. Ionian 29. Sardegna 30. Italy/Sicilia 31. Black Sea 32. Ibisa 33. Egypt 34.Sicilia/Italy/Western Mediterranean 35. Western Mediterranean 36. Nan

Table 1 (continued)

Field name	Type	Description
'Content'	String	A product carried in an amphora: 1. Wine 2. Olive oil 3. Fish sauce 4. Defrutum 5. Unknown 6. Nan 7. Olives 8. Fruits 9. Alum
'Site'	String	A modern name of an archaeological site from which an amphorae assemblage came
'Site_type'	String	A site category: 1. Urban 2. Urban/harbour 3. Rural 4. Unknown
'Grouped_sites'	String	A grouping of the field 'Site' per region or ancient settlement (*e.g.* grouping all sites in Rome under a single 'Grouped_sites' value 'Roma')
'Amphora_type_lower_date'	Float	A production start date of an amphora
'Amphora_type_upper_date'	Float	A production end date of an amphora
'Lower_context_date'	Float	A consumption start date of an amphora
'Upper_context_date'	Float	A consumption end date of an amphora
'Frequency'	Float	An amphora frequency
'Pleiades URI'	String	Site geographical coordinates according to the Pleiades Atlas
'Latitude'	Float	Site geographical coordinates in latitude
'Longitude'	Float	Site geographical coordinates in longitude
'Tyrrhenian_vs_Adriatic'	String	Indication of whether the site is on the Tyrrhenian, Adriatic or Central regions of Italy 1. Tyrrhenian 2. Adriatic 3. Central, but better connected with the Adriatic region 4. Central
'Publication'	String	Bibliographic reference for assemblage publication

Table 1 (continued)

Field name	Type	Description
'Period'	String	Categorical indication of site chronology in the Roman historical period: 1. MR/LR (middle Republication to late Republican) 2. LR (late Republican) 3. LR/EI (late Republican to early Imperial) 4. EI (early Imperial) 5. EI/LI (early Imperial to late Imperial) 6. LI (late Imperial) 7. unknown
'Notes'	String	General notes on the sites and types
'Site_notes'	String	Notes and considerations on the site and its location
'Amphora_type_notes'	String	Notes and considerations on the amphora type or typical prime use contents designation
'Problems'	String	Considerations of problems related to the type identification and whether they could be merged with other types

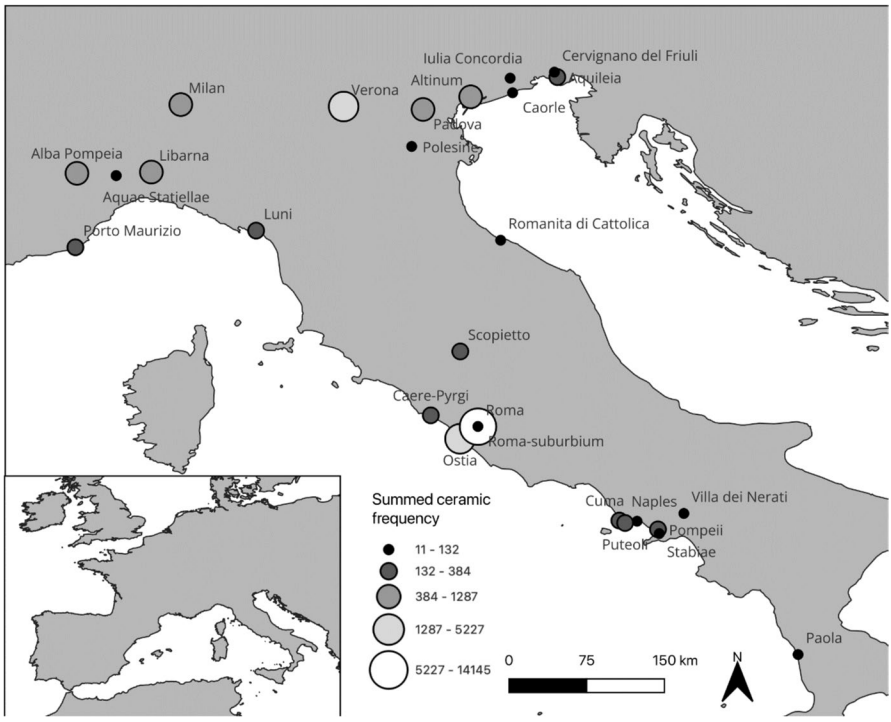

Fig. 1 A map of the grouped sites. Point colour and size represent the summed ceramic frequency for each group of sites

(Villa dei Nerati, Villa romana di contrada Cutura, Paola). However, other contexts do not provide sufficient evidence to establish direct connections with the Roman elite. The remaining 'site' was classified as unknown, as it concerns amphorae from different (and quite old) museum collections in Padova, and no information regarding their possible discovery is available. The database includes the geographic locations of each site and whether they are in Adriatic, Tyrrhenian or Central Italy. This database structure allows for it to be compared or merged with other datasets in future synthetic pottery analyses, and the inclusion of each site's URI from the Pleiades gazetteer allows it to be linked to other datasets with this identifier.

The chosen method is not free from the risk of misidentification of amphorae by ceramologists working on it prior to the publication of the archaeological report. In order to minimise this risk, we considered mostly recent open access publications for which we could verify the ceramic identifications. However, the aim of this study is to identify large-scale trends that are robust to a certain degree of misidentification, and we therefore consider it inappropriate to interpret the small-scale patterns and variations in our results which are much more sensitive to misidentification. Other problems to be acknowledged include the reuse of amphorae and their replacement with barrels in certain areas. The scale of reuse was likely small but its impact on amphora data patterns should be formally assessed in future studies (Brughmans & Pecci, 2020), while the use of barrels has only been confirmed for a

Table 2 Numbers of amphora fragments at different settlements

Site name	Site type	Number of fragments (RBH)
Acqui Terme	Urban	47
Alba Libarna	Urban	907
Alba Pompeia	Urban	930
Altinum	Rural	637
Aquae Statiellae	Urban	57
Aquileia (Casa delle Bestie Ferite, Grandi Terme)	Urban	337
Caere-Pyrgi (Montetosto)	Urban	384
Caorle	Urban	72
Cuma	Urban	228
Iulia Concordia	Urban	97
Luni	Urban	328
Milan	Urban	819
Naples (Palazzo Corigliano)	Urban	70
Ostia (Binario Morto, Casa delle Pareti Gialle, Domus dei Pesci, House of the Porch, Piazzale delle Corporazioni, Taberna dell'Invidioso, Terme del Nuotatore)	Urban/harbour	4943
Ostia (La Longarina)	Rural	284
Padua (Piazza de Gasperi, Via Beato Pellegrino, Via Gattamellata)	Urban	969
Padua (Roncaglia di Ponte San Nicolo)	Rural	168
Padua (varie)	Other	150
Paola, (S. Agata-Despar, Villa Romana di contrada Cutura)	Rural	70
Polesine	Rural	82
Pompeii (Casa di Ariadna)	Urban	247
Porto Maurizio, Liguria	Urban	216
Puteoli (Cratere Senga, Rione Terra)	Urban/harbour	226
Roma (Basilica Hilariana, Vigna Barberini + Mercati di Traiano + Palatinum, Foro di Nerva, Via Marmorata, Terme di Elogabalo, Gianicol, Roma, Via Nova, Crypta Balbi, Foro Transitorio, Vigna Barberinio, Terme di Traiano, Domus Tiberiana, Meta Sudans)	Urban	13.979
Roma suburbium (varie)	Rural	166
Roma suburbium (Boccone del Povero)	Rural	132
Romanità di Cattolica	Urban	47
San Michele, Cervignano del Friuli	Rural	35
Scoppieto, Umbria	Rural	168
Stabiae (Villa Arianna, Villa San Marco)	Urban	95
Verona	Urban	1.950
Villa dei Nerati	Rural	11
Total:		**28,851**

limited time period and geographic area (Marlière, 2002; Marlière & Torres Costa, 2005; 2007; Komar, 2021: 6). Nonetheless, we refer to these possible biases while discussing results of our study further in this paper.

Data Analysis Methods

In the result section, we present outputs of three types of queries (rows in figures): temporal changes in sherd frequency, the number of sites at which amphorae were attested and the number of amphora types. We generate all three queries using two different sources of dating (columns in figures): ceramic typological dates are considered to be more representative of production patterns, and context dates are considered more representative of consumption patterns. We do this to explore differences in production and consumption patterns, but also to remain critical to how typological and site occupation dating might structure the results.

The queries are performed using a probabilistic aoristic method which divides a frequency equally over each year within a relevant date range (Crema, 2012; Johnson, 2004), a method that has been used before in Roman archaeology to explore temporal patterns in ceramic datasets (Fentress & Perkins, 1988; Franconi *et al*., 2023). This method is explained and applied in a previous study by some of the authors on Roman amphorae in Germania (Franconi *et al*., 2023), and we use the same implementation of queries here. It is worth noting that overlapping start and end dates can introduce artificial spikes when applying the probabilistic aoristic method without additional data preprocessing such as adjusting date ranges. To preserve consistency with the source databases and align with prior studies (*e.g.* Franconi *et al*., 2023), we chose to retain the original data format and exclude these spikes from consideration in our analysis. The queries are implemented in Python and openly available in iPython notebooks per figure to enable replication of all results and figures.[2]

The sherd frequency results using type dates are produced by dividing the frequency of an amphora type over the years of the standard typo-chronological date range of that amphora type and summing up all results per year. The sherd frequency results using context dates are produced by dividing the frequency of all sherds in a dated context by the number of years in that site's contextual date range and summing up all results per year. As stated above, we believe the sherd frequency results are most sensitive to selection, survival and publication biases. We therefore interpret the sherd frequency temporal patterns as descriptions of the available published data, and not as direct reflections of traded volumes.

We believe the site count and amphora type count queries produce more robust results in light of known biases. The site count queries using type dates are produced by counting the number of sites per year that have evidence of any amphora type for which that year is within its typo-chronological date range. The site count queries using context dates are produced by counting the number of sites per year that have evidence of any amphora type and where the year in question is within the

[2] https://github.com/Tom-Brughmans/Sonata

context's date range. These site count queries give us a good description of general temporal trends in the width of distribution of amphorae: periods in which certain amphorae were present in many places, and periods when they had a more restricted distribution.

The amphora type count queries using type dates are produced by counting per year the number of different amphora types for which that year is within its typo-chronological date range. This query gives a good description of temporal trends in the frequency of amphora types that were produced. The amphora type count queries using context dates are produced by counting the number of different amphora types per year, where that year is within the context's date range of the context where the amphora type was found. These two queries give a good description of the general temporal trends in the number of amphora types that were respectively produced or consumed: periods when more amphora types circulated, and periods when fewer amphora types were deposited at sites.

Results

We present new results on patterns of trade in amphora-borne foodstuffs in Central Italy as well as chronological trends in the consumption of wine, olive oil and fish sauces of various provenances and destinations. In this section, we first describe general patterns in the database as a whole, which is followed in the next section by a more detailed description of trends. These patterns allow us to trace a number of important economic phenomena, such as changes in Italian and provincial supply and demand as well as changing commercial networks in the Mediterranean. A detailed interpretation of how our results reveal these phenomena is presented in the subsequent discussion section.

Effects of Dating Evidence and Site Grouping

The overall chronological patterns following type dates and context dates, though similar in a broader perspective, differ in their details. In Fig. 2A, we see that using context dates shows a dramatic peak in frequency during the late 1st c. CE. But using the type dates significantly reduces this peak. This pattern points to the overrepresentation of Flavian contexts, especially in Rome, which should not

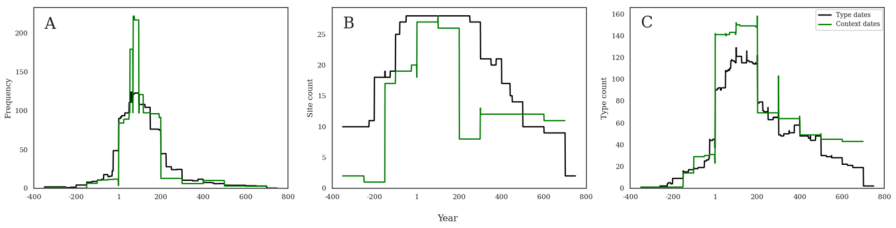

Fig. 2 Sherd frequency (**A**), site count (**B**) and type count (**C**) results for the entire dataset, using both type dates (black) and context dates (green)

be interpreted as a period of particular increase in amphora importations beyond what the peak of 'type dates' shows. The frequency lines are overall very similar, however, which means that most of the Mediterranean foodstuffs were consumed in Italy from the beginning until the end of the life of their commercial packaging (*i.e.* the amphorae). Figure 2B shows the comparison between the two dating methods when considering the count of sites at which amphorae are present. The line reflecting type dates suggests that the distribution width of amphorae in Italy experienced a dramatic increase in the early second century BCE and a similarly abrupt fall around the late third and early fourth century CE. However, the distribution width is rather different when using context dates for the same amphora data: we notice a dramatic growth around 150 BCE), while the fall in distribution occurs as early as 200 CE. Although most amphora types were produced until c. 300 CE, their consumption in Italy stopped abruptly at the end of the 2nd c. CE, which suggests a consumption crisis associated with factors other than political and economic instability during the 3rd c. CE. Perhaps, consumption trends in Italy changed earlier than in the rest of the Mediterranean, and it may suggest a different pace of economic development for different parts of the empire. Figure 2C shows more similarity in the comparison between the two dating methods when considering the diversity of amphora forms in the sample and revealing a higher diversity of amphora types in the early Imperial period.

Although neither dating method is without issues, this comparison of their results allows us to identify patterns that are visible no matter what dating method is used and patterns that are very sensitive to the choice of the dating method. Having such a quantitative understanding of the impact of these dating methods on the results is crucial for enabling an appropriate interpretation in the 'Discussion' section.

No matter which method of dating we choose (Fig. 2A, B, C), all graphs show us similar general patterns (with the exception of the distribution width: Fig. 2B). We observe an overall increase in amphorae in Italy from 200 BCE, which accelerated considerably during the 1st c. BCE. The period between 100 and 200 CE experienced the highest frequency, distribution and diversity of transport containers.

Moreover, all graphs show a general decrease in frequency (Fig. 2A), site count (Fig. 2B) and type count after 200–300 CE. The 50% drop, or even more than 90% in the case of the frequency graph, might point to a dramatic shrinking of the Italian economy towards the end of the empire.

All site count results presented in this paper concern counts of settlements (*e.g.* Pompeii) and not individual excavations within that settlement (*e.g.* Casa di Ariadna). But what is the impact on these site counts of grouping excavations within settlements together? Fig. 3 demonstrates that the patterns are the same, but their magnitude is different. This is hardly surprising given our dataset consists of 66 excavations at 28 settlements, and grouping the same ceramic data together will merely result in a reduction in the magnitude of the pattern by roughly 40 sites. We argue that it is most meaningful to present and interpret results for settlement counts rather than excavation counts throughout.

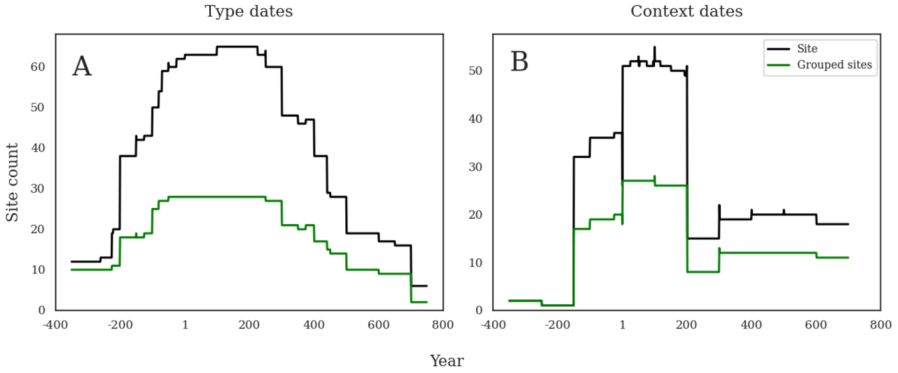

Fig. 3 Comparison of the effects of grouping all excavations per settlement (green line) versus keeping individual excavations (black line) on the site count results for the entire dataset, using both type dates (**A**) and context dates (**B**)

Deposition Settlement Type

The remainder of our results focus on three major substantive avenues of investigation: deposition settlement type (urban, harbour or rural; Fig. 4), typical content (wine, olive oil or fish products; Fig. 5) and vessel origin (*e.g.* Italy, Aegean, …; Figs. 6 and 7).

Figure 4 reveals comparable patterns of deposited ceramics at different site types, suggesting consumption and distribution diversity were comparable at different site types across Italy. Regardless of site type, the highest volumes and most diversified foodstuffs were consumed during the early Imperial period, and all experienced a late Republican increase in consumption and a late 2nd/early 3rd c. decrease which lasted until the end of the empire. However, there are a few differences between the site types' patterns. Most striking is the clear difference in magnitude, mostly reflecting the number of sites of each type (urban = 20 grouped sites, corresponding to 46 individual sites; urban/harbour = 3 grouped sites, corresponding to 9 individual sites; rural 9 grouped, corresponding to 10 individual sites; unknown = Padova varie). This magnitude difference is most striking in the frequency results (Fig. 4A, B), the late 1st c. CE peak being caused by the overrepresentation of urban contexts that were precisely dated to the Flavian period by their construction phases. Type counts show a slightly higher diversity of types in urban centres, especially after 300 CE, but trends in growth and decline follow almost identical shapes for all site types (Fig. 4E, F). We also note that rural sites have a much lower frequency and type count diversity compared to urban or urban/harbour sites (Fig. 4A, B, E, F), suggesting less diversity in amphora consumption at rural sites but also revealing a lower frequency of ceramics from rural sites having been published. Finally, the increase in urban centres started earlier (200 BCE) than in urban/harbour or rural sites (100 BCE) (Fig. 4A, D), but this should be associated with the fact that no rural or urban/harbour contexts dated before 150 BCE are present in the database.

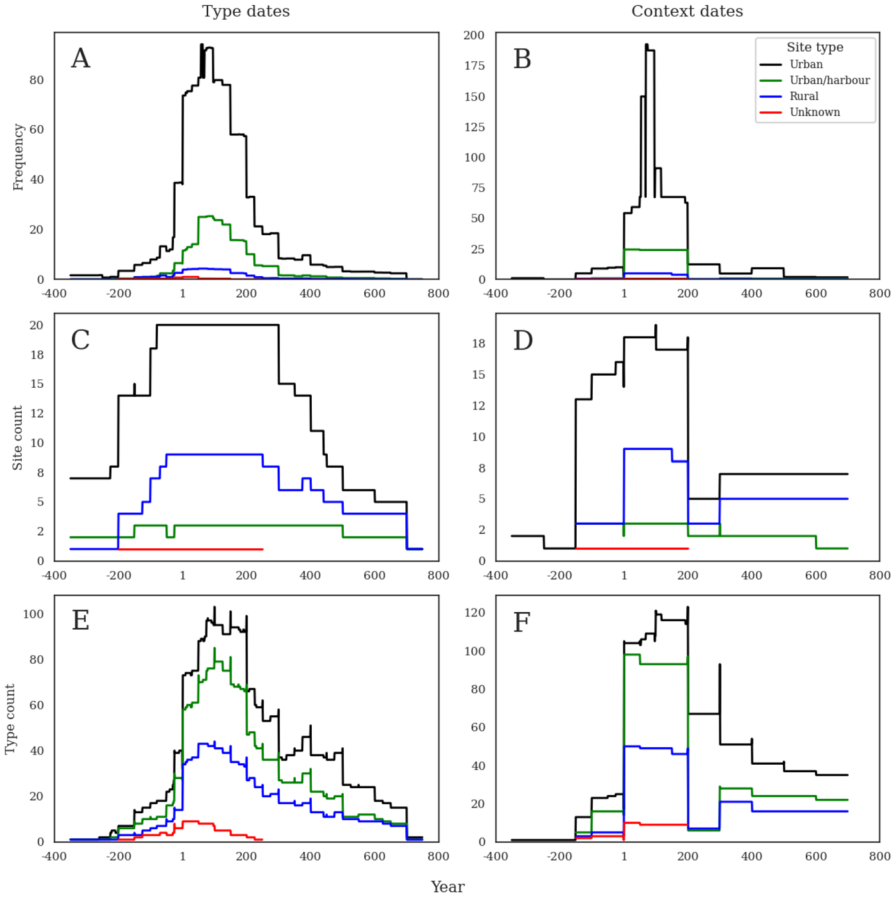

Fig. 4 Patterns per site type. Sherd frequency (**A**, **B**), site count (**C**, **D**) and type count (**E**, **F**) results, using both type dates (**A**, **C**, **E**) and context dates (**B**, **D**, **F**)

Typical Content

Figure 5 also shows similar patterns for wine, olive oil and fish products, though the former were the earliest to reach Italy. Wine carried in amphorae (the so-called Greco-Italic produced at the beginning in the south of the Apennine Peninsula and later in Campania and Adriatic Italy) appeared in Central Italy already during the 4th c. BCE in very small volumes (Olcese 2005–6), while fish products and olive oil started to arrive c. 200 years later. From the perspective of amphora frequency and type count (Fig. 5A, B, E, F), it is clear that wine amphorae were most common and diversified, especially during the Republican period. At the same time, wine is present at comparable numbers of sites as oil and fish amphorae (Fig. 5C, D).

Imported olive oil and fish sauces started to appear in Italy during the 2nd c. BCE, on the highest number of sites (Fig. 5C, D), but until the turn of the eras, they were rather rare (Fig. 5A, B). From the Augustan age until 200 CE, the amounts

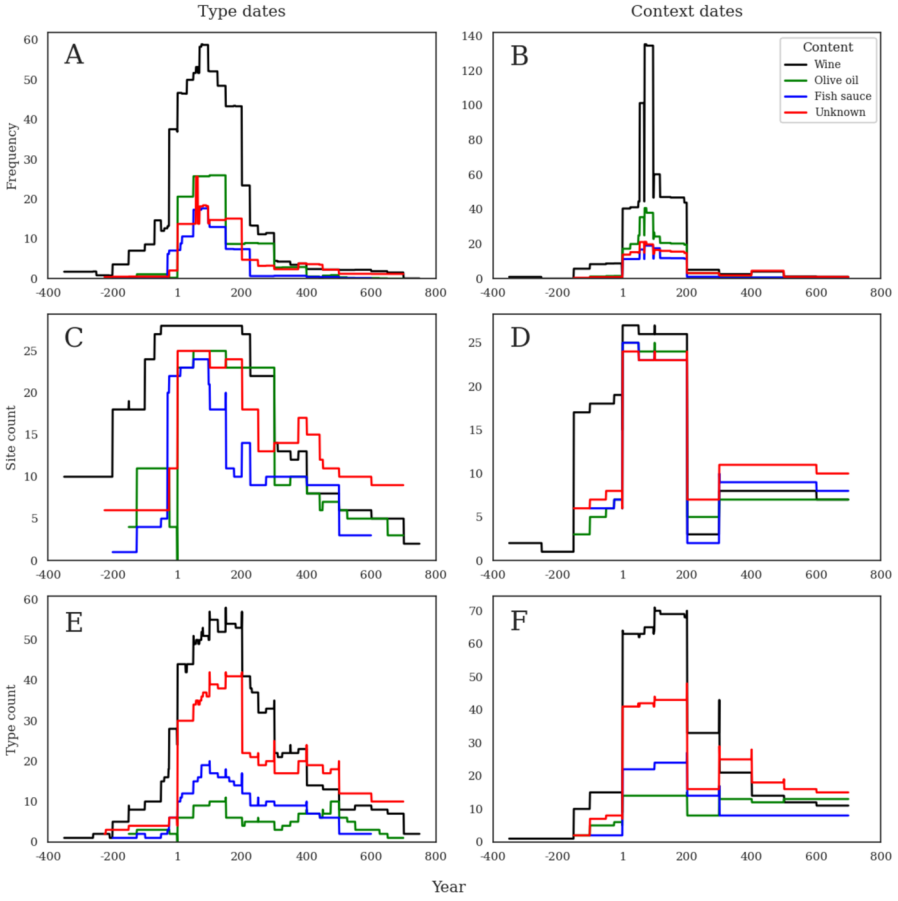

Fig. 5 Patterns per typical prime use contents. Sherd frequency (**A**, **B**), site count (**C**, **D**) and type count (**E**, **F**) results, using both type dates (**A**, **C**, **E**) and context dates (**B**, **D**, **F**)

of all the oil and fish amphorae (Fig. 5A, B) were comparable and their presence in various contexts was equally widespread (Fig. 4C, D), and after this date, their partial disappearance was parallel. Again, amphora production dates (Fig. 5A, C, E) show less abrupt changes than context dates (Fig. 5B, D, F), the latter suggesting more dramatic shifts in consumption patterns of all types of foodstuffs.

These results demonstrate that there was much more diversity in wine amphorae (Fig. 5E, F) compared to containers with other content, which reflects a higher diversity in wine consumption (although the typical content of many types is unknown). This diversity can refer to both the geographic origins of wines or their different qualities—literary sources mention many more wine than olive oil or fish sauces varieties in antiquity (Komar, 2020: 76–127; Komar, 2021: 14–17). Wine, being highly variable in quality and price, is most commonly associated with the market exchange without state interference—at least until the late third century CE, when Emperor Aurelian ordered free distributions in Rome. By contrast, the olive oil trade was likely much more

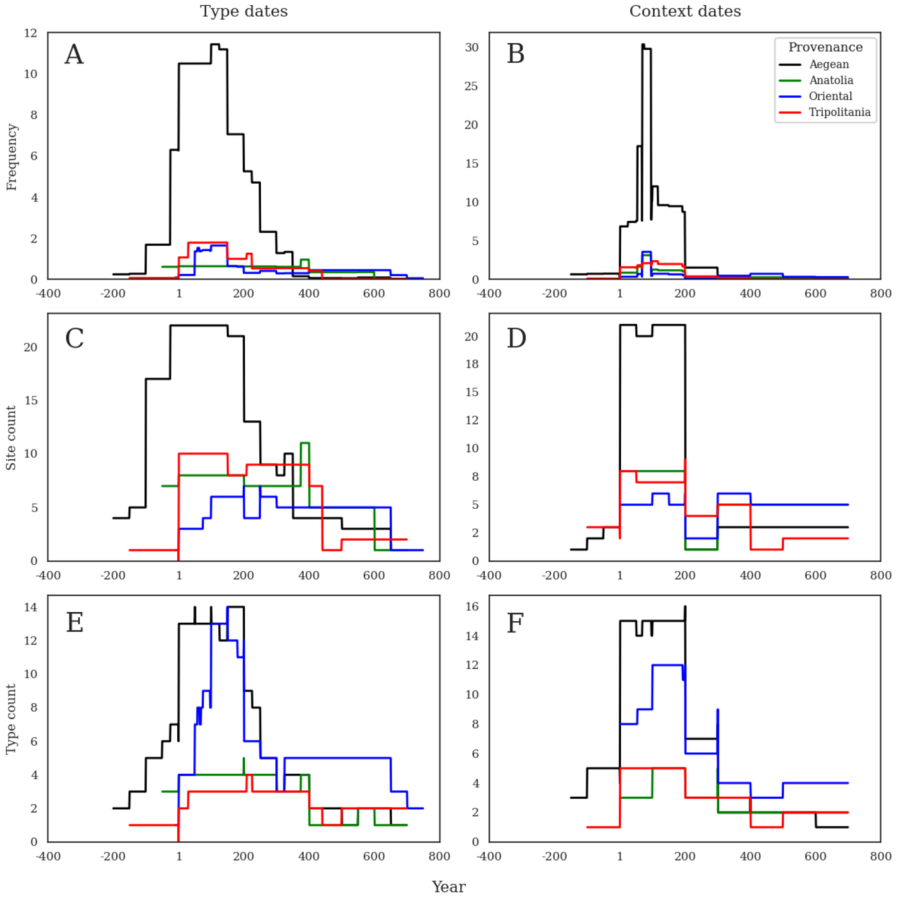

Fig. 6 Patterns per eastern provenance. Sherd frequency (**A**, **B**), site count (**C**, **D**) and type count (**E**, **F**) results, using both type dates (**A**, **C**, **E**) and context dates (**B**, **D**, **F**)

dependent on state directives, possibly as early as the Roman military expansion into Gaul and Britain, and certainly under Septimius Severus at the beginning of the third century CE (Remesal Rodríguez, 1986, 2019). This distinction may also explain differences in the variability of amphora types connected with wine and olive oil transport. This could also explain why the diversity of wine amphora types decreased after 300 CE, while the variability of olive oil containers remained similar. On the other hand, the typological variation of wine amphorae is in general higher than the diversity of olive oil or garum jars. Therefore, some issues related to typological variations of amphora forms and their classification may also be responsible for these differences (Fig. 5E, F).

Vessel Origin

This study clearly demonstrates that Italy imported goods from all over the Mediterranean, the main supplying provinces being the Aegean, Africa, Baetica,

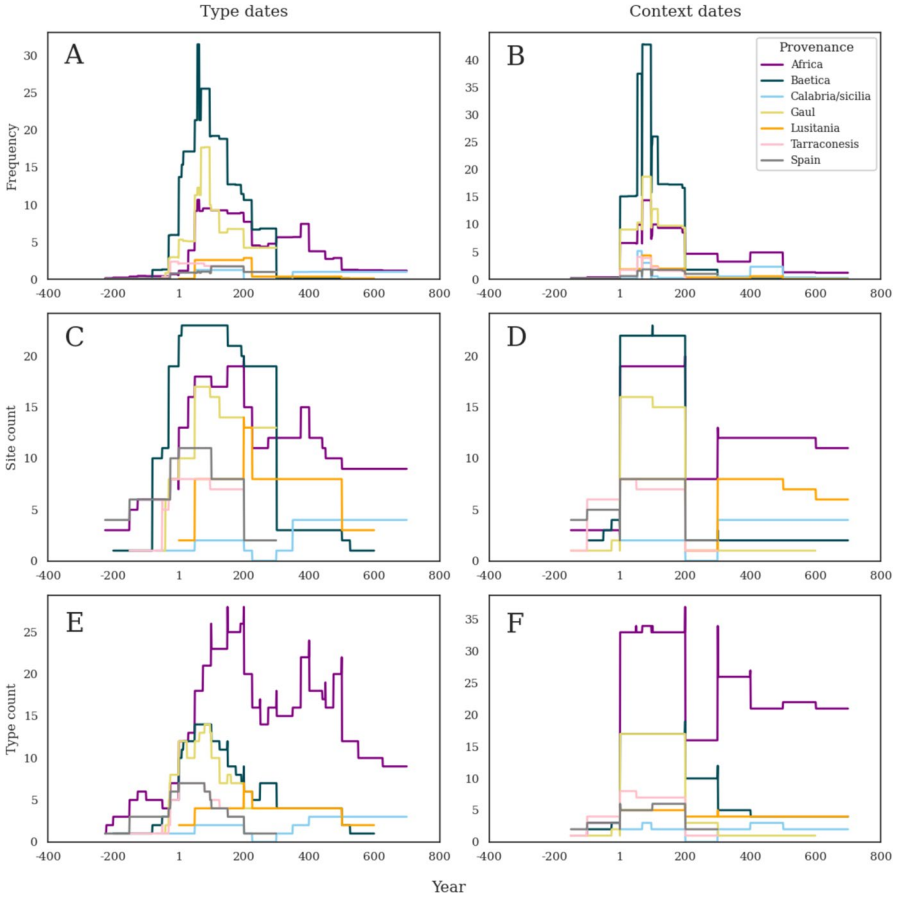

Fig. 7 Patterns per western provenance. Sherd frequency (**A**, **B**), site count (**C**, **D**) and type count (**E**, **F**) results, using both type dates (**A**, **C**, **E**) and context dates (**B**, **D**, **F**)

Gaul and Sicily. What concerns imports from the east (Fig. 6), Aegean amphorae arrived earliest, appearing from 200 BCE. During the mid-2nd c. BCE, they were followed by Tripolitanian imports, while other Oriental (Levantine, Egyptian, Cypriot and Cilician) and Anatolian products appeared at the turn of the eras. Aegean amphorae are most frequent among the eastern imports, and were also attested on a considerably higher number of sites than other types of containers (Fig. 6C, D). Anatolian, Tripolitanian and Oriental amphorae are less attested in Italy (Fig. 6A, B), but they retained their limited distribution and diversity (albeit in small volumes) when those of Aegean amphorae declined in various contexts starting from the 3rd c. CE (Fig. 6C–F). During this period, they also became much more diversified, exceeding the diversity of Aegean products, as indicated by the type count (Fig. 6E, F).

Figure 7 shows results for amphorae of Western Mediterranean origins. All started to appear in Italy after 200 BCE, while their numbers, diversity and

distribution grew considerably in the late 1st c. BCE (using production dates) or early 1st c. CE (using consumption dates). Baetican products had the highest frequency, and they were also most widely attested on different sites in Italy until 200 CE, but after this date, they almost disappeared giving way to African containers. They were followed by Lusitanian and Calabrian/Sicilian amphorae. A considerable change in Italian supply may be observed after 200 CE, when all imports decrease significantly. Imports from the Iberian Peninsula and Gaul disappeared from the record, either by the change in container type (from amphorae to barrels) or a breakdown in production capacities in the West during the third century. This makes African, Lusitanian and Calabrian/Sicilian goods the most common on the market, but even though they were quite widespread in different parts of the Apennine Peninsula, their combined numbers constitute only a small percentage of Baetican imports during the early Empire.

African types were the most diverse starting from the first century CE, as shown by Fig. 7E and F, especially during the late Imperial period. However, the high diversity of African containers during the late Imperial period cannot only be interpreted as reflecting the high diversity of African products on the Italian market, but should rather be associated with typological issues—in Keay's typology (Keay, 1984), many forms exist in several variants, which points to a lack of standardisation rather than deliberate actions (see *e.g.* Keay 61 Type, Variants A, B, C & D or Keay 62, A, D, E, Q & R).

Discussion

In the following sections, we place these results in a broader context and explore their implications for Roman economic history. This will be done in five parts, starting from the broad trends revealed above and their economic implications, followed by more in-depth evaluations of production and consumption patterns in different parts of Italy:

1. Economic development in Italy
2. Production of export goods in Italy and Sicily
3. Rome: exception or rule?
4. Consumption in the rest of Italy
5. Supply of foodstuffs to Italy

Economic Development in Italy

This study clearly shows that amphora-borne staples were present in Italy in considerable quantities and diversity between 200 BCE and 500 CE (Fig. 2). However, a significant increase in the frequency and site count curves can be observed during the 2nd and 1st c. BCE; they remain stable until c. 200/300 CE; and after this date, they fall to the levels of the middle Republican period and stay low until the end of our period of study. From the perspective of the consumption dates, this trend

demonstrates a real boom in importing foodstuffs to Italy between c. 100 BCE and 200 CE. But both the flow and ebb of amphorae were dramatic, which suggests that there must have been sudden changes in trade and consumption patterns in Italy throughout the Roman Imperial period.

The overall pattern mirrors what has been observed for other archaeological proxies of economic growth—a general growth in urbanisation and mining activity in the Mediterranean (De Callataÿ, 2005; Scheidel, 2009; McConnell *et al*., 2018; Hanson, 2016: 95–6); a construction boom in Italy and Germany (Jongman, 2007b: 615; 2007a: 189–90, graph 3 and 4; 2009; 2014: 174–5, Fig. 2 and 3); production boom suggested by increase in wine and olive presses and garum factories (Wilson, 2014: 158, Fig. 8; Marzano, 2013b: 133–4, Fig. 5.12 and 5.13; 2013a; 2015); and a consumption boom, which was well documented especially in Italy (Santangeli Valenziani & Volpe, 2012: 66–7; Volpe, 2009: 379–81; Jongman, 2007a: 189–90, graph 3 and 4; id. 2014: 174–5, Fig. 2 and 3; De Ruyt, 2000: 178–9; Komar, 2021). All of these phenomena started around the Augustan age and lasted until the late 2nd c. CE.

This pattern, reflected most clearly by a site count (Fig. 2B), can be compared with models of economic growth in the Roman Empire. There is a consensus among scholars that aggregate economic growth occurred between the late Republican age and the 2nd c. CE, but its nature and scale are still debated (Hopkins, 1978, 1980, 2002: 190–230; Saller, 2005: 223–38; De Callataÿ, 2005: 361–372; Friesen&Scheidel, 2009: 61–91; Scheidel, 2009: 46–70; Lo Cascio, 2009: 87–106; Erdkamp, 2016; Kron, 2014: 123–46; Jongman, 2006: 237–54; 2014: 169–88; 2017a: 260–8). For example, certain scholars argue that the growth was rather moderate and unsustainable, stopped by population growth (Saller, 2005; Scheidel, 2007: 332–46; 2009: 46–70), while others presume its sustainability, blaming external factors (epidemics or ill-guided policies of the emperors) for the economic contraction (Silver, 2007: 191–252, especially 236–9; Temin, 2013: 220–39). Our results, demonstrating the abrupt and huge increase in imports from all over the Mediterranean, suggest that gross growth probably took place in most parts of the empire during the late Republican and early Imperial period. Rapid enrichment of the inhabitants of Italy as a consequence of the conquest of new territories, war booties and incomes from new investments during the last years of the Republic, postulated by Scheidel (2009), offers a potential explanation of the consumption boom on the Apennine Peninsula. However, it also seems that the Roman conquest, unification of the empire and capital brought by the Roman elites positively influenced the productivity in the provinces.

Several studies suggest that the population of Italy, particularly in the Roman hinterland, experienced significant growth by the late Republican period. Estimates indicate that the population of the *Urbs* doubled during this time (Van Limbergen, Monsieur, Vermeulen 2017: 344). The expansion of rural settlements in Central Italy coincided with the urban growth of Rome and nearby towns, both of which peaked during the late Republic and early Empire, along with an increase in pottery finds. Although different categories of pottery reveal an uneven distribution of amphorae and fine wares, the growth in amphora quantities corresponds with population increases, ruling out food shortages or other signs of impoverishment (Jongman, 2014; De Haas, *et al*., 2011; Tol, 2017). While more evidence is needed

to definitively support the case for intensive growth, the opposite scenario seems unlikely. The Aegean region and the Iberian Peninsula, Baetica in particular, were the most productive regions of the Empire until the 3rd c. CE, but they gave way to Africa during Late Antiquity. The quantities of Spanish goods, mostly Baetican olive oil, but also wine from Tarraconensis and fish sauces from Lusitania, highlight the special role that the Iberian Peninsula and especially the province of Baetica played in Italian supply. It should be emphasised that the consumption boom during the late Republic and early Empire regarded Aegean wines and Baetican olive oil in particular. Aegean imports were not only the earliest Eastern amphorae to arrive in Italy, but also the most numerous (Fig. 6A, B), the most widespread along the Apennine Peninsula (Fig. 6C, D) and the most diverse (Fig. 6E, F). This confirms the suggestions of other scholars, according to which Greece was the main Italian vineyard (Komar, 2020), as Egypt was its granary. Considering that Baetican olive oil was the second product among those that most largely contributed to the consumption boom, the role of this province as an olive oil warehouse for Italy and Rome in particular, already suggested by the discoveries from Monte Testaccio (*e.g.* Remesal Rodríguez, 2008, 2018, 2019), now seems even more pronounced. Nevertheless, the position of Baetica is not as dominant among western amphorae as the role of the Aegean area among Eastern Mediterranean amphorae, which suggests that the supply from the west, which included considerable amounts of Gallic and African products, was more even and diversified than the supply from the east.

After 200 CE, the Aegean provisions broke abruptly and the share of goods from the rest of the Eastern Mediterranean in Italian supply became almost equal. The diversity and distribution width of Oriental, Anatolian and Tripolitanian amphorae in Italy did not change much between the early and late Imperial period (Fig. 6C, D, E, F), despite the fact that after the 3rd c. CE, the demand was considerably smaller as a consequence of wars, depopulation, movement of the capital and a general instability (O'Donnel, 2009, 48; Durliat, 1990, 117, Fig. 1; Russel, 1958: 73). It seems, therefore, that the Italian consumption shrinkage affected mostly the Aegean imports, or that this part of the Mediterranean experienced the strongest problems in surplus creation and was no longer able to satisfy the demand in the centre of the empire. At the same time, the considerable decrease in Baetican olive oil imports (and other products from the Iberian Peninsula) on Italian market cannot easily be interpreted in the similar manner due to the barrel issue, but the political instability in the West postulated by a number of other studies (Keay, 1988: 173–178) inclines to acceptance of the hypothesis regarding the shrinkage of the export economy of the Iberian Peninsula during Late Antiquity (Funari, 1994: 99–101). Moreover, the frequency curves (especially in Fig. 7) demonstrate that even though Africa dominated the late antique supply, its capacity for provisions should not be overestimated. All products from Africa during Late Antiquity hardly reached a half of Aegean wines or Baetican olive oil imported during the early Empire.

It seems that population growth in Italy was not able to devour the general wealth for over 200 years of the Principate, as the numbers of imported products suggest wellbeing and stability, which was only broken at the turn of the 2nd and 3rd c. CE. The decrease in amphora frequency is too abrupt and dramatic to be explained as a result of natural factors. Sudden, external shocks, such as plagues (of the Antonines

and Cyprian), which caused the economic problems in the Empire (McConnell *et al*., 2018), seem a better fit with the amphora data. Therefore, the results of this study corroborate better with the assumption that there was a sustainable development in the Roman economy and that it was stopped by external factors.

Furthermore, our aggregated data from terrestrial sites can be compared with the shipwreck curve created by Parker and later analysed by Wilson (Parker, 1992; Wilson, 2009a, 2009b a, b). Numbers of shipwrecks diminished in the early 2nd c. CE, which means a century earlier than the frequencies of amphorae. Our study, therefore, agrees with the assumption that the decrease in the number of attested shipwrecks was due to other reasons than the collapse of trade and cannot be seen as an indicator of Roman economic performance during this century (Wilson, 2009a, 2009b, 2014).

Finally, Fig. 3B demonstrates a third century decrease in imports and then a small recovery during the fourth and fifth centuries, which, however, cannot be compared with late Republican and early Imperial prosperity. We could, thus, suggest the following hypothetical scenario: the sustainable economic growth in Italy was stopped by the Antonine plague and then strengthened by the crisis of the third century (civil wars and barbarian raids, Cyprian plague *etc*.). The attempts to restore the Italian wellbeing were probably impeded in Late Antiquity by climate change (Harper, 2017). But new data does not allow us to link economic and population changes with the climate (see Roberts *et al*., 2019; Xoplaki *et al*., 2021), but they cannot be properly approached using amphora statistics due to the use of barrels, which became much more popular during Late Antiquity.

The type count (Fig. 2C) shows that there was a higher diversity of amphora types in the early Imperial period, coinciding with a supposed period of economic development. More amphora diversity means more variability in offer for consumers and potentially more competition on the market. This diversity could indicate an increased prosperity reflected in an increased ability to import from diverse regions, but also potentially a decentralisation and freedom of choice which would not exist if only foodstuffs from one or few producing regions were available. Obviously, a wider variety of amphora types per se is too little to argue about the prevalence of free market commercial transactions over the coerced transfers, but the correlation of this pattern with the period of economic growth is of interest. Interpreting the decrease in the diversity of amphora types during Late Antiquity is difficult since it is obscure whether the pattern reveals certain market changes in the variability of goods or is simply caused by the use of barrels, which replaced many amphora types. The results presented in Fig. 4 show that the consumption levels grew between 200 BCE and 200 CE all over Italy and that the pattern was similar for urban, harbour and rural areas. The magnitude of the growth and decline, however, varies depending on whether we count the number of sites of each type and the number of ceramics published per site type. Overall, this means that imported foodstuffs were available not only to the urban inhabitants of big cities or the ports that received supplies for these cities but also to people living in the country. Therefore, smallholder farmers living in distant areas of the Apennine Peninsula, commonly seen as very self-reliant for their subsistence, had access to imported goods. This suggests that the economic growth indicated by the scale of imports was not unevenly distributed and not limited only to imperial and municipal elites, which could

indicate that it had a *per capita* character. This agrees with other studies emphasising an early Imperial wellbeing of the inhabitants of Italy (Kron, 2005: 70–1, 77–8; Jongman, 2007b: 608–9; 2007a: 194, graph 7; Kron, 2014: 129; contra Wilson, 2009b: 74; Wilson, 2014: 149, 156; Koepke, 2016; Harper, 2017: 77, Fig. 3.3 and Jongman *et al*., 2019). An important caveat is provided by the much more limited diversity of types at rural settlements (Fig. 4E, F), suggesting their inhabitants had access to less diverse foodstuffs.

As mentioned above, the earlier influx of imported goods registered in urban areas cannot be interpreted by an assumption that people inhabiting Roman cities got access to imported goods earlier than villagers, and especially workers associated with harbour facilities (Fig. 4B). This just shows that earlier contexts were distinguished in the cities, which are so far lacking in other types of sites, as it would have been illogical to assume that no imports reached ports via which the cities were supplied.

It is worth mentioning that all types of sites experienced a decrease in imports after 200 CE, which demonstrates that the 3rd c. crisis and late antique 'recession' had a similar impact on urban and rural areas, at least in terms of accessibility of imported foodstuffs.

Production of Export Goods in Italy and Sicily

Italy not only consumed goods imported from the provinces, but also produced high volumes of wine and olive oil, which were exported during the late Republic mostly to Gaul (wine), military camps on the German limes, the Eastern Mediterranean and even as far as India (Gupta *et al*., 2001; Lawall, 2006; Tchernia, 2016, 276–296; Franconi *et al*., 2023). Nonetheless, during the early Empire, these surpluses largely remained on the Apennine Peninsula due to the increased demand for foodstuffs. We therefore zoom in on the consumption of different Italian amphorae to explore economic conditions and the pace of development of different parts of the Apennine Peninsula (Fig. 8). Sicily, although it is clearly a province, is included here, because of the challenges of the attribution of the provenance of a few amphora types, especially Dr 21–22 and Keay 52, which were produced both on the island and in south Italy, most probably in Bruttium and Calabria (Panella & Rizzo, 2014, 135–149).

The inner part of the Apennine Peninsula was almost insignificant in terms of supply of amphora-borne goods, and only the Tyrrhenian and Adriatic facades and the Tiber Valley were regions that allowed for large-scale regional or pan-Mediterranean export of their staple goods. Production of surpluses for export started earlier in western Italy, but in the eastern part, it was more intensive during the early Empire. Only these Adriatic and Tyrrhenian products gained popularity all over Italy, while other amphorae had a limited distribution (Fig. 8C, D) and (except Sicilian) diversity (Fig. 8E, F).

Tyrrhenian Greco-Italic forms appeared from 350 BCE and were accompanied by other types of Italian production. Starting from the turn of the era, Adriatic amphorae became more frequent and typologically more diverse than Tyrrhenian ones (Fig. 8), especially on the sites situated on the eastern part of Italy, and their predominance continued until the early 2nd c. CE. However, in this period, Tyrrhenian amphorae were present on slightly higher numbers of sites than Adriatic amphorae

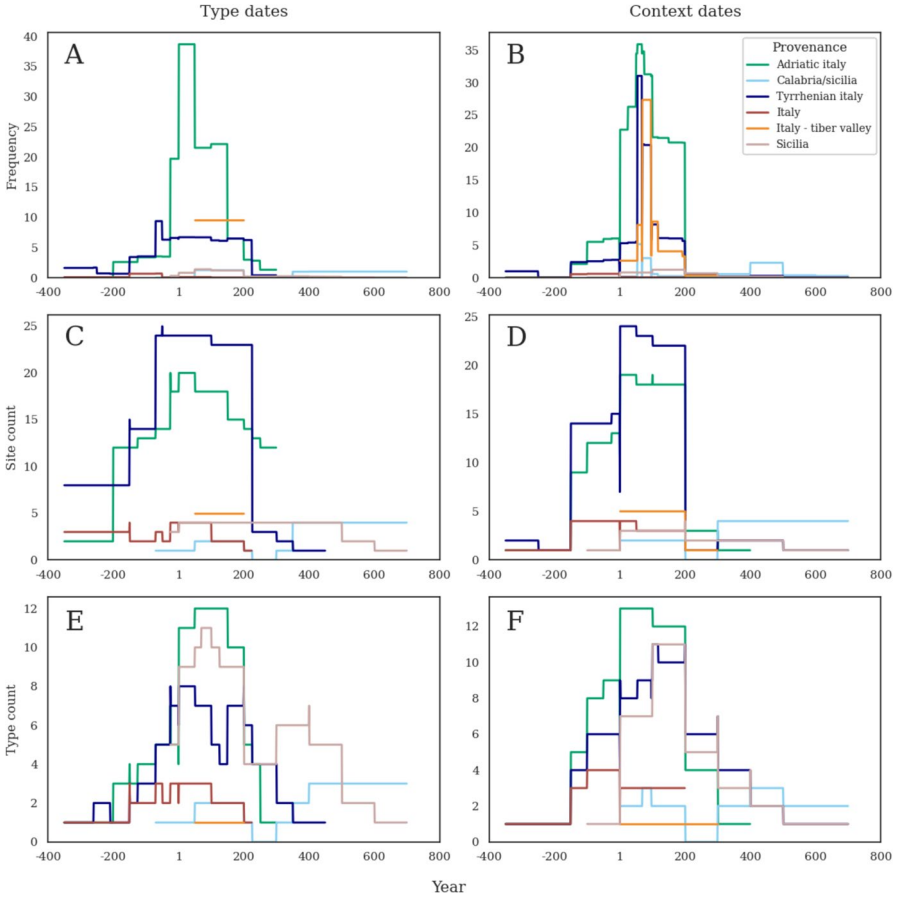

Fig. 8 Patterns per Italian provenance. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

(Fig. 8C, D). Tyrrhenian and Adriatic amphorae patterns suddenly drop after 200 CE. It seems that some Tyrrhenian and Adriatic amphorae continued to be produced in the 3rd c. CE and they were exported abroad, *e.g.* Dressel 2–4 jars discovered near Hadrian's Wall (Arthur, 1995, 245; Arthur & Williams, 1992, 253–254; Williams, 2004, 449), but their consumption in Italy almost ceased. Amphorae produced in the Tiber Valley ('di Spello' type) were in use between the second half of the 1st and 2nd c. CE, but their distribution width was not particularly high. It seems that the export of wine from the Tiber Valley was limited mostly to supply Rome and its neighbourhood. According to Tchernia (2016: 81–82), the Tiber Valley blossomed as a wine exporter during the crisis in Campanian viticulture caused by the eruption of Vesuvius. Our results show that amphorae from the Tiber Valley remained in circulation until the economic breakdown of the late 2nd and early 3rd c. CE (Fig. 8). Containers from Sicily and south Italy were rare throughout the whole antiquity, but

remained in production and consumption after 300 CE (*e.g.* Calabrian/Sicilian type Keay 52) when most other Italian productions ceased being widely distributed.

These results reflect that the biggest consumption centres, such as Rome and the Po Valley, gave impulse to surplus production in the neighbouring Tyrrhenian and Adriatic areas. This production was moreover exported outside of Italy. When it ceded (at least based on amphora evidence), new production areas entered the stage, such as south Italy and Sicily—the distribution of flat-bottom containers in Sicily and the Mediterranean shows that during the Early Roman period, their supply was limited to a few places in Sicily, a few in Tyrrhenian Italy and Gallia Narbonensis, while only in late Roman times, the distribution pattern changed to pan-Sicilian and pan-Mediterranean (Franco, 2014, especially Fig. 7.4–7.8).

The continuing presence in Italy of the wine of *Brutti* (Keay 52 amphorae of Calabrian/Sicilian origin), praised by Cassiodorus as a delicacy (Cassiod. *Variae* XII 12), might have been the result of the outflow of Egyptian grain to Constantinople and the later Vandal conquest of Africa, which caused the growing demand for Sicilian grain, and probably other products from the region, which was becoming gradually important for the Roman nobility. On the other hand, the appearance of the Keay 52 type further correlates with the Aurelian-era distributions of wine for Rome's inhabitants—they are the only Italian wines transported in amphorae during this period, which, according to some scholars, links them with *canon vinarius* paid by these areas after their inclusion to *Vicariato Suburbicario (*Pacetti, 1998; Panella, 1993, 646; 2001, 180, 196; 2017, 114).

Finally, one may question whether different parts of Italy relied on the same integrated market. Exploring this issue requires analysing the patterns of amphora provenance across various regions within Italy. For example, survey data show variations in pottery distribution in different parts of central Tyrrhenian Italy (*e.g.* Nettuno, Asturas, Forum Appii, Norba and Pontina), suggesting that even within the region near Rome, distinct supply systems existed. This evidence supports the argument that Italian markets were not uniformly integrated (Tol, 2017). However, a thorough analysis of this topic is beyond the scope of this paper, as a comprehensive, separate study would be required to assess all relevant data carefully.

Rome: Exception or a Rule?

The city of Rome is often considered an exceptional urban community in the Mediterranean—the Empire's hub to which all roads led. It was the biggest centre of consumption, with imperial elites among its inhabitants, and particularly well connected with the rest of the Mediterranean. The so-called primitivist theories assume that big cities, such as Rome, Alexandria, Ephesus and Carthage, received more imports than ordinary settlements, but that these patterns were exceptional (Finley, 1999: 123–149; Bang, 2008: 142, 297–298). Is this reflected by amphora production and consumption patterns?

The frequency and type count curves from Rome (Fig. 9) show the same general pattern as the dataset as a whole: the appearance of amphorae c. 400 BCE, an increase in the 2nd and 1st c. BCE, peak in the 1st c. CE and the sudden and almost constant decrease in frequency and diversity after 200 CE (but a higher type

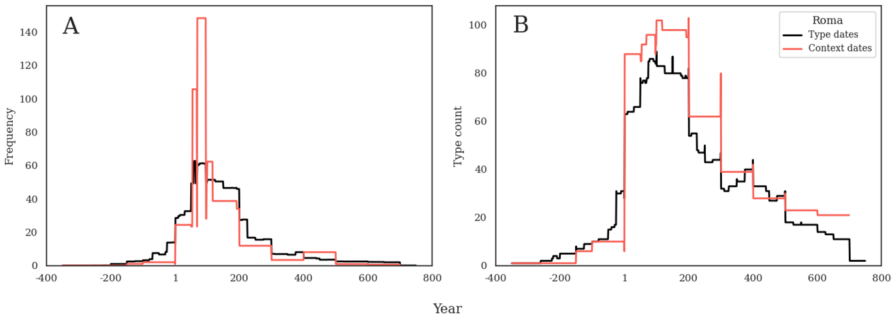

Fig. 9 Patterns for all sites in the city of Roma, of sherd frequency (**A**) and type count (**B**) results, using both type dates (black) and context dates (red)

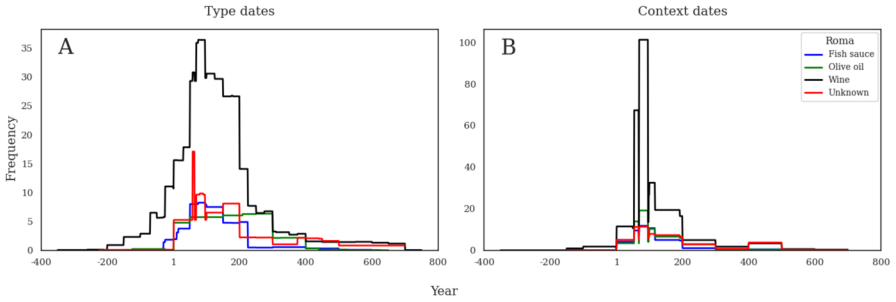

Fig. 10 Patterns of typical prime use content for all sites in the city of Roma, of sherd frequency results, using both type dates (**A**) and context dates (**B**)

diversity in the late Imperial times than during the late Republic). This similarity is not surprising, since the frequency of evidence from Rome constitutes 49% of the entire dataset and therefore plays an important part in shaping the overall pattern (14,145 out of 28,851). The amplitude is much bigger while looking at context dates than when considering only type dates, but as mentioned above, this is associated with a high number of contexts that could be precisely dated to the narrow period of the Flavian rule. Figure 10 demonstrates that wine amphorae were not only the most common, but also the earliest to be imported to Rome. Olive oil and fish sauce containers were not attested in larger quantities before the turn of the eras, and they reached a peak during the early Imperial age. Olive oil jars disappeared gradually after 300 CE, while fish sauce jars remained until at least 400 CE, but after 200 CE, their quantities dropped considerably. In comparison to the overall dataset patterning (Fig. 5A, B), wine is even more dominant in relation to other contents.

Nevertheless, the lack of considerable differences in the amphora curve for Rome as compared to the pattern established for the whole dataset suggests a couple of important potential research issues. First of all, it seems that what happened in Rome did not stay in Rome, but was soon mirrored all over Italy, albeit possibly on a smaller scale. The consumption habits of the Roman ruling elite, at least in terms

of types and provenance of wine, olive and fish products, did not considerably differ from the habits of the rest of Italy. This corroborates with Rowan's studies of sewers in Pompeii, which show that the diet of the wealthy did not differ in principles of the diet of the poor (Rowan, 2015), as well as with the results of the research in Portus (O'Connell *et al*., 2019: 731). Secondly, we should ask a question of whether it was the inhabitants of Italy that imitated the consumption patterns of the Romans or the other way round. For example, there is evidence that wine from Crete became very popular in Campania around half a century before it flooded the tables of the inhabitants of the *Urbs* (Komar, 2020: 179). Finally, it seems that Rome, although definitely exceptional as the seat of the emperor, senate and elite, might have behaved as an ordinary city in other aspects, *i.e.* consumption of basic foodstuffs.

On the other hand, since the research regarding the city of Rome has been the most scrutinised, it allows us for a better understanding on certain trends observed in our amphorae curves. For example, the reduction in amphora frequency after 200–300 CE could be associated with a drop in demand for foodstuffs. It is assumed that during the 2nd c. CE, the city had a population of roughly one million inhabitants, which decreased to 800,000 around 400 CE, while the transfer of the capital to Ravenna and Constantinople as well as the Vandal raids might have resulted in the population shrinking to just 100,000 by 500 CE (O'Donnel, 2009: 48). Other estimates are even more pessimistic, setting the Roman population during the 5th c. CE at 350,000 and during the 6th c. CE at a mere 60,000 inhabitants (Durliat, 1990: 117, Fig. 1), or even as little as 58,000 around 419 CE (Russel, 1958: 73).

The change in amphorae patterns during Late Antiquity could also reflect changing consumption habits. A part of 'old' Roman elites moved to Ravenna and Constantinople, and new elites with possible different consumption habits appeared in Italy. The development of Christianity encouraging fasting and ascetic practices among devotees might have also influenced the decrease in demand, wine in particular (but wine used during the Eucharist was still needed and might have levelled this decrease) and to a lesser degree also olive oil and fish products. However, we expect such factors would account for a smaller part of the reduction of amphora patterns as compared to the effects of a significant decrease in the city's population size.

Consumption Patterns in Different Areas of Italy

In Fig. 11, we compare the patterns from Rome with those from sites in Ostia; sites along the Bay of Naples (which includes mostly contexts from the Vesuvian Cities (Pompeii and Stabiae), but also from Naples, Puteoli and Cuma); and all other sites in the dataset. These results allow us to conclude that all areas of Italy had a comparable pattern of growth and decline seen through the consumption of different amphora-borne products, but with some differences in amplitudes. For example, Fig. 11A and B clearly demonstrate how Rome makes up about 49% of frequency in the database, and allows us to explore how the pattern of Rome differs from that in other areas. Frequency graphs organised according to amphora production dates (Fig. 11A) show that all areas imported goods according to the

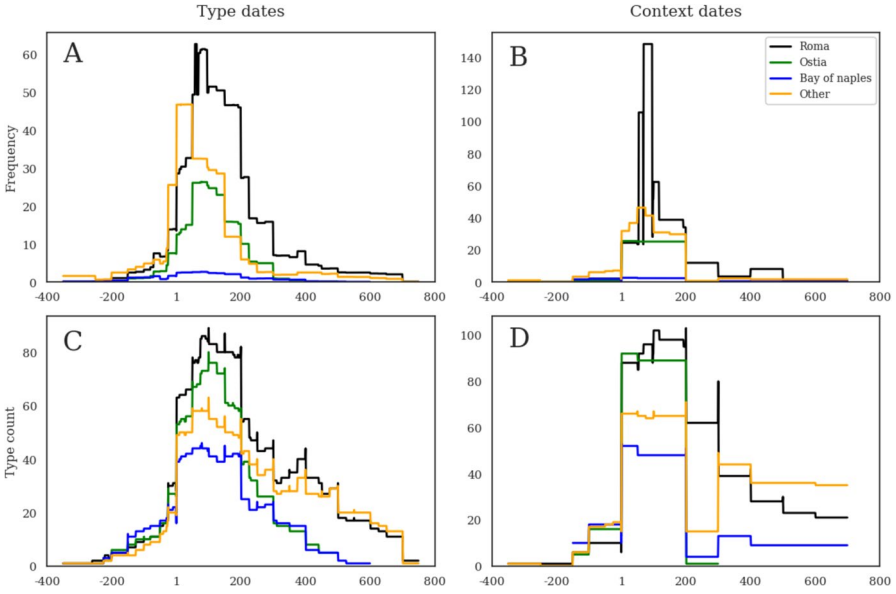

Fig. 11 Comparison of patterns for sites from Roma, Ostia, the Bay of Naples and all other sites in the dataset. Sherd frequency (**A**, **B**) and type count (**C**, **D**) results, using both type dates (**A**, **C**) and context dates (**B**, **D**)

same general pattern, but we can notice that the frequency peak in 'Other' started slightly earlier, which means already in the late 1st c. BCE and early 1st c. CE. On the other hand, this earlier increase is less pronounced when looking at site dates (Fig. 11B) or type count (Fig. 11C, D). The highest diversity of amphora types is attested in Rome, but Ostia, especially during the 1st c. CE almost reached Roman levels. The Bay of Naples has the lowest diversity.

The highest diversity of products in the capital is perfectly understandable, as this is what we also observe in modern times—the largest diversity of consumers lives in big cities, which is why the widest variety of goods is necessary in order to satisfy their demand. The main function of Ostia was to supply Rome, which is why the variety of goods attested there was comparable. However, despite attempts in magnifying the capacity of *Portus*, it was not able to receive all the goods that the capital demanded, which is why it soon started to specialise in receiving western products, while the eastern reached Puteoli in Campania (Pavolini, 1996: 228–230; Komar, 2020: 159). This also explains the lower diversity of products in the Bay of Naples—only eastern goods were common and popular there. Considering that Campania produced plenty of high-quality agricultural goods, so needed less imports, only a small part of western commodities reached this area (*e.g.* for special demands of certain consumers or simply incidentally).

We will now explore the consumption patterns of typical contents for Ostia, the Bay of Naples and all other Italian sites (Figs. 12, 13, 14). Wine amphorae were significantly more frequent and diverse in Ostia than olive oil or fish sauce containers (Fig. 12). This reflects the pattern observed for Rome (Fig. 10). Imports of olive

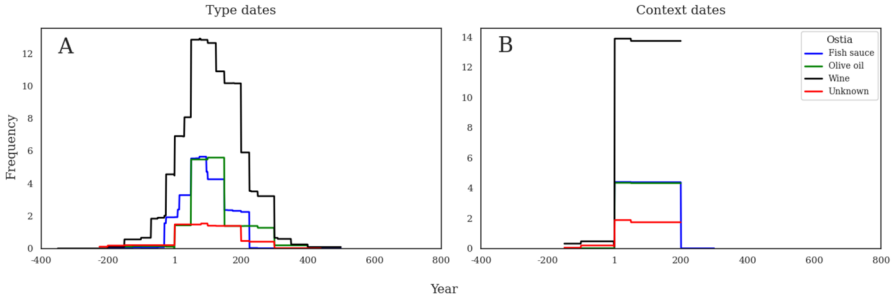

Fig. 12 Patterns of typical prime use content for all sites in the city of Ostia, of sherd frequency results, using both type dates (**A**) and context dates (**B**)

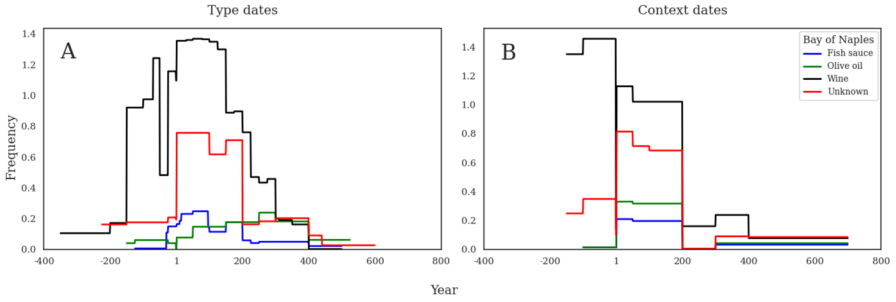

Fig. 13 Patterns of typical prime use content for all sites in the bay of Naples, of sherd frequency results, using both type dates (**A**) and context dates (**B**)

oil and fish sauces reached Ostia from the 2nd c. BCE, but since numbers of wine amphorae increased during this period, for fish sauce amphorae, the growth started in the late 1st c. BCE, while for olive oil jars in the 1st c. CE. Imports peaked in the first century CE and declined after the second century. This suggests that Ostia became an important reloading place for Roman supply starting from the beginning of the Empire and remained such until the 2nd/3rd c. CE. This peak period also coincides with the infrastructure investments of Augustus, Claudius and Trajan in the neighbouring harbour of Portus (Meiggs, 1973; Giuliani, 2001; Boetto&Bukowiecki, 2010). It should be mentioned that there are few contexts in Ostia dated to Late Antiquity so it is difficult to understand what exactly happened after the 3rd c. CE.

The frequency curve for the Bay of Naples (Fig. 13) differs considerably from the general pattern for the whole of the Apennine Peninsula (but it is important to note that this frequency graph is based on just 3% of all sherds, a summed ceramic frequency for the Bay of Naples of 866). The frequency peak occurred 100–200 years earlier—in the late Republican period and not in the early Imperial period (Fig. 13B). This pattern is best reflected when using site dates (Fig. 13B) rather than type dates: the former reflects better the fact that the Vesuvian cities were not occupied after the eruption in 79 CE and the crisis in Campanian production caused by this event (Tchernia,

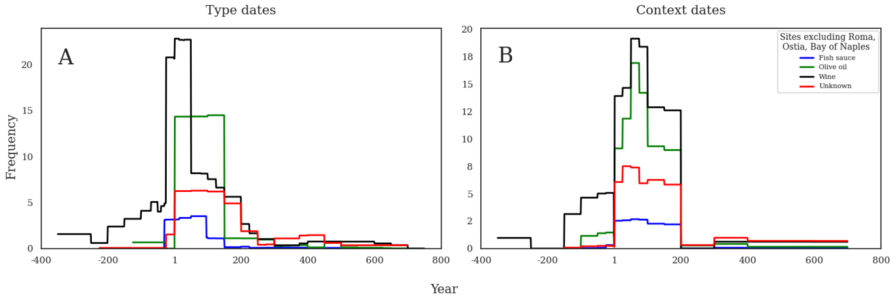

Fig. 14 Patterns of typical prime use content for all sites in the dataset excluding those in Roma, Ostia and the bay of Naples, of sherd frequency results, using both type dates (**A**) and context dates (**B**)

2016: 81-82). The frequency curve based on type dates (Fig. 13A) roughly agrees with the general pattern, established for Italy as a whole, except for an earlier higher peak in wine amphora frequency, which equals the Imperial levels. Olive oil and fish sauce containers were attested in comparable quantities, but a number of amphorae of unknown content are very high in this region, so establishing a content for a part of amphora types currently classified as unknown is likely to change patterns.

The consumption pattern for Italy with Rome, Ostia and the Bay of Naples excluded shows again a similar development—wine amphorae were the first and most commonly imported (Fig. 14). They considerably exceeded the numbers of other jars during the Republican age and peaked in the early 1st c. CE (Fig. 14B). However, the more limited variability between amphorae carrying different contents at Italian sites shows a clear difference with the consumption pattern in Rome (Fig. 10A, B), where the quantitative dominance of wine amphorae is much more extreme.

Wine was clearly the most widely consumed amphora-borne foodstuff regardless of the area of Italy. The high frequency of wine amphorae in Campania during the late Republican age on the one hand points to its role as a wine producer, while on the other highlights consumption capacities of towns and *villae otia* in the region (Adams, 2005: 274–293; Varriale, 2016; Marzano&Métraux, 2018). Olive oil and fish amphorae on the other hand demonstrate no considerable differences between the consumption trends in the capital and on other sites.

Tyrrhenian vs. Adriatic Consumption and Economic Development

The Tyrrhenian part of Italy started to consume foodstuffs imported in amphorae around 400 BCE, but until 200 BCE, their numbers were low and imports were limited to wine (Fig. 15). Olive oil and fish sauces became more frequent during the 1st and 2nd c. CE and, as elsewhere, after 200 CE, a drop in their numbers may be observed. Site dates (Fig. 15B) demonstrate that imports were consumed in Italy in higher quantities during the 1st and 2nd c. CE. Note the particularly high levels of wine transport containers dated to the Flavian period for Tyrrhenian sites as compared to Adriatic sites (compare Figs. 15B and 16B). This is caused by contexts dated to the Flavian period predominating in the Tyrrhenian part of Italy, especially in Rome. Site count

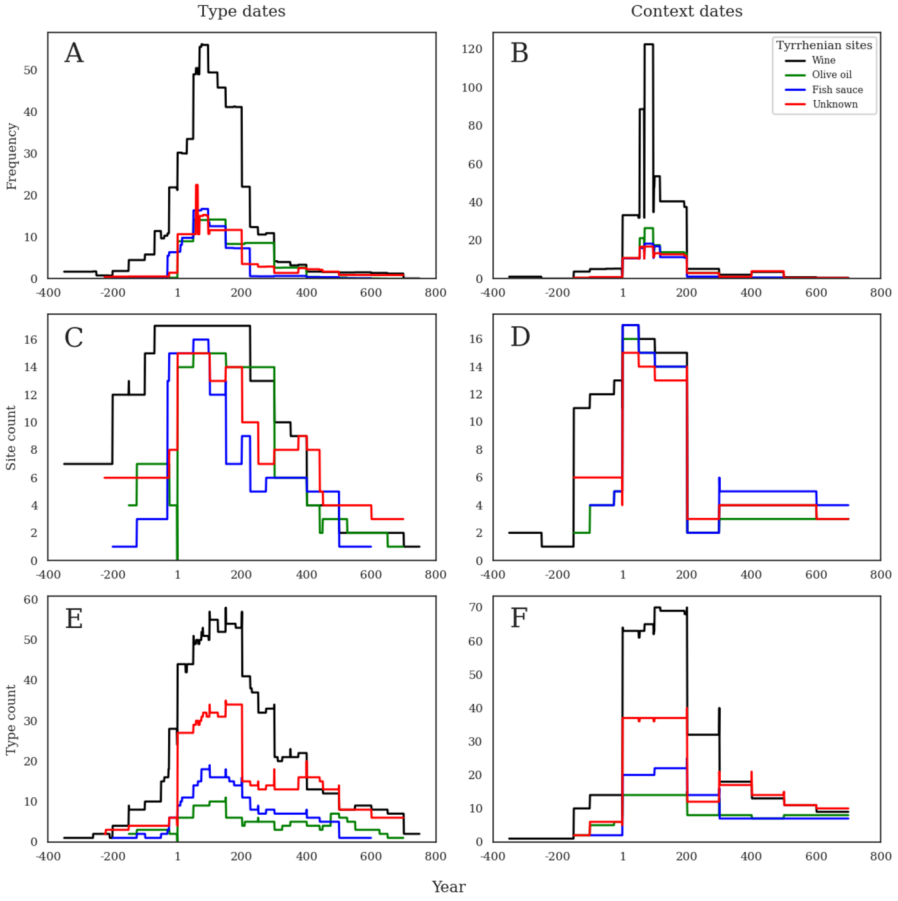

Fig. 15 Patterns of typical prime use content for all Tyrrhenian sites. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

shows (Fig. 15C, D) that wine, olive oil, fish sauces and other goods were equally widely distributed in the western part of Italy. However, wine, as elsewhere, was imported in the highest volumes (Fig. 15A, B) and diversity (Fig. 15E, F; although the typical contents of many types are unknown), though diversity in imported wine types may only be observed during the period of the consumption boom.

Consumption patterns in Adriatic Italy differ in interesting ways, because the frequency of wine and olive oil containers is almost equal but much lower in amplitude compared to the Tyrrhenian sites (compare Figs. 15B and 16B), while fish sauce and other products are attested in very small numbers. Another interesting difference is the much lower diversity of wine amphora types at Adriatic sites as compared to Tyrrhenian sites (compare Fig. 15F with 16F). Site count (Fig. 16C, D) shows that numbers of sites which imported amphorae were only slightly lower during Late Antiquity than during the Principate, which suggests that even though the general

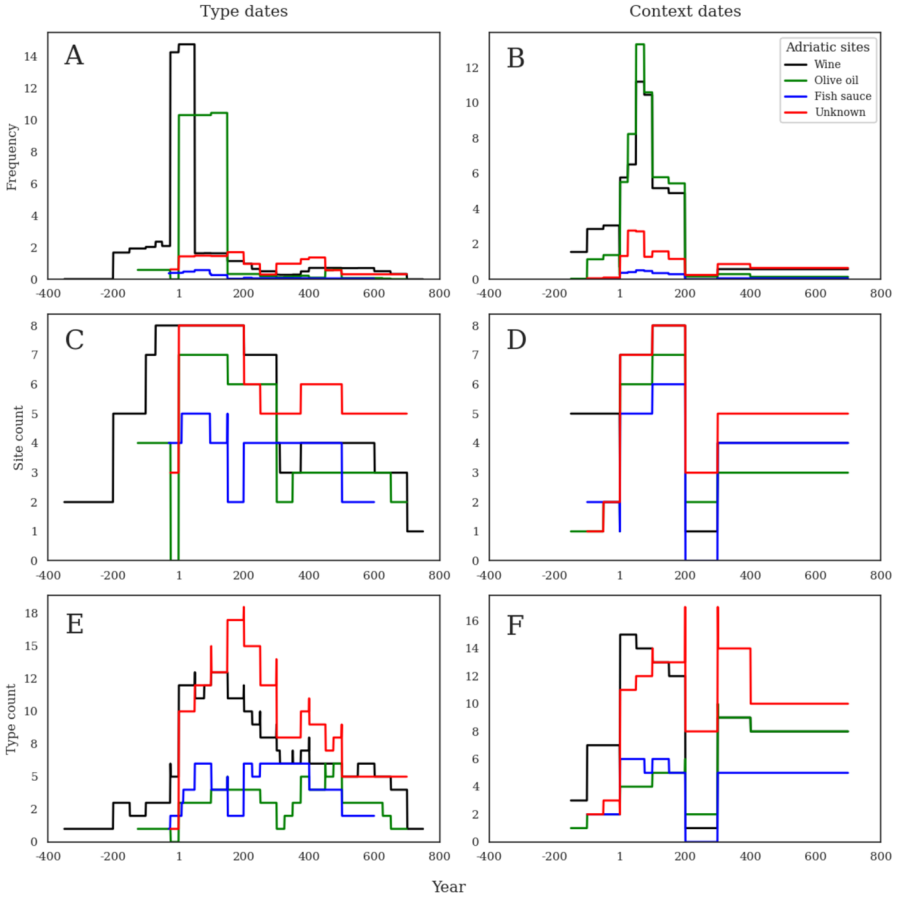

Fig. 16 Patterns of typical prime use content for all Adriatic sites. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

volume of imports decreased starting from the 3rd c. CE (Fig. 16A, B), imported products had a broader range than in the Tyrrhenian part. The highest diversity of goods was registered during the early Imperial period, and regarded mostly wine, and those of unknown content (Fig. 16E, F). The high number of types with unknown prime use contents in late antiquity reveals the need for more research dedicated to identifying these contents.

Numbers of imported products, their scale and diversity did not differ much between the western and eastern parts of Italy, though it seems that the Crisis of the Third Century had a different impact on these two areas. In the Tyrrhenian part numbers, the range and diversity of imports decreased significantly due to the effect of the peak of wine amphorae in the first to second centuries CE, while in the Adriatic, this wine peak did not exist and so the drop in the third century is less pronounced.

Foodstuffs in Cities vs. Foodstuffs in Villages

Figures 17, 18 and 19 demonstrate that there were no considerable differences in the consumption patterns between urban, rural and harbour sites in Italy—all imported the highest quantities of wine, especially, between 1 and 200 CE, but wine was also much more popular during the late Republic. Olive oil held the second position in urban sites and harbours, while fish sauce amphorae were more common in rural sites (Figs. 17A, B; 18A, B; 19A, B). All amphora types, regardless of the foodstuff they carried, had an equally wide distribution, but wine containers had a wider distribution in the late republican period in urban contexts (Figs. 17C, D; 18C, D; 19C, D). Wine amphora types were the most diverse in urban and harbour sites from the late Republican and early Imperial period, and they were also slightly more diverse on rural sites in this period (although the prime use content of a high number of types is unknown). The diversity of fish sauces and olive oil containers was comparable (Figs. 17E, F; 18E, F; 19E, F).

These patterns show that no considerable differences can be observed in consumption trends of different foodstuffs on rural, urban and harbour sites. All consumed high volumes of wines, olive oil and fish sauces, but obviously on harbour and especially rural sites, both their volume and diversity were smaller. This difference is caused by much lower numbers of rural sites with lower ceramic frequencies in the database (see Fig. 4). Also, it seems that cities and harbours imported more olive oil than fish sauces, while villages needed more fish products than olive oil. Although the quantities and differences are small, this is an interesting minor pattern. The explanation of this phenomenon may be quite simple—most rural sites were situated inland, where local production of fish products is limited due to lack of sea fish and often salt. At the same time, olive trees can be easily cultivated and they grow even better in hilly inland territories than at the coast.

Italian Supply in Different Foodstuffs

We have already analysed production and consumption patterns from the perspective of the product provenance and destination. Now, it is time to concentrate on each type of imported foodstuff separately in order to analyse in detail how the supply of Italy in wine, olive oil and fish products was organised and which were the main supplying regions.

Wine Suppliers to Italy

There were four main areas that supplied Italy with imported wine, namely, Africa, Gaul, Spain (provinces Baetica and Tarraconensis) and the Aegean region (mostly islands belonging to the province of Asia, as well as Crete). However, from the 4th and 3rd c. BCE until the Augustan age, almost all wines consumed in Italy came from the Apennine Peninsula, from its Tyrrhenian and Adriatic part, with an overwhelming preponderance of the latter at the turn of the eras (Fig. 20A). They were transported

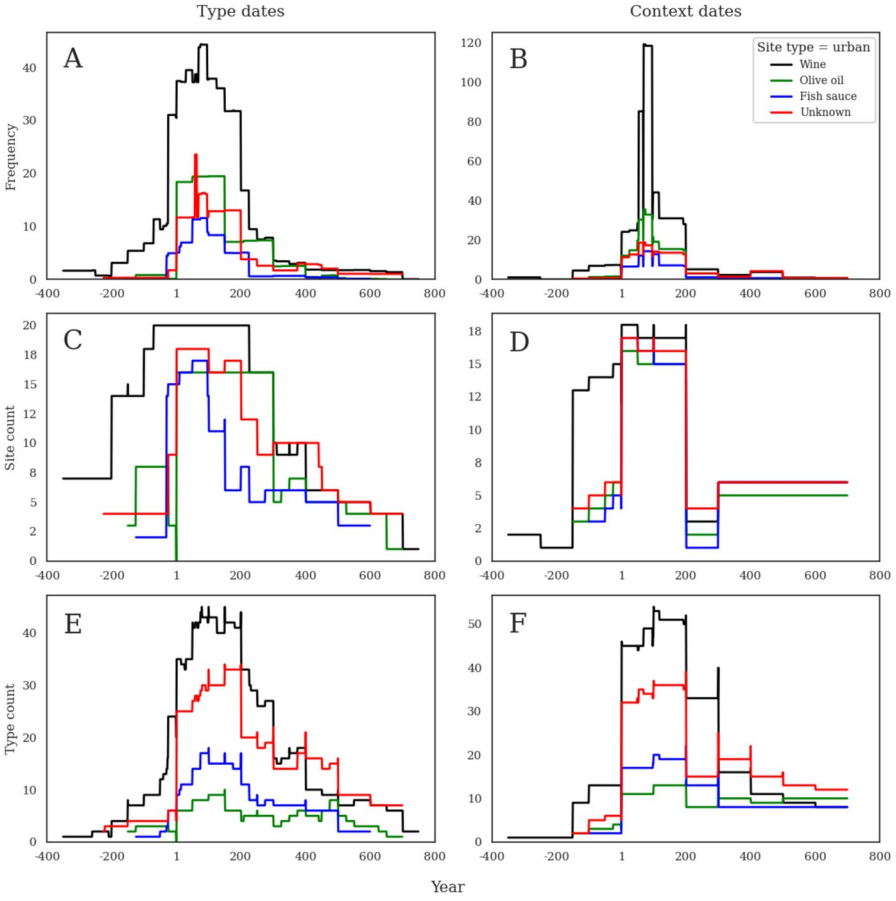

Fig. 17 Patterns of typical prime use content for all urban type sites. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

in Greco-Italic amphorae, produced mostly in southern Italy and Sicily, but also elsewhere in the Apennine Peninsula (Lyding Will, 1982; Vandermersch, 1994) as well as probably in Lamboglia 2 containers starting from the 2nd c. BCE (Formenti *et al*., 1978). Aegean wines were the earliest provincial imports, and they reached Italy already in the 2nd c. BCE. There are, however, single finds of Rhodian stamps, which suggest an even earlier appearance of Greek wines in Italy, which means the late 3rd c. BCE. Nevertheless, even based on stamps, one may conclude that larger-scale and more diversified imports started during the 2nd c. BCE (Taylor, 1957: 134; Lusuardi Siena, 1977: 233–234; Bevilacqua, 1994, 463; Tchernia, 1986: 103; Pascual Berlanga *et al*., 2008: 509–513), which corresponds with the results of this study.

Aegean wines were followed by Tarraconesian in the 1st c. BCE, but wine from Spain was never imported in particularly high volume. During the Augustan age, Gallic imports appeared in Italy and they reached a peak in the late 1st c. CE, exceeding

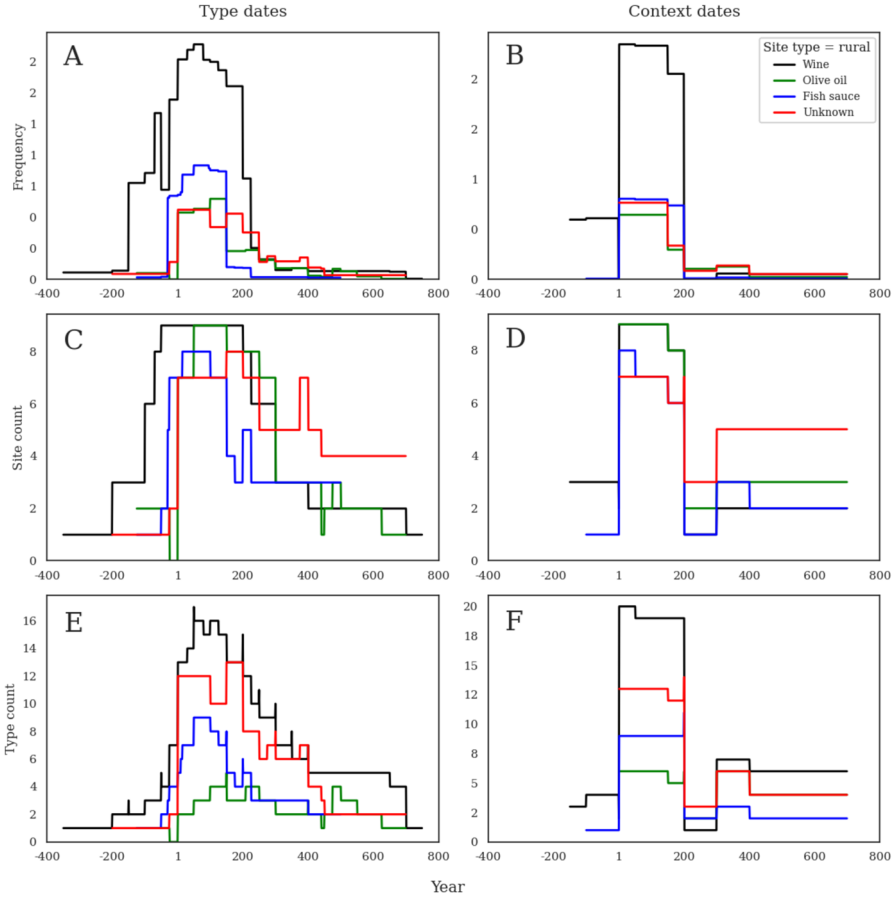

Fig. 18 Patterns of typical prime use content for all rural type sites. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

Tyrrhenian and Adriatic wines (at least using amphora production dates). Imports of African and Baetican wines started during the Augustan age and lasted until c. 400 and 200 CE respectively. All wine imports were the most numerous between 1 and 200 CE, and fell down to very modest levels after this date. Site dates point to particularly high levels of Tyrrhenian and Aegean amphorae during the late 1st c. CE, but this was probably due to the predominance of contexts dated to the Flavian period in the database upon which this study was based (Fig. 20B). All types of imports were distributed all over Italy, but Italian, Aegean and to a lesser degree Gallic wines were discovered on the highest number of sites, other imports being considerably less common (Fig. 20C, D). Aegean and Gallic imports had also the highest diversity (Fig. 20E, F).

The obvious conclusion is that Italy was rather self-sufficient in terms of wine supply until the Augustan age, as both its Tyrrhenian and Adriatic parts produced enough to satisfy most of the consumption demand. The only provincial imports that

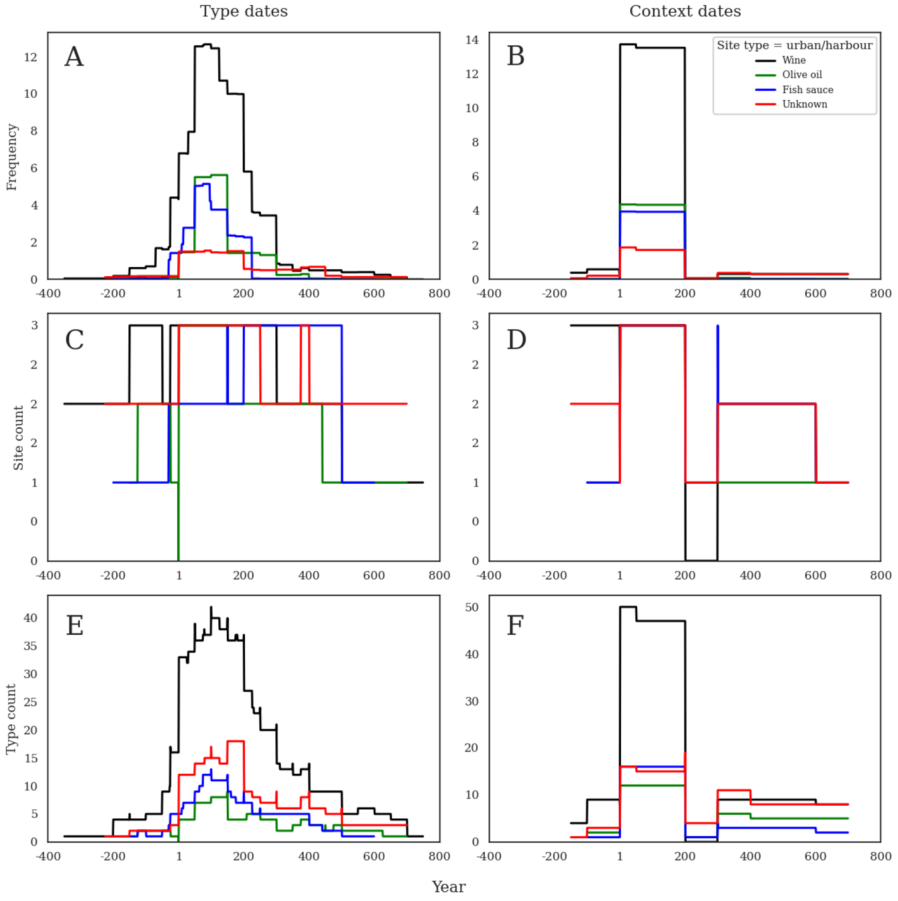

Fig. 19 Patterns of typical prime use content for all urban/harbour type sites. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

counted during the late Republic were Aegean vintages, often highly praised in literary sources from this period, which indicates that they were top-quality products during the Republic. Large quantities of Gallic, Spanish and African wines were necessary in Italy during the first two hundred years of the Principate, but it seems that also during this period, the Aegean region was the most important provincial wine supplier considering the volume of imports, their distribution and varieties. These varieties, however, were no longer among eastern luxury products (Komar, 2020: 76–127). Gaul held the second post in imperial wine supply, but Gallic wines were clearly less numerous and less widely distributed. Moreover, after 200 CE, only provincial imports from the Eastern Mediterranean and Africa were seen on the Italian market, but it should be emphasised that they arrived in much smaller quantities. Surprisingly, Oriental wines have a wider distribution in Italy during Late

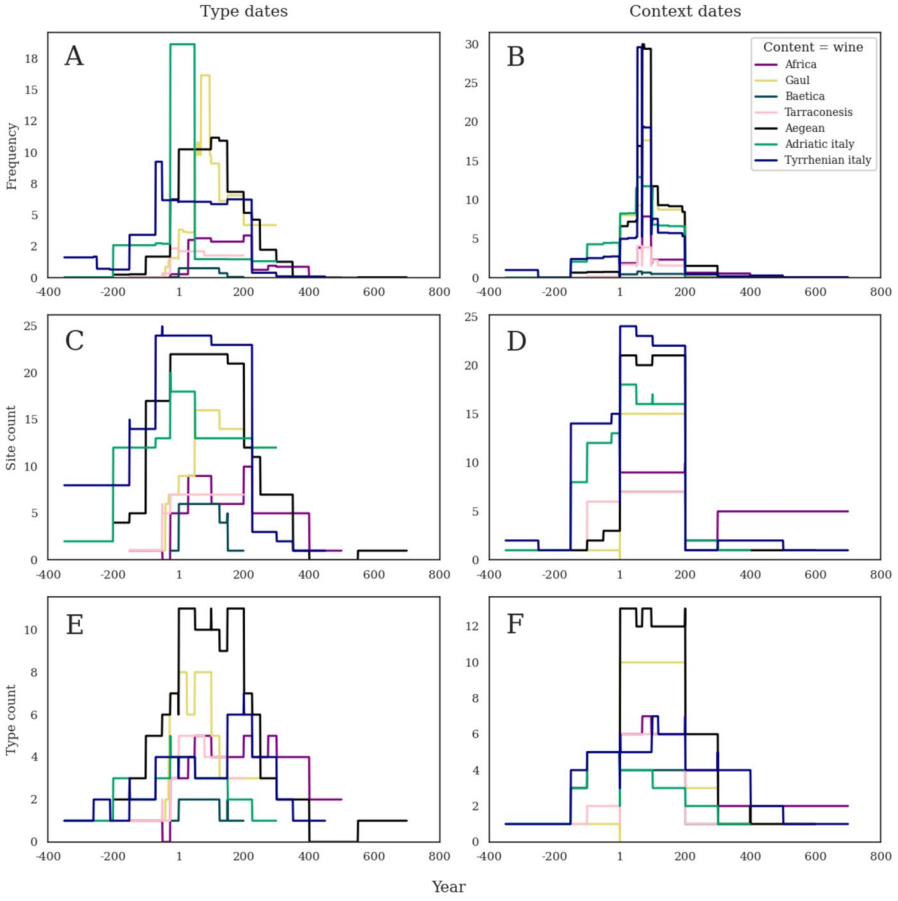

Fig. 20 Patterns of provenance for all amphorae with wine as their typical prime use content. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

Antiquity and their diversity is higher than before the 3rd c. CE. Also, they appear to have been more popular than the Aegean and African wines during this period.

It is clear that wine trade had the biggest share in Italian supply and that wine was not only the earliest, but also the most important import (Fig. 5A, B). Therefore, we should not overestimate the role of the trade in Baetican olive oil, which, although seems massive from the perspective of Monte Testaccio, was actually less economically important than wine.

Olive Oil Suppliers to Italy

Adriatic Italy was the most important olive oil supplier during the Republican and early Imperial period, but since the 1st c. CE, high numbers of Baetican and African olive oil containers appeared on the Apennine Peninsula (Fig. 21A, B). Olive

oil amphorae from the Aegean region and the Tyrrhenian part of Italy were minor in volume, distribution and diversity. Adriatic olive oil containers were the most widely distributed during the Republican age, while Baetica overtook this position during the early Imperial age and Africa started to dominate during the late Empire (Fig. 21C, D). Considering diversity, African containers held first place throughout the whole of antiquity.

These results clearly demonstrate that the Italian olive oil suppliers were considerably less numerous than the suppliers of wine. Only two provinces, Baetica and Africa, provided the Apennine Peninsula with significant quantities of olive oil, the former being more widely distributed, but the latter probably providing the highest variety of oil types. These imports must have been particularly important for the Tyrrhenian part of Italy, which produced considerable surpluses of wine, but almost none of olive oil. At the same time, cultivation of olives and oil production were vigorous in the Adriatic part, and during the Republican age, this region satisfied most of the need for imported olive oil on the Apennine Peninsula. Maybe this explains the scarcity of Dressel 20 amphorae observed in the Adriatic part of Italy.[3] As elsewhere, we see that most provincial imports were consumed during the first 200 years of the Empire and that their consumption was the most intense until 200 CE.

The lack of diversification of olive oil suppliers, *i.e.* the predominance of only two provinces, seems to agree with Mattingly's observations regarding the elite involvement in the olive oil production (1988b) and a regular and controlled supervision of olive oil supply to Rome and the army (Mattingly, 1988a: 53). However, the lack of considerable differences in olive oil consumption patterns between rural and urban sites suggests that either Italian supply in general was similarly regular and controlled (as in the case of Rome) or that there was nothing special in olive oil imports to the *Urbs*. A careful analysis of the origin of imported amphorae in rural contexts could help solve this dilemma. Mattingly also noted that Betican olive oil export benefitted from the Roman demand of metals (mined in Spain), while African olive oil simply accompanied grain supply. This is probably why we observe the increase in African imports in the Imperial period; this is when Egyptian grain was not able to satisfy the growing population of Italy. At the same time, the diversity of olive oil amphorae, which, as revealed by this study, grows starting from the 3rd c. AD, correlates with the appearance of Tunisian amphorae on the market.

Fish Products Suppliers to Italy

Figure 22 demonstrates that Baetica was the main Italian supplier of imported fish products. These imports started in the Augustan age; they were the most numerous between 1 and 200 CE and attested in a high number of contexts (Fig. 22A, B, C, D). The second post was held by Lusitania—the range of amphorae from this area was particularly high during late Antiquity. Other areas that also produced salted fish and fish sauces, which means Gaul, Africa and Hispania Tarraconensis, could not compete with Baetica, as both the volume and distribution range of imports from

[3] Ex Baetica amphorae II, conference proceedings in preparation.

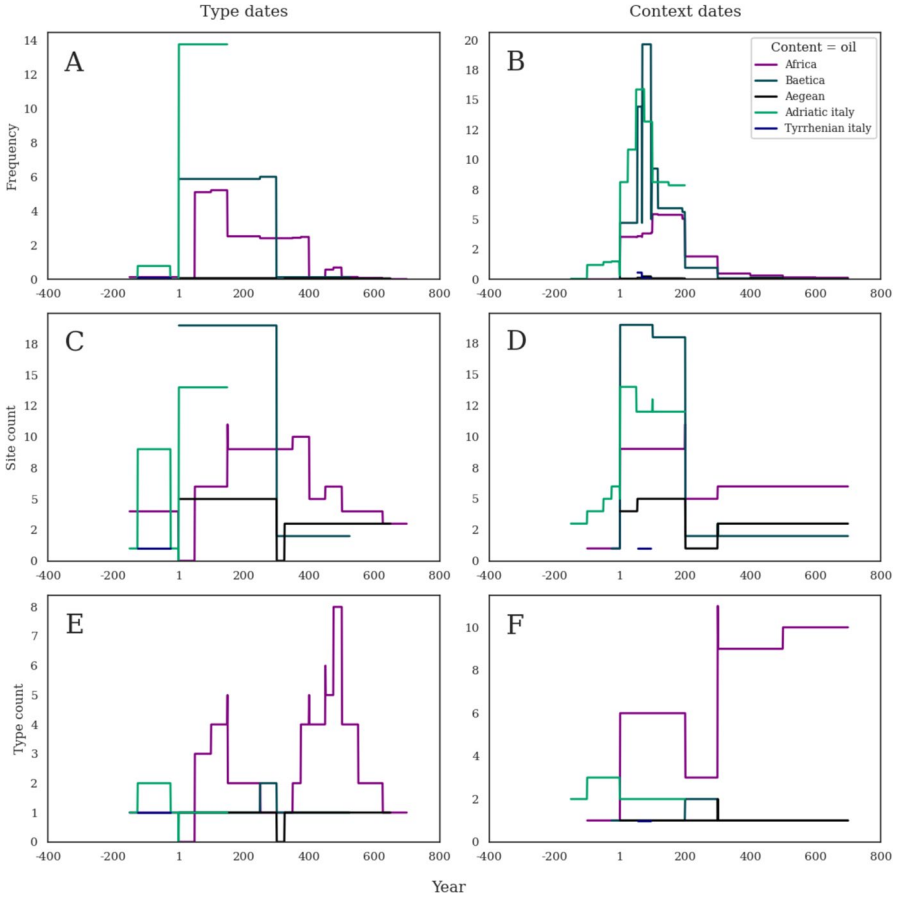

Fig. 21 Patterns of provenance for all amphorae with oil as their typical prime use content. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

these areas were considerably smaller, c. 10% of Baetican results. Africa produced a significant number of fish amphorae, which were more numerous than Baetican during the late Imperial age. Tyrrhenian and Adriatic fish amphorae are in the minority.

It seems that Italy, both Tyrrhenian and Adriatic, produced very little salted fish and fish sauces and had to rely mostly on provincial imports. The products from Baetica were the most important, especially during the early Imperial age, which indicates that this region was the most indispensable among Italy's suppliers, providing the highest volumes of both olive oil and fish sauces, at least until the 3rd c. CE. During Late Antiquity, African products became much more significant, but in terms of fish sauce provisions, African imports gave way to Lusitanian in frequency and diversity. Other areas, such as Gaul and Hispania Tarraconensis, provided Italy with some amounts of fish products, but they were neither numerous nor popular, as only attested occasionally in small quantities.

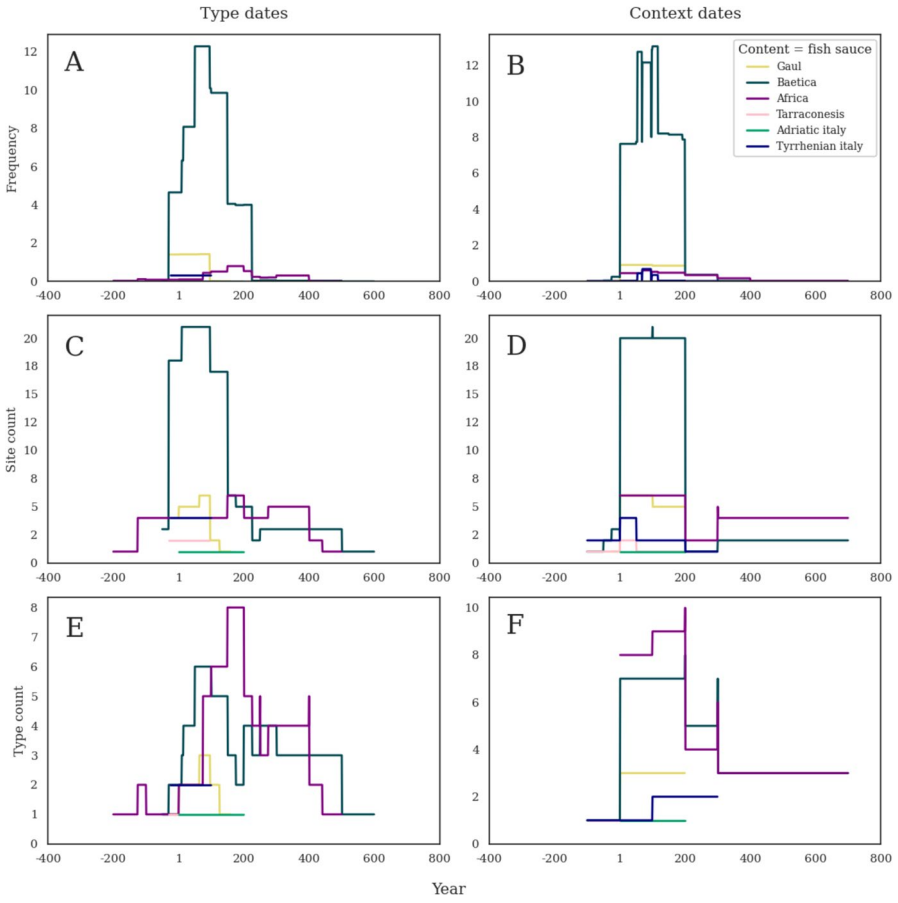

Fig. 22 Patterns of provenance for all amphorae with fish sauce as their typical prime use content. Sherd frequency (A, B), site count (C, D) and type count (E, F) results, using both type dates (A, C, E) and context dates (B, D, F)

Conclusions

This paper investigates many different aspects of amphora assemblages discovered in 66 sites across Italy, including 28.851 diagnostic fragments dated roughly between 400 BCE and 700 CE. This scale of amphora analysis for Italy has never been attempted before, but a similar study regarding transport containers discovered in Germania has been undertaken (Franconi *et al.*, 2023), so the results can easily be compared. Previous synthetic works were limited to one or a few sites at most (*e.g.* Terme del Nuotatore in Ostia, see Panella & Rizzo, 2014; or several contexts in Rome, see Rizzo, 2003 or Rizzo and Moreno Megías, 2019), and they adopted traditional approaches of quantitative visualisations, presenting numbers of fragments (all, RBH, NMI or EVE *etc.*) and occasionally their weight, and using only site dates. Therefore, analyses of long-lasting trends in amphora commerce and

consumption based on a large database and presented according to different visualisation methods were missing. The methods we have used here not only demonstrate new ways of quantifying and classifying ceramic assemblages at a broad, synthetic scale, but also are transparent and can be reproduced for assemblages from other areas of the Roman Empire or beyond in the future. Thanks to these methods, we were able to identify known patterns and reveal completely novel chronological patterns of the trade and consumption of amphora-borne foodstuffs in Italy.

First of all, it has been suggested by a number of archaeological sources (see above) that the Roman Empire experienced extensive and maybe also intensive growth during the end of the Republic and the beginning of the Principate and that this growth might have had a sustainable character, although there are still many doubts regarding this matter. This study provides further evidence suggesting that the growth existed, and that it can be observed all over Italy, regardless of geographic location and the function of the site. The variations observed between the Tyrrhenian and Adriatic parts as well as between urban and rural zones regarded only the scale of consumption increase and product diversity. Considering that the observed consumption boom existed not only in the capital, but also in inland rural parts of the Apennine Peninsula, it seems reasonable to conclude that it might have had a per capita character, which brought a general improvement of life standards for all the inhabitants. During the late Republican and early Imperial period, the ubiquity of goods, reflected in the number of sites they were attested at, and the diversity of products, seen by both the highest number of amphora types and their almost pan-Mediterranean provenance, were the highest. Such patterning suggests a considerable market integration during this period, as also argued in other studies that analysed different categories of evidence, namely grain prices and eastern sigillata (Brughmans & Poblome, 2016; Temin, 2001, 2013; contra see Tchernia, 2016: 72-96 and Bransbourg, 2012). The fall in amphora curves after 200 CE seen not only by the frequency, but also by site and type count, was equally dramatic all over Italy and touched both urban, harbour and rural areas, which suggests sudden external shocks as a cause of the decline and, at the same time, the sustainable character of the growth.

Moreover, this study showed that Rome was not exceptional in terms of consumption trends and commercial supply networks, as results observed for Rome resembled the general pattern as well as the trends noted for different parts of Italy separately. What happened in Rome was probably soon, or immediately followed all over Italy, which suggests that the inhabitants of the capital might have set trends for most of the parts of the Apennine Peninsula, or that Roman supply was simply in line with general consumption trends. Therefore, if the consumption boom is to be interpreted as a sign of economic growth, it seems that Italy in general (not only Rome) experienced this growth that lasted from c. 200 BCE and had a peak in the 1st and 2nd c. CE and was followed by a 3rd c. decrease.

The general lack of differences in consumption patterns between cities and villages (except for the volume of imports) again suggests the same pace of development of these areas. Moreover, this implies that rural sites were not outcasts isolated from the general economic growth of the Empire. Since fish products were important elements of the Roman diet, even inhabitants of inland villages could import

them, regardless of how far from the seaside they lived. This points to a general similarity in the diet of the wealthy and the diet of the poor (demonstrated also on a smaller scale by other studies) and may also indirectly suggest the existence of the *per capita* growth. However, to confirm these conclusions, further studies are necessary. It is essential to enlarge the dataset for rural areas and analyse more regional patterns in pottery provenances.

All parts of Italy imported considerable amounts of each type of amphora-borne foodstuff, which again indicates that the development and consumption and the supposed economic growth had a similar pace all over the Apennine Peninsula, and cannot only be associated with conspicuous consumption of the Roman elites. Therefore, it is possible to suspect that the growth had other causes than only a conquest of new territories and predatory actions, as suggested by Scheidel (2009). Even if the conquest and exploitation of the provinces brought the first spur of economic development, then this must have been supported by other factors, such as the general productivity, which allowed small farmers in the centre of the Apennine Peninsula to enjoy imported foodstuffs (especially wine) as a daily and natural choice, not a luxury.

This study sheds new light not only on the economic development, consumer preferences and trading networks on the Apennine Peninsula, but also in the provinces. Italy was supplied with amphora-borne foodstuffs predominantly from the coastal provinces, such as Africa, Hispania Baetica, Tarraconensis, Gaul, Sicily, Achaia, Asia, Cilicia and Palestine. However, the supply was not equal throughout, as different areas blossomed and withered in different conditions and chronological periods and they also specialised in different types of supply. Regarding provincial imports, Aegean wines came first and remained the most common in Italy during the Republican and early Imperial age. Gaul and Hispania Tarraconensis were other, but less important imperial wine suppliers. All these imports, however, disappeared after the Crisis of the Third century leaving the market for African and Oriental wines. Baetica was the main Italian olive oil and fish sauce supplier, but its position was important only during the first 200 years of the principate. During this period, fish sauces came to Italy also from Lusitania, Gaul and Hispania Tarraconensis, but in much smaller volumes and diversity. However, during Late Antiquity, both olive oil and fish sauces were imported mostly from Africa, and in the case of the latter Lusitania, which became the main foodstuff supplier in this period. Wine was definitely an important element of the diet and high volumes needed to be imported constantly between 400 BCE and 600/700 CE, with the highest levels of wine consumption obviously attested for the early Empire. The large-scale imports of olive oil and fish sauces lasted considerably shorter than the imports of wine. All three categories of foodstuffs were equally traded to different parts of Italy regardless of geographic location and site function, the only exception being small differences in olive oil and fish products between the cities (higher needs for olive oil) and villages (higher needs for fish sauces). Summing up, the trade patterns presented in this study revealed elements of consumption preferences in Italy and production strategies in widely different parts of the Mediterranean, stretching from the Iberian Peninsula and through North Africa to the Levant.

Furthermore, this analysis provided evidence regarding the agricultural productivity and specialisation in different regions of Italy. This study has shown that the Tyrrhenian part of Italy started to produce surpluses earlier, already during the middle Republican period, but during the 2nd c. BCE, the Adriatic part joined the Italian amphora production and export. Nevertheless, since the Tyrrhenian part specialised predominantly in wines (famous Campanian vintages), the Adriatic was equally active in both the production of wine and olive oil. There is little amphora evidence regarding the large-scale production of fish sauces for export on the Apennine Peninsula. The Central Tyrrhenian coast and North Adriatic Italy (the Po Valley in particular) were the main (if not the only) pan-Italian producers of export surpluses during the Republican and early Imperial period, but in the 2nd c., the Tiber Valley blossomed as wine supplier to the capital. During Late Antiquity, south Italy (and Sicily) became the only supplier of amphora-borne foodstuffs, probably mostly wine, from the Apennine Peninsula.

Summing up, this study confirmed and revealed not only commercial and consumption trends in Italian supply, but also their dynamism in both time and scale, as well as their duration. This comprehensive view allows us to understand the tastes and preferences among Italian consumers as well as long-distance trade connections between Italy and other regions of the Roman Empire. It is worth emphasising that the patterns of Mediterranean integration and disintegration have not so far been quantitatively empirically explored on Empire-wide levels, but only limited to narrow case studies.[4] This study is, thus, the first one to offer such a broad perspective and is the first based on such a large database for Central Italy. Actually, each pattern or trend revealed by this study could be an object of a detailed analysis, which considers other categories of evidence that are beyond the scope of this paper. Overall, this paper not only provides methodological guidance for future synthetic approaches to pottery analyses, but can also be seen as an incentive for further studies of different economic trends observed based on amphora quantifications.

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Author Contribution Paulina Komar and Tom Brughmans wrote the main manuscript text and Ekaterina Borisova prepared Figs. 1–21. All authors reviewed the manuscript.

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Data Availability The dataset used is openly available as part of our Github repository: https://github.com/Tom-Brughmans/Sonata.

Declarations

Competing Interests The authors declare no competing interests.

[4] There were, however, case studies regarding Spain, see Reynolds 2010, and Mediterranean harbours, see Rice 2011.

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