Abstract

The aim of this study is to detect the patterns of olive oil production that link amphora workshops and amphoric stamps. Roman provinces such as Baetica became important production and distribution centers during the Roman Empire. However, it remains under debate how this province was organized and whether it is possible to identify patterns in the olive oil market.

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Our case of study has been focused on the production processes located in Baetica province (currently Andalusia) from 1st to 3rd AD. In particular, we want to explore economic dynamics that include the production and distribution of olive oil trade. Amphoric stamps are used to identify the presence of different producer groups that might share similar stamps. To achieve this goal, we analyse a set of stamps from different workshops in Baetica province in order to detect a relation between the distribution of amphoric stamps and the economic structure in this province. Here we use methods borrowed from Ecology that allow us to identify if amphora workshops share similar amphoric stamps depending on the spatial distance.

The analysis explores how quantitative approach provides a useful tool for the interpretation of the economic processes. Finally, results pretend to highlight the organization of Baetican olive oil production in the Roman Empire linked to the differences observed in the archaeological evidence.

1. Introduction

Material culture allows us to understand a part of mechanism of production... (aquí creo que me repito como siempre)

The economy of Roman Empire have been an object of study in the last centuries. (cambiar)

This paper aims to highlight the production dynamics in relation to a specific area within Roman Empire. We want to detect the pattern of olive oil production that link amphora workshops and amphoric stamps. We focus here on exploring the economic relation between stamps and amphora production centres.

Roman provinces such as Baetica became important production and distribution centers during the Roman Empire. However, it remains under debate how this province was organized and whether it is possible to identify patterns in the olive oil market.

All the amphora stamps belong to Dressel 20 types (Dressel, 1878; Martin-Kilcher, 1987). Dressel 20 is commonly associated with transportation of Baetican olive oil through the provinces during the Roman Empire (Berni, 2008). Most Dressel 20 were marked in stamps and *tituli picti* and inked in graffities with different information but there is not a general consensus about the meaning of them (Remesal, 1998). Stamps are the most studied in this type of amphorae. There is evidence that stamps were used for almost three centuries. (economía oleica betica). Frequently, stamps were marked mainly in handles but rarely in rims and body.

The information of the stamps is shown in different forms and letter content and it seems that there was not a unique criteria (CITAR). Stamps was mostly formed for a code of three letters. There letters can appear in a abbreviated form or complete and they are known as *Tria Nomina* (Berni, 1996).

The meaning of the amphora stamps is still under debate. Some authors suggest that they were identified as the land-owners of the olive groves (Remesal, 1977). Other authors propose that stamp could be the owners of the making-amphorae workshop (CITAR) or even a production counting system (Berni, 2008). In any case, the use of these stamps defined somehow the system of working in the workshops.

Here, therefore, this study aim to explore the effect of Baetican olive oil production in the Roman Empire of production organization over Baetican olive oil production.

2. Material and Methods

2.1. Case study

Our case study examines the relation between the distribution of amphoric stamps and the workshops. We studied a dataset of 3787 stamps collected from different amphora workshops in Baetica provice (see CEIPAC database). The workshops were situated in different locations in Baetica province, along the river Guadalquivir and its tributary Genil in order to detect similarities between stamps from workshops and spatial distance.

However, the 70 % of stamps cannot be tested due to fragmentation or incomplete information. Consequently, we discard integrate the fragmented stamps in our dataset. We finally filter a total sample of 987 stamps composed by 131 different stamps from 81 workshops.

The chronology in the workshops is widely diverse from the first to the third centuries AD . However, some stamps show a more specific chronology while the majority of them display a large activity of production being difficult to specify an accurate chronology. A reason may be that most of them were partially excavated and only focused on archaeological surveys to collect the maximum stamps as possible (CITAR)

2.2. Quantifying the diversity Dissimilarity correlation

The approach proposed here is based on the idea of measuring the similarity between amphora workshops by quantifying similar stamps. A measure of dissimilarity has been chosen to analyse the dataset. We use the statistical technique Morisita-Horn index. The formula can be described as follows

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This method was performed to measure the overlap between different samples of sets (Morisita, 1959; Horn, 1966). In Ecology, it describes the dissimilarity between the system of two communities.

Considering our dataset as non-uniform sample, this method provides a useful tool to handle large samples with different sizes and diversity (Wolda, 1981).

Morisita-Horn index can be expressed considering 0 as total presence of similarity of stamps and 1 a totally dissimilarity between stamps. In our case, it will be calculated the number of times that one stamp appear in a amphora workshop. This method allows to bear in mind the similar number of times for each repeated stamp per workshop.

3. Results

The analysis shows that amphoric stamps could not be correlated with spatial distance.

The correlation coefficients range from a minimum to a maximum. The dendrogram shown in Fig. 2 1 was obtained with Morisita-Horn index. This dendrogram suggests that amphora workshops used different stamps for their prodution system. Accordingly only few closer workshops show a similarity on the stamps while most of them seem to display different stamps roles.

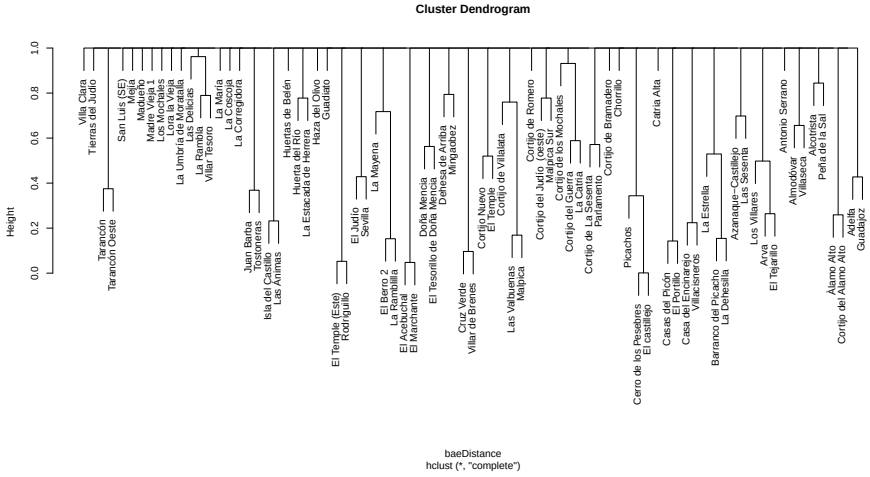

Figure 1: Dendrogram obtained by Morisita-Horn algorithm of different amphora workshops in Baetica area

4. Discussion and Conclusion

No strong relation between stamps and spatial distance have been detected in amphora workshops. Indeed, the analysis suggests that there is not connection between stamps and the same amphora workshops, excluding certain exceptions. Consequently the majority of stamps are located in different amphora workshops and only few similar stamps between closer amphora workshops were found.

The hypothesis about groups of amphora workshops sharing the same stamps seems not match with the results of analysis even though there are shareable stamps in closer workshops. Probably same stamps detected in closer amphora workshop could have being wrongly catalogued twice in different way in spite of belonging to the same place or being closer between each other.

By contrast, we have located different stamps in a same amphora workshop. Neither it seems that stamps were used to specify the quality or value of the product (Callender, 1965). Rather our results could be interpreted due to several reason according to previous hypotheses. On the one hand, the use of these amphoric stamps could be exclusively running by the owner or family to distinguish the amphora workshop (CITAR).

(aumentar) Considering that Dressel 20 type was not marked in several cases (CITAR) it can be interpreted somehow a batch systematic organization to prepare and distribute the commodity (CITAR)

it could be somehow a batch systematic organization to prepare and distribute the commodity, considering that Dressel 20 was not marked in several cases. This method was used of counting BLA BAL

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As summary, this method presented here highlights

5. Acknowledgements

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6. References

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