Building a Regional Chronology from Diverse Digital Data: an example from Jamaica

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1. Introduction

As the scale of digital-data sharing increases in the discipline, archaeologists will increasingly find themselves faced with the need to build fine-grained chronologies for assemblages from different sites excavated by different investigators using different methods. Here we describe an approach to this problem which has proven useful in recent research into the social dynamics of slavery in Jamaica during the 18th and early 19th centuries.

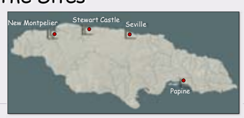
Our approach combines three key ingredients:

• We employ two complementary statistical methods – correspondence analysis (CA) and mean ceramic dating (MCD)– to seriate assemblages. Comparing the results from the two methods allows us to evaluate the results ***objectively.***

• We use this same set of methods to determine if the data for each of our study sites will support an intrasite chronology and to place the intrasite phases into a single island-wide chronology.

• For sites sampled using shovel-test-pit survey, we use empirical-Bayes methods to mitigate the effects of small samples and extract an intrasite chronological signal from spatial variation.

2. The Sites



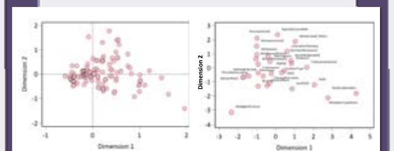
This study uses archaeological data from four Jamaica sugar estates collected by three research teams since the 1970's and digitized by the DAACS project since 2006. All data are available at **http://www.daacs.org.**

Estate	P.I.	Method	Dates
New Montpelier	Barry Higman	Area excavation, stratigraphic test pits	1973-1980
Seville	Doug Armstrong	Area excavation	1987-1993
Stewart Castle	DAACS	STP survey	2007
Papine	DAACS	STP survey	2008-2010

3. Seville: House 16

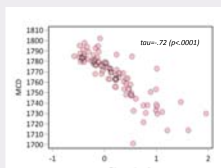
House 16 is part of a much larger slave village associated with the Seville sugar estate. Two superimposed floors suggest a lengthy occupation. This is confirmed in our CA and MCD analysis.

Our intrasite chronology starts with a CA of historical ceramic ware-type frequencies in stratigraphically excavated contexts with 5 or more sherds.



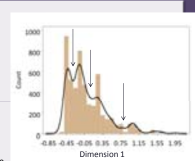
While the proportion of inertia accounted for by the first and second CA dimensions is modest (.12 and .11 respectively), the plot of ceramic ware types on the two axes suggests that the first axis successfully captures time, with later types on the left of the graph.

We can test the truth of this claim by plotting the CA dimension-1 scores for the assemblages against their mean ceramic dates.



A strong linear relationship between CA scores and MCDs confirms that the latter capture time. We can therefore use the CA to aggregate assemblages into larger counting units.

Phase Boundaries

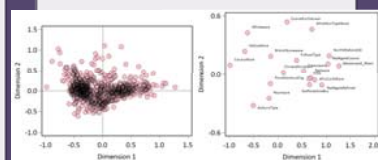


To help decide where to put the phase boundaries, we use a *weighted histogram* of dimension-1 scores, where the weights are the total sherd counts in each assemblage. The histogram bar heights measure the number of sherds in the assemblages whose CA scores fall in a given histogram bin. Histogram troughs measure fall off in deposition or periods of rapid change in the location of deposition among the contexts or proveniences recognized by the excavators. Cutting the continuum of CA scores at the histogram troughs as highlighted by a kernel density estimate yields four temporal phases.

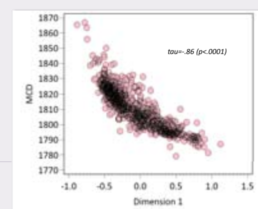
4. Papine Slave Village

Between 2008 and 2010, DAACS and the University of West Indies at Mona (UWI) have run a collaborative STP survey of the slave village site associated with the Papine sugar estate, located on what is today the UWI campus. Over 1000 STPs on 6-meter centers have been dug. This dataset presents novel analytical challenges. Assemblages from individual STPs are tiny, ensuring that MCDs and CA scores will reflect a small amount of sampling error.

We circumvent this problem by using empirical-Bayes techniques to smooth counts of ceramic ware types in each STP, based on prior probability distributions whose parameters were estimated from counts in STPs within 12 meters. The gamma-Poisson model was used to smooth ware type counts initially. A beta-binomial model provided final estimates of type proportions.

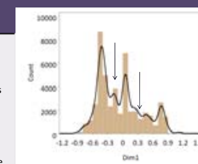


The first two CA dimensions capture .35 and .14 of the inertia in the ceramic frequencies. This improvement over the Seville, House 16, case is due to the Bayesian smoothing. A preliminary indication that dimension 1 captures time is given by the fact that early ceramic ware types have negative dimension 1 scores, while later ones have positive scores.



A strong, slightly nonlinear relationship between CA scores and MCDs confirms that the latter capture time. We can therefore use the CA to aggregate assemblages into larger counting units.

Phase Boundaries

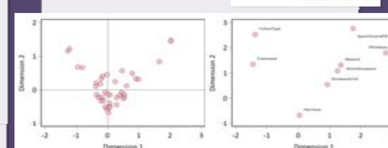


The weighted histogram of dimension-1 scores reveals three modes. Again, the troughs between them become the phase boundaries. The resulting three phases represent periods of stability in village location, while the troughs represent shifts in location.

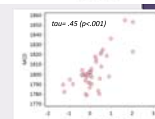
By plotting the phase assignments for the STPs in space, we can see how the village location changed over time, moving from the west to the east side of an aqueduct that runs across the site.

5. New Montpelier: House 37

House 37, a slave house at New Montpelier, excavated by Barry Higman in the 1970's demonstrates that our methods can detect cases in which the CA and MCD are less well correlated, implying that intrasite phases should be viewed more skeptically



In this case, the plot of ceramic types on CA dimension 1 hints at a temporal trend from creamware to pearlware to whiteware, from left to right. However, the plot of CA scores against MCDs suggest the relationship is more noisy than in the previous cases, perhaps too noisy to justify phasing the assemblages.



6. Putting it Together

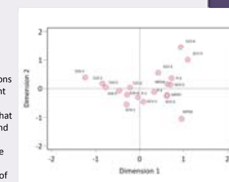
We used the foregoing methods to create the following analytical units:

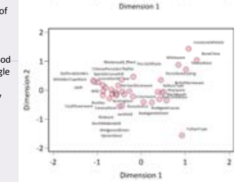
Estate	Unit	Phase	Abbreviation
New Montpelier	House 37		MP37
New Montpelier	House 24		MP24
New Montpelier	House 26		MP26
Stewart Castle	Great House	Phase I	SCH-1
Stewart Castle	Great House	Phase 2	SCH-2
Stewart Castle	Slave Village	Phase 1	SCV-1
Stewart Castle	Slave Village	Phase 2	SCV-2
Stewart Castle	Slave Village	Phase 3	SCV-3
Seville	House 15	Phase 1	S15-1
Seville	House 15	Phase 2	S15-2
Seville	House 15	Phase 3	S15-3
Seville	House 15	Phase 4	S15-4
Seville	House 16	Phase 1	S16-1
Seville	House 16	Phase 2	S16-2
Seville	House 16	Phase 3	S16-3
Seville	House 16	Phase 4	S16-4
Papine	Slave Village	Phase 1	P-1
Papine	Slave Village	Phase 2	P-2
Papine	Slave Village	Phase 3	P-3

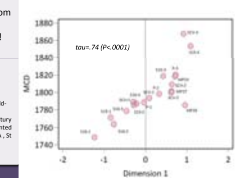
7. Results

The first two CA dimensions capture 45 and 15 percent of the variation in the dataset. Ceramic types that are known to be early tend to have negative dimension-1 scores, while those that are late have positive scores. The plot of dimension-1 scores and MCDs reveals a strong linear relationship, suggesting that the method has yielded a reliable single chronological framework that can be used to study changes in the use and deposition of material culture over time and space.

For a case study using locally-made coarse earthenware ceramics from Jamaica, see Galle *et al.* 2010. It's right next door!







References

Galle, Jillian, Leslie Cooper, Fraser Neiman, and Ivor Conolley 2010 "Identifying change in household-and specialist-produced coarse earthenwares from 18th and 19th-century Jamaican slave villages." Poster presented at the 75th Annual Meeting of the SAA , St Louis. MO.