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Toward a Morphometric Phylogeny of Caddo Ceramics: A Test of 3D Geometric Morphometrics

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INTRODUCTION

Before profitable discussions of cultural transmission in Caddo communities can be undertaken using ceramic vessel form, there is need to explore whether there are substantive, and measurable, amounts of variation that exist within Caddo ceramic vessels. We began our exploratory study of morphometrics with NAGPRA vessels from the Washington Square Mound site (41NA49) in Nacogdoches County, Texas (Selden 2013). That analysis served as the basis for the study reported here, which developed during a subsequent NAGPRA documentation effort at the Gregg County (Texas) Historical Museum (GCMH) (Perttula et al. 2013). The collection from the Vanderpool site represents a small fraction of the total number of vessels documented during the course of that work, in which we became clear that some vessels of vessel form appeared more regularly within and across assemblages than did others.

Analyses of stone tools and debitage using 3D geometric morphometrics have received considerable recent attention in the archaeological literature (Bintle and Conard 2012; Clarkson 2013; Lee et al. 2016; Stock and Cramon-Taubadel 2013; Lycett et al. 2012). Similarly, 3D scanning technology as an archaeological tool to study ceramics has been outlined by Karak and Smilansky (2012) who have employed it as a means to better document (Groshen et al. 2008; Sibold et al. 2004; Karak and Smilansky 2012, and illustrate how Docker software can be used for geometric morphometric analysis, not to our knowledge it has not been used to study vessel form. In the following sections we outline the methods, application, and implications of applying geometric morphometrics to understanding differences in form among the Vanderpool vessels.

METHODS

Data collection took place at the GCMH, where three-dimensional scans of the Vanderpool vessels were generated using a handheld 3D laser scanner and 3D scanning software. Post-processing of the 3D images—generating point clouds, meshes, landmarks, and 2D screen captures for each vessel in Geomagic’s Verity (3D inspection software) and Geomagic Design X (3D reverse-engineering software)—required the greatest investment of time and was conducted at the Center for Regional Heritage Research (CRHR) at Stephen F. Austin State University. The data were saved in a variety of formats and are publicly available in CRHR-ARCHEOLOGY—the CRHR’s digital repository (CRHR 2014).

Vessel form is determined by measuring redundant landmark coordinates. Using the “reference point” function in Geomagic Design X, data were generated from 41 landmarks: one in the center of the base (CB), eight around the periphery of the base of the jar (UB), eight within the area of the base body (BB), eight from the upper body (UBB), eight from the bottom of the carination or neck (CN), and eight from the rim (RI). In the event that a vessel did not have a carination or neck, the CB point was placed equidistant between the UB and RI points.

Using the categories of vessels from the Vanderpool site, we employed a custom program to generate a variety of vessel forms and subsequently in the study. The categories of vessels from the Vanderpool site were assigned to one of two categories: jar (n = 5), bottle (n = 3), carinated bowl (n = 12), bowl (n = 6), and compound vessel (n = 1). Since there is only one compound vessel, it was not used in the morphological analyses presented here.

RESULTS

Although sample size from the Vanderpool site is small, the results demonstrate that a detailed analysis of ceramic vessel form is a useful tool in archaeological application.

Bottles

The PCA analysis for Caddo bowls demonstrates that the first three PCs account for 71.51%, 15.35%, and 7.49% of variation, respectively, or 94.36% of the total variation. The first two principal components indicate that morphological variation in the Vanderpool ceramic bowls is red (FIN-S16), whereas white pigment is associated with globular carinated bowls (FIN-S20).

The PCA analysis for Caddo jars from the site demonstrates that the first three PCs account for 60.15%, 16.53%, and 11.69% of variation, respectively—98.37% of the total variation. The first two principal components indicate that the majority of shape fluctuation in jars occurs across the entire range of vessel morphology and is not limited to a single landmark or point location.

The PCA analysis for Caddo bottles demonstrates that the first three PCs account for 93.33% and 20.67% of variation in the small sample. The first two principal components indicate that the majority of shape variation occurs in the body of the vessel, but a secondary area of variation occurs in the neck of these bottles.

The PCA analysis for Caddo carinated bowls indicates that the first three PCs account for 61.99%, 14.89%, and 6.72% of variation, respectively, which accounts for 83.54% of the total variation. Although there is some degree of variation in vessel form, the first two principal components indicate that the majority of shape variation in carinated bowls occurs in the body of the vessels.

SUMMARY

The 3D morphometric analyses found considerable diversity in vessel form across the assemblage. In some cases, the morphometric groups were found to correlate with burnish (jars, bottles, and bowls), with the exception of the carinated bowls—both angular and globular—that appear across burials 5-5. In this sample, pigment associated with angular carinated bowls is red (FIN-S16), whereas white pigment is associated with globular carinated bowls (FIN-S20).

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