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

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**Methods**

Data collection took place at the GCHM, where three-dimensional scans of the Vanderpool vessels were generated using a handheld 3D scanner (3D Systems) and a Zscan software. Post-processing of the 3D images—generating point clouds, meshes, textures, and 3D scans for capture in each vessel in GeoMagic 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:ARCHAEOLOGY—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 at the juncture of the inner body (IB), eight within the area of the inner body (IB), eight from the upper body (UB), 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 IB and IB points. Using the categories of vessel form that archaeologists working in the Caddo region have used (Selden and Jelks 1996), the vessels were assigned to one of five categories: (1) jar (n = 5), (2) bottle (n = 3), (3) carinated bowl (n = 12), (4) bowl (n = 6), and (5) compound vessel (n = 1). Since there is only one compound vessel, it was not used in the morphological analysis. Point data generated from each vessel were exported from GeoMagic Design X, opened and saved in Microsoft Excel, and organized by folk categories in Excel prior to import in version 2.5 of Morphologika. Geometrically independent landmarks for each folk category of vessels were independently subjected to a generalized Procrustes analysis (GPA), then principal components analysis (PCA), with the methods, application, and implications of applying geometric morphometrics to understanding differences in form among the Vanderpool vessels.

**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 archeological application.

**Bowls**

The PCA analysis for Caddo bowls demonstrates that the first three PCs account for 71.51%, 15.56%, and 7.49% of variation, respectively. This indicates that morphological variation in the Vanderpool ceramic bowls is not limited to a specific area of the vessel.

**Jars**

The PCA analysis for Caddo jars from the site demonstrates that the first three PCs account for 69.15%, 16.53%, and 11.69% of variation, respectively, which accounts for 83.54% of the total variation. Although there is some degree of variation in the vessels, the results show that the majority of shape variation in carinated bowls occurs in the body of the vessels.

**Discussion and Conclusion**

Temporal and spatial considerations concerning ancestral Caddo sites, communities, and artifact assemblages are categorized in large part on the basis of a taxonomy focused on ceramic decorative elements and motifs, but distinctive vessel attributes also play a role in taxonomic assignments (Selden and Jelks 1996). Whereas stone tool taxonomies—initially defined in Suhm et al. (1954)—continue to evolve (see Turner et al. 2015)—no consensus update to Jelks and Selden (1972) ceramic taxonomy has been developed in the Caddo area. The modest efforts described here are meant to be a step in that direction.

Although the results of our analysis could be applied to a variety of theoretical models, it is within evolutionary archaeology that we see the greatest potential. Several recent 3D morphometric studies of stone artifacts (partially evolutionary theory in studies of morphological variability (Bretzke and Conard 2012), technological origins (Jung et al. 2010), and variability (Jung and vanCommen-Taubaldi 2013), the transmission of technological knowledge (Shohat et al. 2012), and phylogeny (Jung 2009). Given recent syntheses and analysis of chronometric data in the Caddo region (Selden 2012, Selden and Perttula 2013), and the temporal resolution gained through recent innovative studies of decorative elements and motifs (early 1220; Garant 2013), we believe that a single-scale study of vessels lends itself to the degree of analysis required. This study would incentivize both quantitative data from morphometric analysis and qualitative data from decorative elements and motifs to produce significant analytical and theoretical progress regarding cultural transmission processes that occurred within and across the ancestral Caddo region.

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