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Geometric Morphometrics of Gary Dart Points from the Davy Crockett National Forest

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This analysis represents ancillary findings from a larger research project that remains focused upon better understanding the morphological variability associated with specific components for suites of diagnostic artifacts recovered from the National Forests and Grasslands in Texas (NFGT). While the methodological approach employed in this study is novel in several ways, it should be noted at the outset that geometric morphometrics (GM) is not new to archeology, and has been used in material culture studies since the mid-1980s. The recent resurgence in GM applications to archeological problems is largely a result of the Procrustes paradigm, as well as numerous theoretical and methodological advancements in paleontology and the biological sciences.

The initial challenge in this particular analysis was to devise a method in which three-dimensional (3D) and two-dimensional (2D) data could be used in the same analysis. The study required that the landmark and semilandmark configurations remain consistent across the entirety of the sample. An algorithm was created to translate the 2D specimens through a suite of pre-processing protocols that rendered a scaled and aligned model atop a planar surface within 3D space. The constellation of landmarks and semilandmarks relies upon reference geometry calculated in Geomagic Design X (Dx), where the landmarks associated with basal geometry are defined by three tangents (two vertical, one horizontal), with 3D equidistant semilandmarks between below. Once populated, these data were exported and subjected to a generalized Procrustes analysis (GPA) (top center). Procrustes superimposition translates, scales, and rotates the coordinate data to allow for comparisons among objects. Principal components analysis (PCA) was used as an exploratory means of visualizing shape variation among the specimens (bottom center).

A Procrustes ANOVA was run to assess whether a significant difference exists between the type specimens and the sample from the Davy Crockett National Forest (DCNF). A residual randomization permutation procedure (RRPP; n=1000 permutations) was used for all Procrustes ANOVAs, which has higher statistical power and a greater ability to identity patterns in the data should they be present. Results indicate that there is a significant difference in basal morphology between the type specimens and those recovered from the DCNF (RRPP = 1000, Rsq = 0.19551, Pr(F) = 0.0002). This was followed by a Procrustes ANOVA with pairwise comparison to identify which of the type volumes differ significantly from the DCNF sample. Results indicate that the DCNF sample differs significantly from those specimens included in the Suhm, Krieger and Jelks (1954) (effect size = 0.500964, P-value = 0.0001), Turner and Hester (1999) (effect size = 3.434843, P-value = 0.0005), and Turner, Hester, and McReynolds (2011) (effect size = 3.000086, P-value = 0.0007) volumes.

While some of the basal shapes vary significantly by site on the DCNF, recent finds are being added to this study, and will be reported at a later date. Significant allometry was found in that sample, and may aid in the refinement of resharpening trajectories that can be further explored using phenotypic trajectory analysis. Future directions include the addition of Gary samples from sites where the type was in use prior to the publication of the Suhm, Krieger, and Jelks (1954) volume. The high degree of variation in Gary morphology has been noteworthy for some time; however, it has been difficult to characterize these findings, while preliminary, highlight the utility of the GM approach to the analysis of the Gary type, where this robust and rigorous analytical toolkit is aimed at our taxonomic definitions and the construction of a morphological epistemology rather than an analysis of cultural implications.

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