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A study of Late Woodland projectile point typology in New York using elliptical Fourier outline analysis

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ABSTRACT

A sample of Late Woodland triangle points from the Mohawk Valley, New York, is studied using 2D elliptical Fourier analysis (EFA) in order to assess the applicability of formal tool typologies for the region. Lithic analysts have questioned two types of triangle, Levanna and Madison, as valid analytic units as they are quantifiably indeterminate when measured using caliper methods such as length and width. The geometric morphometric analysis here takes outline data from a previously studied collection of projectile points and uses elliptical Fourier harmonics analysis combined with principal components and discriminant functions tests to objectively define and separate the two types of projectile point. The result is a bimodal distribution of types that conforms to the traditional typological classification system for the region, in contrast to recent scholarship that conflates the two types into one. This study describes a high-resolution technique that offsets the inherent drawbacks of subjective, coarse-grained measurement approaches to projectile point characterization and comments on the study of typology as a whole.

1. Introduction

For decades, Northeast North American archeologists have sought to supplement qualitative typological definitions of projectile point form with quantitative analysis of unidimensional metric attributes such as length, width, and thickness. These definitions are the foundation of pan-regional formal tool typologies (Cambron and Hulse, 1969; Converse, 1973; Deller and Ellis, 1984; Ellis, 1981; Fitting, 1963; Fogelman, 1988; Goodyear, 1974; Holland, 1970; Justice, 2009; Kenyon, 1980; Kenyon, 1981; Lewis and Kneberg, 1946; MacDonald, 1968; Ritchie, 1971). This "caliper-based" method is useful but does not always adequately clarify variability in projectile point assemblages. The Late Woodland Period triangle point in particular has defied efforts to identify temporal variation on the basis of metric analysis.

Traditional typological approaches to Late Woodland triangle points have discriminated between the early Late Woodland Owasco Levanna point and the classical Iroquoian Madison point (Fig. 1) (Justice, 2009; Ritchie, 1971). In the Mohawk Valley, the Levanna point is the proto-Iroquois point form, that which reaches and becomes commonplace in New York around 900 AD, though it is found elsewhere in earlier assemblages as well. Generally, this type is larger, thicker, and more equilateral than the later Madison point, which is associated with later Iroquois groups including the Mohawk and the Onondaga. Ritchie describes the Madison point as being "the distinctive Iroquoian form" (Ritchie, 1971). Both are described as arrow points.

However, caliper metrics are not able to distinguish between the two subtypes. Analysts are increasingly grouping all triangular points and abandoning Madison and Levanna as truly distinct subtypes, noting the wide and overlapping range of shape metrics that triangle points can take (Bradley, 1987; Engelbrecht, 2014; Snow, 1995; Tuck, 1971). For example, Snow describes the points from the Nahrwold #1 site as being, "of the typical Owasco-Iroquois triangular form" and does not invoke traditional nomenclature, citing lack of certainty over triangular shape changes over time (Snow, 1995).

The shift in perspective away from typological distinctions is a result, in part, of the lack of fit between the metric attribute analysis and expectations based on typological classification. This lack of fit between attribute analysis and typological classification might actually reflect the inadequacy of conventional caliper-based metrics.

The present study turns to the field of geometric morphometrics as an alternate means of quantitatively examining variability within triangular point assemblages. The outline-based geometric morphometric technique of elliptical Fourier analysis is used here to quantify and analyze 293 triangle points from the Late Woodland Period. When overall shape, as opposed to isolated (non size-adjusted) linear metrics or ratios of two metrics, is integrated throughout the analysis, a bimodal distribution of point shapes corresponding to the typological categories is revealed. The results are consistent with traditional typological frameworks that separate these groups, albeit exhibiting a greater range of intra-type variability than has been previously recognized and which may have been confounding research. The present study approaches

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Fig. 1. A–E: Madison points from the Elwood site. F-I: Levanna points from the Nahrwold #1 Site.

the typological problem of separating Late Woodland triangle points based on form using multiple dimensions of shape carried through the analytic process with the intent of serving as a more holistic, quantitative approach to analyzing variability in formal tools.

2. Previous investigation

This study is a re-examination of Robert Kuhn's (1996) analysis of Mohawk Valley projectile point assemblages (Kuhn, 1996). Kuhn's original study presented and interpreted the results of a descriptive statistical analysis on 441 points from Owasco and Mohawk sites, comparing the measurements to nearby Owasco and Onondaga sites' projectile point assemblage measurements for the same time period — AD 1000–1700. Kuhn's original purpose for analyzing projectile point metrics was to assess whether Mohawk Valley Iroquoian triangle points fit a previously suggested model of linear change through time established for the nearby Onondaga Iroquois triangle points (Bradley, 1987; Kuhn, 1996; Tuck, 1971). The interpretive purpose of this model was to create a high-resolution relative dating technique based on projectile points in aggregate, a "temporal order for Mohawk sites [that] can be used to cross-date the Mohawk and Onondaga site chronologies."(Kuhn, 1996). Kuhn measured length, width, and thickness of all points to the nearest half millimeter and recorded base and side shape (Kuhn, 2013). For the maximum length, width, thickness, and the ratio of length to width, he calculated the mean, range, standard deviation, and coefficient of variation on all Mohawk sites. Of the investigated metrics, only the length/width ratios exhibited a temporal trend described as, "generally increasing over the course of Mohawk prehistory and then decreasing during the historic period." (Kuhn, 1996).

In this technological narrative, the change from equilateral to isosceles happens gradually, over hundreds of years. At one end of this spectrum is an equilateral triangle point found earlier and generally indicative of the Owasco time period. The narrower, isosceles, Iroquoian triangle point is found at the other end. Points morph from one to the next with plenty of variability manifested by individual specimens within large assemblages. There is the assumption that this pattern is unaffected by the Owasco/Iroquoian cultural transition in the Mohawk Valley. This clinal model is in contrast to the binary model that traditional typologies describe.

3. Methodological background and relevancy

Geometric morphometrics are a relatively recent development in the study of form that typically includes computationally-intensive measurements able to analyze multiple dimensions of an object at once (Bookstein, 1997a; Bookstein, 1997b; Kendall, 1977; Kendall, 1989; Lele and Richtsmeier, 2001; MacLeod, 1999; Neal and Russ, 2012; Rohlf and Marcus, 1993). The key difference between traditional morphometric approaches and their geometric counterparts is that the latter approach preserves the geometry of an object and carries this through all levels of analysis (Adams et al., 2004). The term is meant to associate itself with the study of shape which Slice (2005) defines as, "the geometric properties of an object that are invariant to location, scale, and orientation". This approach includes a wide variety of techniques meant to include and describe geometric structures and the relationships between these structures; landmark and outline methods are the two kinds of geometric morphometrics available today. To compare with traditional metrics, listing a series of distances between two points on an object, such as length, width, thickness