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Environment, space, and morphological variation of projectile points in Patagonia (Southern South America)

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ABSTRACT

The aim of this work is to assess shape variation in Patagonian stemmed projectile points related to spatial and environmental factors by means of geometric morphometric and multivariate methods. The sample includes 1445 projectile points from Fuego-Patagonia (Southern South America) assigned to Late Holocene (ca. 3600 BP). Besides the authors' own research and the revision of published literature, most of the projectile points come from a broad survey program of museum collections. Previous research showed a trend of shape change related to latitudinal axis in continental Patagonia, but no digital sample was available at that time from some areas, especially Isla Grande de Tierra del Fuego, in southernmost Patagonia. With the purpose of extending our analysis to overall Patagonia (continental and insular) and taking advantage of the new digital dataset available, we focus on the correlation between spatial and environmental variables (precipitation and temperature) and morphological change. The new results obtained show a pattern of high morphological variation in lithic projectile points across Patagonia. In particular, we note that there is not a clear global trend for the distribution of shapes along the study area in relation to environment at the large scale considered in the present study. However, smaller scale spatial patterns were detected which allow discussing the role of local variations in environment, resource availability, technological strategies, reduction intensity and/or mobility ranges in overall technological behavior.

1. Regional background

Fuego-Patagonia -or simply Patagonia -is the southern tip of South America located between latitude 39° and 52° South (Fig. 1). Its topography is characterized by the presence of Andean Cordillera in the west and plateau and low plains in the east. The Isla Grande de Tierra del Fuego is separated, to the north, from the mainland (named continental Patagonia) by the Strait of Magellan, and from the outer islands by the Beagle Channel, to the south (McCulloch et al., 1997).

The regional climate is conditioned by the westerlies coupled with precipitation induced by the high Andes flanks, which results in a strong west–east gradient with annual rainfalls of 4000–7000 mm on the western slopes in Chile at 50° South and less of 800 mm on the eastern side in Argentina due to rainshadow effect (McCulloch et al., 1997). Moreover, annual precipitations are less than 200 mm in the driest areas of Argentinean Patagonia (Haberzettl et al., 2005; Mayr et al., 2005). The winds reach Patagonia from the west laden with moisture picked up over the Pacific Ocean. As they reach the coast and rise over the mountains they deposit their moisture as rain or snow, thus being much drier as they continue eastwards (Moore, 1983:4).

Vegetation pattern is closely related to temperature -which decreases southward- and precipitation gradients: Magellanic moorland with dwarf shrubs occupies high rainfall areas mainly on the west Patagonian coast; forest develops where annual precipitations range 800–400 mm, and it gives way to the shrub-grassland of the Patagonian steppe where rainfalls is below 400 mm and evaporation is high due to persistent strong westerly winds (Pisano, 1977;

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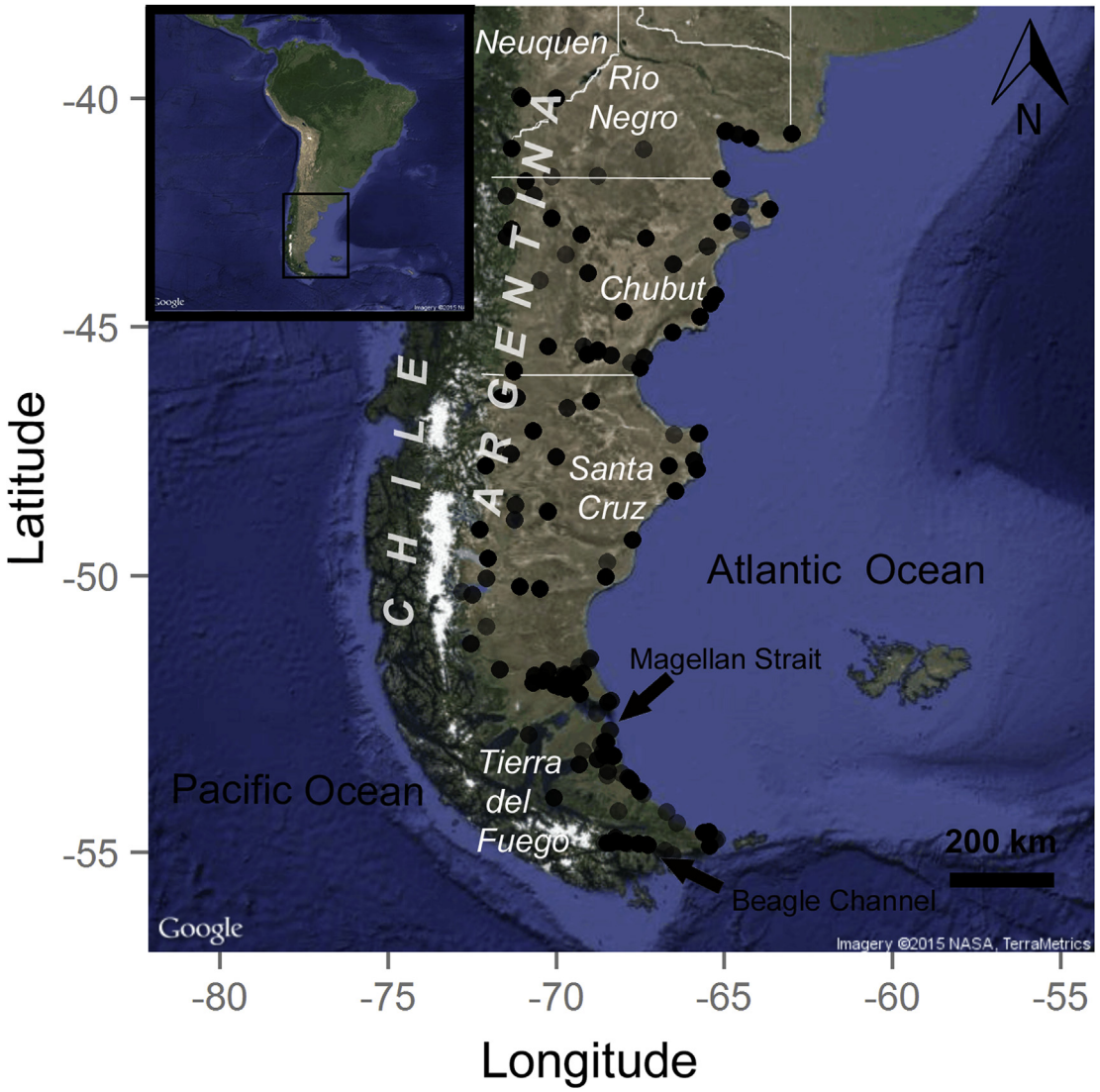

Fig. 1. Location of the study region (dark rectangle) and sample distribution (dots). Dot grayscale shows sample size (black dots exhibit larger samples).

Moore, 1983; McCulloch et al., 1997; León et al., 1998). Moreover, data on carrying capacity for domestic herbivores, which is closely related to vegetation pattern, provided a general qualitative scheme of environment productivity for archaeological research in southern continental Patagonia (Barberena, 2008).

The application of geometric morphometric based methods (see below for a definition) to the study of lithic projectile point in Patagonia have addressed several issues such as spatial and temporal patterns of change, tool modularity, artifact life history, and functional variations, among others (Franco et al., 2009; Charlin and González-José, 2012; González-José and Charlin, 2012; Charlin et al., 2013, 2014; De Azevedo et al., 2014; Cardillo and Alberti, 2015; Cardillo and Charlin, 2015). Here, we outline previous results obtained from the application of geometric morphometric and phylogenetic methods to a sample of stemmed projectile points from continental Patagonia between 40°–52°S (Cardillo and Charlin, 2015), since the present study derives several expectation based on these previous outcomes (see below).

The exploration of shape variation on this broad scale pointed out the existence of a spatial pattern of shape variation compatible with a model of isolation by distance, where consensus shapes of neighbor areas are more similar to each other than most distant ones. This trend showed that the morphological change is not an abrupt phenomenon related to a qualitative discontinuity but a gradual and relatively continuous one, explicable by the increase in the spatial distance among samples (Cardillo and Charlin, 2015).

Isolation by distance model was tested by phylogenetic tree reconstruction on consensus shape by latitudinal fringe (averaged shape that represents approximately six equidistant fringes in the regional space). Results obtained support the hypothesis that space is a primary vector of change, and it probably worked as a selective factor that prompted a divergence process in northern (40°–49°) and southern Patagonia (50°–52°) projectile points during the Middle–Late and Late Holocene (Cardillo and Charlin, 2015). This process is probably related with the Santa Cruz River (50°S) functioning as a biogeographic barrier, like the distribution of other lines of evidence had also suggested (Orquera, 1987; Borrero, 2001; Franco, 2002; Cardillo, 2011; Charlin and Borrero, 2012). Similar processes have been proposed in relation to continental and insular southern Patagonia. The formation of the Magellan Strait and the

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