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Moving into an arid landscape: Lithic technologies of the Pleistocene–Holocene transition in the high-altitude basins of Imilac and Punta Negra, Atacama Desert

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ABSTRACT

In this work, we use taphonomic and technological analyses as a basis for study of the spatial and temporal variability of six lithic assemblages from the Pleistocene-Holocene transition (12,600–11,000 cal BP), recovered in the Imilac and Punta Negra basins (3000 m. a.s.l.), Atacama Desert (24.5°S). During the initial peopling of this area, the lithic sub-system was based on local raw material procurement and highly interconnected, complementary operative chains. This non-centralized structure resulted in even distribution of technical investment in the different stages of the reduction process, achieving great flexibility and responsiveness. We propose that this strategy allowed high mobility to co-exist with a generalized subsistence economy. Finally, we discuss the results and how they relate at the regional scale.

1. Introduction

1.1. The peopling of South America and lithic technology

The chronology and routes involved in the peopling of South America are still under discussion (Anderson and Gillam, 2000; Rothenhammer and Dillehay, 2009; Magnin et al., 2012; Miotti and Magnin, 2012; Bueno et al., 2013; Borrero, 2015a; Madsen, 2015). However, consensus exists that at the end of the Pleistocene and beginning of the Holocene, groups of hunter-gatherers scattered across the continent had already colonized the diversity of environments available (Borrero, 1999, 2006, 2015b; Dillehay, 1999, 2000, 2004; Politis, 1999, 2015; Aceituno et al., 2013), with varying degrees of success (Rivero, 2012).

In this process, human groups equipped with a broad spectrum of technological strategies ranked the advantages of ecological patches (Ardila, 1991; Dillehay, 1991; Politis, 1991; Kaulicke and Dillehay, 1999; Borrero, 2015b). The use of all these technologies was not uniform. Some were active over a long period and were shared across extensive regions, but at the same time new technologies appeared locally, replacing or even complementing their predecessors ("co-technologies"), while others remained hidden, only to reappear in specific contexts as "sleeping technologies" (Borrero, 2011). Far from being a single, standardized repertory, the technology of the human groups which colonized South America covered a wide range of decisions and options, forming a great geographical mosaic of technical traditions (Dillehay, 2013; Borrero, 2016).

It is quite possible that this variability resulted from different cultural units and migratory pulses (Dillehay, 1999, 2009; Madsen, 2015). From the point of view of colonization, the technological systems evolved as part of a process of learning and familiarization with the landscape. The human groups which dispersed to unknown landscapes developed new knowledge and shared different types of information (Borrero, 1994–95; Meltzer, 2002; Rockman, 2003, 2009; Ford, 2011). During the colonization of South America, their networks of interaction might reach different levels of integration, from the construction of stable niches and relations, as occurred on the Peruvian coast where greater social complexity developed (Dillehay, 2013), to small, mobile, relatively autonomous

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groups in Patagonia and the Andean highlands (Aschero, 1994).

The density and frequency of social interactions had direct repercussions on the learning and transmission of technical knowledge. When they were unstable or absent, learning by trial and error was a key factor in encouraging innovation, introducing greater technological variations (Hoguin and Restifo, 2012). Borrero for example says that "(…) *process based on learning by trial-and-error is known as guided variation* (…) *The possibility always existed that some sleeping technologies constituted Trojan horses, and maladaptation can be the result. Trial and-error is an expensive but necessary tactic, since it is difficult to be conservative when you are exploring new lands*" (Borrero, 2011:220).

Although regional models are lacking, lithic technology during this period presents characteristics which distance it from North American models (Kelly and Todd, 1988). These may be discussed under the following headings:

(1) In general, it is assumed that raw material procurement strategies focused on locally available rocks (<40 km), with a small contribution from distant sources (Nami, 1994; Borrero and Franco, 1997). However, the local/extra-local ratio can fluctuate considerably in some sites (Hajduk et al., 2012), with the balance reversed. Certainly, the management of lithic resources in each location resulted from decisions taken on the basis of various factors simultaneously. Several papers have emphasized the influence of long-distance interaction networks (Yacobaccio et al., 2005; Messineo, 2012; Flegenheimer et al., 2003), site functionality and activity planning (Flegenheimer and Mazzia, 2013; Skarburn et al., 2015; Suárez, 2015), availability of raw materials (Hajduk et al., 2010, 2012; Skarbun, 2011; Méndez and Jackson, 2012), knowledge of the landscape (Franco, 2002a, b; Paunero, 2009; Skaburn, 2012), differential transport and the use of space (Méndez, 2010, 2015; Franco et al., 2015; Méndez and Jackson, 2015).

(2) It has also been suggested that the first groups manufactured and carried toolkits appropriate to a generalized, rather than a specialized subsistence economy (Bryan, 1991; Dillehay, 2000, 2009; Lavallée, 2000; Politis and Messineo, 2008; Politis et al., 2014; Martínez et al., 2016). In this context, it has been observed that multifunctional tools were produced which could be used simultaneously in a diversity of tasks such as processing animal, vegetable and mineral resources (Aceituno, 2001; Aceituno and Loaiza, 2015; Aceituno and Rojas-Mora, 2015; Mazzia et al., 2016).

(3) Another important aspect is the co-existence of a high diversity of projectile points designs. Without doubt, fishtail points are a characteristic element of this period; they are distributed throughout South America and part of Central America (Politis, 1991; Flegenheimer et al., 2003; Suárez, 2000, 2006; Suárez and López, 2003; Nami, 2009; Castiñeira et al., 2011, 2012; Hermo and Terranova, 2012). There is some discussion as to their technological relationship with the Clovis technological tradition, particularly the "fluting" technique (Morrow and Morrow, 1999; Pearson, 2002, 2004; Faught, 2006). However, differences in the reduction sequences suggest a different but linked origin (Politis, 1991; Dillehay et al., 1992; Nami, 1997, 2003, 2014b; Borrero, 2009).

There is also an important record from other contemporary designs. Here we may mention a broad diversity of stemmed-barbed projectile points such as "El Inga" in Ecuador (Nami, 2014a), "Rastrepo" (Ardila, 1991) and "Magdalena" (López, 1990; Cooke, 1998) in Colombia, "Tigre" in Uruguay (Suárez, 2010, 2015, 2011), "Paiján" (Pelegrin and Chauchat, 1993) on the coast of Peru, the so-called "Paiján-like" at the Monteverde site in the southern Chile (Dillehay et al., 2015), "Punta Negra" in the Atacama Desert (Grosjean et al., 2005) and "Las Cuevas" (Latorre et al., 2013) recovered at the Maní-12 site, among many others. In some cases, they have been found together with fishtail points (Chauchat et al., 1998; Cooke, 1998; Briceño, 1999; Nami, 2010, 2014b). We may also mention records of triangular (Aschero, 1984, 2010; Núñez et al., 2002; Hocsman et al., 2012) and lanceolate non-stemmed points (Dillehay and Collins, 1991; Dillehay, 2000; Gnecco and Aceituno, 2006).

(4) Perhaps one of the most discussed aspects has been the existence of an unifacial reduction technology (Bryan, 1973; Dillehay, 2000) reported in several early archaeological sites of South America (Politis and Messineo, 2008; Lourdeau, 2012; López and Cano-Echeverri, 2013; Stothert and Sánchez, 2011; Aceituno and Rojas-Mora, 2015). Although this term has been used with different connotations, the fact remains that in several early assemblages there is little or even no bifacial work (Sandweiss et al., 1998; Dillehay, 2000; Lavallée, 2000). Indeed, it has been claimed that bifacial traditions such as fishtail and Paiján, may be slightly later adaptations (Maggard and Dillehay, 2011; Maggard, 2015). Otherwise, some authors have remarked on the influence of differentiated transport and site functionality in the frequency of bifacial tools in the assemblages (Nami, 1993; Flegenheimer and Cattáneo, 2013; Aceituno and Rojas-Mora, 2015; Skarbun et al., 2015; Borrero, 2016).

In recent years, discussion on the chronology of the peopling of South America has given way to interest in understanding how colonization occurred in differing environmental scenarios (Borrero, 2015b, 2016). Thus, lithic technology has progressively been treated less as a chrono-cultural marker and more as a subject to be studied from a behavioural perspective. Despite the poor visibility of the early record (Sandweiss, 2015), there is increasing interest in micro-regional and regional scales, rather than study in isolated contexts. Today, lithic studies not only attempt to characterize technological strategies, but they contribute to discussion of cultural variability, peopling routes and adaptation processes (Aceituno and Rojas-Mora, 2015).

1.2. The colonization of the highlands of the Southern Atacama Desert

Far from being a restrictive bio-geographical barrier, the Atacama highlands or "*puna*" offered ideal environmental conditions for human settlement from the end of the Pleistocene and beginning of the Holocene. An environmental event known as the Central Atacama Pluvial Event (C.A.P.E.) increased rainfall on the western slope of the Andes Mountains above 2000 m. a.s.l. (Latorre et al., 2002; Placzek et al., 2009). As a result, the lakes above 3800 m. a.s.l. increased to six times their current size (Geyh et al., 1999; Messerli et al., 1993; Grosjean et al., 2001). Groundwater table levels in the pre-Cordillera (3000–3800 m. a.s.l.) rose, leading to the formation of extensive wetlands and marshes (Betancourt, 2000; Rech et al., 2002; Grosjean et al., 2005; Quade et al., 2008). Increasing aridity and rising temperatures at the end of the Early Holocene caused these formations to collapse around 9700 cal BP (Quade et al., 2008) resulting in the existing salt flats of the Andean pre-cordillera (Rech et al., 2002) (Fig. 1A).

During the Pleistocene-Holocene transition, relatively autonomous groups with low demographic density and high mobility patterns arrived from other biomes (Muscio, 1998–1999; Aschero,

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