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Late Pleistocene lithic technology in the Ivane valley: A view from the rainforest

Anne Ford

Department of Anthropology & Archaeology, University of Otago, PO Box 56, Dunedin, New Zealand

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ABSTRACT

Lithic assemblages in late Pleistocene sites within rainforest environments in Southeast Asia and Australasia are characterised as being simple core-and-flake technologies with little evidence for formal tools. This is usually attributed to the Bamboo Hypothesis, which proposes that modern humans first moving into these rainforest environments would have exploited available plant resources such as wood or bamboo at the expense of lithic technology. This paper challenges this portrayal by reporting the presence of formal tools in the Ivane valley of Papua New Guinea, dating from first occupation between 43,000–49,000 years cal BP.

1. Introduction

Throughout archaeology's history, stone tools have formed an integral part of archaeological analyses as, due to their ubiquity and relative robustness taphonomically, they are often the most abundant material class left at archaeological sites. In the late Pleistocene in particular, formal types of stone tools have been used as type fossils to distinguish between different hominin archaeological industries. Industries such as Oldowan, Acheulean, Mousterian, Clovis and Folsom can be readily identified through the presence of particular diagnostic tools. Yet this formality of types appears to break down when applied to modern human assemblages that belong to the rainforest environments of Southeast Asia and Australasia during the late Pleistocene (Bowdler, 1992; Mellars, 2006; O'Connell and Allen, 2007).

This is not a new concept, the lack of bifacial handaxes in the Far East/Southeast Asian regions, despite their contemporary presence in African, Middle Eastern and European Acheleuan assemblages and the presence of similar *Homo erectus* hominin fossils, was first described by Hallum Movius (1948). The Movius Line now separates those Acheulean assemblages with handaxes from those that do not (although see Brumm and Moore, 2012 for a recent critique of the validity of this distinction). Later in time, during the global migration of modern humans out of Africa, a similar phenomenon occurs. While sophisticated tool kits comprising composite tools, blades, backed blades and hafted implements, as well as a variety of specialised formal tools have been found in later Middle Stone Age (MSA) sites in Africa and Upper Palaeolithic sites in Europe, these tools are generally lacking in the forested regions of Southeast Asia and Australasia until the Holocene. Why is there a lack of formal tool types within the Pleistocene rainforest record? The purpose of the current paper is to investigate whether there is evidence for formal tools within a Late Pleistocene modern human rainforest assemblage, using the Ivane valley in Papua New Guinea as a case study.

2. Rainforest technology = amorphous technology?

Lithic technology in late Pleistocene Southeast Asia and Australasia is renowned for its lack of formal tool types (White, 1977; Bowdler, 1992; Holdaway, 1995; Mellars, 2006; Moore, 2013). Instead this technology is characterised as an amorphous core-and-flake industry, distributed across a mosaic of environmental zones and remaining relatively unchanging until the Holocene. A variety of theories have been put forward for this lack of formality which shall be discussed further below. However, those theories relating to loss of knowledge in how to create sophisticated tool forms, citing issues such as cultural drift or problems with demographics associated with the migration out of Africa (Mellars, 2006; Lycett and Bae, 2010; Lycett and Norton, 2010), will be put aside. While these may explain loss of original technology, they do not explain why new formal tools were not invented within rainforest landscapes, which is the principal focus here.

To begin with, do rainforest landscapes have the geological resources from which technologically sophisticated stone tools can be made? A lack of high quality fine-grained raw material, such as flint, chert or obsidian, has often been suggested as a reason for a lack of complex formal tools (Mellars, 2006). The problem with this idea is that it provides a very broad scale explanation, characterising a large section of the world as "lithic-poor". While each

E-mail address: anne.ford@otago.ac.nz.

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specific lithic landscape needs to be evaluated in terms of its geological resources, it would appear that at least in some areas this characterisation is unfounded. For example, in rainforest environments in Papua New Guinea, there are high quality sources available for flaking, including obsidian (Summerhayes and Allen, 1993), and chert (Pavlides, 2004). In the Holocene, these raw materials are used to produce complex formal lithics, such as the stemmed tools found in New Britain (Torrence et al., 2009). At the same in Papua New Guinea's Highlands, a complex polished stone axe-adze technology develops, which also indicates that high quality raw material sufficient to produce larger tools was available.

If rainforest landscapes have the geological resources for the production of sophisticated tools, why is there a lack of evidence for them? A second common argument is the transformation conceptually of the Movius Line into the Bamboo Line (Brumm and Moore, 2010; Bar-Yosef et al., 2011). The Bamboo Hypothesis proposes that bamboo and other plant materials were utilised in East and Southeast Asia as an adaptation to the rainforest environments prevalent in these areas (Watanabe, 1985; but see Brumm and Moore, 2010 for a critique). Watanabe (1985) argues that ethnographic data from modern foragers in rainforest environments shows that these groups are highly mobile, with a broad spectrum diet focused on plant foods and hunting of small animals. Extrapolating this back to the archaeological record, Watanabe suggests that the high mobility of past forager groups may mean that rather than carry heavy stone tools with them or because of limited availability of stone in rainforest environments, they turned to organic materials which were readily available throughout the rainforest and more economical to procure, such as bamboo and rattan. Further evidence used to support this argument is that the extractive subsistence technology of modern tropical foragers such as snares and projectiles are made primarily from plant materials (for example Bulmer and Bulmer, 1964 or Sillitoe, 1988 for a discussion on montane hunting technology in Papua New Guinea).

A review of ethnographic studies of material culture in the rainforest environments of the Papua New Guinean Highlands indicates that organic materials were used for a variety of activities, with bone used as scrapers, engravers, piercers, projectile points and ornaments (Blackwood, 1950; Bulmer and Bulmer, 1964; Sillitoe, 1988); wood used for digging sticks, scrapers, clubs and projectile weapons such as bows and arrows (Blackwood, 1940, 1950; Bulmer and Bulmer, 1964; Sillitoe, 1988); bamboo used as knives (Blackwood, 1950; Sillitoe, 1988); and shell used primarily for ornaments (because of the distance from the coast shell was considered a prestige item) (Bulmer and Bulmer, 1964). However, the use of organic tools does not necessarily preclude a complex lithic technology (Brumm and Moore, 2010). At the same time that organic tools were being used in Papua New Guinea, a complex system of polished axe use developed, incorporating both utilitarian and symbolic functions (Bulmer and Bulmer, 1964; Hughes, 1977; Burton, 1984, 1989). In the MSA sites in Africa, organic technologies including bone tools coexisted with a lithic technology that included bifacial points (Henshilwood, 2007), blades, geometric microliths and composite tools (McBrearty and Brooks, 2000; McBrearty, 2007).

Experimental archaeology completed by Bar-Yosef et al. (2011) also notes that while bamboo provides an effective cutting edge, it may not be sufficiently robust for undertaking all activities, such as cutting through the outer hide during butchery. A similar verdict was reached by West and Louys (2007) who noted that stone was a more reliable and effective tool than bamboo, particularly as it cut faster and kept its edge for longer. It is also worth noting that current experiments have focused on bamboo's effectiveness as a cutting tool, mostly in relation to butchery. Yet, as shown by ethnographic studies in rainforest cultures in Papua New Guinea, stone tools are primarily used for forest clearance activities: chopping wood, felling trees, grubbing tree stumps, activities that require a heavy duty edge that organic technologies would not be able to provide.

Another problem with the Bamboo Hypothesis is that evidence for its existence is drawn from the modern ethnographic record rather than actual archaeological evidence. The use of organic technologies will always be difficult to identify in the archaeological record, particularly from the late Pleistocene as unless preserved in exceptional conditions they do not survive (Barton et al., 2009). However, bamboo residues have been identified on stone tools from Niah Cave in Borneo dating to the late Pleistocene (Barker et al., 2007) and from Callao Cave in the Philippines at c. 25,000 years ago (Mijares, 2008), suggesting that they may have been used to modify bamboo into tools.

Perhaps a more fruitful avenue of research is to understand the development of lithic technology within its own particular evolutionary environment (Norton and Jin, 2009; Shea, 2011; Rabett, 2012). This concept of independent development and innovation based on local social, economic and environmental conditions is an important factor to consider in understanding the development of late Pleistocene rainforest stone technology used by modern humans. Rather than examining why this technology differs exactly from tool types observed in Upper Palaeolithic assemblages in Europe or MSA assemblages in Africa, we should be considering the specific historical conditions in which it developed.

This type of study is not new. Henshilwood and Marean (2003) contrasted Mousterian/MSA technology to Upper Palaeolithic/Lower Stone Age technology in Europe and Africa. As an alternative to understanding increasing technological complexity and sophistication as a result of shifts in behavioural modernity or cognition, Henshilwood and Marean (2003) examined whether these same advances could be explained by other factors such as economic, demographic or environmental. The basis for their model was foraging theory which stipulates that resource selection is the result of choices made by the consumer based on a cost-benefit analysis. Over time, these choices may be forced to change because of internal or external factors such as resource over-exploitation, environmental change or population pressure. Modelling technological change in Africa and Europe, Henshilwood and Marean (2003) postulated that as population pressure increased, changes in technological complexity could have resulted from a diversification of resource base, with new technologies required to be invented to acquire these resources. Kuhn and Stiner (2001) also use population increase to explain changes in technology from the Mousterian to the Upper Palaeolithic in Europe and Western Asia, but note that as well as increased diversity in the assemblage to cater for a broader subsistence base, technology will also specialise in order to intensify resource acquisition.

Although the theme of the above studies suggests that population pressure is a primary driver of technological change, the focus here will be environmental effects on technology. This is where analysis of Pleistocene rainforest technologies is particularly interesting. Previously, it has been suggested that rainforest environments were not inhabited until modern humans developed complex technologies or agriculture (Gamble, 1993; McBrearty and Brooks, 2000). Yet, during their global migration out of Africa, modern humans clearly moved into rainforest environments in South and Southeast Asia, as well as in Australasia and Africa itself (Mercader, 2002; Roberts and Petraglia, 2015) with what is usually typified as an amorphous technology. This raises an important question – as modern humans were colonising new environments with unfamiliar flora and fauna resources, what impact was this having upon their technology? Numerous studies have suggested that adaption to a new environment should cause innovation and modifications to pre-existing technologies, particularly as people begin to learn how to procure and process new resources (Fitzhugh, 2001; Blanton, 2003). To investigate whether this applies to

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