Quaternary International xxx (2015) 1–31

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Characterisation of the use-wear resulting from bamboo working and its importance to address the hypothesis of the existence of a bamboo industry in prehistoric Southeast Asia

Hermine Xhauflair [a, *], Alfred Pawlik [b], Claire Gaillard [a], Hubert Forestier [a], Timothy James Vitales [c], John Rey Callado [d], Danilo Tandang [d], Noel Amano [a], Dante Manipon [b], Eusebio Dizon [c]

[a] UMR 7194 of the CNRS, Département de Préhistoire, Muséum National d'Histoire Naturelle and Université de Perpignan Via Domitia, Institut de Paléontologie Humaine, 1 rue René Panhard, 75013, Paris, France
[b] University of the Philippines, Archaeological Studies Program, Albert Hall, 1 Lakandula Street, Diliman, Quezon City 1101, Philippines
[c] Division of Archaeology, National Museum of the Philippines, Padre Burgos Drive, City of Manila, Philippines
[d] Division of Botany, National Museum of the Philippines, Padre Burgos Drive, City of Manila, Philippines

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Southeast Asia
Stone tools
Bamboo hypothesis
Use-wear analysis
Experiments
Reference collection

ABSTRACT

Prehistoric stone tools discovered in Southeast Asia contrast with what is found in the rest of the world: they are simple and their production techniques remained unchanged for millennia. To explain these unique characteristics, some scholars offered what is called the "bamboo hypothesis": if SE Asian stone tools are simple it would be because they were actually used to manufacture more complex implements made of bamboo. This hypothesis relies on a series of indirect evidence, among which the fact that use-traces occurring on the stone tools result from plant processing. These traces are often interpreted as due to bamboo working although in the absence of an adapted reference collection such a precise diagnosis is impossible to make. A fundamental question remains to be addressed: is it possible to distinguish the working of bamboo from the one of other plants based on the traces they produce? To answer this, we carried out several experiments, grounded on ethnoarchaeological observations, which involved 15 tropical plant taxa, including 3 bamboo genera and conducted microscopic use-wear analysis of the experimental tools. Our results show that the use-wear created by processing mature bamboo is well-developed and can be defined through a set of criteria. Altogether they distinguish bamboo wear from the one produced by other plants, although some overlapping exists. Our results can be used as a reference to which the traces on archaeological stone tools can be compared in order to determine whether they were really used to process bamboo and to what extent.

1. Introduction

Stone tools discovered in Southeast Asian Palaeolithic sites are mostly made of unretouched flakes and core-tools. In contrast to Europe, Africa, Western and Northern Asia most of them do not correspond to formal tool types, and therefore do neither permit identification of different groups and traditions nor relative dating (Movius, 1948; Reynolds, 1993, 2007; Moore and Brumm, 2007; Pawlik, 2009). In addition, the techniques used to manufacture them are rather simple, mostly direct percussion with hard hammer, producing flakes of irregular shapes. Terms like "smash-and-grab", "expedient technology" and "opportunistic" have been used to describe the lithic technology of Southeast Asia. The idea behind these terms is that prehistoric people struck almost randomly on a block of raw material to produce a series of flakes and then looked at them to select the appropriate ones to perform immediate tasks. These technical behaviours, once again, unlike in Europe, Africa, Western and Northern Asia, seem to have been

* Corresponding author.
E-mail addresses: hermine_xhauflair@hotmail.com, xhauflair@mnhn.fr (H. Xhauflair), afpawlik@up.edu.ph (A. Pawlik), gaillacl@mnhn.fr (C. Gaillard), hubforestier@gmail.com (H. Forestier), archaeofreako@yahoo.com (T.J. Vitales), johnreycallado@gmail.com (J.R. Callado), sue93653@yahoo.com (D. Tandang), noelamano@rocketmail.com (N. Amano), dantericardomanipon@gmail.com (D. Manipon), drbongdizon@yahoo.com (E. Dizon).

http://dx.doi.org/10.1016/j.quaint.2015.11.007
1040-6182/

lasting, with very little change, during the Pleistocene and Early Holocene, and persisted in some cases until the historic period (Fox, 1970, 1978; Hutterer, 1976, 1977; White, 1977; Coutts and Wesson, 1980; Coutts, 1983; Reynolds, 1993, 2007; Mijares, 2002; Pawlik, 2009).

To explain these characteristics, it was suggested that Southeast Asian stone tools were actually mostly used to create and maintain a complementary industry made of light organic materials such as bamboo, which wouldn't be preserved in the archaeological record. The technological development in the region therefore would have taken place in plants rather than in stone (Narr, 1966; Boriskovsky, 1967; Gorman, 1969, 1970, 1971; Fox, 1970; Heekeren van, 1972; Solheim, 1972; Hutterer, 1976, 1977; Testart, 1977; White, 1977; Pope, 1988, 1989; Reynolds, 1993, 2007; Forestier, 2003, 2010).

This theory of a bamboo or lignic industry, an expression first used by Solheim (1972), relies on a series of indirect evidence. One of them is the fact that micro-wear studies showed that many of the stone artefacts analysed present use-traces attributed to plant or hard organic material working, which are widely interpreted as being due to bamboo processing (Gorman, 1970, 1971; Peterson, 1974; Hutterer, 1976; Ronquillo, 1981; Bannanurag, 1988; Pookajorn, 1996, 2001; Mijares, 2001, 2002, 2008; Davenport, 2003; Forestier, 2003, 2010; Teodosio, 2006; Lewis et al., 2008; Xhauflair, 2009; Xhauflair and Pawlik, 2010; Borel, 2010, 2012; Pawlik, 2010, 2012; Borel et al., 2013). Nevertheless, it has been impossible so far to make a precise diagnosis of these use-traces which affect the surface of chert tools, and therefore to test further the hypothesis of a bamboo industry. This situation is due to the absence of an experimental reference adapted to the specific vegetation of this tropical region despite a few valuable first experimental works (Mijares, 2001, 2002; Davenport, 2003; Teodosio, 2006; Xhauflair, 2009; Borel, 2010, 2012; Xhauflair and Pawlik, 2010; see also Kononenko, 2011 for obsidian).

These traces might indeed be the result of bamboo tools manufacturing but they could also have been produced by the processing of plants other than bamboo and the simplicity of the lithic industry could rather, as suggested by Blench (2013), be due to reliance on plants in a broader sense in this region of the globe. Macro and micro plant remains found in archaeological sites in Southeast Asia and Papua New Guinea indicate that many plants were known and used by people during Late Pleistocene and Early Holocene (Gorman, 1969, 1970, 1971; Paz, 2001, 2005; Denham et al., 2003; Chacornac-Rault, 2004; Barton, 2005, 2012; Fullagar et al., 2006; Barton and Paz, 2007; Barker et al., 2007, 2011, Barker and Janowski, 2011; Lewis et al., 2008; Mijares, 2008; Viet, 2008; Lentfer et al., 2010; Summerhayes et al., 2010; Barton and Denham, 2011; Haberle et al., 2012; Hunt and Prematilake, 2012; Sémah and Sémah, 2012; Barker, 2013; Yang et al., 2013; Ochoa et al., 2014).

A fundamental question which still needs to be answered is whether it is possible or not to distinguish the working of bamboo from other plants processing by analysing the use-traces these activities produce on the stone tools. The research presented here aims at bringing new elements to answer this question.

2. Material and methods

2.1. Experiments

2.1.1. Introduction and ethnoarchaeological grounds

In order to compare the use-wear created by bamboo and other plants processing, we conducted a series of experiments. Micro-wear or use-wear analysis is an actualistic method, which is based on microscopic observation of minute alterations developing on a tool's surface during use. To understand the use-wear present on the artefacts it is necessary to create modern comparatives and to carry out potential activities that have likely happened during the past with experimental stone tools, replicas of archaeological artefacts (Semenov, 1970; Keeley and Newcomer, 1977; Anderson, 1980; Keeley, 1980; Kamminga, 1982; Plisson, 1985; Vaughan, 1985; Owen and Unrath, 1986; Beyries, 1987; Van Gijn, 1989; Pawlik, 1992, 1995; Rots, 2010; Kononenko, 2011). In order to design realistic experiments, we turned to the knowledge of forest experts: Pala'wan traditional communities who live in the forested highlands near Brooke's Point in Palawan Island, Philippines and whose economy relies largely on wild plants (Macdonald, 1977; Revel, 1990-1992). HX and TV conducted an ethnoarchaeological fieldwork with a goal to determine the plant taxa currently used by the Pala'wan communities and, equally important and often absent from ethnographic accounts, how they are processed (Xhauflair et al., 2012). Among the numerous activities observed during a three months fieldwork which involved 95 plant species (Xhauflair, 2014), we selected 16, involving the processing of 15 different plant taxa, including three bamboo genera, to be reproduced experimentally.

To replicate these activities as closely as possible with stone tools, we described in detail their respective chaîne opératoire which is defined as the "series of operations that transform a raw material into a product, the latter being either a consumer good or a tool" (after Cresswell, 2010 – 1st ed. 1976: 25). Each operation of the selected activities was performed using two different stone tools (See Table 1).

2.1.2. Places

Most experiments took place in 2012 in the Mount Makiling Forest Reserve in the Province of Laguna (Fig. 1), and on the campuses of the University of the Philippines (UP) Diliman and Los Baños (UPLB), both vast and verdant parks. Many local trees, bamboos, palms and other plants are growing there spontaneously or have been planted. A few experiments were conducted within the botanical garden of UP, Department of Biology. In addition, one set of experiments was conducted in Cavinti, also in the Province of Laguna, where pandan (*Pandanus simplex*) is abundant and a major source of income for the people (see Fig. 2). Some plants were also collected, dried, and later worked on in Cannes, Southern France.

2.1.3. Selected plants

We included different families and taxa that are characterised by different levels of hardness and by various water and silica contents. These three latter attributes are known to influence the development of use-wear on stone tools (Anderson, 1980; Keeley, 1980; Vaughan, 1985; Fullagar, 1991; Pawlik, 1995; Ollé and Vergès, 2008). Other elements were considered to make the selection. One of them is the frequency of an activity or of the use of a taxon by our Pala'wan informants during the ethnoarchaeological fieldwork, suggesting its importance for their subsistence. Another is the mention of indications that a taxon was exploited by humans during the Late Pleistocene and the Early Holocene in the literature (macrobotanical remains, starch grains, pollens, and others, e.g. see Paz, 2005; Barton, 2005). The selection was also influenced and limited by the availability of the taxa at the experimental locations and, if they were reported to occur there (Fernando, 2004), by our luck to find them, especially within the gigantic forest of Makiling. For instance, we would have liked to include wild *Dioscorea*, whose use during prehistory is attested by palaeobotanical studies (Barton, 2005; Fullagar et al., 2006; Barker et al., 2007, 2011; Barton and Paz, 2007; Summerhayes et al., 2010; Barker, 2013) but the few specimens that we found were not sufficient for an experiment. Palm trunk processing to make sago, a staple food which seems to have been quite important during the past (Barton and Denham,

Please cite this article in press as: Xhauflair, H., et al., Characterisation of the use-wear resulting from bamboo working and its importance to address the hypothesis of the existence of a bamboo industry in prehistoric Southeast Asia, Quaternary International (2015), http://dx.doi.org/10.1016/j.quaint.2015.11.007