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Timing and pace of dairying inception and animal husbandry practices across Holocene North Africa

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ABSTRACT

The timing and extent of the adoption and exploitation of domesticates and their secondary products, across Holocene North Africa, has long been the subject of debate. The three distinct areas within the region, Mediterranean north Africa, the Nile Valley and the Sahara, each with extremely diverse environments and ecologies, demonstrate differing trajectories to pastoralism. Here, we address this question using a combination of faunal evidence and organic residue analyses of *c.* 300 archaeological vessels from sites in Algeria, Libya and Sudan. This synthesis of new and published data provides a broad regional and chronological perspective on the scale and intensity of domestic animal exploitation and the inception of dairying practices in Holocene North Africa. Following the introduction of domesticated animals into the region our results confirm a hiatus of around one thousand years before the adoption of a full pastoral economy, which appears first in the Libyan Sahara, at *c.* 5200 BCE, subsequently appearing at *c.* 4600 BCE in the Nile Valley and at 4400–3900 BCE in Mediterranean north Africa.

1. Introduction

A picture is now beginning to emerge of the widespread importance of dairying in the subsistence economies of Neolithic people. A combination of faunal and biomolecular evidence presently suggests that, in some instances, the adoption of dairying often occurs concurrently with the exploitation of domesticates, such as cattle, sheep and goats, albeit on varying scales of intensity and depending on local environmental, economic and cultural settings (e.g. Evershed et al., 2008). However, in other cases, such as in the Libyan Sahara, there seems to be a gap of at least one thousand years between the appearance of the earliest domesticates and the inception of dairying practices (di Lernia, 2013). Thus, it is increasingly becoming clear that the adoption and occurrence of dairying may have been a piecemeal process developing in varying ways (Evershed et al., 2008; Dunne et al., 2012; Debono Spiteri et al., 2016). Consequently, it is now recognised that what we see in the archaeological record reflects regional and chronological variation in the appearance, spread and intensification of the different innovations.

1.1. The secondary product revolution and lifetime products

It is now more than thirty years since Andrew Sherratt (1981, 1983) argued that, several millennia after the beginning of the development of animal husbandry, another innovation in animal exploitation occurred, involving the intensive use of secondary products such as milk, blood, wool and traction, which can be repeatedly extracted from an animal throughout its lifetime. There has been much debate, and some criticism, of Sherratt's model (e.g. Bogucki, 1982, 1984; Chapman, 1982; Whittle, 1985; see Greenfield, 2010 for a review and references therein) which has essentially crystallised over the timing of secondary product use. Nonetheless, Greenfield (2010) argues that Sherratt was always concerned with how and when the *scale* of exploitation changes and how this ultimately affected human society. He suggested that a distinction should be made between the first origins of dairying practices and the timing of its later intensification. Regardless, it now seems clear, from both organic residue analyses of absorbed residues from archaeological pottery and zooarchaeological techniques allowing

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the reconstruction of animal management practices, that the exploitation of secondary products begins with the first Neolithic farmers, supporting claims that milk was one of the main attractions leading to control/domestication (e.g. Vigne and Helmer, 2007; Evershed et al., 2008; Conolly et al., 2011). Interestingly, this provides valuable information regarding the sophisticated technological capabilities of 9th millennium BC herders. Although early milking may have been difficult, it seems the first farmers persevered, likely for the benefits it provided (Vigne and Helmer, 2007).

The importance of dairy foods in the diet of these early farmers should not be underestimated. Dairy foods are one of the most nutritionally dense foods, being significant sources of several nutrients, particularly calcium, riboflavin, phosphorus, protein, magnesium, vitamin B_{12}, niacin equivalents, vitamin B_6, and when fortified, vitamins A and D. Milk and milk products are also one of the main sources of dietary calcium which is highly important both in bone formation, and the maintenance of healthy bones and teeth. It also plays a role in the prevention, mitigation, and reversal of age-related decreases in bone density (Jensen, 1995). Yet, these early farmers are known to have been lactose intolerant, meaning the digestion of fresh milk would have caused extreme discomfort (Flatz and Rotthauwe, 1977). However, certain methods of milk processing, such as fermentation, will reduce the lactose concentration (milk sugar) to lactic acid, making dairy produce more digestible to lactose intolerant people (Ingram et al., 2009). Hence, it seems likely that early farmers would have been able to produce a wide range of low-lactose, storable commodities through the processing of milk into products, such as butter, cheese and yoghurt, as observed in many modern-day societies.

It is also important to note the possible importance, among Holocene North African groups, of blood obtained from domesticates as a dietary resource. Today, the triad of milk, meat and blood common to pastoralist societies is well-documented (e.g. Evans-Pritchard, 1940; Holtzman, 2009). The consumption of blood is known to play a significant role in social relationships and is also an important source of dietary nutrients. However, although the use of blood would be difficult to identify archaeologically, it may well have its origins within these early pastoralist societies.

1.2. The identification of dairying practices

Analyses of absorbed organic residues from archaeological pottery, often combined with faunal osteo-archaeological age at death data, have provided direct evidence of the origins and transmission of dairying practices worldwide (e.g. Dudd and Evershed, 1998; Copley et al., 2003; Craig et al., 2005; Evershed et al., 2008; Dunne et al., 2012; Cramp et al., 2014a, 2014b; Smyth and Evershed, 2015; Debono Spiteri et al., 2016). Consequently, the identification of dairy and ruminant and non-ruminant carcass products from lipids extracted from ancient ceramics has revolutionised our knowledge of human diet and ancient economies (Evershed, 2008).

Herein, we explore the timing and spread of dairying in North Africa, a region where studies of organic residues are still rare. This is an area where, rather than the move from a mobile hunter-gathering to a sedentary farming lifestyle seen across the Near East and Europe, pathways to food production are very different. In contrast, across North Africa, generally semi-sedentary hunter-gatherer-fishers transition to more mobile pastoralist lifeways, likely in response to changing environmental conditions. In this study, questions of scale and intensity of milk production, both spatially and chronologically, will be addressed where possible, and the stable carbon isotopic values of the lipid residues will be used to infer animal management strategies and prevailing environmental conditions.

1.3. Food production in north Africa

The existence of pastoralism as an established and widespread way of life in Africa, instead of the adoption of farming, and long before the domestication of plants, has been very hard for scholars to accept (e.g. di Lernia, 1999, 2013; Garcea, 2004, 2006; Gifford-Gonzalez, 2005; Barich, 2014) despite it being clear that the Near East model of 'Neolithisation' does not fit the model for the development of African subsistence strategies, which were likely shaped by the unstable, marginal environments that early Holocene Saharan hunter-gatherers lived in. Then, predictable access to resources would have been the major concern, rather than the intensification of yield more applicable to early farmers in the Levant (Marshall and Hildebrand, 2002). For example, in Saharan Africa, it seems that largely sedentary and pottery-producing hunters, fishers and gatherers quickly adopted the 'new' herding strategy, albeit dependent upon regional variations in climate and environment (di Lernia, 2013). Certainly, Marshall and Hildebrand (2002), among many others, have noted the 'patchy spread of food production' in Africa, where, in contrast to European prehistory, African hunter-gatherers and food producers (pastoralists, agriculturists) continued to co-exist (e.g. di Lernia, 1999, 2002, 2013; Hassan, 2002; Garcea, 2004; Gifford-Gonzalez, 2005; Barker, 2006; Linstädter, 2008; Marshall and Weissbrod, 2011; Linstädter et al., 2012a, 2012b; Lucarini, 2013). It is likely that spatial variation in climatic and environmental conditions, together with availability of food resources, dictated whether managing livestock or hunting took place. In addition, delayed use of food resources (Woodburn, 1982) by early Holocene foraging groups conceivably facilitated the adoption of the new herding strategy (di Lernia, 2001). Within this complex and varied mosaic of food production strategies, there are three distinct regions in North Africa, each of which follows its own pastoral trajectory. These areas comprise 1) Mediterranean north Africa including the Maghreb 2) The Nile Valley and the adjacent dry hinterlands and 3) Saharan Africa from west of the Nile to West Africa.

1.4. North African pastoral trajectories

Pastoralism spread unevenly from the northeastern corner of Africa to the Acacus (Libya) and Tibesti (Chad) massifs between *c.* 6500 and 4000 BCE and although early Holocene patterns of plant use persisted, Saharan pastoralists still hunted and fished (e.g. Smith, 1980; Gautier, 1987; Marshall and Hildebrand, 2002; di Lernia, 2013; Lucarini, 2014). The Sudanese Nile also offered reliable, fertile resources and pastoralists utilised large permanent camps such as Esh Shaheinab and Geili. Domesticates, predominantly cattle, were the dominant mammal at sites such as Kadero *c.* 4600 and 3800 BCE, where wild plants were again intensively exploited (Gautier, 1984; Caneva, 1988; Krzyzaniak, 1991; Haaland, 1992, 1995; Marshall and Hildebrand, 2002). The prehistory of Mediterranean north Africa follows a different trajectory although the cultural processes leading to the espousal of Neolithic innovations, such as the adoption of pottery and the exploitation of domesticates in the region, are still poorly understood. A simultaneous maritime spread of agriculture along the shores of the Western Mediterranean has been proposed, and as the adoption of a Neolithic lifestyle in both northern Morocco and south-western Spain is virtually contemporaneous, some contact and trading relationships between the two regions seems likely (Zeder, 2008; Linstädter et al., 2012b; Broodbank, 2013).

We now synthesise previously published evidence for the first dairying in Neolithic Saharan Africa (Dunne et al., 2012, 2013) and

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