Fields of change

Progress in African archaeobotany

EDITED BY

René Cappers

BARKHUIS &
GRONINGEN UNIVERSITY LIBRARY
GRONINGEN 2007

Early domesticated pearl millet in Dhar Nema (Mauritania): evidence of crop processing waste as ceramic temper

D.Q. Fuller, K. MacDonald
Institute of Archaeology, University College London, London, United Kingdom

R. Vernet
Université de Nouakchott, Nouakchott, Mauritania

New evidence relating to the early cultivation of pearl millet (*Pennisetum glaucum*) in Southeast Mauritania is reported based on material recovered during archaeological fieldwork in 2000 in Dhar Nema. Evidence of Tichitt tradition ceramics from the sites of Djiganyai and Oued Bou Khzama are predominantly chaff-tempered, and examination of the impressions through casting and SEM indicates tempering with the winnowing by-products of fully domesticated pearl millet. At the latter site chaff-tempered pottery and tuyères are associated with early iron-smelting by the mid-first millennium BC. At the earlier site Djiganyai, direct AMS dates on the organic fraction of sherds put the earliest millet chaff-tempered pottery back to ca. 1750-1600 cal. BC, providing a *terminus ante quem* for domestication and even earlier cultivation of this species. The use of winnowing by-products implies large-scale processing of this crop in the vicinity of ceramic production suggesting local cultivation, perhaps in wadis that flow into the nearby Amourj Palaeolake. Earlier untempered wares may imply the lack of local cultivation, the absence of the domesticated form that requires threshing, or different tempering choices.

1 Introduction

A two year programme of research of the Dhar Néma region of Southwest Mauritania (figure 1) based on surface survey and limited test-pitting has produced important new evidence about the Tichitt Tradition (2000-200 BC) relating to early agriculture, iron metallurgy and social complexity (MacDonald *et al.*, 2003). Fieldwork by MacDonald, Vernet and colleagues included survey on foot of two 5 km radius areas on the Néma escarpment and two areas of the floodplain, around ancient palaeolakes that were surveyed by vehicle. 25 sites were located, of which three were test excavated, including Djiganyai and Bou Khzama. From both of these sites large surface collections of pottery, as well as excavated material was examined for plant impressions, and the present paper focuses on the discussion of the contribution of these remains to the history of agriculture within this region and the domestication of Pearl Millet (*Pennisetum glaucum*). The chronological framework suggested by pottery stylistic analysis has been tested through direct AMS dates that also secure the antiquity of the identified plant impressions. The current evidence is part of a growing body of evidence indicating the widespread cultivation of domesticated Pearl millet in West Africa by the early to mid second millennium BC.

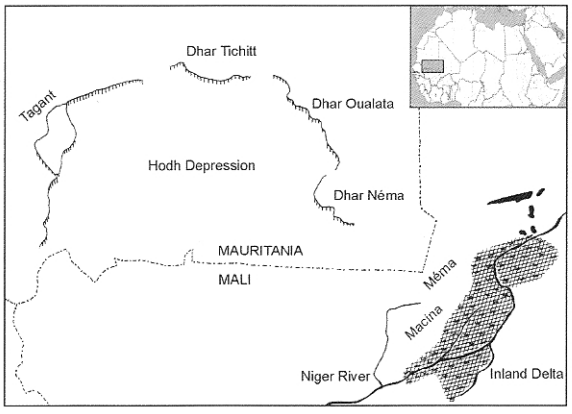


Figure 1: Map showing the location of the Dhar Nema sites.

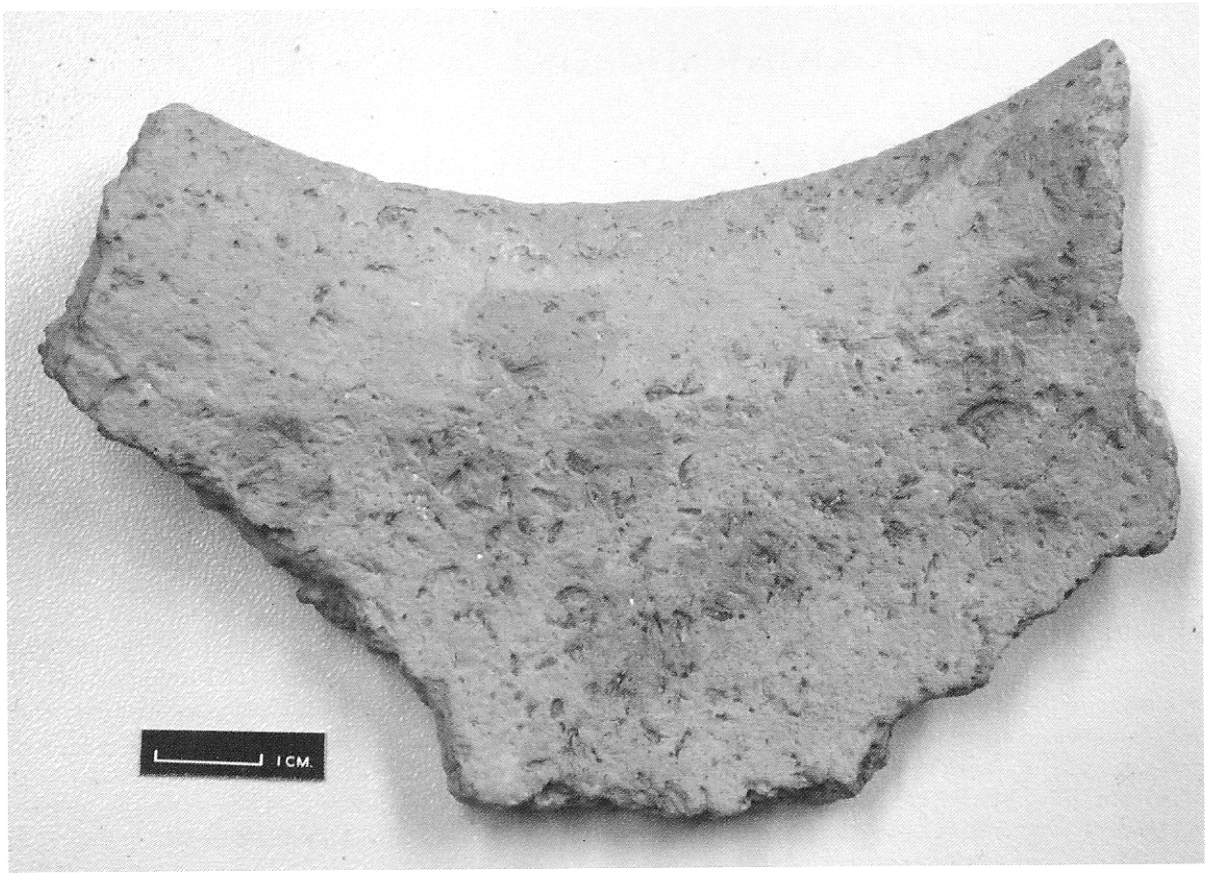


Figure 2: Example of sherd with impressions from Oued Bou Khzama.

2 An Early Tichitt site: Djiganyai (Dj)

This site of 3 ha was located by a wadi leading to the Palaeolake Amourj. Test excavations indicated 1 m of intact deposit, including three horizons of distinct material culture. This sequence begins with a Pre-Tichitt Ceramic Late Stone Age Occupation, followed by Classic Tichitt and Late Tichitt Ceramic phases, and thus represents the first large site with stratified Tichitt tradition materials. The lowest occupation (Pre-Tichitt Phase) includes pottery with little or no recognizable vegetable temper, despite a high organic content (directly dated back to ca. 1950-1750 BC), while subsequent Classic and Late Tichitt material is often heavily tempered with vegetable material, which has been examined in the current archaeobotanical study. Test excavations also provided bone evidence for domestic fauna (cattle, sheep/goat, dog), hunted game (gazelles, warthog, giraffe), and aquatic resources (*Clarias* catfish, *Tilapia* carp, gastropods and bivalves). Due to the exploratory nature of the excavation intensive sampling for plant macroremains was not possible, although hackberry tree fruit pits were also recovered (*Celtis* cf. *integrifolia*). Despite examination, the sand-tempered pottery of the lowest level was not found to contain plant impressions. But this absence of evidence need not imply an absence of agriculture, as chaff-tempering practices may only have developed in the next phase. Plant impressions are profusely preserved from the second (Classic Tichitt) and later phases.

3 A Late Tichitt site: Oued Bou Khzama (OBK)

This site of ca. 5 ha is located on the flanks of the Néma escarpment, and features two small enclosures, agricultural terraces, and schist grain bin stands. It has evidence for sixteen iron furnace mounds, and excavations of one slag mound revealed remains of an oval low shaft furnace, with tuyères. The Late Tichitt ceramic material from the site and the tuyères proved to be tempered with domesticated pearl millet. The AMS dates confirm ceramic typological dates of 800-200 BC, and suggest the beginnings of iron metallurgy in the first half of the First Millennium BC.

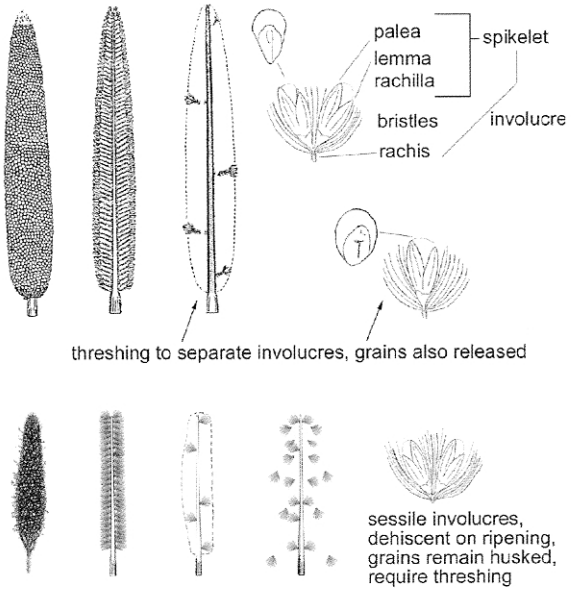


Figure 3: Diagram comparing domesticated (top) and wild (bottom) forms of pearl millet. Wild millet is shown schematically to indicate natural shedding of sessile involucres. This diagram does not represent the order in which involucres mature and are shed.

4 Laboratory methods

The sherds were brushed to remove sand and examined under a binocular microscope to identify examples with promising impressions (*e.g.* figure 2). These impressions were then cast using a dental casting agent of Polyvinylsiloxane. This material is easy to use, does not require a clay mold rim, is quick drying and easy to remove. Multiple casts were taken from each impression site, as early casts tended to remove embedded sand and lack anatomical details. It was found that this process also tended to remove small parts of the sherd surface with each generation of casting. Casts were then sorted under a binocular microscope and the best examples were trimmed and mounted on a SEM stub, sputter coated and imaged with a SEM.

5 Radiocarbon dates

Selected sherds, with identifiable pear millet impressions and also of interest in terms of stylistic information relating to conventional ceramic dating, were selected for direct dating of the organic fraction using AMS-dating. The results so far are given in the following list, with calibration ranges of the 1-sigma intercepts (Stuiver *et al.*, 1998):

1. GX-29358-AMS. Djiganyai, Context 6, Sherd with indeterminate organic temper:
   3550+/- 40bp; 1970-1780 cal BC
2. GX-29359-AMS. Djiganyai, Sf-S2, Sherd with millet temper:
   3370+/- 40bp; 1740-1620 cal BC
3. GX-28140-AMS. Djiganyai, Sf-S9, Sherd with millet temper:
   3260+/- 40bp; 1620-1510 cal BC
4. GX-28137-AMS. Bou Khzama, Sf-S1, Sherd with millet temper:
   2340+/- 40bp; 760-400 cal BC

6 Domestication traits, threshing and tempering

The domestication trait *par excellence* in seed crops is the loss of natural seed dispersal mechanisms, selected for by regimes of harvesting (by methods such as sickles or uprooting) and sowing from stored seed. In pearl millet this selective pressure created a stalk (lengthened rachis) at the base of the involucres (Brunken *et al.*, 1977), whereas in wild *Pennisetum* the sessile involucres are shed on ripening (figure 3). Adapted to animal (and wind) dispersal these spiny involucres tend to retain their seeds, whereas the less spiny domesticated forms readily lose their seeds (*i.e.* they are free-threshing). Grain plumpness, however, is a problematic character for identifying domestication due the existence of involucres with 1, 2 or more grains on a single ear (Godbole, 1925). Recent gene linkage studies, show that all of these domestication traits are controlled by a single set of linked gene loci (Poncet *et al.*, 2000).

Most impressions in the examined pottery consist of macerated plant material, including a large number of bristle fragments, which match those of *Pennisetum* as well as some larger fragments of spikelets (figures 4 and 6) and involucres (figures 5 and 7), including rachis stalks, comparable to domesticated pearl millet. All of this material is consistent with the use of the by-products of threshing and winnowing as ceramic temper. Characteristic bristles with uniseriate hairs are also visible (figure 8).

The presence of domestication traits such as involucre raches therefore attest to fully domesticated Pearl Millet in Dhar Nema by the Classic Tichitt period. This provides a *terminus post quem*, with the beginnings of cultivation necessarily earlier.

The absence of other plant species is to be expected as weeds are rarely incorporated in the crop-processing by-products of pearl millet on account of its dense spikes which are readily harvested alone (Reddy, 1994, 1997). Threshing is most likely to have occurred in the vicinity of cultivation to minimize transport of bulky harvested plants, while the ready availability of win-

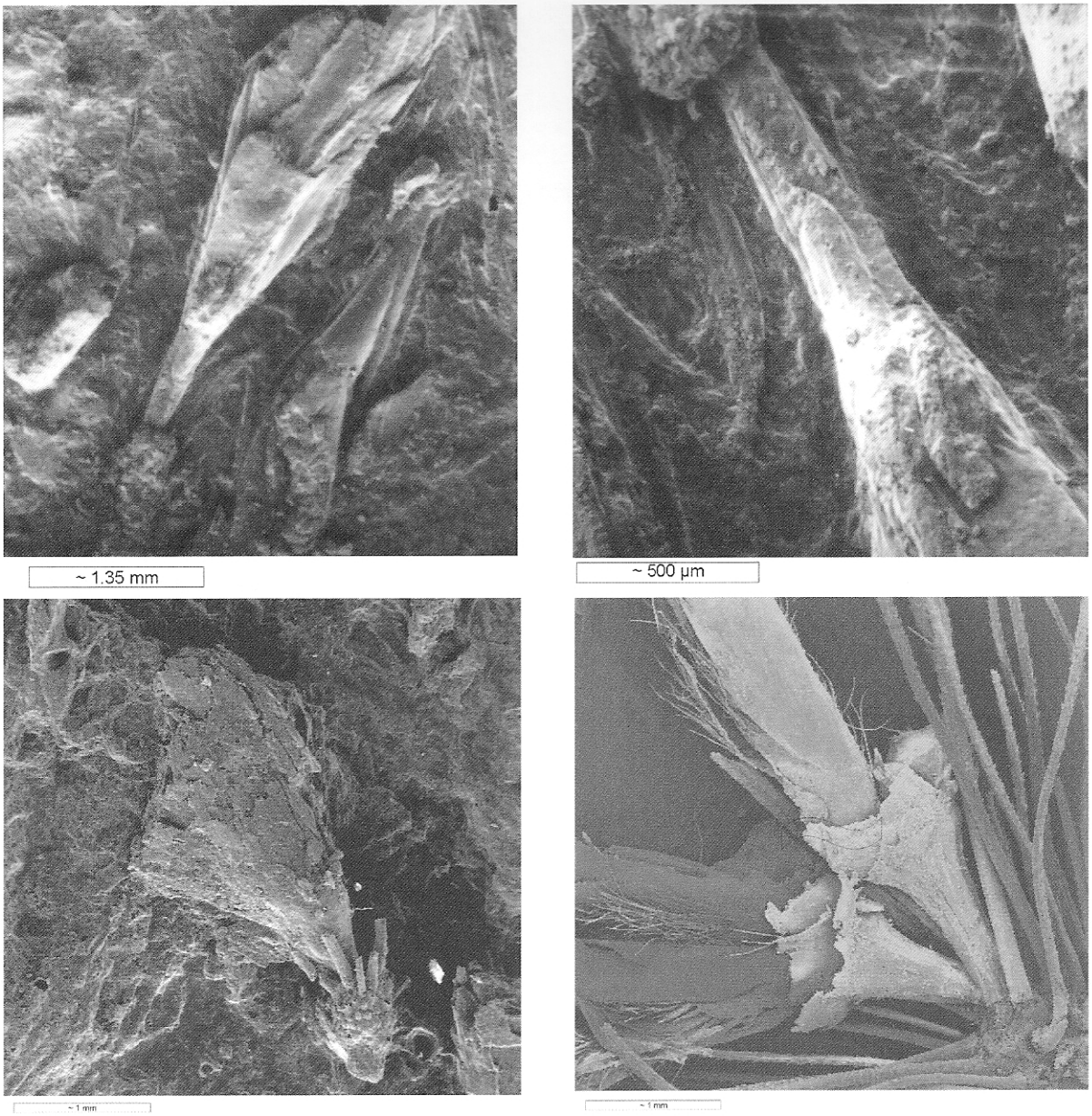


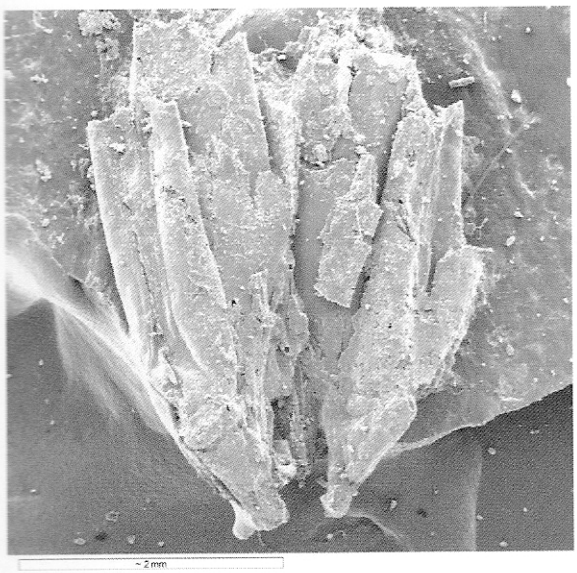
Figure 4 (page 74, first row): Impression of two partial spikelets, with bristles (Left), with Close-up of spikelet base, attached to involucre, with some bristles visible (right), from Djiganyai (Dj-00 context 2), directly dated specimen, 3260 bp.

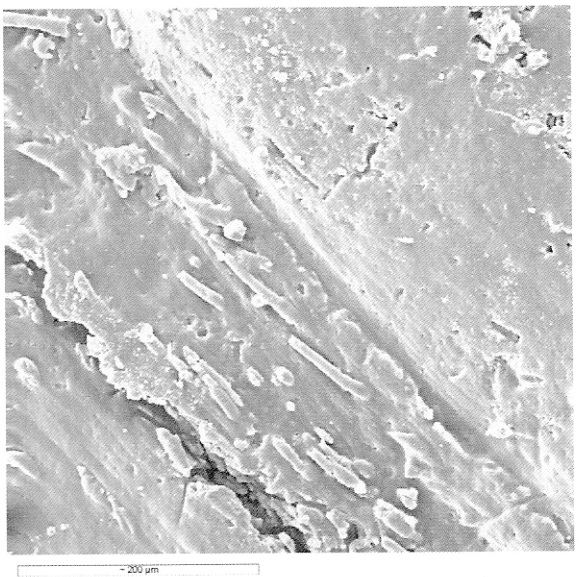
Figure 5 (page 74, second row): Impression of a spikelet and involucre apex, showing rows of radiating bristle bases sherd from Djiganyai (Dj-00 context 6), directly dated specimen 3370 bp (Left); Modern reference material of Pennisetum glaucum (right), two spikelets in a single involucre arising above bristles. Note fine hairs on the margins of the lemma and palea.

Figure 6 (page 75, first row): Impression of paired pearl millet spikelets (mainly lemmas), separated from involucre (left), from OBK(1). Arrow indicates location of hairs shown in close-up (right). Direct AMS date: 2430 bp.

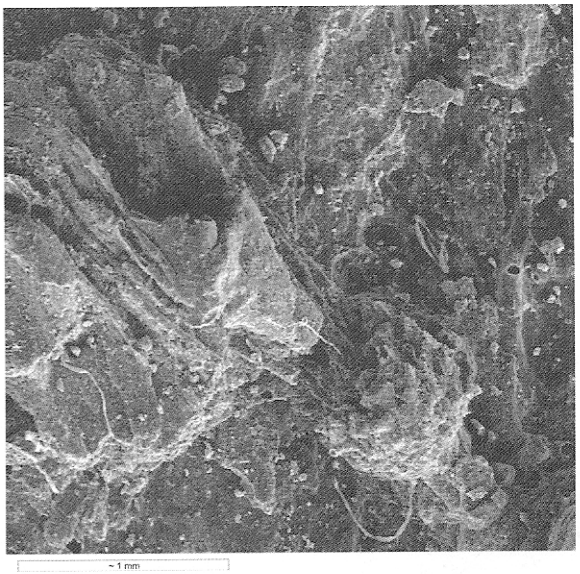
Figure 7 (page 75, second row)): Impression of involucre apex, with bristles, surrounding spikelets (left), from excavated tuyère, OBK, submitted for AMS date; and impression of involucre apex, with bristle bases, and fragment spilet chaff (right), from same.

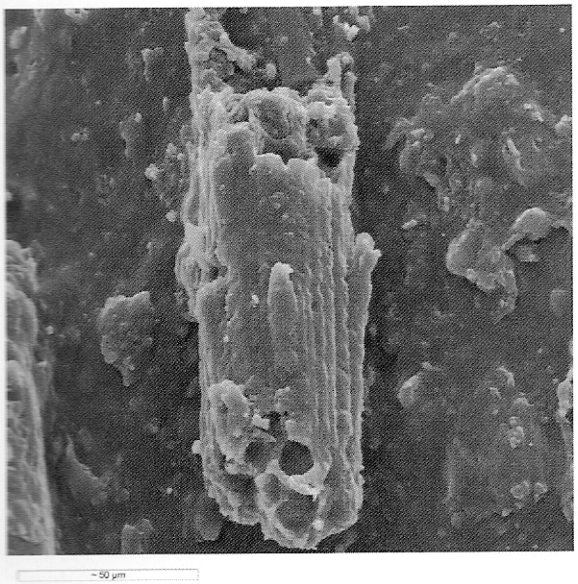
Figure 8 (page 75, third row): Impression of bristle fragment, showing serrate hairs, from OBK(1), directly dated specimen, 2430 bp (left); Close-up of bristle in modern material, showing the numerous unicellular serrate trichomes on the bristle surface (right).

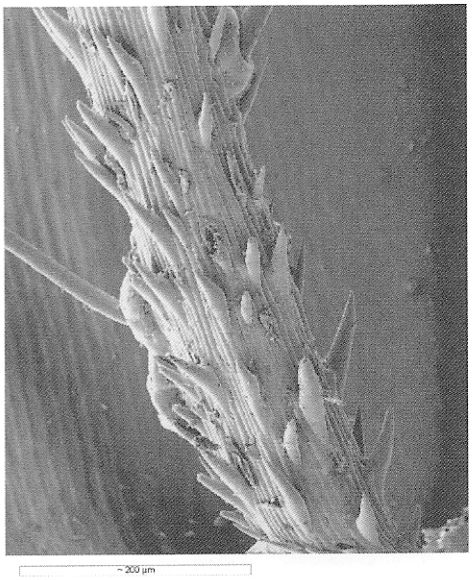

~ 2 mm


~ 200 µm


~ 500 µm


~ 1 mm


~ 50 µm


~ 200 µm

nowing waste is likely to have been near to pottery production sites. This implies cultivation and pottery making in the same locales, such as in the vicinity of Djiganyai. The millet impressions in the ceramics from Bou Khzama represents the same range of threshing and winnowing by-products as that described for Djiganyai.

Recent isozyme surveys of wild populations and domesticated varieties have identified only a limited number of modern wild populations that are close to the domesticated crop (Tostain, 1992, 1998), notably two foci, one in the far west of Africa (Mauritania) and the other in the region west of Lake Chad. For the eastern domestication, the *terminus ante quem* is at present provided by finds in India from the first half of the second millennium BC, which remains earlier than the limited evidence in Africa (Fuller, 2003). This implies that the present evidence, like earlier reports (Amblard & Pernes, 1989; Neumann, 2003) thus provides a minimum domestication age of ca. 1700 BC for the western of these pearl millet centres of origin.

7 *References*

Amblard, S. & J. Pernes, 1989. The identification of cultivated pearl millet (Pennisetum) amongst plant impressions on pottery from Oued Chebbi (Dhar Oualata, Mauritania). *The African Archaeological Review* 7, pp. 117-126.

Brunken, J., De Wet, J.M.J. & J.R. Harlan, 1977. The Morphology and Domestication of Pearl Millet. *Economic Botany* 31, pp. 163-174.

Fuller, D.Q., 2003. African crops in prehistoric South Asia: a critical review. In: K. Neumann, A. Butler & S. Kahlheber (ed.), *Food, Fuel and Fields. Progress in Africa Archaeobotany* (= Africa Praehistorica 15). Heinrich-Barth-Institut, Köln, pp. 239-271.

Godbole, S.V., 1925. *Pennisetum typhoideum*. Studies on the Bajri Crop. I. The Morphology of *Pennisetum typhoideum*. *Memoirs of the Department of Agriculture in India* (Agricultural Research Institute, Pusa) 14(8), pp. 247-268.

MacDonald, K., Vernet, R., Fuller, D. & J. Woodhouse, 2003. New Light on the Tichitt Tradition: A preliminary report on survey and excavation at Dhar Nema. In: P. Mitchell, A. Haour & J. Hobart (ed.), *Researching Africa's Past. New Contributions from British Archaeologists* (= Oxford University School of Archaeology Monograph No. 57). Oxford University School of Archaeology, Oxford, pp. 73-80.

Neumann, K., 2003. The late emergence of agriculture in Sub-Saharan Africa: archaeobotanical evidence and ecological considerations. In: K. Neumann, A. Butler & S. Kahlheber (ed.), *Food, Fuel and Fields. Progress in African Archaeobotany* (= Africa Praehistorica 15). Heinrich-Barth-Institut, Köln, pp. 71-92.

Poncet, V., Lamy, F., Devos, K.M., Gale, M.D., Sarr, A. & T. Robert, 2000. Genetic control of domestication traits in pearl millet (Pennisetum glaucum L., Poaceae). *Theoretical and Applied Genetics* 100, pp. 147-159.

Reddy, S.N., 1994. Plant Usage and Subsistence Modeling: An Ethnoarchaeological Approach to the Late Harappan of Northwest India. Ph.D. thesis, University of Wiscosin. Ann Arbor Michagan: University Microfilms.

Reddy, S.N., 1997. If the threshing floor could talk: integration of agriculture and pastoralism during the Late Harappan in Gujarat, India. *Journal of Anthropological Archaeology* 16, pp. 162-187.

Stuiver, M., Reimer, P.J., Bard, E., Beck, J.W., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, G., Van der Plicht, J. & M. Spurk, 1998. INTCAL98 Radiocarbon Age Calibration, 24,000-0 cal BP. *Radiocarbon* 40(3), pp. 1041-1083.

Tostain, S. 1992. Enzyme diversity in pearl millet (Pennisetum glaucum L.) 3. Wild millet. *Theoretical and Applied Genetics* 83, pp. 733-742

Tostain, S. 1998. Le mil, une longue histoire: hypotheses sur sa domestication et ses migrations. In: M. Chastanet ed., *Plantes et paysages d'Afrique. Une histoire a explorer*. Editions Karthala and Centre de Recherches Africaines, Paris, pp. 461-490.