Nonalimentary Tooth Use in Prehistory: An Example From Early Holocene in Central Sahara (Uan Muhuggiag, Tadrart Acacus, Libya)

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ABSTRACT Signs of nonalimentary tooth use were observed on the dentition of an adult male from a single burial excavated in an area close to the Uan Muhuggiag rock shelter (Tadrart Acacus, Libya), dated to more than 7800 uncalibrated years BP, that represents the most ancient human remain found in the Libyan Sahara, and provides a first glimpse of human adaptation in the early Holocene of this region. The wear pattern shows large grooves running across the occlusal surfaces of maxillary and mandibular anterior teeth and premolars. The results of macroscopic and microscopic observation, together with scanning electron microscope (SEM) examination and experimental tests, suggest that the microdamage might be due to repeated friction of vegetal fibers, probably as a consequence of basket making, net production, or mat processing. Further data are needed to allow us to distinguish among plant-oriented activities related to food acquisition (e.g., rope and net processing), food storage (e.g., basket making), or domestic handicraft (e.g., mat processing), whose implications may generate different interpretations of sexual division of labor. Am J Phys Anthropol 120:225–232, 2003. © 2003 Wiley-Liss, Inc.

During the 1991–1992 Italian-Libyan Joint Missions in the Tadrart Acacus (Fezzan, Libya), excavations at the Uan Muhuggiag rock shelter, in the central expanse of the Wadi Teshuinat (900 m above sea level), led to the discovery of human skeletal remains which are the object of the present study (Di Lernia and Manzi, 1992a,b, 1998). The aim of this paper is to present an analysis of the deep grooves observed on the occlusal surfaces of maxillary and mandibular anterior teeth and premolars.

The dentition is often used in nonalimentary activities, ranging from tooth-tool use to the use of teeth as a third hand, producing peculiar and diagnostic wear patterns on the dental enamel. Ethnographic documentation of nonalimentary tooth use includes leather processing by Eskimo women (Merbs, 1983); the use of anterior teeth as pincers or pliers by Eskimo men (Merbs, 1983); sinew processing by Australian aboriginals (Campbell, 1958, 1963; Brown and Molnar, 1990); and basket, net, or mat production (Powers, 1874; Wheat, 1967). Besides tooth-tool use, some aesthetic or cultural habits (artificial mutilation or cultural deformation, Brothwell, 1981; Blakely and Beck, 1984; pipe stem holding, Brothwell, 1981; Cruwys et al., 1992; Ubelaker, 1996; repeated nonfunctional activities, Formicola, 1988, 1991) can produce modification of tooth faces. Moreover, therapeutic, palliative, or hygienic practices such as toothpick use can give rise to interproximal grooving or other changes of enamel surfaces (Borgognini Tarli and Repetto, 1985; Puech and Cianfarani, 1988; Turner, 1988; Frayer, 1991). Documentation of prehistoric tooth wear probably due to cultural or habitual activities ranges from specimens attributed to *Homo erectus* (Boaz and Howell, 1977; Puech and Cianfarani, 1988; Turner, 1988), *Homo heidelbergensis* (Ascenzi and Segre, 1996), *Homo neanderthalensis* (Frayer and Russell, 1987; Lalueza Fox and Perez Perez, 1994), some European Upper Paleolithic (Formicola, 1988), or Neolithic samples from the Near East (Molleson, 1994).

THE SITE, THE BURIAL, AND THE SKELETON

Uan Muhuggiag represents a site of primary importance, given the artistic and archaeological

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Fig. 1. Upper incisors in mesial (M), distal (D), and labial (L) view. Mesial/distal grooves are indicated by arrows.

record collected in the past (Mori, 1965; various papers in Barich, 1987). This rock shelter is also known for the discovery of the mummified body of a child, dated to 5405 ± 180 years BP (Mori and Ascenzi, 1959).

An extensive analysis of the new skeleton discovered in 1991, in association with the contextual geoarchaeological evidence, is reported elsewhere (Di Lernia and Manzi, 1992b, 1998). The interpretation of the stratigraphic sequence and the results of carbon 14 dates on charcoal indicate that the burial was realized earlier than the range 7800–7500 years BP; it is therefore referred to late hunter-gatherers in the region, belonging to the so-called "Late Acacus" archaeological horizon (Di Lernia and Manzi, 1998).

The skeleton was in anatomical connection but poorly preserved. Only portions of the long bone diaphyses, elements of the two hands, cranial fragments, and some teeth were present. Cranial and postcranial features indicated an adult male with a robust masticatory apparatus (i.e., heavy mandibular body, marked temporal lines, and massive mastoid processes) and very large teeth (Di Lernia and Manzi, 1998). Signs of slight linear enamel hypoplasia (Goodman and Rose, 1991) were visible on the upper central incisors, lower right canine, and both lower premolars. Occlusal wear was strong (ranging between grades 5–6, according to Molnar, 1971), probably reflecting the composite effect of food, environment (sand), and nonalimentary tooth use.

MATERIALS AND METHODS

Because of the poor state of preservation, only seven isolated teeth were available for study: first upper left (LI^1) and second upper right (RI^2) incisors (Fig. 1); first lower left incisor (LI_1), right lower canine (R_C), first lower right and left premolars (RP_3 and LP_3); and second lower right premolar (RP_4).

All the dental elements were observed with a stereomicroscope (Wild 5M, magnification range 7.5–62.5×) and, together with image documentation, under a scanning electron microscope (SEM Jeol JSM 5200, magnification range 30–300×).

In order to avoid damage to the specimens, all observations were done on epoxy replicas (Araldite LY 554 catalyzed by Araldite HY 956) obtained on molds performed using high-resolution silicone-based dental impression material (Coltène President Light Body).

Groove dimensions were measured by digital electronic caliper (accuracy to 0.01 mm), while microstriation breadth was measured on the scanned photos (magnification ×150) by the computerized image analysis system Microwear 3.0 (Ungar, 1995).

An experimental model was set up in order to verify the agreement between the microdamage observed and that produced by rubbing of known vegetal fibers. For this purpose, artificial abrasion with *Typha latifolia* leaves (a plant most probably used in basketing and net production, as suggested by archaeological evidence) was produced by rubbing the occlusal surface of an upper central incisor from a Medieval burial. The apparatus, especially devised for this test, ran for a time span sufficient to produce microscopically appreciable modifications of the tooth surface. In this experiment, the duration was evaluated in an empirical way and found to be 245 hr. A detailed description of the apparatus, together with the results obtained using different animal and vegetal rubbing material, is given in Minozzi (1994–1995). In order to document the modifications induced on dental enamel, molds of the occlusal surface were taken at the beginning, at various stages, and at the end of the experimental test. The casts obtained were examined by means of binocular and SEM microscopy.

RESULTS AND DISCUSSION

All teeth examined showed a marked occlusal groove, whose average breadth was 2.5 mm (range, 1.6–3.2 mm). The grooves on upper incisors were located in distal position, running on the partially exposed dentin in a labial-distal/lingual-mesial direction.

The grooves on lower incisors, canines, and premolars were running in a labial-mesial/lingual-distal direction. A wide wear facet located on the labial margin, in distal position, was present on all lower teeth, showing the same or a mirror-like location and direction. In labial view, the whole lower teeth showed a wavy margin (Fig. 2A,B), due to the presence of mesial grooves and distal wear facets (the left central incisor excepted, which showed two symmetrical depressions on the labial margin). However, the two depressions were not equivalent in terms of microscopic characteristics, the proximal one being almost free from microdamage and the distal one being striated in a buccal-lingual direction, and therefore presumably equivalent to a groove.

In Figure 3A, the associated set of lower teeth is shown, and in Figure 3B the position of the grooves on both arches is schematically represented, and their probable direction is indicated. On the three adjacent teeth of the right lower arch (C, P_3, and P_4), the grooves have a parallel direction, while on the

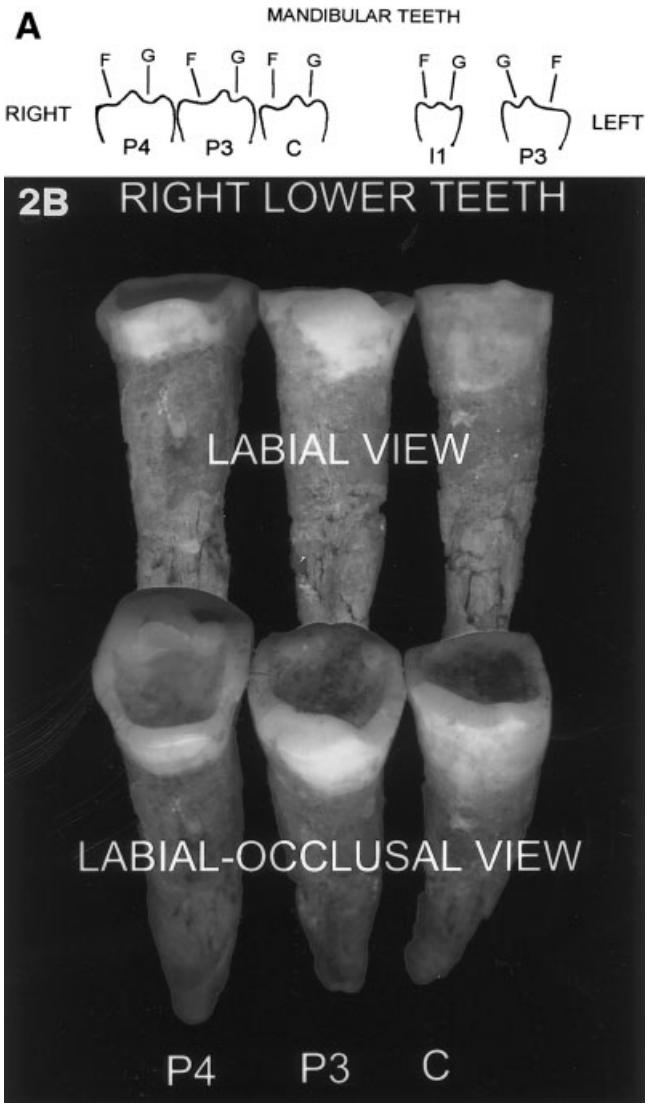

Fig. 2. A: Diagram of mandibular dentition of Umg.H2 in buccal view. Occlusal edge has a wavy appearance, due to presence of a groove in mesial position (G) and of a wear facet in distal position (F). Central incisor has two almost symmetrical indentations; the distal one was identified as a groove. **B:** Associated lower right teeth in labial and labial-occlusal view.

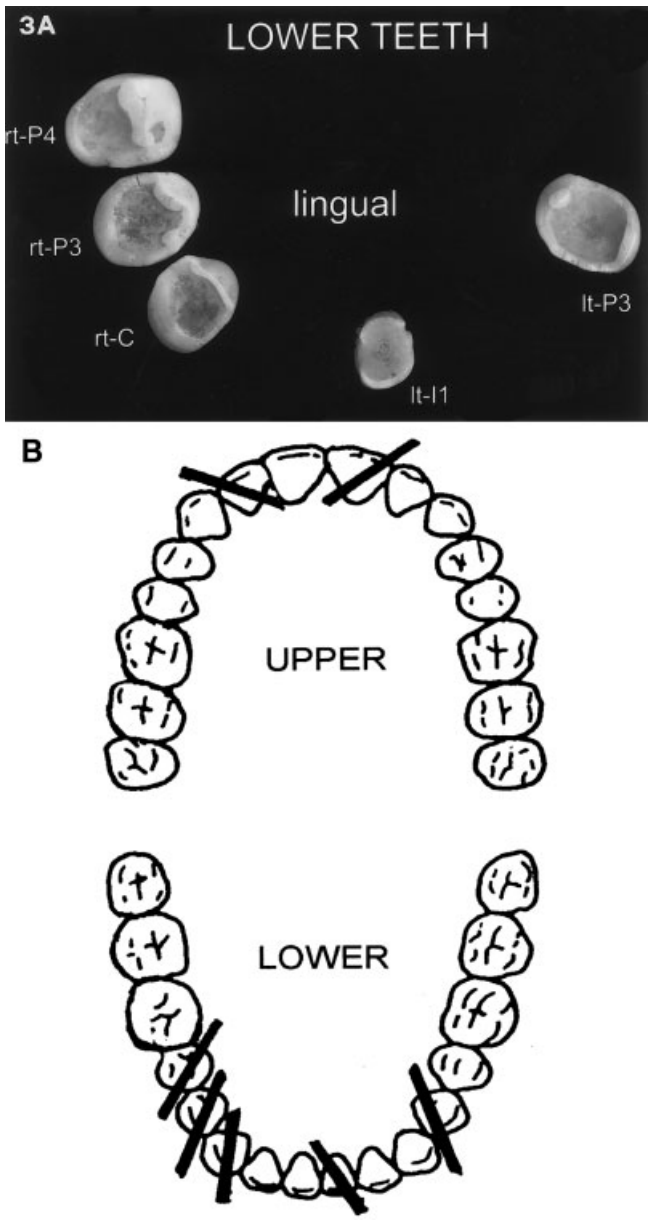

Fig. 3. A: Associated set of lower left (lt) and right (rt) teeth in occlusal view. **B:** Diagram of maxillary and mandibular dentition of Umg.H2, indicating possible positions and directions of observed grooves.

teeth of the contralateral side (the first incisor, I_1, and the premolar, P_3), the groove has a mirror-like direction.

Results of the macroscopic and microscopic wear study are reported in Table 1 and Figure 4. Taken as a whole, the observations on groove dimensions, position, and microdamage pattern suggest that the wear was produced by attrition of fibers whose diameter was between 3.2 mm (the largest groove breadth) and 1.6 mm (the smallest groove breadth). In particular, the presence of striated furrows as defined by Borgognini Tarli et al. (1989) suggests friction of fibers along the dental (mostly occlusal) surfaces. The presence of rush artifacts in Late Acacus hunter-gatherer settlements (Di Lernia, 1998; Maspero, 1999) suggests the possible vegetal nature of the abrasive material, as confirmed by striation dimensions, and by experimental data obtained with artificial abrasion on Medieval material (Minozzi, 1994–1995, and present paper). More precise indications might have been gained by exact data on groove relative position on the dental arch and on antimeres and/or on antagonist teeth, but this analysis was not possible, since the few available teeth were isolated. The position and probable direction of the grooves on the lower teeth (Fig. 3B) seem to indicate that the fiber was held or dragged in a labial-lingual direction by tooth clenching, but the absence of antagonist teeth did not allow us to exclude that the item was dragged from side to side.

TABLE 1. Results of macro- and microscopic analysis of wear pattern observed on dental surfaces of Umg.H2 (Early Holocene, Libya)

	Groove breadth	Groove position	Microwear pattern
Upper			
Left I1	2.8 mm	Distal edge	Parallel striations run along surface of groove (Fig. 4A). Labio-lingual striations and striated furrows on incisal edge and on groove surface.
Right I2	2.6 mm	Distal edge	Thin parallel striations run along surface of groove.
Lower			
Left I1	1.6 mm	Bucco-distal portion of incisal edge	Heavy wear (as opposed to low degree of wear of corresponding maxillary incisor). Short and broad parallel striations run along groove surface.
Left P3	2.6 mm	Mesio-buccal edge of occlusal surface	Thin parallel striations run along groove on occlusal surface (Fig. 4B). A small, densely pitted wear facet is present on labio-distal edge of occlusal surface.
Right C	1.8 mm	Mesio-buccal edge of occlusal surface	Parallel striations and striated furrows run along groove on occlusal surface. A wide (3.7 mm), densely striated, and pitted wear facet is present on labio-distal edge of occlusal surface.
Right P3	2.7 mm	Mesio-buccal edge of occlusal surface	Many pits and some thin striations run along surface of groove. A wide densely striated and pitted wear facet is present on labio-distal edge of occlusal surface.
Right P4	3.2 mm	Mesio-buccal edge of occlusal surface	Parallel striations run along groove on occlusal surface. Besides mesio-labial groove, a large depression is present on labio-distal edge.

Larsen (1985) observed a similar occlusal grooving attributed to basket making on male skeletons. On the other hand, a similar pattern detected by Molleson (1994) at Abu Hureyra and related to the preparation of mats, whose remains were found at the site, was observed on female skeletons. Interestingly, *Typha* sp. (marsh reed) and mat remains were found at Uan Muhuggiag, in analogy with the Early Neolithic Northern Syrian site studied by Molleson (1994). Although the *Typha* remains from Uan Muhuggiag are somewhat later (Mori, 1965) than Umg.H2, the use of mats, ropes, and baskets made by rushes in settlements from the whole Acacus area, particularly in the almost contemporaneous levels of the nearby Uan Afuda cave, is documented during a time span which includes the adult burial at Uan Muhuggiag.

We attempted a reconstruction of the working activities on the basis of the peculiar wear pattern of Umg.H2. Two nonmutually exclusive hypotheses were formulated:

1. Dragging of fibers of different nature. This movement can be done in two ways: 1) pulling the fibers in a lingual-labial direction by tooth-clenching, when the strand is thin, soft, and flexible (e.g., sinews or strings), or in the case of tooth use as pincers (e.g., for splitting fibers from stems); and 2) dragging the fibers in both directions (labial-lingual and lingual-labial), not necessarily with tooth-clenching, when the material is thicker and more rigid (e.g., twigs). An example of the first type of activity was observed among Australian aboriginals during the preparation of kangaroo tendons (Campbell, 1958, 1963; Brown and Molnar, 1990), and among American Indians during the preparation of ropes, strings, and nets (Powers, 1874; Schulz, 1977).
2. Tooth use as a third hand to grasp fibers during working activities. This type of activity was observed by Wheat (1967) among Native Americans (Paiute women) during basketry, and hypothesized by Larsen (1985) and Molleson (1994) for prehistoric samples.

Comparing the wear pattern observed in this specimen with the above data from the literature, it would seem that the grooves observed on Umg.H2 might have been determined by tooth use as a third hand during the processing of some vegetal fibers. Although basketry is generally reported as a female task, the preparation of fishnets, fowling bags, or ropes is reported as a male occupation (Larsen, 1985). In order to shed more light on the etiology of the wear pattern reported here, we tried to replicate the microdamage produced by *Typha* fibers using the experimental model described above. Figure 5 shows SEM photos of the dental surface before and after artificial rubbing. As can be observed, abrasion by *Typha* fibers produced many parallel striations. Test striations were measured using the same magnification factor as the one used for case striations ($\times$150). Striation breadth had similar values: 7 $\pm$ 0.4 μm on the test-tooth, and 8.5 $\pm$ 0.3 μm on the Umg.H2 teeth. Moreover, a comparison between the microwear patterns shown in Figure 4 (case teeth Umg.H2) and those of Figure 5 (test-tooth) showed that the morphology of striations was similar. However, when interpreting the results obtained by the above procedure, it has to be stressed that artificial conditions differ from natural ones. In particular, the absence of saliva, the different pressure, speed, and direction of movement as compared to mastica-

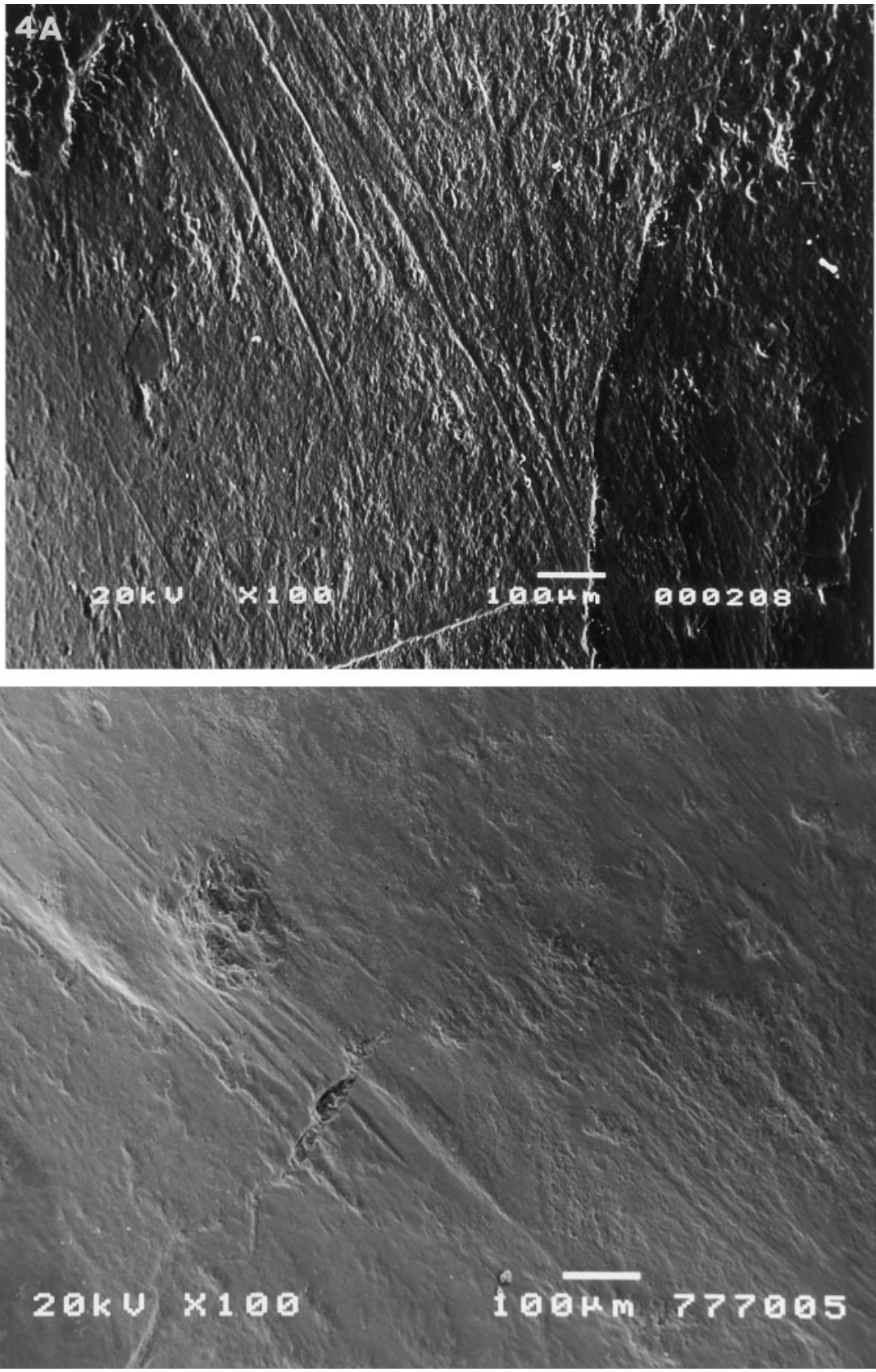

Fig. 4. A: Left maxillary central incisor of Umg.H2. Parallel striations run along lingual surface of distal groove. SEM image, ×100. **B:** Left mandibular first premolar of Umg.H2. Parallel striations run along occlusal surface of mesial groove. SEM image, ×100.

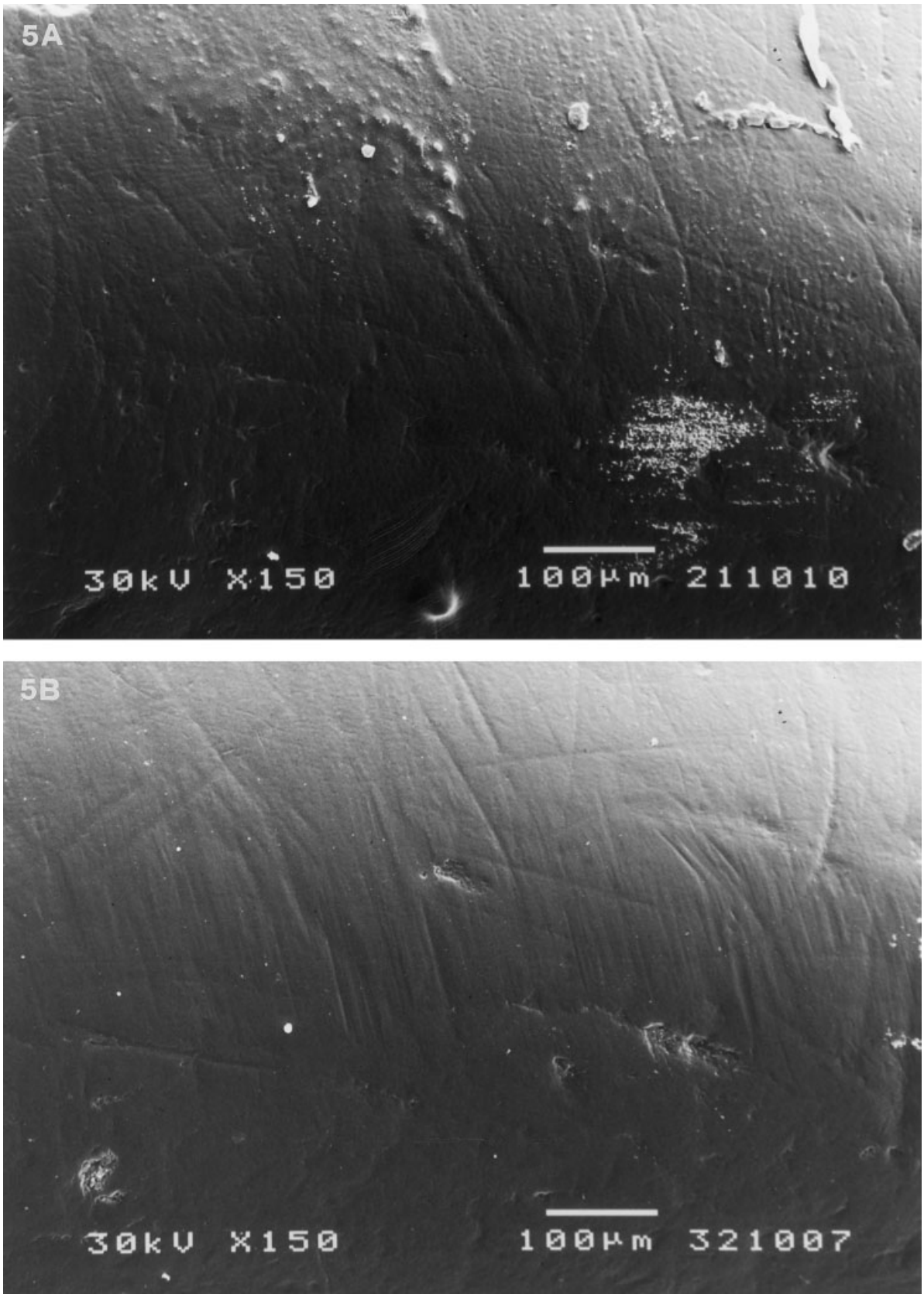

Fig. 5. A: Occlusal surface of Medieval maxillary central incisor before inducing experimental wear pattern. **B:** Same area of Medieval incisor after 245 hr of experimental friction with marsh reed (*Thypha latipholia*) leaves. SEM images, ×150.

tion proper, the absence of food items, and abrasive contaminants like sand or soil have an unpredictable effect on actual dental microwear as compared to artificial wear.

Although this last result cannot be considered conclusive, it can be used to support the hypothesis that the teeth of Umg.H2 were worn by *Typha* fibers, as suggested by archaeological evidence and by analogous findings from Abu Hureyra.

CONCLUSIONS

Macro- and microscopic examination of the preserved teeth from the Late Acacus skeleton Umg.H2 at Uan Muhuggiag, in the Tadrart Acacus (Libyan Sahara), together with the results of experimentally induced abrasion, suggest an explanation of the observed nonalimentary tooth wear. In particular, the contextual and regional archaeological evidence (Cremaschi and Di Lernia, 1998; Di Lernia, 1999a) is consistent with treatment of vegetal fibers for basketry, net working, or mat processing.

Grooves are present on the occlusal surface of all preserved teeth, and their orientation suggests symmetrical involvement of both dental arches due to friction of fibers whose diameter ranged approximately between 1.6–3.2 mm. It is probable that the teeth of Umg.H2 were used as a third hand to grasp fibers during working activities. Microscopic results of experimental abrasion of the occlusal surface of a Medieval tooth with vegetal fibers (leaves of *Thypha latifolia*, or marsh reed) did not disprove the above hypothesis, since the morphology and dimensions of experimental striations were similar to the microwear pattern observed on the dentition of the prehistoric specimen.

However, the available evidence is incomplete due to the fragmentary state of the dentition, and the experimental test is necessarily a rough approximation of actual intraoral conditions (e.g., lack of saliva, lack of interaction with dental wear due to mastication).

Of interest here are some gender implications of tooth-wear data, namely, evidence of a male activity related to plant processing. Further data are needed to allow us to distinguish among plant-oriented activities related to food acquisition (e.g., rope and net processing), food storage (e.g., basket making), or domestic handicraft (e.g., mat processing), whose implications may signal different sexual division of labor.

For late hunter-gatherer societies of the Central Sahara, emphasis on plants is a major trait (Di Lernia, 1999b), and the evidence presented here provides further support for the interpretation of a plant-oriented economic organization of these groups. Nonetheless, the relationships between the social status of the adult male buried at Uan Muhuggiag (Di Lernia and Manzi, 1998) and at least some of his life activities (e.g., the occupation suggested by tooth-wear) appear to represent an exciting frontier for the understanding of these late hunter-gatherer societies of Central Sahara.

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