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The Oldest Hominid Habit? Experimental Evidence for Toothpicking with Grass Stalks[1]

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It has long been appreciated that integrating biological and cultural data sets represents one of the most productive approaches in paleoanthropology. The earliest evidence of material culture from the hominid paleontological record consists of stone tools embedded in sediments more than 2.5 million years old (Semaw et al. 1997). Behavioral insights into the butchery of large mammals by hominids have been generated by zooarchaeological analysis of modified animal bones of equivalent antiquity. Building on this record, the remains of early hominids themselves have often been used in attempts to understand early hominid behaviors.

Early in the last century, some fossil hominid teeth were observed to bear grooves between adjacent postcanine teeth. A recent review of these interproximal wear grooves demonstrates how behaviors can be inferred from skeletal evidence (Ungar et al. 2001). These grooves appear mostly on the root, their axis often paralleling the cervicoenamel junction of some premolars and molars from members of the genus *Homo*, including *H. erectus*, *H. neanderthalensis*, and *H. sapiens*. These grooves are semicircular in mesiodistal cross section and 1.5 mm to 2.6 mm in width and typically appear as elongated ovals on the mesial and/or distal aspects of the teeth.

Interproximal wear grooves have been recognized for almost a century, and different ideas have been put forth to explain them. Ungar et al. (2001), summarizing this literature, conclude that toothpicking is the only hypothesis consistent with the known distribution, microanatomical morphology, and anatomical placement of these grooves in early hominid premolars and molars.

Next to the use of lithics, the use of toothpicks by hominids is potentially one of the most persistent behaviors visible in the archaeological record. As Turner (1988) puts it, interproximal wear grooves represent the earliest evidence of any hominid habit. Toothpick grooves provide evidence for paleodiet, oral health, and possibly, because they sometimes occur at higher frequencies in males than females in modern human populations, even gender roles (Berryman, Owsley, and Henderson 1979, Turner and Cacciatore 1998).

One of the primary criticisms of the toothpicking hypothesis is, as Ungar et al. (2001) and others (Brown and Molnar 1990) note, that these grooves have never actually been documented in the molars or premolars of modern industrialized populations, even among heavy toothpick users. Additionally, for early hominids, the regular shape of these grooves and their wide distribution in time and geography would appear to require toothpicks of a regularity of manufacture beyond what is seen even in the latest Paleolithic, and yet they are present in the Oldowan.

The most viable alternative theory is the preparation of strands of sinew (Brown and Molnar 1990). Ethnographic films from Swanport, South Australia, show sinew-stripping activities that might result in interproximal wear grooves. However, the morphology of the grooves themselves is not always consistent with such activities, since not all of the grooves are worn completely across the cervicoenamel junction from buccal to lingual and not all are uniform in shape, some being more conical. Both the toothpick and sinew explanations are plausible and not necessarily mutually exclusive. Experimentation has been called for from both sides of the debate (Eckhardt and Piermarini 1988, Frayer 1991, Formicola 1991).

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I present here experimental evidence that elucidates the etiology of these grooves. Ungar et al. (2001) note several characteristics that any dental probe creating these grooves would have required. The probes would have to have been made of a rigid, fairly inflexible material and one that left microscopic linear striations. As noted previously, modern people who frequently use toothpicks have not been found to have these grooves, but most of these toothpicks are made of wood and are not, under normal circumstances, highly abrasive (Wallace 1974). The probes must have ranged in diameter from approximately 1.5 to 2.6 mm, and they must have been widely accessible, because the grooves have been found in populations throughout the world save for those in the Arctic. One material that meets all four of these criteria is grass.

Many plants contain phytoliths, biogenic deposits of silica. These siliceous bodies are hard and very abrasive. Within the grasses, the Gramineae, phytolith production ranges from common to abundant (Piperno 1988). Because of this phytolith content, grasses cause considerable wear on the occlusal surfaces of the teeth of grazers (Walker, Hoeck, and Perez 1978). This study is designed to test the hypothesis that naturally occurring highly abrasive toothpicks in the form of grass-stalk segments that were widely available across space and time during the course of human evolution could have resulted in the occurrence of interproximal wear grooves.

Materials and Methods

Experimentation was conducted on two maxillary specimens, those of a baboon (*Papio hamadryas*) and a modern human. The experiment was first performed on the nonhuman primate to ascertain the effectiveness of grass stalks in producing these grooves. The human experiment followed. In order to replicate the oral environment that would have existed in life, both craniodental specimens were prepared with dental molding putty (Coltène President© regular body putty) to mimic the gumline (fig. 1). The dentitions were then soaked in water for 24 hours prior to the initiation of the experiment and kept moist during the toothpicking.

Grass-stalk toothpicks of approximately 7–10 cm in length and 0.5–2.0 mm in diameter were prepared from a wide variety of North American Gramineae species. These grass stalks were oriented as they would have been if used as a toothpick in life (see fig. 1, following Berryman, Owsley, and Henderson 1979) to wear on the mesiolingual cervicoenamel junction of the baboon maxillary left first molar (LM^1) and between the maxillary right third and fourth premolars (RP^3 and RP^4) of the human. Toothpicking was performed for a total of eight hours on the baboon specimen. These were short strokes probing into the gumline. For the human specimen, the grass toothpicks were moved buccolingually completely across the side of the tooth, with the stalk passing from the cheek side all the way into the oral cavity. For the human experiment, 40 toothpicks were used, evenly spread over the course of three hours of interproximal probing.

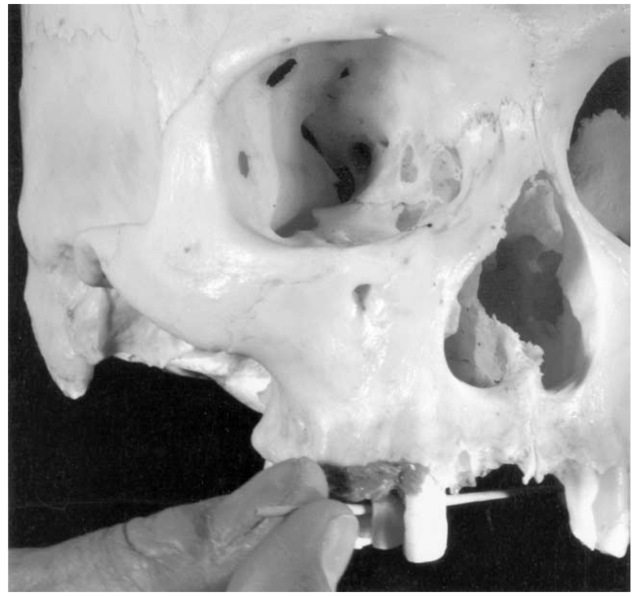

Fig. 1. *Modern human experimental subject with artificial gum created with putty. Grass-stalk toothpick placed in orientation of axial motion.*

Results

The baboon LM^1 mesiolingual groove is 3.5 mm long and 1.75 mm in diameter. It is oval in appearance and superiorly oriented. On the human RP^3 a groove 5.4 mm in length and a uniform 1.4 mm in diameter was worn parallel to the cervicoenamel junction (fig. 2,*a*). When examined under a light microscope, both specimens were found to have linear striations running parallel to the grass-stalk orientation that were identical to those seen in previous experimental studies and scanning electron microscopic images of early-hominid interproximal wear grooves (Walker, Hoeck, and Perez 1978, Ungar et al. 2001).

Discussion

These results show that the use of grass-stalk toothpicks produces grooves whose macro- and micromorphologies are identical to many of the interproximal wear grooves identified in the hominid fossil record and in modern human osteoarchaeological collections. Given the ubiquity of diverse grass species throughout the world and the fact that these objects are effective toothpicks requiring little or no modification prior to use, toothpicking activities employing grass stalks probably produced many of the interproximal grooves documented for ancient and modern humans. Experimentation with sinew

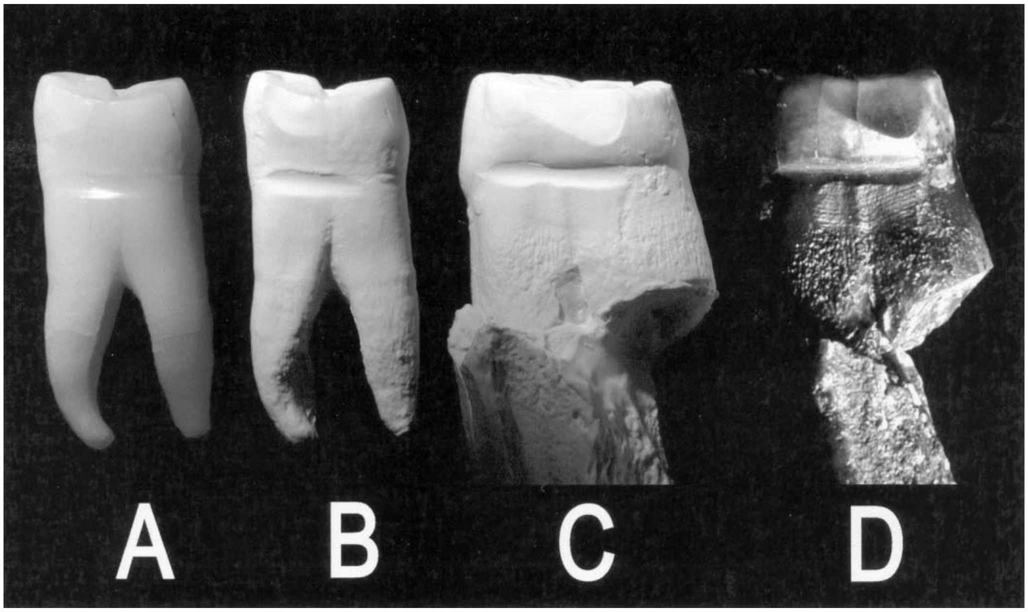

FIG. 2. a, *human experimental subject, mesial view of RP³;* b, *plaster replica of* a, *highlighting the interproximal groove;* c, *cast of Omo L 894-1, RP³, showing interproximal groove;* d, *original Omo L 894-1 RP³ fossil specimen (courtesy T. D. White).*

stripping is needed to assess the plausibility of that hypothesis, but the observation of interproximal groove distribution in molars and premolars and not the anterior dentition renders this latter hypothesis less likely (Frayer 1991, Ungar et al. 2001).

It is not surprising that grass-stalk toothpicks, with their highly abrasive phytolith content, might produce significant interproximal grooves, but this is the first time that replicative studies have demonstrated this phenomenon. The unexpected result of this study is how little time it takes to produce large interproximal grooves. Only three hours and 40 grass-stalk toothpicks were needed to reproduce the dramatic groove seen on the human RP³, which is remarkably similar to that seen on the 1.8-million-year-old fossil *Homo* premolar from the Omo (Boaz and Howell 1977), one of the oldest known hominid specimens with this type of wear (fig. 2, *b–d*). Interproximal grooving has been attributed to prolonged habitual idiopathic compulsive use of dental probes (Formicola 1988). The demonstration that such grooves can be reproduced with grass toothpicks in a relatively short amount of time and with minimal effort combines with the wide distribution of these grooves to suggest that these features may not represent such abnormal behavior as has been suggested (Turner and Cacciatore 1998).

These experimental replications demonstrate that grass-stalk segments used as toothpicks are capable of creating interproximal wear grooves identical to those found in the hominid fossil record. Therefore toothpicking with grass stalks probably represents the most persistent habit documented in human evolution.

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