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Reconstructing diet and behavior in bioarchaeological groups using incisor microwear texture analysis ☆

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ABSTRACT

Diet and behavioral strategies of modern humans are examined through several indirect and direct lenses. One of the direct lenses is dental microwear texture analysis (DMTA), which examines enamel texture signatures associated with food fracture properties or behavioral regimes. While molar texture signatures are linked to dietary proclivities, those of incisors appear to reflect diet, abrasives, and non-dietary anterior tooth use behaviors. This study builds upon previous research of incisor microwear textures with the addition of six recent modern human groups. This expands the known database of incisor microwear textures to 11 bioarchaeological samples.

Dental microwear textures from six bioarchaeological samples ($n = 142$) were collected using a white-light confocal profiler with a 100× objective lens. High-resolution casts of maxillary central incisors were scanned for clean, antemortem microwear textures. Four adjacent scans of the labial surface, nearest the incisal edge, were created, defects were removed, and scans were characterized for microwear textures using SFrax and Toothfrax scale-sensitive fractal analysis software packages.

Results show that the samples differ significantly from each other in four texture variables: anisotropy, textural fill volume, heterogeneity, and complexity. These data strengthen previous hypotheses concerning anisotropy and textural fill volume as indicators of non-dietary anterior tooth use and anterior loading regimes, respectively. Moreover, while heterogeneity indicates abrasive load exposure, this measure may be exacerbated by non-dietary behaviors. Complexity is found to be significant in the current study and may reflect a balance between abrasive loads and non-dietary regimes.

1. Introduction

Dental microwear texture analysis is a useful tool for discerning differences in dietary and behavioral strategies of fossil and modern hominins (Scott et al., 2005, 2006; Krueger and Ungar, 2010, 2012; Ungar et al., 2008, 2010, 2012). While molar microwear is especially valuable for distinguishing dietary proclivities (e.g. El Zaatari, 2008, 2010; Scott et al., 2005; Ungar et al., 2008, 2010), incisor microwear texture studies show considerable promise in understanding behavioral strategies, such as non-dietary anterior tooth use behaviors and abrasive load exposure (Krueger and Ungar, 2010, 2012). Pilot research conducted on five bioarchaeological samples generated preliminary hypotheses that suggested incisor microwear textures may be useful for determining differences in behavioral strategies (Krueger and Ungar, 2010). The present study tests these hypotheses by analyzing incisor microwear textures of six additional bioarchaeological samples with a range of dietary and non-dietary behaviors.

The samples presented here are ethnographically documented or inferred to have used their anterior teeth in distinct non-dietary behaviors. These behaviors encompass a range of activities, including hide production, wood and vegetation softening, and tool retouching. Additional factors incorporated into analysis include dietary behavior and abrasive exposure, which also affect anterior dental wear. Further analyses will no doubt shed light on these factors, as well as recognize potential connections between microwear textures and behavioral regimes.

Results presented here strengthen previous analyses, which demonstrate the importance of anisotropy (*epLsar*) for disentangling non-dietary from dietary tooth use, textural fill volume (*Tfv*) for understanding anterior loading regimes, and heterogeneity (*Hasfc*) for understanding exposure to abrasive loads. Moreover, complexity (*Asfc*) is newly significant here, and preliminary hypotheses are generated for this variable. These data can be used to better understand the adaptive strategies of these bioarchaeological groups and, when combined with those groups from Krueger and Ungar (2010), are a valuable comparative database for better understanding the behavioral regimes of our fossil hominin ancestors.

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2. Background

Incisor microwear analysis has been used to determine several factors associated with ingestive and non-ingestive behaviors of non-human primates, fossil hominins, and bioarchaeological samples (Bax and Ungar, 1999; Lalueza Fox and Frayer, 1997; Kelley, 1990; Krueger, 2011, 2014; Krueger and Ungar, 2010, 2012; Ryan, 1980, 1981, 1993; Lukacs and Pastor, 1988; Ryan and Johanson, 1989; Spencer and Ungar, 2000; Ungar, 1990, 1994a,b; Ungar and Grine, 1991; Ungar and Spencer, 1999; Walker, 1976). Additional studies have tested whether striations on the labial surfaces of hominin and recent modern human incisors could determine handedness (Bax and Ungar, 1999; Bermúdez de Castro et al., 1988; Lalueza Fox and Frayer, 1997), while others have investigated whether such cultural factors as lip labret use, clamping and grasping activities, tool chipping, and weaving practices yield specific microwear signatures (Krueger, 2011, 2014; Krueger and Ungar, 2010; Lukacs and Pastor, 1988; Ryan, 1980, 1993; Ryan and Johanson, 1989; Ungar and Spencer, 1999).

More recent work on incisor microwear has established its importance for determining the dietary strategies, abrasive loads, and non-dietary anterior tooth use behaviors of modern humans and Neandertals (Krueger, 2011; Krueger and Ungar, 2010, 2012). This work focused its methods on texture analysis, an objective and repeatable technique for the study of dental microwear. Preliminary research on bioarchaeological samples found that anisotropy, textural fill volume, and heterogeneity 3 × 3 were particularly useful for distinguishing samples by their diet, abrasive loads, and non-dietary anterior tooth use behaviors (Krueger and Ungar, 2010). This study expands upon that research in an effort to reinforce, revise, and develop new hypotheses for incisor microwear signatures and behavioral regimes of bioarchaeological groups.

3. Materials and methods

A total of 142 permanent maxillary central incisors from six modern human bioarchaeological samples were used in this analysis (Fig. 1). These samples extend from 5000 BP to the early 20th century. The samples are: Andamanese ($n = 15$), Chumash ($n = 19$), Nunavut Territory Sadlermiut ($n = 27$), Point Hope Ipiutak ($n = 22$), Point Hope Tigara ($n = 34$), and Prince Rupert Harbour Tsimshian ($n = 25$). Detailed information about the diet, non-dietary anterior tooth use behaviors, and abrasive loads of each sample is provided below.

3.1. Materials

3.1.1. Andamanese

3.1.1.1. Study sample. The Andamanese sample is from Port Blair, Great Andaman Island, and dates to the second half of the 19th century, after the British colonized the region (Man, 1883, 1885; Portman, 1899).

3.1.1.2. Diet. The Andaman Island diet consisted of wild pig, turtles, turtle eggs, shellfish, fish, coconuts, wild fruit, tubers, roots, palms, honey, nuts, seeds, and grubs (Man, 1883, 1885).

3.1.1.3. Non-dietary anterior tooth use behaviors. Ethnographic reports describe the Andamanese participating in stuff-and-cut practices, straightening wood, and retouching arrow points with their anterior teeth (Man, 1883, 1885).

3.1.1.4. Abrasive loads. Port Blair is a coastal site, so it is hypothesized that environmental abrasives, such as sand, may have contributed to the Andamanese abrasive load.

3.1.2. Chumash

3.1.2.1. Study sample. The Chumash sample is from Santa Cruz Island, part of the Santa Barbara Channel Islands, and dates from 5000 to 4000 years BP (Van Valkenburgh, 1933).

3.1.2.2. Diet. The Chumash diet consisted of abalone, fish, sea otter, seals, sea lions, island fox, skunk, mule deer, birds, nuts, acorns, wild cherries,

Fig. 1. A global map showing the locations of the bioarchaeological samples analyzed in this paper (bold font) and those from Krueger and Ungar (2010, regular font).