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Methodology for Analysis of Diet Grit Size on Molar Attrition for Fourche Maline and Caddo People

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ABSTRACT

Using the Murphy (1959) system for scoring the degree of dentin exposure, Fourche Maline (Woodland) molars show a greater attrition rate than Caddo (Mississippian) molars. Archeological evidence suggests that this differential in attrition rates is caused by the use of stone grinders for food preparation in the Fourche Maline culture and their absence among the Caddo. Analysis of scratches on the occlusal surface of molars from these samples confirms this hypothesis. Several techniques for observing these scratches and reconstructing the grit sizes and grit particle frequencies responsible for this differential abrasion are evaluated.

INTRODUCTION

The reconstruction of prehistoric diets for some time has been of interest to both archeologists and biological anthropologists. One important aspect of this reconstruction is a consideration of the effects of consistency of diet and various food processing techniques on the rate of dental attrition. For example, Dahlberg (1960) reports the rapid dental attrition of Neolithic agriculturalists, and others note a decline in attrition rates as food preparation techniques improve (Armelagos and Rose 1972; Molnar 1971). Walker (1976) demonstrates that the prehistoric inhabitants of Santa Rose Island had greater dental attrition rates than the inhabitants of the California mainland. This increased rate is attributed to the islanders' maritime adaption and the sand and grit associated with seafood.

This study is concerned with reconstruction of the dietary consistency of the Fourche Maline (ca. 500 B.C.-800 A.D.) and Caddo (ca. 800 A.D.-1550 A.D.) cultures of western Arkansas and eastern Oklahoma. McWilliams (1970) states that the Fourche Maline focus (considered Middle Woodland) probably represents a peripheral survival of a southeastern U.S. Archaic hunting and gathering complex. Burials were interred in midden areas containing large quantities of fresh water mussel shells and animal bones, but no evidence of cultigens. Collected plant food was prepared in stone grinders commonly found at Fourche Maline sites. Caddo subsistence patterns include maize agriculture in addition to the harvesting of wild plants and hunting. Stone grinders are notably absent from Caddo sites, and it is assumed that wooden mortars were used in food preparation (Swanton 1942: 131, 134). The use of these wooden mortars would not be expected to contribute as much grit to the diet, and this should be reflected in dental attrition rates. It is this assumption, that the Caddo did not use stone grinders for food preparation, which is tested in this study.

DENTAL ATTRITION

The Fourche Maline sample consists of 18 individuals aged between 18 and 30 years from the Sam and Wann sites in eastern Oklahoma. The Caddo sample consists of 22 individuals aged between 18 and 30 years from 8 Caddo sites in southwestern Arkansas. Attrition rates were determined using the Murphy system (1959) which assigns each tooth a numerical value (1-8) based on the progressive exposure of dentin on the occlusal surface of the molar. This system allows computation of the mean attrition stage for each molar as well as the attrition gradient. The attrition gradient is defined as the difference in attrition between the first and second, and the second and third molars as a result of differences in eruption time.

The mean attrition scores for the Fourche Maline sample are 6.9, 5.4 and 1.9 for the first, second and third mandibular molars respectively. The attrition gradient is 1.5 and 3.5. The mean attrition scores for the Caddo sample are 2.5, 1.5 and 0.36 for the first, second and third molars respectively. The attrition gradient is 1.0 and 1.1. The Fourche Maline dental attrition rate is twice that of the Caddo sample, appearing to support the assumption that the Caddo did not use stone grinders in food preparation. The data, however, only establish that there are differences in attrition rates; it does not provide information on the consistency of the diet. To establish differences in the consistency of the diet, a microscopic analysis of the occlusal surfaces of mandibular molars was attempted.

MATERIALS AND METHODS

Optimally, this type of analysis is performed with the scanning electron microscope as reported by Shkurkin and co-workers (1975). However, this procedure is expensive and is not feasible for routine analysis. Consequently, the following techniques were tried in order to observe the attrition or abrasion pattern of human enamel.

Five mandibular molars were selected from both the Roden and Mahaffey skeletal collections. The Roden collection represents the Caddo tradition, and the Mahaffey collection represents the Fourche Maline. Both sites are from eastern Oklahoma and exhibit attrition rates comparable to the skeletal series reported above. After cleaning in a sonic cleaner with 95% ethanol for two hours, each tooth was mounted on a slide with beeswax so that the occlusal surface would be as parallel to the microscope as possible.

After a number of attempts to make peels of the occlusal surface (e.g., using various concentrations of acetate and acetone) it was found that the best results involved photographing the occlusal enamel surface through a Zeiss universal microscope with reflected nomarski differential interference contrast optics. Four flat areas of each tooth were photographed at 160 magnifications, with Panatomic X 35mm film developed at 100 ASA. The negatives were printed on 8 x 10 paper at an enlargement of 10X. Counts and measurements of the scratches were taken directly from these prints. Scratch widths were measured with a needle point Helios dial caliper to the nearest tenth of a millimeter. Counting procedures utilized a Weibel linear grid pattern of 15 lines each 4cm long, scribed on an acetate sheet which was laid over each photograph. Any scratch intersecting a scribed line was counted.

RESULTS

General observations of the photographs of the 10 teeth in the sample showed some differences between the two cultures. Both Roden and Mahaffey teeth show a quiltwork pattern of short narrow scratches characteristic of all human tooth wear. On the Roden teeth these scratches are overlain by a random pattern of long deep scratches varying in frequency per photograph from none to many. The Mahaffey teeth also contain deep scratches varying from moderate to many on all photographs with much of the quilt pattern being obliterated.

The best photograph of each tooth in the sample was chosen for total scratch counts. All scratches intersecting the 15 lines in the

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Weibel grid were tabulated, and mean frequencies per 4cm grid line were calculated (Table 1). The mean frequencies and variances were not significantly different within each culture. However, a mean abrasion frequency for the five Caddo teeth of 9.6 as compared to 14.0 for the Fourche Maline molars is significant at the five percent level using a one tail student's t statistic.

The apparent differences between the patterning of abrasions as caused by large particles was then investigated. The widths of the 17 largest abrasions were measured for both samples, which resulted in mean widths (as measured on the prints) of 3.4mm for Fourche Maline and 3.6mm for Caddo. This would suggest that there is no real difference in particle size between the two cultures. The smaller abrasions (less than 1mm in width) are not reliably measured. The frequency of large abrasions (at least 1mm in width) was tabulated for each tooth (Table 2) using the Weibel grid and averaging the total grid scores from the four photographs of each tooth. The Fourche Maline teeth have over twice the abrasions ($\bar{m}$=25.0) as the Caddo teeth ($\bar{m}$=10.3). These differences are significant at the one percent level (student's t).

Table 1. Mean frequency of abrasions per 4cm Weibel grid line

FOURCHE MALINE		CADDO	
MOLAR	MEAN FREQ.	MOLAR	MEAN FREQ.
m40-1	13.3	r2-b	7.7
m4	17.9	r1-a	10.8
m58h	16.7	r1-b	13.2
m2	14.3	r1-c	8.0
m40-2	8.0	r18	8.1
mean	14.0	mean	9.6

Table 2. Mean frequency of abrasions larger than 1mm for Fourche Maline and Caddo molars

FOURCHE MALINE		CADDO	
MOLAR	MEAN	MOLAR	MEAN
m40-1	41.8	r2-b	11.0
m4	21.8	r1-a	21.8
m58h	22.2	r1-b	9.2
m2	18.2	r1-c	7.8
m40-2	21.2	r18	11.0
mean	25.0	mean	10.3

DISCUSSION

The attrition rate data demonstrate that the Fourche Maline suffer more than twice the tooth loss due to abrasion than do the Caddo. This greater attrition rate can be attributed to either a greater frequency of particles in the diet and/or the inclusion of larger particles in the diet. An examination of the total abrasion counts indicate that the Fourche Maline have a slightly greater frequency of observable abrasions, which indicates an increase in particle frequency in the 0.5 to 5.0 micron range. Particles of smaller dimensions would not leave abrasions observable by this technique (verified with standard thin section abrasives). For the 5 micron and greater range of particle sizes, the Fourche Maline have more than twice the abrasions of the Caddo. This greater number of the larger abrasions in the Fourche Maline sample indicates that at least part of the greater attrition rate can be explained by an increased frequency of these larger particles in the diet.

Dental attrition of dietary origins results from the abrasions of coarse foods such as roughly milled grains. All people also suffer to some extent from abrasion due to accidentally introduced sand and grit in the diet. Due to the many similar ecological and cultural conditions for the Fourche Maline and Caddo cultures, this grit content might be expected to be similar for both groups. However, the use of stone manos and metates for grinding grains provides an excellent source for numerous fine particles (not observable in this study) as well as numerous larger particles of silicon to be introduced into the diet. The rapid attrition of metates from use in grinding grain is easily observed in archeological specimens. If the assumption is correct that the Caddo utilized wooden mortars for pounding grains the frequency of large particles in the diet should be significantly smaller than the frequency for the Fourche Maline peoples. This initial research demonstrates a significantly lower frequency of the larger particle sizes in the Caddo diet.

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