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# Dental Health at Oakwood Mound, Will County, Illinois

Daniel L. Osborne

*Human dentitions from Oakwood Mound were examined to ascertain dental health in this population. Attrition rate, carious lesions, and antemortem tooth loss were scored for each adult. No significant differences were present between the aforementioned variables by age or sex. The attrition rate supports the hypothesis that the individuals interred in Oakwood Mound shared similar subsistence strategies. The prevalence of carious lesions suggests a dependence on carbohydrates as a major dietary resource. High rates of antemortem tooth loss also may have resulted from reliance on this food source, although this connection is not as direct as the caries data. These data, along with more recent data on Langford subsistence, support the notion that these groups strongly relied on maize agriculture as a dietary staple. There appears to have been very little difference in maize consumption between Langford and neighboring Mississippian groups. These results are tentative, pending further information from other Mississippian sites.*

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## Introduction

**T**he Oakwood Mound (Figure 1) located in Joliet, IL, was excavated in 1928 by archaeologists from the University of Chicago (Skinner 1953). Work was halted before the mound was completely excavated, further limiting the amount of data available for analysis. Little is known about this site, largely due to a paucity of artifacts and limited investigation of the mortuary data and skeletal material. Skinner (1953) places it as an Upper Mississippian site based on the presence of grit-tempered ceramic vessels with rolled lips and marked shoulders. It is now recognized, based on the method of mound construction and ceramic type, that Oakwood belongs in the Langford tradition (Emerson 1999; Jeske 1990).

The Langford tradition existed for approximately 300 years (A.D. 1200–1500) in the Upper Illinois River Valley and its tributaries (Brown et al. 1967; Emerson 1999; Jeske 1990). Langford sites are found in a variety of settings, including river bottoms and tributary streambeds on prairies, forested bottom lands and bluff tops, or marshlands (Brown et al. 1967; Emerson 1999; Jeske 1990). Such environments would have provided the local inhabitants with a variety of foraging opportunities, as well as fertile soil for agriculture.

The sudden appearance and decline of the Langford tradition is widely believed to be due largely to social and political influences from Mississippian chiefdoms from the south (Emerson 1999; Jeske 1990). Both Emerson (1999) and Jeske (1990) agree that such an influence would result in consistent settlement, mortuary, and subsistence patterns, as well as

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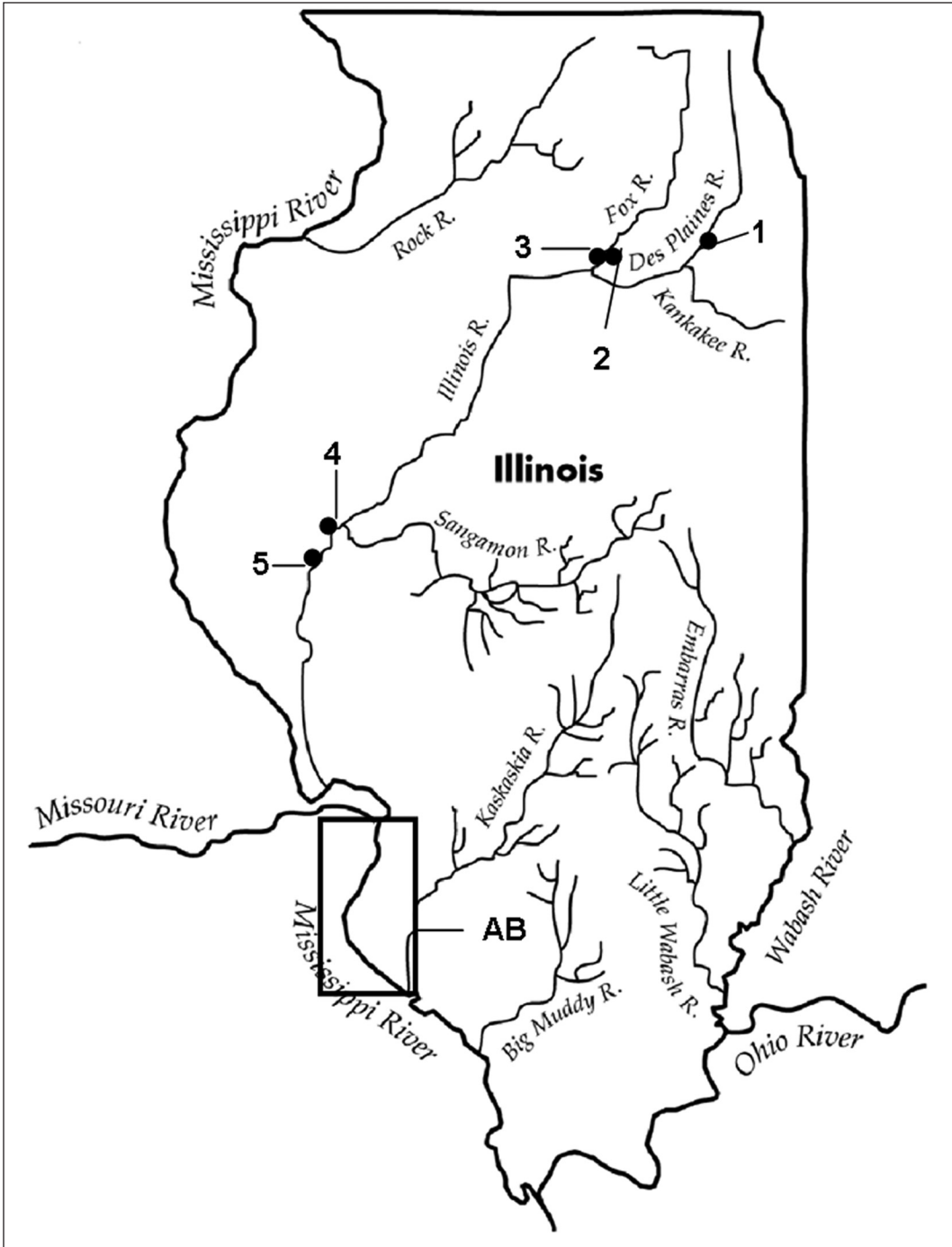


Figure 1. Locations of sites referenced in text; 1) Oakwood Mound, 2) Material Service Quarry, 3) Gentleman Farm, 4) Corbin Mounds, AB American Bottom.

intergroup relations in a process termed “Mississippianization.” Emerson (1999) and Jeske (1990) are quick to point out the need for further data collection to better understand how specific populations were affected during this period in prehistory.

The relative importance of maize in the subsistence of Mississippian peoples remains open for debate and appears to vary by region (Emerson 1999; Jeske 1990). Possible reasons for the observed variation in maize consumption could have important implications in reconstructing sociopolitical complexity during this period. Specifically, the recent literature on this period in prehistory indicates that the peoples of Cahokia were sedentary year round, while smaller tribal populations to the north were quite mobile, dividing into winter hunting bands and living communally for the remainder of the year (Emerson 1999; Jeske 1990). If this is the case and if greater reliance on maize agriculture afforded Cahokian populations a sedentary lifestyle, then one would expect to see differences in the skeleton consistent with observed differences in agricultural and foraging groups.

In an attempt to illuminate subsistence patterns among Langford peoples, Emerson et al. (2005) analyzed archaeobotanical, paleopathological, and stable isotope data to assess dietary trends at several Langford sites. The authors used archaeobotanical data to inform about the relative contribution of nuts, maize, and indigenous plants to the diet of Langford populations and compare them to Mississippian groups from different regions, such as the American Bottom (Emerson et al. 2005). The archaeobotanical data suggest that Mississippian and Langford groups were equally reliant on maize as a food source, regardless of region. As the authors point out, if we are to assume that maize agriculture is associated with “longer term, more intense occupations,” then it would appear that these data support the notion that Langford groups were in fact sedentary for most if not all of the year (Emerson et al. 2005:87). However, while Langford populations relied on maize as a staple crop, they differ from other Mississippian groups in that they did not rely on the Eastern Agricultural complex but rather used local flora, such as nuts, fruit, and tubers, possibly as a safeguard against crop loss.

Using samples from the Gentleman Farm and Material Service Quarry sites, the authors evaluated skeletal lesions and dental pathology and morphology, all essential for study of paleodiet. General inflammatory lesions present at these Langford sites were comparable in frequency to those at sites from the American Bottom as well as the Dickinson Mound site (Emerson et al. 2005). These lesions are signs of chronic disease stress and are commonly found in prehistoric groups whose high population densities fostered the transfer of communicable disease. Similarly, the frequency of linear enamel hypoplasia, an indicator of developmental arrest, for the Gentleman Farm and Material Service Quarry sites exceeds values reported for the American Bottom sites. Likewise, the frequency of carious lesions in the Langford samples also exceeds that which is reported for the American Bottom sites (Emerson et al. 2005). These patterns of poor skeletal and dental health typify prehistoric agriculturalists (Larsen 1997).

To maximize their understanding of the dietary strategies of Langford peoples, the authors evaluated stable isotope data for the Gentleman Farm and Material Service Quarry sites (Emerson et al. 2005). Isotopic data on  $\delta^{13}\text{C}$  are particularly useful in evaluating the transition from  $\text{C}_3$  to  $\text{C}_4$  plant consumption, a process often attributed to the shift from local resources to maize agriculture in the Midwest. Data on nitrogen isotope values illuminate the relative contribution of animal protein to the diet. Both Langford sites analyzed by the authors suggest substantial maize consumption and a diet that was primarily plant based

but that included a fair amount of meat consumption (Emerson et al. 2005). Interestingly, the data suggest that the population at the Gentleman Farm site likely consumed a greater proportion of C<sub>4</sub> resources than did the population at the Material Service Quarry site (Emerson et al. 2005). The isotopic data from the Langford sites is comparable to what has been published for other Mississippian sites.

These sites show that maize agriculture was a major contributor to dietary strategy. The relative contribution of maize to the diet of Langford peoples appears to be on par with that of other Mississippian groups. While these data are compelling, it is important to evaluate these findings against other Upper Mississippian sites.

To this end, dental health of adult remains from Oakwood Mound were analyzed to ascertain dietary strategy. Because teeth are the only part of the skeleton that come into direct contact with the external environment, features such as dental wear and pathology are helpful in illuminating dietary patterns (Burt 1993; Hillson 1996; Larsen et al. 1991; Powell 1985, 1988). Dental wear also is informative about the life histories of individuals because increased wear tends to be associated with foraging populations and decreased wear with agricultural groups (Benfer and Edwards 1991; Kaifu et al. 2003), although evidence suggests that this kind of wear pattern may indicate a change in food processing technology (Pechenkina et al. 2002). Dental wear not only informs about dietary strategy but also shares an inverse relationship with the prevalence of carious lesions; with more wear on the dentition, there tend to be fewer carious lesions (e.g., Kaifu et al. 2003). However, evidence exists to the contrary because this relationship seems partly dependent on processing technologies. For instance, the use of grinding stones introduces more grit than the use of wood-based tools, resulting in more dental wear in the agricultural groups that employ such technology (Larsen 1997). In addition to macroscopic dental wear, dental microwear also has been employed to investigate dietary history. For example, Schmidt (2001) found that a diet high in grit and plant material will produce microscopic wear in the form of scratches, while a diet high in hard foods will produce a higher percentage of pitting. Schmidt (2001) used these data to identify a shift in subsistence practice toward greater reliance on hard food sources, such as nuts and seeds. Studies on microwear analysis are somewhat limited in that they provide a relatively limited view of dietary history because the features used to evaluate diet appear to have a high turnover rate (Scott et al. 2006).

Enamel survives in archaeological contexts very well, as do the features that result from various pathological and mechanical forces that act on teeth. Further, dental data are characterized by low intra- and interobserver error, making comparisons between different studies a viable research option. Thus, the dentition provides a very informative view of a group's subsistence practices. This paper examines the dental health of the adult individuals interred in Oakwood Mound with two goals in mind: (1) examine population homogeneity in subsistence strategy as reflected by rates of dental wear, and (2) examine antemortem pathologies (i.e., caries and antemortem tooth loss) as a means of inferring subsistence strategy. These results are subsequently placed within a regional context.

## Materials and Methods

Craniodental remains from the Oakwood Mound were examined to determine the demographic profile of this population. Because this analysis is concerned with establishing the

probable subsistence strategy in this Langford sample, only adults were analyzed. Dental health in these individuals reflects lifetime exposure to diet and therefore presents a better indicator than would subadult dentition. Subadults were categorized as such based on dental eruption and were excluded from analysis. Given the abundance of data suggesting that age estimation in the adult skeleton is highly variable (e.g., Katz and Suchey 1986; Nawrocki 1998; Osborne et al. 2004), a conservative approach was taken in creating the age groups. Adult age categories were determined via dental wear and were divided into three categories: (1) young adult, (2) middle adult, and (3) old adult. If dentition were not sufficiently present, cranial suture closure was used to estimate age at death (Nawrocki 1998). Sex of the adult individuals was determined via cranial morphology and was scored as female, male, or indeterminate. There were approximately 35 crania examined, most of which were female. The demographic structure of the adult portion of this sample as determined by the available craniodental material is provided in Table 1. Given the bias in the age classes in this sample, the 30–50 and 50+ year age groups are combined in subsequent statistical comparisons of the data between males and females.

Dental wear of adult individuals was scored after Murphy (1959). In this system, attrition is organized along on a continuum ranging from “no wear” to severe attrition or “H1.” Maxillary left molars were scored unless absent, in which case the right side was used (Table 2). Results of the dental wear analysis were quantified so that tests of significance could be performed. The principle axis method was used to examine wear gradients of the rate of dental wear in this population to address the possibility that the individuals interred in this mound exploited different subsistence types. The principle axis method regresses the

*Table 1. Demographic Profile.*

	<b>18-30 Years</b>	<b>31-50 Years</b>	<b>50+ Years</b>	<b>Total</b>
Female	16	9	1	26
Male	1	1	7	9
Total	17	10	8	35

wear score for the first molar onto the wear score for the second molar (Benfer and Edwards 1991). If the slope is high, this reflects a high-wear environment that one might expect to see among foragers, who often have a greater proportion of grit in their diets (e.g., Kaifu et al. 2003). Conversely, a low slope value suggests a low-wear environment, as is common in agricultural subsistence. The third molars were not used in this analysis given their increased variability in eruption timing relative to the first and second molars (Powell 1988). High rates of antemortem tooth loss may influence the results of dental wear analysis.

Each tooth was scored for carious lesions by anatomical location (Buikstra and Ubelaker 1994). A conservative approach was taken such that only caries in an advanced stage of decomposition were scored. Using such methodology decreases the chances of scoring enamel defects as caries, thereby avoiding inflation of the data. If carious lesions were too large to determine their source, they were scored as “large caries.” Carious lesions result from greater consumption of carbohydrates. Generally speaking, carbohydrate-rich foods such as maize are not as available to foragers as they are to intense horticulturalists or agriculturalists. Thus, one would expect caries frequency to increase with greater reliance

*Table 2. Dental Attrition at Oakwood Mound.*

Wear Score	Female Maxillary Molars			Male Maxillary Molars		
	1	2	3	1	2	3
No wear present	0	1	5	0	0	0
A	2	3	3	0	0	1
B	2	5	1	0	1	1
C	3	3	0	0	0	1
D	3	2	0	1	0	0
E	4	1	0	0	1	0
F	2	0	0	0	1	0
G	1	0	0	2	1	1
H	0	0	0	1	1	0
H1	0	0	0	1	0	0

on carbohydrate-rich foods such as maize (Larsen 1995). There are several negative health consequences associated with a maize-rich diet, but the goal of this analysis is simply to identify the likely subsistence base(s) of the individuals interred at this site.

Antemortem tooth loss was scored for each individual when teeth were absent upon investigation and the alveolus clearly demonstrated healing. Antemortem tooth loss may be caused via ablation, trauma, or infectious means (Hillson 1996). However, there was only one clear case of trauma to the mandible (bilateral fracture of the body of the mandible) and no evidence for antemortem healing of ablation. There was evidence of only one active (i.e., unhealed) abscess in the sample. Thus, quantification of antemortem tooth loss in this population will be considered a reflection of carious tooth loss during the life of the individual. All statistics were calculated using SPSS v.14.1 (2006).

## Results

Independent samples *t*-tests indicate a significant difference between male and female wear on the first and second molars ( $p < .05$ ). Results of the regression on dental wear suggest a low-wear gradient for the first and second molar in both sexes, although neither is significant (Table 3). However, when the male and female data are combined, significant differences are found, perhaps due to increased sample size or increased variability in age at death. Regardless of whether the regression is significant, the low-wear gradient supports the notion that these individuals likely practiced some form of agriculture (Benfer and Edwards 1991). Thus, Oakwood Mound may be considered a homogenous sample in terms of dietary strategy. This is not to say that the dead were interred in the mound over a short period of time, but that the subsistence base of these individuals was similar.

Overall, 49 percent of the individuals examined in this study suffered from some form of caries. Independent samples *t*-tests revealed no significant differences in caries frequency

*Table 3. Wear Gradients for the First and Second Maxillary Molars.*

	Slope	t	Significance
Females	0.54	0.31	$p > 0.05$
Males	1.19	0.11	$p > 0.05$
Combined	1.02	13.57	$p < 0.001$

by sex ( $p > .10$ ) or age ( $p > .69$ ) group. Only 12 percent (61 out of 499) of the teeth present were carious. Table 4 presents caries frequencies by location on the tooth or size of the caries. Because molars are disproportionately affected by caries, a separate analysis of caries frequency was conducted examining molars only. The frequency of carious lesions for molars was 27 percent, double what was found for all teeth. These results are not surprising given the small sample sizes associated with this study. One might expect to see a positive relationship between age and caries frequency, but the nature of age estimation in the skeleton limits our ability to accurately define discrete age classes.

As is the case with caries, antemortem tooth loss is quite high in this population (54 percent of individuals affected). No significant differences exist among sex ( $p < .20$ ) or age ( $p < .47$ ) groups. Relative to the number of teeth observed, this sample is missing 46.5 percent (232/499) of its teeth antemortem, assuming that each individual had a full complement of permanent dentition.

## Discussion

Although the biological data available for Oakwood Mound are limited, they reinforce existing archaeological data and present new questions for future consideration. The demography of Oakwood Mound indicates that a high frequency of young females and children were interred in this mound. Archaeological excavation of the mound was cut short prior to completion, so the demographic profile could be biased.

*Table 4. Percentage of Caries by Type.*

Location on Tooth	n	Frequency
Occlusal surface	14	23%
Interproximal	25	41%
Large caries	22	31%

Results of the dental wear analysis in this population suggest that these individuals likely shared a similar subsistence strategy. This supports the available archaeological data for Oakwood Mound, which show no stylistic differences in grave goods or structural changes throughout the mound, suggesting that the mound's use as mortuary space was confined culturally and temporally (Skinner 1953). This theme is consistent among penecontempo-



rary groups in the region. For instance, Harn (1980) describes dental attrition at Dickson Mound (A.D. 1100-1250) in Fulton County, Illinois as very homogeneous, with little differences within the population. Likewise, Powell (1988) reports little variation in dental wear within the Moundville population located in west-central Alabama. While the Moundville site may not be geographically proximate to Oakwood Mound, sufficient archaeological and biological data support subsistence strategy in the former; thus, it was included as a reference population. These results suggest that each of these groups maintained similar subsistence practices throughout the duration of occupation, implying the use of a dietary strategy with the potential to support a large, centralized population.

The presence of statistically significant differences in wear rate between the sexes within the Oakwood sample is similar to what is found in Moundville (Powell 1988). In the Moundville sample there were significant differences in dental wear on the molars in approximately half of the comparisons between males and females, with males experiencing greater wear on average than females (Powell 1988). Interestingly, status segments at Moundville did not differ significantly in attrition rates; rather, biological variables are responsible for the observed significant differences. The presence of significantly different rates of wear between males and females also may be due to differences in food processing strategies, access to particular food sources, or the age distribution, with males being on average older than females in this sample. Alternatively, the greater (on average) wear in male teeth in these populations could be explained by sexual dimorphism in enamel thickness. In fact, greater enamel thickness in females was recently demonstrated in a contemporary population, although the sample was composed of deciduous teeth (Moore 2002).

The frequency of individuals affected by carious lesions at Oakwood suggests consumption of carbohydrate-rich foods such as maize, but this population is not an outlier by any means. For instance, the 12 percent caries rate observed for Oakwood Mound, while within the range of caries rate reported for agricultural populations, is less than the mean caries rate (15 percent) for these groups (Larsen 1997). This value changes, however, if the frequency of carious lesions on molars only is included, in which case the 27 percent rate at Oakwood would exceed the mean caries rate reported by Larsen (1997). Powell (1985) reviewed caries frequencies in the Caddoan and Fourche Maline populations, each demonstrating vastly different levels of dental health. Again, while these sites are not geographically relevant to Oakwood Mound, they have provided sufficient archaeological and biological data to warrant their inclusion as comparative samples in which subsistence strategy is well known. In the Caddoan sample, 90.6 percent of the individuals were affected by caries, with significant differences by age and sex (Powell 1985). This clearly resulted from intense reliance on maize agriculture. In contrast, the Fourche Maline population maintained a low caries frequency (24.4 percent), owing to the introduction of grit into the diet with the use of stone mortars to process their foods, as well as their minimal reliance on maize as a food source (Powell 1985). At Oakwood Mound, almost half of the individuals exhibit carious lesions, suggesting that they likely did depend on maize agriculture to some degree.

When placed in a regional context, it is clear that individuals at Oakwood Mound incorporated maize into their diets. For instance, a sample from the Corbin Mounds site had a frequency of caries of 29 percent (Hedman and Hargrave 1999). The Gentleman Farm and Material Service Quarry sites produced a higher rate of 32 percent carious dentition, data that are supported by stable isotope research suggesting that these groups consumed maize (Emerson et al. 2005). Milner and Smith (1990) provide another Mississippian comparison in

their report on the Norris Farms 36 sample, a Bold Counselor phase of Oneota occupation. The authors report that 30.4 percent (568/1869) of the teeth are carious in this population. Farther north at Tremaine, another Oneota site, 49.2 percent of individuals had carious lesions (Grauer 1995). Gentleman Farm and Material Service Quarry report that >75 percent of individuals were affected by carious lesions (Emerson et al. 2005). Frequency of carious teeth in the Oakwood sample was 12 percent (or 27 percent for molars), with 49 percent of individuals affected by carious lesions. Thus, it is likely that maize agriculture was used as a food source at Oakwood, although these data do not necessarily speak to the proportion of maize consumed. For instance, evidence exists that the processing of certain foods in the mouth for later consumption by others can contribute to the development of carious lesions (Larsen 1997). Thus, the data can speak only to the probable incorporation of maize in the diet rather than absolute or perhaps even relative amounts. Further confounding this issue is the possibility that carious lesions do not provide a complete history of dental health in prehistoric populations; they represent caries only at the time of death and do not describe earlier tooth loss due to cariogenic processes.

Although not regularly reported with data on carious lesions, antemortem tooth loss may well complement research on dental pathology and dietary strategy. Antemortem tooth loss in the Oakwood population provides additional evidence for reliance on maize as a primary source of food. Powell (1985) demonstrates the utility of this indicator by comparing antemortem loss in the Caddoan and Fourche Maline populations. In the Caddoan sample, 37.7 percent of the individuals were affected, while at Fourche Maline, only 20 percent of the individuals were affected. The greater antemortem loss of teeth in the Caddoan sample is likely explained by that population's greater reliance on maize agriculture. Interestingly, the rate of antemortem tooth loss in the Oakwood Mound sample (54 percent) is higher than even that of the Caddoan population. While antemortem loss of dentition can be attributed to many factors, cariogenic loss is the most plausible scenario in this sample, given the high caries frequency. Antemortem loss of dentition at Oakwood is therefore consistent with reliance on maize agriculture.

Analysis of antemortem loss of teeth in regional context is somewhat limited because these data are not always reported. Oakwood Mound has a higher percentage of antemortem tooth loss than does Norris Farms cemetery (37 percent) (Milner and Smith 1990). While the temporal overlap between these groups is similar (Langford Tradition: A.D. 1200–1500; Bold Counselor phase: 1275–1425), they diverge in terms of geographical distribution. However, both sites are located in the Central Illinois River Valley, with Oakwood Mound located on the Des Plaines River, a tributary of the Illinois River. Emerson (1999) notes stylistic similarities in ceramic design between Oakwood Mound and Oneota populations to the north. The caries data suggest that these populations had quite different subsistence strategies, with the Norris Farms 36 population relying more on maize agriculture. At Moundville, another temporally relevant site, only 13.5 percent of the population exhibit antemortem tooth loss (Powell 1988).

Although problematic, this line of evidence does raise an interesting question. Should populations peripheral to larger Mississippian populations display fewer dental pathologies? There is a common belief that Langford peoples were mobile for part of the year, dividing into separate hunting camps during the winter period. If these populations consumed less maize year round than did the sedentary Mississippian populations, this may be reflected in caries frequency. The dental evidence for maize agriculture for some Upper Mississippian sites

is compelling, perhaps suggesting that these groups were sedentary year round. Mobility of Upper Mississippian peoples was likely complex and dependent on population density and local sociopolitical complexity. However, given the incomplete and limited nature of the Oakwood sample, such claims must await further data from other populations.

## Conclusions

Taken together, the rates of dental wear, caries, and antemortem tooth loss observed in this population are consistent with a subsistence base that incorporated maize agriculture and was likely supplemented by foraging. The rate of carious lesions present on the dentition supports the notion that carbohydrates, probably maize, contributed to this population's diet. Since a marked difference exists in the sex ratio of the individuals interred in Oakwood Mound, any interpretations of the results on dental decay and antemortem tooth loss should be mediated by the knowledge that females tend to suffer from caries more often than do males (Hillson 2001). Although there were no statistically significant differences between sex and age groups, this likely is due to small sample sizes. In fact, given that dental wear, caries formation, and antemortem tooth loss are dependent on age, diet, and perhaps sex, one might expect to see statistically significant differences between age, sex, and subsistence groups upon larger scale analysis. At present, however, based on dental evidence, there appear to be no dietary differences between males and females at Oakwood Mound. The results presented herein should be considered very preliminary findings due to problems with sample size, age structure, and potential scoring discrepancies.

By and large, even with the problems discussed above, the results for Oakwood Mound are comparable to those of other Mississippian populations. Clearly, maize agriculture was very widespread and commonly practiced by Upper Mississippian populations. The relatively lower frequency of carious lesions at Oakwood than at other Langford sites may hint at the diversity of local adaptive strategies. However, before any real conclusions can be drawn about the social dynamics of this region in prehistory, comparative analyses must be performed within and between sites. This underscores the importance of revisiting previously excavated sites with new hypotheses, a process that must take place if we are to fully understand the complexities of life history among prehistoric groups.

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