

Totem: The University of Western Ontario Journal of Anthropology

Volume 17 | Issue 1

Article 10

6-24-2011

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Recommended Citation

Masur, Lindi J. (2009) "Stature Trends in Ancient Maya Populations: Re-Examining Studies from Tikal and Altar de Sacrificios," *Totem: The University of Western Ontario Journal of Anthropology*: Vol. 17: Iss. 1, Article 10.
Available at: <http://ir.lib.uwo.ca/totem/vol17/iss1/10>

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Keywords

stature, Classic Maya, Tikal, Altar de Sacrificios, collapse

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Stature Trends in Ancient Maya Populations: Re-Examining Studies from Tikal and Altar de Sacrificios

Lindi J. Masur

Introduction

The causes for the collapse of the Classic Maya civilization in the tenth century A.D. remain a highly controversial topic among historians and anthropologists today. Danforth (1999:103) stated that ecological hypotheses predominantly emphasize a “health crisis” emerging in the Pre-Classic period, therefore many anthropologists strive to find such evidence in the archaeological record. One method of analyzing a potential “health crisis” is studying stature trends in Maya archaeological contexts (Danforth 1999:103). Larsen (1987:340) illustrated that as the growth and maintenance of skeletal tissues are a reflection of the individual’s environment, studying human skeletal tissues can help make inferences about that individual’s behaviour, and the relationship with their environment. Genetic and environmental components must both be considered when analyzing stature to make inferences about nutrition, but increasing nutritional variability has also proved to result in increasing variability of stature (Danforth 1999:103). Therefore, analysis of stature change over time within genetic populations can help anthropologists infer environmental conditions, including food availability during the Classic Maya time period, in hopes of shedding light on the overall ‘big picture’ of the cultural collapse (Danforth 1999:104).

Haviland (1967) and Saul’s (1972) studies on intertemporal stature trends were the first of their kind to show data that suggested increasing nutritional deficiencies resulted in shorter stature. Human ecologists as well as anthropologists began to question

whether or not this trend was a result of plastic response to environmental challenges, or whether it was a plastic adaptation to a changing environment (Beaton 1989, Messer 1989). The question of whether such proposed adaptations would result in “small but healthy” individuals has been the topic of many debates in recent years (Beaton 1989, Messer 1989). This paper proposes that while there is evidence to support the trend of decreasing stature in Haviland (1967) and Saul’s (1972) studies, such trends are likely due to plastic responses to environmental variations, rather than plastic adaptation. This paper also argues that Haviland (1967) and Saul’s (1972) data cannot be used to infer a regional trend because of differential access to resources across the Maya region. Furthermore, too much variability exists spatially and temporally to conclude that this trend was widespread.

Study at Tikal, Guatemala

Haviland’s (1967) analysis of the skeletal remains excavated at Tikal provided some remarkable statistics with regards to secular trends in stature, but the study is hampered by sampling problems. Haviland’s (1967:316) sample was comprised of 55 skeletons from Tikal burial sites, with a temporal span from the Pre-Classic to the Late Classic. Haviland (1967:316) stated that the analysis of stature at this site cannot only reveal information about nutrition, but can also be used to make inferences about demography and social complexity over time. Analysis of usable collected remains led Haviland (1967:316) to theorize that Tikal was initially settled in Pre-Classic

times by a population of individuals of moderate stature, and that stature remained stable throughout the Early and Middle Classic periods. However, his data showed that in the skeletons from the Late Classic period there was a statistically significant reduction in stature, which he believed was a result of nutritional stress, and a reflection of the deteriorating environment and the collapsing Maya regime (Haviland 1967:316).

Between the Pre-Classic and Early Classic periods, Haviland (1967:320) noted an increasing trend in differences in stature between skeletons found in tombs, and those not found in tombs. Those interred in tombs were suggested to have been of higher status and have better access to food resources. This nutritional advantage allowed them to maximize their growth potential. The noted difference between those individuals of higher status and the other individuals was an average of seven centimeters (Haviland 1967:320). Haviland (1967:231) stated that one would expect to see this trend of increasing stature among the individuals interred in tombs, but this is not the case. The samples acquired from the Late Classic exhibit reduced stature in all individuals regardless of status; the mean difference in height still remained the same between the two status groups, but they both seemed to be getting progressively shorter (Haviland 1967:322). Haviland (1967:319) stated that by the Late Classic, the mean height for adult males was 157.4 cm, stature comparable to that of some pygmies.

Haviland (1967:323) noted that in Pre-Classic Tikal there is marked sexual dimorphism, which fluctuates and then decreases. Female height remains relatively constant for all periods (an average of 147 cm), while mean male height increases from 164.5 cm during the Pre-Classic period to 167 cm in the Early Classic, then drops to 157.4 cm by the Late Classic. Haviland

(1967:323) suggested that sexual dimorphism involves not only the biological notion that females are not as strongly affected by nutritional stress as are males, but also the fact that males might have always had preferential access to more nutritious foods; therefore women would have always been experiencing a relative nutritional stress. Haviland (1967:319) stated that nutritional stress is directly related to the downfall of the Maya civilization, and that decreasing stature was a direct result of environmental degradation.

Haviland (1967:320) proposed that the population density of southern Tikal could have been as high as 136 people per square kilometer, much higher than the optimal range of 38-77 people per square kilometer. He concluded that such a large non-farming population would have to rely heavily on the agricultural sector, and the combination of soil degradation, crop failure, and having too many mouths to feed would lead to an overall nutritional stress that even the wealthy could not avoid (Haviland 1967:319).

Haviland (1967:316) recognized some factors that could affect the accuracy of his study, such as small sample sizes from each time period, and the disproportionate number of tomb bodies to other burials. Tomb remains were better preserved because they were not exposed to processes such as acidic erosion from soils and floralturbation, therefore they were more likely to be suitable for analysis (Haviland 1967:316). He also noted that women, even those of higher status, were not typically interred in tombs, except during the Pre-Classic period (Haviland 1967:323). This is unfortunate because no definite conclusions can be drawn about the degree to which females are naturally buffered against nutritional stress, since comparison between higher status women who could maximize growth potential and women without such

benefit is lacking. One can also conclude that since Haviland's data of female specimens in general are so lacking, there is little basis for his statement of continuing stability of female stature. Another weak point in his methodology is his purposeful exclusion of four burials (burials 23, 24, 38 and 144), which he deems "highly unusual" and "abnormal" (Haviland 1967:322). These Late Classic burials were of individuals he deemed to be either extremely robust or extremely gracile compared to the other burials, which he reasoned was the result of elitist endogamy: "close inbreeding can result in the expression of genes which would produce various anomalies [...] in stature, [and would yield] a higher frequency in later populations" (Haviland 1967:322). However, considering his sample is comprised of only 55 individuals, a total of four individuals (7.2% of his sample) cannot be considered anomalies. If elitist endogamy results in what would be similar to the founder's effect (when an isolated group exhibits a higher occurrence of a particular genotype and phenotype than the population as a whole), and the founders of Tikal were of moderate stature, the result would have therefore been descendants who were also of moderate stature, not a range including both exceptionally robust and exceptionally gracile individuals.

Study at Altar de Sacrificios

The excavations at Altar de Sacrificios yielded 90 fragmentary skeletons that spanned a two thousand year period from 800 B.C. to A.D 1000 (Saul 1972, cited in Buikstra 1974:456). Buikstra (1974:456) wrote, "given inherited genetic stability, Saul interprets the (male) trend towards stature decrease as an indication of increased dietary/disease stress in more recent populations". His data, however, did not illustrate tall stature among high status Maya males, nor did it propose trends in

female stature (Buikstra 1974:456). He did note however, a high frequency of porotic hyperostosis, osteitis, and subperiosteal hemorrhages, which can indicate considerable nutritional stress, such as iron and vitamin C deficiencies, and that treponemal infection would add substantially to the disease load (Saul 1972, cited in Buikstra 1974:456). His findings therefore somewhat mirrored Haviland's (1967), and Buikstra (1974:456) noted that Saul's data is "spotty" as well, but does not elaborate.

Nutrition, Stature, and Plasticity

Poor nutrition causes depressed growth rates, which in turn have a negative impact on adult stature (Larsen 1987:349). Larsen stated potential nutritional deficits in the ancient Maya as the result of the transition to agriculture, where the primary dietary staple was maize:

Although maize will serve to meet caloric requirements, it contains only moderate amounts of raw protein and is deficient in two essential amino acids, lysine and tryptophan, and a vitamin, niacin. [...] If maize is not supplemented with another protein source, niacin deficiencies are sure to develop. [...] Clearly, then, a dependence on a limited food resource like maize will have a profound impact on growth and development. (Larsen 1987:349)

However, protein and amino acids which are lacking in maize can be obtained from other commonly cultivated plants in the Mesoamerican region, such as beans (Kaplan 1973:75). In regions where these synergistic crops were both cultivated and incorporated into cuisine, they would have provided the ancient Maya with a "complete protein package" (Kaplan 1973:77).

Traditional alkali treatments of maize increased its nutritional quality as well (Katz et al. 1974, cited in Larsen 1987:349), suggesting other factors aside from agricultural intensification of maize were involved in the decrease in overall nutritional quality.

Traditional debates on the secular reduction of size amongst the Classic Maya question whether it is an example of plastic response or plastic adaptation. On one side of the spectrum are plastic responses, which are disadvantageous responses to an individual's environment (Beaton 1989:31). Poor nutrition would result in poor growth and development, and an unhealthy individual (Beaton 1989). On the other side of the spectrum are plastic adaptations, the responses from an environmental stress presenting a permanent shift in the adult phenotype (Bogin 1995:69). Stini (1981, cited in Larsen 1987:349) described how size reduction could be a selection in response to food shortages. Stini (1981, cited in Larsen 1987:350) hypothesized that when nutrient availability is limited, smaller individuals would fare better than larger ones, as they would require less food, and that a secular trend in decreasing stature would reflect an "optimization of growth that permits a greater number of individuals to function under reduced dietary resources." Therefore, plastic adaptations are advantageous, and result in increased survival at a population level (Beaton 1989:31).

The "small but healthy" model of plastic adaptation in itself warrants further review. The question of whether or not the development of smaller stature is actually beneficial is currently being investigated by many scholars (Beaton 1989). Beaton (1989:31) wondered if a smaller stature would actually protect individuals with poor nutrition from becoming malnourished. If so, such an adaptation would mean that

smaller stature would no longer be the predictor of malnutrition and health problems due to chronic malnutrition, but rather becomes the outcome of chronic malnutrition through time and multiple generations (Beaton 1989:32).

Messer (1989:40) also critiqued the "small but healthy" hypothesis, questioning the validity of reduced stature as an adaptive mechanism in the Maya region. Messer (1989:40) noted that among the majority of ancient societies, robusticity symbolized good health, strength, and wealth, and therefore she doubted that smaller stature would have been selected. She also indicated that greater stature and weight would be the favourable trait to be selected among agricultural labourers (Messer 1989:49). Therefore in Mesoamerican regions with large agricultural stress and a large population of agricultural workers, the most likely adaptations that would have arisen would have been a trend in increasing robusticity among commoners. This trend would not have been as observable in the tomb burials because robusticity would not be necessary for the elite. Haviland (1967) and Saul's (1972) data do not reflect this sort of pattern by any means.

Messer (1989:40) also stated that under-nutrition leads to underproduction, which in turn would lead to more under-nutrition. Therefore it can be illustrated that agricultural stress and decreased nutrition status would result in decreased energy levels, leading to a greater decrease in agricultural efficiency. Messer (1989:40) indicated that this alone is not indicative of inevitable adaptation, because with reduced nutritional requirements, a reduced reproductive capacity should also be observed. Also, Messer (1989:43) suggested that adaptations favouring slower growth rates resulting in shorter stature should reflect high neonatal and infant mortality in the population, as development of organs is

crucial in early years. In contrast to this expected result, Messer (1989:49) described the cultural favourability for plump children, which would result in maximized growth potential. Messer (1989:49) believed that in order to further disprove the “small but healthy” hypothesis, anthropologists must compile more data on the relationship between food supply, productivity, and cultural ideology represented in body image. Messer (1989:43) even stated that agricultural stress could have been potentially dealt with by traditional equilibrium responses. In a Maya scenario, this would most likely entail increased population leading to increased agricultural stress, which would result in famine, and a leveling-off of the population. This in turn would reduce the aforementioned agricultural stress, returning the environment to a state of equilibrium.

Mesoamerican Environment

If one is to believe that Haviland (1967) and Saul’s (1972) claims are valid, nutritional stress on humans and increased agricultural intensification should be reflected in bioarchaeological studies of the Classic Maya period. Wright and White (1996:147) stated that analysis of stature is not useful for directly making inferences about environment, and that instead it is helpful to employ paleopathological and isotopic paleodietary analyses on skeletal tissues. Wright and White’s (1996:147) study proposed that if the Maya collapse involved deteriorating diet, there would need to be evidence to support continual dietary changes during the Pre-Classic and Early Classic periods through the Terminal Classic. While their study does not focus on nutrition and its role in stature development, their hypothesis deals with similar trends, and therefore can be used as a comparative study.

Agriculture

Wright and White (1996:148) reported that widely accepted data show that the Maya region during the Classic period consisted of “a complex agricultural system [...], and a diverse population of farmers, traders, artisans, and religious specialists,” and that most studies do indicate trends in increasing population density throughout the Classic periods. This implies that there was marked variability between how individuals made a living among differing social strata, and also much variability spatially between urban and rural areas. Wright and White (1996:148) stated that with increasing population density, farmers needed to increase their annual yield of crops (typically maize) to support booming urban centers. Such population pressures would also exhaust hunting resources, reducing the amount of protein available (Wright and White 1996:148). Lentz (1999:14) stated that paleo-ethnobotanical studies reveal that the staple agricultural crop across the Maya region was indeed maize, but that squash, peppers, beans, and possibly manioc and other root crops were also popular. Wright and White’s (1996) study also yielded the same results. Wright and White (1996:149) took a closer look at the farmers in this scenario, and noted that the type of agriculture practiced in tropical regions, called *milpa farming*, is a common factor in environmental degradation due to soil erosion and nutrient loss which would result in the decreased dietary quality and quantity of crops. Lentz’s (1999:14) study illustrated proof of orchard farming at the site of Ceren, where “avocado, hogplum, mamey, guava, nance, cacao, cashew, and calabash” trees were grown near homes. He stated that the inclusion of tree farming would also lighten agricultural stress, but revealed that apart from this site there is not much evidence to indicate this was a homogenous

practice across the Maya region (Lentz 1999:14). Therefore evidence suggests that while maize was the staple crop, many other crops were grown, and that there was much variation in agricultural production across the region.

Hunting, Fishing, and Iron Deficiency

Wright and White (1996:159) also analyzed data pertaining to iron deficiencies represented in skeletal assemblages throughout the Classic period, and spanning the whole Maya region. They concluded that the data varies greatly between sites, but that there was a high prevalence of iron deficiency: 77% of subadults, and 65% of adults were affected (Wright and White 1996:159). However, iron deficiencies do not always reflect deficiencies in the menu, but may also be indicators of parasitism, which varied from region to region and was quite common (Wright and White 1996:159). Wright and White (1996:160) also cautioned that while intensification of maize production and its reliance in diet did parallel an increased population density, this is not the only factor when accounting for iron deficiencies: a site comparison between two sites with a high maize production rate shows one site holding the lowest incidence of iron deficiency, and the other among the highest.

Emery (2007) investigated the reliance on wild game in inland regions with little access to marine resources. She indicated that between the Pre-Classic and Early Classic sites there is an increased reliance on hunting white-tailed deer, which corresponded with an increased efficiency in hunting large game (Emery 2007:190). This is followed by a decline in large game hunting from the Late to Terminal Classic, due to over-exploitation (Emery 2007:190). Emery (2007:191) stated that the most intriguing trend in the hunting of wild game was during the Pre-Classic. This is the time

period where the Maya civilization rapidly grew in complexity and social stratification (Emery 2007:191). The secular trends in increased hunting were likely due to increased hunting pressures, not just because of nutritional needs, but for the use of animal products, such as skins and bones used in ceremonies, and objects which reflected high status (Emery 2007:191). Emery (2007:191) also indicated that in the Late Classic, when social complexity was at its peak, panthers, monkeys, and brightly coloured birds were in very high demand among the elite, although they were not necessarily eaten. Shaw (1999:83) also noted that meat acquisition was typically done by hunting and fishing, due to the lack of large domesticated animals.

A study done by Shaw (1999:83) at the Colha site in Belize indicated that the Maya in the area were exploiting a large variety of fish and game during the Pre-Classic period, before increasing agricultural intensification. In the Middle Pre-Classic, Shaw (1999:88) stated that the Maya exploited several terrestrial and aquatic species, with an emphasis on fish. She even suggested that hunting, fishing, and collecting were the primary strategies for food acquisition from the evidence found at Colha (Shaw 1999:88). By the Late Pre-Classic, however, long-term exploitation, and therefore a decrease in faunal availability, led to an increasing dependence on crop procurement to meet increasing food stress in the growing population (Shaw 1999:92). To leave towns and cities for the sole purpose of hunting would not be an efficient food acquisition strategy, and therefore she suggested that the Maya of this region practiced “garden hunting,” where only garden predators and nearby game were hunted (Shaw 1999:84). She stated that this change in the organization of food procurement, rather than intensification, would actually increase the diversity of

meats available (Shaw 1999:94). This can be illustrated by a scenario where, instead of leaving to hunt specifically white-tailed deer and to fish, staying in the garden and gathering any deer, rodents, or dogs that come into the area increases the diversity of species consumed.

A study by Glassman and Garber (1999:121) further illustrated the wide variability of food procurement strategies across the Maya region. Late and Terminal Classic sites were excavated at Ambergris Cay, where highly acidic soils and swamps would have hindered agricultural production (Glassman & Garber 1999:121). Individuals in this region depended primarily upon marine resources, wild animals, and plants, but also may have imported shelled maize from the mainland to supplement their diet (Glassman & Garber 1999:121). This is quite a different scenario than for many other sites of the Terminal Classic, where intensive agricultural production and homogeneity of food sources were at their peak. This indicates that not only does resource exploitation vary spatially, but also temporally. Glassman and Garber (1999:121) noted that protein-rich marine resources were easily obtainable. The evidence suggests that when marine and terrestrial animals are both available, there will be a preference for marine resources as the staple food, and that terrestrial animals and imported maize would supplement this diet (Glassman & Garber 1999:122). Glassman and Garber (1999:130) also examined the skeletons to check for nutritional deficiencies that this type of subsistence practice might cause, but found that the individuals were of good health, and had nutrient-rich diets. Only two instances of porotic hyperostosis, a possible indicator of iron deficiency, were noted among the entire sample, and these individuals appeared to be from a lower social stratum. Therefore, nutritional deficiency would

probably have been more influenced by differential access to food resources, or even parasites, rather than environmental resource availability (Glassman & Garber 1999:127). Glassman and Garber (1999) also investigated the stature of the individuals, which shall be addressed later on in this paper.

Discussion

While there seems to be a secular trend towards a decrease in stature among Haviland (1967) and Saul's (1972) samples, by reviewing the recent literature it can be suggested that not only was there large variability within regions as to who had access to certain resources, but there was also large interregional variability. The high degree of intra and interregional variability suggests that the trend in decreasing stature was not necessarily widespread, and therefore does not reflect a plastic adaptation among the whole Maya population.

Haviland (1967) and Saul (1972)

Danforth's (1994) article on stature change outlined the many limitations of Haviland (1967) and Saul's (1972) investigations, and the lack of evidence to suggest such change in stature was a widespread phenomenon. First, she indicated that only six sites in the Maya lowlands offer intertemporal comparisons, therefore there is great difficulty in trying to acquire trends within regions over time (Danforth 1994:207). She stated that small sample sizes within each site become even smaller after the remains are divided between age, sex, and social status, which limit accuracy (Danforth 1994:207). Along with the fact that there is poor preservation of skeletons to begin with, Danforth (1994:208) also stated that as sex determinants are not well preserved in the highly acidic soils of the Maya region, there could be methodological errors determining

sex. Robust and gracile characteristics can also be somewhat ambiguous, and therefore classifying by these characteristics alone often proves faulty (Danforth 1994:208). Danforth (1994:208) also pointed out a discrepancy in Haviland (1967) and Saul's (1972) studies, which neither mention, specifically that the data actually support a slight increase in female stature over time.

Environmental Variability and Socio-political Factors

Wright and White (1996:180) suggested that other than marked variability of resources between regions, there is great variability of resources available within regions, and this is not always based on environmental constraints. "Tribute or taxation that was paid with agricultural produce must have influenced the mixed crops planted by farmers, thereby shaping the diets of the populace at large," (Wright and White 1996:180). They argue that social determinants can have a significant effect on the variability of resources between and within regions, and therefore they would also affect nutrition (Wright and White 1996:180).

Study of Stature at Ambergris Cay

The study of stature at Ambergris Cay by Glassman and Garber (1999) produced very different results than Haviland (1967) and Saul's (1972) studies. The Ambergris Cay sites, which were Late and Terminal Classic sites, were populated by healthy individuals of moderate height, who were much taller than expected (Glassman & Garber 1999:129). The average height for an Ambergris male was estimated to be 165.2 cm, and 156.4 cm for females (Glassman & Garber 1999:129). Males were on average 7.8 cm taller than the Tikal sample, and females were between 9.4 cm and 14.4 cm taller (Glassman & Garber 1999:129). Glassman and Garber (1999:129)

stated that the measurements were based on the same methodology used by Haviland (1967) and Saul (1972), and therefore can be compared. They suggested the difference in nutrition, such as the high protein diet of the Ambergris Cay populace, would account for such differences (Glassman & Garber 1999:129).

Plastic Response versus Plastic Adaptation

Glassman and Garber (1999:129) stated that compared to other Maya populations in the Late Classic period, because of environmental determinants, the Ambergris were more likely to achieve their genetic stature potential. Because there is such variability among a whole larger Maya population, it is more likely that stature variations are caused by plastic responses due to varying accessibility to resources, and not plastic adaptations. According to Beaton (1989), if a plastic adaptation to a "small but healthy" stature was taking place, one should be able to observe a widespread decrease in stature among the whole population, but this is not the case.

Danforth (1994:209) pointed out that modern Maya are much shorter on average than prehistoric Maya, ranging from 153-157 cm for males, and 140-145 cm for females. However, based on Bogin (1995), this is likely also a plastic response. Bogin (1995:71) stated that while modern Maya appear to be shorter, this is likely because of rampant "chronic undernutrition and disease," and limited access to healthcare in Guatemala. However, Bogin (1995:71) noted a marked increase in stature among the children of Guatemalan refugees. In this instance, the restoration of proper nutritional conditions immediately increases growth potential. Great changes of stature from one generation to the next cannot result from plastic adaptation, as adaptations are processes that take multiple generations. Had plastic adaptation been the case, the

succeeding generation would have been just as small. Therefore by comparing the rate of plastic response in modern Maya, it may be fair to suggest that plastic response is the likely process in the case of Tikal and Altar de Sacrificios.

Conclusion

Many methodological factors, environmental variation in food availability, and differential access to food between social strata, lend to the argument that Haviland (1967) and Saul's (1972) data suggest that the trend of decreasing stature among the Maya was not necessarily an interregionally nor intertemporally widespread phenomenon. It is argued that because of the nature of plastic adaptation and plastic response, Haviland (1967) and Saul's (1972) data are likely the result of Tikal and Altar de Sacrificios' plastic responses to food stress in those particular regions. This data cannot be directly inferred to other regions, an investigation proves that as the Maya region is not a homogenous area; many different types of subsistence practices exist interregionally and result in different nutrition statuses. Furthermore, skeletal tissues provide insight to an individual's environment, and small, unhealthy individuals suffering from nutritional deficiencies in the Maya archaeological record may lend credence to ecological theories of the collapse of the Maya civilization, such as environmental degradation, and poor health in certain political centers.

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