

Canine Proxies for Native American Diets

By Elizabeth S. Chilton (Harvard University), Nikolaas J. van der Merwe (University of Cape Town), Ninian Stein (Harvard University), and Kimberly Oakberg Allegreto (Brandeis University)

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Abstract

Staple isotope analysis of human bone is the most direct way to assess the level of maize consumption in the ancient North American diet. However, destructive analysis of human remains is often neither possible nor advisable because of NAGPRA and the concerns of native peoples. Recent studies indicate that dogs may serve as proxies for human diets. In this paper we discuss the results of stable isotope analysis of seven dogs from northeastern North America, dating to the Woodland and Contact periods (A.D. 1000-1700). Expanding this preliminary study will shed much needed light on prehistoric maize horticulture in New England.

Introduction

During the last few decades, archaeologists have become increasingly concerned with the role of maize cultivation in New England. While most archaeologists agree that maize horticulture had spread to New England by A.D. 1000, the degree of reliance on maize by native peoples is a subject of debate (Chilton 1999). Present thinking is that maize was a late introduction to coastal New England without a significant impact on lifeways (Bernstein 1999:114; Chilton 1999). The degree of reliance on maize horticulture in the New England interior, however, continues to be open to debate (Bernstein 1999; Chilton 1999). This paper examines the effectiveness of stable isotopic analysis of New England dog teeth for understanding maize cultivation during the period just prior to European colonization. For this project, we conducted stable isotope analysis on seven dog molars from two inland, two coastal, and one estuarine sites in New England and New York which date to A.D. 1000-1700, encompassing the Late Woodland and Contact periods.

The degree of reliance on maize horticulture in different locations across New England is currently difficult to determine. Problems arise not only in the preservation of maize in acidic New England soils (Chilton 1999; Smith 1992), but also in interpreting the relationship between the quantity of recovered maize kernels and the degree of involvement in horticulture they represent (Chilton 1999). Stable isotope analysis, on the other hand, is one of the most effective techniques for reconstructing prehistoric diet and for assessing changes in diet

through time. Because maize is a non-indigenous plant, and because it utilizes a different photosynthetic pathway than nearly all other native edible plants in temperate eastern North America (C_4 for maize and eel grass, as opposed to C_3 for all other indigenous plants), it is possible to detect the level of maize in the diet using a combination of $\delta^{13}C$ and $\delta^{15}N$ values. Thus, one can assess the relative importance of maize, as well as other types of plants and animals, in the diet using the ratios of carbon and nitrogen in bone (see van der Merwe 1982).

Staple isotope analysis of human bone is the most direct way to determine ancient human diet. However, destructive analysis of human remains is often not possible or advisable because of NAGPRA and other political and social concerns. As a result, archaeologists have begun to look to other species that could serve as an indicator of human subsistence patterns. A number of studies indicate that in many parts of the world, dogs may serve as “valid surrogates” for human consumers in stable isotopic analyses (Katzenberg 1988; Clutton-Brock and Noe-Nygaard 1990; Cannon, Schwarcz and Knyf 1999). For the purpose of this study, our assumption is that, as domesticated animals, that dogs ate primarily garbage, scraps of food, and human feces in the vicinity of human habitations. While we recognize that the proportion of maize in the diet would not necessarily be equivalent for humans and dogs, we believe that the presence of maize in human settlements and perhaps the quantity of maize available should be reflected in the stable isotope analysis of dog bone.

Methods

Teeth are ideal for stable isotopic analysis for a number of reasons. First, teeth are more likely to survive in archaeological contexts than soft tissues and other types of bone (Cannon Schwarcz and Knyf 1999:401). Second, teeth are ideal because they contain both collagen and apatite. According to Lee-Thorp et al. (1989:586) the isotopic values of various tissues in the same individual differ and can offer unique information about an individual's diet. Testing both collagen from the roots of the teeth or the dentine and the apatite from tooth enamel is important because different diets will produce characteristic differences or spacing between bone collagen and apatite values, providing more information than either would alone (Lee-Thorp et al. 1989:588). Isotopic values from collagen provide information primarily on the protein portion of the diet, while the enamel values more closely reflect total diet (ref needed). Fortunately, teeth also contain sufficient collagen for radiocarbon dating, making them ideal for all of the analyses necessary to understand the diet of New England dogs through time.

Whenever possible we used third molars in this analysis as these are laid down latest in a dog's life when the dog would presumably be eating an adult diet. In two cases, because the third molar was missing, we used either the first or second molar. The seven teeth were submitted to Kimberly Oakberg in the Archaeometry Labs of the Peabody Museum. She performed chemical

pretreatment and purification of the collagen and apatite samples using the whole bone method for collagen and a modified version of Lee-Thorp's carbonate preparation for the enamel apatite. Isotope ratios were measured in the Archaeometry Research Unit of the University of Cape Town under the direction of Nikolaas van der Merwe, using a Finnegan MAT252 mass spectrometer. This instrument has on-line sample preparation systems for collagen (a Carlo Erba elemental analyzer) and for enamel (a kiel II autocarbonate device). The carbon isotope ratios were calibrated against the PDB standard by using a series of BNS standards and the nitrogen isotope ratios were calibrated against AIR. The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are reported in parts per mil; the measurement precision was better than 0.1 per mil. In order to determine the precise date of all of the samples, most of which were excavated before the introduction of stratigraphic excavation procedures or adequate field recording techniques, a portion of four of the samples was submitted for AMS dating at Geochron Laboratories in Cambridge, Massachusetts.

The Sites

Because this was to be a preliminary study to assess the feasibility of the method, the seven dog teeth chosen for this analysis were selected from those available in the collections of the Peabody Museum and the Museum of Comparative Zoology. Dogs remains in the Northeast are relatively rare. In

many cases dogs occur in burials, either by themselves or with humans. Dog remains that were known to be associated with human remains were not made available to us. We consulted with representatives of the Mohawk and Aquinnah Tribes because some of the dog remains were known to have been excavated in their traditional homelands.

Two of the dogs were from Late Woodland period Iroquoian sites in upstate New York, where maize was thought to have been very important to prehistoric peoples: the Garoga Site and the Ripley Site. Garoga was excavated by M. R. Harrington in 1904-1905. In general diggings Harrington recovered a dog jaw with teeth, most likely from a midden context, although the exact provenience is unclear. Later excavations at the site conducted by William Ritchie and Robert Funk for the New York State Museum revealed that the site was a palisaded Mohawk village dating to the fifteen and possibly sixteen centuries (Funk 1967:83). The radiocarbon date for the dog tooth analyzed in this study was cal AD 1518-1643 ($p=1.00$, 1 sigma).

The other Iroquoian dog came from the Ripley Site, which was excavated by Harrington in 1904. Subsequent excavations by Arthur C. Parker in 1906 revealed that the site was an Iroquois village and associated burial ground (Green and Sullivan 1997:4). Recent excavations by the New York State Museum from 1988-1992 have also been conducted at the site (Green and Sullivan 1997). The dog tooth we tested was found on August 18, 1904 in pit 42. This pit, which appears to have been located in the village portion of the site, contained

“ordinary refuse” as well as a few household items such as a shell scraper, rejected projectile points and potsherds (Harrington 1904:3). The Ripley Site has been radiocarbon dated to cal AD 1220-1390 and cal AD 1280-1420; however, the presence of European trade goods in a few of the later pits indicates that the site is “either multicomponent or was used continuously for two centuries” (Green and Sullivan 1997:5). At the request of the MCZ, we extracted only an enamel sample from this tooth, so we were not able to derive nitrogen ratios or obtain an AMS date for this dog.

Five dog teeth from New England sites were also tested. Three of these were from coastal sites: Revere Beach, Site J, and Squantum. Revere Beach was excavated by Frederick Ward Putnam and Charles Willoughby on April 2, 1890. This dog skull appears to have been found in a shell midden along with large clam shells and a few stones. In his discussion of the artifacts from the Revere Beach Site, Willoughby (1924) includes numerous Contact period artifacts such as items made of re-worked European copper and glass beads. However, the dog tooth we analyzed dated to cal AD 1305-1399 ($p=1.00$, 1 sigma).

Site J was excavated by Samuel Guernsey as part of his Martha’s Vineyard survey in 1912-1913. Although little information could be found from Guernsey’s field notes for the explorations, in his 1916 “Notes on Explorations of Martha’s Vineyard” Guernsey briefly discusses the shell midden at Site J, noting that it covered roughly a quarter of an acre and contained predominantly shell and fire-cracked rock. Diagnostic artifacts were limited to a scattering of potsherds that

apparently date to the Late Woodland period. In the midden, Guernsey also excavated a fragment of a dog's jaw. The molar from this jaw was AMS dated to cal AD 1224-1282 ($p=1.00$, 1 sigma), confirming the Late Woodland attribution of the site.

The Squantum dog was excavated by Dena Dincauze in October of 1971. The dog was discovered during the excavation of a column sample at the southern end of the Chapel Rocks Shell Midden in Squantum, Massachusetts (Dincauze 1971:1). Due to the unusually good state of preservation, some concerns were raised about the age of the dog skeleton. Nelson (1989:29) writes that the neighboring midden was thought to date to the Middle or Late Woodland period on the basis of associated ceramics. A direct radiocarbon date on one of the dog's ribs in 1987 revealed a date of cal AD 245-412 ($p=1.00$, 1 sigma), confirming the Middle Woodland interpretation. However, our AMS date of a molar from the Squantum dog was cal AD 1649-1946 ($p=1.00$, 1 sigma), making this most likely a Contact Period dog.

The last two dogs analyzed for the purposes of this study were from the Watertown Arsenal site, which is located approximately 8 miles or 13 km from Boston Harbor. The site was excavated by Samuel Guernsey in 1912 and is situated on the banks of the Charles River, which in prehistoric times was part of a great estuary. The description of the excavations at the Watertown Arsenal in the Peabody Museum Annual Report states merely that "an interesting site on the grounds of the U.S. Arsenal was explored by the kind permission of the

Commandant" (1912:4). Two series of projectile points from the site were included in Willoughby's 1935 *Antiquities of the New England Indians* (1935:121) and appear to represent Early and Late Woodland components at the Watertown Arsenal site. Two dog skulls were also unearthed during these excavations. We believe the first dog dates to the Contact or Historic period, because of the clear gun shot to the head. The context of the second dog within the site is unknown. We believe on the basis of associated artifacts and state of preservation that it dates to the Late Woodland period, but radiocarbon dating is clearly needed in this case.

Results and Interpretations

We will offer here our results and some very tentative preliminary interpretations. Of course a sample size of seven is extremely small. This preliminary study was only intended to assess the feasibility of a much larger study, which will include an isotopic analysis of potential foods available to humans and dogs in the various ecosystems.

First, the inland sites:

Garoga. Although Garoga is a Late Woodland Mohawk site whose human inhabitants are thought to have consumed a large quantity of maize, this particular dog from Garoga does not appear to have been eating much maize at

all. For the collagen values, the $\delta^{15}\text{N}$ value of 10.6 combined with the $\delta^{13}\text{C}$ value of -19.2 indicates that this dog consumed a mixed diet that included significant quantities of C-3 fixing plants and a lesser quantity of C-3 feeding prey, as well as, perhaps, some maize. Katzenberg et al. (1995:341) propose that a diet for this region that was lacking in maize should be expected to have a $\delta^{13}\text{C}$ value of -21. From archaeological and ethnohistoric evidence we believe that during the Late Woodland period people were eating a diet dependent on maize, but which also included nuts, berries, seeds, and game (Katzenberg 1995: check). The enamel apatite value for $\delta^{13}\text{C}$ of -14.35 also supports the interpretation that little maize was consumed by this dog. The lower than expected quantities of maize in this dog's diet are intriguing, and raise questions about the health and societal role of this particular dog. Because this sample was a first molar, it is possible that it reflects a juvenile or infant diet (e.g., the dog could have been nursing). However, we would still expect a stronger maize signal. Follow-up studies will attempt to locate additional dog skulls from the Garoga to determine whether reduced access to maize is common in dogs from that site.

Ripley. The $\delta^{13}\text{C}$ value of -5.90 (enamel), suggests that the Ripley dog consumed a significant quantity of maize, an interpretation which is in keeping with what we know of the human diet for this region and time period. Because we are lacking collagen values for this sample, we can not say much more about what this dog was eating, although again, from what we know of human diet at

the time, the available foods would have included nuts, berries, seeds, and game. We hope to test other dogs from Ripley or similar sites in the future.

The New England results are more difficult to interpret because of the complications of the marine influence:

Revere Beach. The stable isotopic ratios of a tooth from this dog are consistent with heavy reliance on marine resources with a collagen $\delta^{15}\text{N}$ of 14.8. On the basis of the $\delta^{13}\text{C}$ value of -11.3 on collagen, the dog may have also consumed some maize. The $\delta^{13}\text{C}$ value of -3.25 for enamel apatite may indicate an unusually high maize consumption. The collagen-apatite spacing here of 8.0 ppm is, likewise, unusually high. For most of the dogs in this study the spacing is about 5 ppm, which is typical for primates and omnivores (Catherine Smith, personal communication 2001). Herbivores tend to have a 7-8 permil spacing, suggesting that this particular dog may have eaten an herbivorous diet (Catherine Smith, personal communication 2001). An alternative explanation of the large spacing between enamel and collagen values is that there may have been a problem in the analysis or with the sample itself. It may also indicate a striking difference between day to day diet (as indicated by enamel) and the protein portion of the diet as indicated by collagen. One potential problem with evaluating tooth enamel values is that it represents a "snapshot in time," reflecting the diet *while the enamel was forming* – enamel does not get remodeled or altered after that. Thus, it is possible that it was not that representative of the

dog's lifetime, although it usually represents at least a year or two. This tooth is recommended for an additional strontium analysis to help sort out some of these complex dietary issues.

The dogs from Site J and Squantum appear to have had a typical marine-based diet.

Site J. For Site J the collagen $\delta^{15}\text{N}$ value of 13.3 and the $\delta^{13}\text{C}$ value of -12.5 indicate that this dog consumed primarily marine resources with the possibility of a minor contribution from maize. From archaeological and ethnohistoric sources we believe the Late Woodland coastal human diet consisted of shellfish, deer, fish, waterfowl, crustaceans, turtle, and (rarely) whale and seal (Little and Schoeninger 1995), as well as maize, nuts, berries, and roots. The $\delta^{13}\text{C}$ value for this dog from enamel apatite is consistent with this interpretation. Because the N and C isotopic values of lobster, eel, and maize are similar to each other, it is not currently possible to sort out the maize signal using our current data. This molar would also be recommended for strontium analysis in order to determine a more precise percentage of marine resources. As with the Revere Beach dog, the dog from Site J is within the range of humans whose subsistence was based primarily on marine resources.

Squantum. The Squantum dog shows an elevated collagen $\delta^{15}\text{N}$ of 13.6 and a $\delta^{13}\text{C}$ value of -14.0 which is consistent with marine based diet, as well as the possibility of a small contribution of maize or other C-4 plants or C-4 plant-

eaters to the diet (i.e., eel grass or eel-grass eaters such as eels and lobsters). The enamel apatite values are also consistent with this interpretation. Strontium isotopic analysis would also be helpful in sorting this out further.

Watertown Arsenal. The two estuarine dogs from the Watertown Arsenal site appear to have consumed a more terrestrial-based diet than their coastal counterparts, with some marine influence as well as the possibility of a small contribution from maize (although in this case the contribution of maize may have been even lower than it was for the coastal dogs). Both dogs had slightly lower $\delta^{15}\text{N}$ values as well as lower $\delta^{13}\text{C}$ values for both enamel apatite and collagen than did the coastal dogs. The resources of the estuary will need to be considered in depth in order to sort out this complex picture.

Conclusion

The results of this preliminary study reveal that stable isotopic analyses of dogs from New England can, to some extent, be linked to subsistence patterns which included maize and/or marine resources. The two coastal dogs from Revere Beach and Site J on Martha's Vineyard revealed clear marine signals in their isotopic ratios. The inland and estuarine dogs revealed a stronger contribution from terrestrial resources with more or less of a contribution from maize, depending on this site. In sum, the results of this preliminary study are

promising for the use of dogs as indicators of subsistence patterns at a local level throughout New England.

Given these encouraging results, Ninian Stein plans to continue this research. Future studies will ideally include dogs from the Early and Middle Woodland Periods, prior to the introduction of maize to New England, dogs from Euro-American communities, as well as a greater diversity of native breeds of dogs from both inland and coastal environments. Further research is needed on the social context of dogs and their place in the subsistence regime. For example, some dogs in the Northeast were honored at the time of death with a formal burial, while others were deposited in middens and were apparently butchered and consumed. Thus, any further research on dogs and dog diet in New England should include comparisons of dogs from these various contexts. This additional data will hopefully allow us to come to a more complex understanding of the role of dogs in the Northeast, as well as the role of maize cultivation during the Late Woodland and early Contact Periods.

Chart 1: New England Dog Samples with Stable Isotope Values

Site	Town, County and State	Time Period	Inland/Coastal	13/12-C (enamel)	18/16-O (enamel)	15/14 N (dentine)	13/12 C (dentine)
Garoga	Ephratah, NY	AD 1518-1643	Inland	-14.35	-7.15	10.56	-19.21
Ripley	Ripley, NY	Late Woodland	Inland	-5.90	-8.55	NA	NA
Revere Beach	Winthrop, MA	AD 1305-1399	Coastal	-3.25	-8.23	14.77	-11.29
SiteJ	Aquinnah, MA	AD 1224-1282	Coastal	-8.80	-7.57	13.25	-12.51

Squantum	Quincy, MA	AD 1649- 1949	Coastal	-8.12	-6.69	13.64	-14.07
Watertown Arsenal	Watertown, MA	Contact Period (gunshot)	Estuarine	-9.07	-7.07	11.60	-15.22
Watertown Arsenal	Watertown, MA	Late Woodland	Estuarine	-9.72	-6.96	12.52	-13.85

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