Preliminary Analysis of Dental Calculus from Viking Age Iceland: Implications for Reconstructing Diet and Lifeways

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I. Abstract

Dental calculus (calcified plaque) analysis is becoming increasingly important in the area of dietary reconstruction for ancient humans. As it forms, dental calculus incorporates food and other particles that are in the mouth, providing a record of ingested items. Iceland is an area where not much is known of ancient diet other than the fact that meat and fish were the main sources of sustenance. A high-protein diet affects the pH levels of saliva, which in turn can produce excessive amounts of plaque. In this study, calculus samples from multiple individuals recovered from the farm Keldudalur (c. 1000 AD) in the Skagafjörður region in northern Iceland were chosen for reflected and transmitted light microscopic analysis. Preliminary results reveal that starches and phytoliths were present in most samples. The range of sizes of starch grains suggests the consumption of at least three different plants, one of which may be barley. In addition, twisted hairs and/or fibers that may derive from textiles were observed under both reflected and transmitted light. Red and blue fibers suggest dying of textiles, an unusual result from this early time period. Further analysis of dental calculus from Keldudalur has the potential to illuminate areas of Viking Age Iceland which are otherwise invisible archaeologically.

Individual	Age/sex	Reflected Light	Transmitted Light
A-11	Middle adult M	Fish scale? Possible feather Phytoliths	Phytoliths Dyed(?) red fibers Colorless fibers
A-19	Middle adult F	Hair Starch Plant Fibers Possible fish scale	Not analyzed yet
A-22	Mature adult M	Starch grains	Starch grains Phytoliths Colorless fibers Dyed(?) blue fibers
A-34	Young adult M	Dyed(?) red fibers Colorless fibers Phytiliths	Phytoliths Starch grains Dyed(?) blue fibers
A-35	Juvenile	Not performed due to small sample	Starch grains Colorless fibers Dyed(?) blue fibers Phytoliths
B-16	Mature adult F	Plant fibers Hairs Possible feather Dyed(?) red fibers	Starch grains Phytoliths Colorless fibers

Table 1

Figure 2: Note extreme calculus deposits. Singular tooth from KEH – A-11

II. Introduction

Iceland was unoccupied until European settlers arrived in the 9th century. This study examines human skeletons from the farm Keldudalur in the Skagafjörður in northern Iceland (Figure 1) in order to investigate early Icelandic diet. Keldudalur dates to around 1000 AD, just after the Icelandic conversion to Christianity (Zoëga and Traustadóttir, 2007). Viking Age Icelandic diet is thought to have been particularly protein-focused due to a lack of agriculturally fertile land and a lack of historical and archaeological evidence to the contrary. It is known that domesticated animals were consumed as well as sea birds, seals and fish (McGovern, 2006). While there is some evidence of wild plant consumption, it is not thought to have been a major part of the diet.

In order to investigate diet, dental calculus (mineralized plaque) was recovered from the skeletons at Keldudalur (Figure 2). Dental calculus allows us to study materials that are a direct link to consumption, as well as provides a record of items that are potentially inhaled into the mouth (Hardy, 2009). Starches and other materials tend to become trapped within plaque and if the plaque is not removed, it calcifies and becomes calculus (Lieverse, 1999). Therefore, anything that comes in contact with saliva has the potential to become part of the dental calculus. This would include items ingested for eating or inhaled. Using calculus analysis as a means identifying materials that came in direct contact with the teeth, what can we learn about this early Icelandic population?

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III. Methods

Of the 54 graves uncovered, 23 individuals had teeth that could be sampled for calculus. Six individuals are examined here. Calculus samples from Keldudalur were collected using dental picks and powder-free gloves over an aluminum foil lined box. I collected 2-3 samples from each individual, depending on the amount of calculus present. Unprocessed calculus was first examined with a reflected light microscope (Olympus BX30, 50-500x magnification) in order to visualize any items in situ and to eliminate the possibility of modern contamination. Subsequently, calculus samples were processed to recover and isolate plant microfossils. Calculus was dissolved with 10% HCl , centrifuged, rinsed with distilled water and resuspended in 100% ethanol. An aliquot of the processed sample was mounted in glycerol on a microscope slide and viewed with a transmitted light microscope (Olympus BX60, 50-500x magnification) magnified from 50x-500x. For both types of microscopy, images were captured with a DinoLite USB camera. The images captured were compared with modern material and published samples for identification (Henry and Piperno, 2008; Hardy and Moncel 2011).

Figure 3: Phytolith from individual KEH – A-11 original magnification 100x.

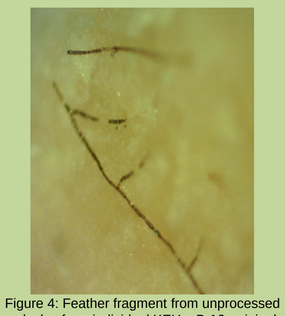

Figure 4: Feather fragment from unprocessed calculus from individual KEH – B-16, original magnification 100x.

V. Results & Discussion

Microscopy of the calculus samples resulted in the identification of a wide variety of materials including plant fibers, phytoliths, starch grains, hair, feathers, fish scales, and possible textile fibers (Table 1). All of these types of materials were observed in unprocessed calculus, thus demonstrating that they are not modern contaminants.

Plant fibers and phytoliths:

Plant fibers and/or phytoliths were visible in most samples that were examined under reflected light and in all samples under transmitted light. Figure 3 shows a phytolith that may derive from a wild edible plant (McGovern et al., 2007). While some phytoliths may be diagnostic of particular plants, a larger reference collection of phytoliths from Icelandic plants is necessary before a more specific attribution can be made.

Hair:

Hairs were observed under reflected light in more than one of the samples, but none were seen under transmitted light. Hairs could be incorporated into calculus through diet or other cultural practices.

Feathers and fish scales:

Possible feather fragments were seen under reflected light microscopy from two samples (Figure 4). Feathers are potentially identifiable to the Order level if diagnostic anatomy is preserved (Brom 1986). Possible fish scales were identified in two of the samples as well. These materials are likely the result of direct consumption.

Starch:

When starches are viewed under cross-polarized light, an extinction cross is the most easily identifiable feature, which expresses itself as a distinctive "X" (Wilson et al., 2010). If a starch granule has been heated, the extinction cross may be less distinct and cracks may occur along the edge of the granule. Five of the six samples presented starches, both modified and unmodified. The lack of starch in one individual may be the result of the small amount of sample taken. Figures 5 and 6 show a cluster of starches under transmitted light, both cross-polarized and not polarized. Interestingly, in the sample of KEH – A-35, which was a juvenile and contained the smallest amount of calculus, a fair amount of starches were discovered (Figure 7). Some of these starches could be from barley (*Hordeum vulgare)*, based on size and morphology of the starch grains. There is archaeological evidence that barley was consumed in Iceland (Trigg et al., 2009), although none has been recovered at Keldudalur. At least two other unidentified starches, most likely from wild edible or medicinal plants, were also observed. A larger comparative collection of starches from Icelandic plants may allow more specific identification in the future.

Fibers:

An unanticipated result is the presence of twisted fibers of different colors, ranging from undyed to red to blue (Figures 8 and 9). The presence of a twist in the fiber along with the added color, suggests that these fibers have been processed for use as textiles (Catling and Grayson, 1982). Although the identification is not conclusive, these fibers closely match the morphology of modern dyed wool fibers (Figure 10). These fibers could enter the mouth through various scenarios, such as wrapping food in textiles, wrapping the head and face in a cold climate and inhaling the fibers, or could be incorporated into the mouth through the practice of spinning wool which can involve licking of fibers. Although working with textiles has historically been the task of females, three of the samples that contained twisted fibers were from males, while only one sample from a female contained fibers. This may be an artifact of sample size or may suggest that the inhalation of fibers from clothing is responsible for their presence in calculus. To the best of my knowledge, this is the first evidence of textile fibers recovered from dental calculus in an archaeological context. This avenue of research has enormous potential in Iceland as the earliest preserved textiles come from the Medieval period some 400 years later than Keldudalur. Further analysis may also provide information about the dyes used and if these were local or imported textiles.

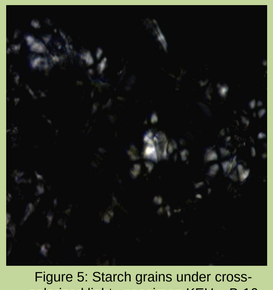

Figure 5: Starch grains under cross-polarized light, specimen KEH – B-16 (original magnification 500x)

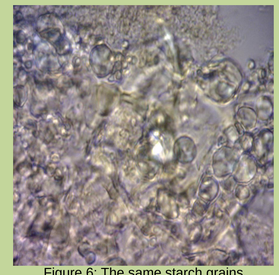

Figure 6: The same starch grains as Figure 3, but not cross-polarized

Figure 7: Possible modified starch grain from juvenile KEH – A-35 (original magnification 500x)

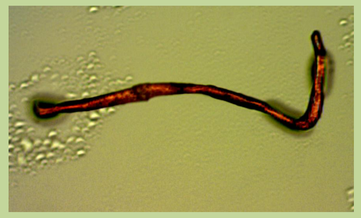

Figure 8: Red dyed fiber from KEH – A-11 (original magnification 500x)

Figure 9: Blue twisted fiber from KEH – A-22 (original magnification 500x)

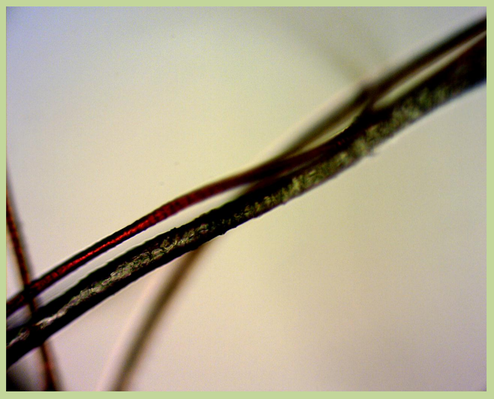

Figure 10: Modern wool fibers (original magnification 500x)

VII. Conclusions

Preliminary results suggest that this Viking Age Iceland population was consuming starches on top of the high-protein diet that has been historically documented. As we increase the sample size and build our knowledge of possible foods, we can make better comparisons and assumptions about early Icelandic foodways. If the observed fibers are from textiles, they provide a record of material and practices that are otherwise invisible archaeologically. The analysis of dental calculus from Keldudalur has demonstrated the enormous potential of this method to further elucidate early Viking settlement in Iceland.

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