How do archaeologists reconstruct the diets of past peoples, and why is this an important topic of study?

There are a number of different methods over which archaeologists can reconstruct the diets of past people, with the complexity ranging widely from simple observations of teeth to analysis of the elements found in bones. The diet of past people is important for a number of reasons. It provides insight into the daily lives of individuals, and is one of the few ways to study average people throughout history. This opportunity isn't afforded by many other areas of study, such as looking at artefacts and written records, as the average person didn't own large and ornate possessions capable of surviving until modern times, and records commonly tell very little about people other than their name and age. Records are also a relatively recent area of study, as writing down large quantities of data was not common in prehistoric times. Therefore, studying diet is one of the only ways to truly study humans.

The first way that archaeologists construct the diets of past peoples is through dental paleopathology. Not only can the teeth of an individual tell us their age and general health, but abrasions and micro abrasions to the enamel can hint at specific diets. For example, a hard and fibrous diet can lead to heavier tooth wear, while a diet of softer plant foods leads to less. In an archaeological sense, it is possible to examine teeth, and observe their state. Loss of enamel can be due to a more fibrous diet, and as the enamel stains brown over time, it is one of the most obvious indicators of diet[1].

The diet of modern humans consists of much softer foods than our prehistoric ancestors. The inclusion of grains, dairy products and beans, and the slow decline in the amount of meat and fish we consume, as well as its preparation, has led to much lighter tooth wear. In opposition, hunter-gatherers of early history would have consumed higher levels of meat, and likely eaten it raw or off the bone[2]. This would have damaged their teeth more, leading to the kind of wear observable on early human teeth.

There are two ways of investigating tooth wear: microwear, which can be studied through the use of scanning electron microscopy, and macro wear, which consists of studying the teeth using the naked eye and cataloguing the observations. Microwear studies can yield information about the physical properties of the food consumed by past peoples, for example, its abrasiveness. By studying the damage to the teeth, archaeologists can make theories on what sort of food the individual ate. Such examples of tooth wear come from the ingestion of heavily fibrous plants, which cause scratches to the enamel, and eating raw meat, especially off the bone, which damaged the molars of many early humans[3]. Dental examination can also provide clues as to how the food was prepared, and examples of this include damage done by quartz dust and grit[4].

A study led by Peter Lucas, a Dental Anthropologist at Kuwait University, looked into how phytoliths - rigid, microscopic structures made of silica or mineral that are found in plant tissue[5] - damaged ape's teeth. The findings suggested that the ingestion of phytoliths alone

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[1] Clement, A, 2008
[2] Pobiner, B, 2013
[3] Hernando, R, 2021
[4] Than, K, 2013
[5] Collins Dictionary

was not enough to cause scratches to the enamel of teeth. This discovery led to testing the effect of quartz on teeth. They rubbed microscopic particles of quartz over an orangutan tooth, and found that even one pass led to the chipping of enamel. These findings suggest that some of the microwear visible on early human teeth could be in part due to their location, for example, sand coating food would have led to the wear of enamel. This makes it difficult to accurately decide diet based on wear to the teeth, however, there are some general patterns. Teeth from specimens who lived pre-agriculture often have lower rates of cavities, suggesting that the bacteria present in their food was not as detrimental to their teeth. Researchers are currently following these findings, extracting calcified plaque from teeth to learn how strains of bacteria evolved after the widespread introduction of farming[6].

The evolution of diet also follows the evolution of humans. Leslie Aiello proposed that as Homo Erectus, a direct ancestor of modern humans who lived around 2 million years ago, began to eat calorie dense meat, their diet became higher quality and relied less heavily on bulky plant fibres. This introduction of meat and reduction of fibrous plant material led to the evolution of a smaller gut, as the digestion was simpler. As the gut requires lots of energy, less energy is available for the brain. But, as humans evolved with a smaller gut, more energy was afforded to their brains. Currently, humans use around 20% of their body's energy on powering the brain, the highest percentage of all modern apes[7].

The skeletal remains of past people also hold information about diet. Two such ways are through recording the Strontium/Calcium ratios within bones, and stable carbon isotope measurements. Firstly, archaeologists can use Strontium/Calcium ratios. When plants take up strontium and calcium from soil, they do not favour either element. Due to this, the ratio in a plant is nearly identical to the ratio of the soil and water around it. Mammals, conversely, favour calcium over strontium in the digestive absorption and eventual deposition within bones. This leads to a lower Sr/Ca ratio, meaning that a herbivore, for example, will have a lower Sr/Ca ratio than the plants it consumed. In wider application, Sr/Ca ratios decrease going up a food chain, with carnivores having the lowest ratio in any given food chain. This is useful for determining diet as archaeologists can infer the amount of meat an individual consumed: the higher the levels of meat consumption, the lower the Sr/Ca ratio[8].

Additionally, stable carbon isotopes can also be used to determine diet. Carbon has three isotopes that occur naturally: 12C, 13C, and 14C, the last of which is unstable and is used in radiocarbon dating. As 12C is a lighter isotope, it reacts faster in chemical reactions and is therefore used by plants more often. When plants fractionate atmospheric carbon dioxide, it is either fixed as a three-carbon molecule (C3), or a four-carbon molecule (C4). Tropical and savanna grasses commonly use C4. They metabolise almost off of the carbon dioxide they take up and therefore retain more of the heavier isotope (13C) in their tissues. Trees, the majority of shrubs and temperate grasses use C3. These C3 plants are not as efficient as C4 plants, and due to this more 13C escapes the plant through the stomata during respiration. Due to this loss of 13C, C3 plants have a lower percentage of the heavier carbon isotope[9]. As less fractionation occurs within animals, the levels of different carbon isotopes in plants are carried through the food chain. This makes it possible for the relative amounts of

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[6] Boissoneault, L, 2018
[7] Gibbons, A, 2013
[8] Sillen, A, 1986, p 16-17
[9] Smithsonian, National Museum of Natural History, 2022

different plants in animal diets to be determined[10]. In its application to archaeology, it means that scientists can calculate the levels of carbon isotopes present in human remains, and from the results, distinguish which types of vegetation the human is likely to have eaten.

Deficiencies from a poor diet can also lead to observable deformities in bones. For example, rickets, a condition that can occur due to a lack of vitamin D or calcium, causes bone deformities and osteoporosis[11]. A Neolithic skeleton discovered by amateur archaeologists in 1912 in the Hebrides is believed to show signs of rickets. The bones belong to that of a 25-30 year old woman, who would have lived between 3340 and 3090 BCE[12]. Her condition could have been caused either by a lack of vitamin D, or a lack of calcium. It is unknown what caused her case of Rickets, but if it was due to a calcium deficiency, we can infer that the consumption of dairy products was not common during her lifetime.

While such finds are rare, there have been several discoveries of human remains with their stomach contents still intact. Much of the time, this is due to the body being preserved in peat bogs (dense wetlands filled with partially decaying vegetation due to their acidity[13]), such as the Tollund Man who died in approximately 405 - 380 BCE[14], and the Huldremose Woman, who died between 160 BCE and 340 CE[15]. Along with peat bogs, there have also been incredibly well-preserved bodies discovered in ice. One example is of Ötzi the Ice-Man, who was alive between 3350 and 3105 BCE[16]. All of these bodies were in remarkable condition, owing to the preservative properties of peat and ice. Due to this preservation, it has allowed archaeologists to examine their stomach contents, and learn what food they had eaten in the last 24 hours before their deaths. For example, when archaeologists explored the stomach of the Tollund Man, they found the remains of a barley porridge, pale persicaria, flax, and bony fish[17]. Beyond this, charred food crusts found in his gut suggest that the porridge was cooked in a clay pot. Analysis of the Huldremose Woman's stomach contents showed her last meal was coarsely ground rye with large amounts of seeds, and animal hair and tissue found suggests that she also ate meat before her death[18]. Both bodies were discovered in Jutland, Denmark, which is a common location for these well-preserved bodies to be located owing to the vast number of peat bogs.

The discovery of Ötzi the Ice Man in the Ötztal Alps[19] also provides an insight into Neolithic diets. He is Europe's oldest known natural human mummy, and died over 5,000 years ago. Soon after his death, his body was covered and protected by a layer of glacial ice, which preserved his remains until their discovery in 1991. His last meal consisted of dried ibex meat, red deer, einkorn wheat, and small amounts of toxic fern[20]. Unlike the Tollund Man and the Huldremose woman, who are both believed to be victims of sacrifice, Ötzi was likely murdered. An X-ray conducted in 2001 discovered a flint arrowhead lodged in his left

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[10] Sillen, A, 1986, p 18
[11] Healthline: Rickets
[12] BBC News, 2015
[13] WWT - Peat Bogs
[14] Wikipedia - Tollund Man
[15] Goran, D, 2016
[16] Vidale, M, 2016
[17] Geggel, L, 2021
[18] National Museum of Denmark, 2022
[19] Pinkowski, J, 2021
[20] Wei-Haas, M, 2018

shoulder, which could have injured his subclavian artery and caused him to bleed to death[21]. Due to his violent death, his last meal is a direct reflection of what humans were eating at the time, while the Tollund Man and Huldremose Woman's last meals may have formed part of the sacrificial rituals performed before their deaths[22].

It is estimated that between 200-700 bodies and skeletons have been removed from peat bogs, with the majority dating back to the European Iron Age and Roman period (800 BCE to 400 CE)[23]. The discoveries of Bog bodies (the term given to naturally mummified human corpses who are killed and placed in a peat bog[24]) are crucially important to the study of past peoples, and they cannot only tell historians about their diet, but also their clothing, health conditions, stress levels, and even whether they were left or right handed. The incredible preservative properties of peat bogs are owed to a number of factors:

1. The water being deep enough to prevent attack by maggots, rodents and foxes, and adequately oxygen-deficient to prevent bacterial decay
2. The bog containing sufficient tannic acid to preserve the outer layers
3. The temperature of the water being below 4 degrees Celsius

There are many benefits that come from studying what past peoples diets consisted of. Firstly, food transcends history[25] - throughout the history of the entire world, people always have and will always need to eat. Education on diet and food of past people's is one of the best ways to engage the general public with archaeology, as it is possible to relate to it, and historical recipes offer an interactive learning experience. Similarly, diet has always been an important evolutionary driving force. When early humans began including meat as a large component of their diet, it not only changed the size of their intestinal tract and brain, but also led to a reduction in tooth and jaw size as meat required less chewing, a reduction in the time needed for food gathering, allowing more time for social activities and teaching of the young, and an ability to live in a more varied environment, due to a lower reliance on seasonal fruits, tubers and other plant foods[26].

Similarly, diet allows the study of so-called 'normal people'. While no human can ever be described as normal, we can take this to mean the study of humans who weren't particularly rich or powerful in their society. Large artefacts or settlements that survive are often a reflection of the wealthier individuals, but studying diet is relatable to the wider world of history.

Finally, the study of diet allows us to study how humans reacted and evolved to changes in their environment. For example, the last ice age corresponds with the Upper Palaeolithic period (40,000 to 10,000 years ago), in which Homo Sapiens had emerged and settled in Northern Europe. During the ice age, hunters would have gathered large quantities of meat in the warmer months, then dried and stored it for winter[27]. This strategy worked well for thousands of years, but the rising temperatures at the end of the ice age would have

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[21] Garlinghouse, T, 2021
[22] National Museum of Denmark, 2022
[23] Hirst, K, 2019
[24] Malone, A, 2021
[25] Forbes, 2017
[26] Dorey, F, 2020
[27] Roos, D, 2021

changed many of the Homo Sapien's food sources. Namely, it would have provided a higher abundance of plants, seeds and nuts[28], supplementing the high-protein diet of meat they consumed in the ice age.

Overall, there are multiple techniques available to archaeologists to determine the diet of past peoples. Some of the most common methods are studying microwear and macro wear of teeth, investigating the Sr/Ca ratio and carbon isotopes present in bones, and directly looking at the stomach and intestinal contents of well-preserved humans. The study of diet is important for the continued education of people about archaeology, understanding how and why humans evolved, and relating history to average people of the time.

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