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Hunters' and Farmers' Genes

There are those who believe agriculture to have been the most disastrous invention in history. The American author and physiologist Jared Diamond, for example, once described it as the 'worst mistake in the history of the human race'. It is a common view that diseases, class divisions, war and misery of every other kind befell us when we abandoned our lives as hunters and made the transition to farming-based societies.

Sometimes I am inclined to agree that things were better during the age of the hunters, before we started to farm the land. That would be my view on comparing the Raspberry Girl and the Österöd woman, for instance, two of the most important finds of female individuals from prehistoric Sweden.

On the one hand, we have a 19-year-old slip of a girl who, for the sake of some murky beliefs, was bound and thrown into a lake to drown. Although the nature of these beliefs is obscure, they may have been linked in some way with the harvest and supernatural forces. The Österöd woman, on the other hand, was a well-nourished, athletic 80-year-old with teeth in better condition than those of most Swedish pensioners today, who died in the archipelago off Bohuslän after a long and active life as a hunter.

If I were to swap places with one of them, there's no doubt who I'd choose to be – the Österöd woman. However, we need to bear in mind that she represents a unique stage in Sweden's early history. She and the group she belonged to came to a virginal land, where nature provided more than they could ever need. They had no competitors; they could fish, hunt dolphins and elk, and gather shellfish, berries and nuts to their hearts' content. When the population expanded during the Mesolithic period, life became much harder.

I also ponder the fates of other individuals I have heard about during my journey to prehistoric Europe – such as the young Ice Age woman at Abri Pataud who died with her newborn baby 30,000 years ago. She may have lost her life through giving birth. However, her teeth were so inflamed and so badly damaged that that alone would have been enough to cause a protracted and agonising death.

It is simply not true that we humans first encountered lifestyle diseases through agriculture, nor does there seem to be any decisive difference in infectious diseases before and after the advent of farming. Tuberculosis, for instance, seems to have been with us at least since some of us left Africa over 55,000 years ago. When DNA researchers compare the immune defence of early European hunters with that of farmers several millennia later, they cannot discern any definite signs of an increase in the incidence of disease.

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One variant of the low-carbohydrate diets so trendy these days is known as the 'Paleo diet' and is supposedly inspired by the Palaeolithic, or Old Stone Age. It involves eating a high proportion of meat and fish and avoiding dairy products and cereals, which only became common with the emergence of farming. Although a Paleo diet includes some sweet berries, there is very little place for starch.

Such a diet may well have some advantages in terms of both flavour and health properties, compared to today's hyper-processed food with its high sugar content and fast carbohydrates. But the advocates of Paleo diets often give an extremely simplified – indeed, mistaken – account of what people ate in Palaeolithic times.

Firstly, people like us, anatomically modern *Homo sapiens*, lived through the Old Stone Age for at least 100,000 years, on all the continents except Antarctica – a long period, in many different locations with disparate conditions. We lived in tropical, temperate, Arctic, dry and wet climates. Our living conditions varied enormously. Some Palaeolithic peoples ate

mainly reindeer meat, others almost exclusively seal meat and fish, while still others lived largely on starchy roots. Insects and other small creatures were often an essential part of the diet. Everyone who had access to honey consumed it. Ethnological studies of today's hunter-gatherer peoples show the importance of honey to people everywhere that wild bees are to be found – which is in most places apart from those at Arctic latitudes. Traditional groups such as the peoples of the rainforest and the Hadza of East Africa obtain a considerable proportion of their nutrients from honey, which they collect from several species of bees.

So far, archaeology has given a distorted picture of what people ate in the past, as the remains of large mammals and shellfish are preserved so much better than those of plants. Bones and oyster shells are visible evidence, even after several millennia. However, new technology is now emerging that can reveal the part played by plants in the diet. For instance, it is now possible to examine microscopic deposits in the tartar on human teeth. One of the leaders in this field is Amanda Henry, a colleague of Svante Pääbo at the Max Planck Institute for Evolutionary Anthropology in Leipzig.

She examines the surfaces of ancient teeth for microscopic traces of starch and minute traces of silica from different types of plant, which differ in appearance according to species. Analyses carried out by Henry and her collaborators show clearly that people have been eating plant material for a very long time. People in the caves at Blombos in South Africa and Skhül in Israel were already eating different types of grass seed 100,000 years ago. The people of Skhül also had traces of dates on their teeth. During the Ice Age in Europe, people ate grass seeds and the starchy roots of plants including water lilies and bulrushes. This has been shown by analysing teeth from sites such as Cro-Magnon, Abri Pataud, Dolní Věstonice and La Madeleine.

Simple mortars in which microscopic traces of starch have been preserved have also been found at sites including Kostenki (Russia), Biancino (Italy) and Pavlov in the Czech

Republic. All of these date back about 30,000 years. The starch seems to have come mainly from the roots of bulrushes and ferns.

Amanda Henry says she is irritated by those who seek to make money by writing books claiming that people in general have an 'evolutionary adaptation' to a particular way of eating. There is no scientific proof that any particular kind of 'Paleo diet' suits everyone best.

In other words, the notion that evolution has shaped us to do without carbohydrates almost completely is mistaken, even though some pundits want to give this impression. We are genetically equipped, to a far greater degree than apes, to digest starch in our food. The reason for this is that starch in the diet has played an important part in our survival for the last six million years, since our evolutionary branch diverged from those of our nearest relatives, the chimpanzees and bonobos.

However, we may differ in our sensitivity to the large proportion of starch typical of the modern diet, and our genetic background may account in part for that sensitivity. After all, there can be no doubt that the switch to agriculture represented a dramatic change. Most farming societies throughout history have eaten more starch than most hunting societies. Even our dogs changed their way of life, as is shown by a number of interesting DNA studies.

Kerstin Lindblad-Toh, a Swedish researcher based in Uppsala, is the world's leading expert in canine DNA. Comparing the genetic material of various breeds of dog – which are often exactly bred to meet pedigree specifications – is an ingenious shortcut to identifying disease-bearing genes that also occur in human beings.

In 2012, Lindblad-Toh and her collaborators made a contribution to the heated debate on when dogs were domesticated. The main conclusion their study reached is probably incorrect. The team suggested that wolves became humans' companions only when we took to farming – that is, slightly less than 12,000 years ago. This cannot be right, as there is convincing archaeological evidence – and other DNA

studies – that show dogs must have been with us for several millennia before that.

However, the results of the study are very interesting anyway, as regards both the history of dogs and that of humankind. This is because the Uppsala researchers managed to show that dogs, just like people, have a number of genes whose function is to break down starch. These genes emerged after dogs had started living together with humans; wolves have them to a far lesser degree. The conclusion is thus that dogs have adapted through evolution to the food they have been given by farmers over the millennia, which includes quite a large proportion of leftover porridge and bread.

The one minor error in this initial conclusion is that it is not true of absolutely all dogs. A few years later, an international team of researchers published a new study. They had examined the DNA of more breeds of dog, including some very old ones. Their study showed that a number of ancient breeds, such as dingoes, basenji and Siberian huskies, resemble wolves in that they are not genetically equipped to break down starch. Lindblad-Toh's team subsequently confirmed these findings and added further old breeds, such as Greenland sled dogs.

So the conclusion to be drawn from these latest results is that some dogs were already living with humans when we were hunters, and were genetically adapted at that time to live almost exclusively on meat. Dogs adapted to consuming farmed food at a later stage, when their human companions went over to farming. A parallel can be drawn here between dogs and people. Farmers have largely displaced Europe's earlier population of hunters. At the same time, farmers' starch-eating dogs have multiplied at the expense of the older breeds of dogs that accompanied the hunters.

Humans, too, have undergone a similar genetic adaptation to farmed food. For example, there is a gene known as AMY-1 whose function is to break down starch by means of saliva in the mouth. Our cousins the chimpanzees normally have a single gene that works like this. Bonobos, which are equally closely related to us, have none. A human being, on the other

hand, can have several copies of the AMY-1 gene. Some have only a few, while others can have up to 15 or 20 copies. Individuals who have many copies can break down starch more efficiently.

And the capacity to break down starch efficiently has been vital for survival in certain human environments, but not in others. This is why the Hadza, a people of hunter-gatherers living in East Africa, have a comparatively large number of copies of AMY-1. They live in a dry tropical climate and live largely on starchy roots that they dig up out of the ground. The Aka and Mbuti peoples also live in the tropics, but in regions with humid rainforests. Their traditional diet contains more animal protein and sugars from fruit and honey, and they tend to have fewer AMY-1 genes. People from farming cultures based on the cultivation of grain, such as the Japanese, have significantly more genes of this type.

It is simply the case that the capacity to break down starch varies depending on the type of environment in which our ancestors lived. Their lives – whether they were hunters or farmers – marked our genes in different ways.

Most people living in today's Europe have a mix of 'hunter genes' and 'farmer genes'. We represent different waves of immigration, which affected the early history of our continent in different ways.

Take me, for example. Following my own mitochondria and thereby my direct maternal lineage, I can go back several tens of thousands of years to Ice Age forebears who hunted reindeer and other deer. Following my paternal grandmother's mitochondria, my maternal lineage goes back to Syria and the cradle of early agriculture. I am a mix. We all are.

However, the fact is that the first wave of 'hunters' and the second wave of 'farmers' do not really account adequately for the early history of Europe. DNA researchers are beginning to be increasingly convinced that there was a third wave.

That wave came from the east.