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Reading History From DNA

Studying ancient human DNA can help us better understand the early histories of states and nations – says **Prof. Marek Figlerowicz** from the PAS Institute of Bioorganic Chemistry in Poznań.

Prof. Marek Figlerowicz is a specialist on molecular biology, a Corresponding Member of both the Polish Academy of Sciences and the Polish Academy of Arts and Sciences (PAU). Professor and Director of the PAS Institute of Bioorganic Chemistry, where he also leads the Department of Molecular and System Biology. Until 2020, he was a Professor at the Institute of Computing Science, Poznań University of Technology. Leader of the project "Dynasty and Population of the Piast State in View of Integrated Historical, Anthropological and Genomic Research."

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ARTUR DĘBSKI

Analysis of remains from the Mausoleum of the Silesian Piasts in Legnica

What does the field of *archaeogenomics* deal with?

It's a relatively new interdisciplinary field in science that attempts to combine archaeological and historical research with genetic and genomic studies. Swedish evolutionary biologist and geneticist Svante Pääbo, who contributed significantly to the establishment of this new discipline, was awarded the Nobel Prize in 2022.

Back in 2014, when we began the project "Dynasty and Population of the Piast State in View of Integrated Historical, Anthropological and Genomic Research," only a dozen-odd ancient genomes had been sequenced for humans or our close relatives,

Neanderthals or Denisovans. Our project started around the same time as the archaeogenomic revolution unfolded. It arose out of two technological breakthroughs: firstly, the development of modern DNA sequencing methods, which now relatively cheaply and quickly allow us to sequence the entire human genome – the full genetic information present in each of our cells. This includes the so-called nuclear genome, consisting of linear DNA running about 3 billion base pairs long, as well as the mitochondrial genome, with circular DNA about 16,000 base pairs long. Secondly, methods were developed that now allow us to isolate deoxyribonucleic acid from fossil remains.

What can we gain from this new trend in science?
While archaeology and history are disciplines in which we try to learn something about humans by studying the products of their civilization, archaeogenomics allows us to learn about the biological history of individuals and populations by analyzing information encoded in DNA. As it turns out, this can tell us quite a lot. Not only about our origins, who our ancestors were, but also about certain unexpected issues, such as social relations, including the lack of equality between women and men or different groups of people, and the impact of these relations on the genetic structure of populations. Archaeogenomics is, therefore, a new research direction in which genomic analysis is used to strive to better understand and comprehend human history.

What's so remarkable about this? Such research provides hard evidence of how things really were, rather than being based on mere speculation or assumptions about how things might have been. I am convinced that the history we learn in school is largely a kind of "imagined reality," a very simplified and embellished vision of the past, often far from the truth. Of course, archaeogenomic research will not answer all our questions, but it does allow us to verify certain theories about where we came from, who our ancestors were, and what they looked like. Moreover, archaeogenomics can tell us a lot about the social relations that prevailed among particular populations or groups, to what extent they were based on inequality, whether they had a patriarchal or matriarchal system, etc.

But how is it possible to draw conclusions about social inequality, by looking at samples under a microscope?
In his book *Inequality: A Genetic History*, the Spanish biologist Carles Lalueza-Fox gives many examples of how this can be done. One of them concerns the colonization of America. It turns out that a small group of newcomers from Spain so dominated some regions of Mexico that there are virtually no native male lineages there today. They have been almost entirely replaced by European lineages. This shows the degree of the European dominance: it indicates that children fathered by locals had no chance of survival, or that there were no such children at all. Women were treated as machines for producing offspring for the invaders. The variation in the genomes clearly show this. Women contribute the X chromosome to the genome, and men X or Y. Thus, significantly less variation in the Y chromosome than in the X chromosome indicates that the very same men were constantly having children with many different women.

Similar conclusions are also drawn from other studies. As a result, it seems to be a valid view that women are the source of greater genetic variability than men. We have observed a similar phenomenon in our studies of populations that inhabited areas of contemporary Poland 1,000 and 2,000 years ago. We found that in the entire first millennium CE, practically the same female lineages were maintained in this area. This means that the women were always local, and if incomers appeared, they were men.

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How does collaboration between scientists working in such different disciplines work in practice?
The team of our Institute itself is highly interdisciplinary; we work in chemistry, biology, and computer science. Therefore, when talking within the institute, we often use different languages. Perhaps as a result we have developed certain methods of communicating with people who apply different research approaches or represent a different way of thinking. Besides, I personally have an interest in philosophy, which is a kind of reflection of our history and combines the sciences and humanities. Philosophy tries to form a coherent picture of the reality we experience; it epitomizes interdisciplinarity and is the key to understanding the world around us.

It is therefore a great pity that philosophy is almost absent from our daily lives. If we could convince people to take a slightly broader view of our world, they would surely see that it does not belong to us alone, that other people, animals, and plants all inhabit this world, that there are different ways of arriving at the truth. This would undoubtedly make the world

a much better place. No one would believe that their laws and arguments are supreme. Unfortunately, for a long time, one of the features of European philosophy was the assumption that there is a single objective truth. We tried to capture it by positing dogmas, which unfortunately usually have the flaw of being unverifiable. Science grew to become another way of striving for the truth.

> It is not good that the humanities have been developing for many years in a certain isolation from the biological history of humankind.

How is your research likely to change our school textbooks?

For many years, we have been studying human, animal, plant, and viral genomes in our laboratories only in order to solve very specific biological problems. The findings were usually published in specialized international journals, which are in practical terms inaccessible to the general public. I wanted to change this state of affairs and to do research that would have a direct bearing on people's lives. Around the same time, I realized the great potential of combining genomics with history and archaeology. It can contribute to a better understanding and comprehension of the past, especially in situations where our ideas about what happened are based on very tenuous premises. This is the case, for instance, for the processes leading to the formation of the first state in the region of present-day Poland, ruled by the Piast dynasty. There are no written documents about those historical events. The supposedly well-known facts about the alleged progenitor of the Piast dynasty, Kołodziej – about scattered settlements among great forests – are in fact unsupported notions that have been propagated for years.

Additionally, for 200 years there has been debate over the origin of the Slavs in the territories of contemporary Poland. The beginnings of that debate coincide with the times in which Poland was under foreign partition, which further intensified it. The first, "allochthonous" hypothesis stipulates that 2,000 years ago these lands were inhabited by German tribes, but they emigrated away during the Migration Period, resulting in a so-called settlement void. Then around the 6th century CE, the Slavs arrived from the east to fill it. The second hypothesis posits that Slavs have lived here for several thousand years. Our hope is that studying genomes will finally allow us to resolve this mystery.

Anthropological analysis of ancient remains

MAŁGORZATA MARCINKOWSKA-SWOJAK

So are you looking for authentic Slavic DNA?

Our findings indicate that the concept of "Slavs" is more of a cultural category. We think that this group was formed by populations of different genetic origins. We have shown that people who lived in the territory of contemporary Poland both 2,000 and 1,000 years ago were genetically similar to their contemporaries in northern Europe, living in the territories of present-day North Germany, Denmark, Sweden. So it can be said that we had much more in common with the west and north of today's Europe than with the populations inhabiting the territories of present-day Russia or Ukraine. Poland's inhabitants were as distant from the Sarmatians living in the east as from the Spaniards in the west. So where did the idea come from, that we Poles have a common genetic background with Croats or Serbs? If we look at our appearance, our phenotype, we can plainly see that we are different. It seems that the culture with which we identify prompted us create common roots.

Our work has shown that all the genetic elements needed to form the society of the Piast state were present in the territory of present-day Poland around the 4th century CE. These observations coincide with the recent findings of linguists. They believe that the individual Slavic languages, including Polish, Russian, Czech, began to form in Central and Eastern Europe at about the same time, around the 4th century CE. This means that people who had previously led a more nomadic lifestyle began to produce local cultures that became somewhat more stable and began to take on their own character.

How should we view the history of our entire species?

It is not good that the humanities have been developing for many years in a certain isolation from the biological history of humankind. *Homo sapiens* arose roughly 300,000 years ago. We then lived as hunter-gatherers for about 290,000 years. That is, all of known human civilization based on agriculture and urban centers came in just the last 10,000 years. Unfortunately, in our considerations about the human condition we often rely solely on this last period, ignoring the first 290,000 years of our development. Fortunately, we can now read the information that is written in our genes concerning our distant past. Only once we manage to combine this information with the observations of archaeologists and historians will we have a real chance to get to know humans as thinking beings.

In the course of evolution, nature constantly creates and verifies new traits. At some point, humanity was endowed with intelligence, which is such a new feature that is now being tested out. I have serious doubts about whether we will manage to pass this test. Every species has a beginning and an end. A particular trait may offer a temporary advantage, but it must disappear if in the long run it does not benefit the whole Earth. We often think that our civilization is extremely old and everything we have created within it has already been thoroughly tested out. We forget that individual biological species develop over hundreds of thousands, millions of years. The 10,000 years of the existence of our civilization is just a blink of the eye, a time of blindly testing out various far-from-optimal solutions. This is best evidenced by the fact that everything we have created so far has been based on inequality, injustice, exploiting other people. We have not yet matured to use our intelligence on a mass scale in a creative and positive way.

MAŁGORZATA MARCINKOWSKA-SWOJAK

A lab for studying ancient DNA (aDNA)

INTERVIEWED BY
JUSTYNA ORLOWSKA, PHD

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