ANCIENT DOG DNA UNVEILS 11,000 YEARS OF CANINE EVOLUTION

Genomes trace how the animals moved around the world — often with humans by their side.

By Ewen Callaway

Human history is for the dogs. The largest-ever study of ancient genomes from the canines suggests that where people went, so did their four-legged friends — to a point. The research also identified major regional shifts in human ancestry that left little mark on dog populations, as well as times when dogs changed, but their owners didn't.

The analysis of more than two dozen Eurasian dogs also suggests the animals were domesticated and became widespread around the world well before 11,000 years ago. But it does not make any claims as to when or where domestication from wolves happened, an issue that has vexed researchers and sparked sometimes heated debate.

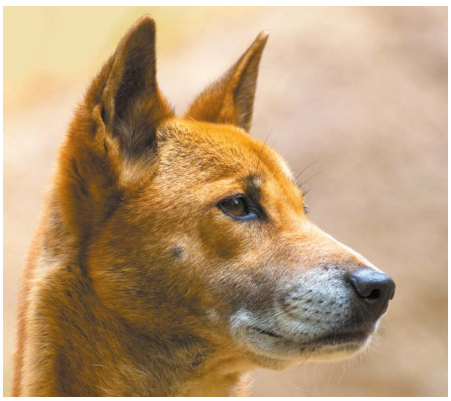
"Dogs are a separate tracer dye for human history," says Pontus Skoglund, a population geneticist at the Francis Crick Institute in London who co-led the study (A. Bergström *et al*. *Science* **370**, 557–564; 2020). "Sometimes human DNA might not show parts of prehistory that we can see with dog genomes."

Until the past few years, canine genetic history had been told largely through DNA from modern dogs. But this has offered a muddled picture, because much of early dogs' genetic diversity was probably lost when modern breeds were established. The first studies of ancient dog genomes hinted at past changes in canine populations. But with just six ancient dog or wolf genomes available until now, such conclusions have been preliminary.

Pedigree chums

To expand the pool of ancient dog DNA, Skoglund's lab joined groups led by Greger Larson, an evolutionary geneticist at the University of Oxford, UK, and archaeologist Ron Pinhasi at the University of Vienna. The teams sequenced 27 ancient dog genomes from Europe, the Middle East and Siberia, ranging from 11,000 to 100 years old.

By modelling the relationships in and between groups of ancient and modern dogs, the researchers determined that a 10,900-year-old dog from Russia was distinct from later ancient European, Middle Eastern, Siberian or American dogs, as well as a canine lineage characterized by modern New Guinea singing dogs (which are related to Australian dingoes). "Already, 11,000 years ago, there were at least 5 different groups of dogs across the world, so the origin of dogs must have been substantially earlier than that," says Skoglund.



A New Guinea singing dog.

DANIEL HEUCLIN/NPL

With so many genomes, the researchers could follow ancient canine populations as they moved and mixed, and compare these shifts with those in human populations. Sometimes, the dogs' travels paralleled people's. When Middle Eastern farmers started expanding into Europe 10,000 years ago, they took dogs with them, and the animals — like their owners — mixed with local populations. Ancient Middle Eastern dogs that lived around 7,000 years ago are linked to modern dogs in sub-Saharan Africa, which could be connected to 'back to Africa' human movements around that time.

But the histories of humans and dogs haven't always overlapped. A major influx of people from the steppes of Russia and Ukraine 5,000 years ago led to lasting change in the genetic make-up of Europe's humans, but not its dogs. The study also revealed that the ancestry of European dogs has become much less varied in the past 4,000 years, a period when thorough sampling of ancient human DNA has revealed less tumult.

The cause of this disconnect is a mystery, says Angela Perri, a zooarchaeologist at Durham University, UK. "Was it a case of the introduction of something like disease? Cultural preference?" she wonders. "These are likely cultural questions the DNA can't answer."

WEALTHY FUNDER PAYS REPARATIONS FOR USE OF STOLEN CELLS

Howard Hughes Medical Institute's six-figure donation aims to compensate for research on HeLa cell line.

By Alexandra Witze

A major biomedical-research organization has for the first time aimed to make financial reparation for the continuing experimental use of cells from Henrietta Lacks, a Black woman who was the source of the historic 'HeLa' cell line, which has been a mainstay of biological research for decades. The Henrietta Lacks Foundation announced the six-figure gift from the Howard Hughes Medical Institute (HHMI) in Chevy Chase, Maryland, on 29 October.

In 1951, doctors took cancerous cells from Lacks without her consent, and later created the HeLa cell line, which today supports a multibillion-dollar biotechnology industry. Lacks died soon afterwards, and, for decades, her family saw no financial compensation and were not consulted on other medical decisions stemming from the use of the cells in research.

"We felt it was right to acknowledge Henrietta for the use of HeLa cells and to acknowledge that the cells were gained inappropriately," says Erin O'Shea, president of the HHMI. "And to acknowledge that we have a long way to go before science and medicine are really equitable." The HHMI did not disclose the exact amount of the donation. "I can't speak for everybody, but I know some family members are grateful for this gift," says Jeri Lacks-Whye, a granddaughter of Lacks. "Hopefully, other institutions will follow suit."

The HHMI decided to make the donation after this year's transformative protests over racial injustice in the United States, including the killing of George Floyd, an unarmed Black

man, by police in Minneapolis, Minnesota, in May. The institution's high profile as one of the world's biggest private funders of basic biomedical research could set a precedent for other research organizations to take similar steps towards reckoning with racial injustice in the sciences, and making reparation for experiments conducted unethically on people from communities of colour.

The donation is "absolutely thrilling – it's from an institution that's well recognized and has a lot of power and a lot of sway", says Donté Alexander Stevens, a cell biologist and graduate student at the University of California, San Diego (UCSD).

Stevens and his colleagues working in the laboratory of UCSD biologist Samara Reck-Peterson had discussed ways of addressing systemic racism in science earlier this year. After many conversations, including with members of the Lacks family, they settled on donating to the Henrietta Lacks Foundation every time their lab created a new HeLa cell line, as well as for those created in the past. Reck-Peterson is an HHMI investigator, and her lab's action triggered the HHMI's leadership to consider making its own donation, says O'Shea.

Righting wrongs

The HeLa story became widely known with the 2010 publication of the book *The Immortal Life of Henrietta Lacks*. But until recently, no institutions had stepped forward to make restitution for using the cells, says the book's author, Rebecca Skloot. In August – the month in which Lacks would have turned 100 – the UK biotech firm Abcam in Cambridge announced that it had made an unspecified donation to the foundation. And individuals have made private donations. For instance, Francis Collins, the director of the US National Institutes of Health, is giving an unspecified amount of his 2020 Templeton Prize, worth US$1.4 million, to the foundation.

The HHMI gift, though, is the largest yet, says Skloot, the foundation's president and founder. "The more of this that we do – whether through the foundation or other things – the closer we're going to get to being able to fix some of the wrongs that have happened," she says.

The foundation gives grants to people who have unknowingly been part of historic medical-research studies, and to their families who did not benefit from that work. Recent grants have included educational and medical expenses for members of the Lacks family, as well as support for the families of the Black men who, from 1932 to 1972, were part of a US government experiment to observe the effects of untreated syphilis. The men thought they were receiving free health care, but doctors gave them placebos and administered sham procedures instead.

Q&A

The data scientist keeping tabs on bots and the US election

EMILIO FERRARA

Social-media platforms such as Twitter were used to sow discord in the United States in the run-up to the 2016 presidential election, according to a report finalized this year by the US Senate. Russian operatives manipulated tools such as bots — automated accounts that share content — in an attempt to deceive social-media users in the United States and sway the election in favour of President Donald Trump, the report found (see go.nature.com/38b0dlk). Ahead of the 2020 election, researchers were more worried than ever about interference from bots. The fake accounts have become harder to detect, says Emilio Ferrara (pictured), a data scientist at the University of Southern California in Los Angeles who studies social-media bots to understand how they can change people's beliefs and behaviours. He spoke to *Nature* about his team's findings.

You have analysed billions of tweets in the past few years. Have bots changed over that time?
Back in 2016, bots used simple strategies that were easy to detect. But today, there are artificial intelligence (AI) tools that produce human-like language. We are not able to detect bots that use AI, because we can't distinguish them from human accounts. These bots survive longer on social-media platforms and can create botnets, which are networks of bots that push the same messages. To detect botnets, we have developed methods to identify accounts that seem to be synchronized.

How effective are bots at spreading disinformation?
In 2016, people retweeted content originated by bots at almost the same rate at which they retweeted content originated by human accounts. Today, the number of users retweeting bots has greatly diminished. One explanation is that companies such as Twitter have got better at detecting bots and suspending them. Another explanation is that people have got better at spotting content originated by bots. But another possibility is that we can't identify the more sophisticated bots, so we can't detect when they are retweeted by human users.

What worries you most about bots today?
In 2016, I was worried that no one was paying attention to social-media manipulation. Today, the situation is different: there are millions of eyes on this. Governments and companies are involved in monitoring social-media platforms. My biggest concern now is, what are we doing with these platforms? Are we okay with them being incubators of misinformation? Do we want to have some regulations on them, and where should the regulations come from?

Earlier this year, your team analysed more than 240 million tweets related to the 2020 election. Tell us about your findings.
Human accounts usually outnumber bots. But around certain political events [such as the national conventions of the US Democratic and Republican parties], we observed that the amount of bot activity dwarfed human activity (E. Ferrara *et al. First Monday* https://doi.org/fgkf; 2020). We also found an enormous amount of bot activity associated with conspiracy theories such as QAnon and the one depicting COVID-19 as a liberal scam. About one in four accounts that use QAnon hashtags and retweet [far-right outlets] Infowars and One America News Network are bots. [QAnon is a baseless far-right conspiracy theory alleging that a group of paedophiles is running a global child sex-trafficking ring and plotting against Trump.]

Does your research show interference from countries such as Russia in this election?
Using data on accounts banned from Twitter, we found that interference operations from China and Russia are targeting both right-leaning and left-leaning users, whereas operations from other countries, such as Ghana and Nigeria, mostly interact with left-leaning users. Some researchers think that foreign actors tend to inject themselves into fringe communities. But, at least from our analysis, it turns out that they target mainstream conservatives or liberals.

Interview by Giorgia Guglielmi
This interview has been edited for length and clarity.