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The horse genome

Riding high

The DNA of the domesticated horse shows evolution at work

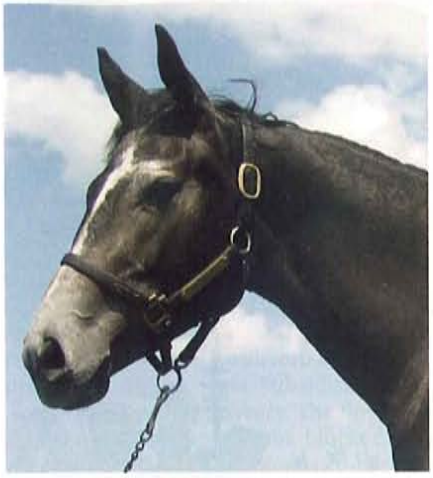
THE genomes of many mammals have now been completed, including the cow, the dog, the chimpanzee and, of course, the human. This week it was the turn of the horse to have its DNA sequence decoded. With it emerged further evidence of how horses have been close human companions and, like other mammals that share an evolutionary history with man, how they could help the understanding of hereditary diseases. But there was also a surprise: horses have a newly forming part in their genetic make-up which shows the evolutionary process in action in a way that has not been seen before.

A team of researchers led by Claire Wade, then at the Broad Institute, in Cambridge, Massachusetts, collaborated on the project, which is reported in the latest issue of *Science*. They analysed DNA from a mare called Twilight (pictured above) to reveal a genome that consists of up to 2.7 billion base pairs (the "letters" in which the genetic message is written). This is slightly larger than the genome of a dog, but smaller than that of a human or a cow. They also compared Twilight, a thoroughbred, with members of other horse breeds.

The surprise was found on equine chromosome 11, in the form of a developing centromere. This is the nexus of a chromosome, from which its arms dangle. Relatively little is known about centromeres. They are difficult to analyse, not least because they contain highly repetitive DNA sequences. But every chromosome has one, and they play an essential role in ensuring that when a cell divides, each daughter inherits a copy of every chromosome in the mother cell.

The appearance of a new centromere, therefore, lets geneticists examine the process by which new chromosomes come into existence. The new horse centromere seems common to all breeds, and has not yet acquired any repetitive DNA. This discovery solves one mystery: centromeres appear before repetitive DNA, rather than being caused by it. And it opens more lines of research.

The equine genome also indicates how extensive crossbreeding was in horse evolution. Domestication probably began 4,000-6,000 years ago, with wild horses initially being hunted for food, and then herded for the same purpose, before being harnessed to provide power and transport. This was unlike the domestication of dogs, where a small number of wolves probably



Just a song at Twilight

domesticated themselves, by cosying up to groups of people and acting as four-legged garbage-disposal units, before being selectively in-bred into the varieties seen today. In horses, a large number of mares but few stallions appear to have been involved in the development of the genome, and—with the exception of thoroughbreds—there was also a lot of genetic sharing between breeds.

That pattern is partly a consequence of the fact that herds of horses usually contain a lot of mares guarded by a single stallion. And then there was the effect of Genghis Khan and his descendants, whose armies travelled with their ponies across much of Eurasia. According to Dr Wade, who is now at the University of Sydney, "war and conquest, with the horse as a means of transport, meant the genetics were spread widely".

As well as developing new centromeres, chromosomes also reorder their genes during the course of evolution. The researchers found that 53% of horse genes appear on their chromosomes in the same order as they do in humans—in contradistinction to dogs, where the figure is 29%. Since, even with this relatively low level of synteny, as the relationship is called, dogs have proved useful in the study of some human diseases, the researchers hope that the high-synteny horse could be similarly illuminating.

They tested this by looking for the as-yet unknown genetic mutation involved in what is called the leopard complex. This afflicts spotted horses, particularly a breed called Appaloosas, with a form of night blindness similar to one that sometimes afflicts people. Horses with a single copy of the gene in question (inherited from either sire or dam) have white patches that contain polka dots. If they have two copies (one from each parent), they show no spots in their patches and are likely to suffer from night blindness. From millions of possibilities, the researchers were able to whittle the culprit down to being one of two candidates that reside in an area of the genome that is also responsible for coat markings. The dog may be man's best friend, but his horse may thus prove to be more genetically helpful. ■

Nanobiotechnology

Seeding the seeds

Carbon nanotubes find an unusual use as fertilisers

MANURE, compost and ash were used as fertilisers for centuries before the 1800s, but people did not understand how they worked until the science of chemistry was developed in the 19th century and it became clear that they supply plants with nitrogen, phosphorous and potassium. Today, something similar may be happening with a different sort of fertiliser altogether. For reasons that are not yet entirely clear, it looks as though exposing seeds to carbon nanotubes before they germinate makes the seedlings that subsequently sprout grow faster and larger.

A carbon nanotube is, as its name suggests, a tiny cylinder of carbon atoms. Such tubes have been proposed for all sorts of fancy uses, particularly in electronics, but they and other nanoparticles (so called because their dimensions are measured in nanometres, or billionths of a metre) have also been objects of concern. The fear is that if they became ubiquitous, they might damage living creatures, people included, by interfering with the way cells work.

In the case of plants, a few studies over the past decade have suggested that some nanoparticles can, indeed, breach the rigid walls that surround plant cells. Instead of viewing that as a threat, however, Mariya Khodakovskaya and Alex Biris of the University of Arkansas at Little Rock wondered if it might be an opportunity. They therefore considered the possibility of using nanoparticles to penetrate the tough coats that surround unsprouted seeds.

The reason for their interest was that these coats are something of a mixed blessing. They are there to protect the seed—and the germinating seedling—from desicca- ▸▸