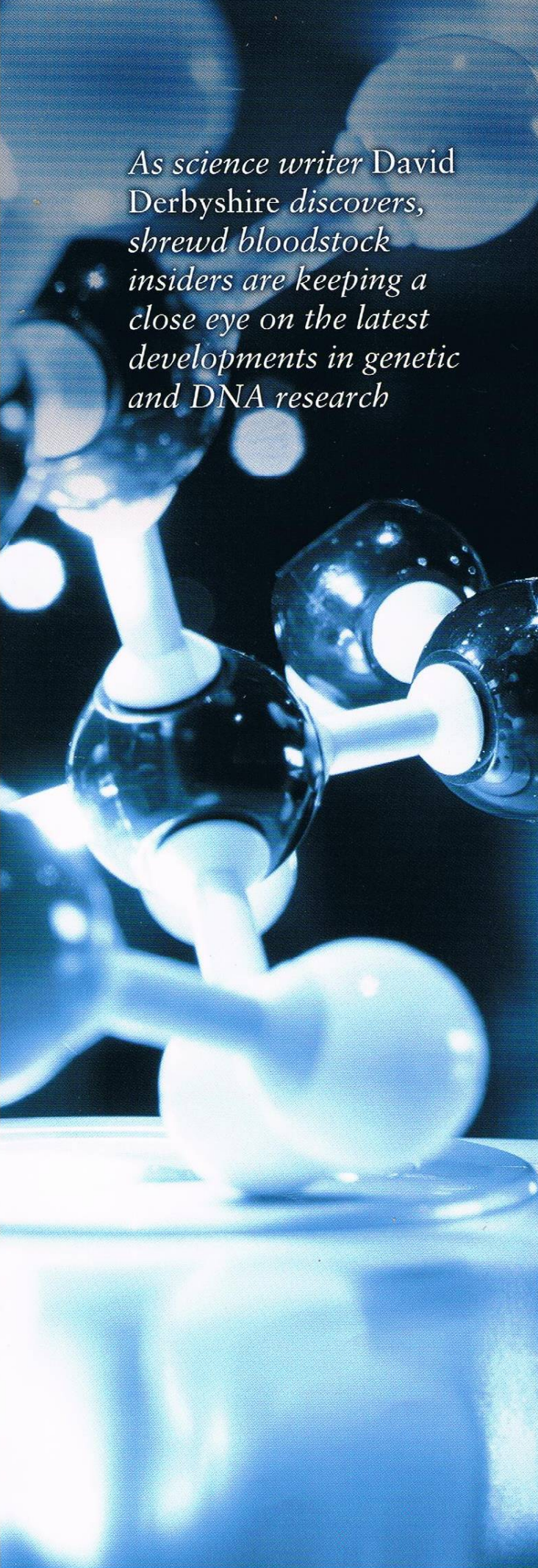


Good-looking genes





As science writer David Derbyshire discovers, shrewd bloodstock insiders are keeping a close eye on the latest developments in genetic and DNA research

After Galileo Gold stormed to victory in the 2,000 Guineas under Frankie Dettori earlier this year, the thoughts of trainer Hugo Palmer turned naturally to the Derby. Palmer knew the thoroughbred was something special and believed he had the potential to be the best three-year-old colt in Europe. But his immediate future was uncertain. Galileo Gold's muscular build and impressive speed indicated he was a miler like his sire Paco Boy. Yet there were clues in his pedigree that suggested the colt might do well at Epsom. He was out of a mare by Galileo and from the family of Montjeu - two sires with plenty of Derby winners between them.

For centuries, trainers like Palmer have relied on a mixture of gut instinct, innate horsemanship and experience when deciding which races suit which horses. But this year, Palmer tried something different. In May the Newmarket trainer made headlines - and raised a few eyebrows - when he announced Galileo Gold would not be running in the Derby after a DNA test indicated he would be unlikely to stay the course. Palmer may not have been the first British trainer to use genetic tests when assessing a horse's suitability for a specific race, but he was the first to come out in the open. "It's the only time that I've done it", says Palmer, who says the test was just a small part of the decision to keep Galileo Gold out of the Derby. "At that time it looked like it was going to be a very open Derby where no one could clearly see the winner. We were discussing the horse after the Guineas and I was saying I didn't think he could stay a mile and a half, I didn't think it suited the horse." Dublin-based equine science firm, Plusvital, which includes the equine genetics subsidiary Equinome, carried out the test. The results concluded there was a 99 per cent probability Galileo Gold would not stay the one-and-a-half miles needed for the Derby. "It came back confirming everything that we knew about the horse so we knocked it on the head there and then", he adds.

The decision generated controversy in the racing press. Some argued that DNA testing was taking the uncertainty, and fun, out of racing. Others argued it undermined traditional skills of horsemanship. But Palmer insists DNA tests have a useful role. "I view it as an interesting tool in your armoury if you want it", he says. "Having done a genetic test, its implications have opened my eyes into thinking about what the optimum distances of a horse could be - and how that can contradict the normal assumptions that might be made based on pedigree."

Using DNA to assess horses for performance and breeding is still in its infancy. It was only in 2009 that scientists published the first complete horse genome - the entire genetic blueprint of a horse. The breakthrough has led to a host of discoveries about genetic links to health, stamina, speed, strength and breeding potential.

One of the biggest names in this new branch of the racing industry is Equinome, a company spun off from research by Dr Emmeline Hill at University College Dublin and which merged last year with Plusvital. In 2010, Dr Hill discovered that a single gene played a vital role in determining the optimum racing distance for horses. It was an extraordinary finding because traits linked to single genes are rare. In humans, scientists know of only a handful. The ability of people to roll up their tongues is one - as is the stickiness of earwax, having a big toe shorter than the second toe and having a widow's peak.

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- Hugo Palmer

Usually, complicated characteristics such as athleticism, height, muscle strength or intelligence - are the result of complex interactions between dozens, if not hundreds of genes, and environmental factors such as diet and upbringing.

Despite initial scepticism, Dr Hill's findings about the so-called speed gene have been repeated and validated in independent published scientific studies. Her test works like this: Almost every cell in a horse's body contains a complete set of DNA, arranged in 32 pairs of chromosomes. Each of these chromosomes contains hundreds of thousands of genes, written in the four chemical 'letters' of DNA - named A, C, T and G. Any slight variation in the spelling of a particular gene can lead to a big difference in a horse's appearance, health or performance. Dr Hill's test looks at variations in the myostatin gene (MSTN) that carries instructions on how to build a protein that regulates muscle development and muscle fibre type. Tiny changes in the make up of this gene can determine whether a horse will be built like sprinter Usain Bolt or long distance runner such as Paula Radcliffe. At one crucial point, the MSTN gene contains either the letter C or the letter T. Every horse inherits two copies of the MSTN gene, one from each of its parents. That means a horse can carry three possible variations - CC, CT or TT.

Dr Hill found that horses with the CC combination have more rapid muscle development when they first start training and are more suited to sprints - with 98 per cent having an optimum race distance of a mile or less. These typically have seven per cent more 'fast twitch muscle fibres' than the other types of horses. This type of muscle tissue is used for bursts of movement. Animals with the TT combination tend to have relatively more 'slow-twitch' muscle - useful for endurance. They are leaner and more suited to distances over a mile-and-a-half. And those with the CT variants are usually the most versatile, doing well in middle distance races. Galileo Gold was discovered to be CC - making him best suited for races of a mile or less.

Donal Ryan, chief operating officer of Plusvital/Equinome, says: "It's not the first time that someone has made that decision based on a horse being a CC, but it is the first time someone has been public about it. "Initially, when the test first came out, there may have been some concerns that it would take away from the traditional skills of horsemanship, or it will be the silver bullet that means we can pick out the Group One winners straight away. "We never claimed that. It is a tool to complement existing horsemanship skills and existing ways of managing and breeding horses. Hugo had a feeling this horse wasn't going to suit a mile-and-a-half and this test gave him greater confidence." Ryan says the test deals with probabilities not certainties. Around 95 per cent of horses that are CC do best on shorter races - but that still leaves one in 20 that may be better on slightly longer distances based on the pace or conditions of the race.

Since launching the speed gene test, Plusvital now offers seven more tests, based not on single genes but clusters of genes. The company's scientists have analysed the performance and physical traits of thousands of horses and then used computer software to sift through the genes, looking for common patterns. One test, Distance Plus, looks at 48,000 genetic markers to refine the speed test. It can show whether a CC horse, for instance, is likely to do better at six-furlong sprints or miles. Other tests can give insights into whether a foal is likely to ever make it to the racecourse, a foal's potential for elite breeding and racing success, and for American owners whether a foal will be more suited to dirt or turf racing.

The company says more than 13,000 horses from 19 countries have been tested - including around 1,000 Group/Listed winners. It's probably too soon to see the impact of the equine genetic revolution in race results. However, there is already evidence that horses are continuing to get faster, despite fears a few years ago that speeds had plateaued since the 1950s. A study at Exeter University in June looked at 600,000 races run by 70,388 horses on the Flat throughout British racing history. Lead author Dr Patrick Sharman found little improvement between 1910 and 1975. However, since then there has been a steady improvement in sprint races with the average winning time for a six-furlong race over the last 15 years being cut by one second.

And, while changes in training and riding techniques are partly the cause, Sharman feels there may also be genetic change. "My hunch is that we are seeing a genetic change, with breeders focusing on speed rather than endurance", Dr Sharman told the BBC at the time. That change has mostly been brought in through traditional breeding decisions based on pedigree. But the demand for speed and sprinting ability suggest the demand for DNA tests will only grow. The tests aren't cheap however. The single speed gene test costs around £500, while a premium pack of all eight tests costs £1,215.

Aware that the price may be prohibitive to some owners, other companies are looking at alternative routes. Geneticist Dr Steve Harrison, of Canterbury-based Thoroughbred Genetics, launched the first test for racehorse performance in 2000. Over the last decade his team has analysed DNA from thousands of animals to find genetic markers linked to stamina, strength, respiration and energy use. His tests analyse 750 genetic markers to produce graphs showing whether a horse is suited to sprints, stamina or something in between. By comparing the graphs of stallions and mares, owners can also improve their odds of breeding a winner.

Thoroughbred Genetic's tests also reveal the level of inbreeding. A degree of inbreeding is inevitable because virtually all the world's 500,000 or so thoroughbreds trace their ancestry to just

28 healthy, fit horses born in the 18th and 19th centuries, while around 95 per cent are descended from just one stallion - the Darley Arabian born in 1700. Dr Harrison's research has found that slightly more inbred horses tend to be better sprinters, while outbred mongrels are more likely to do well at longer courses. He says his tests are 75 per cent better than non-genetic methods of picking a winner.

Harrison is most proud of his success with Sacred Choice, bred by Ken Williams' Tarcoola Stud in Victoria. She collected nine wins from 37 starts including two of Australia's major mile events - the Myer Classic at Flemington and the Doncaster Handicap at Randwick. "Her mother Sacred Habit wasn't much good", says Dr Harrison. "The genetic profile we did suggested the mother had potential, but was too inbred." Following Dr Harrison's advice, Williams bred her to Choisir to increase the 'mongrelism' in the offspring. "It did the trick", says Dr Harrison.

With DNA testing becoming more common, and more competitive, his company is looking to offer cheaper alternatives. Dr Harrison's team is creating a computer database of tens of thousands of horses along with their DNA and performance profiles. Once the database is complete, the company will be able to offer virtual DNA tests to indicate the most suitable breeding and racing options. "The computer will work out what age it is likely to come into prominence and give it a profile with probability limits. In this way you can cyber test inaccessible animals", he says. The accuracy of the test will vary from animal to animal and will depend which ancestors have been genetically screened. But Dr Harrison says the model, which he hopes to be up and running this year, still gives better results than purely looking at pedigrees. "Attitudes are changing as time progresses. You get younger people with fresher outlooks. They've been brought up on new technology and they are more willing to embrace it", says Dr Harrison. "The contribution of genetics varies from 35 to 55 per cent. In some ways it is everything and in other ways it's nothing. If you have a horse with the wrong genetic make up it won't progress no matter what you do. It is similar to Formula 1 racing - it is partly due to the design of the car, but the rest is the management and the driver and the circumstances."

Donal Ryan agrees that the role of genetic factors in horse performance mustn't be overstated. "Sixty per cent is out of our control - it's the training, nutrition and management", he says. "Genetics is the single biggest factor, but 60 per cent of a horse's performance is not to do with their genes but the training, nutrition and management. "That's great because it means there is sport in it. Our tests let you understand more about the horses so that you can manage and train them and place them in the races that gives them the best opportunities to perform to the maximum."



Galileo Gold