Selective breeding

Why aren't horses faster?

William G. Hill

We are used to new records being set in men and women's track events. In the Olympic games, for example, the time taken for men to run 1,500 metres declined by 15 seconds (or 7 per cent) from 1936 to 1984. These improvements cannot be attributed to genetic change, but to better training, health, tracks and wider screening of the population. Yet despite the efforts of breeders, the winning times of thoroughbreds in the English classic horse races have not fallen substantially over the past 50 years. The lack of improvement is disturbing because the horse-breeding industry is a large and competitive business, with much attention being paid to performance and to pedigree. If limits to performance are real, they may be relevant to other species with a shorter history of intense selection. Elsewhere in this issue, however, B. Gaffney and E.P. Cunningham (*Nature* **332**, 722–724; 1988) estimate heritabilities and rates of genetic change for a measure of racing performance, and conclude that genetic variance is still present in the thoroughbred population.

Because race times are available only for winners and in a limited number of races, Gaffney and Cunningham analyse TIMEFORM ratings of three-year old horses. A TIMEFORM rating is supposedly based only on the horse's own performance, and is expressed as the weight in pounds which a horse should carry in a free handicap race. Using several methods, Gaffney and Cunningham obtain heritability (h^2) estimates of TIMEFORM ranging from 0.39 to 0.76, the highest based on son-on-sire regression. (Heritability is essentially the proportion of the variation in a trait which is genetic.) In most cases this method is least biased by common environment, but the likely explanation is that sons of the best stallions get the best trainers. Generation intervals are long, but selection differentials on TIMEFORM ratings are high, equivalent to selecting the best 6 per cent of males and 52 per cent of females; so assuming a conservative value of 0.36 for h^2, they predict a genetic improvement in TIMEFORM of 0.92 units per year.

The standard method now used to assess breeding values of animals and thereby estimate genetic change in populations with overlapping generations is called BLUP — best linear unbiased prediction (Henderson, C.R. *Biometrics* **31**, 423–447; 1975). As long as parameters such as heritability are known and all information on which selection decisions were based is included, unbiased estimates of genetic change can be obtained. In essence, the performance of contemporary animals that have parents of different ages are compared and correction is made for selection applied. Gaffney and Cunningham use the most simple BLUP model in which only sire families are identified, yet estimate a change of 0.94 TIMEFORM units per year, almost identical to prediction.

Thus, Gaffney and Cunningham conclude there has been a genetic change over a 25-year period equivalent to more than 20 pounds of handicap. My university library is weak on horse racing, and handicapping is obviously a complicated process. But I believe that for a 2-mile (3.2-km) race, it is 1 pound (0.45 kg) per length. For the 1.5-mile Derby, a change of 0.94 TIMEFORM units per year is equivalent to at least 0.7 lengths per year, or 17 lengths over 25 years. (I guess the length of a running horse to be about 2.5 metres, so this is equivalent to an increase in speed of about 0.1 per cent per year, clearly more than has been achieved.) So why aren't horses running any faster? These results contrast with the high rates of genetic improvement being achieved in farm livestock, which are of the order of 1 per cent per year (Smith, C. *R&D Agric.* **1**, 79–85; 1984).

Assuming the genetic change they measure is real, Gaffney and Cunningham suggest it is not inconsistent with classic winning times which refer to the extremes, not the population as a whole — but this would involve a change in the distribution of speed. It seems to be unlikely that the environment is worsening, for even if training methods are no better, health and nutrition have surely improved over the past 50 years and the turf of the tracks is long-established. Alternatively, Gaffney and Cunningham's estimate of genetic change is too high: even their lowest h^2 values may be biased upwards by common environment through special treatment, and the BLUP estimates depend on h^2. Gaffney and Cunningham use $h^2 = 0.36$ and 0.48 and find little difference, but because they assume effective selection the BLUP estimates may be substantially biased upwards if the true value of h^2 is near zero.

I think resolution of this issue is of importance not just to horse breeders, punters and bookmakers (my namesake is not a known relative). If there is real genetic change, then training methods need investigating. If there is not we need to look again at estimates of heritability and genetic progress, for Gaffney and Cunningham acknowledge that theirs is not the most complete BLUP model. More particularly, we need to explain the apparent selection limit. If all useful variation has been lost and none generated, then why? Perhaps the effective breeding population is too small? Why do breeders not cross outside the thoroughbred population? Why has the population not been divided into stayers and sprinters? What is the point of selection at all?

Breeders of species other than horses have something to learn whatever the real state of affairs. Perhaps thoroughbred horse breeders could also learn from professional geneticists, which so far they have been reluctant to do. □

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Slow progress — today's racehorses are not appreciably faster than their forebears. The engraving "In and Out" is taken from a painting by Henry Alken, Jr.