SELECTIVE BREEDING FOR RACING PERFORMANCE IN HORSES

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SUMMARY
Improvements in Thoroughbred racing performance have been found in classic races conducted in Australia (The Golden Slipper, 1200 metres) and in the United States (the Kentucky Derby, 2011 metres). A significant (P<0.001) reduction in winning time of 0.068 seconds per year was estimated from the forty Golden Slipper races conducted since 1957. In the period 1896-1956 there was a significant (P<0.001) reduction of 0.13 seconds per year for the Kentucky Derby but no significant change was identified for the period between 1957 and 1996. The significant effects noted that influenced racing performance were year of event and condition of track with the slowest times being recorded on 'muddy or heavy' tracks. Important sire lines that have contributed to these classic races include Star Kingdom (IRE) and Danehill (USA) in the Golden Slipper and Bold Ruler and Raise A Native in the Kentucky Derby.

Keywords: Horse racing, Golden Slipper, Kentucky Derby.

INTRODUCTION
Improvement in racing performance has been established in Quarter horse races of 402 metres in the United States (Willham and Wilson, 1991), where the phenotypic trend was a decrease in racing time of 0.02 seconds per year for the period 1960-1983. Cunningham (1991) has also indicated improvement is occurring in short distance Thoroughbred events in the United States but to be improving little or not at all in the longer classic races in England, the Derby and Oaks (2414 metres) and the St.Leger (2816 metres). This lack of progress warrants further enquiry since Gaffney and Cunningham (1988) reported heritability estimates of 0.35 for track performance. Furthermore, Hill (1988) estimated that the rate of improvement in speed in the winners of the English Classic races was only one tenth the rate of genetic progress noted by Smith (1984) in economic traits in other domesticated livestock. Studies of racing performance in Australia are limited to winners of the 2040 metre Cox Plate (Gallagher et al 1992) in which no significant decrease in winning time was noted for the forty five year period that the race has been completed. However, in that study of winning times only the year of the race was considered. It was the aim of this study to establish if there has been an improvement in winning time in the Golden Slipper, the major short distance Australian classic of 1200 metres for two year old Thoroughbreds and to define the level of improvement in the United States classic for three year olds, the Kentucky Derby (2011 metres).
MATERIALS AND METHODS
A study was conducted on the data of the Golden Slipper (Anon. 1996) and the Kentucky Derby (Chew, 1974) and more recent records of the Kentucky Derby (Anon. 1975-1996). Multiple regression analysis (SAS 1987) was used to establish rate of change of winning time in the Golden Slipper race for the forty races since the inception of the event in 1957. A similar analysis was used for Kentucky Derby records for the period during which this race has been run over 2011 metres (1896-1996). Prior to 1896 the Kentucky Derby was raced over 2414 metres.

The dependent variable $T$ = time recorded in seconds for each winning horse ($Tgs$, Golden Slipper and $Tkd$, Kentucky Derby), while the independent variables included were

- **Year:**
  - 1957-1996 in the Golden Slipper
  - 1896-1996 in the Kentucky Derby

- **Race condition:** scored as follows:
  - good=1, clear=2, fast=3, slow=4, muddy=5, sloppy=6, heavy=7 (Kentucky Derby)
  - fast=1, good=2, dead=3, slow=4, heavy=5 (Golden Slipper)

- **Handicap weight:**
  - 55.5kg, 2 year old colts and geldings, fillies 52.5kg (Golden Slipper)
  - 50-53kg (1896-1919) and 57 kg (1920-1996) in the Kentucky Derby

- **Number of horses in race:**
  - Golden Slipper (5-19), Kentucky Derby (3-22)

- **Barrier position in race**
  - Available only for the Golden Slipper.

RESULTS AND DISCUSSION
Mean and standard deviations for winning racing times in the Golden Slipper and Kentucky Derby are shown in table 1

<table>
<thead>
<tr>
<th>Race</th>
<th>Period</th>
<th>Mean time (secs)</th>
<th>S.D.(secs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Slipper</td>
<td>1957-1996</td>
<td>71.6</td>
<td>1.50</td>
</tr>
<tr>
<td>Kentucky Derby</td>
<td>1896-1956</td>
<td>126.2</td>
<td>3.14</td>
</tr>
<tr>
<td>Kentucky Derby</td>
<td>1957-1996</td>
<td>122.2</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Highly significant regression equations for several variables were found for the Golden Slipper and Kentucky Derby (before 1957) as shown in table 2. It can be observed that there was a significant reduction in winning times in both the Golden Slipper (0.068 seconds/year) and the Kentucky Derby before 1957 (0.13 seconds per year) while after 1957 there has been no significant change in the Derby. The reason(s) were not resolved in this study for an apparent change in the trend of racing times for the Kentucky Derby, commencing within the 1950’s and no significant reduction in times since that period.
It was also noted that the important independent variables in both races were year and track condition with extremely slow times recorded on heavy tracks for the Golden Slipper in 1963, (Pago Pago) and 1990 (Canny Lad). The slowest time (135.2 seconds) in the Kentucky Derby (post 1896) was recorded by Stone Street in 1908 on a heavy track. The slowest race run in recent time was 125 seconds recorded by Sunday Silence on a muddy track in 1989. Records for the races were established by Secretariat (119.4 seconds) for the Kentucky Derby in 1973 and by Bint Marscay (68.88 seconds) for the Golden Slipper in 1993.

Regression coefficients for handicap weight, number of starters per race were not significant for the Golden Slipper or Kentucky Derby. It should be noted that since 1920 a standard handicap of 57kg has been carried by all starters in the Kentucky Derby and handicaps applied in the Golden Slipper are identical within sex status. Barrier position recorded for the Golden Slipper was not significant.

Table 2. Regression relationships between winning time in seconds in Golden Slipper (Tgs) or Kentucky Derby (Tk), dependent variable and independent variables year (Y), track conditions (T), handicap weight (W), number of starters (S) and barrier position (P)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Constant</th>
<th>Independent variables</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tgs (1957-1996)</td>
<td>203***</td>
<td>-0.068Y*** +1.09T*** + 0.001W +0.08S - 0.036P</td>
<td>0.83***</td>
</tr>
<tr>
<td>Tk (1896-1956)</td>
<td>361***</td>
<td>-0.13Y*** +0.88T*** + 0.17W +0.03S</td>
<td>0.67***</td>
</tr>
<tr>
<td>Tk (1957-1996)</td>
<td>141</td>
<td>-0.01Y +0.37T +0.11S</td>
<td>0.13</td>
</tr>
</tbody>
</table>

***P<0.001

Improvement in Thoroughbred racing time over 1200 metres in the Golden Slipper and over 2011 metres in the Kentucky Derby (before 1957) have been achieved and appear to be greater than the improvement (0.02 seconds per year) reported for Quarter horses racing over 402 metres (William and Wilson, 1991. The apparent lack of reduction in race times for the Kentucky Derby since 1956 is consistent with the longer classic races studied by Gaffney and Cunningham (1988).

How is the apparent lack of progress toward reduced race times for long races reconciled? Langlois (1980) drew attention to estimates of the heritability of track performance based on timing ($h^2<0.20$) and handicap weight ($h^2=0.4$). Langlois also noted that the magnitude of correlations reported by Bormann (1966) between corrected mean times and handicap weight were -0.25 in two year olds and -0.50 in three year olds. Corrections applied were distance, ground condition, weight and age. Thus Langlois suggested that speed and handicap are not measuring the same ability.

In addition there have been many reports that have highlighted additional factors that need to be taken into account when explaining variation in racing performance. These include herd x dam effects (Tavernier, 1988), racing surfaces i.e. dirt or turf (Oki et al. 1994), jockey effects (Oki et al.
1995) and pre-race horse behaviour (Hutson and Haskell, 1996). In the Golden Slipper one trainer has been successful in training the last four winners of that event confirming the importance of trainer effects noted by Schulze-Schleppinghoff et al. (1987).

The current study also emphasises the success of particular stallions in siring winners of the Golden Slipper e.g. Star Kingdom (IRE), the sire of the first five winners of the event and Danehill (USA), the sire of the last three winners of this event. Chew (1974) has also indicated the importance of the Bold Ruler sire line which dominated winning performances in the Kentucky Derby in the 1970's. This continued with Swale the 1984 winner and progeny of 1977 winner Seattle Slew. In the last decade an important sire influence has been Raise a Native with wins by Alysheba 1987, Unbridled 1990, Strike the Gold 1991, Thunder Gulch 1995 and Grindstone in 1996.

In the previous studies, with horses racing short distances of 402 metres (Willham and Wilson 1991) and in the current study of horses racing over 1200 metres and 2011 metres (prior to 1957), improvement in racing times have been demonstrated. However, Beatson (1989) has calculated the difference in speed of the first and last horse in trials and concluded that there is insufficient between animal variation to effect a significant reduction in running times in the English classic races (2400-2800 metres). In the study of the Cox Plate (2040 metres) by Gallagher et al (1992) no significant reduction in winning time was noted though the only independent variable fitted was 'year'.

One might also ask are we setting the horse an impossible task by seeking improvement in time in horses racing over long distances? In short distance racing there is aerobic metabolism of muscle glycogen to carbon dioxide and water. Hillidge (1988) reported that with long distance racing, anaerobic muscle metabolism yields hydrogen ions and lactate and if organic and inorganic phosphate muscle buffers are inadequate, an accumulation of hydrogen ions causes pH to fall to 6.3 which in turn is thought to contribute to muscle fatigue. Thus whereas a physiological reason may account for lack of improvement in speed over long distances (Cunningham, 1991), estimations of the heritability of racing performance depend on how racing performance is defined and measured and the extent to which variables including track conditions and jockey and trainer effects are taken into account. Inclusion of these variables will assist studies of rate of genetic progress in equine racing performance compared to the rate of genetic progress in economic traits in other domesticated livestock.

REFERENCES